Too often, technology is used only to automate production and thus reduce skill and labor requirements. But its potential to inform organizational members about the work process and thus improve operations and increase innovation is the aspect of technology that will be most important to long-term organizational success.

Automate/Informate: The Two Faces of Intelligent Technology

Shoshana Zuboff

Put your eye to the kaleidoscope and hold it toward the light. You see a burst of color, tiny fragments in an intricate composition. Imagine a hand slowly turning the kaleidoscope's rim until hundreds of angles collapse, merge, and separate to form a new design. A fundamental change in an organization's technological infrastructure wields the power of the slow-moving hand at the turning rim. Technology defines the horizon of our material world as it shapes the limits of what is possible and what is barely imaginable; it erodes assumptions about the nature of our reality, the "design" in which we dwell; and it creates new choices. An innovation like the steam engine, the telephone, the electric light, or the computer is not only an element within the pattern; it is a force that turns the rim, a concrete presence that silently evokes a new vision of the potential for relatedness and, in the end, provides the occasion for a new design.

It is in this sense that technology cannot be considered neutral. It is brimming with valence and specificity in the opportunities that it creates and forecloses. Air travel has allowed us to conquer time and distance in a new way by knitting the planet together

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and giving us access to other peoples, places, and cultures. The electric light rescued the night from darkness. Telephones permit us to pursue intimate contact without bodies that touch or eyes that meet. The litany of dramatic new organizations of reality engendered by new technologies is a long one.

But between the turning rim and the emergence of a new pattern, another force infuses the final configuration of elements with meaning. This is the human activity of choice. As the limits of the possible are newly defined, so too is the opportunity for choice multiplied. Shall I fly or drive or take a train? What is my destination? Shall I use the telephone to maintain intimate contact with friends I rarely see? If so, whom shall I call, how often, and for how long shall we speak? The metaphor of kaleidoscopic change is finally a limited one. Those pretty fragments align themselves without meaning, but change in human societies is not quite as blind. Though intentions do not necessarily predict consequences, human beings do proceed by constructing meaning, assessing interests and, with varying degrees of awareness, making choices. It is in the realm of choice that technology reveals a certain indeterminacy. Though it redefines the horizon of possibility, it cannot determine what choices will be made and for what purposes.

In these final decades of the twentieth century, many long-standing assumptions about how work is organized are being challenged by a new technological presence. Advanced computer-based information technology is providing a new infrastructure that mediates many of the productive and communicative activities most central to organizational life. This article will examine the role that information technology can play in restructuring the work place. Having interviewed approximately 500 workers and managers at ten research sites representing six companies, in industries as diverse as banking, telecommunications, and paper and pulp production, I shall discuss some themes that cut across organizational boundaries and seem to have relevance to a wide range of settings. Specifically, this article will sketch two divergent conceptions of information technology and their respective implications for the organization of work.

Automate / Informate: The Duality of Intelligent Technology

As the logic of Frederick Taylor's scientific management began to take hold earlier in this century, the substitution of machine power for human labor became the obvious solution for increasing the speed and volume of production. Beginning with Ford's Highland Park auto-assembly plant in 1915, technology would be relied on to complement or supplant human direction. In *Mechanization Takes Command*, Siegfried Giedion describes this process:

> The instruction cards on which Taylor set so much value, Ford was able to discard. The conveyer belt, the traveling platform, the overhead rails and material conveyers take their place. . . . Motion analysis has become largely unnecessary, for the task of the assembly-line worker is reduced to a few manipulations. Taylor's stopwatch nevertheless remains, measuring the time of operations to the fraction of a second.

