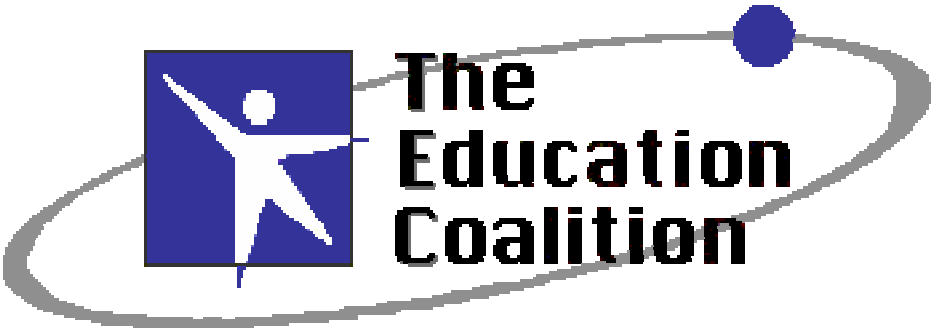

31 Segovia, San Clemente, CA 92672
(949) 369-3867 • TECemail@aol.com

This file can be found on the TEC website at
http://www.tecweb.org/eddevel/depth/reform.pdf

Technology and Systemic Educational Reform

This study, written by Dr. Carla Lane, was funded under a Star Schools Dissemination Grant to The Distance Learning Resource Network (DLRN) through OERI, U.S. Department of Education.

Contents

Abstract

Systemic reform of education and training is built upon a number of converging events. This study reviewed the literature in the areas that directly affect systemic reform, and concludes with recommendations that will enable technology to play a significant role in this movement. Literature from the following areas were reviewed: paradigms, change strategies, systemic reform, Goals 2000, legislation, constructivism, student empowerment, andragogy, equitable access, current use of technology in education, problem-based learning, evaluation through performance based assessment, technology as a force for systemic reform, technology's potential as a partner and tool for systemic reform, new ways to think about the use of technology for education, competing in the global economy, total quality management in education, using the national information infrastructure for education and training, and instructor in-service and pre-service.

When "A Nation at Risk" was released in 1983, it sounded an alarm for educators and the nation. It stated that the educational system of the United States was not serving the nation well. Approximately ten years after the release of "A Nation At Risk," the Goals 2000: Educate America Act was signed (March 31, 1994).

The Information Infrastructure Task Force (1994) found that the way Americans teach, learn, transmit and access information remains largely unchanged from a century ago. They found the following conditions in American education and training:

- The textbook remains the basic unit of instruction. Absorption of its contents tends to be the measure of educational success.
- Teachers and instructors use "chalk and talk" to convey information. Students are often recipients of instruction rather than active participants in learning.
- School teachers work largely in isolation from their peers. Teachers interact with their colleagues only for a few moments each day. Most other professionals collaborate, exchange information and develop new skills on a daily basis.
- Although half of the nation's school teachers use passive video materials for instruction, only a small fraction have access to interactive video, computer networks, or even telephones in the classroom.
- While computers are a frequent sight in America's classrooms and training sites, they are usually used simply as electronic workbooks. Interactive, high performance uses of technology, such as networked teams collaborating to solve real-world problems, retrieving information from electronic libraries, and performing scientific experiments in simulated environments, are all too uncommon.
- "U.S. schooling is a conservative institution, which adopts new practice and technology slowly. Highly regulated and financed from a limited revenue base, schools serve many educational and social purposes, subject to local consent. The use of computer technology, with its demands on teacher professional development, physical space, time in the instructional day, and budget ... has found a place in classroom practice and school organization slowly and tentatively" (Melmed, 1993)

In late June, 1994, the Carnegie Foundation for the Advancement of Teaching reported on the results of an international survey of 20,000 college professors in five European, four Western Hemisphere and four Asia-Pacific nations, plus Hong Kong. American college professors rated their students the lowest of the 14 countries participating. Only 15 percent said American high schools adequately prepared students for college-level math and quantitative reasoning. Asked if undergraduates are adequately prepared in writing and speaking skills, 20 percent or less of the faculty thought so in the United States (San Jose Mercury News 1994).

Since "A Nation at Risk," a number of forces came into play. As with any paradigm shift, it takes years and a number of events to reach a critical mass that moves theory and practice forward. Blanchard (1994) refers to "The Structure of Scientific Revolutions," Thomas S. Kuhn's (1970) book which describes how in the history of science, no major discovery ever came from those scientists who were vested (i.e., job, status, professional reputation) in the current predominant paradigm of thought. Instead, what happened time after time was that a young person (a Turk, maverick or rebel to the scientific community) would discover some finding that could not be explained by known scientific laws. He (or she) was scoffed at by mainstream scientists who clung tightly together in blasting the work of the upstart, and if need be the person him/herself. But the young Turk, if persistent, has an ally on his side: truth. And over time other newcomers to the field recognize that truth and a following emerges for a new paradigm that is better able to explain the current reality as it is now known to all. "

Certainly, this describes how early adopters and users of technology in education and training have felt. Blanchard (1994) says, "The old "command and control" paradigm is failing because those who have been clinging to it (corporate America: GM, IBM, Sears, etc.) are now stumbling and upstart companies that are representing a new era of assumptions about work and the nature of employment are thriving. The fact that Wal-Mart gave ownership interests to all its employees has a direct correlation with its rise in overtaking Sears and others on a national scale." This all underscores the "fact that the times they are a changin'," says Blanchard.

To unlock an epochal technology's power, Magnet (1994) says, companies have learned that they must restructure themselves and how they work as they weave computers into their most basic processes. "A technological revolution," he says, "is more than a merely technological matter; It entails an organizational transformation too. That's what U.S. business' recent frenzy of re-engineering has been all about, as companies flatten and decentralize along a unifying nervous system of the new information technology." As education and training has stretched to realign itself with the economy, it too has gone through a frenzy. Downsizing has occurred in teachers, resources, and facilities; technology has not been added, or has been added sparingly. Criticism has resulted in changes in curriculum, most notably state frameworks and national standards. Instructional methods have been questioned and new ones put into place. Certainly, this is the basis of systemic reform where schools have decentralized, reorganized, and rethought their production capabilities in the learning and teaching process, and are now organizing along a unifying nervous system of the new information technology. Educators should become more comfortable with information technology as they become familiar with technology, as information has always been their business.

There are a number of elements that created the movement for systemic reform and enabled the passage of the Goals 2000: Educate America Act. The Goals 2000: Educate America Act covers all Americans; it includes the cradle to grave lifelong learning that has become necessary in a global economy. It should not be perceived to cover only K-12 education.

The Paradigm Shift

Baker (1992) provides the following definitions for paradigm shift:

Thomas S. Kuhn (1970): Scientific paradigms are "accepted examples of actual scientific practice, examples which include law, theory, application, and instrumentation together-- (that) provide models from which spring particular coherent traditions of scientific research."

Adam Smith (1975): A shared set of assumptions. The paradigm is the way we perceive the world; water to the fish. The paradigm explains the world to us and helps us to predict its behavior." Smith concludes that "when we are in the middle of the paradigm, it is hard to imagine any other paradigm."

Willis Harmon (1970): "The basic way of perceiving, thinking, valuing, and doing associated with a particular vision of reality. A dominant paradigm is seldom if ever stated explicitly; it exists as unquestioned, tacit understanding that is transmitted through culture and to succeeding generations through direct experience rather than being taught."

Barker (1992): "A paradigm is a set of rules and regulations (written or unwritten) that does two things: (1) it establishes or defines boundaries; and (2) it tells you how to behave inside the boundaries in order to be successful."

Barker (1992) identifies the following Paradigm Principles:

- Our perceptions of the world are strongly influenced by paradigms.
- Because we become so good at using our present paradigms, we resist changing them.
- It is the outsider who usually creates the new paradigm.
- Practitioners of the old paradigm who choose to change to the new paradigm early, must do so as an act of faith rather than as the result of factual proof, because there will never be enough proof to be convincing in the early stages.
- Those who change to a successful new paradigm gain a new way of seeing the world and new approaches for solving problems as a result of the shift to the new rules.
- A new paradigm puts everyone back to zero, so practitioners of the old paradigm, who may have had great advantage, lose much or all of their leverage.

Barker states that in times of crisis, people expect and demand great change. This willingness to accept great change generates two results: More people try to find new ways, i.e., new paradigms, to resolve the crisis, thus increasing the likelihood of paradigm shifts. Because of the crises mentality, more people willing to accept fundamentally new approaches to solve the crisis, thus increasing the opportunity to change paradigms. This sets the stage for radical change. Barker provides the following sequence for a paradigm shift:

- The established paradigm begins to be less effective.
- The affected community senses the situation, begins to lose trust in the old rules.
- Turbulence grows as trust is reduced (the sense of crisis in creases).
- Creators or identifiers of the new paradigm step forward to offer their solutions (many of these solutions may have been around for decades waiting for this chance).
- Turbulence increases even more as paradigm conflict becomes apparent.
- The affected community is extremely upset and demands clear solutions.
- One of the suggested new paradigms demonstrates ability to solve a small set of significant problems that the old paradigm could not.
- Some of the affected community accepts the new paradigm as an act of faith.
- With stronger support and funding, the new paradigm gains momentum.

- Turbulence begins to wane as the new paradigm starts solving the problems and the affectedcommunity has a new way to deal with the world that seems successful.

Change Strategies

Even if we know exactly where we want to be in ten years and what the National Information Infrastructure will be...and even if we knew how much funding we could count on to get us there, we would still need to plan. There is a great body of literature on planning for technology, change, adoption of innovation, and strategies of adoption. As you read through this literature review on systemic reform and the use of technology, it may be useful to refer to model change strategies. Blanchard (1994) suggests that we can "make the times changes faster" through planning. His recommendation for a "viable blueprint for the pending evolution (revolution?) is based on a study of six organizations (Beer, Eisenstat and Spector, 1990) on "the process of change that leads to performance improvement." The six-step change strategy includes:

- Mobilize commitment
- Develop a shared vision
- Foster consensus
- Spread revitalization without directive
- Institutionalize revitalization through formal policies
- Monitor and adjust strategies

Mojkowski (1990) suggests that a strategic approach to technology implementation should include the following:

- Consider curriculum and learning outcomes first, then technology
- Link the use of technology to organizational priorities
- Develop a strategic sense guided by the organization's vision, mission, and goals
- Simultaneously transform and integrate technology in the learning and teaching process
- Document and evaluate the implementation

Farrell and Gring (1993) suggest another five-step model that is tied to a milestone timeline.

- Needs assessment; gathering and analyzing data (where are we today)
- Shared vision that leads to creating goals (where do we wish to arrive)
- Select goals - clarify, attainability, measurability and appropriateness
- Prioritize goals and write a plan (how do we get from here to there and when)
- Implement and evaluate the progress of the plan (how do we know when we arrived)

Pearson (1989) identified a model specifically for distance education programs. There were nine elements in the program and to be successful, all must be followed.

- Decide to plan for change: Awareness
- Recognize real vs. perceived need: Interest
- Understand the real reason for implementation: Advantage
- Mission of the organization: Evaluation
- Plan the program: Trial
- Review What the organization does now: Observability
- The gap: Compatibility
- Contingency: Pre-Adoption (Pilot)
- Implementation: Adoption

What is Systemic Reform?

During the last decade, it has become obvious that the contributions of teachers, administrators and the use of technology have made important changes in the lives of students. What became apparent is that the successes in the classroom needed to be viewed in the larger context of the educational system and curricula reform. The changes in the larger system were needed in order to enable wider spread changes in the classroom. Thus we began to use the words change, reform, restructure and finally systemic reform which includes K-12, higher education and training.

The National Commission on Time and Learning (1994) states that "Higher education needs to get involved. Colleges and universities, as institutions, have been bystanders for the most part in the school reform debate." They can do this by admissions requirements that validate learning and not seat time, by aligning programs that educate teachers with the movement to higher standards (which will require changing offerings in schools of education and the design of undergraduate programs in core disciplines), and by becoming involved in the struggle to reinvent local schools.

