

ADVANCES IN SOCIAL NETWORK ANALYSIS

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Network Analysis and Computer-Mediated Communication Systems

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Computer-Mediated Communication Systems: Constraints and Interaction

Networks, as a theoretical perspective, analytical construct, methodological approach, and pragmatic concern, have been important to a wide variety of communication research concerns, including small groups (Shaw, 1978), R&D collaboration (Allen, 1977), organizational communication (Tushman, 1977), organizational structure and relations (Aldrich & Whetten, 1981; Tichy, 1981), and numerous other topics such as diffusion of innovations and national development (Rogers & Kincaid, 1981). The breadth and depth of network-oriented research in the communication sciences is too vast to even outline in a single chapter. Rather, this chapter limits its focus to one specific, but new and growing area of interest: the adoption, uses, and implications of computer-mediated communication (CMC) systems.

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CMC systems bring together capabilities of both computers and telecommunication networks to facilitate the creating, structuring, processing, storing, retrieving, and exchanging of (perhaps multimedia) content among multiple users. CMC systems include electronic mail, computer conferencing, computer bulletin boards, facsimile, teletex and videotex, voice messaging, group decision support systems, and related media such as desktop videoconferencing and other "groupware" (see, among others, Galegher, Kraut, & Egido, 1990; Hiltz & Turoff, 1978; Johansen, Vallee, & Spangler, 1979; Kerr & Hiltz, 1982; Kiesler, 1986; Licklider & Veza, 1978; Rice, 1980, 1987b; Rice & Associates, 1984; Vallee, 1984).

Designers, implementors, managers, and users of CMC systems may program the computer to structure communication processes (such as polling on-line groups or prioritizing and summarizing incoming content to reduce overload). CMC systems can reduce or alter some of the temporal, physical, and social constraints on communication. For example, at the place and time preferred, a user can send messages or documents and apply the computer's processing capabilities to create, store, format, and distribute; and a receiver may scan, read, print, forward, copy, edit, or delete the content. Other potential changes associated with CMC systems are consequences of the capabilities of telecommunication networks to connect diverse, often unacquainted users in different locations. For example, users can expand their networks by seeking out and sending messages to other individuals whom they may not know personally (such as through distribution lists or bulletin boards).

Because of the combination of computers and transmission networks, CMC systems have attributes that reduce some constraints, and impose others, on human and organizational communication (see Rice, 1987b). Potential changes in communication may reinforce traditional network patterns but may also foster new kinds of interaction, data, and processes, perhaps institutionalizing new organizational structures or changing the nature of interpersonal relations (Huber, 1984, 1990). Thus, because CMC systems are physical networks, they can be used to structure communication flow and content and they facilitate communication among networks of users, and because network analysis can raise our awareness of the multidirectionality of influence, network analysis is a theoretically and practically appropriate method for the study of the adoption, uses, and implications of CMC systems.

A Network Approach

This review emphasizes how network analysis approaches, data, and methods have been used to help answer ongoing research questions about CMC systems. The following review focuses on only a few central distinctions in CMC research that uses network analysis methods: (a) structural phase, (b) time period, (c) unit of analysis, (d) conceptualization of structure, and (e) aspects of computer-monitored data. Table 7.1 describes the empirical studies reviewed here according to these five distinctions.

Structurational Phase

Primary among the distinctions that may be useful is the theoretical orientation toward the role of CMC systems. The simplest theoretical concern is often called the "technological imperative"—that is, does the CMC system "cause" certain outcomes? However, continual meta-theoretical as well as practical concerns about how social and organizational change comes about have led not only to investigations of many different components of "technology" and "outcomes" but also to new questions about the primacy of technology as a causative agent, questions about the assumptions underlying studies of computing in general, and questions about whether causality can even be a defensible focus of research on human behavior (Burrell & Morgan, 1979; Kling, 1980). Thus any review of research on CMC systems in general, but in particular those that take a network perspective, must apply some simultaneously simplifying but also clarifying framework to identify these different underlying theoretical orientations (Rice, 1992).

Contractor and Eisenberg (1990) have attempted to integrate Giddens's (1984) structurational theory and Burt's structural theory of action (1982) to develop a useful initial framework for applying a network perspective to the study of CMC systems. Social and organizational networks not only constrain and influence how individuals adopt and use technologies such as CMC systems to accomplish goals, but the very appropriation of such systems, with their own objective and perceived constraints and capabilities, in turn constrains, influences, and perhaps changes individuals' goals, actions, and social relations. Orlikowski (1992) has more generally developed this approach to help understand the diversity of uses and consequences associated with organizational

Table 7.1 Categorization of Empirical Studies of Networks and CMC Systems

Authors	Phase	Data	Time	Unit	Structure
Anderson & Jay (1985)	A/U	M	C	N	P
Anderson, Jay, Anderson, & Schweer (1987)	A/U	M	C	N	P
Anderson, Jay, & Hackman (1983)	A/U	M	L	N	P
Aydin & Rice (1991)	U	—	C	N	R/P
Bernard, Killworth, & Sailer (1982)	U	I	L	E	R
Bikson & Eveland (1990)	U/I	M	L	N	R
Bizot, Smith, & Hill (1991)	U/I	M	L	N	R
Black, Levin, Mehan, & Quinn (1983)	U	M	L	N	R
Burkhardt (1991)	I	—	L	N	R
Burkhardt & Brass (1990)	A/U/I	—	L	E/N	R/P
Corman (1990)	U	I	L	E	R
Danowski (1982)	U/I	I	L	N	R
Danowski (1988)	U	M	L	N	R
Danowski & Edison-Swift (1985)	U/I	M	L	N	R
Davis, Bagozzi, & Warshaw (1989)	U	—	C	E	R
Dykman (1986)	U	—	C	E	R
Eveland & Bikson (1987)	U/I	M	L	N	R
Eveland & Bikson (1988)	U/I	M	L	N	R
Feldman (1987)	U/I	M	C	E	R
Finholt, Sproull, & Kiesler (1990)	U/I	M	L	N	R
Finn (1987)	U/I	I	L	N	R
Foster & Flynn (1984)	U/I	—	L	E	R
Freeman (1980)	U/I	—	L	E	R
Freeman (1984)	U/I	—	L	N	R
Fulk (1993)	A/U	—	L	E	R
Gurbaxani (1990)	A	M	L	N	R
Gutek (1982)	U/I	M	L	E	R
Harasim (1987)	U/I	M	L	E	R
Hart & Rice (1988)	I	—	L	N	R/P
Hartman et al. (1991)	U/I	M	L	E	R
Hayne, Rice, & Licker (1994)	I	I	L	E/N	R
Hepworth (1989)	U/I	M	L	N	R
Higgins, McClean, & Conrath (1985)	U	—	C	E	—
Hiltz (1982)	U	I	L	E	R
Hiltz (1984)	A/U/I	M	L	E	R

informational systems. She argues that communication technologies present both opportunities for and limits to human choice, organizational design, and technology development and use. Thus we can identify three phases in which social networks and CMC systems may

Table 7.1 continued

Authors	Phase	Data	Time	Unit	Structure
Hiltz (1986)	U/I	M	L	E	R
Hiltz & Turoff (1978)	U/I	M	L	E	R
Holmes (1986)	U/I	M	L	N	R
Johansen, Vallee, & Spangler (1979)	U	M	L	N	R
Kerr & Hiltz (1982)	A	M	L	E	R
Kiesler, Siegel, & McGuire (1984)	U	I	L	E	R
Kiesler & Sproull (1986)	U	I	C	—	—
Killworth & Bernard (1976)	U	M	C	N	R
Leduc (1979)	U/I	—	L	E	R
MacGregor, Lee, & Safayeni (1991)	U/I	—	C	N	R
Markus (1990a)	U	M	L	E	R
McKenney, Doherty, & Sviokla (1986)	U/I	M	L	N	P
Newell & Clark (1990)	A	—	C	E	R
O'Keefe, Kernaghan, & Rubenstein (1975)	A/U	—	L	E	R
Papa (1990)	U/I	—	L	N	R
Pava (1983)	U/I	—	L	N	R
Quinn, Mehan, Levin, & Black (1983)	U/I	M	L	N	R
Rice (1982)	U/I	M	L	N	R/P
Rice (in press)	U/I	M	L	E/N	R/P
Rice & Aydin (1991)	I	—	C	N	R/P
Rice & Barnett (1985)	U/I	M	L	N	R/P
Rice & Danowski (1993)	U	M	C	N	R
Rice, Grant, Schmitz, & Torobin (1990)	A/I	—	L	N	R
Rice & Love (1987)	U	M	L	N	R
Rice & Shook (1990)	U	M	C	N	R
Robey, Vavarek, & Saunders (1990)	U/I	M	L	N	P
Safayeni, MacGregor, & Lee (1987)	I	—	C	E	R
Schaefermeyer & Sewell (1988)	U	I	C	E	R
Schmitz & Fulk (1991)	U	—	C	E	R
Sherblom (1988)	U	M	C	E	R
Walker (1985)	U/I	—	C	N	P

NOTE: Phase: A = adoption, U = use, I = institutionalization; data: M = monitored data, I = initiated data; time: C = cross-sectional, L = longitudinal; unit: E = ego network, N = full network; structure: R = relational, P = positional. Some publications include several studies; the listings reflect the most complex of the categories of any of the studies in that publication.

influence each other: (a) adoption, (b) use, and (c) institutionalization (or, as Rice, 1987b proposed, input, conversion, and output). Within each phase, designers, researchers, theorists, implementors, and users may be interested in different variables and relationships as

well as different conceptions of the role of CMC systems, as, for example, outcomes of social processes, ongoing social processes, or influences on other social processes. Within the first phase, studies may be concerned with how variables such as potential adopters' network position, the social system's critical mass, or social information processing influence the adoption and use of CMC networks. Within the second phase, studies may be interested in how usage reflects communication constraints, the distribution, form, and content relations of usage, and the extent to which CMC networks complement ongoing (organizational) networks. Within the third phase, studies may focus on whether, and how, CMC networks influence outcomes, such as intra- or interorganizational networks, including scientific communication networks.