H. L. Arnold, an industrial journalist, wrote enthusiastically about the Ford innovations that maximized the continuity of assembly. He summarized the key elements of the productivity strategy: First, all needless motions were eliminated from the workman's actions and second, the task was organized to require the "least expenditure of will power, and . . . brain fatigue." This formula is of enduring significance as it has dominated the

Shoshana Zuboff *is assistant professor of organizational behavior and human resource management at Harvard University, Graduate School of Business Administration. She earned her Ph.D. in social psychology from Harvard University and an undergraduate degree in philosophical psychology from the University of Chicago.*

Since 1980, Zuboff has been engaged in field research that focuses on the social psychology of work as it is reorganized by computer-based technology She is currently completing a book based on her field research (to be published by Basic Books in 1987), and has written numerous articles on the subject of information technology in the work place, including "New Worlds of Computer Mediated Work" (Harvard Business Review, 1982) *and "Technologies that Informate"* (*in* Human Resource Management: Trends and Challenges, *edited by Richard Walton and Paul Lawrence, Harvard Business School Press, 1985). She has also published articles on the historical and ideological dimensions of work organization, including "I Am My Own Man: The Democratic Vision and Workplace Hierarchy"* (*in* Democracy at Sea, *edited by Robert Schrank, MIT Press, 1983) and "The Work Ethic and Work Organization"* (*in* The Work Ethic, *edited by Jack Barbash, Industrial Relations Research Association, 1983).*

Zuboff has lectured and consulted widely in the United States, Latin America, and Europe. Her consulting work has focused on the opportunities offered by information technology for innovative approaches to work organization and management. She is a member of the editorial boards of the Harvard Business Review *and of* Office: Technology and People *as well as a member of the Visiting Committee to the College of the University of Chicago. Her initial field research was supported by an award from the National Institute of Mental Health.*

design of mass-production technologies throughout the twentieth century. It calls for simplification (and sometimes intensification) of effort, while skill is increasingly subsumed by technology.

In the 1980s, the rapid development and diffusion of advanced information technology have focused new attention on the underlying logic of technology deployment. To what extent will applications of this powerful new technology reproduce the formula of labor substitution, which was perfected through decades of economic success in the mass-production industries?

Managers typically invest in new information technology because they believe it will allow them to accomplish their operations more quickly and at less cost. Increasingly managers are beginning to appreciate the more complex ways in which information technology can provide new sources of competitive advantage. In either case, when managers harness information technology to their strategic goals, they usually plan to accomplish one or more of three interdependent operational objectives – to increase the *continuity* (functional integration, enhanced automaticity, rapid response), *control* (precision, accuracy, predictability, consistency, certainty), and *comprehensibility* (visibility, analysis, synthesis) of productive functions.

In a manufacturing environment, for example, microprocessor-based devices such as programmable logic controllers (PLCs) or sensors can be integrated into production equipment and linked to a hierar-

chy of computer systems, thus increasing both the continuity and the control of production operations. In an office environment, the standardization, real-time updating, and orderly storage of transaction histories made possible by computer systems enhance both the control and the continuity of office functions.

Information technology also increases the comprehensibility of the very processes that have been automated. Indeed, greater comprehension is both a condition and a consequence of such applications. Any activity, from a clerical transaction to spraying paint on an automobile, if it is to be computerized, must first be broken down into its smallest components and analyzed so that it can be translated into the binary language of a computer system. For most organizations, this step prepares the way for automation and simultaneously creates a deeper understanding of the activity itself. Once they are automated, the intelligence of the very devices that increase control or continuity generates new streams of data that provide an opportunity to develop an even more penetrating understanding of the operation. For example, PLCs or microprocessor-based sensors not only apply programmed instructions to equipment; they also convert the current state of product or process into data, thus creating the possibility of increased comprehension. Similarly, the same systems that make it possible to automate office transactions create an overview of real-time organizational functioning and coordinate many levels of data, which are then available for tracking, reporting, and analysis.

By its very nature, then, information technology is characterized by a fundamental duality that has not been fully appreciated. First, the technology can be applied to *automate* operations. The reasoning behind such applications is essentially the same as that applied to Ford's early assembly plant. The aim is to replace human effort and skill with a technology that enables the same processes to be performed at less cost and with more control and continuity.