"We really need to be more involved in collaboration with the public schools," says Dr. Thomas Schnell, associate dean of research at the University of Missouri - St. Louis (1994). "In the past we've had our differences. Public school teachers and administrators have viewed colleges as being ivory towers with no sympathy for life in the trenches, and colleges have viewed public schools (teachers) as being practitioners with no appreciation for innovative theory."

The goal is still to have an impact on the students, but impacting their learning depends on the teacher and the support that the teacher is receiving from the school's administration, district, higher education, state and federal government. As this definition broadened, other groups were identified to be included in system reform. Parents needed to be involved as first teachers and remain involved through their children's academic careers. Schools of education needed to be involved as they significantly impacted the pre-service and in-service of teachers and administrators. Curriculum groups began developing curriculum frameworks for all areas. Performance based assessment and authentic assessment became major movements. Teachers began to learn facilitation methods.

Textbook authors, media program producers, the Public Broadcasting System, educational associations, teachers' unions, communities, PTAs, county offices of education, state departments of education, U.S. Department of Education and the administrations of Presidents Bush and Clinton became involved. Each group defined the contributions it could make as well as the changes that needed to be made within its structure in order to contribute to successful systemic reform. At the federal level, the use of technology was enabled through the Star Schools legislation. The movement became synergistic until finally, interest, understanding, and change developed a critical mass that enabled the passage of the most sweeping educational legislation in the history of America, Goals 2000: Educate America Act.

Yet another layer of systemic reform deals with time - the time to learn, think, and reorganize for teachers and students. "Unyielding and relentless, the time available in a uniform six-hour day and a 180-day year is the unacknowledged design flaw in American education," according to the National Education Committee on Time and Learning (1994). "By relying on time as the metric for school organization and curriculum, we have built a learning enterprise on a foundation of sand, on five premises educators know to be false." The first is the assumption that students arrive at school ready to learn in the same way, on the same schedule, all in rhythm with each other. The second is the notion that academic time can be used for nonacademic purposes with no effect on learning. Next is the pretense that because yesterday's

calendar was good enough for us, it should be good enough for our children -- despite major changes in the larger society. Fourth is the myth that schools can be transformed without giving teachers the time they need to retool themselves and reorganize their work. Finally, we find a new fiction: it is reasonable to expect 'world-class academic performance' from our students within the time-bound system that is already failing them. These five assumptions are a recipe for a kind of slow-motion social suicide. The key to liberating learning lies in unlocking time."

Meyer, Brooks, and Goes (1990) describe discontinuous or second order change as the type of strategies organizations employ when confronted by rapid change. "Discontinuous or second-order change transforms fundamental properties or states of the system." Fullan (1991) describes it as changes which "alter the fundamental ways in which organizations are put together, including new goals, structures, and roles."

Meyer, Brooks, and Goes (1990) describe two strategies which are used at individual work sites and at the industry level to react to sudden, jolting changes in the environment. The first is metamorphosis which is frame-breaking change within an individual organization; the second is revolution which is described as the emergence, transformation, and decline of entire industries.

Conley (1993) distinguishes between three types of changes that schools undergo, sometimes simultaneously. They are renewal, reform, and restructuring. He defines them as follows:

"Renewal activities are those that help the organization to do better and/or more efficiently that which it is already doing." "Reform-driven activities are those that alter existing procedures, rules, and requirements to enable the organization to adapt the way it functions to new circumstances or requirements." "Restructuring activities change fundamental assumptions, practices, and relationships, both within the organization and between the organization and the outside world."

David (1991) says that the central feature of restructuring is that it is a system wide process.

For the purposes of this article, systemic reform will be defined as second order change, or restructuring of educational agencies and processes, at the local, regional and national levels.

The dominant thinking about reform and its student level elements is to increase learning, especially advanced or higher-level skills, and to enhance student motivation and self-concept. Reform stresses the elements in the second column of Table 1 (Means, et al, 1993).

Table 1.

Comparison of Conventional & Reform Approaches to Instruction

Conventional Instruction	**Reform Instruction**
Teacher-directed	Student Exploration
Didactic teaching	Interactive modes of instruction
Short blocks of instruction on single subject	Extended blocks of authenticand multi-disciplinary work
Individual work	Collaborative work
Teacher as knowledge dispenser	Teacher as facilitator
Ability groupings	Heterogeneous groupings
Assessment of fact knowledge	Performance-based assessment and discrete skills

A Framework for Understanding Systemic Reform and Technology

Elements that have lead to and still are contributing to educational systemic reform and technology include a number of significant factors.

Global economy

- Chance that US may become a third world country due to a failure of education
- Quality movement - Total Quality Management (TQM)
- Industry
- Education
- Health industry
- Re-engineering the corporation
- The enabling role of information technology

Legislation

- Clinton Administration concentration on technology
- Goals 2000: Educate America Act
- School-to-Work Act
- 1934 and 1994 Communications Act
- Star Schools Legislation and Programs
- Equitable access for all students
- NTIA Programs

Research

- "A Nation At Risk"
- Star Schools programs
- Authentic Performance Assessment
- Student Portfolios
- Teacher Portfolios

Technological advances

- National Information Infrastructure
- Digital fusion/convergence - movement of technologies to tele-computing
- Ability to provide interaction
- Easy to use machine interface - user friendliness
- Interoperability thorugh worldwide technology standards
- Cable company advances in the use of interactive programming
- Game technologies
- Telephone companies wanting to provide programming
- Cost reductions in technology
- Computer Laboratories phased out
- Computers installed in classrooms with access to information through modem
- Computer drill and practice phased out in favor of problem solving
- Movement from Industrial Age to Information Age to Communications Age

Understanding how to use technology

- Uses for education
- Uses for business
- Uses for home
- Uses for entertainment - Nintendo

Educational System

- Collaborations between K-12 and post-secondary
- Star Schools Grant RFP calls for teacher pre-and in-service
- The system being seen as a system rather than separate entities of parents as first teachers, pre-school, elementary, middle school, high school, college continuing education, training, adult basic education, GED, ESL
- Learning
- Understanding of learning styles
- Understanding the mismatch of teaching and learning styles
- Application of learning styles in teaching
- Attitude change toward technology
- Facilitation is used rather than "teaching"
- Problem solving skills used by all learners
- Learners construct their own knowledge
- Collaborative study groups are used by all learners
- Experiential, hands-on learning used by all learners
- Seeing new teaching role models that do more than lecture from the book
- Merging of constructivism and andragogy

The Millennium

- The expectation that something dramatic occurs not only at the change of the century but at the end of the second one-thousand years on the planet.

As can be seen from the list, any one change or advance was not significant enough to cause a paradigm shift. However, when all of these factors are taken together, the critical mass is established that can move the country to a paradigm shift in education.

Goals 2000: Educate America Act

At the kickoff meeting of Goals 2000: Educate America Act, Secretary of Education Richard Riley said that " technological and economic changes have occurred so fast that even the standards that we thought were high -- just a few years ago -- have to be higher today if we want all of our young people to be properly prepared. Technology has been growing exponentially. Education is even more important. We have to strive once again for higher standards. Here, it is important to recognize that in the next ten years this nation will have more children and young people in school than ever before. That's another change. The Baby Boomers filled up our classrooms in the 1960s and '70s, and some of us still remember the enormous amount of effort it took to teach all those children (Riley, 1994b)."

"Now, we have the same dynamic and something more," Secretary Riley continued. "By year 2004, data tells us we will have approximately 55.7 million students going to school, seven million more than we have today. The majority of these young people will not be suburban kids. The majority will be Hispanic, African-Americans, Asian, and new immigrants -- children who can learn if we teach them to high standards. But we have to expect them to learn and teach them high standards. If we ignore their education, if we continue to give them a watered-down curriculum and link inner city schools up last to the Information Superhighway, we will find this country in an economic pickle of the first order. We will have a work force that simply does not know how to work in today's economy."

"Like many of you, Ray Cortines, the very fine chancellor of education in New York city, is setting an example by raising academic standards for every student in New York city. He had it right, a few weeks ago, when he announced the new academic requirement and said that, 'the easy way out is the road to nowhere.' We can all find an easy way out. For that is the heart of the matter. If we accept 'the easy way out,' it will surely be the road to nowhere for a generation of young people who need our help. It will be a great injustice to their families and costly to this great nation of our's. We must do this for all of our students - - our most talented students as well as all those young people who are in the middle, students from disadvantaged backgrounds, students whose first language is not English, and students with disabilities. Even homeless students like those who are being taught by our National Teacher of the Year, Sandra McBrayer -- San Diego children who have no one to speak up for them -- who go to college like many of Sandra's students...if we believe in them. We need to remember that good teachers like Sandra are at the heart of it all. They make the difference. If we want our children to be 'living report cards,' we simply have to honor the work and effort of America's teachers -- and listen to what they are telling us about our children. They simply have to be at the very center of our reform efforts. If you try to reform the schools in any other way, it will fail" (Riley, 1994b).

"Americans want the best for our children. They always have. They know our children need to learn more to get ahead...that the world they are growing up in is so different than the one that even all of us grew up in...more global, more knowledge-driven and certainly it's more competitive. This is why Goals 2000 is at the very center of an effort to redesign the American education system for the coming times -- to create a strategy of lifelong learning that beings with it Head Start and Even Start and many other pre-school programs...that makes our schools safer...that raises standards and expectations across-the-board at the K-12 level...that helps young people make the transition from school-to-work...that prepares many more young people for college or other postsecondary learning. Goals 2000 is your act - your victory, your achievement...and our opportunity...together...to lift up American education (Riley, 1994b).

In March, 1994, Goals 2000: Educate America Act legislation was passed and signed into law. It's preamble states: "To improve learning and teaching by providing a national framework for education reform; to promote the research, consensus building, and systemic changes needed

to ensure equitable educational opportunities and high levels of educational achievement for all students; to provide a framework for reauthorization of all Federal education programs; to promote the development and adoption of a voluntary national system of skill standards and certifications; and for other purposes."

The Goals

- School Readiness: By the year 2000, all children in America will start school ready to learn.
- School Completion: By the year 2000, the high school graduation rate will increase to at least 90 percent.
- Student Achievement and Citizenship: By the year 2000, all students will leave grades 4, 8, and 12 having demonstrated competency over challenging subject matter including English, mathematics, science, foreign languages, civics and government, economics, arts, history, and geography, and every school in America will ensure that all students learn to use their minds well, so they may be prepared for responsible citizenship, further learning, and productive employment in our Nation's modern economy.
- Teacher Education and Professional Development: By the year 2000, the Nation's teaching force will have access to programs for the continued improvement of their professional skills and the opportunity to acquire the knowledge and skills needed to instruct and prepare all American students for the next century.
- Mathematics and Science: By the year 2000, United States students will be first in the world in mathematics and science achievement.
- Adult Literacy and Lifelong Learning: By the year 2000, every adult American will be literate and will possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship.
- Safe, Disciplined, and Alcohol-and Drug-Free Schools: By the year 2000, every school in the United States will be free of drugs, violence, and the unauthorized presence of firearms and alcohol and will offer a disciplined environment conducive to learning.
- Parental Participation: By the year 2000, every school will promote partnerships that will increase parental involvement and participation in promoting the social, emotional, and academic growth of children.

Technology is a vital part of Goals 2000 and is embodied as Title III. "Educational technology is a vital part of systemic reform. Electronic networks, for example, can facilitate the development and implementation of content and performance standards by allowing teachers and other educators to converse with one another across States. Instructional tools can be powerful resources in raising motivation and performance of all students. Furthermore, students must have technologies to enhance their learning and to master the skills necessary for the workplace. States, districts, and schools will benefit from examining technology issues as an integral part of systemic reform" (Guidance, 1994). Title III technology grants are awarded to state educational authorities (SEAs) to assist them in integrating the use of state-of-the-art technology as part of their State improvement plans

In Goals 2000, we address the need for equitable access to information for all learners. You know the metaphor of providing an on-ramp to the information highway for school buses. You know that our natural resources are the same as other countries. The only thing that will set us apart in the global market is the ingenuity of our work force gained through an educational system that provides the tools for learning. In the past we provided buildings, teachers, blackboards, chalk and books. Now we must add daily access to information for all learners These are major demands. If they are not met, the prediction is that we will create a new third world country called the United States. In the U.S., education has always been a third world country (Lane, 1994a).

