Appendix A Schooling and Learning in an Information Society

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"We have now reached the stage when virtually anything we want to do in the field of communications is possible: the constraints are no longer technical, but economic, legal, or political." Arthur C. Clarke (3)

Whether one considers it a curse or a blessing to be born in "interesting" times, such is the plight or good fortune of the current generation. Events and inventions of the past several years strain credulity even for those accustomed to seeing the unlikely occur. There is little doubt that the years at the later part of the 20th century will provide a rich subject for historians as they explain to future generations the remarkable events of today. Those of us living amid this period of monumental change are faced with the difficult task of pulling back to gain perspective to see what is so close to us.

No developments among those of the past several decades are of greater consequence than those pertaining to information and communications technology. We have come to the point where indeed as Arthur Clarke says, "anything we want to do in the field of communications is possible." This audacious statement is correct even when we broaden the scope to include information/computer technology; for indeed, the line between communications and information technologies is sufficiently blurred so that it is impossible to know where one ends and the other begins.

The relevance for students and teachers of a technology that is used by scientists, technicians, business people, public officials, and others as the dominant means to create, store, and distribute information is obvious. As computer applications for personal productivity become increasingly powerful and prevalent, and as networks become the "places" where scientific, technical, and cultural information is stored, there is little reason to wonder if

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such technology belongs in schools. Schools, no less than other agencies, and more than many, need to take advantage of information technology. The essence of the issue for schools is this: If anything is possible, what should we make probable in schools? What should be done to make the immense capability of information technology a means for improving the lives of our children and for enabling them to live productive and satisfying lives in an increasingly complex and changing world?

Every new technology brings with it speculation about the impact of the technology on the future. Looking back, it is not difficult to find those who look silly because they badly underestimated the significance of a major technological advance. Arthur Clarke tells of the reaction of the chief engineer of the British Post Office upon hearing of the news of Alexander Graham Bell's invention. He told his colleagues, "The Americans have need of the telephone—but we do not. We have plenty of messenger boys . . . " (3). This British Postal Official made the mistake of thinking that the telephone would fit—or fail to fit—into the world as he knew it. He did not allow the possibility that the telephone would generate other developments which, in a sense, would remake the world so as to create a place for itself. Similarly the impact of computer technology has been misunderstood even by some who we might think would have been unlikely to do so. Shortly after World War II, Thomas J. Watson Sr. predicted that five machines would make up the world market for computers and, as recently as 1970, Kenneth Olsen, the founder of Digital Equipment Company, was quoted as saying that he saw "no reason for any individual to have a computer in their home"(17). "Solemn prophesy," J. B. Priestly is reported to have said, "is obviously a futile proceeding, except insofar as it makes our descendants laugh" (16).

Speculation about the impact of technology often takes a utopian tone; the technology is seen as the means to achieve whatever lofty goals the proponent espouses. Ralph Waldo Emerson, who believed that America was destined to be a pastoral republic, hailed the advent of the steam locomotive. Railroad travel, he believed, would disperse the population to rural communities. As a result of the invention of the steam locomotive, Emerson believed that the time was coming when, in his words, "the whole land is a garden and the people have grown up in the bowers of a paradise" (14). Emerson's prediction reads no more quaint or mistaken than the statements from computer proponents which abounded in the early 1980s about a "computer revolution" which would transform the schools and turn them into their own realization of an educational paradise by the end of that decade.

New technologies typically also generate a body of apocalyptic commentary. While Emerson greeted railroad technology as a means for improving the human condition, his contemporary Herman Melville was among those who feared that the machines emerging during this time would undermine the human condition. The theme of technology as a nefarious force which reduces human control and denigrates human values is longstanding. This has been the case with computers and information technology. Many persons have expressed the fear that computers would depersonalize schools as children sat before a screen without any human contact from teacher or peers.

The record of past technologies suggests that the consequences of technology are seldom, if ever, so consistent or unambiguous to warrant either the utopian or apocalyptic characterization. There is little reason to believe that information technology will bring either heaven or hell to earth; but it is clear that information technology is causing profound changes in how we live, work, play, and learn. Many will continue to debate whether information technology is making our lives better or worse, but there is little argument that information technology is making our lives very different from what they were before this technology was invented.

The changes caused by information technology in what and how children, youth, and adults learn are not something we await in the future; we are in the midst of these changes. Information technology is transforming the amount and nature of the informational content of civilization as well

as the processes whereby this information is acquired. The modest changes in the nature and conduct of schooling in recent decades stand amidst monumental changes in how, when, where, and what learning occurs in our society. As information technology-based learning opportunities become increasingly ubiquitous and efficacious, schooling, teaching, and learning will take on a new character and the establishment of a new balance between school and nonschool learning will be established.

CURRENT CONDITIONS IN SCHOOLS

In the past couple of decades, the plight of United States public schools has been documented in many books and articles; thus, a detailed account is not necessary here. A brief recapitulation of key aspects of the current status of schools will provide the context for the ensuing discussion.

- **Widespread dissatisfaction.** With the publication of *A Nation at Risk*, concerns which had been building in the preceding years about the American public schools coalesced and achieved prominence. Concerns about declining test scores, the fitness of American young people to provide the skills required by American business and industry, and the prevalence of drugs and violence in American public schools became a major issue in federal and state political campaigns, as well as a popular story in the print and broadcast media.
- **Federal, state, and local reform efforts.** Dissatisfaction about the status of the schools led to the creation of America 2000 which was the federal response to the need for a national reform of American schools. Many state legislatures enacted reform legislation of various types, such as charter schools, mandated school reform plans from local districts, lengthening of the school day or the school year, etc. At the local level, thousands of reform projects were initiated. While most of these were modest in intent and scope, a number of more extensive efforts were launched.
- **Privatization.** A number of school districts entered into contracts with private corporations to provide services previously provided by public employees, such as custodial work, transportation, special education, etc. The most extensive use of "contracting out" by a public school was announced in October 1994, when Minneapolis-based Education Alternatives, Inc. entered into a contract with the Hartford Public School District to run its schools. The Edison Project led by Frank Whittle was an even more ambitious plan for school privatization. This project, which began as an effort to develop a nationwide network of schools under the aegis of a private, for-profit corporation, more recently has entered into negotiations with school districts to develop contracts to provide instructional programs in a manner similar to Education Alternatives, Inc. By the later part of 1944, fiscal distress in the Whittle empire made the future of the Edison project tenuous.
- **Constraints.** Even though school reform laws have been enacted in states throughout the nation, state law and policy is frequently a barrier to change. Collective bargaining agreements also offer a substantial obstacle to change. College entrance requirements form yet another barrier since entrance requirements play a substantial role in setting curriculum requirements for high schools. Parents who may support curriculum changes at the high school become less supportive if it appears that the changes will compromise their child's college entrance. The climate and morale of schools provides yet another barrier. In some cases teachers and administrators may resist change, but it is not uncommon to find instances wherein teachers supportive of the need for change "do themselves in" with a self-fulfilling prophesy of failure based on past experiences.
- **Technology integration.** Much of the discussion about schools and information technology in the 1980s and 1990s has focused on how the technology could be integrated with the existing fabric of life in schools. From a political, as well as from a business point of view, this may be a plausible stance. If the task is to sell computers to schools or to persuade teachers to use them, then it is sensible to try to make them fit

into schools as they are now. If, however, the task is to use information technology to renovate schools, then the disintegrative aspect of the technology becomes the focus. Information technology becomes a means for disrupting existing practices and for creating a new way of schooling rather than becoming an accouterment to the existing practices.

PURPOSE AND FOCUS

This paper is written for the United States Congress, Office of Technology Assessment study entitled "Teachers and Technology." The purpose of the paper is to analyze the opportunities, prospects, problems, and barriers for technological change and its impact on K-12 schooling in the next five to 10 years. The question which serves as the focal point of this paper is: What are the implications of information technology for schools and learning in American society?

The use of the two terms "schooling" and "learning" in the title of this paper is not a redundancy. The pivotal point in this paper is the distinction between schooling and learning. Learning refers to the fundamental human process by which individuals acquire the knowledge, skills, attitudes, and perspectives which enable them to function in society. Functionality requires a range of complex skills such as language, understanding of rules of conduct and social interaction, life skills such as required by the specifics of the environment wherein the individual lives, and an array of cognitive skills such as reading, writing, etc. Schooling refers to the institution which, for the past century and a half in the United States, has been expected to accomplish the preponderance of learning outcomes for children and youth. Schools operate within a framework of well-established, and until recently, well-accepted policies, practices, and conventions. The educational impact of information technology is not confined to schools, and it is only when the broader implications of information technology for where and how learning takes place in society beyond the boundaries of the school are considered that we can understand what can and should done in schools.

Information technology, which has caused a transformation in so much of how life is lived in the waning days of the 20th century, has not bypassed how learning occurs in American society and will affect schooling, even though such has not occurred to any appreciable extent at present. Many persons have called for schools to be proactive with regard to the implications of information technology for school practices. There is less reason to be concerned about the lack of proactiveness in schools on this matter than their lack of reactivity. Teachers, administrators, and policymakers need to understand what is happening all around them and react to cause the changes to make schooling harmonious with a new way of living, working, playing, and learning.

In order to understand the full significance of the impact of information technology on human life and learning in particular, it is necessary to step back and take a quick journey through a half million years of human existence.

THE THREE GREAT CODES AND THE CREATION OF HUMAN CULTURE

Over the span of human history, from the dawn of time to the present moment, there have been three great inventions which have shaped the development of human culture. Each of these inventions has been an innovation in communication, and in each instance a new chapter was begun in the story of civilization. The current generation is in the midst of the invention of one of these codes and is witness to changes of a magnitude which are rare; only a handful of generations among the thousands who have walked on earth have ever experienced events such as these.

In the beginning was the thought. Certainly, there could not have been the word had there not been the thought. Human beings have an inner life of the mind. They think, and it is the ability of *homo sapiens* to be conscious of what he or she is thinking about which is the basis for the creation of human culture. As a human being we can

"look" into our own mind and "reflect" on our thoughts. We see the faces of those whom we encounter, but we are not privy to their inner life unless they choose to tell us about it. Nevertheless, we know that their minds, like ours, are spinning a tapestry woven of thoughts and feelings. Writers such as Proust tried to present a representation of "stream of consciousness" in their work, but it is terribly difficult to provide a completely faithful representation of human consciousness because of the dynamic and amorphous nature of consciousness.

Human beings had consciousness long before they had any particularly effective language system to tell others about it unless a scream of pain, a sigh of ecstasy, or a grunt of approbation is to be considered a language system. The initial step in the story of the creation of human culture was the invention of the first great code which was used to put what was in the mind into a form which enabled the transmission of the inner world of the mind to others. Sounds produced in the larynx were used to represent cognition, and as language developed, increasing richness and subtlety of expression was possible.

The invention of speech changed the human condition. Even with the fullest power of our imagination, it is difficult to get a good sense of how different life must have been when human beings existed together without the ability to talk to one another. With speech it became possible not only for one person to see another's face, but also to hear what was in their mind. Unlike the changes resulting from information technology which are occurring in the world at present, changes which are propelling us from one era to a new one in the span of a generation, the development of speech occurred over thousands of years. Thus, the changes in how the increasing sophistication of speech affected the nature of human existence were so gradual as to be scarcely noticed.