The fundamental point of this framework is that CMC systems are not independent, objective, a-social "technologies" that cause outcomes, but are products of, become embedded in, and reinstitutionalize ongoing social processes. Because few studies make explicit which of these assumptions underlie their analyses, it seems useful to organize such studies according to these three general structural phases.

Time Period

Because the rationale for most CMC studies is to understand the adoption, implementation, or impacts of such systems in specific (typically organizational) contexts, longitudinal research designs would seem to be required. However, the bulk of CMC studies still use cross-sectional data, whether collected at one time period, or aggregated into one time period, due to constrained data collection, incomplete organizational access, inadequate conceptualization, or insufficient methodological training.

Unit of Analysis

The majority of network-oriented CMC studies collect and analyze data at the level of individual respondents (or "ego networks"). This perspective may be as simple as using estimates or actual counts of how many others or what categories of others one communicates with as individual-level variables. The crucial distinction here is that neither the raw data nor the summary indices are based on a link-list or matrix of interactions; the analysis is still focused solely on the individual's

personal network and cannot represent systemwide influences or structures. Alternatively, a study may take the perspective of the full network (such as all the members of a group or organizational unit or all the users of a CMC system). Typically such studies use responses to a questionnaire roster or computer-monitored who-to-whom message data. The analysis may proceed at the group level as well as use individual-level network indices.

Conceptualization of Structure

In the *relational* or *cohesion* view, the basis of structure is the extent to which actors interact directly and indirectly as they process resources and information (Rogers & Kincaid, 1981). The relational network model thus conceptualizes a "clique" as those who interact more with each other than with others, forming highly cohesive or dense subsets. In the *positional* view, individuals occupy the same "position," or are equivalent, to the extent that they interact with the same, or similar, others, thus having similar roles or sets of obligations, status, and expectations (Burt, 1980; Lorrain & White, 1971). These positions are defined by the pattern of relationships, both present and absent, relative to all others in the social system (perhaps across multiple network relations). These two conceptualizations are quite general, and a wide variety of measures, levels of analysis, and network algorithms are associated with each (Rice & Richards, 1985), and these may be used in conjunction with other standard descriptive, bivariate, and multivariate analytical techniques. While there are many terms and varieties of relational and positional groupings, the following discussions will refer to relational groupings as "cliques" and positional groupings as "positions," unless more specific terms are appropriate. The term *group*, or *grouping*, will be used as the general term indicating some set of actors, whether a clique or a position. The majority of CMC network studies to date apply the relational perspective, largely because of the inherent preference communication researchers have for operationalizing interaction as direct relationships and groups as cliques of dense interactions. However, more fundamentally, it is difficult to argue that conceptualizations of groupings of CMC users that include nonlinkage to others are of primary concern to the study of CMC contexts. Indeed, as Rice (1987a) argues, electronic networks may be substantially different than material-based networks precisely because of the ephemerality of the social space. One of the particularly intriguing aspects of CMC systems

is the ability to reduce precisely such status and gender cues (Rice, 1984), usually communicated by nonverbal cues (appearance, gender, race, age, office furnishings, and so on) that reinforce or establish roles, social differentiation, and thus network structure in the first place. Thus some of the underlying concerns to positional advocates—differences of social status and rank, and a closed social system with limited material resources—seem, so far, less relevant to an understanding of the flow of messages through a CMC system.

Aspects of Computer-Monitored Communication Data

Sources

An intriguing aspect of studying CMC systems is that they can be more or less unobtrusive components of the research design (Webb, Campbell, Schwartz, & Sechrest, 1966). The system may be programmed to *monitor* and collect, unobtrusively, communication usage or network data. A more obtrusive and reactive use of CMC systems is to *initiate* user activities or system structures that would not otherwise have occurred, collected by the computer for immediate feedback or later analysis, such as on-line questionnaires (Harasim, 1987; Hiltz, 1979; Schaefermeyer & Sewell, 1988) or on-line controlled experiments investigating effects of CMC in small groups (Finn, 1987; Hiltz, 1982; Hiltz & Turoff, 1978; Kiesler, Siegel, & McGuire, 1984; Rice, 1984).

Kinds

There are at least four categories of kinds of CMC data possible—extent of sampling, measures of usage, measure of network flow, and content.

A CMC system's computer can be programmed to monitor a *census* or requested *samples* of usage. Samples may consist of selected users, time frames, sets of commands, or content (such as message headers with specific topics, or the full text of the messages). CMC network studies have analyzed censuses of interactions within one or more selected time frames (Danowski & Edison-Swift, 1985; Eveland & Bikson, 1987; Rice & Love, 1987; Robey, Vavarek, & Saunders, 1990) or from the entire time series of network data since the initiation of the system (Rice, 1982).

The computer supporting a CMC system may be programmed to collect various measures of *usage*, such as the number of times a user "logs on" to a system, the duration of sessions, specific messaging functions used (such as initiating a new message or replying to someone else's message, copying or forwarding a message to someone else, sending a message to a distribution list), various sequences of commands, errors made, the time of certain interactions, or the percentage of day spent using the system (see Rice & Borgman, 1983; and Rice, 1990a, for reviews).

Network flow data collected by a CMC system are typically limited only by the number of users, the accuracy of accounting records, and memory limitations in the network analysis program. The raw data are links (indicators of messages) identified by the account number of the sender and receiver, length, initiation date, and, in some systems, the receipt date. Such data may be aggregated across categories of users, across specific individuals across time, and so on.

Analyses of full-text message *content* and network flows (whether collected in electronic form or printed transcripts) may be combined in a variety of ways to illuminate how users' social structure both provides a context for meaning and is affected by the content exchanged within that structure. Message headers (such as the "Subject:" field) or the computer-monitored transcripts, if stored in computer-readable form, may be automatically content-analyzed by computer programs (Weber, 1984). Analysis of *content networks* considers the number of similar words that co-occur in a given unit (such as an on-line message or a message-response pair) as a measure of the strength of the relationship between concepts. The weighted relationships between concepts can be network-analyzed to detect patterns of meaning communicated via the system over time (Danowski, 1982, 1988), such as through scaling and clustering the distances among the concepts, identifying equivalent positions of meanings, or describing links within and across concept cliques. Or, content networks of responses to open-ended survey questions or focus group comments can be compared with the respondents' level or type of system usage (Rice & Danowski, 1993). *Content-network comparison* analyzes the relationships of the content of messages exchanged by users to the network of message flows among the users (Danowski & Edison-Swift, 1985). *Content-network mapping* analyzes the content communicated by system users according to its distribution among their cliques or positions (Rice & Love, 1987; Robey et al., 1990).

Accuracy and Validity

When self-reported relationships from each of two individuals disagree, it is typically impossible to disentangle measurement error (due to problems of recall, biased responses, questionnaire wording, and so on) from "true" asymmetries in the relation. However, computer-monitored network data represent the "true" (that is, accurately measure the behavioral component of) CMC messaging, so hypotheses involving reciprocity, asymmetry, transitivity, and so on can be explicitly separated and tested.

Such aspects of computer-monitored CMC data are significant in light of ongoing questions about self-report communication and network data. Self-reported measures of a wide range of behaviors—including responses to network questions about the number and intensity of linkages with other individuals—often disagree with comparable measures of observed (possibly "actual") behavior (Bernard, Killworth, Kronenfeld, & Sailer, 1984). Self-reported amount of system usage and interactions are not highly correlated with comparable computer-monitored measures (Bizot, Smith, & Hill, 1991; Killworth & Bernard, 1976; Rice & Shook, 1988), even when respondents are surveyed on-line within minutes of actual system use (Bernard, Killworth, & Sailer, 1982). For example, diary data significantly understate recorded frequency of communication as monitored by a PBX system (Higgins, McClean, & Conrath, 1985). Bikson and Eveland (1990) found that up to 24% of their sample reported use or nonuse of the CMC system that was discrepant with computer-monitored records.

Thus computer-monitored usage and network data are potentially more *accurate* than corresponding self-report data. However, monitored system usage or network data may represent a different aspect of human communication than does perceived usage, so they are not necessarily more *valid*. Results from several studies support this interpretation. Different demographic and information need variables differentially predict monitored usage versus self-report usage (Rice & Shook, 1988). The two data sources differentially predict perceived system benefits (see Rice, 1990a). Computerized but voluntary questionnaires tend to have similar response rates but higher response variance than written questionnaires (Sproull, 1986), produce less socially desirable responses to closed-ended questions and more disclosing responses to open-ended questions, exhibit greater completion rates and fewer item completion mistakes (Kiesler & Sproull, 1986), and attract a different subsample

than equally accessible written questionnaires (Kiesler & Sproull, 1986; Newsted, 1985). However, Corman (1990) found that computer-initiated collection of network data (via an on-line programmed unstructured Q-sort) had a somewhat higher test-retest reliability and more frequent imbalances and asymmetries than did self-report network data.