When universal access was provided in the 1934 Communications Act, the only place that did not get access was the classroom. This can change if media connections are provided in all classrooms for voice, data and video. This is the only way to provide equitable access to information for all learners. Learners need access to resources that can be provided through telephone, cable, satellite, public broadcasting, wireless, commercial on-line services, Internet and any other technology. Learners need access whether they are in school, work or home. Providing one education cable drop and education rates for telephone service is a beginning...but it will not provide equitable access for all learners. We need more if we are to educate employees of the information age (Lane, 1994a).

There are a number of problems in the use of technology that have been seen in the schools. Most schools are not wired for telephone, cable or television access. Most schools have only two to four telephone lines. One line is usually reserved for emergencies. Teachers must go to the school office to call parents. They do not have privacy. All of the teachers in the school share the same phone lines with the principal, office staff, and school nurse. Many schools have computer labs but do not have computer modems to access information. Students go there several hours a week but may spend as little as ten minutes a week working on the computer. Computer labs do not enable integration of technology with curricula. They do not develop information gathering skills, or the application of newly found information to problems on which the children are working in class. Most schools do not have a satellite dish or access to programming through a satellite dish (Lane, 1994a).

A cable company may provide a cable drop and one channel for educational use, but the school has to wire the building, buy the equipment and buy or produce the programming. In a K-12 district, available programming overlaps for the age groups. Few get the programming that they want - even on tape. With limited funds, schools can usually get the cable signal to one classroom which they call a resource classroom. All of the classes at the school take turns using the room - usually only six classes per day can use the room. University campuses may have only one sophisticated distance learning classroom to be used by 20,000 students; it is rare for that classroom to be assigned to or built by the school of education. Teachers teaching in groundbreaking on-line programs such as the University of Phoenix On-line Program, have purchased the equipment in order to teach classes for students throughout the U.S. (Lane, 1994a).

Teachers do not have training in the use of information technologies. Funding is still too limited to provide this. Telecommunications operators seldom provide the training that is needed. Most states do not require information technology courses for students graduating from schools of education. Several require one three hour course. In K-12 schools that receive Star Schools programs, many do not have a satellite dish. Students view the programs on the cable access channel, public television station, or on tape (Lane, 1994a).

The Star Schools programs are meant to be interactive, but most schools cannot afford the telephone line. Some teachers provide interaction by taking students to the phone - in the principal's office. Some teachers provide interaction by fax with the television teacher. Most schools do not have a fax machine. One teacher gives the fax to her husband who drops it off at the high school where there is a fax machine (Lane, 1994a).

In research on the TEAMS Star Schools Project, a new model of teacher re-education was identified (Lane, 1994 b). The research shows that teachers who watch a television teacher are presented with a role model for the new instructional methods. After using the programs for three years, the teachers report that they have changed their instructional methods so that the benefits to the children include constructing their own knowledge and become self-directed learners (Lane, 1994a).

What would help? To make the benefits of distance learning available, all classrooms must have access to information technologies - voice, data, and video - as part of a network. Just as we believe that libraries should be open to the public so that everyone can share the information, we must extend the same provision to all information providers - whether it arrives on a telephone line, coaxial cable, fiber optic cable, satellite, wireless or broadcast. Low educational rates should be available from all telecommunications entities which come under the jurisdiction of the FCC. Specifically, there should be lower educational rates for cable, telephone, satellite, broadcast, commercial on-line services, Internet and provisions made for low educational rates for future information providers (Lane, 1994a).

In order to compete we must build an educational system to match the needs of the Information Age. Being successful in the global economy is clearly linked to a strong education system. The critical natural resources of the Information Age are knowing how to learn, and access to education...which includes access to information. Because of this, it is imperative that we provide equitable access to all learners. If universal access is to mean equitable access for learners, then legislation must state this and provide methods by which it can be implemented. Providing one line to a school is not enough. Providing ten lines to a school with 600 students is not enough. If we were expected to share access to information with 60 other people, little work would get done. The same goes for children. Their job is to learn. Most new and exciting learning resources that inspire and motivate them to construct their own knowledge and prepare them to work in the future are available through learning technologies. They can't do the work of childhood - they can't learn - without access to information. The same is true for adults (Lane, 1994a).

Distance learning facilitates high performance education by encouraging new instructional techniques and by allowing electronic access to information from any location. It is a driving force in the restructuring efforts of American education. The restructured school must bring these resources to the classroom and substantially supplement or replace the dated, non-interactive material used today if we are to implement Goals 2000. Working and learning are becoming synonymous. The work world for which students are being prepared requires learners who know how to learn and construct knowledge. These learners will become continuous lifelong learners. The real superhighway, is the highway of the mind (Lane, 1994a).

Models of Learning

1. Constructivism

The changes that are being advocated are based on a growing body of work and research that theorizes that learners actively construct their own understanding of the world around them by fitting their perceptions of the world into their existing knowledge and understanding. The positions represented by psychological, philosophical, pedagogical and thinking skills advocates are called constructivism. These theorists (von Glaserfeld, 1987; Shapiro, 1989; Confrey, 1990; Noddings, 1990; Davis, 1990; and Cobb et al, 1992) generally agree that learners must construct their own knowledge. Each learner has conceptions and skills "with which he or she must construct knowledge to solve problems presented by the environment. The role of the community -- other learners and the teacher -- is to provide the setting, pose the challenges, and offer the support that will encourage construction."

Anderson, et al (1994) elaborate this perspective on learning and teaching.

- Learning is dependent upon the unique prior conceptions that the learner brings to the experience. Old knowledge is the foundation into which the new knowledge must be integrated.
- The learner must construct his or her own meaning. Students must organize and reorganize knowledge themselves until it fits with prior conceptions and has meaning within the learner's overall system. Learning is not memorizing or taking in knowledge in a form designed by someone else.
- Learning is contextual and should be based on concrete experiences that. The meaning that new knowledge has is highly dependent upon its context; it should not be presented in the abstract, independent of any meaningful context.
- Learning is dependent upon the shared understandings that learners negotiate with others. Learners and teachers bring individually held knowledge, beliefs, and feelings to the classroom and through daily interaction, they negotiate shared understandings of knowledge. These intersubjective meanings, "consensual domains," increase the importance of discussion and cooperative learning.
- Constructivist teaching involves understanding students' existing cognitive structures and providing appropriate learning activities to assist them. Teachers need to attend to students' existing cognitive structures and provide learning activities accordingly.
- Rote learning is often used because it is easier than dealing with the learners preconceptions and misconceptions. It is easier to memorize facts because it does not build on prior learning, and therefore, is not influenced by misconceptions. Students when exposed to rote learning for several years come not only to accept it but to actually prefer it. Learners must be made aware that meaning is something they construct, not something given to them by the teacher.
- Teaching can utilize one or more of several key strategies to facilitate conceptual change depending upon the congruence of the concepts with student understanding and conceptualization. Models include some variation of awareness, disequilibrium, and reformation. Awareness is based on the student working with information sources which link prior knowledge and construct meaning. In disequilibrium, learners evaluate the new constructs for consistency (agreement) or dissonance (disagreement) with prior knowledge. To reformulate their thinking, during the reformation phrase, students may be presented with formal concepts that lead to the resolution of anomalies and to the dissipation of cognitive dissonance.
- The key elements of conceptual change can be addressed by specific teaching methods which address awareness, disequilibrium, and reformation.

- Constructivism leads to new conceptions of what constitutes excellence in teaching and learning and in the roles of both teachers and students. The classroom is no longer teacher-centered but is student centered. The teacher serves as a facilitator, pathfinder, guide, clarifier, and maintains the environment. Students shift from that of a passive receptacle to that of an active participant, exploring, investigating, discussing, and constructing his/her own knowledge. These role changes are among the most difficult to attain.
- In constructivist teaching and learning, more emphasis is placed on learning how to learn than on an accumulation of facts, creating a philosophy of content in which "less is more."

2. Student Empowerment Model of Learning

Cummins (1989), in a synthesis of research and theory on successfully learning by language, cultural and ethnic minority students, provides the model of student empowerment. At its core are four components, each with a major shift from the traditional educational paradigm to an empowered paradigm. The four core components are:

- **Cultural-Linguistic Incorporation:** moving from additive rather than subtractive; where students' languages and cultures are incorporated into the school program rather than being seen as hindrances to their learning
- **Pedagogy:** interactive/experiential pedagogy, rather than one of transmission of information; promotes intrinsic motivation on the part of student to use language in order to formulate meaningful questions and generate knowledge; based on the work of Paolo Freire and others
- **Community Relations:** inclusive rather than exclusive; full community participation encouraged as an integral component of children's education
- **Assessment:** advocacy oriented rather than legitimization oriented; professionals involved in assessment become advocates for students by focusing primarily on the ways in which students' academic difficulty is a function of the interactions within the school context rather than legitimizing the location of the "problem' within students

3. Andragogy

Malcolm Knowles identified a model for adult education (1975) which he called andragogy and defined as "the art and science of helping adults learn." According to Knowles (1983) the media have not been used effectively for adult education because they have been seen as one-way transmissions of teacher-controlled instruction which does not result in optimal learning; they are based upon the pedagogical model of education and the entertainment model of media use. Knowles recommends the andragogical model of learning and the educational model of media.

Knowles makes the distinction among the andragogical and pedagogical models of teaching based upon sets of assumptions about learners which teachers make. The teacher who makes one set of assumptions will teach pedagogically whether he or she is teaching children or adults, whereas the teacher who makes the other set of assumptions will teach andragogically whether the learners are children or adults (Knowles, 1975). The key features of the model are interaction, task-centeredness, individualization, and self-directedness. Knowles states that learning is most effective when learners engage interactively in the inquiry process. Interaction can be introduced between the learner and the program using interactive video disc, computers, and interactive reading materials. There are many striking similarities between andragogy and constructivism.

- **Concept of the learner:** The learner is self-directing. The psychological definition of adult is "one who has arrived at a self-concept of being responsible for one's own life, of being self-directing." Adults who have arrived at that point develop a deep psychological need to be perceived by others, and treated by others, as capable of taking responsibility for themselves. In situations where others impose their wills on the adult without allowing the adult to participate in making decision which affect the adult, he/she will often experience a feeling of resentment and resistance. Adults entering a situation labeled "education" or "training" hark back to their conditioning in school, assume role of dependency, and demand to be taught. However, if they really are treated like children, this conditioned expectation conflicts with their much deeper psychological need to be self-directing, and their energy is diverted away from learning to dealing with this internal conflict.
- **The role of the learner's experience:** Adult enter into an educational activity with both a greater volume and a different quality of experience from youth. For many kinds of learning, adults are the richest resources for one another, and hence the greater emphasis on group discussion, simulation exercises, laboratory experiences, field experiences, and problem-solving projects that make use of the experiences of the learners. Because of the vast difference in learners' experiences, emphasis is placed on individualized learning plans through self-directed learning contracts. Adults derive their self-identity from their experience; if this is ignored, not valued, or not made use of, it is not just the experience that is being rejected - it is the person.
- **Readiness to learn:** Adults become ready to learn when they experience a need to know or do something in order to perform more effectively in some aspect of their lives. Chief sources of readiness are the developmental tasks associated with moving from one stage of development to another; but any change -- birth of children, loss of job, divorce, death of a friend or relative, change of residence - is likely to trigger a readiness to learn. To induce a readiness to learn, learners can be exposed to more effective role models, engaged in career planning or provided with diagnostic experiences in which they can assess the gaps between where they are now and where they want and need to be.
- **Orientation to learning:** Because adults are motivated to learn after they experience a need in their life situation, they enter an educational activity with a life-centered, task-centered, or problem-centered orientation to learning. For the most part, adults do not learn for the sake of learning; they learn in order to be able to perform a task, solve a problem, or live in a more satisfying way. The chief implication is the importance of organizing learning experience (curricula) around life situations rather than according to subject matter units. Another implication is the importance of making clear at the outset of a learning experience what its relevance is to the learner's life tasks or problems. One of the first tasks of a facilitator of learning is to develop "the need to know" what will be learned.
- **Motivation to learn:** The most potent motivators are internal -- self-esteem, recognition, better quality of life, greater self-confidence, self-actualization, and the like. These intrinsic motivators are superior to external motivators such as a better job, a salary increase, and the like.
- The basic format of the andragogical model is a process design which assigns a dual role to the facilitator of learning; first and primarily, the role of designer and manager of processes or procedures that will facilitate the acquisition of content by the learners; and only secondarily, the role of content resource. Besides the facilitator, other resources include peers, experts, media, experiential learning, and field experiences. It is the facilitators job to link the resources and the learners.
- Climate setting create a climate that is informal and conducive to learning. The physical environment may be one large circle or several small circles of chairs. The psychological

climate includes mutual respect, collaborativeness, mutual trust, supportiveness, openness and authenticity, pleasure, and humanness.

