CHAPTER 20

TECHNICAL LITERACY AND THE KNOWLEDGE IMPERATIVE

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20.1 INTRODUCTION

The pace of business change, characterized by globalization, higher consumer expectations, greater competitive pressures, and shorter process cycle times, has forced many organizations to fundamentally redesign work structures to meet rapidly changing marketplace requirements. Pressures for workforce productivity gains are intensifying. Organizations and industries now look beyond obvious efficiency gains from automation and personnel reduction to more systematic and breakthrough ways of being low-cost producers of high-quality products and services. The useful life of information is shrinking (McLagan, 1989), and organizations that are able to work in less time gain competitive advantage. Hierarchies are dissolving and being replaced by flatter, more flexible organizations that strive to generate new ideas and then transfer or generalize those ideas to action faster than their competitors.

In this dynamic environment, organizations increasingly view physical advantages in production technologies as a fleeting source of competitive advantage (Stein and Sperazi, 1991).

In search of a new winning formula, organizations increasingly focus on developing human asset competencies; such competencies have surprisingly become an increasing portion of value-added and, as many organizations are now discovering, the most difficult asset to duplicate (Casio, 1989). Some estimates suggest that even in manufacturing, which has traditionally placed strong emphasis on production and process technology, perhaps three-fourths of value added derives from knowledge (Losee, 1994). Jeffery Pfeffer of Stanford University writes in *Competitive Advantage through People* (1994, p. 6):

> Traditional sources of success—product and process technology, protected/regulated markets, access to financial resources, and economies of scales—still provide some competitive leverage, but to a lesser degree now than in the past, leaving organizational cultures and capabilities, derived from how people are managed as comparatively more vital.

This *primary* emphasis on managing human assets in the firm is a relatively new phenomenon (Ulrich, 1986). Organizations have always strived to manage scarce resources and accordingly have paid relatively less attention to those resources which are readily available. Traditionally scarce resources have been capital; abundant resources included skilled workers who have been highly capable of sustained performance. The easy availability of competent employees resulted in an emphasis on capital over competence. However, today's demographic trends such as an aging workforce, reduced growth in the rate of new workforce entrants, and declining educational system quality have made competence increasingly a scarce resource. In this scarce market for competence, firms are aggressively competing worldwide to attract, motivate, and retain competent employees.

As we approach the next millennium, business strategies will be more dependent on the quality and versatility of the competent human resource. Moreover, organizational resources will be expended toward identifying and assessing scarce human capital in much the same manner as obtaining physical assets and technologies have traditionally been sought as a means to achieve competitive advantage. One author has suggested that convergence of these forces in the 1990s has ushered in the era of "people power" as the key competitive force (Doyle, 1990). Another states "Strategies of the nineties will not be delivered if the organization's people aren't capable and committed. Organizations that apply only money and technology to problems, without bringing the people along will not survive" (McLagan, 1989).

Organizational changes in response to environmental pressures require corresponding changes in employee roles and the skill sets required to be effective in those roles (Katz and Kahn, 1979). As organizations have downsized their workforces in the 1980s and now the 1990s, many jobs have all but disappeared, leaving tasks that still need to be accomplished but fewer workers to perform the work (Hammonds et al. 1994). The tremendous effort now spent on organizational design initiatives is partially a reaction to headcount reductions. These redesign efforts frequently concentrate on self-directed work teams, process reengineering, and culture change to achieve a balance or "fit" between multiple organization tasks and competent workers who can perform these tasks (Fisher, 1993; Manganelli and Klein, 1994). Further, rigid jobs are displaced by team accountability and flexible, multiskilled job designs. These are more participative team-based designs which require a greater level of technical, business, and interpersonal skills than was required in a more rigid hierarchical structure with narrowly defined tasks. Now, organizational members are asked to do "knowledge work" which requires judgment, flexibility, and personal commitment to the job rather than compliance and submission to organizational procedures (McLagan, 1989). Peter Drucker has characterized the current era as an information society where

knowledge workers constitute the primary source of competitive advantage (Drucker, 1985). To be effective in this fluid environment, employees must understand the organization's business objectives in order to take direction from the work itself in meeting those objectives rather than relying on policy manuals or being told what to do by their supervisor. The supervisor may have been replaced and the manuals may describe jobs which no longer exist or procedures which are obsolete in the newly configured workplace.

The incentive to develop and acquire competent employees with the requisite abilities is clear: Those high-performance organizations that are able to leverage the performance of individuals in their "jobs," as team members, and as organizational resources, will be the recipients of economic gain (Stein and Sperazi, 1991; U.S. Department of Education, 1992a). What is less clear is how and where American organizations will develop and acquire the type of talent required to be competitive. When productivity and quality are discussed, often the issue of the skill level of the workforce emerges as a potential barrier to improving organizational capacity (Charp, 1995).

