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**Information Technology  
and Work Organization**

Kevin Crowston  
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**Working Paper**

**Management in the 1990s**



Massachusetts Institute of Technology  
Sloan School of Management



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that systems designed to simply automate existing procedures tended not to lead to any organizational changes.

Past studies of IT have viewed it in different ways. Markus and Robey (in press) identify three different conceptions of IT. First, a researcher can simply measure IT as an independent variable, and attempt to correlate its use (and perhaps other factors) with organizational changes. Alternately, IT can be analyzed as a special kind of production technology. For example, some researchers (e.g., Woodward, 1980; Perrow, 1979) have suggested ways in which an organization's structure depends on the nature of the technology it uses. Finally, the use of IT may be an alternative organizational design strategy. For example, Galbraith (1974, 1977) suggests ways in which an organization can increase its information processing capacity, including through the use of IT.

One distinction we will make is between the use of IT as a production technology and as a coordination technology. IT can be used as a production technology, to directly produce some output, for example, by producing account statements in a bank, by keeping track of policy holders in an insurance company or controlling a machine tool in a factory. These uses should be distinguished from the use of IT as a coordination technology, for example, by providing the data necessary to more closely integrate two stages in a production line or to better make some decision.

#### **2.4. The link between structure and technology**

The final necessary component of a theoretical basis for research in this area is a link between some aspects of the two bodies of theory outlined above. Unfortunately, few past studies have been explicit about the nature of the link they were drawing. Markus and Robey (in press) discuss three different kinds of links that have been used in past research: the technological imperative, the organizational imperative and the interactionist perspective.

*Technological imperative* The technological imperative assumes that the technology will have some determined effects on the structure of the firm (see Figure 1). For example, Woodward (1980) found that formality of the structure of a company seemed to depend on the type of production technology used: job shops using unit production were relatively informal, mass production companies were much more formal and continuous flow production companies were again informal. The focus of research is predictive, in that it attempts to predict what changes will occur in response to the use of IT.

This view can be somewhat adapted by assuming that the effects of IT are contingent on other factors, such as the environment of the firm. There are, however, many possible other factors that need to be examined. For example, Leavitt and Whisler (1958) hypothesized that different groups would be differently affected because they differ in ease of measurement of outcomes, economic pressures and acceptance of programming of jobs.

*Organizational imperative* A second view Markus and Robey call the organizational imperative. This view reverses the direction of causality by assuming that managers make organizational changes (including adopting certain kinds of IT) in response to certain organizational needs (see Figure 2). Markus and Robey describe this view as prescriptive, since most authors have attempted to suggest what IT a manager should use under different conditions. For example, Galbraith (1974, 1977) gives four methods to increase organizational information processing capacity. This view focuses on the intentions of managers, however, ignoring possible unintended side effects of the use of IT. It also discounts possible non-rational goals for using IT, such as increasing political power. Furthermore, such studies have only mixed empirical support. For example, Child (?) found no conclusive evidence that organizations with different forms performed differently under the same conditions.

*Interactionist perspective* A final view suggested by Markus and Robey is an interactionist perspective, which holds that the result of the use of IT is a complex interaction between what the

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technology allows and what the organization and the managers want (see Figure 3). They point out that unlike the other perspectives, this view does not allow predictions about the effect of IT. In fact, they claim that this view shuns prediction for understanding the underlying reasons for a change, leading to a focus on *post hoc* analyses. Such an approach may, however, be most appropriate for studies of complex organizations, which are affected in many ways besides by technology.

We take a modified interactionist point of view. We believe that in many cases IT acts as an enabling factor that makes certain kinds of organizational change possible. If those changes are desirable, they may then occur. Certain kinds of change may be especially desirable, and thus especially common, but different effects are still possible. Kling (1980) expresses a similar view, noting that IT does not have deterministic impacts, but rather common impacts that may differ under different conditions, depending on the particulars of the organization being studied, the way the technology is used, and, perhaps most importantly, on the goals of those using it. Rather than attempting to predict changes due to particular systems, then, we hope to suggest conditions under which different uses of technology are likely to be desirable.

### 3. Survey of Empirical Research

Our aim in studying past research is not to predict what must happen, but rather to illuminate possible outcomes, including some that may not usually be considered, and to suggest the factors that lead to these outcomes. To do this we will present a variety of scenarios as examples of possible changes. In each case we will attempt to tell a plausible story about how the IT had the effect observed.

As a basis for this presentation we will draw on a number of different kinds of evidence. First, this subject has been a source of much interest and coverage in the popular business press. These articles

describe the experiences of specific firms, and provide a number of interesting examples of effects that IT could have. On a more rigorous theoretical level is a long tradition of studies of the links between different kinds of production technology and aspects of organizational structure. A number of writers have summarized this body of literature (Fry, 1982) and we will attempt to determine where these findings are applicable. Finally, there are many studies of the impact of IT in particular, and some summaries of this body of research (Attewell and Rule, 1984, Robey, 1981, Rice, 1980)

Unfortunately, this body of literature has several limitations that make it difficult to draw general conclusions. First, the findings are mostly out of date, most of the studies are more than five years old, and the data they draw on are older still. These studies examine traditional applications such as payroll systems, while the technology has rapidly advanced. There are few studies that investigate the use of technologies such as personal computers or electronic mail, even though these kinds of applications are likely to have enormous and quite different impacts. Second, it is difficult to generalize from these earlier studies because they were often quite vague about how the technology was actually being used. This makes it difficult to trace out the mechanism through which some application affected the firm. Finally, the methodologies employed were sometimes weak, making the strength of the conclusions questionable.

Studies of the organizational effects of IT have viewed IT and organizations in different ways and many effects have been noted. Each organizational perspective suggests different kinds of effects that should be studied. To organize our survey, therefore, we have grouped the effects based on the four perspectives discussed above (see Table 1). Some effects (such as centralization) have been widely studied, however, and we will survey these issues from multiple perspectives.