- Involve learners in mutual planning as people tend to feel committed to any decision in proportion to the extent to which they have participated in making it.
- Involve participants in diagnosing their own needs for learning. This involves meshing the needs of which the learners are aware (felt needs) with the needs their organizations or society has for them (ascribed needs). Using a model of competencies allows learners to identify the gaps between where they are now and where they need to be.
- Involve learners in formulating their learning objectives. Learning contracts provide structure for this. Goals are set by mutual negotiation.
- Involve learners in designing learning plans which help learners identify resources and devise strategies for using the resources to accomplish their objectives.
- Help learners carry out their learning plan. Knowles sees the model as being a process design rather than a content plan so that there is no attempt to cover particular content areas; instead the student samples content in relevant problem situations. It is useless to have a stockpile of content information without having a process or method by which to handle it.
- Involve learners in evaluating their learning by judging the quality and worth of the total program and their learning outcomes. The evaluation of the learning which has occurred is done through mutual assessment of the evidence which is prepared by the learner

For media programs to be effective with adult learners, Knowles states that they must be organized around the acquisition of the knowledge, skills, understandings, attitudes, and values that are applicable to performing the life tasks with which adults are concerned. Knowles (1975) states that one of the most significant findings from research (Tough, 1979) about adult learning is that when adults go about learning something naturally, rather than being taught, they are highly self-directing. He finds that evidence is accumulating to support that what adults learn on their own initiative - through planning and constructing their own learning - they learn more deeply and permanently than what they learn by being taught.

Current Use of Technology in Education

"In the 1980s, reform efforts tried to improve student performance by increasing course requirements," according to Means and Olson (1994). "Reformers did not, however, examine the way that teaching and learning unfold." Technology applications "exist primarily on the periphery of a school's instructional program" (Farrell and Gring, 1993). "Many technology initiatives are unconnected to the school's improvement activities and not part of any long-range plan.

Means and Olson (1994) believe that earlier attempts to introduce technology into schools failed because "the attempts were based on the wrong model of teaching with technology. Product developers believed in their content knowledge, pedagogical techniques, and in the power of technology to transmit knowledge to students. With satisfaction, the developers touted the so-called 'teacher-proof' instructional programs." Means and Olson observe that the vendors must have been surprised that their applications were never used for very long. Another primary problem is that the applications were an "imperfect and incomplete match with the bulk of the core curriculum" (Means and Olson (1994). They believe that education reform and the use of technology is a basis for optimism.

Ohler (1991) lists a number of ways that distance education has been used.

- To overcome geographic isolation in order to receive a state-sanctioned education
- To avoid or reinforce particular content
- Because of incarceration
- To avoid social influences
- To experience or avoid certain learning dynamics
- Because of a disability
- To avoid having to abandon a life-style or culture
- To avoid a schedule conflict
- Because the student is not learning in school
- To escape tracking
- To learn in a more global context
- To learn information-economy skills
- Remediation
- Because schools are too expensive for the state to provide
- To improve local communication under certain conditions
- To reduce anxiety and improve face-to-face communication
- Because the media are motivational
- To associate with a particular segment of society, or conversely, to become diffused within a heterogeneous population
- To take advantage of a world of experts and resources that only media can provide

"Schools are not moving to integrate technology, nor are they keeping up with the latest development; in fact, they are falling farther and farther behind as the equipment they purchased in the 1980s becomes obsolete and they are unable to purchase new equipment" (Elkmer-Dewitt 1991). "Schools are out of step with the times," according to David (1991). "Inside and out, schools today look very much the way they did a hundred years ago: the buildings, the size and shape of classrooms, the divisions based on age, and the ways of delivering instruction have changed very little. Yet the world has changed remarkably. Families, jobs, social organizations and entertainment look nothing like they did at the turn of the century. From inside a school, however, one would hardly know that visual images, rapid motion, technology, and change are pervasive in the world outside."

"Schools are neither organized nor funded in a way that enables them to keep up with changes in knowledge or changes in technology used to store and present such knowledge" (Elkmer-Dewitt 1991; Levinson 1990). "Schools have defined technology as computers. There are many types of technology in addition to computers that will have an equal or greater impact on learning" (Conley, 1991). "Textbooks are an obsolete technology, yet they continue to be central to the way schools conceive of teaching and learning" (Conley, 1993). "Statistics such as the number of computers per teacher are worse than useless as a measure of progress to determine effective use of technology in schools; careful examination of schools' attempts to use computers yields results that are dismaying and disheartening" (Borrell 1992).

Conley (1993) says that the most striking observation one reaches about technology in education over the past dozen years is not its impact but its lack of impact." Informational technologies have been adopted in the central offices, but "technology has not revolutionized learning in the classroom, nor led to higher productivity in schools. While telecommunications may prove to be a powerful tool for restructuring, its use at this point is primarily to expand, not to change, the existing curriculum by offering courses such as physics or French to schools not otherwise able to offer them and by employing traditional instructional strategies." Certain technologies have definitely found niches in education, but Smith and O'Day (1990) say that the technology of the last two decades has changed schools far less than it has the worlds of work, entertainment and communication. On the whole, they say, teachers have simply closed their classroom doors and gone right on teaching just as they were taught.

According to the Information Infrastructure Task Force (1994) (IITF), while computers and some communications capabilities are present in American schools, high speed communications technology is limited to very few classrooms. Substantial local infrastructure investments will be necessary to realize the promise of NII applications. The installed base of computers, modems, networks, and video technology indicates that growth has been, at best, uneven. Most schools, communities, and state and local governing bodies have neither recognized nor acted on the need to build the technological capability to access the information superhighway. A key, but not well understood requirement, is for technical expertise to install and maintain high speed connections to the NII. Once the high speed communications linkages of the NII are brought to the schoolhouse door, the challenge is to build the internal high speed linkages within the building to connect the user hardware.

Instructional video has made the most notable inroads into the schools. Seventy-five percent of America's schools have cable television, and half of its teachers use video material in their courses (CPB, 1991). The Stars Schools programs are reaching over 200,000 students in 48 states with advanced placement courses in mathematics, science, and foreign language instruction using fiber optics, computers, and satellites. Cassette videotapes for instruction are widely used in schools and work places, and the development of these videotapes for both education and training has become a vigorous industry.

Hundreds of thousands of students in schools, community colleges, and universities now take courses via one-and two-way video and two-way audio communication. In South Carolina, high school students across the state study with a teacher of Russian based in Columbia through South Carolina Educational Television. Boise State University offers a masters degree program conducted entirely over networked computers to students all over the country. The University of Phoenix Online Division offers an undergraduate and graduate degree in business. The Education Coalition (TEC) has formed to collaboratively produce programming for teacher in-service and pre-service, and K-12 social studies programming. The California State University System has distance learning classrooms on each campus which can be linked. The University of Missouri - St. Louis and St. Louis Community College offer courses over the Higher Education Channel (cable) that reaches over three million homes. The TEAMS Star Schools

program produced by the Los Angeles County Office of Education has provided mathematics and science programs to over 60,000 fourth through sixth graders throughout the U.S. in one year.

The Department of Defense is investing well over one billion dollars in the development and implementation of networked distributed interactive simulation. This technology, which allows dispersed learners to engage in collaborative problem solving activities in real time, is now ready for transfer to schools and workplaces outside of the defense sector.

The IITF states that the installed base of computers in American elementary and secondary schools is largely incapable of supporting multimedia graphical applications because of obsolete or obsolescent hardware. Eighty percent of the base includes Apple IIs (about 55 percent) and IBM PCs, XTs, ATs or similar class machines (about 24 percent), with limited modern graphic or multimedia capabilities; the remaining part of the base is made up of 10 percent Apple Macintoshes and eight percent IBM compatible 386s or 486s and is capable of supporting high level applications. The number of computers in the schools, 2.5 million, is equivalent to one per classroom (Malmed, 1993).

In a 1993 survey of NEA members, only four percent of teachers reported having a modem in their classroom, while 38 percent reported having access to a modem somewhere in the school building (Princeton, 1993). Another survey found that among 550 educators who are actively involved in using telecommunications, less than half have access to the Internet. They use the Internet services twice as often for professional activities as for student learning activities (Honey and Henriquez, 1993).

In 1994, 3Com Corporation based in Santa Clara, CA committed $1.9 million in cash, personnel and networking equipment to link every high school classroom in San Jose and eventually all 35 schools in the county to each other, and the Internet (Bank, 1994). A four week summer institute at San Jose State University trained 450 teachers, 100 students and 50 administrators to master the technology, and develop teaching methods and curricula that take advantage of the new capabilities. By the end of the second year of the project each teacher will have a computer workstation linked to the network, and four student workstations with access to the Internet through the teacher's computer.

3Com was attracted to Santa Clara because they "did not look at this as a technology issue but as a fundamental change in curriculum development and the way teachers collaborate among themselves and with administrators. Networking is just a piece, but it's a fundamental catalyst" according to Eric Benhamou, 3Com's chief executive. When the network is done, the 33-district network will be one of the largest of any kind in the country. David Katz, director of the San Jose Education Network stressed that this is not a project to teach students to use computers, but "rather to use computers as a tool for learning in general. In a world where al the information is available with a keystroke, the teacher has to change to the role of a facilitator, to help kids learn to find information, to think critically, to decide what's important. In the workplace of the 21st century, that's how value is going to be determined, by your ability to add value to information" (Bank, 1994).

Laser video disc-based programs enable the user to interact with still or moving images and print. Texas, Florida, and West Virginia have approved laser video discs for instruction. In 1990, Texas approved Optical Data Corporation's "Windows on Science" program for use in lieu of textbooks. The corporation's studies strongly suggest that the medium improves a variety of educational outcomes (Hancock and Betts, 1994).

Information collection, according to the IITF (1994) includes location and retrieval of documents such as lesson plans and research reports, but it also includes newer data sources such as

CAD databases for workplace technologies and equipment, and multimedia information retrieval from digital libraries that can be accessed by students, workers, or people in homes, libraries, and museums. Over 60,000 electronic bulletin boards are used by more than 12 million Americans every day (Investor's Business Daily, 1994). The annual rate of Gopher traffic on the Internet, which directly represents an effort to use NII facilities to gather information, is growing at an annual rate of approximately 1000 percent (Treese, 1993). The Department of Education has a Gopher server which points to or contains educational research information, such as the AskERIC service and information from sources such as CNN, Academy One, and the Educational Testing Service. NASA Spacelink makes lesson plans on space flight and related science topics available on the Internet. Until compelling applications are available, education will not realize the potential of the NII.

