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A Theory of the Effects of Advanced Information Technologies on Organizational Design, Intelligence, and Decision Making

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This article sets forth a theory of the effects that computer-assisted communication and decision-aiding technologies have on organizational design, intelligence, and decision making. Several components of the theory are controversial and in need of critical empirical investigation. The article focuses on those technology-prompted changes in organizational design that affect the quality and timeliness of intelligence and decision making, as contrasted with those that affect the production of goods and services.

This article draws on the work of organizational researchers, communication researchers, and information systems researchers to set forth, in the form of a set of propositions, a theory concerning the effects that *advanced information technologies* have on organizational design, intelligence, and decision making. The motivations for such an article are four.

One motivation concerns the need to reinvestigate and possibly revise certain components of organization theory. A large part of what is known about the factors affecting organizational processes, structures, and performance was developed when the nature and mix of communication technologies were relatively constant, both across time and across organizations of the same general type. In contrast, the capabilities and forms of communication technologies have begun to vary, and they are likely to vary a great deal in the future. For example, communication technology (or communication medium) is now a variable whose traditionally relatively constant range (from face-to-face at one extreme to unaddressed broadcast documents at the other, cf. Daft & Lengel, 1984, 1986) is being expanded by organizations to include *computer-assisted communication technologies* (e.g., electronic mail, image transmission devices, computer conferencing, and videoconferencing) that facilitate access to people inside and outside the organization with an ease that previously was not possible. Also, more sophisticated and more user-friendly forms of *computer-assisted decision-aiding technologies* (e.g., expert systems, decision-support systems, on-line management information systems, and external information retrieval systems) are in the late stages of development or early stages of implementation. Consequently, as the uses, capabilities, and forms of communication and decision-aiding technologies increase in their range, researchers must reassess what is known about the effects of these technologies because what is known may change. "That is, new media impacts may condition or falsify hypothesized relationships developed by past research"

(Williams & Rice, 1983, p. 208). Thus, one motivation for setting forth propositions concerning the impact of advanced information technologies is to encourage investigation and debate on what the nature of organizational design, intelligence, and decision making might be when these technologies become more sophisticated and more widely used.

The second motivation is to take a step toward creating a theory of the effects that advanced information technologies have on organizations. *Advanced information technologies* are devices (a) that transmit, manipulate, analyze, or exploit information; (b) in which a digital computer processes information integral to the user's communication or decision task; and (c) that have either made their appearance since 1970 or exist in a form that aids in communication or decision tasks to a significantly greater degree than did pre-1971 forms. (For expanded discussion of the term *advanced information technologies*, see Culnan and Markus, 1987; Gibson and Jackson, 1987; Johansen, 1988; Rice and Associates, 1984; and Strassman, 1985a.) The need for such a theory has been exemplified in a review by Culnan and Markus (1987) and in a special issue of *Communication Research* (Steinfield & Fulk, 1987). In that special issue, the guest editors noted that, although there are many empirical findings concerning the effects of advanced information technologies on organizations, "there has been little synthesis, integration, and development of theoretical explanations [and] that it is time for theory development and theory-guided research" (Steinfield & Fulk, 1987, p. 479).

Together, the propositions in this article comprise a theory such as that called for by Steinfield and Fulk, but like any theory, it is limited. It includes as dependent variables only (a) characteristics of organizational intelligence and decision making, such as timeliness, and (b) aspects of organization design associated with intelligence and decision making, such as the size of decision units. Further, within this still rather large set of dependent variables, the theory includes only those (a) that seem to be significantly affected by advanced information technology, (b) that are of interest to organization scientists or administrators, or (c) whose variance seems to have increased with the advent of advanced information technologies. The dependent variables included in the theory are shown in Table 1. Variables that are not included in the theory, but whose omission is briefly discussed, include horizontal integration, specialization, standardization, formalization, and the distribution of influence on organizational decisions.

As independent variables the theory includes

Table 1
Dependent Variables Included in the Theory (and the numbers of the propositions related to them)

Design Variables (Subunit Level)	Design Variables (Organizational Level)	Design Variables (Organizational Memory)	Performance Variables
Participation in decision making (1)	Centralization of decision making (4,5)	Development and use of computer-resident data bases (8)	Effectiveness of environmental scanning (10)
Size and heterogeneity of decision units (2)	Number of organizational levels involved in authorization (6)	Development and use of computer-resident in-house expert systems (9)	Quality and timeliness of organizational intelligence (11)
Frequency and duration of meetings (3)	Number of nodes in the information-processing network (7)		Quality of decisions (12)
			Speed of decision making (13,14)

only (a) the use of computer-assisted communication technologies and (b) the use of computer-assisted decision-aiding technologies. The theory does not encompass the use of computer-assisted production technologies or the use of transaction-enacting technologies such as computerized billing systems. (For ideas concerning the effects of advanced information technologies, broadly defined to include computer-assisted automation, on a broader set of organizational attributes, see Child, 1984, 1988; Gibson & Jackson, 1987; Strassman 1985a; Zuboff, 1984.) Finally, the theory does not explicitly address use of advanced information technologies for impression-management purposes such as those described by Sabatier (1978) and Feldman and March (1981).

The third motivation for integrating the work of organizational researchers, communication researchers, and information systems researchers is to help researchers in each of these fields become more aware of the existence, content, and relevance of the work done by researchers in other fields. Without such awareness, the efficiency of the research establishment is less, opportunities for synergy are lost, and progress in theory development is inhibited.

The fourth and last motivation is of practical, administrative importance. Advanced information technologies are becoming a pervasive aspect of organizations, but their relatively recent appearance and rapidly changing nature virtually guarantee that administrators and their advisors will not have experience as a guide in anticipating and planning for the impacts they may have. In the absence of experience, the value of theory is considerable.

It is important to note that the theory described here is not based on a great deal of directly applicable empirical research. There are two reasons for this. The first is that the components of organization theory that were drawn upon in developing the propositions were not validated under conditions in which decision and communication systems were computer assisted; consequently, they may not be valid for organizations that presently use a good deal of advanced information technology. The second reason is that many of the empirical studies that were drawn upon inductively in developing the propositions pertain to forms of technology that are not necessarily representative of the more sophisticated forms now in use or expected to be in use in the more distant future. (See Hofer, 1970; Pfeffer, 1978; Rice, 1980; Robey, 1977; Whisler, 1970, for brief reviews of some of these early studies, and Olson and Lucas, 1982, for some thoughtful speculations concerning the effects of advanced information technologies on a variety of organizational attributes and behaviors.) Thus, most propositions about the organization-level effects of advanced information technology must be viewed with some caution, whether derived from mature, but possibly outdated, organization theory or from recent, but perhaps soon-to-be outdated, empirical findings.

The above cautions notwithstanding, the propositions set forth are supportable to the degree necessary to be responsive to the motivations just noted, especially if the qualifications attendant to each proposition are seriously considered by users. In any case, these propositions can serve as a basis for the development of specific hypotheses.