Speech provided a new dimension to human interaction. Speech made thought a social commodity. With speech it became possible to make public and to store human cognition. The knowledge of individuals could be accumulated and the accumulated knowledge of the society was stored in the brains of the elders. By memorizing the accumulated knowledge of the society and by passing it to successive generations by word of mouth, the products of human minds achieved a durability beyond the life span of the humans "who thought them up." Just as a person could leave the product of their hands such as a bowl or an ax to their progeny, speech now enabled them to leave behind the products of their mind—their stories, their truths, their ideas.

Speech was responsible for the first and, in a sense, the most important information revolution. The spoken word provided a means for humans to put structure to thought and to transmit it to others. By so doing, information was created. Speech made it possible for one person to tell something to another person, i.e., for one person to inform another. Information may be significant or trivial, true or false, valuable or worthless, but in each case the transference of information requires a shared coding system which makes the information intelligible to those who know the code. The nature of the coding system and the second order consequences which result from it create distinct conventions, processes, and beliefs pertaining to the accumulated information of the culture.

The second great step occurred with the development of a code which made use of graphic symbols to record speech. The earliest known use of graphics was the cave drawings of the Upper Paleolithic period, c. 30,000 - 10,000 BC, in southwestern France. The earliest use of writing involved the use of written symbols for numerical information such as calendars, inventories of property, etc. These cave drawings were probably not a primitive form of writing but were representational of important aspects of the life of early humans in a way similar to primitive music and dance. The first use of graphic symbols as a means to code speech occurred around 3500 BC after about 500,000 years of human experience with an oral tradition (27). The literate tradition was born.

Several millennia later, the advent of printing providing a means for information to become more popularized because of the favorable economics of movable type as contrasted to manuscript production. Early printing simply auto-

mated manuscript production. The form of the modern book did not fully evolve until about a century after the invention of printing. A series of inventive and generally unknown printers created the form of the modern book with a title, author, and publication information page, a table of contents, an index, and page numbers. An additional line of developments created the modern library, which initially was private but later (largely stimulated by private philanthropy) became public. As more and more books become available, it became necessary to devise ways to retrieve information. Earlier such was not necessary since a literate person would know of all of the books for which they had use. The information explosion caused by the invention of printing necessitated the development of systems for cataloging books, such as the Dewey Decimal System. The economics of printing along with the invention of new processes for the manufacturing of paper were sufficiently favorable so as to make printed material—books, newspapers, magazines, encyclopedias—available to everyone who could read.

For most of the era of literacy, written information was available to only a small number of people. It is only in the past few centuries that people other than an educated elite have access to written material. This fact is generally known. Less well recognized is the fact that until the development of cheap papermaking processes in the 14th century (a development stimulated by the invention of the printing press) pictures were a scarce commodity. Artists were available to the nobility to depict historical scenes as well as portraits. For the ordinary people, pictures in the stained glass windows of the great cathedrals of Europe were used to provide information about the life of Christ and the saints. Pictures, like words, are means of storing and distributing information, but their value and their use as a communication or learning resource has often been minimized. Cheap paper opened an iconic as well as a literate domain to a greater number of people, but reading pictures requires no training and the fact that pictures are so universally accessible may explain why the value of pictures as an information source has been underestimated.

While both the oral and literate traditions are means of constructing and storing the information of the society, there are significant differences between oral and literate traditions. Writing made knowledge much less precarious than it had been in the era of dependence on the spoken word. Enormous effort was required simply to maintain the existing knowledge so that the subsistence economies of early societies could devote few resources into the expansion of knowledge. In preliterate societies the advances of knowledge, even substantial advances when they occurred, were often not noticed. The advancement of knowledge within the oral tradition occurred though gradual evolution as it was transferred from person to person or as it was publicly talked out. The advancement of knowledge was a communal process; there were no Newtons or Einsteins in oral cultures (27).

Writing stabilized, depersonalized, and objectified knowledge. In the oral tradition, the elder is venerated since it is he who is the source and receptacle of knowledge. There is no such thing as a fallacy of an "argument to authority" in oral culture. Words, and the information they constitute, take on a different character in an oral as contrasted with a literate tradition. For example, in Biblical times:

> The Israelite conception of "word" and particularly the "word of God" was not considered to be the mere verbalization or articulation of thought. Rather it was God himself, communicating and giving himself in self-realization. Dabar (the Hebrew equivalent of "word") is therefore a manifestation of God. In other words, "word" to the Israelites was something extremely personal, so that it would be correct to say that the communication of the word is actually the communication of the speaker him/herself (32).

Writing existed when Socrates was born in 499 BC, but the sprit of the oral tradition was still strong. Socrates spoke; Plato wrote. In the *Phae-*

drus Plato recounts how Socrates inveighed against writing as a means of advancing human knowledge. Knowledge, for Socrates, was not something which resided in the inert written word but only in the minds of humans. Socrates compared writing to a painting. While the artist's portrait stands before us as if alive, we cannot question it. In the same way, we cannot interrogate the book. The faces in a good artist's painting appear alive and:

> . . . seem to talk to you as though they were intelligent, but if you question them they maintain a most majestic silence. It is the same with words: they seem to talk to you as though they were intelligent, but if you ask them anything about what they say, from a desire to be instructed, they go on telling you just the same thing for ever. And once a thing is put in writing, the composition, whatever it may be, drifts all over the place, getting into the hands not only of those who understand it, but equally of those who have no business with it; it doesn't know how to address the right people, and address the wrong. And when it is ill-treated and unfairly abused it always needs its parent to come to its help.

After several centuries of life within a literate tradition, the disconnection of words from the living sentient being that produced them is accepted and even appreciated since it objectifies the information presented. Indeed, as citizens of a literate world we often turn Socrates' argument upside-down and tell the person who is concerned that their message may be misunderstood or misinterpreted to "get it in writing."

Writing did not eliminate talking but, as Ong points out, writing caused both an expansion of talking and a transformation of it. Writing was a phenomenon of urbanization. Writing occurred in compact settlements and people in these environments talked with one another more than those in scattered settlements; writing gave them more to talk about. Writing also transformed speech. It made possible highly complex and deeply organized treatises on topics which were not possible in an oral tradition and enabled a use of language to manipulate and organize thought in ways which were quite different and more powerful than that which could be done with speech. Having learned to express oneself in the manner which could be accommodated by writing, individuals could, and did, emulate these conceptual and semantic structures in speech (26).

The invention of school was a consequence of literacy. The development of schools as places removed from the primary productive processes of society is closely connected with the development of writing. Records of the first known schools date to 2000 BC in Sumer. These schools were a direct consequence of the need to teach cuneiform writing to a scribe class (26). Goody speaks about the creation of schools where children were removed from their families and placed under special authorities as "decontextualization" (10). In oral cultures, learning was largely experiential and integrated into daily life. One did not learn by reading written procedures and instructions but by observation and practice. A person could learn to speak by listening to others speak and by imitating their behavior, but learning to read and write could not be accomplished in the same way since writing and reading were activities confined to a scribe class. Thus, schools as places where learning was decontextualized or disassociated from the everyday natural life tasks of the individuals were required to provide the development of skills which required extraordinary means for them to be learned. With the advent of writing, words—both spoken and written—became more central to learning in contrast to learning by observing and doing.

It is fitting that like the invention of the first and second great codes, the time and place of the invention of the third and most recent code is also uncertain. The popular choice (at least in the United States) is Samuel Morse who on May 24, 1844, sent the message "What hast God wrought!" via telegraph. But there are other candidates in Russia, Germany, and England. Possibly the first was in Germany where in 1809 a "chemical telegraph" was displayed in Munich which sent electrical current through wires in a water container

with each wire indicating a particular letter of the alphabet.

Around the time that Samuel Morse was working on his invention, an Englishman named Charles Babbage was deep at work on his Analytic Engine, the precursor of the modern computer; however, Babbage's Analytic Engine operated mechanically rather than electronically. Babbage saw a type of telegraphy similar to the one developed in Munich and understood the relevance of the use of electronics in his machine. But given the state of the art, this was impractical for him (13). In a little more than a century, however, the paths initiated by these two inventions would converge in the form of the ENIAC computer. This computer, which is generally acknowledged to be the first digital electronic computer, was developed by Mauchly and Eckard during World War II at the University of Pennsylvania. The information age had begun.

The terms "information society" or "information age" are buzzwords. They are widely used often with only a casual effort to unpack the meaning from them. Probably, for many, these terms mean little more than that computers and other associated technologies are an omnipresent feature of life and that most people will need to use them with considerable regularity. Yet, it is clear that a new manifestation of the human condition has emerged which is of a magnitude comparable to the two earlier advances in the construction of human culture.

The rapid advancement of information technology over the past few decades is one of the most dramatic episodes in the history of human ingenuity. As is well known, the power and performance of the laptop computer of today which sells for less than $2,000, is substantially more powerful than the mainframe computers of a couple of decades which sold for hundreds of thousands of dollars. Scholarship such as that provided by Ong (26) and Goody (10) shows clearly that the progression from an oral to a literate and from a literate to an electronic tradition changed the human condition. Each step has altered the relationship between the person and his/her own inner mental life. Also, each step has had enormous consequences on the amount and nature of the information within the culture. It is not difficult to recognize that a person living in rural Oklahoma has a different type of existence than one living in the inner city of Manhattan because of the difference in the physical environments. Similarly, changes in the intellectual environment of the magnitude that has occurred with the creation of speech, writing, and electronic information have had immense impact in shaping the way in which humans live their lives.

The most obvious implication of the information revolution is the expansion of knowledge. Walter Ong estimated that at the beginning of human history knowledge took from 10,000 to 100,000 years to double. Later it took from 500 to 1000 years to double. Currently, it is doubling in 15 years or less (27). Within the oral tradition, one person could, and did, commit to memory the totality of the knowledge of the society. Where is the person who could memorize all of what is known in our time? Within the literate tradition, it was possible for sensible people to take on the task of creating a set of books which contained the totality of human knowledge in an organized fashion. Who would set out to construct an encyclopedia which purported to be *everything* which is known in *all* fields of human endeavor? As knowledge expands because of information technology, it is information technology which offers the means to cope with the massive expansion of knowledge which is occurring. The knowledge which an individual has committed to memory, or the books he or she has read, are less and less a determinant of functional ability. Increasingly, it is one's ability to interact with the words, numbers, and pictures stored in computers in ways which result in informing (in the fullest sense of that word) him/herself which determines functional ability.

As was the case with the progression from an oral to a literate tradition, the new tradition does not replace but transforms the old. Word processing does not merely automate the process of writing; it transforms it. Jay David Bolter provides a detailed and thoughtful analysis of the impact of word processing on writing:

> How the writer and the reader understand writing is conditioned by the physical and visual character of the books they use. Each physical writing space fosters a particular understanding both of the act of writing and of the product, the written text. In this late age of print, writers and readers still conceive of all texts, of text itself, as located in the space of a printed book. The conceptual space of a printed book is one in which writing is stable, monumental, and controlled exclusively by the author. It is the space defined by perfect printed volumes that exist in thousands of identical copies. The conceptual space of electronic writing, on the other hand, is characterized by fluidity and an interactive relationship between writer and reader. These different conceptual spaces foster different styles and genres of writing and different theories of literature (1).