### 3.1. Rationalist perspective

In this section we will draw mainly from classical organization theory, with its focus on rationality and efficiency. We will consider several features of organizations suggested by this perspective. First, we will examine a number of interrelated aspects of the level of employment. Second, we will consider centralization, specifically, changes in the locus of organizational decision making. We will conclude by briefly discussing two other structural features: the degree of specialization and differentiation between jobs and the overall degree of formalization in the firm.

### *3.1.1. Employment*

Organizations differ in size, and intuitively we expect different size organizations to behave differently. Differences in size are reflected in several interrelated measures, including the number of employees, the number of levels of management in a hierarchical organization, the number of employees reporting to a specific manager (the manager's span of control), and the ratio of production workers to administrative workers in a firm (the firm's administrative intensity). Obviously, these features are interrelated, and a change to the structure of an organization may affect a combination of them. For example, a firm may reduce its head count either by eliminating some employees from all parts of the organization, reducing the number of employees reporting to a single manager, or even by eliminating an entire level of management.

Studies of these aspects of size have not found consistent results. This is partly because there may be no general effects. In addition, however, past studies have often treated these various factors independently, making it difficult to see any more general patterns. In addition, different uses of IT have not been separated, further clouding the issue, since the actual effect seems to depend heavily on how the technology is used. In this section, we will differentiate between the use of IT for production and for coordination functions.

An early common prediction was that widespread use of IT would replace most routine workers, thus causing massive unemployment (*e.g.*, Myers, 1967. Mumford, 1967), and in fact, systems have often been cost justified on the basis of reductions in numbers of employees (*e.g.*, Matteis, 1979). For instance, Rice (1980) cites a study of 33 companies (Sanders, 1977) in which 90% reduced employment (one laying off thousands of workers) or increased output with the same staff. The prediction of an overall reduction in employment due to the use of IT is difficult to support empirically, however, as most studies have been cases, examining only a few firms or a few industries, and more comprehensive census data are difficult to interpret unequivocally (Attewell and Rule, 1984). Furthermore, other factors may more strongly affect employment, masking the effect of the use of IT.

In fact, it is interesting to note that IT may, in some cases, increase rather than decrease employment. For instance, Osterman (1986) suggests several means by which the use of IT may affect clerical employment. First, computers might be used simply to replace clerks. Second, the use of IT may itself create some new jobs, such as data entry clerks, or positions in the data processing department. Third, the use of computers may make the firm more efficient, increasing the demand for its products and thus indirectly its total level of employment. Finally, coordination may be viewed as a complementary input in the production process. For instance, if IT makes coordination more effective and less expensive, the demand for coordination and therefore for both IT and the clerks who provide it may increase. This analysis holds only for coordination functions, however, suggesting that clerks employed in production functions are more likely to be displaced by the use of IT. The total effect of the use of IT on the employment of managers may be less, since fewer managers are involved in production rather than coordination functions. Osterman combined these effects in a microeconomic production function, and attempted to calculate the rate of substitution between clerks and computers.

Using census data from 1970 through 1978, he found that the use of computers initially led to decreased employment, but that this effect was partially offset by a subsequent increase in employment due to increased amounts of coordination. As he points out, however, this later increase may involve a different set of workers than were initially displaced.

### 3.1.1.3. Administrative intensity

The jobs of most managers are so far less affected by automation of production functions than those of clerks. In this case, the decreased numbers of production workers and unchanged number of managers and other coordination workers indicates that the administrative intensity (the ratio of administrative to production workers) may actually be increased by the use of IT to automate production functions. Osterman also suggests that the use of IT will affect the jobs of workers in production more than those in coordination functions, again increasing administrative intensity. A number of studies are consistent with this general prediction. For instance, Stabell and Forsund (1983) found that increased use of computers is associated with higher levels of administrative intensity. Scharek and Barton (1975) note a reduction of low level personnel. Whisler (1970a) found the companies he studied reduced the number of clerical employees they employed, but the supervisory and managerial levels stayed about the same. Blau *et al.* (1976) and Rice (1980) also note a raised proportion of professionals and Business Week (1984) describes a firm that changed from 70% clerical to 60% professional, with an overall reduction of 20%. Zuboff (1983b) and Nolan and Pollock (1986) describe this change graphically as a shift from a triangular hierarchy to a diamond shaped firm, thicker in the middle than at the bottom or top.

### 3.1.1.4. Levels of hierarchy

One of Leavitt and Whisler's (1953) original predictions is that the number of levels of hierarchy in organizations will decrease as computers are used to perform the functions of those middle managers. So far, however, there is no conclusive evidence that this prediction has been realized. Changes in levels of hierarchy seem to depend heavily on the way the IT is used, and different studies have reported opposite findings. Business Week (1984), for example, discusses firms that are replacing bureaucratic functions with computers and thus trimming the number of levels of hierarchy. Also, Crowston, Malone and Lin (in press) studied the use of a computer conferencing system used to help eliminate a level of hierarchy. They found, however, that new central staff specialist positions were created at the same grade level as those eliminated, leaving the total employment approximately unchanged. Whisler (1970a) found little evidence of changes in hierarchical levels in his studies, but noted one case where the number of levels increased at the upper level and decreased at the lower level, keeping the total the same. Blau *et al.* (1976) hypothesized that IT could actually increase the levels of hierarchy, since it could be used as an impersonal means of control, and shorten the feedback loop even if the number of levels is increased. Similarly, Pfeffer and Leblebici (1977) found that the use of IT as a means of control led to more levels of hierarchy and more departments when controlling for the size of the firm.

### *3.1.2. Centralization and decentralization*

Centralization is perhaps the mostly commonly investigated organizational effect of the use of IT. When this literature is examined, however, it becomes apparent that the concept of centralization has been variously defined and the effect of IT will differ depending on which construct is examined. We will examine mainly centralization or decentralization of decision making. Even so, IT may affect decisions differently, simultaneously causing both centralization and decentralization.