Nature of Advanced Information Technologies

What are the critical characteristics of advanced information technologies that might cause these technologies to have effects on organizational design, intelligence, and decision making different from the effects of more traditional technologies?

For purposes of discussion, characteristics of information technologies will be divided into two groups. *Basic characteristics* are related to data storage capacity, transmission capacity, and processing capacity. Advanced information technologies, largely as a result of their digital computer component, usually provide higher levels of these basic characteristics (Culnan & Markus, 1987, p. 420; Rice & Associates, 1984, p.

34). [No distinction is made in this definition or in this paper between data (stimuli and symbols) and information (data conveying meaning as a result of reducing uncertainty).]

Characteristics of the second group I will call *properties*. Although the above basic dimensions are relevant to users, often it is the multidimensional configuration of the levels characterizing a particular technology that is most relevant for a particular task. Some authorities have considered these configurations when comparing advanced information technologies with traditional information technologies, and have made generalizations about the resultant properties of advanced information systems. Because these properties cause the use of advanced information systems to have effects such as those noted in this paper, some of these generalizations are reviewed here. (See Culnan & Markus, 1987; Rice & Associates, 1984, especially chapter 2, for discussions of how these properties follow from the levels that the technologies attain on the basic dimensions.)

In the context of *communication*, these properties include those that facilitate the ability of the individual or organization (a) to communicate more easily and less expensively across time and geographic location (Rice & Bair, 1984), (b) to communicate more rapidly and with greater precision to targeted groups (e.g., Culnan & Markus, 1987; Sproull & Kiesler, 1986), (c) to record and index more reliably and inexpensively the content and nature of communication events, and (d) to more selectively control access and participation in a communication event or network (Culnan & Markus, 1987; Rice, 1984).

In the context of *decision aiding*, the properties include those that facilitate the ability of the individual or organization (a) to store and retrieve large amounts of information more quickly and inexpensively; (b) to more rapidly and selectively access information created outside the organization; (c) to more rapidly and accurately combine and reconfigure information so as to create new information (as in the development of forecasting models or financial analyses); (d) to more compactly store and quickly use the judgment and decision models developed in the minds of experts, or in the mind of the decision maker, and stored as expert systems or decision models; and (e) to more reliably and inexpensively record and retrieve information about the content and nature of organizational transactions. (Discussions of these properties of computer-assisted decision-aiding technologies, richer in detail than space allows here, are contained in Sprague & McNurlin, 1986; Sprague & Watson, 1986; Zmud, 1983.)

Mistaken Impressions

It may be helpful to draw upon the above discussion of the basic characteristics and properties of information technologies to dispel some occasionally held, but mistaken, impressions. One such mistaken impression is that advanced information technologies are universally inferior or superior to traditional technologies. This impression is erroneous because the properties just delineated may be less important than other properties possessed by a more traditional technology. In addition, particular uses of the advanced technologies may have undesirable side effects (cf., Culnan & Markus, 1987; Markus, 1984; Zuboff, 1984). Further, traditional technologies often score higher with respect to acceptability, ease of use, and richness (cf., Culnan & Markus, 1987; Fulk, Steinfield, Schmitz, & Power, 1987; Trevino, Lengel, & Daft, 1987), or have scores that overlap on these properties with the scores of advanced information technologies. For these reasons, use of advanced information technologies will not eliminate use of traditional technologies. However, when the properties of advanced information technologies are useful for enhancing individual or organizational effectiveness, and when retarding forces such as those just noted are not potent, it is reasonable to believe that organizations will use the advanced technologies.

The availability of the advanced information technologies increases the communicating or decision-aiding options for the potential user, and thus in the long run, unless the selected technology is inappropriately employed, the effect is to increase the quality (broadly defined) of the user's communication or decision-making processes. Presumably, through experience or observation, organizational members learn which communication or decision-aiding technology is most likely to achieve their purpose, and then adopt it. Field studies, which will be cited later, verify this belief.

In a related vein, it is a mistake to view advanced information technologies solely as substitutes for traditional technologies. To the contrary, advanced information technologies are frequently used more as supplements and complements to traditional technologies, rather than as substitutes. For example, electronic mail is often used to confirm with text what was said in a phone conversation or to set up face-to-face appointments, and image transmission devices are often used to make available drawings that will be discussed after all the parties have had a chance to study them. Of course, people do substitute computer-assisted media for traditional media when it seems efficacious to do so. Overall, the effect of availability of user-friendly computer-assisted communication technology is to increase the range of options for the communicator. Presumably, through experience or observation, organizational members learn to choose communication technologies wisely. Evidence, which will be cited, indicates that this presumption is correct. An analogous discussion applies to computer-assisted decision-aiding technologies, but limits of space force its omission.

A final mistaken impression is that, although advanced information technologies may lead to rational outcomes (such as information that is more accurate and comprehensive or decisions that are more timely) in organizations characterized by strong adherence to a norm of economic rationality, these outcomes are unlikely in more highly politicized or power-driven organizations. In the absence of scientific evidence with which to develop the required contingency theory, three observations are offered. The first is that the external environments of many organizations are sufficiently competitive that, in order to survive, the organizations must adopt and properly use rationality-enhancing communication and decision-aiding technologies. If organizational politics interferes with such adoption or use, the marketplace or parent organization intervenes until universal conformance is achieved. Thus, in their time, the telegraph became a pervasive technology in railroads, the calculator in brokerage houses, and the radio in armies. In the organizations that survived, those managers whose proprietary inclinations caused them not to use the technologies to further organizational goals (such as timely delivery of freight, accurate and comprehensive information for investors, or effective coordination in battle) were evidently converted or purged. In essence, superordinates or organizations require subordinates or subunits to help them compete effectively or otherwise satisfy environmental demands, and if rational use of technology is necessary, it occurs in the long run, whatever the proprietary inclinations of the subordinates or subunits.

The second observation is that highly politicized or power-driven organizations also have highly competitive internal environments, and in such environments it is necessary for managers to maximize their own competitive effectiveness by appearing to satisfy the goals of resource controllers on an issue-by-issue basis. In these environments, technical or financial analyses are widely used to persuade the resource controllers that the manager's proposals best satisfy the resource controller's goals (Burgelman, 1982; Kelley, 1976; Shukla, 1982). Thus, even in organizations where power plays a significant role in resource allocation, so also do "the numbers" (cf. Gerwin, 1979; Pfeffer & Moore, 1980; Sabatier, 1978; Shukla, 1982). Man-

agers who do not employ the most appropriate technologies in developing and selling analyses are at a competitive disadvantage; they must adapt or lose out.

The third observation is that, in almost all organizations, effective fulfillment of organizational responsibilities contributes to the development and maintenance of a manager's reputation. Thus, aside from whatever a manager might do to negatively or positively affect the quality or timeliness of the design, intelligence, or decision making of superordinate units, he or she is likely to employ any communication or decision-aiding technologies that can contribute to his or her personal effectiveness or the effectiveness of his or her own unit (cf. Daft, Lengel, & Trevino, 1987).