It is essential that educational systems from kindergarten through university recognize increasing demands on workers to keep pace with a rapidly changing technological environment. Fewer workers leave the education system with the skills needed to do the job. This has been referred to as the "national crisis" in public education. As a result, highly technical organizations are undertaking a great deal of on-the-job training and education. What knowledge gaps are these companies increasingly having to fill? Primarily, the underpinnings of basic learning and thinking: research, data synthesis, and analytical skills (McKendree, 1991). Companies who for decades invested in technical training only for relatively specialized jobs can no longer ignore the need to teach the workforce how to investigate, analyze, and ultimately anticipate options and challenges that the competitive landscape will present in the years ahead (*Business Week*, 1994).

20.2 THE ROLE OF THE WORKER: A SHIFTING PARADIGM

The movement toward an emphasis on workplace literacy in the United States is in response to the shifts identified earlier from traditional production organizations to high-performance organizations. Traditional production organizations are based on nineteenth- and twentieth-century theories of management and productivity (Roth, 1993). Such organizations emphasize large-scale manufacturing to generate sufficient inventories, and focal attention is given to cutting costs and reducing per unit costs by increasing the number of units produced (Hodgetts et al., 1994). Product cycles are long in duration and new products are infrequently introduced giving the ultimate consumer limited product choice (Stein and Sperazi, 1991). Traditional industries rely on hierarchies in which multiple levels of management control workers in much the same manner as other tools in the production process. In traditional organizations, jobs are broken down into simple tasks, and the role of the worker is to repeat those tasks with machinelike efficiency (Bridges, 1994). Worker reliability and willingness to comply is valued. System improvements are the prerogative of an "elite" cadre of managers charged with reviewing processes (Walton, 1985). Effective in its time, the traditional organizational approach will be insufficient to meet competition in global markets with twenty-first century standards (Sasseen et al., 1994).

In traditional organizations, workforce learning was not viewed as a meaningful

activity in relation to the production process (Stein and Sperazi, 1991). Workers in traditional organizations are expected to engage in only first-order learning, which involves improving the organization's capabilities to achieve known objectives and is often associated with routine and behavioral learning (Ulrich et al., 1993). Traditional workforce programs are problem-centered with outcomes measured in terms of short-term goal attainment. Training is viewed as a technique to prepare workers for action, a form of remedial activity designed to fill gaps in the abilities of workers to perform specific job skills. The "real" activity is viewed as job training which follows workforce education. There is a presumed inconsistency and conflict between education and production, and workers are not given release time for participation in learning (U.S. Department of Education, 1992b).

High-performance organizations view the production process differently. They are constantly reinventing themselves by emphasizing frequent product development even when it requires cannibalization of an existing market leader position. Customized products are built to order, inventories are small, and development time is short. Second order learning is expected of employees, requiring consistent reevaluation of the nature of objectives and the values and beliefs underlying them (Argyris and Schon, 1978). Second order learning, or double-loop learning, consists of "learning how to learn," something that even "smart managers" have difficulty with (Argyris, 1991). Every member of the workforce is responsible for product and process improvement, efficiency gains, and customer satisfaction. The emphasis in the production process is on continuous improvement, increased productivity, and growth. In high-performance organizations, managers function as coaches in "participatory processes" and workers are viewed as resources. Training prepares workers not only for jobs as currently defined but also for the job as it is expected to evolve and for future jobs. Workers are measured on working efficiently and smoothly in self-managed teams and for their ability to creatively solve problems (Fisher, 1993). Since improvements in the process and products are largely a result of worker inputs, perceived threat of job loss is minimized by the worker's role in developing process improvements. If the American economy is to transition successfully into the twenty-first century, then workplace education must respond and adapt programs to the educational needs of high-performance organizations (Stein and Sperazi, 1991).

20.3 CHALLENGES TO THE NEW PARADIGM

Organizations are moving into an era of system solutions where the concern is to resolve issues or make real changes, not just to implement programs (McLagan, 1989). Problem solving and change usually require multiple and diverse actions (training, policy change, job redesign). The number of new jobs in the United States is projected to increase to over 25 million by the year 2000, mostly in management, administrative support, sales, and service (Hudson Institute, 1987). These new jobs will require higher levels of formal education and technical literacy than are presently found, standards formerly expected only of managers and other high-level workers. Basic skill levels that formerly were adequate for assembly line production are inadequate in a workplace with just-in-time inventory processes, elaborate quality-control systems, flexible production, team-based work, and participative management practices (Hudson Institute, 1987). Charp (1995, p. 4) stresses the need for education beyond the "3R's" (reading, writing, and arithmetic) for organizations to maintain competitive advantage in an "information age": "Worker skills must mean more [than] job skills." She describes systems of continuous learning in place in Japan and Korea, which have increased organizational capabilities for learning that enable adaptation to

change and innovation. These educational systems involve investment in training and development with a firm foundation in basic literacy skills at the K–12 (kindergarten through twelfth grade) level. A nation whose core workforce is only basic-skill-literate will not be competitive in the global marketplace.