Second, technology can be used to create information. Even when a given application is designed to automate, it simultaneously generates information about the underlying processes through which an organization accomplishes its work. The word that I have coined to describe this process is *informate.* It is meant to capture that aspect of this technology that may include but also go beyond automation. We see the informating power of intelligent technology at work in the manufacturing environment when microprocessor-based devices such as robots, PLCs, or sensors translate the three-dimensional production process into two-dimensional digital data. Such data are then typically made available on a video display terminal or computer printout, in the form of electronic symbols—numbers, letters, and graphics. This is information that did not exist before. In the office environment the combination of online transaction systems and communications systems create a vast information presence that includes many data formerly lodged in people's heads, in face-to-face conversations, in discrete file drawers, and on various pieces of paper widely dispersed in time and space. In its capacity to automate, information technology has a prodigious ability to displace human effort and to substitute for much that has been familiar as human skill. As an *informating* technology, its implications are equally significant, although not yet well understood.

Information technology can make a powerful contribution to the objectives of increasing control and continuity, but its uniqueness lies in its informating capacity, which can enhance comprehension of the

operations through which an organization does its work. Thus far I have pointed to this informating process as if it were autonomous and unintended. However, an organization can choose to emphasize and exploit the informating potential of intelligent technology. The extent to which either of information technology's two capacities is emphasized will play a central role in determining the organizational consequences of technological change. The choice of emphasis is above all a question of strategy and derives from management's conception of the contribution that this technology can make to the business. Informating may proceed as an unintended and undermanaged consequence of computer-based automation, but it can also be part of a conscious management policy designed to exploit the new information presence to create a different and potentially more penetrating, comprehensive, and insightful grasp of the business. This, in turn, can serve as the catalyst for significant improvement and innovation in the production and delivery of goods and services, thus strengthening the competitive position of the firm.

Yet even as managers begin to recognize and appreciate the informating power of new technology, a strategic approach to technology deployment will in many cases fall short of achieving the desired outcomes. One conclusion from my research is that organizational innovations are necessary to support technological innovations if a firm is to fully benefit from the informating process. It is a process that has implications for the kinds of skills that organization members must develop, the articulation of roles and functions, and the design of systems and structures that support and reward participation in an informated organization.

The Database as Organization Surrogate

As organizations apply information technology, they tend to develop mechanisms that allow information to be automatically generated and captured. As automation proceeds, they search for ways to integrate information and make it valid, immediate, and accessible. Some organizations have already reached a level where they have been able to recreate their own images in the form of detailed, real-time, integrated databases, which give access to internal operations and external busi-

"Some organizations have already . . . been able to recreate their own images in the form of detailed, real-time integrated databases, which give access to internal operations and external business data and can . . . organize, summarize, and analyze aspects of their own content."

ness data and can be reflexive enough to organize, summarize, and analyze aspects of their own content. In a highly informated organization, the database takes on a life of its own. It becomes an autonomous domain, a public symbol of organizational experience, much of which previously had been fragmented, private, and implicit. For example, in one highly automated pulp plant built around a microprocessor base of instrumentation, a computerized database included all vital business and personnel data as well as real-time record of operations—created by continual measurements of the 2,500 key pieces of plant equipment, which were updated several times per minute. A powerful information system like this one becomes an on-line, symbolic surrogate for much of the dynamic detail of an organization's daily life. The fact that the database assumes the status of organization surrogate is even more compelling in the context of the traditionally information-intensive organizations: banks, insurance companies, airlines, and so forth. Indeed, a recent speech found the chairman of MCI Communications referring to changes in financial services with the statement, "Banks are becoming more like databases."

But what does it mean for an organization to "become a database?" In organizations where informating proceeds as an undermanaged and autonomous phenomenon, the growth of the database is experienced as overwhelming and incomprehensible—hence the term *information overload.* An approach to technology deployment that assumes minimal skills at the information interface along with a hierarchical and fragmented division of labor tends to create organizations with a minimal capacity to plumb newly available information in ways that would add value to business activities.