Together, these observations suggest that even though power and politics influence organizational design, intelligence, and decision making, so too do information technologies; *for advancement of their own interests, organizational participants will use advanced information technologies in ways that increase their effectiveness in fulfilling organizational goals.* This fundamental assumption underlies many of the propositions included in the theory and seems to be validated in the studies referenced.

The Propositions

The propositions are grouped for expositional purposes into four sections. The propositions in the first three sections portray the effects of advanced information technologies on organizational design, that is, the effects on (a) subunit structure and process, (b) organizational structure and process, and (c) organizational memory. Although these effects will most often result from evolved practices rather than from prior managerial intentions, I expect that in the future, as administrators and their advisors learn about whatever functional effects of advanced information technologies on organizational design and performance may accrue, more and more of the effects will be the outcomes of inte tions. In the short run, however, many mana ers will probably continue to introduce a vanced information systems in order to redu the number of personnel, to increase manag rial efficiency, or to imitate other managers. A ter the systems are implemented for these pu poses, these managers or other organization participants will sometimes see that the syster can accomplish other purposes and will adju the organization's design to facilitate accor plishment of these purposes (e.g., by extendir the scope of responsibility of an organization unit that now has easier access to a broad range of information).

The propositions of the fourth section set for the effects of advanced information technolo on organizational intelligence and decisi making. Some of these effects are direct a some occur indirectly through changes in c sign. [Organizational intelligence is the outp or product of an organization's efforts to acquir process, and interpret information external the organization (cf. Porter, 1980; Sammo Kurland, & Spitalnic, 1984; & Wilensky, 1967). is an input to the organization's decision mc ers.]

Each of these four sections contains speci suggestions concerning research that wou seem to be useful for examining the validity a domains of particular propositions. The last se tion of the paper contains more general reco mendations for researchers in the areas of org nization science and information systems.

Effects at the Subunit Level

The focus in this section is on those aspects organizational design that ultimately affect ganizational intelligence and decision makir For example, aspects of structure that affect t accuracy of communications or the timeliness decisions are considered. The first three prop sitions of the section deal with variables gen ally thought of in the context of organizatior

subunits. The remaining six propositions deal with variables more associated with the design of the organization as a whole. (This distinction is made solely for expository purposes—the categorizations are not intended to have theoretical merit.)

Participation in Decision Making

In many organizational decisions, technical and political considerations suggest that the development, evaluation, or selection of alternatives would benefit from exchanges of information among a moderate to large number of experts or partisans. But communicating takes time and effort, and so the variety and number of participants is often narrower than post hoc analyses determine to be appropriate. Assuming that the time and effort involved in communicating are critical determinants of the number of individuals who become involved, *what is the effect of computer-assisted communication technology on the breadth of participation in decision making?*

Because computer-assisted communication technologies can greatly reduce the effort required for those individuals who are separated in time or physical proximity to exchange information (cf. Hiltz & Turoff, 1978; Culnan & Markus, 1987; "Special Report," 1988), it is probable that more people would serve as sources of information. Thus, we have the story where

> a product developer sent a message to distribution lists that reach thousands of people asking for suggestions about how to add a particular new product feature. Within two weeks, he had received over 150 messages in reply, cutting across geographical, departmental, divisional, and hierarchical boundaries, almost all from people the product developer did not know. (Sproull & Keisler, 1986, p. 1510)

And, of course, teleconferencing and other similar computer-assisted communication systems are useful for sharing information (Johansen, 1984, 1988; Rice, 1984).

In contrast, authorities have argued that computer-assisted communication technologies do not enable decision makers to obtain "soft" information (Mintzberg, 1975), "rich" information (Daft et al., 1987), the "meaning" of information (Weick, 1985), or information about sensitive matters. To the extent that this argument is correct, it would preclude the use of computer-assisted communication technologies where the need for such information is paramount. However, the circumstances where the arguments of these authorities are salient may be fewer than first thought. For example, the argument that computer-assisted technologies provide fewer cues than does face-to-face communication is valid, but it misses the fact that managers and other professionals usually choose the communication medium that fits the communication task (Daft et al., 1987; Rice & Case, 1983; Trevino et al., 1987). Thus, computer-assisted communication technology might still be used to exchange factual or technical information, whereas other media are used to elaborate on this information or to exchange other types of information.

The issue is not one of the technologies driving out the use of richer media, but rather of the technologies enabling communications that otherwise would be unlikely to occur. For example, Foster and Flynn (1984), Sproull and Keisler (1986), and others (Palme, 1981; Rice & Case, 1983) reported that the availability of electronic mail caused organizational participants to increase the overall amount of their communication; there was not a one-for-one trade-off between media. Overall, the preponderance of arguments and the available empirical evidence suggest that:

> *Proposition 1: Use of computer-assisted communication technologies leads to a larger number and variety of people participating as information sources in the making of a decision.*

There will be exceptions to the relationship explicated in this and all propositions. A proposition states that across a large number of cases, ceteris paribus, there will be a tendency for the

stated relationship to be observed. Extensive testing of hypotheses derived from the proposition will, eventually, identify any *systematic* exceptions to the relationship.

Further research is needed, of course, to determine (a) if the increase in participation is of practical significance; (b) if the increase in participation leads to higher quality decisions or better acceptance of decisions; (c) if the information includes "hard" information, soft information, or both; and (d) if the decision process becomes more effective. (For reviews of the effects that computer-assisted communication technologies have on group behaviors, see Johansen, 1984, 1988; Rice, 1984. For a review of the behavioral effects of teleconferencing in particular, see Svenning and Ruchinskas, 1984.)

It is important to note that although organizational members tend to use the technologies that communicate their messages with timeliness and veracity (Trevino et al., 1987), they also consider the social acceptance of the technology (Fulk et al., 1987), the ease of use (Huber, 1982), and other attributes (Culnan & Markus, 1987).

Size and Heterogeneity of Decision Units

In many situations, organizational subunits are responsible for developing, recommending, or selecting a proposal for action. Thus, aside from the many individuals who might participate in this process, there is usually one individual or one group of individuals who is formally accountable for the decision. Such an individual or group is referred to as a *decision unit* (Duncan, 1974).