20.4 BASIC SKILLS

Basic skills are traditional skills such as the ability to read signs, the ability to add three numbers to determine the amount of a bank deposit, and language fluency sufficient to articulate questions and understand their answers (Adams, 1993; Barton and Kirsch, 1990). Basic skills are a prerequisite, a necessary but not *sufficient* condition, to the skills necessary to be effective in twenty-first-century organizations. The following demonstrates one example of how basic skills provide access to higher-level skill learning (U.S. Department of Education, 1992):

> My employee was involved in the ESL (English as a second language) class wrote a first-line supervisor. I have seen a direct improvement in his confidence level. He will now come to talk to me, instead of having someone else come to ask questions for him. He talks much more freely. His initiative is greater and he looks more motivated. This same employee completed a 40-hour Robot Operating Training Course with two other employees who spoke English as their first language. He was able to participate equally in the training due to his increased English skills.

The quality of the American workforce, for both existing and anticipated entrants, falls woefully short of even this most basic requirement. One of every five current American workers reads at or below the eighth-grade level, and one of every eight lacks a reading competency above the first-grade level (Mikulecky, 1990). In international comparisons of student achievement in industrialized nations on 19 different academic tests, American students never finished first or second, but they scored last seven times. Of all high school graduates, 13 percent are currently illiterate, and among selected minorities, illiteracy is as high as 40 percent. Only 70 percent of U.S. students complete high school, as compared with 98 percent in Japan. The typical high-school graduate in Japan is better trained in the basic sciences and language than half the college graduates in the United States. And the average Russian high-school graduate has taken 5 years of physics, 5 years of algebra, 4 years of chemistry, 4 years of biology, and 2 years of calculus. In contrast, the typical American student has not taken physics or chemistry, and only 6 percent have taken calculus. And, finally, more than half of U.S. high-school graduates lack the sophisticated information processing, communications, teamwork, and analytical thinking skills that most of the coming decade's jobs will require. The U.S. Department of Education reports that by the year 2000 an estimated 17.4 million limited-English-proficient adults will be living in the United States. Immigrants will make up 29 percent of the new entrants into the labor force between now and the year 2000—twice their current share (U.S. Department of Labor, 1991).

Compare this with a cross section of *current* jobs where reading level requirements were found to be between the eighth- and twelfth-grade levels. Of the job-related material in these same jobs, 15 percent required even higher reading levels (Mikulecky, 1990). Clearly the problem of deficient basic skills is not new. What may be new is the inability of organizations to mask basic skill deficiencies within narrowly defined jobs and routinized job tasks. The competitive pressures of the global mar-

ketplace will not absorb the burdensome costs and lack of flexibility characteristic of the mechanistic organization operating in a more insular market (Hammonds et al., 1994).

The number of 18- to 24-year olds entering the workforce is shrinking, and thus reform in the schools, although relevant to longer-term competitiveness, will not eliminate current workforce deficiencies in basic skills (Hudson Institute, 1987). New entrants to the workforce are increasingly female and nonwhite adults (McLagan, 1989). Over three-fourths of those who will be working in the year 2000 are already out of school and most are already on the job (Hudson Institute, 1987). The literacy gap in basic skills continues to widen, and increasing portions of the population are being classified as "functionally illiterate" or unable to speak English (McLagan, 1989). The most lenient literacy standard in use today for employable adults is fourth- to sixth-grade skills, which include the ability to read simple text and street signs. Under this definition of literacy, estimates of the number of functionally illiterate Americans range from 16 to 27 million, with the upper figure representing approximately 20 percent of the U.S. adult population (Adams, 1993). The next-highest literacy standard requires eighth-grade reading skills which include the ability to read a driver's license manual, read a digest or newspaper article, and compute change from a purchase. Under this definition, nearly 45 million adult Americans or roughly one-third of the adult population are illiterates (Chall et al., 1987). These literacy rates can be contrasted with Japan, a major international competitor and trading partner, which reports a 98 percent literacy rate. American employers are thus being forced to reach out to less-qualified workers to develop entry-level workforces and the skills gap between current workforce competencies and future workforce competencies is continuing to widen (Mikulecky, 1990). The New York Telephone Company reported that it tested 57,000 job applicants in 1987 and found that 96.3% lacked basic skills in math, reading, and reasoning (Bradsher, 1990). Chemical Bank in New York reports that it must interview 40 applicants to find one that can be successfully *trained* as a teller (Bank of America, 1990). Filling the jobs that will be created by the year 2000 and in the decades beyond will require organizations to develop in the *existing* workforce the basic and advanced literacies needed (Hudson Institute, 1987).

Organizations must take an active role in moving its members along the continuum from basic skills to technical literacy to knowledge workers. Learning requires mastery of basic literacy and technical literacy at the workplace. Without basic literacy, technical literacy will be difficult to attain. It is clear that many organizations are investing in developing the basic literacy of their workforce to improve their competitive advantage. For example, Laabs (1993) describes Ruiz Foods' commitment to a *Comprehensive Competency Program*, which the company bought from the Ford Foundation (cofunded by the California State Employment Training Program). The company's 1200 employees have the opportunity to learn basic English, computer operations, and math skills. In addition, employees are encouraged to attend team-building seminars. The founder of this family-owned company believes that the investment in basic literacy of the workers is paying off for the company, which has more than tripled its sales during the past 5 years.