While epistemology, the study of the philosophy of knowledge, is an active interest of a small percentage of people, everyone carries with them a conception of the nature of knowledge. Writing, and more specifically the technology of the book, profoundly influenced the way in which people have thought about knowledge for several centuries. The structure of the book became the structure of knowledge. The book is linear. It is divided into chapters, each of which contains a unified and cohesive segment of the totality. The order of the presentation is governed by logic which yields one order of presentation. The book has heft and the words printed on a page have a permanence and a physical presence. These characteristics of the book became transposed to the conception of knowledge with cohesive and distinct disciplines, with a logical order to the structure of the discipline, and with durability.

Just as the traditions of the literate culture and the structure of the book shaped the conception of the nature of knowledge, the emerging traditions of the information culture are providing a new conception of the nature of knowledge. The metaphor for knowledge changes from that of the book to that of a colossal hypermedia stack. Knowledge becomes a network of concepts with many connective pathways. Linkages between concepts are formed on the basis of functional utility rather than on immutable and intrinsic logic. In the context of an electronic information tradition, knowledge is dynamic. Textbooks or reference books which are used for several years before a new edition is produced seem inappropriate, but editing or adding to an information in an electronic format is easily accomplished. The electronic tradition, like the oral tradition, is much more congenial to a communal approach to the construction of knowledge than is the print tradition. Just as there were no Einsteins or Newtons in oral cultures, the advance of knowledge in an electronic tradition is likely to involve fewer advances which are attributable to the work of a solitary genius.

Information technology not only affects what we know and how we come to know it, it also affects what we do. The need for any particular skill is contingent on the context of individuals. Information technology is causing some skills to become less valuable at the same time that new skills are becoming more valuable. Few people in our society rely on their ability to hunt for food to feed themselves. Today, one requires skills at being an effective shopper at the local supermarket. Old skills pass and new ones emerge. Many factory workers who worked with their hands and wrenches, drills, and welding tools no longer require skills with those tools but must now teach their hands keyboarding skills or work with computer programs that control machines that do what they once did with their hands. The value of being able to spell by memory every word a person uses in writing is less important when the individual writes on a word processor with spell check. The task of searching information bases did not exist in any significant fashion a few decades ago. It is now a skill of great value.

At the heart of the difference between a literate and an electronic culture (and certainly at the heart of the issue as it pertains to learning and schools) is the shift from a contemplative to an experiential method of learning. In a writing culture, human beings learn by pulling away from what is happening around them and reading about events, concepts, facts which another person has abstracted and structured. An electronic culture, on the other

hand, puts the person in the midst of the experiences which often are raw, unprocessed and, to use computer lingo, are real-time. The orderliness and "one step back" character of reading is in contrast to the untidy and "plunge into it" nature of electronic experiences. Thus, we do not read about the Persian Gulf War; we experience it on CNN. The concern of many is that what comes to the person in electronic formats are only pictures which may have no meaning beyond the momentary visual or auditory stimulation. Such a criticism goes beyond television or multimedia and pertains to experience itself. Experience is nothing more—or less—than the images, sounds, smells, and feel of what is occurring. The old saying is: Experience is the best teacher. But experience is not an infallible teacher. Thinking and reflecting do not go out of the picture in experiential learning. Thinking, evaluating, and reflecting are all part of "learning from experience," but they are blended into the learning process in a more subtle, less conspicuous way than in instances of "book learning." The texture and rhythm of learning when mediated by electronic resources is in sharp contrast to that which occurs in the environment of the printed word. This is the fundamental "two cultures" problem of schools at present as literate tradition teachers try and too often fail to teach electronic tradition students.

Information technology has substantially elevated the importance of pictures in learning. Today most people learn about their world in pictorial form through television. Pictures are particularly potent in engendering an emotional response. A pictures of a starving child in Mogadishu or of students resisting repression in Tianamen Square has an immediacy of impact which surpasses many columns of print in a newspaper account of the same story. Increasing attention has been devoted to the use of visualization as a means of presenting in pictorial form vast quantities of information. The user of such information might drown in the sea of this information in verbal or quantitative forms. The use of pictures in learning is troubling to some people since there is fear that looking at pictures is an act which can be done without the mind engaged. Picture books are considered acceptable for very young children, but comic books have been discouraged, usually more because of their use of pictures to tell the story than because of the content of the story. Nevertheless, there is a rich tradition of scientists, designers, and artists who think with images, and the capacity of information technology to present still and moving pictures expands the palette for developers of learning resources. For those of us who have lived and learned in a literate culture, there is something unsettling if not invalid in the migration from learning with text to learning with pictures, but it is quite likely that people in the future will look back on the limitations of our bias toward text in much the same way that we have observed the bias of earlier generations to the spoken rather than the written word.

There is little in contemporary life which is not touched in some significant way by information technology. Clearly, it has caused a fundamental transformation of the way people work. In one sense the computer is the most recent of a long series of machines such as the cropping machines used in textile manufacturing in the early 19th century at the outset of the Industrial Revolution. Cropping machines (which incidentally were destroyed by the skilled workers in England who were being displaced by these machines in the Luddite incidents) and other machines such as the cotton gin, the steamshovel, and the drill press automated work that had required a strong back or a steady and trained hand. The computer is quite different from the machines of the Industrial Revolution. To use the words of Shoshana Zuboff (40), who provided a thoughtful analysis of the impact of information technology on work, it is a "smart machine" and as such began a new chapter with regard to the nature of work.

The "Management in the 1990s Research Program" at MIT issued a report called *The Corporation in the 1990s* (23). This report contains rich detail about the nature of the changes at the levels of production, coordination, and management of the workplace. The sweeping changes are visible to anyone who walks on the floor of a factory. One finds fewer people, and many of the workers are using robotics, process control instrumentation,

and intelligent sensors. Less conspicuous are the changes in how those responsible for generating a profit think about their business. There is an expression used by some in the media production business, "I can give it to you cheap, quick, or good. Pick two!" What the business person hears is, "Our company needs to produce a quality product at low cost, and make a profit. Pick three!" Information technology is at the heart of the new conceptions about how to flourish—or at least survive—in a world of new expectations with regard to cost and quality. In the words of the editor of *The Corporation in the 1990s*, "Information technology has important general-purpose power to manipulate symbols used in all classes of work and, therefore, as an 'information engine' it can do for business what the steam engine did in the days of the Industrial Revolution."

Just as information technology is the influential work tool of society, information technology is also the dominant source of recreation. Parents and teachers commonly decry the great amount of time which children and young people spend watching TV. But looking at a screen, be it a TV or a video game screen, is the overwhelming source of recreation for children and young people, just as TV is the major recreational activity of adults. Video games, like TV, are often criticized. But someone, and the someone is often a parent, likes video games enough to make Sega and Nintendo a multi-billion dollar industry (33).

It has been somewhat less than a half century since the first big and clumsy computers appeared on the scene, and in the succeeding years there have been continuing advances and an increasing pervasiveness of the technology. There is a curious similarity between the purpose of writing at its inception several thousand years ago and the purpose of the first computers a half century ago. Both writing and computers began with a limited role in human conduct. The first writing systems and the first computers were "number crunchers." In both cases, they were used for numerical tasks, and also in both cases, the power of the symbol system which was developed gradually moved writing or propelled computers to a vastly expanded role. Even after several decades of plotting the growth of the expansion of computer technology, seasoned pros still can be surprised. Early in 1993 Bill Gates of Microsoft and Andrew Grove of Intel predicted PC sales of between 35 and 40 million, which was an increase from the 32 million sales in a good 1992 sales year. The actual sales were at 50 million, 25 to 40 percent higher than forecasted (9).

Efforts to predict the world that information technology will create can fall victim to a fatal trap if there is the assumption that at some point in the foreseeable future the process will have been completed. There is no reason to believe that anyone alive today will see the completion of this process or the achievement of stability with regard to the development of this technology, it will continue to be open-ended for generations to come. Nevertheless, there are several dominant themes which are likely to shape the expression of the technology in the years ahead:

- **Improvements in microprocessor design and reductions in cost.** The capability of microprocessors continues to increase as costs decrease. The first microprocessor was built in 1971 and in less than 20 years, by 1989, the first microprocessor to contain more than a million transistors was produced. By the year 1976, after five years of transistor production, the total of all the transistors manufactured by the computer industry was about 100 billion which is equivalent to the number of neurons in the human brain. Intel scientists predict a single chip that can hold somewhere between 50 and 100 million transistors will be produced around the turn of the century. With 100 million transistors on a chip, it would require only one 1,000 processors to produce a computer with as many transistors as neurons in the brain. Gelsinger and his colleagues at Intel contend that when systems with hundreds of billions of transistors become available early in the next century, it will then be possible to ask: "When will we put the first brain on a single chip?" (8).

  Even with the dramatic advances in chip design over the past two decades, the capabilities of existing hardware is a constraint in applica-

tions design. There remains a great gap between the way in which the mind processes information and the way in which this is done by computers. This gap will narrow with the improvements in chip design that will soon make today's supercomputers reminiscent of the Apple IIe. As this happens, the price of computing storage and speed will decrease. No one knows what a gigabyte of storage or 100 MIPS of processing speed will cost in the year 2000, but everyone knows it will be quite cheap and probably considerably cheaper than any current prediction.

Increasing the processing power of chips is not equivalent to increasing the horse-power of an automobile which has quantitative significance in terms of the speed with which the vehicle can carry weight. Increases in the processing power have qualitative significance in enabling new applications to be developed. While it is possible to extrapolate from existing applications and speculate about the improvements that will result from increases in processing power, no one knows what inventors will build when they can hold the processing power of hundreds of millions of transistors in their hands.

- **Networks.** It was only about a decade ago that battles were being fought between mainframe proponents and microcomputer proponents. With the increased capability of microcomputers, many (myself among them) were prepared to officiate at the funeral of mainframes. What many failed to see was the growth of wide area networks. Ultimately, in the contest between microcomputers or distributed computing and mainframes or central computing, the emergence of networks made both winners. The use of computers to create networks for communication and access to information has moved from being an important to a dominant theme in the use of the technology. Acronyms associated with networks such as BBS and FTP are migrating from computer insiders to the general population. By 1993, a little more than a decade after the first BBS or computer bulletin boards opened up in California and Chicago, there were more than 60,000 nationwide (34). The massive growth of the Internet demonstrates the rapidly growing interest in the use of networks. As of late July 1994, there were 3.2 million machines worldwide reachable on the Internet. This represents an 81 percent increase over the previous year. No one knows the number of people using the Internet, but it is many times greater than the number of attached machines.
- **Portability.** Advances in wireless technologies in the past few years offer the prospect of making use of the virtually infinite resources of the spectrum of electromagnetic vibrations. In the next few years advances in wireless technology along with the increased installation of fiberoptics will reduce the cost of transmission of information which requires larger bandwidth such as video and two-way communications. Andrew Grove of Intel put it succinctly, "You think computer prices are plummeting. Wait till you see what happens to bandwidth"(9).