Indeed, there is no fundamental reason to expect actual CMC usage averaged over a considerable period to be highly correlated with the reported percentage of time spent using the system in an average workday or week (typical measures). Computer-monitored measures of numbers of messages sent or received, unless weighted by message length or importance of the content, are treated equally, yet much interpersonal communication is insignificant, routine, and less memorable, while in other cases a single sentence can be very memorable and have significant consequences. CMC data also only reflect CMC interactions; if one sends a message by CMC but receives a response by telephone, the CMC data may indicate that the initial message was never reciprocated. Thus CMC data strip away contextual and content-related cues, perhaps removing some of the underlying salience of communication events.

Computer-monitored usage and network data should be considered, then, as one addition to a broader, triangulation approach to understanding communication networks using a variety of channels, rather than as a superior replacement for self-report measures (Williams, Rice, & Rogers, 1988).

Privacy and Ethics

There are potential problems of privacy and ethics in collecting and analyzing data about users' communication behavior. Knowledge of the people with whom a respondent communicates may be a major invasion of privacy, because one's network can reveal patterns of information use and associations with specific other individuals or groups. In studies of communication technology networks that are explicitly experimental, public, or government sponsored, users typically sign consent forms or voluntarily share their communication (Rice, 1982). Other studies solve the problem by randomly reassigning identification codes to the data, so that the merged questionnaire and system data cannot be attributed to specific individuals, or by using only summary measures (Eveland & Bikson, 1987; Rice, Hughes, & Love, 1989). In private organizations, unfortunately, there are usually no human subjects review boards to scrutinize the use and collection of computer-monitored data.

Phase I: Networks and Adoption of CMC Systems

Does Network Position Affect Adoption and Use?

Before a system is available for adoption or use, of course, it must be designed, developed, and implemented in the adopting organization. Only a few studies of this aspect of the adoption phase take a network perspective. Walker (1985) combined nearly a score of network measures to show how network position predicted cognition about software development practices, and used multidimensional scaling to describe how office location corresponded with project team interaction. Pava (1983) used sociograms of project role relationships to show how informal coalitions dynamically develop around topics of contention and should be identified and used in managing the development and implementation process. Newell and Clark (1990), using simple self-reports of organization ego networks, found that British inventory and control system manufacturers were less innovative than comparable U.S. manufacturers, partially due to less communication and interaction with external organizations, conferences, and associations.

Most network-oriented implementation studies, however, focus on the individual users' adoption and use stages, generally analyzing the influence of clique density or position occupancy.

O'Keefe, Kernaghan, and Rubenstein (1975) showed that greater internal cohesion within cliques of hospital researchers and clinicians positively influenced use of a medical information system during a 6-month period. Papa (1990) emphasized the importance of network factors as sources of information and role models whereby employees may learn how to increase their performance using an insurance information query system. He concluded that one's self-reported network diversity, size, and amount of interaction (collected every day for 5 weeks after introduction of the system) all positively influenced work performance increases as well as the learning curve with which an employee reached a 10% higher performance level, once presystem performance was controlled for.

Anderson and Jay (1985) used blockmodeling to determine whether one's position in a set of 24 physicians' self-reported referral, consultation, discussion, and on-call coverage networks affected the extent to which physicians used (as measured by the system) a computer-based hospital information system (HIS). Membership in the four resulting positions (especially positions that were most central and multiplex)

was positively associated with both adoption and use of the HIS, independent of physicians' background and practice characteristics. Anderson, Jay, and Hackman (1983) regressed variables on the three dimensions produced by a smallest-space analysis of the same combined matrices, and found that the dimensions were best predicted by, respectively, high usage of the system, involvement in medical education, and involvement in professional activities. In a similar study, Anderson, Jay, Anderson, and Schweer (1987) predicted computer-monitored HIS usage based upon 30 physicians' membership in structurally equivalent positions in the consultation network. Six positions emerged and were differentiated by physicians' prominence, number of residents, and the lag between the hospital adoption and the physician's first use. Social influence, as measured by the "normative values" of relationally close others (Burt, 1982), predicted time of adoption, use of system, attitude toward the system, and time since the organization adopted.

Does Critical Mass Influence Adoption and Use?

Markus (1990a), Rice (1982), and others have theorized that the value of any particular CMC system rises, and thus the relative cost of adoption decreases, as a "critical mass" of individuals begins to use the system. Because interaction among users provides the basis for this critical mass, associated propositions are most appropriately tested using network data. Rice, Grant, Schmitz, and Torbin (1990), using data from a small government agency, found that the single best predictor of an individual's adoption of an electronic messaging system 9 months after implementation was the individual's self-reported connectedness (relational out-degrees of the ego's network) in the office communication network before implementation. At the industrial level of analysis, Gurbaxani (1990) used critical mass theory to develop a logistic model that nearly perfectly fit the over-time (1981-1988) adoption by U.S. universities of BITNET (a major academic CMC network; see also Schaefermeyer & Sewell, 1988).

Does Social Information Processing Affect CMC Use and Attitudes?

The social information processing model, developed in reaction to the failure of individual attributes or objective task measures to suffi-

ciently explain reactions to job designs, brought theories of social influence to the organizational setting (Salancik & Pfeffer, 1978). Recent followers of this theory argue that individual perceptions of ambiguous phenomena such as a new organizational CMC system are likely to be influenced by the opinions, information, and behaviors of salient others (Fulk, Steinfield, & Schmitz, 1990). Individual-level social information processing for each respondent may be operationalized as the result of first multiplying each other's attitude toward the system with the frequency of communication with the respondent, and then averaging that result over all the respondent's communicants. Group-level social information processing may be operationalized as simply the group's average attitude toward the system or, more generally, membership in different cliques or positions (Rice, 1993).

Empirical results are, so far, mixed. Rice and Aydin (1991) compared the influence of relationally proximate and structurally equivalent sources of social information processing at both the individual and the group levels of analysis. They found a weak individual-level positive influence on one's attitude toward a hospital information system only from those with whom one communicates directly, and a weak group-level negative influence from the mean of one's position, implying that social information based on direct communication produces some convergence in attitudes but that social information that includes others with whom one may have no communication as a member of one's position may lead to discrepant attitudes. Schmitz and Fulk (1991) showed that the attitudes of a respondent's supervisor and the five closest communication partners positively influenced the respondent's attitude toward a CMC system. Further, self-reported usage of the system by these significant others also predicted the respondent's self-reported usage. Using the same data, Fulk (1993) used measures from both emergent groupings (a respondent's five named others) and formal groupings (a respondent's coworkers) to show that social influences on respondents' technology-related attitudes and behavior were greater, and involved both internalization and compliance, when the respondents were highly attracted to their work groups.

But other studies fail to find a social information processing effect. Davis, Bagozzi, and Warshaw (1989) found that MBA students' attitudes toward a software package were not influenced by subjective peer norms. And Dykman (1986) found no influence of manager's use of a CMC system or availability of important communicating others on the relationship between respondents' system use and perceived satisfac-

tion with the system. In a study of a small government office (Rice et al., 1990), clique membership was identified by a relational network program and overlaid onto a multidimensional scaling of the raw frequency matrix. This visual portrayal clearly showed that adoption was pervasive in two cliques, but not in the third clique or among isolates. This indicated preliminary support for a group-level social information processing explanation of adoption. However, neither this group-level effect, nor individual-level social information processing, was a significant influence once critical mass was controlled for.

In addition to critical mass, another alternative explanation to the group-level effect of social information processing is that membership in different social worlds brings with it shared socialization processes and professional norms, and it is these that influence group members' attitudes toward an information system. Aydin and Rice (1991) conducted blockmodeling analysis on individuals' self-reported network relations that had been grouped into five hospital occupations (such as physicians and administrators). Mean attitudes did differ across these positions, and generally ordered according to increasing distance from the administrators' position as portrayed on a multidimensional scaling of the positional relations. However, as only the physicians talked more to themselves than to any other position, the occupational membership effect could not be attributed to relationally based social information processing.

Summary

Network analysis perspectives, methods, and measures have helped us understand how social structure constrains and shapes actions of designer, implementors, innovators, and users of CMC systems. Greater clique density or centrality, and common clique or positional membership, seems to facilitate social constructions of reality and shared resources, leading to similar adoption and usage patterns. Critical mass appears to be an important influence on adoption and evaluation of CMC systems. And using network measures to test social information processing theory indicates that use of a CMC system and attitudes toward it by relationally proximate others has a slight effect on individual's attitudes and use. Yet results so far are mixed; we still need to test for other structural explanations, such as critical mass and professional identification. By bringing to bear measures and constructs of social structure, we can begin to see how simple notions of either autonomous technology or autonomous individuals are incomplete.

Phase II: Use of CMC System Networks

Are Communication Constraints Associated With CMC Usage Networks?