Two-way communication includes communication via electronic mail and conferencing among teachers, students, workers, mentors, technicians, and subject matter experts of every sort (IITF, 1994). Approximately one-quarter of the teachers in Texas regularly sign on to the Texas Education Network, or TENET, to share information, exchange mail, and find resources. A professor at Virginia Polytechnic Institute and State University teaches a writing course entirely on-line. Students swap writing projects and discuss their assignments on-line. In the workplace, electronic mail is used by more than 12 million workers, increasing to over 27 million workers by 1995. Just less than a sixth of U.S. homes now have at least one computer connected to a modem, and this percentage is growing rapidly. As of July, 1993, there were four Internet hosts for every 1000 people in the United States. There are now 60 countries on the Internet. About 137 countries can now be reached by electronic mail (Treese, 1993).

Current application of NII capabilities (IITF, 1994) to work place training is more extensive and technologically advanced than educational applications, yet it lags well behind what is needed and available. Workplace training seems to be a case of the haves receiving more and the have-nots remaining neglected. Small firms, those with 100 employees or less, provide about 35 percent of total U.S. employment, but they lack the expertise to provide in-house training, the resources to pay for outside training, and sufficient numbers of people who need training at any one time to justify focused training efforts. Larger firms are more likely to provide training than smaller ones, but the training they provide is mostly limited to college-educated technicians and managers. The lower the level of skills possessed, the less likely the worker is to receive training from any source. Transportable, quality controlled training and lifelong learning could be made readily and inexpensively accessible using the NII and will have a major impact on improving worker skills and workplace productivity.

In Senate testimony, NEA's Kenneth Malley said, "It should be of little surprise then that teachers and others do not have access to new information technologies and telecommunications services. Last year (1993), NEA conducted a nationwide survey to determine classroom teachers' access to computing and telecommunications technologies. Only 12 percent of U.S. classrooms have a telephone. Only four percent of teachers have a modem in their classroom and these are concentrated in affluent districts. Further, only four percent report having any access to Internet. The consequences of this resource scarcity are obvious. A mere six percent of the teachers surveyed reported that they and their students had ever used electronic networks to collaborate with other teachers. Numbers like these would be astounding in a business environment, yet we continue to expect teachers to work educational miracles without even the most basic communication tools. We do not have any choice but to make this investment. What is at stake is the future of these children, the future of these communities, indeed, the future of the nation itself" (Malley, 1994).

Malley (1994) contends that "we will be unable to attain these technological advances without recognizing that we have a larger problem. Many of our schools are simply incapable of accepting the promise of telecommunications. The physical infrastructure of our nation's schools

is in need of massive renovation and repair. Three-quarters of the schools in the nation are at or near the end of their useful life. While we can bring the Information Superhighway to their door, many are not prepared to receive it in their classrooms. Many teachers work in classrooms with only one electrical outlet and when workers attempt to install additional electrical wiring, they often encounter asbestos and other hazards brought on by years of neglect. Computers sit in cartons because they cannot be safely installed in rooms with leaky ceilings. Schools may have telephone lines, but they most often extend to the principal's office --not to the teacher's desk, let alone a student's computer."

"The structure of knowledge is rapidly evolving. The division of academic disciplines is no longer appropriate for understanding or solving the problems that exist in the world, yet schools cling to the old structure" (Conley, 1993). "Information is seen less as an end in itself than as a means to an end, an essential ingredient in problem-solving. Curricula that focus on information as an end in itself (fact-based rote learning) can be counterproductive, extinguishing the curiosity and inquisitiveness of the learner and providing little practice in applying information to solve problems" (Conley 1993).

In 1991, then U.S. Labor Secretary Lynn Martin established a Commission on Achieving Necessary Skills (SCANS) which reported five learning areas of increasing importance in the workplace and foundation skills (Whetzel, 1992). Workers use foundation skills--academic and behavioral characteristics--to build competencies on. Foundation skills fall into three domains:

- Basic skills--reading, writing, speaking, listening, and knowing arithmetic and mathematical concepts;
- Thinking skills--reasoning, making decisions, thinking creatively, solving problems, seeing things in the mind's eye, and knowing how to learn; and
- Personal qualities--responsibility, self-esteem, sociability, self-management, integrity, and honesty.

Competencies more closely relate to what people actually do at work. The competencies that SCANS has identified fall into five domains:

- Resources--identifying, organizing, planning, and allocating time, money, materials, and workers;
- Interpersonal skills--negotiating, exercising leadership, working with diversity, teaching others new skills, serving clients and customers, and participating as a team member;
- Information skills--using computers to process information and acquiring and evaluating, organizing and maintaining, and interpreting and communicating information;
- Systems skills--understanding systems, monitoring and correcting system performance, and improving and designing systems; and technology utilization skills--selecting technology, applying technology to a task, and maintaining and troubleshooting technology.

"Economic survival in an information society requires being able to work with media, by using computers to navigate and move information effectively" (Wodtke, 1993). It requires being able to relate to and build computer models that address the realities you are working with. It means being able to work with methods that involve computers and a wide range of electronic devices that enable you to communicate and collaborate effectively using electronic media. These thinking skills coupled with hardware and software application skills are becoming the computer literacy essential for survival on many levels - essential for individuals to survive in an information society, for individuals to compete in the job market, for the enterprises of work groups to be competitive in the marketplace, and for countries to compete in the global community" says Wodtke.

Implementation issues center on the fact that technologies "can be used to deliver instruction," but that "does not mean that they will be" (Means, et al, 1993). What has happened in the past is that the technology is adopted by a school but is adapted to traditional school structures and teaching styles if it is flexible, or is discarded if it cannot be adapted (Cohen 1988; Cuban 1986). Cohen contends that the dominant use of distance learning is wider dissemination of a traditional mode of teaching - the lecture. Microcomputers have provided an on-line version of drill-and practice seat work. Piele (1989) suggests that computer labs have failed to transform schools because they are typically not supervised by the classroom teacher so teachers "can ignore them altogether." Cohen (1988) contends that the central instructional program remains much as it was 50 years ago, untouched by the technological revolution going on around it.

Technology has not made a real difference in teaching and learning primarily because of the "imperviousness of the education system to any kind of fundamental change; the barriers that are specific to technology-based changes are very real, but a lesser impediment (Means, et al, 1993). Sheingold (1991b) asserts that it is now understood that the "challenge of integrating technology into schools and classrooms is much more human than it is technological. What's more, it is not fundamentally about helping people to operate machines. Rather, it is about helping people, primarily teachers, integrate these technologies into their teaching as tools of a profession that is being redefined through the incorporation process (p. 1).

Media literacy also plays a part in the use of technology for learning and teaching. To date media literacy skills are seldom taught to teachers or to students. Four principles have been identified by groups working for media literacy (Thoman, 1993)

Media Construct Reality. Media are constructions made through editing in writing or production edits. What is created becomes a version of reality. Understanding the construction process and how the media shape what we know and understand about the world we live in is an important way of helping them navigate their lives in a "global and technological society."

Media Use Identifiable Techniques. Camera angles, music, special effects, layouts and lighting heighten responses to media and vie for attention. Each medium has production codes that are used to construct media - and can be used to de-construct media so that people are less susceptible to manipulative uses.

Media are Businesses with Commercial Interests. Corporations spent $130 billion in advertising in 1991 - the equivalent of $6 per week for every man, woman, and child in the U.S. Young people are susceptible to advertisers; media literacy provides a grounding to help students gain perspective on what's really important and how to make decisions about commercial messages and the program content that is designed to make sure the right audience is watching when the commercials appear.

Media Contain Ideologies/Value Messages. All media--TV, movies, news, sports, game shows, video games, even supposedly objective newspapers--contain points of view. Media literacy aids in recognizing the point of view and the entertainment. The job for educators is to teach critical thinking and critical reading of all media so that people, young and old, can recognize what values are embedded--and accept or reject them.

Interactive instruction systems, especially those combining video disc and computer technologies, are gaining widespread acceptance within educational and training communities according to Rockley L. Miller (date unknown). These systems have been available for over ten years, with hundreds of off-the-shelf programs and custom applications produced to date.

Johnstone (1991) reported that one of the assumptions "inherent in the design of most contemporary distance learning systems is the need for interaction between students and their teachers. Do teachers need to see one another for effective learning and interaction to take place? Is real-time student-teacher or student-student interaction really the best or only model?" Johnstone reports two instances where teachers said that instructors for computer mediated classes reported higher levels of critical thinking than do traditional class discussions and papers.

Harasim (1989) and Quinn, Mehan, Levin, and Black (1983) found that most of the verbal exchanges in face-to-face classrooms come from the instructor, while the reverse is true on-line. Harasims' research indicated that in an active on-line learner-to-learner exchange, between 60 - 80 percent of the verbal exchange in an on-line class comes from the students which indicates a high level of interaction and collaboration. Harasim found that communication in an interactive on-line class is more equitably distributed among class members, whereas a conventional classroom frequently has one or two students dominating the discussion while the majority remain silent.

Quinn, et al (1983) noted that students in their electronic classroom system produced longer and more complex responses than in the classroom groups they compared. The researchers observed that the time-delay in asynchronous communication contributes to the quality and quantity of student interaction. They report that the delay between receiving a message and sending a response allows reflection and the time to compose a substantive answer.

Students using audio conferencing for interaction in conjunction with video programs delivered by satellite, produced longer and more in-depth interaction with a facilitator. Smaller groups produced longer and more in-depth responses than did larger groups (Lane, 1990).

A survey of studies on the effectiveness of technology in schools concluded that "courses for which computer-based networks were used increased student-student and student-teacher interaction, increased student-teacher interaction with lower-performing students, and did not decrease the traditional forms of communications used" (Interactive Educational Systems Design, 1993)

Miller reports that corporate, institutional, and governmental users state the following benefits for educational technologies.

- **Reduced learning time.** Well over thirty studies compiled have found that interactive technologies reduce learning time requirements by an average of fifty percent. This time reduction is attributed to a variety of factors: (a) self-paced instruction encourages students to take the most efficient path to content mastery--skipping areas of existing strength while investing more time in areas of weakness; (b) the combination of visual presentation with audio explanation delivers information in an easily understood format; (c) immediate interaction and feedback provides constant, highly-effective reinforcement of concepts and content; and (d) personalized instruction accommodates different learning styles to maximize student learning efficiency. The IBM Principles of the Alphabet Literacy System, an interactive video-based course, is achieving increases of over two years in reading and writing skills, with only 100 hours of instruction.
- **Reduced cost.** The primary costs of interactive instruction lie in design and in production, not replication, distribution, and delivery. Thus, the cost per student is reduced as more students use the same program. [With traditional instructional methods, the costs of instruction lie primarily in the delivery (i.e. teacher salaries, overhead) and remain constant or even increase as more students place demands on fixed resources. A typical, cost-per-student break-even point for interactive instruction

might occur when from 100 to 200 students are using a program. Beyond that number, savings build dramatically. Federal Express projecting saving over $100 million by using interactive systems for employee training.