  Of course, the elimination of wires also enhances the portability of devices that are already being miniaturized because of advances in chip technology. Smaller machines which are not tethered by wires also will be improved with better display capabilities. The display capability of a typical television set is roughly equivalent to 62 dots per inch. Screens with 200 to 300 dots per inch (which is equivalent to a laser print) will be available. Just as writing did not eliminate reading but transformed it, information technology will not eliminate reading on paper, but reading increasingly will be done using small portable display screens. Screens which display information at a quality level that is comparable to a well-printed color magazine at a cost per word that is substantially less than the cost of the same word printed on paper will have the effect of moving much of what is read to electronic formats. Given the fact that most of the information that is produced at the present time is already in electronic format, the extra step of printing it on paper

will be reserved for those who want paper to satisfy emotional or particular practical needs.

- **"Everything is data."** From our vantage point, it is ironic that Mr. Morse's digital invention was swept away by Mr. Bell's analog device. The future for analog signals such as those used by television does not appear promising. The bifurcated world of computer data in digital format and television signals is ending. As one of my colleagues frequently reminds me: "Everything is data." The efficiency and utility of storage and transmission of information, be it pictures, sound, or words and numbers in digital format is substantially greater than in analog format. Analog is an appropriate technology for a 20th-century broadcast world, not a 21st-century network world. In *Life After Television*, Gilder puts it this way, "The computer industry is converging with the television industry in the same sense that the automobile converged with the horse, the TV converged with the nickelodeon, the word-processor converged with the drafting board, and digital publishing converged with the linotype machine and the letterpress"(9).
- **Applications.** The first applications for computers were directed in ways to manipulate numerical information. Statistical and other numeric processing software was the dominant use of the early computers. The computer was a super calculating machine. As the technology developed, new applications emerged. Applications such as word processing and spreadsheets did not represent new ways to do old tasks, but were new ways to do new things. Over the next several years there will be new software inventions which will go beyond simply improving existing applications (i.e., advancing from version 3.0 to version 4.0). New applications will continue to emerge. For example, there are efforts to develop applications such as idea processors which can be used to manipulate concepts, ideas, and thoughts in a way similar to the manner in which word processing enables the user to manipulate words. The development of specialized software to exploit the full potential of computer mediated group-work, generally referred to as groupware, has just begun. This is an area still waiting for the "killer application," or, more likely, the "killer applications." As primitive and cumbersome as virtual reality is at present, it will become more and more realistic and adept at tricking the mind into believing that what exists only in cyberspace exists in real space. Visual, auditory, olfactory, and tactile perception of environments generated from strings of data will become so lifelike that the differences between virtual reality and "real" reality will seem to be a trivial distinction. There is certain to be a market for virtual reality for pornography and for violence. The fondest sexual and homicidal fantasies will be achievable without fear of criminal indictment. Some educational applications are obvious, such as the use in language learning by enabling the person to learn French in virtual France, or to learn about astronomy by taking a trip through space, or to understand human biology by engaging in an expedition into the human body. Beyond such obvious applications as these there is also an unknown continent of applications of this simulation and virtual reality for learning purposes yet to be explored.
- **Information technology vs. computers.** Throughout this document, the term "information technology" has generally been used rather than "computers." Thinking about the impact of this technology is inordinately truncated if one thinks about it in terms of the microcomputer. Microcomputers are only the current and most prevalent manifestation of the handling of electronic information. Over the next years, multiple and diverse machines will emerge and evolve and it will be increasingly clear that information processing represents a category rather than an entity.

The American public school has remained generally impervious to the impact of information technology. Much of the discussions about information technology and schools has focused on the question: How can information technology help school personnel to achieve the goals and

purposes of schools? In this formulation, schools are the "horse" and information technology is the "cart." Yet in reality, the horse and the cart are reversed.

For previous generations, the American system of schooling was seen as one of the great accomplishments of this nation. Such is no longer the popular perception, but in reality, it is not that schools have deteriorated but that the world has changed around them, making much of what occurs in schools anachronistic. The impact of information technology on schools transcends *what schools do* and affects *what schools are*.

THE AMERICAN PUBLIC SCHOOL AS AN INSTITUTION

Few aspects of life are as commonplace as schools. School buildings are the one place where everyone in society has spent time, some as much as 20 or more years. If a person becomes a parent, he or she is back in school again as they tend to the education of their child. Everyone knows what goes on in schools. In this context, it might seem quite peculiar to ask the question: what is the American public school? This question needs to be answered, not it terms of an inventory of what students and teachers do inside of classrooms, but in terms of what the American public school has meant to people in American society with regard to the learning and socialization required by children.

The American public school is an institution, and the term "institution" is key to understanding what it is as well as grasping the changes which impinge on schools as a result of information technology. Connotatively, the term "institution" carries with it a vague honorific meaning suggesting something of importance and permanence. Often there is little more than superficial use of the term institution as an explanatory concept, even though understanding the American public school as an institution is very helpful in any effort to make sense of what the public school is, why it is what it is, and how it fits into American society.

Many who believe that the school must be reformed, restructured, reengineered, or reinvented draw upon the recent experience of American business and industry to indicate what needs to be done. There is, however, an important distinction between the school and the firm. Both the school and the firm are organizations. As such, both are cohesive entities comprised of elements, each of which performs a specialized function necessary to accomplish the goals for which the organization was formed. Yet, the firm and the school represent two different types of organizations. John Meyer and his colleagues have provided a helpful analysis of the difference between organizations in technical contexts, such as the firm, and organizations in institutional contexts, such as the school:

> Formal organizational structures arise mainly through two processes. First, complex technologies and social environments with complex exchanges (such as markets) foster the development of rationalized bureaucratic structures to efficiently coordinate technical work . . . Second, institutional structures emerge that define given types of roles and programs as rational and legitimate. . . . The emergence of the factory reflects the first process, and the emergence of the school reflects the second (22).

The "technical organization" exists to *do* something. The purpose of the firm as an organization is to produce goods and services in a profitable manner. The term "bottom line" (which has become a popular metaphor) is far more than a figure of speech for the firm. The figure at the bottom of the accounting ledger is the critical criterion, accepted by all within the firm, of the organizational health of the firm. The organizational structure is effective to the extent that the organization is able to do what it needs to do, i.e., produce marketable goods or services at a profit. While the firm is affected by social values which go beyond the specific production or service goals of the firm (such as environmental concerns or racial or gender equity), these are not the *raison d'être* of the firm, but facts of life with which it must contend, grudgingly or willingly.

The school as an organization exists in an institutional context. The "institutional organization" exists to *be* something. It is in this sense that Meyer and Rowan point out that "modern schools pro-

duce education for society, not for individuals or families" (21). This is not to deny that individual teachers or administrators strive to—and do—provide services for children and their parents. Rather it means that for the school, unlike the firm, the beliefs shared by members of the society of the role it plays for the perceived well-being of society is of critical importance. The extent to which it is perceived to be meeting its social mandate is the "bottom line" of the organizational health of the school.

Shared beliefs are more than a desired feature of a society, they are an absolute necessity. Community or society disintegrates in the absence of a core set of accepted beliefs. Sociologists refer to the shared beliefs as the "rational myths" of society which are the structural framework of institutions (22). They are myths, not in the popular use of that term as being untrue, but in the sense of being widely and deeply held by members of the society. The myths are the ideological sinew which hold together the individuals as a community. The issue of the truth or falsity of the myths is irrelevant since the myths are value statements which do not lend themselves to empirical validation. "The beliefs are rational in the sense that they identify specific social purposes and then specify in a rule-like manner what activities are to be carried out (or what types of actors must be employed) to achieve them" (37).

One of the most important tasks of society is to ensure that each successive generation acquires the knowledge, technologies, skills, customs, and affects which they require to maintain the society. In the last century a belief structure was put into place which became accepted about the way in which children would be educated. Schools had existed from the early days of colonization, but early in the last century the American public school as an institution was created.

From 1830 to 1860, the size of the United States grew by 1,234,321 square miles, and the population grew from 12,866,020 to 31,443,321. Only 7.2 percent of the population lived in urban areas in 1820, but by 1860 this had risen to 20 percent. In 1820 there were only 12 cities with a population of 10,000 or greater. By 1860, there were 101 United States cities with a population of 10,000 or greater, and eight of them were larger than 100,000. In 1826, 10,837 immigrants were admitted to the United States. Of the 10,837, most (7,708) were from England or Ireland. During the decade of the 1850s, more than 3,000,000 immigrants entered the United States, with large percentages from Southern Europe.

Industrialization, urbanization, and immigration transformed American society and spawned problems for a nation in transition. Cities became engines of productivity with concomitant disease, poverty, and crime. Many persons felt that homelessness, vice, and alcoholism were out of control. In the 1830s, there were numerous acts of mob violence. The objects of the wrath of mobs were often immigrants or Catholics. By mid-century the Know-Nothing Party, with its platform of bigotry, was the fastest growing political party in America. The success of the Know-Nothing Party was a consequence of the widely held opinion, even by many who did not affiliate with it, that the "American way of life" was in jeopardy.

Coincidentally, with the great social distress in the nation, a fever for reform swept through the country. There has never been a period of more intense reform spirit in America than the second quarter of the 19th century. The reform agenda ranged across a wide range of causes: abolition, temperance, women's rights, vegetarianism, prisons, and treatment of the insane. Organizations sprang up which reflected the fervor and optimism of those who began them: Society for the Suppression of Vice and the Promotion of Good Morals; The Friends of Universal Reform; The Boston Society for the Moral and Religious Instruction of the Poor; The New York Association for the Relief of Respectable, Aged, Indigent Females; and the American and Foreign Anti-Slavery Society to name but a few. Dorothea Dix traveled thousands of miles in her efforts to reform the treatment of the insane. Susan B. Anthony worked for the cause of women's rights and temperance. William Lloyd Garrison took up the cause of abolition.

The theme which transcends the specifics of the reforms of the 19th century was the establishment of social institutions to create a more perfect

society. They believed that the welfare of the individual was enhanced and protected by social institutions rather than threatened by them. The optimism of the reformers was extended over a wide-ranging array of new institutions. The insane asylum was created not as a last resort to lock away the disconcerting and frightening specimens of humanity; rather the asylum was a manifestation of the belief that a properly constructed asylum could cure virtually any incidence of mental illness (35). Other institutions such as the reformatory and the penitentiary were based on the same optimistic beliefs about the potency of these organizations to change people and solve social problems.

Education was one of the focal points of the early 19th-century reform movement. The more perfect society which the reformers sought to construct had clear and obvious educational implications. Though the educational reform movement was centered in New England, there were persons throughout the United States who dedicated their lives to the creation of a new and better way to educate American youth. James G. Carter and Horace Mann in Massachusetts, Henry Barnard and Thomas H. Gallaudet in Connecticut, Calvin Stowe in Ohio, John D. Pierce in Michigan, John Swett in California, Calvin H. Wiley in North Carolina, and Robert J. Breckinridge in Kentucky were some of the most prominent educational reformers. They were joined, not only by common cause, but by association and interaction. They read one another's books and speeches, corresponded, and came into contact with one another in the many educational organizations and associations which flourished.