What is the effect of computer-assisted communication technology on the size and heterogeneity of decision units? To answer this question, note that small groups provide more satisfying experiences for their members (Jewell & Reitz, 1981; Kowitz & Knutson, 1980), and that small groups are less costly in terms of human resources. Also note that homogeneous groups provide more satisfying experiences and, if they have the necessary expertise, accomplish decision-related tasks more quickly (Jewell & Reitz, 1981; Kowitz & Knutson, 1980). Finally, note that the discussion associated with Proposition 1 suggests that computer-assisted communication technologies can help decision units to become relatively smaller and more homogeneous by obtaining information beyond that obtainable using traditional communication media; both experts and constituency representatives can often make their knowledge and concerns available through electronic mail, teleconferencing, or videoconferencing. Cost considerations suggest that organizations will seek such efficiencies in their use of human capital. For example:

> You cannot afford to have an expert in very rare kidney disease on your team, just in case you might need him or her someday. . . . The technology allows you to have experts available electronically. (Strassman, 1985b, pp. 22, 27)

What is the effect of computer-assisted decision-support technology, as contrasted with communication technology, on the size and heterogeneity of decision units? Sometimes experts can be replaced by expert systems and information keepers can be replaced by management information systems. To the extent that a decision unit can properly use the expert system for resolving some uncertainties, the expert need not be a member of the decision unit; therefore, the unit's size and heterogeneity will be decreased.

Research is needed, of course, to determine if these changes occur. They may not. For example, it may be that organizational aspirations will rise and information technologies will be used to acquire additional diverse information, information whose acquisition and interpretation will require approximately the same size face-to-face decision-group membership as is presently found. If the group's task involves less the acquisition of information than it does the routine processing of information, then the increase in the unit manager's span of control that is facilitated by increased internal communication capability may lead to an overall in-

crease in unit size. It will be interesting to see if future studies can ascertain the net effect of the conflicting forces under various conditions. However, it seems that there are many situations where the increasing efficacy of the technologies and the need for efficient use of human resources will make valid the following:

> *Proposition 2: Use of computer-assisted communication and decision-support technologies leads to decreases in the number and variety of members comprising the traditional face-to-face decision unit.*

Thus, although Proposition 1 suggests that the total number and variety of *participants serving as information sources* are likely to increase with use of computer-assisted communication technologies, Proposition 2 suggests that the number and variety of *members within the traditional face-to-face decision unit* will decrease with use of either computer-assisted communication or decision-support technologies.

It was noted earlier that people consider multiple criteria when selecting communication media. Similarly, it is important to recognize that even though organizational members tend to choose decision aids and decision procedures that facilitate the making of timely and technically satisfactory decisions (Lee, McCosh, & Migliarese, 1988; Sabatier, 1978), they also consider other criteria when making this choice (Feldman & March, 1981; Sabatier, 1978).

Meetings

Research confirms the everyday observation that completing an organizational decision process often takes months or years (Mintzberg, Raisinghani, & Théorêt, 1976; Witte, 1972). Meetings are often used to speed up decision processes by creating situations where rate of decision-related information exchange among the key participants is generally higher than that which occurs outside of meetings. Meetings, whether ad hoc processes or co-joined with more permanent structures, such as standing committees, are an important component of organizational decision processes and occupy a good deal of the time of managers and other professionals.

What is or what will be the effect of computer-assisted communication and decision-support technologies on the time absorbed by meetings? Some arguments and evidence suggest these technologies will result in fewer meetings with no loss of progress in the overall organizational decision-making effort. For example, many times discussion is halted and another meeting scheduled because needed information is missing. On-line management information systems or other query-answering technologies, including expert systems, may be able to provide the information, avoiding the need to schedule a subsequent meeting. Also, electronic mail and other computer-assisted communication media sometimes can be used to access soft information that can be obtained only by querying people. Further, decision-support systems can sometimes be used within meetings to conduct analyses that provide new information with which to resolve disagreements about the significance of effects of different assumptions, and thereby allow progress to continue rather than forcing adjournment until subsequent staff work can clarify the effects and another meeting can be scheduled.

Reflection suggests that each of the technologies just mentioned as facilitating the completion of meetings can sometimes lead to the cancellation of meetings. That is, with the added communication and computing capabilities, organizational members can occasionally accomplish the task of the meeting before the meeting takes place. Finally, it seems that because group-decision support systems enhance information exchange, they contribute to the effectiveness of the meeting and, thus, may enable groups to complete their tasks with fewer meetings (Benbasat & Konsynski, 1988; Johansen, 1988).

In contrast, if managers and others involved in making organizational decisions believe that

use of the technologies will result in more effective meetings, the availability of the technologies may encourage them to have *more* decision-related meetings than they would otherwise. In addition, electronic mail, decision support systems, and other information-sharing and generating technologies may facilitate mini-meetings. This might preempt the need for the larger, formal meetings, but the result might be more meetings in total. The outcome of the increase in technologically supported mini-meetings versus the decrease in traditional meetings is a matter for future empirical investigation. However, because such mini-meetings are likely to be shorter, and in view of the several preceding arguments, it seems reasonable to believe that on balance and across time:

> *Proposition 3: Use of computer-assisted communication and decision support technologies results in less of the organization's time being absorbed by decision-related meetings.*

It is important to note that, because computer-assisted communication technologies facilitate participation in meetings by persons remote in time or geography, more people may ultimately participate in a meeting (see Kerr & Hiltz, 1982, and the discussion surrounding Proposition 1). In contrast, the mini-meetings that sometimes preempt the larger, formal meetings will typically involve fewer people. Because the net effects of these two phenomena are likely to be highly variable, no proposition is offered with *person-hours* as the dependent variable.

Validation of Proposition 3 would be a significant step in documenting the effect that computer-assisted technology has on organizational processes. It would be desirable to test this proposition for each technology separately. This may not always be possible, however, because many technologically progressive organizations will have a variety of technologies in place. (For a review of the effects of advanced information technologies on the overhead costs and benefits of technologically supported meetings, such as document preparation and meeting summaries, see Rice and Bair, 1984.)

Effects at the Organizational Level

Centralization of Decision Making

By enabling top managers to obtain local information quickly and accurately, management information systems reduce ignorance and help the managers to make decisions that they, otherwise, may have been unwilling to make (Blau, Falbe, McKinley, & Tracey, 1976; Child & Partridge, 1982; Dawson & McLoughlin, 1986). Motivations for top managers to make decisions that address local, lower level problems might include lack of confidence in subordinates (Vroom & Yetton, 1973), desire to reduce stress (Bourgeois, McAllister, & Mitchell, 1978), need for achievement (Miller & Droge, 1986), or concern that information about the organization's overall situation or about its policies be appropriately utilized (Huber & McDaniel, 1986). Thus, it seems likely that, on occasion, management information systems would cause decisions to be made at hierarchically higher organizational levels than if these systems were not available (cf. Carter, 1984). The opportunity to obtain contextual clarification with electronic mail and other computer-assisted communication technologies would amplify this tendency.

Conversely, electronic bulletin boards enable lower- and middle-level managers to stay better informed about the organization's overall situation and about the nature of the organization's current problems, policies, and priorities (cf. Fulk & Dutton, 1984) and, consequently, permit decisions made by these managers to be more globally optimal, rather than more parochial and suboptimal, as observed by Dawson and McLoughlin (1986). Further, computer-assisted communication technologies allow lower-level units to clarify information in a more timely manner. Thus, on some occasions it seems that computer-assisted communication technologies

would cause decisions to be made at organizational levels lower than if such technologies were not available. Motivations that lead top managers to permit this practice include the desire to decrease the time for organizational units to respond to problems or the desire to provide autonomy for subordinates. Some evidence suggests that this downward shift in decision making occurs—after observing the implementation of networked personal computers in the General Motors' Environmental Activities Staff, Foster and Flynn (1984, pp. 231–232) concluded that "from the former hierarchy of position power there is developing instead a hierarchy of competency. . . . Power and resources now flow increasingly to the obvious centers of competence instead of to the traditional hierarchical loci."