Several studies have analyzed the ability of CMC systems to overcome the communication constraint of physical distance as a prime explanation of network flows (Feldman, 1987; Rice, 1987b). Properties of the users' context, such as physical proximity, may be tested for their influence on usage levels or CMC network relations. For example, in a study of two ad hoc task forces, Bikson and Eveland (1990) found that, while members of one task force without a CMC system exhibited a high (negative, as expected) association between a spatial distance network and their self-reported communication network, the task force with a CMC system exhibited generally little relationship, indicating that their use of the system removed the distance constraint. Users in a study by Bizot et al. (1991) sent 22% of their (computer-monitored) messages to others within the same work group, 19% within the same section, 20% within the same division, and 17% across divisions. However, employees of R&D organizations in a study by Eveland and Bikson (1987) sent 45% of all their (computer-monitored) messages to others in the immediate location, with declining percentages as the distance between the sender and receiver increased. Feldman (1987) found that CMC can facilitate the sharing of new information through organizational weak ties because it reduces the costs of signaling one's interests and of finding other people with similar interests. Markus (1990a) developed a detailed theoretical argument about what kinds of resources and interests are needed to develop the necessary critical mass to support such widespread usage. These results indicate that, while the ability to cross major organizational and geographic boundaries is a motivation for system use, task interdependency may be a greater motivation, while access and cost issues also play influential roles.

Do On-Line Groups Show More Equal Participation and Reciprocity?

Text-based CMC systems may reduce the amount of social presence or information richness (nonverbal communication, social cues, equivocal information, or perception of the other user's "closeness") (Daft & Lengel, 1986; Short, Williams, & Christie, 1976) and other cues (such

as nonverbal, organizational, physical proximity, and status) in the content of the communication, thus limiting the applicability of CMC systems for more socioemotional communication activities. However, the reduction of these nonverbal and social cues may improve the equality of participation and access by those otherwise constrained in interpersonal communication (such as employees with lower organizational status, who have speech difficulties, or who are members of minority groups) (Rice, 1984). Simple cross-tabulation of on-line interactions among individuals generally indicates that, although asymmetry and differential participation still exist, participation is more equal than in face-to-face groups (Johansen et al., 1979).

In some instances, CMC systems can reinforce rather than reduce status differences. For example, while Robey et al. (1990) found some integration of occupational roles over time in an analysis of a semester's worth of (computer-monitored) content and network transcripts from an on-line course for medical professionals, they did find strong patterns of asymmetric relationships that mirrored professional status hierarchies. Tests of hypothesized cross-categorical relationships indicated that physicians sent more messages to nurses than vice versa, while most teachers and physicians occupied a unique structural equivalence position because they received messages similarly from all others.

Harasim (1987), Hartman et al. (1991), Hiltz (1986), and Quinn, Mehan, Levin, and Black (1983) found, based on computer transcripts and system records, that on-line courses can foster more equal discussion relations among students than do traditional classrooms. Based on self-reported ego-network data in one study, teachers also communicated more with less able students in on-line course sections, and the less able students themselves communicated more with other students, than in comparable face-to-face courses (Hartman et al., 1991). Further, student-student interactions in the on-line class at the end of the semester were not associated with interactions reported early in the semester, while they were for the traditional sections, indicating that the CMC system helped develop new interaction patterns.

Another implication of the reduction of status and other cues is that the content of the information and the level of reciprocity among users may become predominant criteria for the development and maintenance of communication roles, rather than more obvious social factors such as organizational hierarchy, material resources, or ability to dominate a meeting. Rice (1982) tested various log-linear models (proposed by Marsden, 1981) of the within- and across-group computer-monitored

messaging among 800 users in 10 groups over 24 monthly time periods and found that a model of "strict reciprocity" (different pairs of groups communicate reciprocally, while within-group preferences are similar across groups) became the best-fitting model after the first 4 months or so. As predicted, groups that occupied positions that could not sustain above-average sending (transmitters) or above-average receiving (receivers) or both (carriers)—primarily task-oriented groups that were necessarily focused on within-group communication—quickly became isolates within the system.

Are Discourse Networks Different in CMC?

The ability to capture the content of CMC messaging allows for analyses of differences in network patterns and in how and what they communicate.

Several studies have examined the propositions of social presence and information richness theories noted above. Rice and Love (1987) analyzed the network flows and content from 6 weeks' worth of transcripts printed out from a public computer bulletin board used by physicians and nurses. First, clique members and isolates were identified. Then their messages were categorized into socioemotional or task-oriented content by means of Bales's Interaction Process Analysis (Bales, 1950). Users who sent more messages sent more overall socioemotional content, but there were few differences in socioemotional content of messages sent by clique members as compared with those sent by isolates. Thus, even if CMC systems *do* suppress socioemotional content (although the study also found that about 30% of the content was, indeed, socioemotional in nature), such content is not always necessary to maintain on-line groups. Finholt, Sproull, and Kiesler (1990) found that, based on a longitudinal study using observational, self-report, and computer-monitored data from seven ad hoc programing task groups, CMC communication involved more discussion of scheduling, task assignment, and socioemotional topics, while face-to-face communication involved more consensus building and problem solving. Robey et al. (1990) showed that content of messages exchanged over a computer conference was significantly related to users' occupational status relations. For example, higher status users (physicians) sent more opinions, information, and requests for opinions to those lower in status (nurses). Bizot et al. (1991) reported that over 90% of the (computer-monitored) messages sent in an organizational CMC

were clearly related to the business of the organization, reflecting a strong administration policy against social uses of the system (perhaps based on some narrow sense of "productivity" criteria for using new organizational media). Note that this is a clear instance of explicit institutionalization by a formal organizational policy rather than "caused" by the characteristics of the technology.

Removing the constraint of linear sequencing of communications inherent in most traditional communication interactions may also give rise to new forms and problems of communication. Quinn et al. (1983) showed that relationships among content categories in on-line class discussions were less linear. That is, comments did not necessarily follow in sequential response to a single prior comment (such as a teacher's question) but rather often referred to prior comments in a different order than they were sent or to multiple prior comments by other students. Further, they involved more even distribution of procedural discussions than in face-to-face classrooms. Black, Levin, Mehan, and Quinn (1983), Quinn et al. (1983), and Holmes (1986) have analyzed content networks in the form of "multiple threads of conversation" revealed in the computer-monitored transcripts of CMC portions of university courses. Here, the "node" is the comment or message, and the relationships are the references among the posted messages. These relationships are displayed graphically and analyzed much like transcripts of spoken conversations by conversation analysts or linguists. Multiple threads occur because CMC comments may be responses to an item added several entries ago but just recently read by the particular respondent, a response to multiple previous topics, or conditional comments that reduce the effect of having to wait for a response to a particular question before being able to provide some informational or make a decision. Such threads are quite unlike the sequential response relationships in face-to-face or written communication. They may be conceptualized as multiplex, nonhierarchical content links. Black et al. (1983) conclude that "the structure of discourse is not fixed, but rather the product of participant interaction and properties of the medium through which dialog is pursued" (p. 75).

Finally, network analysis of comments about a CMC system may provide insights not available through traditional content analysis, which can provide frequency counts of various themes but cannot reveal patterns of word associations. Rice and Danowski (1993), for example, showed that the set of people who used a voice mail system more for messaging (processing communications across individuals and groups)

than for answering (traditional store-and-forward of messages when someone does not answer their telephone) used somewhat different clusters of words (such as "improve communication," "access others on the system," and "group distribution").

Does CMC Complement Organizational Networks?

Eveland and Bikson (1987) analyzed patterns of 69,000 computer-monitored messages sent among 800 users in an R&D organization over a period of nearly 2 years. They took a relational, group-level approach to answering the question of whether the system supported project-related communication. Analyses of 100 samples from users showed that there were no differences in usage levels across departments, programs, or professional categories. Three quarters of the messages crossed departmental boundaries, indicating high cooperation among research disciplines within broad organizational functions, while only 40% of the messages crossed specific research project boundaries. The communication structures within and across research projects were generally not clustered, as were departmental network relations, according to smallest-space analysis of the message flows. Thus using electronic mail allowed individuals in different departments to work collaboratively on R&D projects. Bizot et al. (1991) found similar results. They collected 3 days' worth of messaging (on a commercial integrated messaging and document system, PROFS) and asked each respondent to answer a questionnaire and to comment on the messaging log in an anonymous manner. In this traditionally hierarchical R&D organization, 83% of all messages were sent within a division, and 93% of messages were sent to a recipient either one job type above or below the sender, indicating little circumventing of the traditional organizational structure.

In a different approach to this question, Rice and Shook (1990) used the quadratic assignment procedure (Hubert & Schultz, 1976) to show that the network of status relationships among job levels was associated with the patterns of use of different communication media by respondents in four organizations. While, in each organization, pattern of attendance in meetings was the best predictor of job level, in one organization the second best predictor was use of its CMC system. Thus, clearly, CMC usage can complement preexisting organizational structure.

But this does not mean simply mirroring prior communication networks. Rice (1994) found that initially the network of email communications among members of an R&D organization were strongly correlated with

work and social networks, but, over time, it diverged from those as well as from formal mentor-intern relations. Gutek (1982) developed a unique research design to identify influences of an integrated information/communication system on attitudes and interactions of a single secretary-manager dyad, using multiple surveys and observations over 20 months during preimplementation, stable (computer-monitored) usage, and after removal of the system. Attitudes were most positive during the stable use phase, but the system had little impact on secretary-managerial interactions or the reasons for those interactions.

Some studies have related performance both to use of email networks and to the extent to which those networks complement other organizational networks. Finholt et al. (1990) used simple cross-tabulations of computer-monitored messaging among groups of student programmers using a CMC over four time periods. They found that high-performing groups exchanged greater-than-expected individual messages with other high-performing groups and sent greater-than-expected broadcast messages to all groups. Further, messaging between managers and nonmanagers was greater than expected. The authors interpreted these patterns as supporting spoke and hublike functional CMC patterns in the groups, which lead to higher performance. Rice's (1994) study of mentors and interns in an R&D organization showed that, while simple amount of messaging, or even email network centrality, were not much associated with evaluations of the interns' performance several months later, general work communication and the interns' location within the email network were negatively associated with performance. Rice suggested that overparticipation in early email cliques narrows interns' research focus, encourages the clustering of low performers, and limits interns from associating with wider organizational networks, such as with other mentors.