We can think of the use of IT as a means of reducing the cost of coordination. This often seems to lead to increased centralization, but this effect is not inevitable. We will examine two kinds of reasons—economic and motivational—for why an organization might choose to either centralize or decentralize and we will suggest how cheaper coordination can aid either process

### 3.1.2.1. Economic reasons

*Reduction of buffer inventories.* One motive for centralizing is the reduction of buffer inventories between groups by more tightly coordinating their interaction (e.g., "just-in-time" inventories). This closer integration often requires some decisions to be made at a higher level and implemented by each group. In some cases, IT is used explicitly for coordination. For example, production scheduling systems attempt to more closely coordinate deliveries of raw materials with their use, thus requiring closer cooperation between the purchasing and production departments. Argyris (1970) hypothesized that IT might be used to increase integration between departments and thus reduce the level of interdepartmental competition. Mann and Williams (1960) and Whisler (1970a) note a related effect. In some cases, low level workers in different departments can not simply work out a solution to some shared problem, as they might have in the past, because their results must fit an often inflexible information system. Instead, intervention by higher levels of management and by the data processing staff is required, thus increasing centralization.

*Economies of scale.* Another reason to centralize is to take advantage of economies of scale. In general, as a functional group grows, it becomes more efficient in production, since it can take advantage of economies of scale and share capacity between the different parts of the firm that require its services. For example, a centralized copying center can realize several advantages. First, since it does more copying, a central service can purchase paper and other raw materials in bulk and buy larger and more efficient copiers. Since the service is shared between many users, there is less

variation in the load, so each machine can be used more efficiently. Furthermore, the service can afford to buy more specialized, but less frequently used equipment and train people in its use. These increased efficiencies are offset, however, by the increased cost of coordination, both within and between groups. For example, to get service from such a centralized copying plant might require filling out a requisition, arranging for billing, delivery, etc., increasing the service time. Rush service might be difficult or expensive to negotiate. Furthermore, the central service will need a manager, and perhaps other administrative personnel to ensure its smooth operation. If each department had its own private copier, many of these costs would disappear. Increased use of IT may reduce the cost of the necessary coordination, thus favoring increased centralization. A shift to functional hierarchies is noted by Scharek and Barton (1975). Whisler (1970a) reports the replacement of departments selling different types of insurance with functional departments performing specific tasks for all policies. Osterman (1986) and Rice (1980) both discuss the use of task pools for word processing or routine clerical operations, another form of functional specialization. Malone and Smith (1984) and Malone (in press) present a simplified model of an organization based on the information processing necessary to coordinate the assignment of tasks to different agents within the organization. Using this model, they identify tradeoffs between different organizational structures based on their production and communication costs and robustness of the organization in face of the failure of agents. Malone and Smith (1984) show how this model is consistent with the historical development of American firms (e.g., as discussed by Chandler (1962)) and argues that as the use of IT decreases coordination costs, the tradeoff shifts in favor of functional hierarchies.

As the cost of coordinating decreases further, however, more decentralized organizational forms such as markets may become desirable (Malone and Smith, 1984). Markets are assumed to have lower production costs, since they can further exploit economies of scale and average uncorrelated demand across many firms, but higher coordination costs, since more communication is necessary to find a

supplier, and contracting with an outside party involves higher levels of risk and uncertainty. As the cost of coordination drops, however, these factors become less important. Malone, Benjamin and Yates (1987) argue similarly that the use of IT may lead to the increased use of markets and especially of computer mediated markets, which may offer more efficient coordination.

The use of IT may also allow physical decentralization of work. Many organizations are already geographically dispersed and coordinated using telecommunications. Olson (1982) suggests that "telecommuting" may allow individuals to work at home instead of at a central office. Becker (1986) presents a number of arguments against home work, and suggests satellite work centers instead.

### 3.1.2.2. Motivational and political reasons

Another commonly discussed possibility is that centralization of decision making is inherently desirable to managers, and decentralization takes place only because no single person can control the necessary resources (*e.g.*, information, employees) due to limitations in human information processing capacity (Simon, 1957). These constraints force managers to delegate control over some decisions in order to focus on more important issues (Schultz and Whisler, 1964). The use of IT may lessen these constraints in two ways, first by providing easier access to and facilitating more complete analyses of data about the operations of the firm, and second by providing a mechanism to program jobs and to control workers. The use of IT may thus permit decisions to be made at a higher level and ensure their implementation by subordinates. Leavitt and Whisler (1958) and Pfeffer (1978) both suggest that IT can make centralization possible and that firms will therefore recentralize. As Zuboff (1983a) points out, it may often be difficult for a manager to have data about a problem and refrain from acting on it.

Alternately, a manager might want to encourage decentralization of decisions to increase worker autonomy (which may be desirable for reasons discussed below). Some authors have predicted that IT

will encourage greater participation in decisions by lower level workers. IT provides ways to control the premise of the decision, by allowing more equal access to data or by controlling the way in which a decision is made, and to monitor the results, by providing quicker feedback. Given the ability to ensure that decisions are made consistent with their wishes, managers may be willing to delegate the actual decision. Systems used to provide individual support may also encourage decentralization, as they increase an individual's capacity to analyze data or enforce the use of common decision analysis tools. IT can also support lateral ties between low level workers, allowing them to more easily exchange information and thus coordinate their own activities, as suggested by Galbraith (1974, 1977) and found by Robey (1981).

### *3.1.3. Other structural features*

#### *3.1.3.1. Differentiation*

Another possible impact of the use of IT is the development of increasingly differentiated or segmented jobs. Differentiation is difficult to define or measure precisely. Researchers in this area have measured, for example, the number of job titles used in a given organization or the number of different departments. It seems certain that the use of IT will require some new jobs and departments, such as a data processing or telecommunications group, if only to manage the complex technology. Carter (1984), for example, found that the use of IT in newspapers did lead to the creation of new specialties, such as data processing manager. It is less clear how the use of IT will affect other functions in an organization. Earlier, we argued that IT could lead to a reintegration of some tasks (e.g., handling all aspects of issuing a letter of credit, instead of a single step in a multi-step process (Mateis, 1979)). Such a reintegration would reduce the differentiation between jobs or departments. Alternately, an increased level of functional specialization could increase the degree of differentiation. The empirical

evidence is mixed. Mohrman (1982) cites some evidence that technology reduces differences between different roles, while other researchers (e.g., Carter, 1984) report an increase.