Therefore, *is the net effect of the use of computer-assisted communication and decision-support technologies to increase centralization or to decrease it?* Perhaps this is the wrong question. Together, the arguments in the previous two paragraphs suggest that computer-assisted and decision-support communication technologies, when used to provide most organizational levels with information that was formerly known to only one or a few levels, enable organizations to allow decision making to occur across a greater range of hierarchical levels without suffering as much of a loss in decision quality or timeliness, as would be the case if the technologies were not available. Which hierarchical level would actually make a particular decision would depend on the inclination and availability of the relevant decision makers at the various levels (Cohen, March, & Olsen, 1972) or other idiosyncratic factors, as noted by Fayol (1949/1916) and Duncan (1973). Thus, given that the technologies can reduce the one-to-one correspondence between certain organizational levels and certain types of information, it is likely that:

Proposition 4: For a given organization, use of computer-assisted communication and decision-support technologies leads to a more uniform distribution, across organizational levels, of the probability that a particular organizational level will make a particular decision.

Corollaries to Proposition 4 are:

Proposition 4a: For a highly centralized organization, use of computer-assisted communication and decision-support technologies leads to more decentralization.

and

Proposition 4b: For a highly decentralized organization, use of computer-assisted communication and decision-support technologies leads to more centralization.

Propositions 4, 4a, and 4b follow from the arguments presented, but are not directly based on empirical studies. It may be that the forces implied in the arguments are weak relative to those that influence traditional practices. For example, advanced information technologies enable centralized organizations to become even more centralized without incurring quite the loss in responsiveness that would occur without their presence. Similarly, they enable decentralized organizations to operate in an even more decentralized manner. I believe that, on balance, the arguments preceding Propositions 4, 4a, and 4b will be the more predictive, but empirical studies may prove this judgment to be incorrect. Certainly, the propositions require empirical study.

It is important to emphasize that by increasing the hierarchical range across which a particular type of decision may be made without a corresponding loss in decision quality or timeliness, computer-assisted communication and decision-support technologies allow other decision-location considerations to be applied without prohibitive costs. Such considerations include political matters; adherence to organizational traditions, norms, or culture; and the preferred style of top managers. Because the relative influence of these considerations will vary from organization to organization it seems that:

Proposition 5: For a population of organizations, broadened use of computer-assisted communi-

seems that in some instances reductions would take place. Thus,

> *Proposition 7: Use of computer-assisted information processing and communication technologies leads to fewer intermediate human nodes within the organizational information-processing network.*

(Note that Proposition 7 deals with the number of intermediate nodes, Proposition 1 deals with the number of information sources, and Proposition 2 deals with the number of members in the traditional face-to-face unit.) If the network processes information across hierarchical levels, then a corollary of Proposition 7 is:

> *Proposition 7a: Use of computer-assisted information processing and communication technologies reduces the number of organizational levels involved in processing messages.*

The last two propositions of this section deal with the design of the organization's memory. Designing the organization's memory is a novel idea to organizational scientists, but will become more familiar as organizational learning becomes a more mature area of study and as top management increases its emphasis on intellectual capital.

Effects on Organizational Memory

In their discussion of information search routines in organizational decision making, Mintzberg and his colleagues (1976) distinguished between an organization's memory search and the active or passive search of its environment. *Memory search* refers to "the scanning of the organization's existing memory, human or paper" (or, today, computer-resident) (Mintzberg, Raisinghani, & Théorêt, 1976, p. 255).

Everyday experience and some research suggest that the human components of organizational memories are less than satisfactory. For example, research shows that forecasts about the time necessary to complete organizational tasks are quite erroneous, even when such tasks have been carried out in the organization on many occasions. Kidd (1970), Abernathy (1971), and Souder (1972) studied the judgments of project completion times made by managers, and found them to be woefully inaccurate, even though the managers had a good deal of experience with similar projects. Given what is known about the many factors contributing to inaccurate learning and incomplete recall (Nisbett & Ross, 1980; Kahneman, Slovic, & Tversky, 1982) and to motivational distortions in sharing information (Huber, 1982), it is not at all surprising that the human components of organization memories are less than satisfactory.

The problem of poor memory is, however, much more complex than simple considerations of the deficiencies of humans as repositories of organizational information and knowledge might suggest. Everyday observations make clear (a) that personnel turnover creates great losses of the human components of an organization's memory; (b) that nonanticipation of future needs for certain information results in great amounts of information not being stored or if stored not being easily retrieved; and (c) that information is often not shared by organizational members. For at least these reasons, organizational information and knowledge frequently are less available to decision makers than they would wish.

What are the effects of computer-assisted communication and decision-support technologies on the nature and quality of organizational memory? One answer to this question follows from the fact that more and more organizational activities are conducted or monitored using computer-assisted technology. For instance, it is possible to obtain and maintain information about the times necessary to carry out many organizational activities just as readily as it is to obtain and maintain information about the financial expenditures necessary to carry out the activities (e.g., times necessary to fabricate certain products, to receive shipments, to recruit or train employees, or to deliver services). With sufficient foresight such information can be readily indexed and retrieved through computer technology (Johansen, 1988). Although much orga-

nizational knowledge is computer-resident at some point, its users often do not recognize its potential usefulness for future decision making.

Another type of useful computer-resident information is information that is exchanged across the organizational boundaries. In the future, smart indexing (cf. Johansen, 1988) or artificial intelligence will facilitate retrieval of this transaction information and will result in computer-resident organizational memories with certain properties, such as completeness, that are superior to the human components of organizational memories. Ongoing increases in the friendliness and capability of computer-based information retrieval systems suggest that today and even more so in the future:

Proposition 8: Availability of computer-based activity and transaction-monitoring technologies leads to more frequent development and use of computer-resident data bases as components of organizational memories.

Research is needed to understand what incentives are necessary for those organizational members whose actions produce the data to share it or to maintain its quality.

Since much of what an organization learns through experience is stored in the minds of its members, many organizations nurture members who are expert with respect to an intellectual task such as (a) diagnosing quality problems or equipment malfunctions; (b) learning the identities of extraorganizational experts, influence peddlers, resource providers, or other useful nonmembers; and (c) locating information or resources that cannot be located using official, standard sources. As the processes for eliciting knowledge, building expert systems (Welbank, 1983), and validating information (O'Leary, 1988) become standardized, organizations are creating computer-based expert systems using the knowledge of their own experts (Rao & Lingaraj, 1988; Rauch-Hindin, 1988; Waterman, 1986). These expert systems have properties such as accessibility, reliability, and "own-ability," that are both superior to humans and useful as components of organizational memories. Thus, even though expert systems have properties that are inferior to human experts, it seems reasonable to believe that:

Proposition 9: Availability of more robust and user-friendly procedures for constructing expert systems leads to more frequent development and use of in-house expert systems as components of organizational memories.