These results may be less likely to hold for groups with no prior history or that are not embedded in organizational structures, and when other communication channels are not constrained. For example, Markus (1990b) studied four field-study groups that had access to CMC systems as well as participating in weekly face-to-face meetings, showing that level and type of usage varied considerably within and across groups. CMC network data as well as observations and self-reports showed that social contexts help explain CMC communication structures—including one group using the system primarily so that two antagonistic members would not have to meet face-to-face!

Summary

An important technological characteristic of CMC systems is that they can overcome spatial and temporal constraints. Yet CMC communication patterns in ongoing organizations continue to reflect some of the physical distance relationships, which probably reflect task and resource interdependencies. Another important characteristic is reduced social and nonverbal cues, which theoretically can reduce status differences and domination based on appearance, oral skills, and so on. This is often reflected in more equal participation, more reciprocal communication, and less sequential or linear comments, although CMC systems may still be used to reinforce salient status differences. Further, the reduced social cues do not seem to prevent communication of socioemotional content, and CMC groups do not necessarily exchange more of such content than do CMC isolates. CMC may be used to overcome traditional organizational boundary constraints (such as departments, manager/subordinate relations, headquarters/branch separation), especially in project-related activities and collaborative work. Yet CMC may also reflect an organization's traditional hierarchy if organizational policy demands this.

Phase III: CMC Systems and Institutionalization of Networks

Does Critical Mass Affect CMC Use and Outcomes?

In accord with Markus's (1990a) propositions, Rice et al. (1990) found that the best predictor of some communication-related outcomes was the extent to which an individual communicated with others who had also adopted the system, after implementation of the system, even when social information processing variables were controlled for. That is, "critical mass" seems a theoretically and empirically important construct, in which ongoing network structures influence individuals' CMC usage networks.

Does CMC Change Intraorganizational Networks and Structure?

Organizational structure is central to a wide variety of concerns of organizational communication theorists, such as employee innovative-

ness, R&D unit performance, and organizational effectiveness in the face of changing environments. Traditionally, studies of the effects of computer systems on organizational structure measured structure as differentiation, task scope, centralization, hierarchy, formalization, and so on (James & Jones, 1976), but rarely from a network perspective. Robey (1981), for example, found no changes in formal structure in five of eight organizations that had implemented information systems, and reinforcement in the other three, and proposed elsewhere (1977) that such changes are more dependent on the organization's task environment than on technology. Wigand (1985) summarized government statistics showing relatively high levels of unemployment among managers and administrators in the early 1980s, and recounted organizational instances of "flattening of the hierarchy," both evidence of the ability of information and CMC systems to gather, distribute, and monitor organizational information and provide end users with direct access to it. However, only recently have studies applied network analysis to the enduring question of the effect of systems on organizational structure.

Eveland and Bikson (1987) found little evidence of changes in the departmental or project communication clusters over the 18-month period of study, indicating that the electronic mail system supported, but did not alter, the *intraorganizational* structure of the R&D organization. Another longitudinal study also found that (self-reported) CMC usage networks may develop to complement preexisting task and social network positions (McKenney, Doherty, & Sviokla, 1986). Safayeni, MacGregor, and Lee (1987) provided evidence, based on self-reported and cross-sectional ego-network and dyadic data, that use of the system led to more task-dependent connections where each member of the dyad felt he or she could influence the other's job, to more positive views of others as sources of influence on performance, and to a more flexible organizational network where social relations were the basis of adjusting task dependencies rather than formal procedures. In a later analysis of these data, MacGregor, Lee, and Safayeni (1991) did not find an effect of the CMC system on organizational communication patterns between organizational units compared with functions where the system was not implemented. However, inspection of simple cross-unit interaction tables indicated that frictions and conflict among functions increased, partially due to a poorly designed system implemented for the lower level employees that led to asymmetric messaging among some of the units. Sherblom (1988) studied 157 messages involving one

middle-level manager. His content analysis showed that messages sent upward in the hierarchy were more restricted in function (mostly involving exchange of information); functional categories were more evenly distributed among peer messages; and subordinates were more likely to "sign" their mail than were superiors, indicating that "an electronic parolanguage reflects, reinforces and recontextualizes the organizational structural hierarchy" (p. 50). Such studies lead to the inference that there may be subtle, but not extensive, changes in preexisting organizational networks due to CMC use.

However, other studies find considerable evidence for changes in organizational networks, especially for novel situations or new groups, as the actors institutionalize the altered relationships due to new organizational technologies. Danowski and Edison-Swift (1985) analyzed monitored CMC system usage and content data before, during, and after an administrative crisis experienced by a number of offices in a statewide county extension service, using a relational approach to group-level networks. Relational analysis of the words in the CMC messages showed that crises galvanized the interorganizational network into shared but temporary concern. The structure of the content networks was influenced by the introduction of new communication messages, sent in the prior month, relating to the budgetary source of the crisis. Relational network patterns among users seemed to be more robust, adaptive, or enduring than relationships among communication content during the crisis. Indeed, the issue of how CMC and information systems may facilitate crisis management has only recently received much attention (Rice, 1990b).

Feldman (1987) argued that, because the asynchronous nature of CMC makes it unnecessary for people to communicate at the same time, and because the development of distribution lists makes it easy to define groups of people with common interests and then signal one's own interests and share information with all members of that group simultaneously, the costs of interacting through weak ties are greatly reduced. Her study of the content of messages sent to or from 96 users indicated that 60% of the messages would not have been sent without the CMC system. This percentage is higher for people who did not know one another, who did not communicate other than by CMC, who were spatially or organizationally distant, and who used distribution lists. Feldman also argues that such weak tie messages aid in organizational socialization, shared interpretations, and solving problems.

Burkhardt and Brass (1990) explored the notion of institutionalization using a longitudinal relational approach, analyzing both ego and system networks. They found that, over time, employees in general, but early adopters in particular, increased their power and relational network centrality as they used a new nutrient data analysis and dissemination system. Because individuals' initial power (as rated by other members of the network) and network centrality had no influence on level of adoption, the authors concluded that the system did not reinforce, but changed, preexisting structure and power differences. Multidimensional scaling of the self-reported interaction networks reinforced these results, showing that the network became more centralized overall, but adopters became even more central. Finally, structural equivalence among the actors was significantly correlated with their relative adoption times only at the fourth and final time period, indicating that adoption similarity influenced structural similarity. That is, individuals adjusted their patterns of interaction to learn from those adept at using the new technology. Burkhardt (1991) extended this analysis by investigating the extent to which the new system altered social dynamics, which in turn provided opportunities for the users to create shared interpretations of the system, thus reinstitutionalizing the social structure. Results showed that two relational matrices—(a) path distances based upon the self-reported binary relations among network members and (b) self-reported interactions with powerful others—were associated with a computer efficacy similarity matrix, especially for those with *high* values on a self-monitoring scale. The matrix of users' structural equivalence was also associated with both (a) a matrix of similarity of users' attitudes toward the computer and (b) a matrix of similarity of computer use, especially for those with *low* values on the self-monitoring scale. Thus those who were less aware of their own behaviors and attitudes apparently were more influenced by the usage and attitudes of structurally equivalent others.

Eveland and Bikson (1988) and Bikson and Eveland (1990) found strong evidence that CMC systems can influence the development and maintenance of both task and social networks among groups that had not interacted before as opposed to ongoing organizational groups. They provided CMC access to one of two task forces consisting of randomly assigned retirees and soon-to-retire employees. The supported task force exhibited fluctuating leadership patterns over three time periods, greater communication in all channels, greater connected-

ness in (self-reported) network structure, less centralization over time, more multiplex subcommittee relations and thus less clustering according to task force subgroups, continued (computer-monitored) on-line communication after the report was completed, and considerable (computer-monitored) messaging across the task subgroups. Foster and Flynn (1984) also found evidence of changes in organizational form, roles, and relationships in one company that implemented a computing and communication system. While they used a narrative case study rather than network methods, their results indicated that the system facilitated both social and task contacts, a shift from primarily vertical to lateral communications, the development of a less structured on-line structure that complemented the formal, protocol-driven hierarchy, and an increase in shared responsibilities for overall task completion. Leduc (1979) found a similar shift from vertical superior-subordinate interactions to more interconnection among and across roles after the implementation of a CMC system.

Finally, the implementation of CMC networks raises the possibility of institutionalizing perceived, rather than actual, networks. Hayne, Rice, and Licker (1994) analyzed the use of anonymous commenting in a group support system (GSS) by seven work groups from four organizations to see if participants could identify the authors of the anonymous comments. They found that participants were willing and able to make attributions but that those attributions were extremely inaccurate. Lower inaccuracy was associated in two of the seven groups with greater total prior communication, greater prior network betweenness centrality, and greater prior pairwise communication. These results suggest that the use of GSS anonymity features does not mean that users are not making attributions and, worse, that these attributions are probably inaccurate, creating biases and false evaluations that cannot be countered by the other participants. Such processes could institutionalize new, but unfounded, organizational network relations and assessments.

Does CMC Influence Scientific Communication Networks?