20.5 TECHNICAL LITERACY

An individual with basic skills possesses many of the building blocks required to upgrade to a standard we define below as *technical literacy*. Yet experts in technological education caution that the process of obtaining technical literacy may be funda-

mentally different than obtaining math and reading skills (U.S. Department of Labor, 1991). The deductive and problem-solving skills of an automobile mechanic may be more relevant to achieving technical literacy than reading level, although clearly a minimum performance standard in reading is relevant to utilizing repair manuals. Thus, even if we could magically eliminate the basic skills deficiencies of the workforce, we would still be faced with the development of a number of skills required for effective organizational functioning in the twenty-first century.

Definitions provided for *technical literacy* are often narrowly focused on the ability to use technological tools, especially computers (Filipczak, 1994; Stokes, 1993). A familiarity with computers may not be required of all jobs, but it is fair to say that the percentage of jobs requiring a human-computer interface is likely to increase rather than decrease. Given the exponential growth in computing power and a corresponding increase in the power of the computer to provide increasingly large amounts of data in the same time frame (Gross and Coy, 1995), a critical skill that will be needed is knowing how to produce *useful* data and how to analyze and interpret it. Too often in the name of technical literacy we have focused on *how* to use the computer for generation of the data with ever increasing speed and/or lower cost while paying less attention to educating employees on the *why* of data generation, whether they are truly useful, or whether alternative outputs could be more effectively utilized. Those who view the use of technology as a tool for doing the same tasks faster lose out on potential new ways of operating that redefine tasks rather than speed up the processing of existing tasks. Employees who understand the *why* of the process are equipped to reinvent the process to achieve the objectives rather than to simply repeat the process at increasing speed.

One narrow approach to measuring the technical literacy of a population would be the frequency or extent to which products of technology are used in daily lives and the assimilation of these technologies (Filipczak, 1994). According to research by Dell Computer Corporation, the Austin, Texas-based computer manufacturer, 55 percent of all Americans are technophobic to some degree, meaning that they resist the use of technology in their daily lives. Of the adults surveyed, 25 percent had never used a computer, set the timer on their VCR, or programmed stations on their car radio (Filipczak, 1994). These figures suggest a pronounced aversion of many individuals to alter routine processes through the use of technology to arguably improve their quality of life.

Walter Waetjen, president emeritus of Cleveland State University and chairman of the Technology Education Advisory Council, provides three dimensions to technological literacy in his definition:

1. You need enough knowledge to understand technological advances as they are reported in the media. You may not know how a modem works but do know that it is a tool that can get you on the Internet.
2. You should be able to solve basic technological problems. If nothing appears on the monitor or the printer will not work, do you know enough to check the cord connections?
3. You should know how to use basic low-tech tools to accomplish tasks (Filipczak, 1994). Ignorance of basic tools is a barrier to the development of higher level technical skills.

Another definition of technical literacy or "technoliteracy" as suggested by Filipczak (1994) that comes closer to our own is that to be literate in technology means that you understand what the technology does (a computer can replace both your typewriter and calculator) and you've overcome your fear of the machine in question.

Progressive levels of technoliteracy are then achieved as one begins using technology to solve problems, but the essence of technical literacy is the ability to develop skills requisite to understanding and using the technology to do work. O'Connell (1994) speaks of the management of "technology resources" as an umbrella term for the hardware, software, communications, and employee knowledge and skills needed to solve business problems. All resources, whether natural, human, financial, or electronic, need care and tending if they are to survive and be productive. One such nurturing process is the organization's emphasis and communication of the importance of technical literacy (Koulopoulos, 1993).

We define *technical literacy* as a multidimensional toolkit of skills rather than a unidimensional familiarity with some particular aspect of a specialized technology or a broad familiarity with instruments of technology in general. A radar "technician" who can interpret blips on a computer screen but does not have an understanding of how the blips are generated and who could not rotate to an assignment using a different radar technology without extensive training is not technically literate. This employee is instead required to utilize a narrow skill set in a rigidly defined job where rote learning is more important for successful performance than the ability to engage in continuous learning and improvement. This person performs the job as specified within the boundaries of existing parameters but lacks the *why* perspective, which results in insufficient depth to address change and generate ideas for adaption of the job to business objectives (Reitzfeld, 1989). *Technical literacy* as we define it has three primary components:

1. The ability to understand how a technology can be utilized (i.e., modem as communications device for information access) and to obtain the required information to make an informed business decision (Sasseen et al, 1994; *Business Week*, 1994). This dimension most closely corresponds to what the typical layperson would label technical literacy. Managing technology calls for at least a modicum of technical knowledge, but the critical literacy is in how to apply technology to business problems (O'Connell, 1994).