The 19th-century reforms were a reaction to the approach to education which had prevailed in the United States from the earliest days of colonization to the early years of the 19th century. Education was an important theme in the earliest days of American colonization. The first European settlers in America came to the New World at a time of a great information revolution in Europe. They had left England in the midst of an information explosion. In the century prior to the emigration to America there had been a tremendous expansion of the literacy with the rapidly spreading availability of books in the vernacular. As a consequence there was less dependence on the oral tradition and a greater reliance on books for every facet of life. There was a profusion of books pertaining to all aspects of life, from agriculture to personal conduct. The cost of books was such that for the first time in history the recorded word was accessible to a mass market. The abundance of valuable information which became available through the advances in printing technology placed increasing importance on literacy. Literacy was required if one was to be able to read the various manuals, almanacs and technical information in all fields which was becoming increasingly abundant.

The attitude of people in the 16th century toward their information revolution was similar to the attitude of people in the 20th century to our own. Some rued it, some were oblivious to it, but many, especially middle class townspeople, saw it as a basis for a better life. Robert Ryece, a friend of John Winthrop, the great Puritan leader, wrote to him on the eve of his trip to American on the *Arbella*, "How hard it will be for one brought up among books and learned men to live in a barbarous place where there is no learning and less civilization" (4). As they left civilized England for the untamed New World, there was fear of losing the culture of the homeland. Education was the prophylactic against barbarism. Thus, the Puritans brought their books with them to the New World, but of even more significance, they brought with them a belief that education was an important means in achieving prosperity on earth and salvation in heaven.

The home was the prime educational agency of early American society, and the prime agent for education in the Puritan community was not the state or the church but the family. This did not mean that the parents were the sole teachers of their children; rather, many arrangements were made, depending on the circumstances, for education to occur, and indeed the colonists were prone to establishing schools. In essence, everyone in

the Puritan community was potentially a teacher. Children acquired instruction:

> Anywhere and everywhere, not only in schoolrooms, but in kitchens, manses, churches, meetinghouse, sheds erected in fields, and shops erected in towns . . . pupils were taught by parents, tutors, clergymen, layreaders, preceptors, physicians, lawyers, artisans, and shopkeepers . . . (4).

The manner in which education in the home or the workplace occurred was informal and had to be worked into one's own life as the rhythm of daily life permitted. It was common for children to learn to read, write and cipher within the home with parents, older brothers or sisters, other relatives, or neighbors providing the instruction. For example, as a young child near the beginning of the 18th century, Horace Mann learned to read by following his sister around the house as she did her chores reciting from a copy of Noah Webster's grammar (20). Ministers, who had skills in classical languages, would frequently tutor children who sought entrance to college since knowledge of classical language was the 19th-century equivalent of the SAT for college admission.

Proprietary schooling abounded. There were many persons available to those who were able to pay for schooling or tutoring. Tutoring could be purchased for primary instruction in reading, writing, and arithmetic, and for more advanced instruction in Greek, Latin, geometry, surveying, navigation, and bookkeeping. Wealthy parents might hire a teacher to extend, supplement, or replace their own instruction. The private master would provide instruction for all of the employer's children along with the children of other relatives or friends. Those who wished to advance their position through more advanced learning could secure the services of a teacher, either as a private student or in a school in the tutor's home or business.

Apprenticing was also a very important means of professional and vocational training. Apprenticeship was the way in which persons were trained in agriculture, shopkeeping, manufacturing, the skilled trades, and the professions of medicine and law. In the case of medicine, there was a rather standard form of apprenticeship. In the case of law, the apprenticeship was varied depending on the proclivities of the master (5).

Thus, the flavor of education in the 17th and early 18th centuries was characterized by two elements: personal responsibility and diverse means. It was up to the individual to determine the extent of education necessary for self and children. It was incumbent on the individual to achieve the required education in a manner which provided the best fit between one's life circumstances and educational goals. Writing about the colonial and early national era, Cremin says, "Variegation, then, was the rule, and with it improvisation, imitation, trial and error—whatever historical development there was ended up anything but uniform and linear" (6). But then over the span of 30 or so years at the mid-point of the 19th century a radically different form of education emerged in America:

> The haphazard arrangements of the 17th, 18th, and early 19th centuries cannot be considered true progenitors of the school systems we know today. For by the latter part of the 19th century the organization, scope and role of schooling had been fundamentally transformed. In place of a few casual schools dotted about town and country there existed in most cities true educational systems: fatefully articulated, age graded, hierarchically structured groupings of schools, primarily free and often compulsory, administered by full-time experts and progressively taught by specially trained staff. No longer casual adjuncts to the home or apprenticeship, schools were highly formal institutions designed to play a critical role in the socialization of the young, the maintenance of social order, and the promotion of economic development (15).

The 19th century reformers saw the variegated educational situation of the 18th century when education occurred in many venues in many ways as dysfunctional. Yet, the approach to education which had prevailed from the earliest days of the colonial era through the first years of the republic had served the American people well. The dissatisfaction with the old approach to education was

a consequence of the great changes which were occurring in the nation and the emergence of new beliefs, a new rational myth, about how children should acquire the cultural legacy of their forebearers. If there was one word which caught the essence of the changes the reformers sought to establish it was "system." In the words of one of the reformers, James Carter, the reform movement sought a "consistent system fully developed" (2). The 19th-century reformers created "the school system" not only in the jurisdictional sense as used to refer to a particular school district but also as the system of schooling which was to be the manner in which the society would handle the commonalities of human action associated with the transmission of the knowledge, skills, dispositions, and sensibilities required to maintain the society.

Nineteenth-century Americans were greatly influenced by European education which in the late 18th century was in the early stages of the educational reform which would spread to the United States. A number of reports written detailing the successes of European education achieved a wide and influential readership in the United States. The fundamental conception of the reform movement in Europe was the establishment of the school as the primary social agency for education of the young. This belief grew out of the concern about the neglect of education of the children of the peasants. Concomitantly, there was a shared belief among those involved with school reform that schooling, if systemic and systematic, could produce young people with the knowledge and disposition which were requisite to ensuring economic prosperity and domestic tranquillity. There was, they believed, a pedagogy which rested on a scientific foundation which could ensure that the content the state needed to inculcate in each child could be accomplished. The weak laws requiring parental or citizen support of schools were replaced by laws which established state support of schools and, by the turn of the 20th century, compulsory school attendance.

The idea that the school has had more responsibility thrust on it over the years is inaccurate. The broad nature of the mission of the school was not constituted by accretion but by charter. Calvin Stowe, the husband of Harriet Beecher Stowe, was one of a number of Americans who went to Europe to examine European education and to report on it to the Ohio legislature. His report was presented to the governor of Ohio in 1837. It was widely distributed and became quite popular. He wrote as follows:

> The children must be given up implicitly to the discipline of the school. Nothing can be done unless the teacher has the entire control of his pupils in school hours, and out of school too, so far as the rules of the school are concerned. If the parent in any way interferes with, or overrules the arrangements of the teacher, he may attribute it to himself if the school is not successful (38).

Similarly the words of Horace Mann from his third annual report to the Massachusetts Board of Education express the conviction that the school was the instrument to be used by society to maintain society:

> Common Schools derive their value from the fact that they are an instrument, more extensively applicable to the whole mass of the children, than any other instrument ever yet devised. They are an instrument, by which the good men in society can send redeeming influences to those children, who suffer under the calamity of vicious parentage and evil domestic associations. The world is full of lamentable proofs, that the institution of the family may exist for an indefinite number of generations, without mitigating the horrors of barbarism. But the institution of Common Schools is the offspring of an advanced state of civilization, and is incapable of coexisting with barbarian life, because, should barbarism prevail, it would destroy the schools, should the schools prevail, they would destroy barbarism (19).

The belief that the school could accomplish the intellectual and socializing functions of education was quite functional to a nation increasingly industrial and urban. The conception of schooling as *the* place rather than *a* place where children acquire the knowledge and skill they will require to become effective members of society has remained the prevalent belief for a century. Even

though the existence of many nonschool learning resources exist, and even though many individuals can speak of the impact of these resources in their own lives, they have typically been perceived as ancillary to schooling as the means for educating children and youth. The educated person has been the schooled person. We even lack good terms to refer to the array of educational resources such as books, TV, clubs, movies, friends, parents, and other adults which may make important contributions in terms of the individual's knowledge, skills, and attitudes. They are referred to as "nonformal education" and are thus defined in terms of what they are not in reference to schooling. Even those who do not esteem their schooling tend to answer the question, "Where did you get your education?" by naming a school. Life is divided into two segments. The first segment is the period of schooling. Then there is a commencement or a beginning of the second segment when the individual is expected to become an active and productive member of society.

Much as the economic structure of society rests on the belief that coins and bills are more than bits of metal and paper, so too a sustaining belief maintaining the school structure is that certificates, diplomas, and degrees are more than attractive documents and that they certify competence. The issuance of official certificates as social passports both validates the school and is validated by the school. Certification informs the individual of his or her abilities as assessed by the school, but also, and most importantly, informs society. As long as the school is empowered to issue certificates which affect social status and economic mobility, the school will need to be taken seriously whether or not the individual or their parent perceives he or she has received adequate services. The power of schools to "mint" social currency is significant only as long as the currency is valuable. The accreditation of schools, state certification of teachers, and standardization of the curriculum constitutes the ways in which the state attempts to ensure the value of diplomas.

The reformers believed that a critical requirement for an effective system of education was teacher training. In one of the most important of the European reports which were so widely read by educational and political leaders, Victor Cousin, who had been commissioned by the French government to produce a report on Prussian schools, provided a laudatory description of the Prussian school system and included a lengthy description of teacher training. Cousin argued that teacher training was an essential aspect of the effectiveness of their schools. The skill and demeanor of the teacher was the critical element in achieving the change which was required.

The effort to establish state-supported normal schools in the United States began in the 1820s and many engaged in the reform effort saw this as the keystone of the reform movement. James Carter, a member of the state legislature in Massachusetts, was one of the leaders in the establishment of normal schools in that state. In 1824 and 1825, Carter published a series of essays in the Boston Patriot arguing for normal schools and explaining why state support was appropriate and necessary. In his words:

> It will do but little good, for example, for the legislature of the State to make large appropriations directly for the support of schools, till a judicious expenditure of them can be ensured. And in order to [do] this, we must have skillful teachers at hand. It will do but little good to class the children till we have instructors at hand. It will do absolutely no good to constitute an independent tribunal to decide on the qualifications of teachers, while they have not had the opportunities necessary for coming up to the proper standard. And it will do no good to overlook and report upon their success, when we know beforehand, that they have not the means of success (2).

The champions for teacher training did not come from the ranks of the current teachers and administrators but rather were a cadre of politicians and religious leaders. One very conspicuous figure in the history of normal schools was the Rev. Charles Brooks, who traveled from town to town in Massachusetts lecturing for state support of normal schools. Brooks organized a series of conventions and provided a platform for notables such as Daniel Webster and John Quincy Adams,

who also spoke to the need for normal schools. Rev. Brooks, who had campaigned tirelessly for normal schools, stated the underlying conviction that had motivated him and the others who created the normal school: "As is the teacher, so is the school" (18).