Because communication across institutional and geographic boundaries, and within and across disciplines, is crucial to the development of science, some attention has been focused on the extent of use of CMC systems by, and their influence on, scientific communities. Lievrouw and Carley (1991) and Newell and Sproull (1982) argue that, in spite of

disciplinary, economic, and cultural constraints on this development, the traditional cycle of scientific communication (conceptualization, documentation, and popularization, with some feedback loops) may change, by increased collaboration, diffusion, and feedback through CMC networks, leading to an era of "telescience." Hiltz (1984), Hiltz and Turoff (1978), and Kerr and Hiltz (1982) have provided consistent evidence that such networks do increase in intensity, diversity, and the "stock" of ideas. Researchers who already knew more other researchers who are now on-line (a self-reported ego-network approach) were more likely to use the system more and perceive greater benefits. While this result is consistent with the critical mass studies, Hiltz interpreted this as implying the necessity for a culture of trust among possible scientific competitors.

Freeman (1980) has applied more sophisticated network methodology to this question. He tested the notion that the "backcloth" of social structure (based on network relations such as colleagues, fellow students, teacher-student pairs) is the basis for any "traffic" of communication interaction, including CMC usage. Using Q-analysis, he identified a variety of "backcloth" simplices (relations of relations), and then compared the self-reported "friend" network relations before, and 7 months after, using the nationwide computer conferencing system also studied by Hiltz (1984) and Rice (1982). The number of "friend" links and the number of dyads reporting "close friend" relations both increased. But one of these relations involved people who had never even met before, implying that use of the CMC system produced a small change in the social backcloth itself. In Freeman's 1984 study of the same set of researchers, he found that "strict awareness" relations based on a multiplex self-reported network among the CMC users were stable over three time periods but that 31% of the null awareness relations changed to symmetric relations between time two and time three. On the basis of these studies, he concludes that "the computer, it seems, can perhaps take the place of protracted face-to-face interaction and provide the sort of social structure out of which a scientific specialty can grow" (Freeman, 1984, p. 201).

Does CMC Change Interorganizational Networks and Structure?

New interorganizational networks may develop that have no prior material counterpart. Under these conditions, the basis of relationships

may differ from that of material or face-to-face relations and may be particularly unstable under conditions of change by external factors. For example, interorganizational network relations changed in a longitudinal analysis of computer-monitored messaging behavior by approximately 800 members of 10 research groups using a nationwide computer conferencing system over a 24-month period, when new groups entered or left the system. Based upon the best-fitting log-linear model (the "strict reciprocity" model described in the section on "participation and reciprocity" above), and output from a nonEuclidean metric multidimensional scaling program to model change in location over time, the entire system was found to recover its equilibrium after a few months of such "system shock" (Rice, 1982; Rice & Barnett, 1985).

One growing focus of organizational research is the development and management of interorganizational networks (Hepworth, 1989; Mulgan, 1991). The extension of one organization's boundaries through information networks is likely to affect both the initiating organization as well as the other organizations within a particular industry, such as through increased economies of scope, communication, and cross-organizational projects (Estrin, 1986). As Hart and Saunders (1991) note: "Networking technology bridges inter-organization units that share interdependent computing systems, and interacts with existing power structures to alter relations between organizations" (p. 6). Internally, such networks may lead to fragmentation of the information systems department, with attendant coordination problems and resulting changes in centralization. Externally, they may provide opportunities for oligopoly and price-setting, and decreased ease of entry of other organizations; consolidation, shrinkage, and process redistribution may also result as well as different forms of market segmentation and relationships among buyers, suppliers, rivals, and industry participants (Cash & Konsynski, 1985). These preliminary results and speculations seem ideally suited for testing with network analysis methods.

A wider conceptualization of such information system networks considers cross-industry networks resulting from the increasing convergence of software, computing, telecommunication, and information resources (Fombrun & Astley, 1982) as private computer networks "will allow firms to increase their span of control in geographical and market space, through more flexible technical and social divisions of labor" (Hepworth, 1989, p. 93). Hart and Rice (1988) tested resource-dependency hypotheses on data measuring extent of relations (as measured by linkages varying from short-term leasing through permanent

merger and acquisition) among these four industries, comparing videotex (a more complex service) versus teletext services during the 1980s. Clustering of the normalized form of these two matrices showed that, indeed, relations in the videotex industry involved more subclusters and involved more permanent linkages, as studied by permutation tests comparing hypothesized relations with empirical relations.

A still wider approach considers international information networks, which are changing the mechanisms of control by, relationships among, and nature of the economies of transnational corporations and nation-states. Mulgan (1991), for example, argues that such networks should be analyzed from the perspective of control, due to its "recognition of process and structure, and its recognition that effective power, influence and achievement depend on the ability to formulate strategies and understandings, on channels of command, feedback and surveillance" (p. 8). As Braman (1991) suggests, the growing "ephemeralization," or the "replacement of space and exchange of physical materials (weapons and barriers) with information flows for national security purposes," may lead to increased "confidence in each other's actions and feelings of security in the domestic and international environments." Hepworth (1989) argues that possible changes due to intra- and interorganizational computer networks are far more complex than centralization or decentralization, noting that firms may develop less bureaucratic but larger information work structures and smaller, separate production functions, with new structures such as electronic quasi-integration (shared computer communication infrastructure), electronic franchising (licensing of database services), internationalizing, electronic subcontracting, and information-based specialization. Relational and positional analyses over time of various material and information networks would be necessary to thoroughly test such intriguing propositions.

Summary

Simple technological imperative approaches are concerned primarily with the effects of CMC systems on users and organizations, such as organizational structure and relationships with other organizations. Not only have we seen that CMC systems are not simple causal agents but even that, in the institutionalization phase, CMC systems may be embedded in a variety of other influences. Even users' attitudes toward the outcomes of CMC systems may be influenced through critical mass and social information processing. Organizational network structures may

or may not change along with implementation of CMC systems, but such change may be less likely within single organizations, especially if there is a long organizational history and if there is no explicit policy of using the system to alter structure. CMC systems may or may not reinforce prior power relations. Early adoption of a highly uncertain organizational phenomenon may increase one's value to other organizational members, but only if adoption is voluntary and access is equal. The evidence implies increases in lateral and some diagonal communication, although such systems can be used to reinforce managerial-subordinate relations. Change in structure seems more likely with interorganizational and cross-industrial computer networks, as a host of economic, political, and technological forces constrain and alter organizational relationships. Invisible colleges may be facilitated by the growth of academic CMC networks, leading to new and intense relationships that would not have occurred otherwise. In turn, researchers and others may design these systems to support computer conferences for their own specialties.

Conclusion

The ability of CMC systems to monitor, and even initiate, system usage provides more accurate, larger, and longitudinal data sets. Network-level analyses and methods are necessary to properly embed the individual in a wider set of structural relations, many of which are often unknown to the participants themselves. Both relational and positional analyses provide the ability to identify how membership or role occupancy supersedes individual-level attributes, though with different underlying conceptualizations about what constitutes structure and roles. CMC systems, because they facilitate human communication through computer-based telecommunication networks, may be practically and conceptually intertwined with group, organizational, social, and transnational structures. These structures affect the adoption of CMC systems, influence how network members use the system, and in turn may be altered—even reinstitutionalized—by users communicating through CMC systems. Prior research has provided some examples of how CMC research can use network perspectives, constructs, and methods to articulate, operationalize, and test theories about these processes.

References

- Aldrich, H., & Whetten, D. (1981). Organization-sets, action-sets, and networks: Making the most of simplicity. In P. Nystrom & W. Starbuck (Eds.), *Handbook of organizational design* (pp. 385-407). New York: Oxford University Press.
- Allen, T. (1977). *Managing the flow of technology*. Cambridge: MIT Press.
- Anderson, J., & Jay, S. (1985). Computers and clinical judgment: The role of physician networks. *Social Science and Medicine*, 20(10), 969-979.
- Anderson, J., Jay, S., Anderson, M., & Schweer, H. (1987, February). *The diffusion of computer applications in medical practice*. Paper presented at the Social Networks Conference, Florida.
- Anderson, J., Jay, S., & Hackman, E. (1983). The role of physician networks in the diffusion of clinical applications of computers. *International Journal of Bio-Medical Computing*, 14, 195-202.
- Aydin, C., & Rice, R. E. (1991). Social worlds, individual differences, and implementation: Predicting attitudes toward a medical information system. *Information and Management*, 20, 119-136.
- Bales, R. F. (1950). *Interaction process analysis: A method for the study of small groups*. Cambridge, MA: Addison-Wesley.
- Bernard, H., Killworth, P., Kronenfeld, D., & Sailer, L. (1984). The problem of informant accuracy: The validity of retrospective data. *Annual Review of Anthropology*, 13, 495-517.
- Bernard, H. R., Killworth, P. D., & Sailer, L. (1982). Informant accuracy in social-network data V. An experimental attempt to predict actual communication from recall data. *Social Science Research*, 11, 30-66.
- Bikson, T., & Eveland, J. D. (1990). The interplay of work group structures and computer support. In J. Galegher, R. Kraut, & C. Egido (Eds.), *Intellectual teamwork: Social and technological bases of cooperative work* (pp. 245-290). Hillsdale, NJ: Lawrence Erlbaum.
- Bitzot, E., Smith, N., & Hill, T. (1991). Use of electronic mail in a research and development organization. In J. Morell & M. Fleischer (Eds.), *Advances in the implementation and impact of computer systems* (Vol. 1, pp. 65-92). Greenwich, CT: JAI.
- Black, S., Levin, J., Mehan, H., & Quinn, C. (1983). Real and non-real time interaction: Unraveling multiple threads of discourse. *Discourse Processes*, 6, 59-75.
- Braman, S. (1991). Contradictions in brilliant eyes. *Gazette: The International Journal for Mass Communication*, 47(3), 177-194.
- Burrell, G., & Morgan, G. (1979). *Sociological paradigms and organizational analysis*. London: Heinemann.
- Burkhardt, M. (1991). *Institutionalization following a technological change*. Unpublished paper, University of Pennsylvania, Wharton School, Philadelphia.
- Burkhardt, M., & Brass, D. (1990). Changing patterns or patterns of change: The effects of a change in technology on social network structure and power. *Administrative Science Quarterly*, 35, 104-127.
- Burt, R. S. (1980). Models of network structure. *Annual Review of Sociology*, 6, 79-141. (Palo Alto, CA: Annual Reviews)
- Burt, R. S. (1982). *Toward a structural theory of action: Network models of social structure, perception, and action*. New York: Academic Press.