### 3.1.3.2 Formalization

IT is often hypothesized to affect degree of formalization of organization. Here formalization refers to the degree to which the organization depends on formal rules and regulations in operation. An informal organization, sometimes called an organic organization, is one in which few rules and formal procedures are used. For example, companies with production lines often have rigid work rules, while most research laboratories are administered based on individuals' interactions and not formal rules.

The use of IT can affect the level of formality in an organization in many ways. Most older centralized transaction processing systems are inflexible. Since the systems can only do things in one way, rules are needed to limit actions to this process. The system itself embodies many rules about how the job should be done, again substituting the use of rules and regulations for individual decision making. A system may also make it easier to spot errors and identify their sources, thus further controlling work (Mann and Williams, 1960). On the other hand, Pfeffer (1978) points out that the use of IT may encourage the evaluation of outcomes instead of process, and make enforcement of rules both easier and less necessary by providing of quicker feedback about the outcomes of actions, thus decreasing formality. Finally, since smaller organizations are typically less formal, IT may decrease formality by reducing organizational size. For example, Woodward (1980) found that heavily automated manufacturers, such as oil refineries, had few actual production workers, thus reducing the level of formality among the remaining, mostly managerial or professional workers.

The use of IT for individual support or for communications may well have different effects. On the one hand, Olson (1982) notes that using telecommunications to allow workers to work at home resulted in

less personal interaction and therefore more formal evaluations. On the other hand, both Foster and Flynn (1984) and Pfeffer and Leblebici (1977) found that the use of IT could lead to less formalized interactions. Culnan and Markus (in press) cite research that showed how the use of electronic mail could undermine the formal hierarchy, again suggesting a decreased level of formality. Huber (1984) suggests that as informal processes or "soft" data become more important for organizations, these organizations may become more formal about ensuring their existence.

### **3.2. Information Processing Perspective**

One problem with classic organization theory is that in its focus on organizational structure, it does not address what IT is particularly useful for, namely, processing information. A potentially very useful way to examine the impacts of IT on organizations is to examine the kinds of information the organization uses and the ways it processes this information (Galbraith, 1974, 1977, Tushman and Nadler, 1978). Tushman and Nadler (1978: 292) outline three basic assumptions of such an information processing perspective: organizations must deal with work-related uncertainty; organizations can fruitfully be seen as information processing systems; and organizations can be viewed as composed of sets of groups or departments. In this view, organizational structure is the pattern and content of the information flowing between the subunits and the way they process this information.

#### *3.2.1. Patterns of communication*

IT can affect the pattern and content of organizational communications in many ways. First, the use of IT may lead to changes in the structure of an organization, leading to new patterns of communication or changes in the content or quantity of existing kinds of communication. Integrating jobs, a possible outcome of the use of IT, could lead to reduced needs for communication since a single

person could do the job with no need to communicate with co-workers, an effect noted by Whisler (1970b). For example, storing transaction data in a commonly accessible data base may make requests for information unnecessary. Such changes may also affect the level of social interactions that people experience. Some researchers claim that by integrating tasks, the use of IT eliminates the need and opportunity for workers to interact. For example, Crawford (1982), in a study of use of electronic mail, noted a decrease in the amount of face-to-face communication. Zuboff (1983b) hypothesized that social isolation will be further increased if workers can work at home instead of in an office. On the other hand, Foster and Flynn (1984) found that the use of IT can lead to increased personal contacts, suggesting that different uses of IT will have very different effects.

Second, IT may be used to provide new media for communication, such as electronic mail or computer conferencing, again leading to new patterns of communication. These kinds of systems have been somewhat more heavily studied, and a number of important characteristics of these systems have been identified. For example, computerized media might be preferable to other kinds of communication because it is potentially faster and cheaper (Crawford, 1982). Furthermore, computerized communications has a low incremental cost per message, that is, it costs the sender about the same to send a message to 1 person as it does to 2; if the system supports mailing lists, it may be as easy to send mail to hundreds of people, specifying only the name of the list. Crawford (1982) notes that this form of bulk mailing eliminates the need for secretaries to duplicate and mail multiple copies of memos. Finally, electronic mail or conferencing are asynchronous: only one of the recipients needs to be present at a time, making communications easier to arrange (*e.g.*, across time zones). By thus reducing the cost of communications, IT may make coordination less expensive, with the possible results discussed above. Huber (1984) suggests that such uses of IT will be necessary to allow organizations to deal with the more complex and more turbulent post-industrial environment, with more available information.

The ability to address communications by other than the name of the recipient (*e.g.*, to a mailing list for electronic mail, or to a specific conference for computer conferencing) means that a sender might not know the person with whom he or she is communicating, but only the area of interest. Computers could be used to better support this sort of communication. For example, the Information Lens system (Malone, *et al.*, 1987) is designed to help users of an electronic mail system get more of the information they are interested in and fewer unrelated messages.

### 3.2.2. Weak links

By providing new communications channels, computerized media may facilitate the formation of "weak" (acquaintance) ties. For example, Freeman (1984) studied use of computer conferencing by scientists and found that people became aware of each other and each others' work even though they had not met in person, and suggested that the computer system allowed these contacts to develop more easily. Easier formation of weak ties may also lead to a shift from hierarchical to "all-channel" communications in companies. Some studies have shown an initial increase in vertical communication, followed by a shift to more evenly distributed communications as new horizontal links are formed and the formal reporting system begins to decline in (relative) importance (Culnan and Markus, *in press*). (Interestingly, similar results have been noted for the introduction of the telephone, which provided comparable improvements over prior communications media.) Weak links can be valuable new sources of information (Feldman, 1986). Users of electronic mail in two studies reported that as many as 60% (Culnan and Markus, 1986) or 70% (Sproull and Kiesler, 1986) of the messages they received were messages that they felt they would not have got from another source and 50% of the messages they sent were sent to people with whom they would otherwise not have communicated. Some of this new information may be unnecessary, contributing only to computerized junk mail. In the two studies, much of the new information was not work related. Some of it, however,



included valuable data that were difficult or time-consuming to collect in any other way, such as users' opinions of proposed changes in system features.