How do experts react when asked to articulate knowledge and, perhaps, their secrets, so that these can be incorporated into software that might diminish their importance? How do local managers react in such a situation when their influence and status, which are derived from this information or knowledge, is lessened by giving others the ready access to expert systems possessing much of this local information or knowledge? What incentives are appropriate and effective for motivating experts to explicate their knowledge so that it can be used without their future involvement? These are questions in need of investigation.

Propositions 8 and 9 suggest that certain advanced information technologies increase the range of memory components for an organization, just as other advanced information technologies increase the range of media with which the organization can communicate its information and knowledge.

Effects on Other Design Variables

Before leaving this discussion of organizational design variables, it seems useful to comment on the effects of advanced information technologies on some design variables that have not yet been explicitly mentioned: (a) horizontal integration, (b) formalization, (c) standardization, and (d) specialization. *Horizontal integration*, important as it is, requires little additional comment. Since it refers to the use of communication structures and processes for facilitating joint decision making among multiple units or individuals, the effects are the same as those discussed in Propositions 1, 2, and 3, and, as will be seen, in Proposition 14.

Formalization is used to ensure adherence to

standards, especially when behavioral norms cannot be counted on to provide the desired behavior. Thus, early in the adoption of any new technology, because the required norms have not had time to develop and to take hold, the level of formalization is often high. (Of course, very early in adoption, standards might not exist, so control might not be exercised through either norms or formalization.) As the new technology becomes familiar and "ages," it seems reasonable to believe that the degree of formalization associated with it approaches the degree of formalization associated with the technology being replaced. Consequently, the long-term effect of new technology on formalization might be nil. Although advanced information technology greatly facilitates the recording and retrieval of information about organizational events and activities and, thus, makes control of behaviors and processes through formalization more viable, the use of advanced information technology for closely controlling intelligence development and decision making has not been reported in the literature, to my knowledge. This may be due to the frequent need for initiative and nonroutine activities by those engaged in these processes (cf. Wilensky, 1967). (For a discussion of the use of advanced information technology for controlling other behaviors and processes in organizations, see Zuboff, 1984.)

Standardization is the reduction of variability in organizational processes. As noted earlier, advanced information technologies have greatly increased the range of communication and decision procedures. If organizational members can use discretion when choosing which information technology to use (and such discretion seems commonplace), the variation of technologies will increase, and standardization will decrease: This is so apparent that no proposition is needed.

With regard to *specialization*, advanced information technology can either lead to the addition of job categories (e.g., computer programmer) or the deletion of job categories (e.g., bookkeeper), and, therefore, will affect the degree of specialization within the organization. However, such specialities support, make operational, or become part of technologies. The increase or decrease in the variety of support personnel has little or no impact on intelligence or decision making, independent of the technologies. For this reason, *specialization* was not discussed as a design variable that affects organizational intelligence and decision making.

Propositions 1 through 9 describe the effects that advanced information technologies have on those aspects of organizational design that, ultimately, influence organizational intelligence and decision making. The next section deals with more direct effects of the technologies on organizational intelligence and decision making and, ultimately, on organizational performance in these areas. Of course the development of organizational intelligence and the making of decisions are organizational processes inextricably intertwined with an organization's design. The present conceptual separation of these processes from design is primarily for expository purposes.

Effects on Organizational Intelligence and Decision Making

This section sets forth two propositions dealing with information acquisition and then three propositions concerned with decision making and decision authorization.

Environmental Scanning and Organizational Intelligence

To some degree, all organizations scan their external and internal environments for information about problems or opportunities. Yet sometimes managers do not learn about problems or opportunities in time to act with maximum effectiveness. In many cases the alerting message is delayed as it moves through the sequential nodes in the communication network. In other instances incumbents of adjacent nodes in the communication network have difficulty connecting across time, as in "telephone tag." *What is the effect of advanced information technologies*

on these impediments? What is the effect on information acquisition overall? With regard to these questions, recall that the reasoning surrounding Proposition 7 suggested that the use of computer-assisted information processing and communications technologies leads to rifle-shooting of messages and ultimately to fewer intermediary nodes in the information processing network. This idea, in combination with the fact that the probability and duration of message delay and the probability and extent of message distortion are both positively related to the number of sequential links in the communication chain connecting the receiver to the information source, suggests that use of computer-assisted information processing and communication technologies would facilitate rapid and accurate identification of problems and opportunities.

A contrary line of reasoning exists, however. Since an important role of many information network nodes is to screen, package, and interpret messages, the use of advanced information technologies and the consequent elimination of nodes can result in an overload of irrelevant, poorly packaged, or uninterpretable messages. One study indicated that this danger may not be as serious as it appears. Hiltz and Turoff (1985) found that social norms and management practices tend to develop to reduce the problem to a level below what might be imagined. It is likely that computer-assisted technologies will be used to enhance information retrieval, especially from lower organizational levels and outside sources. Thus, on balance:

> *Proposition 10: Use of computer-assisted information processing and communication technologies leads to more rapid and more accurate identification of problems and opportunities.*

Use of these technologies can aid not only in the identification of problems and opportunities, but also in a wide variety of more focused probes and data acquisitions for the purpose of analysis. Recalling Mintzberg et al.'s (1976) *active search*, and Mintzberg's (1975) notion that managers require timely information, consider that computer-assisted information systems can bring facts to the organization's decision makers almost immediately after the facts occur (e.g., check-out scanners and commodities market data).

Together, technologically advanced systems for the acquisition of external information and the development of computer-enhanced organizational memories enable organizations to increase the range of information sources that the producers and users of organizational intelligence can draw upon. Thus, in summary:

> *Proposition 11: Use of computer-assisted information storage and acquisition technologies leads to organizational intelligence that is more accurate, comprehensive, timely, and available.*

This proposition is based on the assumption that the external information sources are accurate, comprehensive, timely, and available. Otherwise, garbage in, garbage out.

A matter of some interest is how inclined information users are to employ accessible sources, rather than those with the highest quality information (cf. Culnan, 1983; O'Reilly, 1982). How computer-assisted communications and information acquisition systems affect the trade-off between perceived accessibility and perceived quality, and the resultant information-seeking behavior, is an issue much in need of investigation.

Decision Making and Decision Authorization

It is reasonable to believe that the quality of an organizational decision is largely a consequence of both the quality of the organizational intelligence (as implied in Proposition 11) and the quality of the decision-making processes. Further, the discussion associated with Propositions 1 and 3 (and perhaps other of the propositions related to organizational design) strongly suggests that, by facilitating the sharing of information, computer-assisted communication technologies increase the quality of decision making, and that by aiding in the analysis of information within decision units, computer-assisted

decision-aiding technologies increase the quality of decision making. Thus, in helping with Propositions 1, 3, and 11:

Proposition 12: Use of computer-assisted communication and decision-support technologies leads to higher quality decisions.