- Cash, J. Jr., & Konsynski, B. (1985, March/April). IS redraws competitive boundaries. *Harvard Business Review*, pp. 134-142.
- Contractor, N., & Eisenberg, E. (1990). Communication networks and new media in organizations. In J. Fulk & C. Steinfield (Eds.), *Organizations and communication technology* (pp. 143-172). Newbury Park, CA: Sage.
- Corman, S. (1990). Computerized vs. pencil and paper collection of network data. *Social Networks*, 12(4), 375-384.
- Daft, R. L., & Lengel, R. H. (1986). Organizational information requirements, media richness and structural design. *Management Science*, 32, 554-571.
- Danowski, J. (1982). Computer-mediated communication: A network-based content analysis using a CBBS conference. In M. Burgoon (Ed.), *Communication yearbook* (Vol. 6, pp. 905-924). Beverly Hills, CA: Sage.
- Danowski, J. (1988). Organizational infographics and automated auditing: Using computers to unobtrusively analyze communication. In G. Goldhaber & G. Barnett (Eds.), *Handbook of organizational communication* (pp. 385-434). Norwood, NJ: Ablex.
- Danowski, J., & Edtison-Swift, P. (1985). Crisis effects on intraorganizational, computer-based communication. *Communication Research*, 12(2), 251-270.
- Davis, F., Bagozzi, R., & Warshaw, P. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science*, 35, 982-1003.
- Dykman, C. (1986). *Electronic mail systems: An analysis of the use/satisfaction relationship*. Unpublished doctoral dissertation, University of Houston, Department of Information Science.
- Estrin, D. (1986, October). The organizational consequences of interorganization computer networks. *ACM Conference Proceedings on Office Information Systems*, pp. 11-20.
- Eveland, J. D., & Bikson, T. (1987). Evolving electronic communication networks: An empirical assessment. *Office: Technology and People*, 3, 103-128.
- Eveland, J. D., & Bikson, T. (1988). Workgroup structures and computer support: A field experiment. *ACM Transactions on Office Information Systems*, 6(4), 354-379.
- Feldman, M. (1987). Electronic mail and weak ties in organizations. *Office: Technology and People*, 3, 83-101.
- Finholt, T., Sproull, L., & Kiesler, S. (1990). Communication and performance in ad hoc task groups. In J. Galegher, R. Kraut, & C. Egidio (Eds.), *Intellectual teamwork: Social and technological bases of cooperative work* (pp. 291-325). Hillsdale, NJ: Lawrence Erlbaum.
- Finn, T. A. (1987). Process and structure in computer-mediated group communication. In B. Ruben (Ed.), *Information and behavior* (Vol. 2). New Brunswick, NJ: Transaction.
- Fornbrun, C., & Ashtley, W. (1982). The telecommunications community: An institutional overview. *Journal of Communication*, 32(4), 56-68.
- Foster, L., & Flynn, D. (1984, December). Management information technology: Its effects on organizational form and function. *MIS Quarterly*, pp. 229-236.
- Freeman, L. (1980). Q-Analysis and the structure of friendship networks. *International Journal of Man-Machine Studies*, 12(3), 367-378.
- Freeman, L. (1984). The impact of computer based communication on the social structure of an emerging scientific specialty. *Social Networks*, 6(3), 201-221.
- Fulk, J. (1993). Social construction of communication technology. *Academy of Management Journal*, 36(5), 921-950.
- Fulk, J., Steinfield, C. W., & Schmitz, J. (1990). A social information processing model of media use in organizations. In J. Fulk & C. Steinfield (Eds.), *Organizations and communication technology* (pp. 117-140). Newbury Park, CA: Sage.
- Galegher, J., Kraut, R., & Egidio, C. (Eds.). (1990). *Intellectual teamwork: Social and technological bases of cooperative work*. Hillsdale, NJ: Lawrence Erlbaum.
- Giddens, A. (1984). *The constitution of society: Outline of the theory of structuration*. Cambridge, MA: Polity.
- Gurbaxani, V. (1990). Diffusion in computing networks: The case of BITNET. *Communications of the ACM*, 33(12), 65-75.
- Gutek, B. (1982). Effects of "office of the future" technology on users: Results of a longitudinal field study. In G. Mensch & R. J. Niehaus (Eds.), *Work, organizations and technological change* (pp. 191-212). New York: Plenum.
- Harasim, L. (1987). Teaching and learning on-line: Issues in computer-mediated graduate courses. *Canadian Journal of Educational Communication*, 16(2), 117-135.
- Hart, P., & Rice, R. E. (1988). Inter-industry relations in electronic news services. *Journal of the American Society for Information Science*, 39(4), 252-261.
- Hart, P., & Saunders, C. (1991, August). *Elaborations on electronic data interchanges: Antecedents and consequences*. Paper presented at the Academy of Management Conference, Miami.
- Hartman, K., Neuwrith, C., Kiesler, S., Sproull, L., Cochran, C., Palmquist, M., & Zubrow, D. (1991). Patterns of social interaction and learning to write. *Written Communication*, 8(1), 79-113.
- Hayne, S., Rice, R. E., & Licker, P. (1994). Social cues and anonymous group interaction using group support systems. *Proceedings of the Twenty-Seventh Hawaiian International Conference of Systems Sciences*, 4, 73-81.
- Hepworth, M. (1989). Computer networks in multilocational firms. In M. Hepworth, *Geography of the information economy* (chap. 4, pp. 93-128). London: Belhaven.
- Higgins, C., McClean, R., & Conrath, D. (1985). The accuracy and biases of diary communication data. *Social Networks*, 7(2), 173-188.
- Hiltz, S. R. (1979, Winter). Using computer conferencing to conduct opinion research. *Public Opinion Quarterly*, pp. 562-571.
- Hiltz, S. R. (1982). Experiments and experiences with computerized conferencing. In R. Landau, J. Bair, & J. Siegman (Eds.), *Emerging office systems* (pp. 182-204). Norwood, NJ: Ablex.
- Hiltz, S. R. (1984). *Online communities: A case study of the office of the future*. Norwood, NJ: Ablex.
- Hiltz, S. R. (1986). The "virtual classroom": Using computer-mediated communication for university teaching. *Journal of Communication*, 36(2), 95-104.
- Hiltz, S. R., & Turoff, M. (1978). *The network nation: Human communication via computer*. Reading, MA: Addison-Wesley.
- Holmes, M. (1986). *A conversational analysis of computer-mediated discourse*. Minneapolis: University of Minnesota, Department of Speech Communication.
- Huber, G. (1984). The nature and design of post-industrial organizations. *Management Science*, 30(8), 928-951.
- Huber, G. (1990). A theory of the effects of advanced information technologies on organizational design, intelligence, and decision-making. *Academy of Management Review*, 15(1), 47-71.

- Hubert, L., & Schultz, J. (1976). Quadratic assignment as a general data analysis strategy. *British Journal of Mathematical and Statistical Psychology*, 29, 190-241.
- James, L., & Jones, A. (1976). Organizational structure: A review of structural dimensions and their conceptual relationships with individual attitudes and behavior. *Organizational Behavior and Human Performance*, 16, 74-113.
- Johansen, R., Vallee, J., & Spangler, K. (1979). *Electronic meetings: Technical alternatives and social choices*. Reading, MA: Addison-Wesley.
- Kerr, E., & Hiltz, S. R. (1982). *Computer-mediated communication systems*. New York: Academic Press.
- Kiesler, S. (1986, January-February). The hidden messages in computer networks. *Harvard Business Review*, pp. 46-48, 52-54, 58, 60.
- Kiesler, S., Siegel, J., & McGuire, T. (1984). Social psychological aspects of computer-mediated communication. *American Psychologist*, 39(10), 1123-1134.
- Kiesler, S., & Sproull, L. (1986). Response effects in the electronic survey. *Public Opinion Quarterly*, 50, 402-413.
- Killworth, P., & Bernard, H. R. (1976). Informant accuracy in social network data. *Human Organization*, 35, 269-286.
- Kling, R. (1980). Social analyses of computing: Theoretical perspectives in recent empirical research. *Computing Surveys*, 12(1), 61-110.
- Leduc, N. (1979, September). Communicating through computers. *Telecommunications Policy*, pp. 235-244.
- Licklider, J. C. R., & Veza, A. (1978). Applications of information networks. *Proceedings of the IEEE*, 66(11), 1330-1346.
- Lievrouw, L., & Carley, K. (1991). Changing patterns of communication among scientists in an era of "Telescience." *Technology in Society*, 12, 457-477.
- Lorrain, F., & White, H. (1971). Structural equivalence of individuals in social networks. *Journal of Mathematical Sociology*, 1, 49-80.
- MacGregor, J., Lee, E., & Safayeni, F. (1991). *Some subtle effects of electronic mail on patterns of communication between different organization functions*. Unpublished paper, University of Victoria School of Business, British Columbia.
- Markus, M. L. (1990a). Toward a critical mass theory of interactive media: Universal access, interdependence and diffusion. In J. Fulk & C. Steinfield (Eds.), *Organizations and communication technology* (pp. 194-218). Newbury Park, CA: Sage.
- Markus, M. L. (1990b). Asynchronous technologies in small face-to-face groups. *Information, Technology and People*, 6(1), 29-48.
- Marsden, P. (1981). Models and methods for characterizing the structural parameters of groups. *Social Networks*, 3, 1-27.
- McKenney, J., Doherty, V., & Sviokla, J. (1986). *The impact of electronic networks on management communication: An information processing study* (Paper). Boston: Harvard Graduate School of Business.
- Mulgan, G. (1991). *Communication and control: Networks and the new economies of communication*. New York: Guilford.
- Newell, A., & Sproull, R. F. (1982). Computer networks: Prospects for scientists. *Science*, 215(12), 842-851.
- Newell, S., & Clark, P. (1990). The importance of extra-organizational networks in the diffusion and appropriation of new technologies. *Knowledge: Creation, Diffusion, Utilization*, 12(2), 199-212.