When the informating process is pursued as part of a conscious strategy, the new information presence can be felt at every level of organizational activity. The information presence invites organization members to pose questions and generate hypotheses. As aspects of organization functioning are brought to light or seen in different ways, new insights are engendered. The organization can become a learning environment in that work itself becomes a process of inquiry, and the contributions that members can make are increasingly a function of their ability to notice, reflect, explore, hypothesize, test, and communicate.

Mastery at the Information Interface

The quality of skills that people bring to the new information is usually an important determinant of whether the emerging database is experienced as overload or as an opportunity to reach for a new level of comprehension and innovation. My understanding of these emerging skill demands derives from detailed interviews with people who have grappled with the need to make sense of their work when information about their tasks comes to them primarily through the medium of a computer-based system.

Mastery at the information interface depends upon what I define as *intellective skill.* The central problem that confronts the person who must accomplish a significant portion of his or her work through the information interface is that of reference. People find themselves asking, "To what do these data refer? What is their meaning?" Intellective skills become necessary for creating meaning and so grappling with the problem of reference.

The intellective skill base has three crucial dimensions. The first is the ability to think abstractly. For many people—like the mill operator who interacted directly with machinery, the clerical worker whose tasks involved specific pieces of paper and interpersonal routines, or the manager who culled information from meeting and talking with people—work tasks have tended to be embedded in concrete activities. But as work becomes more computer-mediated, it also becomes more abstract and remote from physical cues. Learning what information might mean when it is separated from its action context requires a new emphasis on abstract thinking and relies on the ability to make explicit the inferences that link data to a concrete world. An operator in an automated mill described his experience in a computerized control room:

> Anytime you mash a button you should have in mind exactly what is going to happen. You need to have in your mind where it is at, what it is doing and why it is doing it. Out there in the plant you can know things just by habit. You can know them without knowing that you know them. In here you have to watch the numbers, whereas out there you have to watch the actual process.

The second component of intellective skill is inductive reasoning. Because information in a computer system tends to be reduced to quantitative terms, people must be able to approach data analytically, grasp the potential relationships among variables, and use data to build and test hypotheses. A systems engineer who had worked closely with operators in another highly automated plant described how successful operators managed the production process through the computerized control interface:

> When you want to know what is going on in a part of the plant, you roll through several screens of data. You must keep important data in your mind as you continue to scan. People learn how to organize data in their minds. They build models in their heads about what is really happening, and they build on the model with data until they have a complete picture.

The ability to perform such inductive reasoning ultimately depends on having a theoretical conception of the processes to which the data refer. This is a third dimension of intellective skill; it is this theoretical grasp that provides a guide through the data, a basis from which to generate hypotheses, and clues as to where to search for evidence of the consequences of any given course of action. Consider the words of one account officer for whom a powerful information system provided a real-time overview of his loan portfolio:

> Certain things can be less apparent because there is so much information. We have to spend time pinpointing the major factors we are looking for. You have to know what is significant in order to know how to discern it.

Or, in the words of another plant operator:

> The more I learn theoretically, the more I can see in the information. Raw data turn into information with my knowledge. I find that you have to be able to know more in order to do more. It is your understanding of the process that guides you.

Of course, people learn from and about their work in many ways. When tasks become computer-mediated, people will often look for ways to check back with the precomputer action context to assure themselves that they are doing things correctly. For example, a clerical operation might be performed in both manual and automated modes until people trust the new system. Plant workers sometimes leave the control room to check on equipment, just to see if the computer system accurately reflects "what is really going on." But often these older contexts are organized out of the new environment – there's no going back to check because there's nothing to go back to. Older equipment and instrumentation is dismantled; paper forms and the office routines built around them disappear. When this happens, intellective skill becomes a prerequisite for operating competently in the new computer-mediated environment. Those without it can feel lost.