2. A proficiency in the basic language of business and a familiarity with industry forces to ease categorization of information and facilitate communications (i.e., foundation in management, economics, and statistical process control). To be technically literate in the language of business is increasingly important as organizations engage in business process reengineering (Manganelli and Klein, 1994). Business process reengineering, with its emphasis on processes, requires more cross-functional business literacy than in the traditional hierarchical organization. Business literacy includes both basic generalized business literacy and a literacy that is more firm specific. The general business aspect of business literacy training can be effectively outsourced through the general business curriculum of local universities and community colleges or by bringing faculty on site (Philippi, 1993; U.S. Department of Labor, 1991). Stokes (1993) discusses a more localized, firm-specific, business literacy. He suggests that employees can be responsive to organizational objectives only when they know key industry players, understand developing industry trends, recognize jargon that is specific to the industry, and are attuned to what the enterprise sees as its current and future niche. He also includes in business literacy an understanding of the nature of the organization's political alliances (how things really get done), which increases capability in relating to internal clients and customers. To develop these firm-specific competencies and learning systems, the organization must provide specialized training on industry parameters and environmental forces that affect organizational objectives. Such training will likely have to be developed in house as relatively few outsiders will

possess the expertise and knowledge of organizational objectives that would allow the outsourcing of training. Once employees understand firm and industry forces that impact the organization's business objectives, a need for developing informational systems and networks will arise to accommodate employee demands for the acquisition and processing of informational inputs from multiple levels. The demand for such inputs will present a great challenge for information systems groups who will be challenged to develop informational delivery systems that meet these needs.

3. A set of analytical skills which include problem identification, inference making, data reduction and synthesis, problem solving, and information presentation (i.e., solving organizational problems and conveying learning points to organizational members).

We regard individuals who possess these three technical literacies of technology awareness, business literacy, and analytical skills as possessing the core competencies to engage in "knowledge work." Knowledge workers are, in turn, those individuals who are capable of raising organizational capabilities to the level required of what has become known as the learning organization.

20.6 TECHNICAL SPECIALISTS MAY NOT BE TECHNICALLY LITERATE

The rate of technological change is escalating rapidly. As the workplace changes and employees are asked to continually improve processes, continually do more with less and continually learn, technological literacy is becoming a new learning imperative. Knowledge workers are keenly interested in understanding *why* their function exists in the organization. An understanding of the *why* component is especially important in an era of rapid change and cross-functional interaction. If individual jobs and processes are changing rapidly, then it becomes increasingly important to understand *why* certain things need to be accomplished. Workers who understand the why of the business objective are more likely to be able to evolve and adapt their roles to accomplish that objective. Technical specialists who are up to date on the latest developments in a narrow specialty area are the mainstay of today's organizations, but much of this technical acumen is lost if the individual has only a vague notion of how to apply these skills to meet the organization's business objectives. This person has a tool (technology), expertise using the tool (technical proficiency), but is unsure what the organization needs fixed (lacks business literacy and analytical skills).

Organizations must not only foster the acquisition of technical specialties but must also continually communicate business objectives to allow the employee to have a line of sight between a specialty area (role) and accomplishment of the organization's business objectives. At that point the employee will be able to be more responsive to accomplishment of business objectives by anticipating what needs to be "fixed" rather than being informed by someone with the "big picture" what needs to be fixed. Additionally, understanding internal customer needs is important in the communications process. The knowledge imperative for organizations is to develop in their employees the ability to "learn to learn" or to engage in what Argyris (1978) refers to as double-loop learning, and thereby continually adjust their "jobs" to meet organizational objectives. Workers who have "learned to learn" can, in turn, communicate to organizational members in a way that can be generalized to other organizational situations within relevant boundaries. Employees who understand the *why* of their jobs are

more likely to know the *why* aspect of situational success or failure. By sharing this learning across the organization and embedding this information in the organization's collective thought processes, we have moved beyond basic skills and utilized our technical literacies to engage in knowledge work that fosters real organizational learning.

20.7 IMPROVING ORGANIZATIONAL LEARNING CAPABILITIES

The investment in basic and technical literacy is a component of a competitive strategy based on the ability of all workers to contribute to the production of better-quality products and improved service. This strategy emphasizes the key role of investment in human resources to create what have been termed the "workers of the future" (knowledge workers) (Harrigan and Dalmia, 1991). Harrigan and Dalmia (1991) describe these "knowledge workers" as employees that are problem solvers and innovators. They argue that these workers are the key to competitive advantage in a changing global economy. An individual's ability to learn and to convey learning to other organizational members is crucial to the organization's overall ability to compete. The ability to learn allows an individual to upgrade or acquire new skills in addition to organizing and taking from the experiences of others. These workers need not have high organizational rank or status. Ideally, innovation can be initiated at any level of the organization to improve processes and products (Harari, 1994). Organizations that create environments in which any employee can offer suggestions for improvements have been described as "Learning Organizations" (Senge, 1990a).

20.8 LITERACY AND THE KNOWLEDGE IMPERATIVE IN LEARNING ORGANIZATIONS

Ulrich et al. (1993) describe learning organizations as those that have the following characteristics:

- "Employees are continually challenged to help shape their organization's future."
- "The capacity of an organization to gain insight from its own experience, the experience of others, and to modify the way it functions according to such insight."
- "The process of improving actions through better knowledge and understanding."
- "An organization that is continually expanding its capacity to create its future."
- "An organization that continually improves by readily creating and refining the capabilities needed for success."