### *3.2.3 Social context cues*

Computerized media currently provide fewer social context cues than do many other kinds of communication media. These cues regulate many kinds of interaction, and their absence may change the nature of computerized communications. Since the recipient may know only the sender's name, and the sender may know nothing at all about the recipient, cues such as age, sex, race, appearance or status may be eliminated. Computerized media, in their current text only format, provide only a limited bandwidth channel. This limitation eliminates subtler kinds of communications such as body language, tone of voice, etc. Finally, since many kinds of computerized communications are asynchronous, users are deprived of any feedback as they communicate. (It should be noted that none of these limitations are unique to computerized communications: written memos are also asynchronous and text only, and may be written without knowledge of all possible recipients.) Sproull and Kiesler (1986) claim that this lack of social context cues leads to less inhibited communications, which may have positive or negative effects. For example, people may be more willing to speak out over an electronic system that preserves some anonymity than in a public meeting and what they say may be considered more seriously. On the other hand, they may also engage in more expression of extreme opinions ("flaming") (Kiesler, Siegel and McGuire, 1984).

### **3.3. Motivational Perspective**

The perspectives discussed in preceding sections capture many important aspects of coordinating the activities of people in organizations but they may leave out some of the most important factors about why people are there in the first place

Some factors that affect motivation and satisfaction at work, such as pay, benefits, or working conditions, are primarily extrinsic to the tasks being performed. Herzberg (1968) hypothesized that these "hygiene" factors may lead to dissatisfaction if they are below some acceptable level, but that they are not positive "motivators" for greater effort. In other words, these extrinsic factors may affect which goals people choose and whether they choose to participate in the organization at all (*e.g.*, see March and Simon, 1958, chapter 4), but these factors alone would not usually lead to highly involving and satisfying jobs.

Another set of factors, however, are intrinsic to the tasks being performed and they seem to be particularly important in determining the degree of involvement and satisfaction in an activity (*e.g.*, see Herzberg, 1968). We divide these factors into two groups: 1) individual motivations that may be present in any activity, and 2) interpersonal motivations that depend for their appeal on interactions between people. Even though there are no firm conclusions about the overall consequences of IT for these motivations, Attewell and Rule (1984) note that a number of previous surveys show more cases of increased rather than decreased job satisfaction after the introduction of IT.

### *3.3.1 Individual motivations*

Malone (1982) discusses a number of suggestions for how individual motivational factors such as challenge, fantasy, and curiosity can be used to make user interfaces more interesting and enjoyable. For example, for some users challenge can be enhanced by incorporating successive layers of complexity in an interface with each layer being mastered in turn as users become more skilled. When we expand our focus to include designing systems to be used by groups of people, it becomes clear that computers make it possible and sometimes desirable to redesign whole jobs and organizations, as well as individual programs. Hackman and Oldham (1980) suggest five factors that contribute to highly motivating work: *Skill variety*, *task identity* (*i.e.*, doing a whole job, rather than a piece of one) and *task*

*significance* are hypothesized to contribute to experienced meaningfulness, *autonomy* to experienced responsibility and *feedback* to knowledge of actual results. Workers who feel they are responsible for a meaningful job and who can tell how well they are doing it are believed to be more motivated to do well. These factors are related to the four suggested by Malone, for example, the concept of "skill variety" in well designed jobs can be seen as another way of increasing the challenge of a job. We will discuss the possible effects of IT on skill variety, task identity and significance and autonomy.

### 3.3.1.1. Skill variety

*Deskilling* One particularly common prediction of the effect of IT is deskilling. IT can be used to strip a job of its content, leaving only a dull routine. For example, instead of directly solving some problem, a worker might instead feed the relevant data to a computer and have it solve the problem. This approach may have some advantages for the organization, since it assures a more consistent solution to the problem, but the resulting job may be less desirable for the worker.

Schultz and Whisler (1964) suggest that computers can replace lowest level clerical and analytic functions, displacing an employee if that was all the person did. Clerks are still needed to prepare data for the computer, but these new jobs may have lower skill requirements than the jobs they replace. Glenn and Feldberg (1977) describe this process as the "proletarianization of clerical work". They note that clerical jobs are becoming more like factory jobs, with increased subdivision of work and specialization of workers due to automation and use of scientific management principles from classic organization theory as management attempts to control workers and reduce the variability of their output. Similar deskilling has been noted by Mann and Williams (1960), Whisler (1970b) and Scharek and Barton (1975). As the flow of work becomes more like an assembly line, an individual clerk's pace becomes regulated by needs of processes on either side and the need for interaction and resulting opportunity for social ties to form are reduced.

Zuboff (1983a) points out that a system embodies assumptions about how the work should be done, resulting in a loss of flexibility for the worker. The system may also decrease the ambiguity of work, reducing workers' opportunities to display their mastery of their jobs. Formal rules replace discretion or specific knowledge, thus reducing inner motivation to work. Many of these effects may also apply to jobs of middle managers. As computers are used to handle more and more analyses, middle managers may be reduced to messengers or eliminated altogether.

*Upgrading.* The opposite prediction is upgrading. Instead of doing the job that the worker did, computers could be used to automate the repetitive parts, leaving more interesting components for the human, and producing a more desirable job requiring a higher level of skills or having more responsibilities. For example, Zuboff (1983a) presents a case in which the automation of a paper mill increased the role of the first line production workers since they could control more than the single functions they used to. The jobs therefore required more skill, and the operators began to perform some of the functions of the managers. Mann and Williams (1960) also found some cases of job enlargement and that the system eliminated many routine jobs.

The use of IT may also upgrade the jobs of middle managers. Instead of simple collecting and presenting data, managers will be able to analyze and interpret data. Their role may change from giving orders to convincing others of their interpretations. Argyris (1970) hypothesized that managers would have to be better educated to deal with increased flow of data.

*Deskilling and upgrading.* In practice, both effects seem likely to occur simultaneously. Attewell and Rule (1984) report both deskilling and upgrading, and note that it is difficult to determine which predominates. They present some evidence that there are now more skilled jobs and fewer unskilled ones, but point out that it is hard to determine the cause for this shift. They conclude that the studies that have been done have not been very well designed, again making firm conclusions difficult.