Two Roads Diverge

In one manufacturing organization, the plant manager had a heated debate with his leadership group over the strategic conception that would guide technology deployment. "Are we all going to be working for a smart machine," he asked, "or will we have smart people around the machine?" The response to this question becomes the keystone of any strategy for mutually developing technology applications and the organizational innovations that support them. In this context, "smart people" are organization members who can contribute to and learn from the systems through which they perform their work. A strategy that emphasizes automation focuses on the smart machine. An informating strategy recognizes the value and function of the smart machine, but only in the context of its interdependence with smart people. It is the knowledge and understanding in people's heads – their "intellective skill" – that turns smart machines into an opportunity for fundamental business improvement. Mastery of inference through inductive reasoning and theoretical understanding provides the basis from which those at the information interface can construct, integrate, and synthesize the meaning of information.

Perhaps the most compelling reason that managers are driven to a narrow emphasis on automation is the web of economic logic in which they must operate. Conventional accounting formulas treat technology as a capital substitution for labor. As many managers have learned, "to justify a computer we have to show job eliminations." These lines of economic force cut a deep path and carry certain inevitable implications. For example, organizational resources are channeled in ways that support the fundamental technology strategy. Investment dollars and staff know-how are dedicated to enhancing automation through technology design, application, maintenance, and upgrading. It is a simple and obvious fact that such choices have long-term consequences in terms of which organizational potentialities become robust, atrophy, or are stillborn.

The emphasis on automation is further bolstered by the middle manager's role, which has been largely defined as one of col-

lecting, manipulating, disseminating, or withholding information. As organizations grew in size, middle managers became the information conduits through which planning and execution could be coordinated and controlled. But there is deeper significance to the manager's information function: Managers have traditionally been considered the representatives of ownership. Only they could be counted on for the loyalty and dedication that this symbolic investment of property rights implied. It followed that significant information could be entrusted only to those who could be relied on to serve the interests of ownership. But the informating process unleashed by new technology can provide the nonexempt worker at the information interface with access to data that convey a broad scope of the organization's functioning. One corporate vice-president put the problem this way:

> An issue that the technology is forcing us to face involves the loss of managerial control. . . . There is a legal definition that management is the steward for the owners of the enterprise. They are expected to be loyal and unswervingly dedicated to achieving the objectives of the owners. They are expected to not let the situation ever get out of control. . . . New information technology introduces some very new problems. Suddenly the folks who work with these systems are interfacing with a tremendous technology power—power to see all the functions of the operation. That is pretty scary to some managers.

For middle managers who measure their worth in terms of their ability to exert control and maximize the certainty of outcomes, the choice to create "smart people" can be a threat. Even those willing to consider the obsolescence of their traditional function can find the ambiguity of their emerging role painful enough to elicit resistance. As one manager explained, "As we face change, the big issue is, 'What's in it for me?' If I can keep the box narrowly defined, then I know my worth as a manager. I don't know what my new skills will need to be, so that is uncomfortable."

To the extent that managers confront these dilemmas by emphasizing automation, the structure of Taylorism is likely to be replicated, along with all of its inherent antagonisms. Consider the voice of a worker in a plant that had invested heavily in automatic control systems:

> They need the workers to help them figure out what the computer should do. But why should you tell a man all your knowledge about how this place runs so he can put it into a machine and then it's going to take your job away? It robs me of my dignity, it robs me of what I know how to do. . . . If they don't like me they can hard time me, as I am more expendable now, because my knowledge is in the system.

Or as a clerical worker in the back office of another company put it:

> Because you are dealing with the tube everyday, you can't beat it. You can't get ahead with it. It's just an inanimate object that stands on your desk and you have to fight it every day. And the tube is going to tally what you have worked. . . . It's like a fight that you cannot win. With the tube you do not have a chance.