Learning organizations enable their employees to embrace their intrinsic motivation to learn. According to Senge (1990a, p. 4), "Learning organizations are possible because, deep down, we are all learners." Senge and others advocate the implementation of work-team systems to tap into employees' ability to learn and apply systems thinking. However, without the requisite basic literacy skills, work-team systems are doomed to fail. Prior to implementation of work teams as part of learning systems, an inventory of the requisite basic skills of the workers (reading, writing, basic arithmetic) is a necessary first step.

Given basic literacy, the next level of learning is an understanding of systems

thinking (Senge, 1990a). This level requires a somewhat more abstract level of thinking and the ability to sort out cause-effect relationships. McKendree (1991) notes that organizations increasingly need to fill knowledge gaps in research, data synthesis, and analytical skills. The implementation of most total-quality programs requires employees to have at least this level of technical competency, since such programs are typically grounded in examination of processes in the search for ways to continuously improve them (Sashkin and Kiser, 1993). For example, in a health-care delivery system, a team was formed to examine ways to reduce the amount of time that patients spent waiting for appointments. The team determined that the root cause (80 percent of the situations with waiting periods that were found to be over the average waiting time) was retrieval of medical records and developed a plan to improve access of medical records in situations when patients were waiting for more than 15 minutes. Here, the team members needed basic literacy skills to read and understand the problem, basic math skills to analyze the data available, and basic written and oral communication skills to communicate to the team and prepare necessary reports on recommendations to management. Beyond this, the employee team members needed abstract reasoning skills to determine cause and effect relationships and to generate possible solutions to the problem. It seems clear that the implementation of new work systems based on learning organization principles necessitates basic literacy skills plus the capacity for abstract reasoning.

Many researchers present assumptions about learning organizations including the need for workforce competence (Senge, 1990a; McGill and Slocum, 1993; Ulrich et al., 1993). With knowledge becoming an increasing requirement for international competitiveness, basic and technical literacy have become imperative. Processes must be continuously improved which requires learning. Products must be improved or invented which requires learning. This requires organizations to continuously invest in the capability of their employees to acquire new skills and learn new ways of doing things and new ways of thinking. Ulrich et al. (1993, p. 63) define "learning capability" as the capacity of individuals to "generate and generalize" ideas with impact. "Generating" refers to the creative process through which new ideas are created. "Generalizing" refers to the ability for the idea to be shared with others and across boundaries of time and hierarchy, as well as outside the organization and geography. These abilities of generating and generalizing require abstract reasoning abilities, in addition to basic literacy.

The implications of basic literacy to the learning continuum are depicted in Fig. 20.1. Each level of this continuum assumes that competency at the previous level has

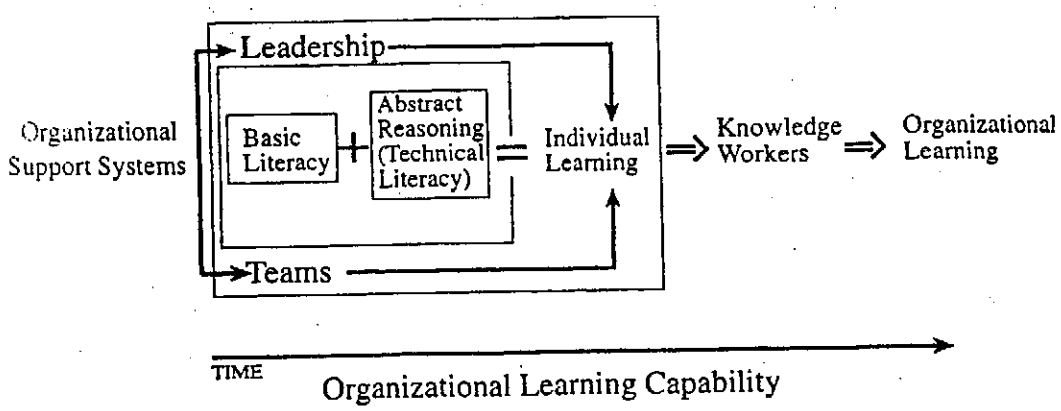

FIGURE 20.1 Technical literacy and organizational learning.

been attained by the worker. Abstract reasoning assumes that the basic tools are in place in order to work with concepts and data (basic literacy). Once abstract reasoning skills are developed, learning can occur because workers will be able to generate and generalize ideas (Ulrich et al., 1993). This enables some of these workers to become knowledge workers, who will be the innovators and problems solvers, which will create competitive advantage for the organization (Harrigan and Dalmia, 1991). In Fig. 20.1, fewer workers exist per level at any point in time in the development of the organization's learning capacity. However, the premise is that workers are learning and moving throughout the process, with the goal being the creation of as many knowledge workers as possible. At some point, a critical mass of knowledge workers, those with requisite knowledge, skills, and abilities (KSAs) will develop. Once this has occurred, a learning organization can emerge (Senge, 1990a). Literacy and knowledge literacy are an imperative for today's organizations and necessary for development of learning organizations.