- **Instructional consistency.** Technology-based instructional systems do not have bad days or tire at the end of a long day. Instruction is delivered in a consistently reliable fashion that does not vary from class to class or school to school.
- **Privacy.** With one-on-one systems, students are free to ask questions and explore areas that might cause embarrassment in group situations. Because instructional systems never lose patience, they encourage learners to persist in asking questions and reviewing materials until real mastery is achieved or natural curiosity is appeased. In one example, an interactive program called "TeenScope" allows teenagers to prepare for the transition to living on their own. Covered topics such as finding a job, pregnancy and parenting, sexuality, building self-esteem, what to do with a paycheck, and feelings about families are difficult to openly explore in group situations.
- **Mastery learning.** Unlike a normal classroom situation, the interactive system will not move on to new material until current material is mastered. This ensures that students have strong foundations for continued learning. In one example, at-risk students in Everett, WA, achieved a 53-point gain, from 38 percent pre-test scores to 91 percent post-test scores; using interactive mathematics instruction from Systems Impact. Similarly, remedial and Chapter I students in Bethel Park, PA, achieved 300 percent improvement, jumping from 21 percent pre-test scores to 88 percent post-test scores using the same program.
- **Increased retention.** The process of interaction with material being studied provides a strong learning reinforcement that significantly increases content retention over time. Spectrum Interactive (a division of National Education Corporation) reports over 25 percent improvement in retention with interactive video courses.
- **Increased safety.** With interactive systems students can explore potentially dangerous subjects without risk. These dangers might be in academic areas (chemistry explosions, burns) or social areas (drugs, sexually transmitted diseases, pregnancy). In one example, the TARGET system allows students to learn about drugs and alcohol and consequences of substance abuse without the dangers of experimentation. In another example, a course on basic electronics and maintenance allows the student to accidentally touch the wrong parts without risking electrocution.
- **Reduced behavior problems.** Interactive systems focus attention and increase individual involvement, thereby reducing the potential for misbehavior.
- **Increased motivation.** Interactive systems provide a level of responsive feedback and individual involvement that has proven to be highly motivating in both individual and classroom learning environments.
- **Increased access.** Interactive systems can provide greater and more equal access to quality instruction. Systems can deliver peripheral subjects in schools where student populations are insufficient to support full time teachers for such subjects or where qualified teachers are otherwise unavailable. Further, interactive systems can be used to simulate laboratory equipment that would be too expensive to actually acquire.

The Institute for Defense Analyses conducted a quantitative analytical review (meta analysis) in defense training and in the related settings of industrial training and higher education (Fletcher, 1994) in which by comparison with over all instructional settings and applications, interactive video disc instruction was found to improve achievement by about 0.50 standard deviations over less interactive, more conventional approaches to instruction. This improvement is roughly equivalent to increasing the achievement of students at the fiftieth percentile to that of students currently at the 69th percentile. An improvement of 0.38 standard deviations was observed across 24 studies in military training (roughly an increase from fiftieth to 65th percentile achievement). An improvement of 0.69 was observed across 24 studies in higher education

(roughly an increase from fiftieth to 75th percentile achievement). Interactive video disc instruction was more effective the more the interactive features of the medium were used. It was equally effective for knowledge and performance outcomes. It was less costly than more conventional instruction. Overall, interactive video disc instruction demonstrated sufficient utility in terms of effectiveness, cost, and acceptance to recommend that it now be routinely considered and used in Defense training and education.

A review of computer-based instruction used in military training found that students reach similar levels of achievement in 30 percent less time than they need using more standard approaches to training (Orlansky and String, 1979).

Hawkins (1991) describes five issues that have evolved in the development of distance learning projects that have spanned the available mediating technologies. The five overall categories have emerged from a synthesis of research. They include the practical issues of technology functioning, issues of community creation and definition, quality of discourse, activity definition for the distance learning work, and quality control. While most of these are obvious topics of research, the issues of community creation have grown out of "a real reason to collaborate or communicate with others across distances," according to Hawkins.

Activities that structure the communicative exchange or information retrieval around carefully designed problems, activities that support collaborative work through the customized design of the software and/or the materials that coordinate the work, and a coordinator responsible for assuring the smooth flow of information throughout the community and who helps with problems helps to build the sense of community according to Hawkins (1991). "Expectations for what it means to participate in the community, and coordinating meaningful collective work or exchange are part of the ongoing definition of a social fabric for these media in education. It is a social world that is emergent, whose norms for interaction and purpose for communications becomes defined in practice," says Hawkins. She contends that as we move into the second phase of research in distance learning, the goal is to understand what designs for distance learning are effective for cognitive and social development.

At the New Jersey Institute of Technology, Hsu (1990) compared the achievement of students in an on-line class and face- to-face class by evaluating their success in learning to make business decisions. When both groups were given a business simulation project to complete, the on-line group fared better by 50 percent. Hsu noted that the most significant difference between the two groups was in their cohesion. The on-line students were better coordinated and more collaborative when working on the project.

University of Phoenix (1992) faculty who taught courses in both traditional classroom and on-line programs compared a number of factors of both programs. The results indicated that faculty were very satisfied with the overall educational environment. They were especially satisfied with on-line students' academic and professional preparation. Compared to the classroom environment, faculty were somewhat more satisfied with the students' mastery of the course content in the electronic environment. Faculty also rated the written communications skills of on-line students higher than the classroom students they teach.

Research on the costs of instruction delivered via distance learning, videotape, teleconferencing, and computer software indicates that savings are often achieved with no loss of effectiveness. Distance learning vastly broadens the learning environment, often providing teaching resources simply not available heretofore. Technology-based methods have a positive impact on learner motivation and frequently save instructional time. Savings in training time produce benefits both by reducing training costs and by shortening the time required to become and remain productive in the workplace.

A Congressionally mandated review covering 47 comparisons of multimedia instruction with more conventional approaches to instruction found time savings of 30 percent, improved achievement, cost savings of 30-40 percent, and a direct, positive link between amount of interactivity provided and instructional effectiveness (Fletcher, 1991).

A comparison of peer tutoring, adult tutoring, reducing class size, increasing the length of the school day, and computer-based instruction found computer-based instruction to be the least expensive instructional approach for raising mathematics scores by a given amount (Fletcher, Hawley and Piele, 1990).

A landmark study of the use of technology for persons with disabilities found that "almost three-quarters of school-age children were able to remain in a classroom, and 45 percent were able to reduce school-related services" (National Council on Disability, 1993).

Most computer mediated on-line education programs are based upon asynchronous (not real time) communication. Computer conferencing messages are text files that are stored in the central computer database awaiting access by the students and instructor. Students participate at a time and a pace convenient to them. This attribute impacts upon the group dynamics and the learning process. Hegegaard (1994) assessed the similarities or differences that might exist in the affective domain, due to the educational delivery system selected by the student. The 15 affective constructs are as follows:

- Self-efficacy - Professional self-confidence and esteem
- Teamwork - Value toward working together to accomplish common organizational objectives
- Strategic Thinking - Value toward systematic, long-range planning
- Education - importance placed on life-long learning
- Developmental Path - Belief in current career path as a means to professional progress
- Risk-Taking - Value assigned to taking risks in order to achieve goals
- Applied Orientation - Value of action/experience in the learning process
- Communication - Importance of communication skills in contributing to professional success
- Anti-Education - Negative value assigned to formal education as a meaningless barrier to progress.
- Proactive Education - Value assigned to long-term appreciation and benefits of higher education for working adults
- Practical Education - Importance assigned to short-term, immediate value and benefits of education for working adults
- Ethics - Importance of having standards of fairness in dealing with employees and customers
- Civic Action - Importance in being an active and responsible member of the community
- Long-term Orientation - Value toward focusing on innovation and efficiency in the long versus the short-term
- Cooperation - Importance of establishing and rewarding cooperative relations in organizations

The results indicated that of the 15 affective constructs, six were significant as a result of time (from beginning to end of program): teamwork, strategic thinking, developmental path, proactive education, applied orientation, and practical education. Nine affective constructs were shown to be significant as a result of the delivery system (classroom or on-line): self-efficacy, risk-taking, applied orientation, communication, practical education, ethics, civic action, long-term education, and cooperation.

Both groups placed their highest values on ethics, civic action, teamwork, long-term orientation and cooperation, on their pre and post assessments (Hedegaard, 1994).

Table 2 shows the factors in which each group experienced significant change from the time they started a program to the time they graduated. While both the on-line and campus students experienced some changes in values over time, only one of the areas of change is common to both groups: teamwork. This indicates that the method of delivery may play a role in fostering certain values over others, but that both delivery methods are equal in their reinforcement of teamwork (Hedegaard, 1994).

Table 2

Significant Change Over Time for UOP Students

Computer-Mediated	**Campus**
Teamwork	Teamwork
Strategic Thinking	Applied Orientation
Developmental Path	Practical Education
Pro-active education	

The on-line group rated the following factors higher than the campus group: Self-efficacy, Education, Risk-taking, Communication, Ethics, Civic Action, and Cooperation. They manifested higher self-concept and esteem, placed a greater value on education to enhance their professional life, and also had a greater propensity toward risk- taking. They rated the importance of communication to their professional development higher than the campus group did. Civic Action was a value which the on-line group not only valued higher than the campus group, but their ratings on this value increased over the program, while the campus group's value toward Civic action declined. The value assigned to having standards of fairness in dealing with employees or customers (Ethics construct) was significantly higher for the online group, over the campus group on both pre- and post-tests (Hedegaard, 1994).

The on-line program doesn't have face-to-face interaction or instantaneous feedback. It relies on processing ideas through the written word, and lends itself to strategic-thinking approaches. As noted by both Harasim (1989) and Quinn, et al. (1983), the on-line program also reinforces a greater quantity and quality of peer interaction. Every member must participate in the discussion and all ideas are first thought through, then put into written form. Finally, they are reviewed and available for comment and archiving by all members of the group. The very mechanics of learning on-line requires a systematic orientation, the benefits of which may not be felt except over time, and this may be why the computer-mediated group experienced the most change in these three areas, as compared to the campus group (Hedegaard, 1994).

Cooperation was valued higher by the on-line group. While it may be characterized as a physically isolated learning experience, it still contains all of the qualities of a cooperative learning environment; one where ideas are shared, scholarly collaboration takes place, and group support is strongly evident. Mason (1989) asserted that collaboration leads to higher-order learning through the process of cognitive restructuring and conflict resolution. Through these collaborative activities, new ways of understanding the material emerge because of contact with new or different perspectives (Hedegaard, 1994).

Development and monitoring of evaluation and assessment standards will influence the effectiveness of on-line delivery. This may involve a restructuring of the traditional university as it is presently perceived. "Virtual classrooms" might give way to the proliferation of "virtual universities" in the future. Universities are strongly traditional, but reflective of the history and

culture they serve. Many are slow to change, and may be reluctant to do so even when provided with empirical evidence that new teaching-learning models and new technologies can be as effective as old methods (Hedegaard, 1994).

Honey and Henriquez study (1993) showed that penpal exchanges, scientific data collection, and social awareness and opinion exchanges represent the telecommunications activities most frequently done as classroom exchange projects. When students conduct research projects, encyclopedias, news retrieval services, weather information, and educational databases are the resources they use most frequently. Penpal exchanges were not rated as highly effective learning tools. They prefer science and social awareness projects. The most useful information resources to use with students werenews retrieval services, scientific databases, encyclopedias, ERIC, and social studies databases. In contrast to the frequency with which telecommunications is used as a professional resource, student learning activities happen with much less regularity. Much of the activity done with students takes place in the classroom, but teachers also telecommunicate from computer labs, library media centers, and their own homes.

The benefits to using telecommunications technology with students include expanding students' awareness about the world in general, accessing information that would be difficult to get otherwise, enabling students to gain familiarity with basic computer applications, helping students to feel successful, and allowing students to undertake more collaborative group-based activities. One of the most important benefits is its impact on their students' higher order thinking skills, suggesting that inquiry-based analytical skills-like critical thinking, data analysis, problem solving, and independent thinking-develop when students use a technology that supports research, communication, and analysis. In contrast, these educators report that develop when students use a technology that supports research, communication, and analysis. In contrast, these educators report that students' involvement with telecommunications does not directly help to improve their performances on state- or city-mandated tests. This finding suggests that there is a gap between what teachers know the creative use of telecommunications can do for their students, and what traditional measures of assessment actually account for (Honey and Henriquez,1993).

There are a number of factors that these educators believe influence the success of student-based telecommunications activities. When teachers are using networks to carry out classroom exchange projects, advanced planning and full cooperation of all participating teachers is viewed as important to the project's success. The scope and content of the activity also need to be well that is designed to support and enhance the curriculum, the relevance of the telecommunications activity to the teacher's ongoing curriculum is important. In addition, timelines that specify when data will be collected and transmitted or when stories will be written and exchanged are viewed by these educators as critical to the success of classroom exchange projects, as is ongoing technical support to ensure that the project runs smoothly.