Because reducing the number of levels involved in authorizing an action will reduce the number of times the proposal must be handled (activities of a logistical, rather than a judgmental nature), it seems likely that:

Proposition 13: Use of computer-assisted communication and decision-support technologies reduces the time required to authorize proposed organizational actions.

Authorization as a particular step in the decision-making process has received little attention from organizational scientists (for exceptions, see Carter, 1971; Gerwin, 1979), and the time required for organizations to authorize action also has received little attention (for exceptions, see Mintzberg et al., 1976; Shumway et al., 1975). These topics are worthy candidates for study in general, and the potential effects of information technology seem to be especially in need of examination, given their probable importance and the total absence of systematic research on their effect on decision authorization.

Once a problem or opportunity has been identified, several types of activities are undertaken that might be more effective if undertaken using advanced information technology. For example, management information systems and electronic mail might enable decision makers to immediately obtain the information they seek when deciding what to do about problems and opportunities (see Proposition 11). Decision-support systems might enable decision makers or their assistants to analyze this information quickly (at least for some types of problems). Electronic mail and video- or teleconferencing might help decision makers obtain clarification and consensus without the delays imposed by the temporary nonavailability, in terms of physical presence, of key participants (see Proposition 1). Finally, forms of advanced information technology might reduce the time required to authorize proposed organizational actions (see Proposition 13). These facts suggest that:

Proposition 14: Use of computer-assisted communication and decision-support technologies reduces the time required to make decisions.

Available evidence supports this proposition:

> For instance, managers in the Digital Equipment Corporation reported that electronic mail increased the speed of their decision making and saved them about seven hours a week (Crawford, 1982). Managers at Manufacturers Hanover Trust reported that electronic mail saved them about three hours a week, mostly by eliminating unreturned phone calls and internal correspondence (Nyce & Groppa, 1983). (Sproull & Keisler, 1986, p. 1492)

However, studies employing casual self-report data need to be supplemented with more systematic studies, such as some of those noted by Rice and Bair (1984). Sophisticated studies may find that the actual reduction in time is marginal, and that the net benefit may be offset to some extent by the losses in decision quality that may follow from a reduction in the time spent cogitating, as noted by Weick (1985).

Toward a Conceptual Theory

Extensive organizational use of advanced information technologies is too new, and systematic investigation of their use is too limited, for a theory of their effects to have evolved and received general acceptance. As a result, the propositions set forth here were not derived from a generally accepted theory. Instead, they were pieced together from organizational communication and information systems research, extrapolating only when it seemed reasonable.

A *theory* may be defined as a set of related propositions that specify relationships among variables (cf. Blalock, 1969, p. 2; Kerlinger, 1986, p. 9). The set of propositions set forth in this article, related to one another (at the very least) through their possessing a common independent variable, advanced information technol-

ogy, passes this definitional test of a theory. Yet, more is expected from a theory, such as a framework that integrates the propositions.

If other connecting relationships can be found to link them, perhaps the propositions of this paper can serve as building blocks for the development of a less atomistic, more conceptual theory. The result would, of course, be quite tentative, in that the propositions require additional substantiation and in that any one author's connective framework must be subjected to review, critique, and discussion across an extended period before gaining general acceptance. As a step in the development of a conceptual theory of the effects of advanced information technologies, the following concepts and constructs are offered. The constructs summarize and the concepts connect ideas that were mentioned previously but served a different purpose at the time.

Concept 1: Advanced information technologies have properties different from more traditional information technologies. *Availability of advanced information technologies* (Construct A) extends the range of communication and decision-making options from which potential users can choose. On occasion a technology will be chosen for use, and when chosen wisely—such that the chosen technology's properties better fit the user's task—use of the technology leads to improved task performance. This reinforcement in turn leads to more frequent *use of advanced information technology* (Construct B).

Concept 2: Use of advanced information technologies (Construct B) leads to more available and more quickly retrieved information, including external information, internal information, and previously encountered information, and thus leads to *increased information accessibility* (Construct C). Concept 2 follows from Propositions 1, 4, and 7 through 11.

Concept 3: Increased information accessibility (Construct C) leads to the *changes in organizational design* (Construct D). Concept 3 follows from Propositions 1 through 7.

Concept 4: Increased information accessibility (Construct C), and those *changes in organizational design* (Construct D) that increase the speed and effectiveness with which information can be converted into intelligence or intelligence into decisions, lead to organizational intelligence being more accurate, comprehensive, timely, and available and to decisions being of higher quality and more timely, decisions that lead to improvements in *effectiveness of intelligence development and decision making* (Construct E). Concept 4 follows from Propositions 11 through 14.

These constructs and concepts are summarized in Figure 1.

Summary and Recommendations

In the form of propositions and their corollaries, this article sets forth a theory concerning the effects that computer-assisted communication and decision-aiding technologies have on organizational design, intelligence, and decision making. Subsequently, the propositions were connected with constructs and concepts, and from these a more conceptual theory was developed.

Some boundaries on the original theory (here called *the theory*) were delineated early in the paper. The theory is, nevertheless, a candidate for elaboration and expansion. For example, it was not possible, within the space available, to extend the scope of the theory to include propositions having to do with the effects of advanced information technologies on the distribution of influence in organizational decision making (see Zmud, in press). Examination of some relevant literature makes clear that numerous propositions would be necessary because (a) the technologies may vary in their usefulness for generating the particular types of information used by decision participants having different sources of influence, (b) the technologies may vary in their usefulness for enhancing the image or status of participants having different organizational roles, and (c) the technologies may vary in their usefulness to different types of participants as aids in the building of decision-determining co-