20.9 ORGANIZATIONAL IMPLICATIONS OF THE KNOWLEDGE IMPERATIVE

The creation of knowledge workers and ultimately learning organizations will require investment in human resources at unprecedented levels (Doyle, 1990). Individual and organizational learning are not isomorphic, but the latter is dependent on the former. Individual learning occurs as *people* acquire tacit knowledge through education, experience, or experimentation. Organizational learning occurs as the *systems* and *culture* of the organization retain learning and ideas are transferred across organizational boundaries of space, time, and hierarchy (Ulrich et al., 1993). This is an important distinction as learning without organizational change can occur when individuals generate new ideas but the ideas are not generalized to organizational systems, or when units of the organization experiment with an idea, but fail to share their learning. In contrast, a learning organization adopts mechanisms to capture individual learning and develop in employees those ways of knowing that lend themselves to policy capturing. Individuals who are able to arrive at the "correct" answer but cannot elucidate the decision process offer the learning organization less than an individual who has been trained in systematic ways of knowing and therefore can assist in transferring knowledge throughout the organization. The organization must actively develop this policy capturing mechanism much the same way that "expert" systems capture aspects of individual learning. Such mechanisms are necessary to achieve learning organization status.

So what must organizations view as a prerequisite to achieving the status of a learning organization? First, the creation of knowledge workers requires basic literacy plus abstract reasoning abilities. To develop these capabilities, organizations will need to increase their investment in training and development. Assessment of knowledge gaps will become a necessary part of the training and development system. McKendree (1991, p. 101) comments that

> ...American companies are, by necessity, filling critical knowledge gaps in their new hires. Fewer workers are coming out of the education system with the skills they need to do their jobs. As a result, highly technical and complex organizations must undertake a great deal of training and education on their own.

Once gaps in knowledge have been identified, training must be provided in basic

skills, plus abstract reasoning ability. These skills are necessary if the organization wishes to fully empower its workers (Taylor and Ramsey, 1991; Dobbs, 1993). *Empowerment* is allowing employees the authority to make decisions about their work without having to ask a supervisor for permission (Taylor and Ramsey, 1991). Too often, organizational decision makers rush to implement work teams, with disastrous results because the workers do not have the necessary basic skills to be fully empowered. Beyond basic skills, abstract reasoning skills are necessary to engage in creative problem solving. Brainstorming is an exercise in futility if the workers do not know how to critically evaluate the ideas generated at the appropriate time in the process or if good ideas have been lost for lack of facilitation skills. Critical thinking skills must be learned and practiced if the processes of brainstorming are to result in some useful product.

Second, learning organizations also employ teams of workers to solve problems and generate new products or services. Recent theories of knowledge suggest that learning organizations create "activity systems" within which workers engage in collaborative work, and share information and ideas (Blacker, 1993). If the team-based organizational form is being implemented, team skills are a prerequisite for all employees in addition to literacy skills (Brachule and Wright, 1993; Katzenback and Smith, 1993; Scholtes, 1993; Schonk, 1992; Sunstrom et al., 1990). Team and interpersonal skills are necessary for generalizing ideas and sharing information effectively within teams, in cross-functional teams, and throughout the organization (Katzenback and Smith, 1993; Schonk, 1992). Given the literacy and knowledge imperative, organizations will require new forms of leadership to implement systems that support and encourage learning. Technical literacy and the knowledge imperative have implications for training and development and leadership (Brachule and Wright, 1993; Katzenback and Smith, 1993; Senge, 1990b). Creation of a learning organization requires that employees have the requisite skills and the opportunity to apply them through participative leadership practices. Command-and-control autocratic leadership is not consistent with the learning organization, and all levels of management will need to unlearn old behaviors and learn new ways of leading (Conger, 1993). They will need to create learning environments in which workers take responsibility for the future of the organization (Fulmer, 1994). The leader's role will shift from telling workers what to do to that of teacher, coach, and role model (Manz and Sims, 1987; Senge, 1990a).

Leaders are responsible for shaping the culture of the organization (Deal and Kennedy, 1982). Leadership at the top is essential for establishing the vision of an organization that is committed to learning, and supporting the efforts of training and development in terms of necessary resources. Leaders in the middle level of management have a critical role in the learning organization, since it is their job to create high-quality work relationships with their workers that support innovative behavior (Graen and Scandura, 1987). Workers must be encouraged to learn, experiment, and keep on learning through courses and application of concepts to the work environment. Middle-level managers must learn to accept intelligent failures and learn a tolerance for employee mistakes. This is a very different type of leadership, in which the manager's job is to support, coach, and teach, rather than to command and control the workers. Senge (1990b) defined the roles of leaders in learning organizations as designer of vision, steward of employee empowerment, and teacher. The role of the leader as a role model is emphasized in the latter role of teacher. Leaders must be willing to "walk the talk" or employees will become disillusioned with the learning process, and perhaps dismiss it as another management fad. In sum, the role of top management is creating vision and support for the learning organization. Generating this idea and then generalizing it through translation to middle-level management is

the next necessary step in the process. Next, it is middle management's role to translate this vision to the workers by being role models who engage in learning practices and serve as role models and teachers. As the organization's commitment to knowledge increases at these three levels, so does the organization's learning capability. Ulrich et al. (1993) provide key principles for extending learning across organizational boundaries.