While important, preparing participating students in the use of telecommunications skills and having students perform the mechanics of telecommunications by logging-on, uploading, and downloading information are factors that received a lower rating of importance than those mentioned above. These findings suggest that central factors that influence the success of any shared learning activity are important to the success of a telecommunications project: planning, cooperation, and well-defined and relevant project goals (Honey and Henriquez,1993)

The research continues to validate that the use of technology and distance learning is a viable means of delivering education and training.

Technology as a Force for Systemic Reform

Many critics of American schools see technology as an important tool in bringing about the kind of revolutionary changes called for in these new reform efforts (Means, et al, 1993). "Having seen the ways in which technology has transformed the workplace, and indeed, most of our communications and commercial activities, the business community and the public in general are exerting pressure for comparable changes within schools."

David and Shields (1991) state that today's reform efforts "strive to change the education system by fostering a different style of learning." The efforts seek to move classrooms away from conventional didactic instructional approaches where teachers lecture and students listen and complete exercises on well-defined, subject-area-specific material (Means and Olson, 1994). Instead, students are challenged with complex, authentic tasks and reformers are pushing for lengthy multidisciplinary projects, cooperative learning groups, flexible scheduling and authentic assessments. "In such a setting, technology is a valuable tool," say Means and Olson (1994). "It has the power to support students and teachers in obtaining, organizing, manipulating and displaying information. These uses of technology will, we believe, become an integral feature of schooling."

"When technology is used as a tool for accomplishing complex tasks, the issue of mismatch between technology content and curriculum disappears altogether. Technological tools can be used to organize and present any kind of information. Moreover, it is not necessary for the teacher to know everything about the tools that students use; students and teachers can acquire whatever technology skills they need for specific projects. In fact, one of the best things that teachers can do with respect to technology is to model what to do when one doesn't know what to do" (Means and Olson, 1994).

"The primary motivation for using technologies in education is the belief that they will support superior forms of learning. Advances in cognitive psychology have sharpened our understanding of the nature of skilled intellectual performance and provide a basis for designing environments conducive to learning. There is now a widespread agreement among educators and psychologists (Collins, Brown and Newman, 1989; Resnick, 1987) that advanced skills of comprehension, reasoning, composition and experimentation are acquired not through the transmission of facts but through the learner's interaction with content. This constructivist view of learning, with its emphasis for teaching basic skills within authentic contexts (hence more complex problems), calls for modeling expert thought processes, and for providing for collaboration and external supports to permit students to achieve intellectual accomplishment they could not do on their own. It also provides the wellspring of ideas for many of this decade's curriculum and instruction reform efforts" (Means, et al, 1993). Sterns (et al, 1991) notes that from the successful uses of technology "we have learned that technology often produces unexpected benefits for students and teachers. From the failures we have learned that implementation without thoughtful planning or sustained support is nearly always futile."

"Thus, support for the use of technology to promote fundamental school reform appears to be reaching a new high. At the same time, we have the opportunity to profit from the experiences of those educational institutions that already have implemented various technological innovations within the context of serious reform efforts. In these cases, technology is viewed as a means of supporting goals related to increased student involvement with complex, authentic tasks and new organizational structures within classrooms and schools (Sheingold, 1990).

David (1991) makes a case for technology and restructuring efforts as partners in educational change. She says: "The concepts behind restructuring the education system and the technology that can contribute to that effort are both part of the Information Age. Together they reinforce a

new viewpoint that magnifies their potential to change education. To the extent that restructuring and technology are twisted to fit the Industrial Age of the past, they will not affect educational practice. To the extent that restructuring and technology are driven by challenging goals for students and supported by long-term commitments to change and investment in human resources, they will increase the productivity of our schools and ultimately of our society.

"Dede (1991) observes that technology is not a silver bullet to resolve the schools' crises, but "advanced information technology is a crucial component in implementing a more effective paradigm for education." He contends that individualized learning and decentralized institutional structures require "complex organizational practices that necessitate sophisticated computational and communications capabilities.

"Farrell and Gring (1993) state that a planning foundation for technology could be based on the concepts that technology is not a panacea for the current problems facing education or a substitute for the basic tenets of a good learning environment; it serves as a tool for the learning and teaching processes. They state that there is no single best use of technology and the potential power of technology is in 'how it meets the needs of the learner."

Educators "have not seen that the information technologies are as central to the operations of education as they are to business, research and the arts," according to White (1990). She contends that without this understanding, "there can be no conceptual framework for the role of technologies in education. Without the conceptual framework, there has been no commitment to invest in the technologies as a rational educational investment.

"Stepping into a classroom," says Dede, "should be like entering a time machine hurtling forward; today's educational system should foreshadow the intelligent tools and interactive media that will pervade future workplaces and communities." Dede projects that a critical mass for large-scale school restructuring can be built through an "iterated process" of the following:

- define basic assumptions about learning, instructional technology and organizational development;
- imagine ideal teaching/learning environments based on design principles stemming from the basic assumptions;
- delineate action in the present to initiate an evolutionary process to shape the desired future; and
- assess the strengths and weakness of the emerging paradigm to minimize unwanted side-effects from technology.

Conley (1993) presents a view for a need for second order change because the worlds in which schools exist are changing rapidly, and in many ways. He says "Social, political and economic systems are evolving (and in some cases imploding) at an ever-increasing rate. Old institutions, beliefs, assumptions and behaviors no longer seem adequate to explain and cope with the problems and issues that present themselves to citizens in complex societies." Conley makes the point that educators may find themselves in a time of sudden, unpredictable jolts changes in the environment for which incremental change could be disastrous. One of these forces, technological advances "create an ever-changing environment in which human behavior and relationships are altered, and new skills are needed to prosper and survive."

The Potential of Technology as a Partner of and a Tool for Systemic Reform

"Reform can only succeed if it is broad and comprehensive, attacking many problems simultaneously," according to the National Education Commission on Time and Learning (1994). The Commission offers eight recommendations:

- Reinvent schools around learning, not time.
- Fix the design flaw; use time in new and better ways.
- Establish an academic day.
- Keep schools open longer to meet the needs of children and communities.
- Give teachers the time they need.
- Invest in technology.
- Develop local action plans to transform schools.
- Share the responsibility: Finger pointing and evasion must end.

"Technology is a great unrealized hope in education reform. It can transform learning by improving both the effectiveness of existing time and making more time available though self-guided instruction, both in school and out," states the National Education Commission on Time and Learning (1994). But the true promise of technology lies in the classroom. Technology makes it possible for today's schools to escape the assembly-line mentality of the "factory model" school. With emerging hardware and software, educators can personalize learning. Instead of the lock-step of lecture and laboratory, computers and other new telecommunications technologies make it possible for students to move at their own pace. Effective learning technologies have already demonstrated their ability to pique student interests and increase motivation, encouraging students not only to spend more of their own time in learning but also to be more deeply involved in what they are doing.

The Commission also notes that the NII can "reshape education." The revolution of schools "depends both on a concerted investment strategy to help educators obtain these technologies and on educators confronting their reluctance to supplement the techniques of the 19th century (textbooks, chalk and blackboards) with the technologies of the 21st (CD-ROMs, modems and fiber optics). They must do so.

"David (1991) say that there are essential conditions for making systemic reform: an invitation to change, authority and flexibility, access to knowledge and time. "Technology alone cannot provide any of these conditions, but it can contribute in a variety of ways to each one of them. Following are potential contributions of technology.

Technology invites change and can act as a catalyst for change in several ways. Technology can "provide an occasion for change a necessary step in restructuring. The presence of technology not only provides an opportunity for change; it also symbolizes that change" (David, 1991). Using technologies, teachers practice learning how to learn technologies change so rapidly they realize there is no right answer, but that learning is a process. Teachers act as colleagues and decision makers as technology foster interactions among teachers. Technology provides problem solving opportunities. And, new relationships in the classroom result from the presence of technology, as collaboration among students and between students and teachers occurs" (David, 1991).

The potential for technology to reallocate and extend existing resources is only beginning to be tapped. Technology can also bring into the classroom resources that facilitate active, problem-based learning and can access information otherwise unavailable or prohibitively expensive. Teachers and administrators, as well as parents and students, can avail themselves of a variety of workshops and courses by means of telecommunications. Teachers no longer need to rely

exclusively on what is available in their districts. Through networks, teachers and students can exchange ideas and expertise with their peers around the world (David, 1991).

Conley (1993) sees technology bringing "a broad array of new techniques for organizing, communicating and disseminating information." David (1991) does not believe that the use of technology will simplify teaching. In fact, introducing technology into schools as currently organized "vastly increases the complexity of teachers' jobs because it makes possible more complex though more effective approaches to teaching." She notes that under the best of current circumstances where teachers have access to the latest technology and sufficient training and support, "the presence of technology complicates teachers' jobs enormously. They are learning not only how to use the technology but also how to teach differently, how to relate in new ways to their students, and how to assume new role as learners, researchers and equipment technicians. Technology offers the potential to undertake more complex tasks in the classroom. Ultimately, when organizational changes team teaching, flexible grouping and scheduling, time for learning and the larger culture of the school and district support restructuring, the potential of technology to simultaneously increase and manage complexity will be exploited."

Bugliarello (1990) and Sheingold (1991a) say that because knowledge is becoming more accessible to more of the population, the teacher's role as gatekeeper must change. Information need no longer be stored in memory for it to be useful; the ability to access information will be as or more important than the ability to store information in one's memory.

Thornburg (Betts, 1994) says that the Information Age is now over. He says we're entering a new Communication Age. "Of course, a lot of schools still have not taken advantage of the tools of the Information Age" and others are barely entering the Information Age. As an example of this, he cited schools which use word processors as glorified typewriters. He says the challenge "is not to use them to do the old job better but to do something new." Does it matter what we call the age in which we live? Probably not, but Thornburg's observation signifies another paradigm shift another way of thinking about our lives and purpose, before we had become accustomed to the last one. The Information Age is generally accepted to have begun in 1985. In less than nine years, another age has begun.

"Now we're seeing tools of the Communication Age starting to change the face of the Information Age," says Thornburg (Betts, 1994). "Students will integrate technologies to create their own multimedia projects. At this point, schools will shift from focusing on Information processing to an emphasis on communication. When we take a look at all the research on learning styles Gardner's Theory of Multiple Intelligence (1985), McCarthy's 4-MAT process (1981), for example we find that students learn best when they learn in the way best suited to them." He feels that by acknowledging that each of us has components of at least seven different intelligences different pathways to learning we can activate more of those pathways each day. The more we do, the more effective the learning environment will be, he says. "If you create rich learning environments where multiple intelligences are addressed simultaneously, kids really thrive. Just by mixing things up and making the classroom a more multisensory environment, you take advantage of these multiple pathways to learning and benefit all of the students. And multimedia is a great tool because it combines images, text, animation all sorts of sensory experiences.

"Information Age technology can empower learners in different ways. Kids will acquire information themselves in ways that are congruent with their natural styles of learning and that's exciting." In the Information Age, "we had our computers bolted to the desk and chained to the wall by two cords, one for power, and the other, when we had it, for telecommunications. Now we're moving toward transportable equipment and wireless communication. That means that the informational tools and communications tools merge into one and become transportable; you

can carry them and use them wherever you are." Thornburg observes that information technology has become personalized" so that "students will be taking more control over their learning, taking control away from the educator. The whole role of the educator has changed." New social factors will drive curriculum changes. Technology is one way we respond to changes in our environment," say Thornburg (Betts, 1994). The idea that learning can occur only within four walls when twenty-five young people interact with one certified teacher is rapidly being replaced with models in which varying combinations of adults and children interact both inside and outside of school (Ratzki and Fisher 1989/1990). The world around the school is becoming a source for curriculum according to Beane (1991). Local issues, problems and resources are being integrated. Information from around the world, available to teachers and students via technology, serves as the framework within which local issues can be understood and examined, creating curriculum that allows students to understand global events in relation to the world in which they live.