Under these conditions certain organizational consequences become more likely than others. Productivity will increase, at least in the short run, as routine jobs are eliminated. Authority will tend to become more centralized as managers set objectives for the machine system. Design efforts will tend to maximize the self-regulating capacity of computer systems and minimize the need for human interaction, understanding, and contribution. Members of the technical and managerial elite are likely to become more powerful, as they will have the intellective skill needed to monitor, improve, or override the automatic systems. In such a scenario the remaining work force tends to become an adjunct to the machine system, with little or no critical understanding of its functions. Such

dependence on automation means that the problems of reliability will be critical. Automatic controls that can provide fail-safe measures to guard against systems errors will be needed, since the ripple effects of such failures can escalate with alarming speed in a highly automatic and interdependent machine system.

Despite the compelling economic, organizational, and psychological exigencies that press managers to exclusively emphasize the automating opportunities offered by information technology, many of the managers with whom I spoke had come to feel that this emphasis tended to prevent their organizations from using the newly generated information as an opportunity for business improvement and innovation.

In one plant converting to a microprocessor-based control system that would allow workers to interact remotely with the production process through a centralized information interface, one of the managers complained:

> We have cut out so many people, there is no one to do the neat things we could use the information for. We need to look at added value and we don't know how. We need to let hourly people make a contribution, but we will go mean and lean as pure profit drives us in the end. Unfortunately, no one is considering the trade-offs.

The ill-considered trade-offs involve the special characteristics of an informating technology. As long as the technology vision is limited to staff reductions and characterized by the assumption that more technology means diminished skill requirements, then the informating capacity of new technology cannot possibly be exploited. It may be true that the quickest route to increased profits is through this kind of labor substitution. It may also be true that for many businesses long term profitability, innovation, and growth will depend on a different approach to technology deployment—one that is able to use "smart people" to exploit the opportunities for competitive advantage that are offered by more, different, and better information.

In one organization, corporate senior managers were trying to assess the experience of their manufacturing sites caught up in the problems of computerization. They began to realize that any attempt to profit from the upward spiral of information availability would require more profound organizational change than anyone had, as yet, seriously considered. One corporate vice-president reflected:

> With the new technology it seems there is an almost inevitable kind of development, if you have as a goal maximizing all business variables and harnessing the entire organization to contribute to that effort. I now think you must choose to distribute information and authority in a new way if you want to achieve that. If you do not, you will give up an important component of competitive advantage.

If it is assumed that the availability of new applications will rapidly equalize any competitive advantage gained from being an early technology leader, then it follows that a sustained advantage is likely to come from an organization's ability to exploit the learning opportunities offered by new information. In many businesses, improvement and innovation in products and services made possible by increased levels of comprehension and insight can make an important contribution to competitive position. These organizations will distinguish themselves by exploiting the informating potential of the new technology. For example, one bank, in the process of creating an on-line, integrated database to provide valid, internally consistent numbers on front- and back-end banking operations, understood the emerging "database environment" as the source of new product development. Banking "products" were being redefined in terms of their informational content and the procedures used to analyze that information. The hope for such a database was that it would provide the flexibility needed to manipulate

data in new ways—and thus create new products. As one bank officer explained:

> Eighty percent of the bank's products can be produced with 150 procedures. The other 20% of the products require at least as many procedures. We want a database that will give us all the pieces—an integrated view of our entire business. It will be like a pictorial view of the bank. Then, any idea that we come up with can immediately be converted into a product. If you use the same procedure in a different order you would get a different product, or you could eliminate one procedure and you'd get a different product. This will give us a truly flexible bank. The challenge will be to train our people to think of products as a conceptual thing, not as a material thing. Our business will depend on data and procedures and the conceptual thinking to come up with new ideas.