### 3.3.1.3 Task meaningfulness

The category of task meaningfulness refers to Hackman and Oldham's notion that jobs are more satisfying when they involve the completion of a "whole" and identifiable piece of work ("task identity") that has substantial impact on the lives of other people ("task significance"). In computer games and in some unavoidably dull jobs, it is possible to use fantasy to increase the meaningfulness of an activity (e.g., the task of controlling a factory process can be mapped into a fantasy display of piloting a space ship (Carroll and Thomas, 1980)). However, the implication of this category name is that organizational use of computers should be designed to make the tasks themselves as meaningful as possible. For example, one of the reported benefits of an early office automation project was that bank clerks had their jobs restructured so that they no longer performed isolated clerical steps in a process they did not understand, but instead handled all the steps in dealing with their assigned customers (Matteis, 1979; Lorsch, Gibson and Seeger, 1975).

### 3.3.1.4. Autonomy

The use of IT can change the degree of autonomy that an individual worker has in doing his or her job. Many researchers believe that computer systems offer new possibilities for supervising and controlling workers (e.g., Briefs, 1981; Zuboff, 1983a; Business Week, 1983). The use of a computer system may make it easier for a worker's superiors to control his or her work (for example, by providing quicker feedback about a worker's performance) and make it clear who is not performing. Blau *et al.* (1976), however, find increased control only in routine jobs.

*Increased control by supervisors* Argyris (1970) suggests that a centralized information system may reveal previously hidden information, reducing an employee's perceived freedom to act, and making the system threatening. Zuboff (1983a) argues similarly that since the system makes information

more widely available, a subordinate may become less willing to act independently on data that his or her superior will also see

*Increased control by system* A system may also become itself an impersonal source of authority (Zuboff, 1983a). One form that such a loss of autonomy can take is when the computer system takes control of the pace of work and determines how quickly the work must be done. Zuboff (1983a) suggests that computer gives quicker feedback, thus increasing pace of work, even if it is not set explicitly. This view was argued by Foster and Flynn (1984), who suggest that IT used to automate routine functions may thus allow more time for thinking about the task to be done. Attewell and Rule (1984) report mixed findings on this topic. 25% of the studies they surveyed reported an increase time pressure; 50%, no change; and 25%, a reduction in time pressure

*Increased autonomy for workers.* A system could also have the opposite effect. As noted above, for example, automating the routine parts of tasks could allow reintegration of several previously separate jobs, resulting in a job that can be done independently and without direct supervision. Managers may also be more willing to delegate responsibility, since their subordinates' results can be tracked by the system.

Walton (1982) provides examples of both increased control and increased autonomy, and points out that the designers of systems have a choice in how the technology is used. Attewell and Rule (1984) summarized a number of studies by noting that most workers do not report an increase in perceived control or in their control over their subordinates, but that feelings of control and being controlled increase at higher levels of the hierarchy. Kling (1980) also reports that the use of IT seemed not to radically change the nature of work, for workers he studied.

### 3.3.2 *Interpersonal motivations*

When we are concerned with group interactions, three kinds of interpersonal motivations (cooperation, competition and recognition) can be as important as individual motivations (see Malone and Lepper, in press). Systems can be designed to engage these interpersonal motivations. For example, one of the problems that may arise in a text-sharing system is how to motivate people to contribute information. In addition to economic pricing schemes, intrinsic motivations may be used for this purpose. For example, people's motivation for recognition might be engaged by a system in which rankings of the most widely read messages in different categories can be displayed along with their authors' names. This approach should be even more effective if messages that are rated by some readers as being very valuable are then automatically redistributed to a wider audience.

### 3.4. Political Perspective

A central construct for political analyses of organizations is power. A political view sees the organization as composed of shifting coalitions that compete for resources. Power can be loosely defined as the ability of one person or group to influence the actions of another (Bariff and Galbraith, 1978). Power has many sources, such as the "legitimate" authority of a superior in a hierarchical organization, the promise of rewards, the control of access to necessary resources (perhaps including information) or expertise. Other measures of a group's power include work flow pervasiveness (the number of other groups that depend on this group), immediacy (how quickly the loss of a group's services is felt) and substitutability (the extent to which some other group can substitute for this one).

The use of IT affects the distribution of power in many ways. First, IT affects access to information, a potentially very valuable resource. In some settings, it is possible that IT will be used primarily for its symbolic value, rather than for any particular functionality, making the IT itself a potential resource (Feldman and March, 1981). Second, IT affects how people do their job, again changing the nature of the relationship between groups. One (likely) possibility is that IT will be used largely to reinforce the

existing power structure of the firm, for if it did not, power holders in the organization would be unlikely to encourage its use (Kling, 1980; Pfeffer, 1978). It also seems clear that use of IT can greatly increase the power of those who control it (Pfeffer, 1978). We will examine two different distributions of power: vertical (*i.e.*, between levels in the firm), and horizontal (*i.e.*, between groups at the same level).

#### *3.4.1. Vertical distribution of power*

One way IT can affect the vertical distribution of power in a firm is by changing who has access to information. For example, a computer system may provide an easier way to monitor the results of subordinates actions and to speed the flow of information upwards in the company, thus centralizing power. For example, Leavitt and Whisler (1958) noted that in companies with computer systems, the junior managers no longer controlled which information was summarized and reported. Similarly, Zuboff (1983a) found that managers of automated plants felt that they no longer controlled information about production and so lost power. Before the introduction of a computer system, for example, the plant managers chose when and how to report problems the plant experienced; with the system, they found out about them at the same time as everyone else did. Many systems may encourage this process, since they are often designed primarily to meet the needs of managers. For example, Grudin (1987) points out that multi-user systems may require many people to work with them, while benefiting only the manager

IT can also be used to decentralize, thus moving power down in the organization. For example, a universally accessible data base can reduce top management's monopoly on company-wide information. The use of IT may thus change the basis of power by making information less of a scarce resource. To the extent that vertical power is thus equalized, other sources of power will become more important. One common prediction is that power will be based on competence and knowledge, rather



than on hierarchical position (Argyris, 1970; Foster and Flynn, 1984). Zuboff (1983a) found that when the system made more information equally available, power was not telling someone what to do (*i.e.*, based on hierarchical position), but rather convincing them to accept your interpretation of the data. Attewell and Rule (1984) reported that most studies find either no change or a reinforcement of the existing power structure, although they note that the use of IT seems to be "compatible with a wide variety of lateral and vertical power relationships in organizations" (Attewell and Rule, 1984: 1189).