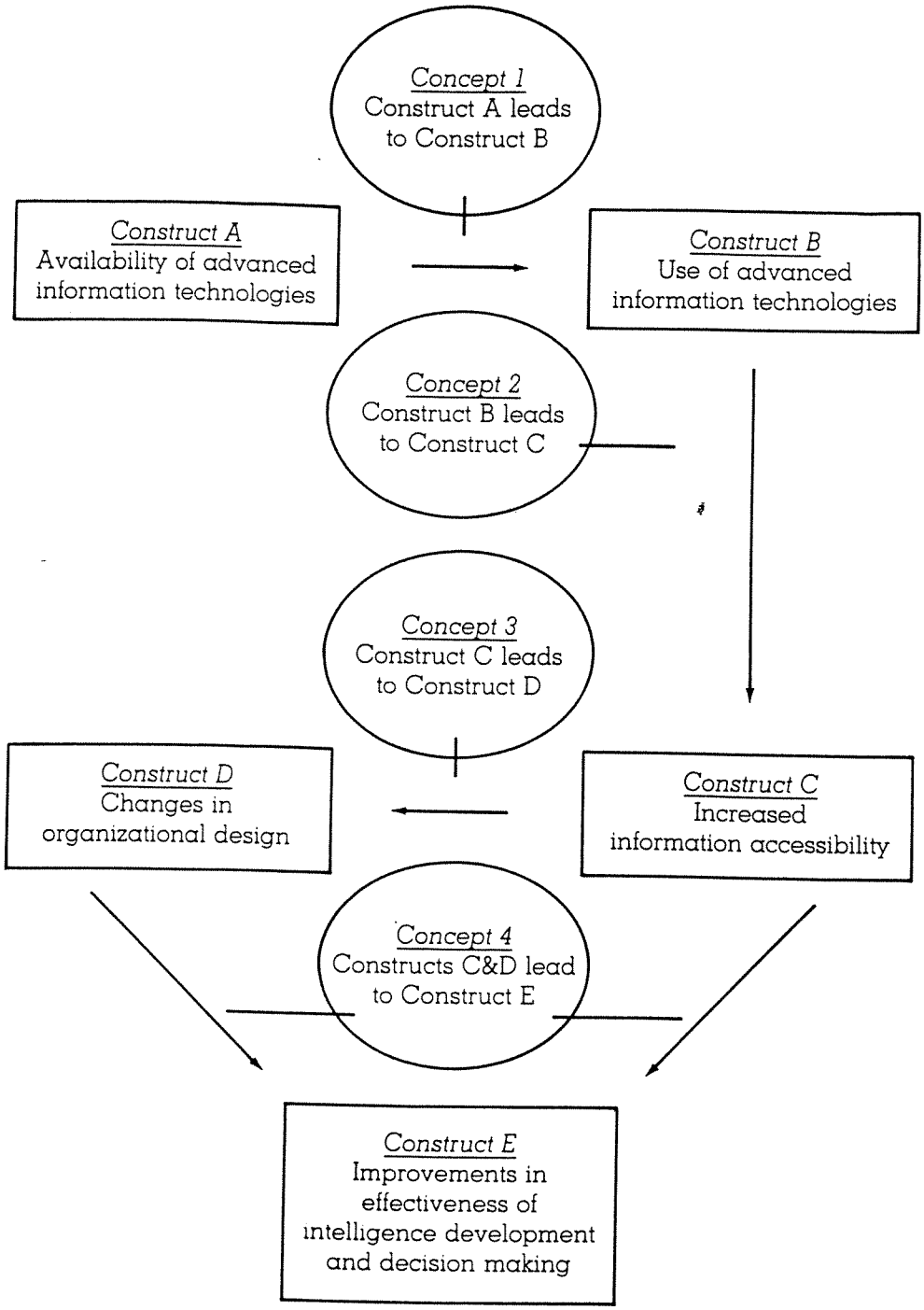

Figure 1. **Conceptual theory of the effects of advanced information technologies on organizational design, intelligence, and decision making.**

alitions. Certainly, the theory is a candidate for elaboration and expansion, just as it is a candidate for empirical testing and consequent revision.

The process used to generate the propositions comprising the theory included drawing on components of established organization theory and on findings from communication and information systems research. Specific suggestions were made, with respect to many of the propositions, about matters in need of empirical investigation. In addition to these specific suggestions, three somewhat more global recommendations are in order. The first is directed to any researchers exploring the effects of advanced information technologies. In this article, different forms of advanced information technology were discussed by name (e.g., electronic mail) yet the propositions were stated in general terms. This latter fact should not obscure the need to specify more precisely the particular technology of interest when developing hypotheses to be tested empirically. As more is learned about the effects of computer-assisted communication and decision-support technologies, it may be found that even subtle differences count (cf. the discussion by Markus & Robey, 1988). Even if this is not so, as researchers communicate about these matters among themselves and with administrators, it behooves them to be clear and precise about what it is that they are discussing.

The second suggestion, directed to organizational researchers, is to believe (a) that information technology fits within the domain of organization theory and (b) that it will have a significant effect on organizational design, intelligence, and decision making. Organization researchers, in general (there are always welcome exceptions), may not believe that these technologies fit within the domain of organization theory. This would be an erroneous belief. Organization theory has always been concerned with the processes of communication, coordination, and control and, as is apparent from the research of communication and information systems researchers (Culnan & Markus, 1987; Rice & Associates, 1984), the nature and effectiveness of these processes are changed when advanced information technologies are employed. Organizational researchers also may not have recognized that organizational designs are, at any point in time, constrained by the capability of the available communication technologies. Two of the infrequent exceptions to this important observation are cited by Culnan and Markus (1987):

> Chandler (1977) for example, argues that the ability of the telegraph to facilitate coordination enabled the emergence of the large, centralized railroad firms that became the prototype of the modern industrial organization. Pool (1983) credits the telephone with the now traditional physical separation of management headquarters from field operations, and in particular with the development of the modern office skyscraper as the locus of administrative business activity. (p. 421)

Also, Huber and McDaniel (1986) state that:

> Without telephones corporations could not have become as large as they have; without radios military units would be constrained to structures and tactics different from those they now use; without computers the processes for managing airline travel would be different from what they are. Any significant advance in information technology seems to lead eventually to recognition and implementation of new organizational design options, options that were not previously feasible, perhaps not even envisioned. (p. 221)

Since information technologies affect processes that are central to organization theory, and since they also affect the potential nature of organization design (a principal application of organization theory), a corollary of this second global recommendation is added: Organizational researchers should study advanced information technology as (a) an intervention or jolt in the life of an organization that may have unanticipated consequences with respect to evolved organizational design, (b) a variable that can be used to enhance the quality (broadly defined) and timeliness of organizational intelligence and decision making, and (c) a variable that enables organizations to be designed differ-

ently than has heretofore been possible. (A review of recent discussions of emerging organizational and interorganizational forms [Borys & Jemison, 1989; Luke, Begun, & Pointer, 1989; Miles & Snow, 1986; Nadler & Tushman, 1987] suggests that use of computer-assisted communication technologies can enhance the usefulness of such designs, requiring, as many will, communication among dispersed parties.)

The third global research recommendation is directed toward information systems researchers. It is straightforward. As is easily inferred by observing organizational practices, much information technology is intended to increase directly the efficiency with which goods and services are produced, for example, by replacing workers with computers or robots. But organizational effectiveness and efficiency are greatly determined by the quality and timeliness of organizational intelligence and decision making, and these, in turn, are directly affected by computer-assisted communication and decision-aiding technologies and are also indirectly affected through the impact of the technologies on organizational design. Therefore, it is likely that administrators will ask information systems researchers to help anticipate the effects of the technologies. In addition, builders and users of computer-assisted communication and decision-aiding technologies generally do not explicitly consider the effects that the technologies might have on organizational design, intelligence, or decision making. Thus, information systems researchers should arm themselves with the appropriate knowledge by increasing the amount of their research directed toward studying the effects that advanced information technologies have on organizational design, intelligence, and decision processes and outcomes.

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