If such a vision is to bear fruit, each level of the organization must be empowered to respond effectively to the information that is most relevant to its functional concerns. Such empowerment depends on two elements. First, those closest to information relevant to their functions must have the authority to respond. Such authority will only emerge from a strategy that stresses the importance of smart people. This both implies and reflects a second requirement—that the organization make a commitment to the development of intellective skill at the information interface. Without a depth of these skills, people will not be able to engage in the quality of "sense making" that can add value. As one worker in a newly computerized plant reflects: "Before, we did not have any way to know what we were learning or to understand the effects of our actions. Now we have so much information and feedback—not to be able to conceptualize it is the real crime."

A New Division of Labor

Informating implies a division of labor different from the logic of work organization inherited from scientific management, perfected in the mass-production industries, and widely applied in white-collar bureaucracies. With scientific management, the worker's implicit know-how was analyzed to generate data that could serve as the basis for developing a series of management functions. These functions allowed management to take responsibility for coordination and control of the production process, including the fragmentation and standardization of tasks.

When intelligent technology creates (or provides new access to) information, and when that information is made available to those at the point of production, the essential logic of Taylorism is shattered. For the first time, technology returns to the worker what it once took away, but with a great deal more as well. The worker's knowledge had been implicit in his or her actions. Informating makes that knowledge explicit; it is a mirror reflecting what was tacitly known but now is in a form that is public and precise. It also expands the range of what can be known, since the newly available information often extends beyond the narrow boundaries of a conventional job definition. Intellective skill becomes the means by which one can reappropriate and expand upon one's own knowledge and engage in the kind of learning process that makes information valuable. As one factory worker put it:

> All the information that you can get through this system gives you an opportunity to see how things could have been done better or how they could be done differently. . . . That is the real potential of this equipment. That would never have occurred if we had just stayed with the old technology.

Informating invites a new vision of the organization: a group of people gathered around a central core—that is the automated database. Individuals relate to electronic information interface according to their responsibilities, which vary in range and comprehensiveness. Intellective skill becomes one of the organization's most precious resources, and the company invests in maintaining and

upgrading that skill base in measures comparable to the investment in technology itself. In this vision, the organization becomes a learning institution for which a fundamental objective is the expansion of knowledge about the business and the opportunities it faces. Such an approach implies a departure from most current practice. Today, it is not unusual for an organization to spend millions on technology purchases and installation, while even the most rudimentary training fails to show up as a line item in the annual budget.

Managers who want to pursue this vision will need to appreciate the intricacies of life at the information interface. Too often it is assumed that human beings will respond to data displays like obedient servomechanisms, immediately recognizing the data's significance and responding appropriately. But the image of the human subject as another factor in the feedback loop is not realistic. The meaning with which people invest their work, their levels of motivation and commitment, and the quality of their skills will each mediate the relationship between the information interface and the human observer.

Indeed, as the work that people do and the effort they must make become more abstract, the need for their motivation becomes all the more crucial. For the first-line manager, the contingencies of supervision are altered. In a conventional environment it is relatively easy for a manager to determine that a worker has not properly repaired a boiler (it continues to malfunction) or failed to type a document properly (it is full of errors). But how does a manager determine that an employee failed to respond to some element in the data? How does a manager evaluate the possibility of missed opportunities to learn more about the business or improve operations in some way? In the final analysis it is only the employee's skill and commitment that can ensure that intellective effort will be exerted and that opportunities made available by an informating technology will be exploited.

A New Language and a New Vision

Anyone applying an informating strategy will come up against a variety of organizational barriers, some of which have been identified in this discussion. These barriers are only part of the problem; a deeper issue to confront, one that is both philosophical and ideological in character, involves the limitations of language. We remain, in these final years of the twentieth century, prisoners of a language that has its roots in a way of life and a way of work that are fast becoming obsolete. Consider the work-place vocabulary

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available to us: Managers require workers; superiors have subordinates; jobs have definitions that are specific, detailed, narrow, and task-related; and organizations have levels that, in turn, create chains of command and spans of control that are either centralized or decentralized. The guiding metaphors are military; the relationships are contractual and often adversarial; the foundational image is one of a manufacturing enterprise in which raw materials are transformed through physical labor and machine power into finished goods. Because production is complex, expensive, and sometimes dangerous, the prevailing notion is that it requires a kind of precise planning and direction that only the management edifice can provide.