### *3.4.2 Horizontal distribution of power*

The use of IT can also change the balance of power between groups at the same organizational level of a firm. For example, a common computer system may lead to greater data sharing and thus power equalization between groups at the same level. This cooperation could then lead to greater coordination, allowing better performance, since the two groups could jointly optimize rather than each trying to do the best it can individually.

As mentioned, use of IT can greatly increase the power of the group that controls the technology. IT may become critical to the operation of the firm: most banks, for example, would be completely unable to function if their computer systems failed. The group controlling computer systems may also control access to data, a potentially scarce resource. The IT group may be in a position to mediate between other groups, for example, by setting corporate standards for computer equipment or software, thus defining the functionality available even to users of personal computers. Schultz and Whisler (1964) suggest that these staff members assume some of the functions of the line managers, and that they therefore should be tied to top management and to the strategic goals of the firm.

## **4. Implications for further research**

Our review of the literature has revealed several shortcomings that should be addressed by further research. First, it is clear that the field needs better conceptualizations and operationalizations of the two major dimensions: technology and organization. Until there is better agreement on the meanings of these central terms, it will be very difficult to compare and integrate different pieces of research. Typologies of technology and organization may also serve other functions, for example, by suggesting relationships that have not been adequately studied

The perspectives we have discussed suggest appropriate variables to investigate and provide theories of likely kinds of interactions as well as methodologies to investigate them. For example, we believe that one of the most important characteristics of IT is that it processes information, and that analysis of the kinds of information an organization uses and the ways the information is processed provides considerable insight into organizational functions, as well as a basis for the design of systems.

Second, the field needs better research design. As in any social science, cause and effect are complex. There are a great many possibly important variables, and it is difficult to identify which are most important and to control the rest. Simple correlational studies are inadequate because they omit too many possible significant variables and relationships and designers should be cautious about making generalizations from such studies. In general, it seems premature to concentrate on only a few variables. In the short run, this may mean an increased use of methodologies such as case studies that emphasize understanding at the expense of generalizability. Most importantly, we need to be able to identify the implications of the use of IT and provide guidance for the designers of systems. Malone (1985) suggests a change of focus from explanatory or predictive theories (*i.e.*, if *X*, then *Y*) to theories of design (*i.e.*, in order to achieve *Y*, do *Z*)

## 5. Implications for the Design of Systems and Work

As we have seen, there appear to be few inevitable results of the use of IT and very many possible outcomes, depending on factors such as the organizational context, the type of IT used, management motivations and so forth. Since no general theories exist for predicting the outcomes of particular situations, our primary advice to designers is simply to use the frameworks and examples presented above to consider more explicitly in advance possible outcomes of the use of IT.

Walton (1982) points out that past studies of the implementation of computer systems have often focused on ways to overcome resistance to a new system. He argues that these efforts should be extended to the design phase as well, to avoid, rather than merely overcome potential problems. He notes (Walton and Vittori, 1983) that even though managers seem to realize that the use of IT can have organizational side effects, there is little effort to predict or reduce them. Walton suggests first that organizations need explicit normative models, stating what kind of effects are desirable. New systems should be explicitly assessed for their organizational impacts and the design process should allow the systems to evolve as the nature of their impacts change or become clearer. Each individual or group within an organization may judge systems differently, however. One issue for a designer, then, is to determine the clients of his design, that is, whose value systems will be used to guide the design.

In the remainder of this section, we will briefly suggest how the four perspectives we discussed above suggest principles for designing systems, work and organizations.

### **5.1. Rationalist perspective**

The rationalist perspective assumes that the organization has an identifiable goal, such as profit maximization, and that IT should be used to achieve that goal more efficiently, for example, by reducing costs or increasing the quality of the output. This can be done by analyzing the functions of

different parts of the organization, and automating where it is cost-justified to do so. Since much current systems design attempts to follow this perspective, we will not discuss it further, except to note that for systems used for coordination it may be difficult to identify inputs and outputs or to place a value on them, making cost-justification problematic (Crowston and Treacy, 1986)

### **5.2. Information processing perspective**

In the information processing view, IT has a major effect by providing cheaper coordination, thus making coordination intensive forms more practical. A company might take advantages of economies of scale by creating larger functional departments, using IT to provide the necessary coordination between different groups. For example, different divisions of a company could all use data stored in one centralized database, rather than each having partial information or passing information between themselves. Alternately, a company could use market-like structures, again coordinated by the use of IT. Airlines, for example, now provide an electronic marketplace for selling tickets.

Systems like electronic mail or computer conferencing may have several advantages. First, they may be a more efficient media for existing communication: faster, asynchronous, and possibly less expensive. Second, electronic media may lead to new patterns of communication, either encouraging people to participate more actively, or helping form weak links, which can provide new data. Systems like the Information Lens (Malone *et al*, 1987) may be used to help process quantities of semi-structured data.

Work redesign could be based on the "object-oriented" modeling technique discussed by Crowston, Malone and Lin (in press). The resulting model of the organization may reveal places where the information flow can be streamlined or where IT can be used to better support the necessary

processing. Possible organizational structures for a given task can be compared by estimating the cost of different kinds of communications links, to determine which will be the most effective.

### 5.3. Motivational perspective

In the motivational perspective, the client of a new information system is the workers, and only indirectly the organization. A successful design will be one that increases worker satisfaction and improves attitudes towards work.

A motivational design might start by analyzing the costs and rewards of a job for the individual holding it. Hackman and Oldham (1980), for example, provide an instrument that attempts to measure the motivating aspects of a job. They also suggest characteristics of an organization that should be checked to assess its readiness for changes. If the conditions are such that a work redesign is likely to fail, or to have little effect, they suggest that it not be attempted.