The campaign in the Massachusetts legislature for state support of schools to prepare teachers gathered considerable momentum in the late 1820s. In 1827, Rep. Carter, who chaired the House Committee on Education, presented a report to the legislature that called for establishing a "Seminary for the Instruction of School Teachers." Carter's proposal failed by one vote. The debate continued, and 10 years later, on April 19, 1837, the legislature established a Board of Education. Creation of the board proved significant in the development of normal schools because Horace Mann (who was then serving as President of the Massachusetts Senate) was chosen to lead the board. Mann believed in the need to create a system to prepare teachers, and he committed himself without reserve to the success of the normal school venture. At one point, when funds for the normal school effort were short, he sold books from his personal library to raise the needed money.

There was considerable opposition to the founding of normal schools, but with Mann's leadership, and with a gift of $10,000 from Edmund Dwight, a member of the state board, the forces in the legislature arrayed against normal schools were neutralized. A year later, members of the Massachusetts legislature attempted to end state support of normal schools. The opponents of the normal schools considered them unnecessary, arguing that anyone who had been taught would know how to teach (18). In a letter to Henry Barnard in 1851, Cyrus Pierce, the principal of the first normal school at Lexington, Massachusetts, explained what he had hoped to accomplish. He agreed that teachers may be able to acquire by trial and error over time the skills and powers they need to teach effectively, "but while teachers were thus learning, I was sure that pupils must be suffering" (34). The normal school would ensure that "teachers may be prepared to enter on their work, not only with hope, but almost with assurance of success" (34) A substantial effort in the Massachusetts legislature to rescind the normal schools and to return the unused portion of Dwights's fund to him failed, and they continued to spread throughout Massachusetts and to other states.

At its inception, teacher training was disassociated from higher education. The normal schools were more like secondary schools than colleges, and considerable emphasis was placed on equipping students with knowledge of the content they were expected to teach. While a number of normal schools would eventually evolve into colleges and universities, the initial connection between teacher education and higher education came through a different route. Chairs in didactics or pedagogy began to be established in American universities in the last quarter of the 19th century. By 1892 the United States Commissioner of Education reported that there were chairs of pedagogy in 31 institutions, chairs of pedagogy combined with other disciplines such as philosophy or mental science in 45 others, and lectureships in an additional eight universities (28).

As early as 1890, New York University had established a School of Pedagogy which offered courses leading to a Master of Pedagogy and Doctor of Pedagogy degrees (28). The introduction of chairs and coursework in pedagogy was met with staunch critics in the university who considered such to be insubstantial or inappropriate for university study. Abraham Flexner, who had led efforts to reform medical education, became involved in efforts to install the study of pedagogy at the university level. In 1919 he was successful in securing foundation funding for the founding of a graduate school of education at Harvard. A decade later, however, Flexner had come to agree with critics that the instruction being provided at schools of education lacked academic rigor and had degenerated into a focus on simple practical problems which could be solved by "experience, reading, common sense, and a good general education"(30). Flexner worried that the nature of programs in schools of education would dissuade the intellectually competent from entering. Despite the efforts of critics, teacher training and oth-

er related programs such as those for school administrators, counselors, curriculum specialists, etc., continued to develop in universities, and many normal schools continued on a path which was to make them into universities. The goal of people like Mann, Carter, and Brooks for universal teacher training was realized, but the benefit of the training in terms of the improvement of schooling has been an issue of considerable debate from its inception to the present time.

So it was that the great reforms of the 19th century institutionalized schooling. Eventually all of the major aspects of the changes they sought were achieved. State departments of education were established which regulated school programs by establishing curriculum requirements and the licensing of teachers. States required local districts to provide free elementary and secondary schools and enacted compulsory attendance laws. Standards for the school buildings and their furnishings became established. Specialized training and licensing was required for those seeking to work as teachers. Districts developed standardized and age-graded curricula. Grouped instruction replaced the method of recitation. Textbooks were provided to students. Centralized control at the district level over building school sites was inaugurated. The concept of a public school system was new and strange to many a 150 years ago. It came to be taken for granted, even axiomatic. Yet, new beliefs about the nature of knowledge, which were a consequence of information technology (discussed above) and changes in understanding about learning, which also are stimulated by developments in information technology (discussed below), both challenge the structure which Mann and his colleagues put in place.

THE HUMAN AS A NATURAL LEARNER

There have been many answers to the question: What distinguishes human beings from other forms of animate life? For Plato, the human was characterized as a featherless biped. For the English essayist William Hazlitt, the human was the only creature that laughs and weeps. In technical terms, the human species is called *homo sapiens*, man the wise. The capability of the human to think, learn, and acquire knowledge was determined to be the characteristic that distinguished the human being from other primates. Other animals learn, as is evident from any trip to the circus, but no other form of life on earth exhibits cognitive capability comparable to the human being. Humanness resides in the central nervous system.

The ability to learn is not an acquired but a natural capability for humans. The human being is a learner from the moment of birth until the moment of death unless such is precluded by some brain abnormality. In the first hours after birth, the infant learns to suckle at the breast or bottle. Very quickly, the baby learns to discriminate his or her mother's face from other faces. The child will learn motor skills such as eating with table utensils, walking, and cognitive skills such as speaking, and social skills such as acceptable and nonacceptable ways of dealing with others as well as distinctions in behavior appropriate for the different people with whom he or she comes into contact. The small child learns a language, and, in many societies, may learn more than one language. Children acquire information and skills whether or not they are prodded or deliberately assisted by parents or other adults. Anyone who has spent any time watching a child cannot help but conclude that learning is a natural process.

In thinking about the human as a natural learner it is important to keep two things in mind. First, "learning" is not an honorific but a descriptive term. To say that the human being is a learner is not *per se* to pay a compliment. People learn bad things as well as good things. Children learn language, mathematics, how to play the piano, etc., but they can also learn prejudice, pot smoking, how to hot wire and steal cars, etc. Learning the wrong things is not necessarily a less impressive task when judged from the complexity of the learning task. It is, for example, probably easier to learn the occupation of a sales person in a fast food restaurant than to learn the occupation of a successful car thief. Second, to say that individuals are natural learners is not to imply that all demonstrate this capability to the same extent. People do

learn how to learn and can become more or less interested in learning and more or less effective in the process.

In the past century there have been thousands of studies of human learning. The vast preponderance of these studies has focused on learning in schools, and since a substantial proportion of the population of school-aged children have problems learning in school, it is understandable that much of the literature has been directed to the nature of learning pathologies. Much less attention has been devoted to understanding natural learning, or learning in those instances when the process is not structured and regulated by others but is woven into the life situation of the person. In these situations, learning occurs even though there is not someone formally designated as teacher directing the process.

In a small book written three decades ago called *How Children Learn* (12), John Holt discusses how children learn when there is minimal or no adult intervention. Holt drew upon his experiences as a teacher in a fifth-grade classroom, but he was less interested in understanding how children learn when the process is prescribed to them by their teachers than in observing how children learn when they are not required to follow rules of the process established by the adults in their environment. Holt sums up his conception about the natural learning style of young children in the following passage from his book:

> The child is curious. He wants to make sense out of things, find out how things work, gain competence and control over himself and his environment, do what he can see other people doing. He is open, receptive and perceptive. He does not shut himself off from the strange, confused, complicated world around him. He observes it closely and sharply, tries to take it in. He is experimental. He does not merely observe the world around him, but tastes it, touches it, hefts it, bends it, breaks it. To find out how reality works, he works on it. He is bold. He is not afraid of making mistakes. And he is patient. He can tolerate an extraordinary amount of uncertainly, confusion, ignorance. He does not have to have instant meaning in any new situation. He is willing and able to wait for meaning to come to him—even if it comes very slowly, which it usually does (12).

One of the places where there is substantial and serious work currently underway to understand learning as a natural process is the Institute for Learning Sciences at Northwestern University. The Institute was established in 1989 with sponsorship provided by Anderson Consulting and Ameritech. The staff includes 21 faculty and researchers, 42 content specialists and programmers, 50 graduate students, and 20 interns and visiting staff. The Institute is dedicated to the task of investigations of human learning as a natural process and to make use of the knowledge obtained from these investigations to construct new means for improving learning in the workplace and then in the schools.

Roger Schank, the Institute director, along with Chip Cleary, one of his graduate students, authored a "hyper-book" which is available on the World Wide Web titled "Engines for Education." This book presents their ideas about what is wrong with education, and the role of educational technology in reforming schools. The book's perspective on natural learning is similar to Holt's. Like Holt they see the type of learning which occurs in schools as dysfunctional:

> In public schools from first through twelfth grade, much of the classroom routine is shaped by an emphasis on rote learning, a strict adherence to standardized textbooks and workbooks, and a curriculum that is often enforced with drill and practice. The methods and the curriculum are molded by the questions that appear on the standardized achievement tests administered to every child from the fourth grade on. Success no longer means being able to do. Success comes to mean "academic success," a matter of learning to function within the system of learning the "correct" answer, and of doing well at multiple choice exams. Success also means, sadly, learning not to ask difficult questions. When we ask how our children are doing in school, we usually mean, "are they measuring up to the prevailing standard?" rather than, "are they having a good time and feeling excited about learning?" (36).

Some caution must be exercised in overdrawing the distinction between school and non-school learning or in romanticizing the child as Holt does. There are classrooms where what is happening for children looks much like a natural learning situation, and it is much easier to know what is wrong about schools than it is to do what is right. Nevertheless, the conditions listed by Schank and Cleary such as standardized curriculum, grade level expectations, as well as an increasingly extensive amount of information which teachers are expected to "cover" create an environment for learning which, too frequently, does create a situation where there is so much to teach that there is no time to learn.

It is not a coincidence that two recent books on learning and technology, one by Donald Norman and the other by Seymour Papert, give considerable attention to informal or natural learning. For those accustomed to "cruising the Internet," "just in time learning," hypermedia, and virtual communities, school or formal learning is far too confining. Interest in using technology in instructional applications is not new. Sixty-eight years ago S.L. Pressey published a paper called "A simple apparatus which gives tests and scores and teaches" (31). In this paper Pressey described the plan for a machine which would be used as an "automatic teacher." It makes use of a typewriter apparatus to display questions and to provide feedback for correct or incorrect answers. Computer technology enables the production of more sophisticated versions of Pressey's "automatic teachers." These applications, while employing more elaborate graphics and more advanced interactive procedures, are fundamentally similar to Pressey's "automatic teacher" and many come out of a behaviorist, programmed learning, orientation. Increases in storage, display, and processing power of computers systems provides developers with the capability to go beyond the design of teaching machines and to create "learning machines" or, to use Papert's term, "knowledge machines." Such applications put in the hand of the user a rich informational environment which is accessible in a way which accommodates the interests of the user. "Learning machines" are based on an orientation which put the learner in control of the learning process and which is compatible with the orientation of natural learning. Early examples of these applications have appeared in the past few years in the form of various multimedia applications.