- Newsted, P. (1985). Paper versus online presentations of subjective questionnaires. *International Journal of Man-Machine Studies*, 23, 231-247.
- O'Keefe, R., Kernaghan, J., & Rubenstein, A. (1975). Group cohesiveness: A factor in the adoption of innovations among scientific work groups. *Small Group Behavior*, 6(3), 282-292.
- Orlowski, W. (1992). The duality of technology: Rethinking the concept of technology in organizations. *Organization Science*, 3(3), 398-427.
- Papa, M. J. (1990). Communication network patterns and employee performance with new technology. *Communication Research*, 17(3), 344-368.
- Pava, C. (1983). *Managing new office technology*. New York: Free Press.
- Quinn, C., Mehan, H., Levin, J., & Black, S. (1983). Real education in non-real time: The use of electronic message systems for instruction. *Instructional Science*, 11, 313-327.
- Rice, R. E. (1980). Computer conferencing. In B. Dervin & M. Voigt (Eds.), *Progress in communication sciences* (Vol. 2, pp. 215-240). Norwood, NJ: Ablex.
- Rice, R. E. (1982). Communication networking in computer conferencing systems: A longitudinal study of group roles and system structure. In M. Burgoon (Ed.), *Communication yearbook* (Vol. 6, pp. 925-944). Beverly Hills, CA: Sage.
- Rice, R. E. (1984). Mediated group communication. In R. E. Rice & Associates, *The new media: Communication, research and technology* (pp. 129-154). Beverly Hills, CA: Sage.
- Rice, R. E. (1987a). Communication technologies, human communication networks and social structure in the information society. In J. Schement & L. Lievrouw (Eds.), *Social aspects of the information society* (pp. 107-120). Norwood, NJ: Ablex.
- Rice, R. E. (1987b). Computer-mediated communication and organizational innovation. *Journal of Communication*, 37(4), 65-94.
- Rice, R. E. (1990a). Computer-mediated communication system network data: Theoretical concerns and empirical examples. *International Journal of Man-Machine Studies*, 30, 1-21.
- Rice, R. E. (1990b). From adversity to diversity: Applications of communication technology to crisis management. In T. Housel (Ed.), *Advances in telecommunications management: Vol. 3. Information technology and crisis management* (pp. 91-112). New York: JAI.
- Rice, R. E. (1992). Contexts of research on organizational computer-mediated communication: A recursive review. In M. Lea (Ed.), *Contexts of computer-mediated communication* (pp. 113-144). London: Harvester-Wheatsheaf.
- Rice, R. E. (1993). Using network concepts to clarify sources and mechanisms of social influence. In W. Richards, Jr., & G. Barnett (Eds.), *Advances in communication network analysis* (pp. 43-52). Norwood, NJ: Ablex.
- Rice, R. E. (1994). Relating electronic mail use and network structure to R&D work networks and performance. *Journal of Management Information Systems*, 11(1), 9-20.
- Rice, R. E., & Aydin, C. (1991). Attitudes towards new organizational technology: Network proximity as a mechanism for social information processing. *Administrative Science Quarterly*, 36, 219-244.
- Rice, R. E., & Barnett, G. (1985). Group communication networking in an information environment: Applying multidimensional scaling. In M. McLaughlin (Ed.), *Communication yearbook* (Vol. 9, pp. 315-326). Beverly Hills, CA: Sage.

- Rice, R. E., & Borgman, C. (1983). The use of computer-monitored data in information science and communication research. *Journal of the American Society for Information Science*, 34(1), 4, 247-256.
- Rice, R. E., & Danowski, J. (1993). Is it really just like a fancy answering machine? Comparing semantic networks of different types of voice mail users. *Journal of Business Communication*, 30(4), 369-397.
- Rice, R. E., Grant, A., Schmitz, J., & Torbin, J. (1990). Individual and network influences on the adoption and perceived outcomes of electronic messaging. *Social Networks*, 12(1), 27-55.
- Rice, R. E., Hughes, D., & Love, G. (1989). Usage and outcomes of electronic messaging at an R&D organization: Situational constraints, job level, and media awareness. *Office: Technology and People*, 5(2), 141-161.
- Rice, R. E., & Love, G. (1987). Electronic emotion: Socioemotional content in a computer-mediated communication network. *Communication Research*, 14(1), 85-108.
- Rice, R. E., & Richards, W., Jr. (1985). An overview of communication network analysis methods. In B. Dervin & M. Voigt (Eds.), *Progress in communication sciences* (Vol. 6, pp. 105-165). Norwood, NJ: Ablex.
- Rice, R. E., & Shook, D. (1988). Access to, usage of, and outcomes from an electronic message system. *ACM Transactions on Office Information Systems*, 6(3), 255-276.
- Rice, R. E., & Shook, D. (1990). Relationships of job categories and organizational levels to use of communication channels, including electronic mail: A meta-analysis and extension. *Journal of Management Studies*, 27(2), 195-229.
- Rice, R. E., & Associates. (1984). *The new media: Communication, research and technology*. Beverly Hills, CA: Sage.
- Robey, D. (1977). Computers and management structure: Some empirical findings re-examined. *Human Relations*, 30, 963-976.
- Robey, D. (1981). Computer information systems and organization structure. *Communications of the ACM*, 24(10), 679-687.
- Robey, D., Vavarek, K., & Saunders, C. (1990). *Social structure and electronic communication: A study of computer conferencing*. Unpublished paper, Florida International University, Department of Decision Sciences and Information Systems, Miami.
- Rogers, E. M., & Kincaid, L. D. (1981). *Communication networks: A new paradigm for research*. New York: Free Press.
- Safayeni, F., MacGregor, J., & Lee, E. (1987). Social and task-related impacts of office automation: An exploratory field study of a conceptual model of the office. *Human Systems Management*, 7, 103-114.
- Salancik, G. R., & Pfeffer, J. (1978). A social information approach to job attitudes and task design. *Administrative Science Quarterly*, 23, 224-252.
- Schaefermeyer, M., & Sewell, E. (1988). Communicating by electronic mail. *American Behavioral Scientist*, 32(2), 112-123.
- Schmitz, J., & Fulk, J. (1991). Organizational colleagues, information richness and electronic mail: A test of the social influence model of technology use. *Communication Research*, 18(4), 487-523.
- Shaw, M. E. (1978). Communication networks. In L. Berkowitz (Ed.), *Group processes* (pp. 313-349). New York: Academic Press.
- Sherblom, J. (1988). Direction, function and signature in electronic mail. *Journal of Business Communication*, 25, 39-54.
- Short, J., Williams, E., & Christie, B. (1976). *The social psychology of telecommunications*. London: Wiley.
- Sproull, L. (1986). Using electronic mail for data collection in organization research. *Academy of Management Journal*, 29(1), 159-169.
- Tichy, N. (1981). Networks in organizations. In P. Nystrom & W. Starbuck (Eds.), *Handbook of organizational design* (Vol. 2, pp. 225-249). New York: Oxford University Press.
- Tushman, M. L. (1977). Special boundary roles in the innovation process. *Administrative Science Quarterly*, 22, 587-603.
- Vallee, J. (1984). *Computer message systems*. New York: McGraw-Hill.
- Walker, G. (1985). Network position and cognition in a computer software firm. *Administrative Science Quarterly*, 30, 103-130.
- Webb, E., Campbell, D., Schwartz, R., & Sechrest, L. (1966). *Unobtrusive measures: Nonreactive research in the social sciences*. Chicago: Rand-McNally.
- Weber, R. (1984). Computer-aided content analysis. *Qualitative Sociology*, 7(1-2), 126-147.
- Wigand, R. T. (1985). Integrated communications and work efficiency: Impacts on organizational structure and power. *Information Services and Use*, 5, 241-258.
- Williams, F., Rice, R., & Rogers, E. M. (1988). *Research methods and the new media*. New York: Free Press.