Sirbu (1980) offers several suggestions for software design that increase the motivating aspects of users' jobs. He suggests that rather than enforce restrictions on users' actions, designers provide mechanisms to hold them accountable for what they do, thus increasing autonomy. To increase feedback, Sirbu suggests that any monitoring reports generated be shared with the users, not restricted to their managers. Finally, he suggests that systems provide opportunities to master new skill and perform new tasks, thus increasing skill variety.

A design methodology that attempts to create motivating work is socio-technical design. Socio-technical design attempts to simultaneously improve the social and technical subsystems of a job in order to achieve the most effective job design. Pava (1983) provides a good introduction to this technique and discusses its applications to the design of information systems.

### 5.5. Political perspective

The political perspective suggests that it is important to explicitly determine the client of a design, since different groups will have possibly conflicting goals and value systems. It may be useful, therefore, to secure support from an existing power holder, such as top management. A designer should also attempt to analyze the existing power structure of the firm to identify vested interests, both for and against the system, which may be at the root of resistance to change. Zuboff (1983a), for example, suggests examining carefully any sources of resistance to a new system. She notes that although the immediate complaints may disappear, the underlying problems may continue to adversely affect the work setting indefinitely. Involving users in the design of the system may improve the design of the system by revealing the designers' implicit assumptions about the nature of the problem, as well as improving the eventual users' feelings of ownership of the system.

## 6. Conclusion

One theme of this paper has been that a system designer is an organizational change agent, whether intentionally or not. Designers must be aware that their systems are not neutral objects, but instead reflect a theory of how the surrounding organization does or should work. Furthermore, the impacts of information technology (IT) are not deterministic: similar systems can and do have widely different effects, depending on the particulars of the organization and the intentions of the managers who deploy them. Designers should therefore be explicit about which effects are desirable, and attempt to predict and control the impacts that the system does have.

To understand these potential impacts, we need to understand organizations, technology and the link between the two. Unfortunately, the body of theory in these areas is neither well developed nor

integrated. Indeed, different researchers approach these topics from different perspectives, often arriving at contradictory findings, or simply talking past each other.

Each of these perspectives provides only a partial view of the relationship between organizational structure and information technology, however, and designers should be cautious about predictions that acknowledge only one view. When a system is viewed from all these perspectives, design can begin to predict and to design the effects of their systems on work organization.

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Technological Imperative



Figure 1

## Organizational Imperative

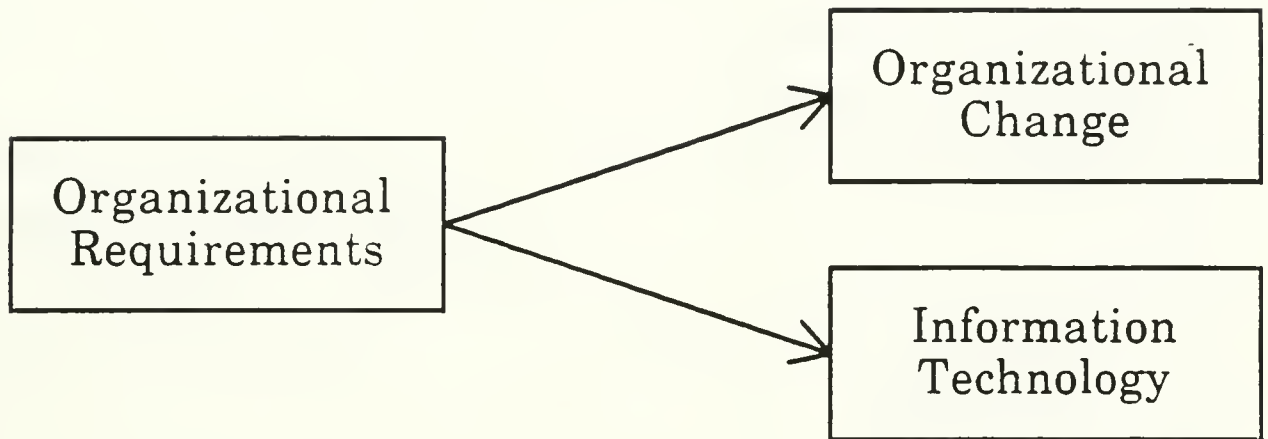


Figure 2

Interactionist Perspective

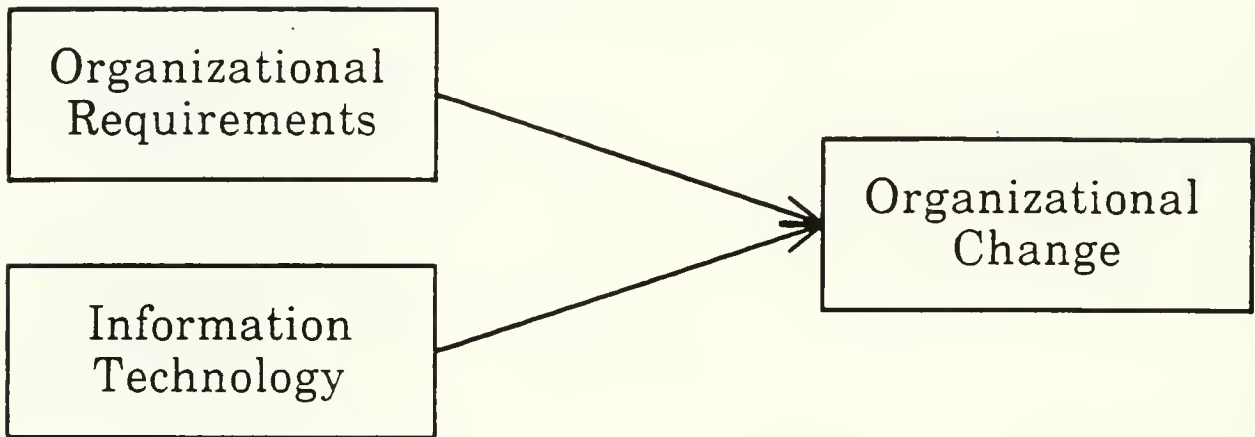


Figure 3

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