In his book called *Things That Make Us Smart* (24), Donald A. Norman cautions that multimedia technology can be used to provide applications that epitomize the worst of what is wrong with school learning or the best of what is possible with natural learning. Norman distinguishes between school learning and natural or informal learning (Table 1).

Norman cites the work of Mihaly Csikszentmihalyi who writes about "flow experiences." Flow experiences occur when the person is totally engaged in the task at hand. Teachers may tell their students to "Pay attention!," and while such an admonition may cause the student to *look attentive*, there is no assurance that the student will *be attentive*. The flow experience can only happen when the goals and challenge of the task captures the attention of the individual. Many observers of life in classrooms as well as teachers have expressed concern about the lack of engagement of students in what they are being told to learn. The lack of engagement of students in their instruction evident in many formal learning situations, kindergarten through college, is the antithesis of the "flow experiences."

Seymour Papert's book, *the Children's Machine* (29), is subtitled "Rethinking School in the Age of the Computer." Papert contrasts two different orientations to education—"instructionism" and "constructionism." Instructionism is the belief that the way to achieve better learning is to teach better. Constructionism, on the other hand, conceives of learning as a manipulative and building process. It draws a direct connection between construction in the physical and mental domains, and sees learning to be an activity involving the creation of mental structures by the learner which organize and synthesize the information and experience which the individual encounters in the world. Papert, similar to others who have dealt with the topic of natural learning, emphasizes con-

crete or experiential learning. He calls for learning which is rooted in concrete experiences rather than that which exists as free-floating abstractions. Perhaps one of the most radical of the assumptions of this perspective is that children can be trusted to find the knowledge they need. If one conceives of learning as an activity which is repugnant to the individual or if one believes that that there is a package of content which can and must be installed into the minds of all students, then trust in the learner is unwarranted. If these two conceptions are rejected, as they are by people like Papert, Holt, and Schank, then trust in the learner is quite appropriate. The task for those involved with the education of the young, as Papert presents it, is to see to it that children are supported materially, psychologically, and intellectually in their efforts to learn. He contends, "The kind of knowledge children need most is the knowledge that will help them get more knowledge"(29).

Holt, Schank, and Papert are only the most recent of a long line of persons to be aware of the discrepancies between school learning and learning as a natural human phenomena. Rousseau published *Emile* in 1762 and Pestolozzi opened a school at Yverdon in 1805. Rousseau as a theoretician and Pestolozzi as a practitioner gained a high degree of recognition for their work. In both cases, they presented a conception of learning which placed emphasis on the interest and experience of the child and saw the learning of the child rather than the didactics of the teacher as the key to the process. Pestolozzi's school was visited by the czar of Russia and by the kings of Spain, Holland, Prussia, Denmark, Wurtenberg, and Saxony.

John Dewey, who had the misfortune of having his work become popular mainly in the form of interpretations developed by his disciples who "watered-down" and sanitized his ideas, saw this issue clearer than most and presented it as forthrightly as anyone almost a century ago:

> What is learned in school is at best only a small part of education, a relatively superficial part of education; and yet what is learned in school makes artificial distinctions in society and marks persons off from one another. Consequently we exaggerate school learning compared to what is gained in the ordinary course of living. We are, however, to correct this exaggeration, not by despising school learning, but by looking into that extensive and more efficient training given by the ordinary course of events for light upon the best ways of teaching within school walls. The first years of learning proceed rapidly and securely before children go to school, because that learning is so closely related with the motives that are furnished by their own powers and the needs that are dictated by their own conditions. Rousseau was almost the first to see that learning is a matter of necessity; it is a part of the process of self-preservation and of growth. If we want, then, to find out how education takes place most successfully, let us go to the experiences of children where learning is a necessity, and not to the practices of schools where it is largely an adornment, a superfluity, and even an unwelcome imposition (7).

It is not remarkable that the contrast between learning inside and outside of schools has been observed by a long line of educational practitioners and theoreticians since the differences are conspicuous to the reasonably careful observer. John Dewey's disciples, most notably William H. Kilpatrick, attempted — and generally failed — to have their cake and eat it too. They sought to implement the conceptions of Dewey about natural and experiential learning while keeping intact the essential conventions of the system of schooling which by the early part of this century was well accepted. As information technology causes more and more of the agenda for learning in our society to transcend the domain of school, the orientation expressed by Dewey a century ago or by people like Papert and Schank in recent months becomes ever more plausible as a basis for the design of learning experiences. The constraints of formal education do not hamper the person who is designing learning opportunities for individuals in the workplace or the home.

This brief summary of thinking on natural learning leads to three key points. First, schools do not own the child's learning. Children are continuously engaged in learning, and even though the learning which occurs in their life outside of

school may be woven into their environment in ways which may make it less conspicuous than when they are sitting in a classroom with a teacher standing before them presenting some concept or information, it is learning nonetheless. Through the span of civilization schooling has been only one of the ways by which humans have learned what they needed to learn in order to function. Until quite recently (when put in the context of human civilization) the extent of the schooled population was quite limited.

Second, information technology has generated interest in natural learning and provided means to create new learning environments. While there is one cadre of developers and vendors of information technology who are intent upon developing uses of technology that fit into the existing conditions, traditions, and procedures of schools as they are, there is another and more important cadre who are attempting to make use of the technology to promote learning with less commitment to where the learning takes place or how well it conforms to expectations of the educational establishment as to its validity. This orientation emphasizes the motivational, attitudinal aspect of learning. The student may not be able to walk out of the boring class, but he or she can certainly switch off the boring multimedia program. Information technology is particularly compatible with the nonlinearity and experiential texture of natural learning.

Third, many who are inadequate learners in the school context seem to have no particular disability when they are learning in out-of-school contexts. The ability to learn is not an esoteric human characteristic; it is quite normal. The high incidence of learning pathologies in schools has much, much less to do with any organic or function disability of learners than it does with what students are told to learn and how they are told to learn it. Designers of educational materials using information technology can focus their attention on the learning requirements of the users rather than on the needs and requirements of the organizations within which the learning is supposed to take place.

THE FUTURE OF LEARNING AND SCHOOLING IN AMERICAN SOCIETY: CONCLUSIONS AND IMPLICATIONS

The 19th century was a period of institution building. It was a time of a great changes in the United States and a time when men and women believed in their power to create institutions to solve the pressing problems caused by the changes. Prisons would eliminate crime. Insane asylums would put an end to mental illness. Reformatories would abolish juvenile delinquency. Schools financed by the state would stamp out ignorance, create a literate populace, and mold upright citizens for the Republic. The state-supported system of schools would be the "melting pot" where children from diverse backgrounds would meet and be instructed in a manner which would ensure the maintenance of the "American way of life."

The reformers were successful in realizing their vision of schooling throughout the United States. They enacted the laws and policies which were required to institutionalize public schools. As a result of the work of the reformers, schools became *the* place—rather than *a* place—designated by society to transmit the cultural tradition to each successive generation. Public policy tolerated, but did not encourage, the formation of alternate approaches such as parochial or private schools. The basic features of the schools put in place by the 19th-century reformers have endured, much to the chagrin of scores of later-day reformers. The durability of the American system of schooling is a function of an architecture which was particularly harmonious with the ideological context of the times. But times have changed.

Information technology is the principal force generating the great transformation of economic, political, and social life in recent years. Information has become central to every domain of human life and pervasive in every venue of human existence. Human beings have always had the task of obtaining, integrating, and using information as a basis for their thoughts and actions, but at no point in human history has day-to-day life for the pre-

ponderance of the population put them in such proximity with the informational resources of the culture. The economic and social value of being informed was never greater than it is now and there is no reason to expect this to abate. The printing press did not turn everyone into an author, but it did substantially expand the number of such persons. Not even desktop publishing and networks will turn everyone into information producers, but we are already experiencing an explosion in the numbers of persons who are producing and publishing information, and more access to these tools can only further expand the percentage of the population who will produce as well as consume information. Within this context, schooling and learning take on a different character than has been the case in the past. The role of schooling in general and the American public school in particular are being changed.

As discussed earlier, one of the consequences of literacy was the establishment of schools as enclaves separated from the ongoing economic and social life of the community. Learning was "decontextualized" and provided in terms of generic skills or as information to be stored in one's mind for later use when the individual was again engaged in activities outside of school. The fundamental implication of an information technology culture for learning and schooling is that learning becomes "contextualized" and becomes part and parcel of daily life. This does not mean that schools will disappear, but it does mean that they will no longer have the dominant presence in society with regard to the transference of the culture from one generation to the next. Schools personnel who do not understand this new world of learning within which they live are likely to lead their own organizations into oblivion or irrelevance.

More specifically with regard to the American public school, it is becoming ever more clear that we are experiencing a deinstitutionalization of education in the sense that the public school is less and less accepted as the essential and principal instrumentality of educating American youth. While home schooling is not a mass movement, a considerable number of children are being educated in their homes. Charter schools have been established in a number of states. Television has become the dominant source of learning about the world. Millions of people are using the Internet as a means of accessing information and learning about an almost infinite variety of topics. There seem to be few people, beyond the circle of public educators, who contest the idea of establishing schools apart from the control of local educational authorities.

The belief in the power of institutions is not as prevalent among the citizens of the later part of the 20th century. Much of the rationale for the establishment of the American public school sym stemmed from the belief that a state-supported system of schooling which educated the rich, poor, immigrants and established middle class was the means to insure a common culture congenial to American political, social and economic life. The extent to which the American public school achieved this mission is a topic of debate between those who believe it did serve to bring the diverse sub-groups of American society into a cohesive entity, and those who believe it served the purposes of a white Anglo-Protestant middle class. The optimism of people in the 19th century about the power and value of institutions overstated the case, but the pessimism of the current generation about institutions probably is also overstated; nevertheless, the "melting pot," "the common school," and standardization are not themes which resonate in contemporary America. Now "choice," "diversity," and "deregulation" are the bywords.

The landscape of American education in the later part of the 20th century is looking more and more like it was in the colonial period through the early days of the Republic. The variegation which so characterized the approach to education appears much more compatible with the nature of an information society than does the uniformity and linearity of the conditions engineered by the 19th-century reformers. The parent who is concerned about his or her child's intellectual development is able to buy learning materials at the mall or through a network service. School personnel who are committed to the welfare of the young people they serve need to be comfortable working with

other organizations and purveyors of learning resources as partners rather than as the agent in-charge.

Most people realize that information technology needs to become part of the schools in some way. People expect to see computers in classrooms and believe that students should spend some of their time in schools working with them. School boards and parent groups have seen to it that there are computers in schools. There are few schools in the United States where one does not find computers in classrooms, media centers, or computer labs, and it is not difficult to identify teachers, here and there, who are making interesting, and in some cases, powerful instructional use of computers. Unfortunately, there are still an appreciable number of proponents of technology in the schools who seem to focus more on getting computers used in schools than they do on the educational value of how the computers are used. Success ought not be measured by how many computers there are in schools, how often they are used, or how well they can be integrated into existing curriculum content—much of which is irrelevant or antiquated. There is nothing to be gained by using information technology in the schools to become a more efficient anachronism. The danger of this is real since many proponents of technology in the schools have a 21st-century conception of technology and a 19th-century conception of knowledge and learning. The challenge is to use information technology to create in schools an environment conducive to the development of individuals who have the capability and the inclination to use the vast resources of information technology in their own continuing intellectual growth and skills expansion. Schools should become places where it is normal to see children engaged in their own learning.