For some organizations, because of the nature of their products, processes, or markets, this approach will continue to be most appropriate. But for many others, organizational success will depend less on competent execution of the status quo than it will on increased understanding of functions, innovations in products and processes, opportunities to expand or develop new markets with customized services, and so forth. In these organizations, informating will be a core process. But for informating to become a conscious strategy, it will be necessary to create a vision that transcends the limitations of our current language. The images associated with physical labor can no longer guide our conception of work. The work place, which may no longer be a "place" at all, might come to be thought of as an arena through which information circulates, information to which intellective effort is applied. The quality, not the quantity, of effort is the source from which added value will be derived. Economists can continue to measure labor productivity as if the entire world of work could be adequately symbolized by the assembly line, but their measures are likely to be systematically indifferent to what is most valuable in the informated organization.

Such a world as this calls for a new vocabulary, one that introduces the possibilities of colleagues and co-learners, of exploration, experimentation, and innovation; one reflecting jobs that are comprehensive, tasks that are abstractions depending on insight and synthesis, and power that is a roving force that comes to rest according to function and need. A new vocabulary cannot be assigned; it will have to be developed by those engaged in breaking ties with an industrial logic that has ruled the imaginative life of our century.

Industrial technology has been liberating; it has created vast wealth and decreased the demands on the human body. It has also been seductive – promising to fulfill the dream of perfect automaticity while healing egos wounded by their need for certainty and control. Part of the dream is an image of "people serving a smart machine." In the shadow of the dream, human beings have lost the experience of critical judgment. But only such judgment can initiate the kind of human action that moves over and against the vortex of stimuli, not merely to respond, but to "know better than," to ask questions, to invent, to say *no*. The dream of automation brings us dangerously close to Hannah Arendt's dark vision of a behaviorist world come true:

> The last stage of the laboring society, the society of jobholders, demands of its members a sheer automatic functioning, as though individual life had actually been submerged in the overall life process of the species and the only active decision still required of the individual were to let go, so to speak, to abandon his individuality, the still individually sensed pain and trouble of living, and acquiesce in a dazed, "tranquilized," functional type of behavior. The trouble with modern theories of behaviorism is not that they are wrong, but that they could become true, that they actually are the best possible conceptualization of certain obvious trends in modern society. It is quite conceivable that the modern age – which began with such an unprecedented and promising outburst of human activity – may end in the deadliest, most sterile passivity history has ever known.

That managers may give themselves over to this dream out of inertia or convenience rather than cogent analysis is all the more disturbing. Organizations that take steps toward a purely automating strategy can set a course that is not easily reversed. The message communicated to the work force and the depletion of skills that would be needed in value-adding activities represent losses that are not easily retrieved.

An informating strategy requires a comprehensive vision that appreciates the unique capacities of intelligent technology and recognizes the need to use the organization to liberate those capacities. It means forging a new logic of technology deployment based on that vision. A coherent rationale will be necessary, particularly as the tide of conventional thinking and familiar assumptions begins to submerge many important value-laden choices regarding basic technology design. As one plant manager pointed out:

> The technology is going in the direction that says one person operates the master controls. Is the technology right? We don't believe it is, and we are working hard to convince vendors to leave the design flexible enough so that it does not preclude the uses we want to make of it.

The informated organization does move in another direction. It relies on the human capacities for teaching and learning, criticism, and insight. It has an approach to business improvement that rests on the innovation made possible by an enhanced comprehension of core processes. And it reflects the interdependence between the human mind and some of its most sophisticated productions. As one worker mused:

> If you don't let people grow and develop and make more decisions, it's a waste of human life – a waste of human potential. If you don't use your knowledge and skill it's a waste of life. Using the new technology to its full potential means using the person to his or her full potential.

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