1. Generate a large number of learning opportunities.
2. Generalize the learning beyond the individual.
3. Build in the desire and opportunity to learn from others.
4. Study failures and satisfactory episodes, not just successes.

20.10 RECOMMENDATIONS

20.10.1 Training and Development

Training and development within learning organizations must be continuous and not ad hoc "fixing up" of skill gaps in the workforce. To attain this objective, assessment of the employee basic and technical literacy skills defined in this chapter must be ongoing. As skill levels of employees improve, new training objectives should be set. Learning must be made a visible and central element of the strategic intent. Employees should be encouraged to challenge the status quo and constantly look for ways to improve their own basic and technical skills, as well as the products, processes, and services the organization provides.

Knowledge acquisition should be encouraged as a core competency, a valued commodity which is recognized and rewarded. Individual, team, and organizational competencies for learning should be a central objective in the organization's staffing and training initiatives. Similarly, the performance management system should encourage individual, team, and process learning by providing explicit feedback on accomplishments through appraisal and the provision of overt and tangible rewards. Continuous assessment and rewarding of individual capabilities that serve to increase organizational capability will encourage the development of a "learning mindset" that may become embedded in the organization's culture as a cherished value (Schein, 1993).

20.10.2 Basic and Technical Literacy as Gateways to Higher-Level Learning

Basic skills and technical literacy as gateways to higher-level learning should be emphasized. In developing our training sessions we must keep in mind that technologies are a tool, and that we need to learn problem-solving skills using that tool. Thus the computer (or any technical competence) must be made a part of training. Training employees on the tool and on needed skills separately is less effective than combining the learning of the skill required using the computer as a tool in problem solving. Research on adult learning (McKendree, 1991) suggests that children tend to learn first and then do, while adults tend to do first and then learn. If we want employees to integrate technology into their work processes, then training must integrate technology and problem-solving skills within a context relevant to the worker.

Computer skills training needs to incorporate the teaching of business skills. "Technical empowerment" is the idea that an employee needs to understand what the numbers on the spreadsheet mean instead of merely learning to manipulate them.

You've got to teach business skills along with technological competencies if you want to get the optimum productivity out of both employee and machine. The teaching of accounting in one course and the use of spreadsheets in another will not help employees blend the skills together, and that blend is the key to technical empowerment.

Training which focuses on problem solving with the computer will avoid confusion, eliminating the need to explain the "bells and whistles" available on many current software packages that may serve to intimidate the user rather than help to acquire basic skills.

20.10.3 Team and Interpersonal Skills

In addition to basic and technical literacy skills, training in team and interpersonal skills is necessary to develop a learning organization. Team-building skills such as knowledge of basic team processes, conflict resolution, and skills in running meetings should be taught. Interpersonal communication skills are a necessary underpinning of such training, in particular how to give and receive feedback and constructive criticism. Senge (1990a) describes team learning in contrast to team building as the necessary team-level process skill for the learning organization. In team learning, employees in teams become colearners and help one another to learn new skills, solve problems, and implement innovative ideas. In a team learning environment employees in teams learn how to learn, adjust, and self-regulate their own learning behaviors.

Implementing the learning organization under the literacy-knowledge imperative has implications for leadership. New roles for new managerial styles will be necessary. Senge (1990b) describes the new role of leaders in the learning organization as vision, steward, and teacher. Participative styles of leadership will increase with a corresponding decrease in the micro management of processes, as employee teams are empowered to make decisions regarding the work they do. The manager's job is to create and sustain activity systems, remove barriers to innovation, and assess and teach. To this end, a new focus on relationship development will be necessary. Mutual trust will become the hallmark of relationships in the learning organization. Employees with the basic and technical skills needed to do the job can be entrusted to do the job, with support and coaching from the leader. Interpersonal trust is needed for close interpersonal relationships and comprises faith of one person in another, dependability on one another, and predictability in the relationship (Rempel et al., 1985). Trust enables social systems to operate, since high levels of trust allow high reliability to be established through faith, dependability, and predictability. Underlying the development of trust is the development of basic and technical literacy of workers and leadership learning to trust them.

20.11 SUMMARY

This chapter reviewed the literature on the implications of basic literacy for work organizations and developed a definition of technical literacy. Next a model of the role of basic and technical literacy in the development of learning organizations is presented (Senge, 1990 a and b; Ulrich et al., 1993). Basic literacy is necessary for technical literacy and, in turn, technical literacy is necessary for learning.

Support systems for the development of basic and technical literacy in the learning organization were reviewed, including training and development, team learning, and leadership. Throughout the chapter, the role of learning as a strategic posture for com-

petitive advantage is emphasized. Organizations that provide training, support systems, and leadership that enables them to learn how to learn and continue to learn will hold the key to competitive advantage in today's global and rapidly changing marketplace.

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