Bringing schooling into an information technology culture is a much more difficult task than doing so for businesses or factories. What was required of American industry to make the changes necessary to survive in an information age was for the leaders of corporate America to understand the nature of what needed to be done and to work with others inside the organization to implement the changes. This was not an easy task, but corporate leaders did not have to get the general public to accept the fact that they would find a strikingly different environment when they walked into an automobile manufacturing plant in 1990 as contrasted with how the plant would have looked in 1950. The general public does not have detailed beliefs about what it means to be a good factory apart from the belief that a good factory turns out a good product. The general public does have beliefs (or, to use the terminology of the earlier discussion, "rational myths") pertaining to schools which are often strongly held. The beliefs about the nature of schools and schooling held by parents, citizens, and policymakers whether articulated or not set the parameters for what is perceived to be legitimate and appropriate activities in classrooms. The crux of the crisis for schools is the discordance between existent beliefs about schools and schooling and the conceptions of knowledge and learning engendered by developments in information technology. A new rational myth needs to be created.

The history of audio-visual technology in schools has established a precedent that needs to be overcome. Radio, telephones, audio tape, filmstrip projectors, slides, television, etc., were all seen as means to be used by teachers to assist them in improving teaching. A popular shibboleth is that the computer is a "tool." While computer applications are tools, the idea that computers are just means to an end is a serious misunderstanding about the extent to which information technology represents essential changes in the creation and transmission of the culture. Those who wish to determine the extent to which schools are using information technology to change more than merely the cosmetic aspects of schools need to begin by asking school personnel what they no longer do or what they have eliminated from the school because of their use of information technology. The next question is: What is happening in this school which did not, or could not have happened, in the past without the use of information technology? The least important question is: What was done in the past and is now being done in a different way

because of the availability of information technology?

At the heart of the way schooling has been carried out for the past century and a half is a conception of knowledge as an historic product. In this formulation, knowledge is something which comes from the past work of scholars, scientists, and artists rather than being a work in progress. The dissemination of knowledge using print has obscured the dynamic and even disorderly nature of the process by which it is created. The school curriculum carves knowledge into subjects and arranges the content of the subjects in a sequential, hierarchical order corresponding to the grade levels. Teachers in the first grade know what math, language skills, etc., they are supposed to teach and they understand that they are not to infringe on what will be taught in second grade. The systematic processes of curriculum standardization and age grading of instruction, as well as the establishment of diploma requirements, is based on the assumption that there is a collection of facts, concepts, and skills which need to be installed into the minds of students and that this needs to be done in a orderly manner which conforms to the logic of the discipline.

Information technology shifts the conception of knowledge from something one has learned to something one uses. This is not a new way of thinking about knowledge. The great philosopher and mathematician Alfred Whitehead referred to knowledge as only something one had to learn and which had no utility for the individual as "inert knowledge." Whitehead wrote with great passion about the need for learning to have connection to the lives, interests, and contexts of the learner. "Ideas," he wrote, "which are not utilized are positively harmful. By utilizing an idea, I mean relating it to that stream, compounded of sense perceptions, feelings, hopes, desires, and of mental activities adjusting thought to thought which forms our life" (39). In Papert's terms, this is a constructionist point of view. The work of individuals such as Whitehead and Dewey make it clear that a dynamic and utilitarian conception of knowledge is not a recent understanding, but information technology elevates the need to recognize this reality because there is less benefit gained by remembering knowledge and more benefit to those who can produce it, find it, or use it.

The 19th-century reformers were inventors. They saw themselves in the tradition of the other great inventors of their day who had constructed machines to do wonderful things. The conception of schooling which they established involved the invention of a social mechanism which they believed would do what it was constructed to do with the same assurance as the other inventions which were transforming American life. Their social mechanism was a carefully crafted system which would produce an educated populace for society. System is no less a popular word in educational parlance in 1994 than it was a 150 years ago, and the term "systemic reform" is also fashionable. Yet, the analyses presented in earlier pages of this paper suggest that it is time to move beyond the system metaphor. Certainly, from a social science perspective, the concept of the school as a social system remains a useful analytic framework with which to define the key structural elements and the roles and relationships of the people who maintain the system. Yet, system, in the context of schools, brings with it much "baggage" which is dysfunctional. It keeps us linked with the 19th-century reformers' belief that it was possible to create a system of schools within which a proper arrangement of the elements of the system and an effective pedagogy could ensure the accomplishment of the expected instructional objectives. There is nothing to be served by continuing a quest for the Magic Fountain of Schooling, since there is none to be found. The time has come to abandon the idea that it is possible to create a social mechanism which can act on the students who are in it in ways which ensure the desired outcome.

Efforts which approach the task of school reform from the perspective of the design of environments offer a better footing for an attack on the problem than those which set out to figure out how to substitute one system for another. More of the mentality of the architect is needed to design environments which incline those who share these places to create learning communities which take

full advantage of personal productivity and networking resources. Ironically, the surest way to increase the likelihood of desired outcomes may be to concentrate on the design of environments which make desired processes more likely. Thinking about schools in this way requires less compulsiveness with regard to content objectives and more focus on the factors which support learning activities. Such environments would be places which no longer fought the losing battle to enforce an unnatural form of learning. Touting this orientation would be an act of futility (as it was for Dewey and Whitehead) were it not for the fact that there are serious and increasing efforts to develop learning processes which understand the centrality of the learners' own interest and involvement in their learning and which respect the natural processes of learning. These efforts are centered mainly outside of formal education and are led by those who are interested in reaching the market for learning in the home and the private sector. Those concerned about learning for children in our society should also participate in the exploration of new forms of learning environments and resources.

In the 1950s and 1960s, in the era of the ascendancy of broadcast technology, there was fear of an informational monolith as three powerful television networks emerged and as fewer cities had more than one newspaper. In the 1990s, in the era of network technology, these fears no longer prevail. Developments in the use of information technology over the next years provide a growing number of new educational alternatives. There is no doubt that there will be great progress in the next decade in the development of learning resources which make use of the capabilities of the technology. Commercial networks such as Prodigy and America On-Line carry educational offerings for young children. They will be joined by other networks bringing learning opportunities wherever there are children. The quality of the offerings will vary. Some, possibly many, will be poor, but there are certain to be very appealing and effective resources as well. With increasing capability in networks and with the development of small, inexpensive devices with multimedia capability, designers of learning resources will have the resources they need to develop attractive and effective learning environments. The federal government, states, and the private sector need to work together to support the development of network resources for children and youth. Children of reasonably affluent parents will have access to network resources, but the concerns, frequently addressed, of a bifurcated society based on information access are real. There is no one solution to the problem of the gap between the rich and the poor with regard to access to information, but public policy needs to be continuously attentive and responsive to this problem.

It is impossible to conceive of how to bring schools into the information age without a very substantial expansion of equipment available to learners. Computer labs or the availability of a few machines in classrooms are hardly adequate. Many schools have had to struggle to provide a relatively small amount of equipment, and they have been provided little funding for applications software, support, maintenance, training, or upgrades. Unless one expects very significant new money to come to school districts (an expectation which few hold), the money needed to make information technology a dominant element in the lives of children in classrooms is not available given existing conditions in school districts. Special millage or bonding initiatives to purchase hardware represents a way for schools to take a significant step forward, but special funding does not address the issue of maintaining information technology as a major and continuing element in the operation of the schools.

The option of having a sufficient deployment of information technology so that it becomes mainstream in schools while maintaining everything else schools currently fund is unrealistic. The funding for substantial increases in technology on an ongoing basis can only be accomplished by changing the way the existing funds are being spent in a substantial way. This may also include labor costs. The painful reality faced by other organizations which have moved to make information technology a major aspect of how they function is that the technology is purchased with

the money recovered from reduced labor costs. Any changes in the way in which school districts spend their money will be sharply contested by teacher unions and, in many cases, by parents and other residents of the district. If public schools do not find ways to move in this direction they will find themselves in competition with other educational entities such as private schools, charter schools, educational networks, and the other new organizations which provide technology-based educational services for children. The restructuring of the public schools and especially the restructuring which entails the effective use of information technology can only occur if school leaders have the courage and political skill to accomplish the task of fiscal restructuring.

The availability of applications software with regard to learning opportunities for children and young people is a mixed situation. There are two kinds of applications which children and youth need to encounter. One type is the various productivity and information utility applications such as word processing, quantitative modeling, bibliographic and informational data bases. Of course, the quality of these applications continues to improve and children and young people need to have access to them as a conventional element in their education. The only problem which needs to be solved with regard to this type of application is seeing to it that children and youth have access to the same tools as those being used in the world beyond the schools and not antiquated applications.

The other type of applications pertains to those programs which are devised as learning resources for children and youth. Most of the programs which are marketed as learning resources for children and youth are of poor quality, even when judged on their own terms as quite conventional drill-and-practice or tutorial programs. Even more problematic is the situation with regard to innovative materials which begin to exploit the design opportunities provided by equipment of increasing capability. Private as well as public funds need to be provided to support the development of applications which furnish concrete and usable versions of the type of rich learning environments discussed earlier.

The creation of colleges of education was a consequence of the school reform movement of the last century. The perceived value of colleges of education was contentious at the point teacher training entered the university and has remained so to the present. The radical changes which information technology is generating in American education creates a need and opportunity for colleges of education. Within colleges of education through-out the United States there are individual faculty members who are involved in efforts to make new technology improve the lives of children and youth. Unfortunately, there are fewer examples of colleges of education which have grasped the significance of information technology for how they are to function and for the viability of their future.

There are two elements to the formation of a future for colleges of education. The first is that colleges of education need to be involved in the development and use of information technology as it improves the educational opportunities for children in the broad array of venues wherein this will occur. For the most part, colleges of education have been "colleges of schooling." The economics and ideology of the past have forged a tight connection between them and schooling, which was usually public schooling. The value of colleges of education will be even more suspect if they attempt to hold to an orientation to education which is less and less an accurate depiction of reality. A misplaced sense of loyalty to formal education will not even serve the needs of schools since schools are faced with the need to function within a new educational world. Colleges of education need to be seen as places where knowledge and skills reside to assist schools in making effective use of information technology. If colleges of education are "on the sideline" on the unfolding of informational technology in teaching and learning, then the future of colleges of education may be increasingly tenuous.

The second element pertains to the long-standing complaint about the disconnection between the training which occurs in colleges of education and the realities of life and learning in the places where teachers and other educational personnel work. Information technology provides a basis for a reconstruction of teacher education. There are obvious but not fully realized implications of the use of networking as a means of establishing linkage between colleges of education and schools and other places where education occurs. Also, colleges of education which produce credible and useful research or development products can make use of information linkages to enable their products to be used.

A new era of the human condition has begun. This transformation will bring with it problems and opportunities. No area of human existence will be more affected than the processes of education. The question of how well the resources of information technology will be used to improve the lives of our children is as yet unanswered. The responsibility to begin the construction of the answer to this question falls upon this generation.

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