Technology is almost an icon in some school restructuring plans says Collins (1991). In other settings, he continues, technology is emerging as an extension of the interaction between teacher and student. In almost all visions for restructured schools, it holds an important, if still indeterminate, place. Conley believes that In the new vision of education, technology is an integral component (1992). Technology is used to provide basic skills support, interface with information sources outside of the school, support individual student creativity, manage information about student performance and achievement, assist teachers in their dual roles as instructors and clerks, and provide students with greater control over their own learning (Conley, 1992).

Technology now makes it possible to "replicate critical elements of the teaching-learning process in live time or asynchronously," according to James Hall, president of Empire State College and SUNY's vice-chancellor for educational technology (Jacobson, 1994b). That "was not able to be done easily by distance learning in the past," which means that "the quality of the campus experience is approached in distance learning, and that's new." He believes that the latest technology can be used to raise the quality of education even as it increases the number of students served.

Dede (1991) observes that the two most common errors in impact assessment are to overestimate how soon a new technology will change society and to underestimate the magnitude of its eventual effects. Typically, he says, communications devices have their impact on institutions in four sequential stages:

Stage 1: The new technology is adopted by an institution to carry out existing functions more effectively;

Stage 2: The institution changes internally work roles, organizational structure to take better advantage of these new efficiencies;

Stage 3: Institutions develop new functions and activities enabled by additional capabilities of the technology; as the roles of different types of institutions expand, new competitive relationships emerge; and,

Stage 4: The original form of the institution may become obsolete, be displaced or be radically transformed as new goals dominate the institution's activities (Coates, 1977).

According to Naisbitt (1982), new technologies pass through three stages. In the first stage, the new technology follows the least resistance into a ready market. In the second stage, users improve or replace previous technologies with the new technology. In the third stage, users discover new functions for the technology and, based on its attributes ask, "What can we do

now that was not possible before?" This is the stage that many educational technology users are in now, but there are others in the earlier stages. For example, educators using computers to create puzzles, or assess student progress are in a stage two usage pattern. "In contrast, educators who have moved to stage three are asking, 'How can these new tools contribute to a more powerful educational experience?' These educators are searching for a paradigm shift, not just a way to squeeze technological tools between the existing bricks of yesterday's educational practices" (Peck and Dorricott, 1994).

Academic leaders should begin planning now for the time, perhaps as little as five years away, when distance learning will give most students virtually unlimited course options from institutions all over the world, regardless of where they may formally enroll, according to Rich Gross, dean of telecommunications at Kirkwood Community College, Iowa (Jacobson, 1994). Gross suggests that by then many colleges will need to become local "gate keepers," helping students choose courses from different networks, showing them how to obtain instructional materials and providing counseling and other traditional student services. Gross projects an increasingly competitive market in distance learning and thinks colleges may need to follow a model in which they strive to be "net exporters" of education no matter what their students may be using from other places.

For those who use technology as an integral component of learning, Peck and Dorricott (1994) developed a "top ten list" of reasons to use technology:

- Students learn and develop at different rates. Technology can individualize instruction with integrated learning systems which offer thousands of lessons covering the same basic skills now taught in a lock-step way through textbooks to groups of students with different backgrounds, interests and motivation. Students can move at an appropriate pace in a nonthreatening environment, developing a solid foundation of basic skills rather than the shaky foundation a calendar-based progression often creates.
- Graduates must be proficient at accessing, evaluating and communicating information. Educational technologies can, by design, provoke students to raise searching questions, enter debates, formulate opinions, engage in problem solving and critical thinking and test their views of reality. On-line tools and resources allow students to efficiently gather and evaluate information, then communicate their thoughts and findings. This communication may require reading, thinking, creating charts, graphs and other images; or the organization and production of information using spreadsheets and databases.
- Technology can foster an increase in the quantity and quality of students' thinking and writing. Perhaps one of the best documented successes with computers in education is in developing students' writing. Word processors reduce writing phobia and the temporary positive feeling makes it easier to take creative risks. Difficulty with handwriting usually does not transfer to the keyboard, so frustration is reduced. Editing and revising are quick, spelling and grammar check programs teach to weaknesses; printed papers generate a sense of accomplishment.
- Graduates must solve complex problems. Higher-level process skills cannot be "taught" in the traditional sense, or transferred directly from the teacher to the learner. They need to struggle with questions they have posed and search out their own answers. Computer productivity tools could revolutionize the way students work and think. Databases, spreadsheets, computer assisted design, graphics programs and multimedia authoring programs allow students to independently organize, analyze, interpret, develop and evaluate their own work. These tools engage students in focused problem solving, allowing them to think through what they want to accomplish, quickly test and retest solution strategies and immediately display the results.
- Technology can nurture artistic expression. Modern technology-based art forms (video production, digital photography, computer based animation) have great appeal,

encourage artistic expression among a diverse student population. These tools provide forms of artistic communication for those students who have been constrained by the traditional options of verbal and written communication, and they increase motivation and foster creative problem-solving skills as students evaluate the many possible ways to communicate ideas.

- Graduates must be globally aware and able to use resources that exist outside the school. Children's domains of discovery at school are limited to the classroom and the school. Technological tools allow students to inexpensively and instantly reach around the world, learning firsthand about other cultures. Various technologies can provide up-to-date maps and demographic data, and computer-based wire services can bring a newsroom quality stream of current events into the school.
- Technology creates opportunities for students to do meaningful work. Students need to produce products that have value outside school, receive feedback on their work, and experience the rewards of publication or exhibition. Technology can provide a widespread audience for students' work. Computers link students to the world, provide new reasons to write and offer new sources of feedback. Students' video products shown on local cable can produce high levels of motivation and accomplishment.
- All students need access to high level and high-interest courses. Electronic media can bring experiences and information previously unimagined by students into the classroom. Through instructional television, students can view and discuss events they otherwise could not experience. Laser discs and CD-ROMs put thousands of images and topics at students' fingertips. Distance education technologies can bring important learning experiences to students, even in districts where small student populations have made some courses impossible to offer.
- Students must feel comfortable with the tools of the Information Age. Computers and other technologies are an increasingly important part of the world in which students live. Many of today's information producers are converting their knowledge bases to digital format and are constructing new technologies to increase speed, capacity and reliability of dissemination. As telephone, computer, television and other media merge, incredible resources will become available. An "I tell you, you tell me, and I'll grade you" model of education will not prepare students to take advantage of these resources.
- Schools must increase their productivity and efficiency. Technology can re-place (not replace) the teacher. When stage three educators determine what students should do and how teachers and technologies can support students, many of the routine tasks done by teachers can be reassigned to technology, elevating the role of teacher. Some things only teachers can do. Teachers can build strong, productive relationships with students. Technologies can't. Teachers can motivate students to love learning. Technologies can't. Teachers can identify and meet students' emotional needs. Technologies can't. Technology-based solutions in education can, and must free the teacher to do the important work that requires human interaction, continuous evaluations and improvement of the learning environment (Peck and Dorricott, 1994).

Hancock and Betts (1994) observe that identifying "promising advanced technologies and planning how to integrate them into instruction are two very different issues. To rise to the latter challenge, planners need to know what to expect when technology is used intensively and effectively.

- **Learning experiences proliferate.** Teachers expect more of their students and present more complex material. The range of learning experiences extends far beyond those offered in traditional classrooms.
- **More individual attention is possible.** Time-consuming paperwork for teachers is reduced, permitting them to focus their attention elsewhere. Teachers can better meet

the demands of individual students, give them more attention, allow more independent work, and accommodate different learning styles.

- **Roles shift.** Teacher-centered classrooms tend to evolve into student-centered ones. The teacher acts more as a coach than an information dispenser. More collaboration and small-group work occurs. To realize any vision of smarter schooling by using technology, school districts and colleges of education must prepare teachers to use the technology. Apart from funding considerations, adequate teacher preparation is probably the most important determinant of success.

Another essential according to Hancock and Betts (1994) is to put technology into teachers' hands. Ways to do so include rent-to-own agreements in cooperation with local businesses; professional contract revisions to recognize that the ability to do productive work is not restricted by time or place; teachers-only electronic tools provided in classrooms, teachers lounges or library/media centers; technology loan programs for teachers' home use; technological competency requirements in all teacher education programs; state-of-the-art electronic tools for professors of education; and a telephone line in every classroom.

Research by Sheingold and Hadley (1990) suggests that seven years of administrative support, staff development and planning time are required before teachers fully integrate technologies into their repertoires. To move this process along, teachers must have timely opportunities to use technology for classroom and personal productivity. Hancock and Betts (1994) suggest that putting a laptop and telephone into teachers hands will provide the proper impetus. Distance learning and other applications of technology hold great promise for contributing to educational reform efforts. Exploiting that promise, however, requires that activities such as those sponsored by Star Schools be more closely tied to other reform efforts than currently is the case. "Over the long term, both distance learning and educational reform will benefit from a close relationship" (Tushnet, et al, 1993). To facilitate the integration of distance learning technology into educational reform, the U.S. Department of Education could provide grants to projects which effectively show the contribution to systemic reform that distance learning and educational technologies make.

Equitable Access Through Technology

Educational technologies can enable change. Milken (1994) writes that, "In approaching the millennium, Americans may justifiably argue that millennial ideas are in short supply. Faced with a multitude of challenges from within, our society is seeking the visionary concepts from worlds as diverse as economics, multiculturalism and even particle physics that will lead us into the 21st Century. However, such direction will not be found in financial innovation, social service or scientific discovery. Rather, it will come from the frontiers of education."

Milken values the people as a society's most valued resource, rather than the factories, building or natural resources. Comparatively, our natural resources are the same as our competitors in a global economy. The only significantly different resource that we have is people. If education does not improve the resource, we run the very real risk of creating another third world country in the United States. Certainly, the gap is widening between the technological haves and have-nots.

Equity is a second major concern according to the NEA (Malley, 1994). "Rural areas face special challenges in modernizing their infrastructure to support advanced technologies. Similar challenges are found in many of our most urban districts, where critics have charged that telecommunications providers are 'redlining' certain communities out of their modernization plans." Malley asserts that "without addressing this issue head-on, we will assure a divided country unprepared to face the challenges of the information age. We will condemn whole segments of the population to dead-end jobs and menial existence. We cannot have any particular segment of our student population falling behind, because their community has not been connected to the Infrastructure or because advanced services are not being offered there. Our whole social fabric relies increasingly on education to offset the social and economic disparities that exist in our society. Schools, then, need to be one place where any student, anywhere, can have access to the best learning tools available. Deficits in education lead fairly directly to difficulties in the job market and to other social problems."

U.S. Department of Education Deputy Secretary Madeleine Kunin asks "will technology narrow the gap between the haves and have-nots or if we don't do the right thing, does it have the potential to widen the gap even further? I think this is such a fundamental question, not only for technology's sake and what that means, but because it goes right to the heart of education itself. Access to a quality education is what our whole education reform effort is about. And now that we have some marvelous new tools such as Goals 2000 and the School-to-Work Legislation, we have an opportunity that has not been given us before to bring excellence to scale" (Kunin, 1994).

Kunin provided figures that showed "where we are in terms of equity right now. We have an average of about 2.4 computers per 30 students. Most of the computers about 55 percent are Apple. They're usually at the low end of the scale. There are some ways in which these statistics are not as bad as you might expect; 41 percent of the computers are in classrooms, 46 percent are in labs; 64 percent of schools with access to outside networks, 12 percent of schools have some telephones in the classroom. That's probably the cheapest investment to simply get a telephone and that's the one where we have the furthest to go. This can be the great equalizer. It can be our great opportunity to really put muscle behind the rhetoric of equal opportunity. That is exactly what we must achieve because the stakes are extraordinarily high. I don't think we'll have a chance quite like this again. We won't have a chance, first of all, to really keep the faith in public education itself" (Kunin, 1994).

"Tomorrow's promise," according to Milken (1994), "is grounded in the marriage of education and technology, in interactive networks that will bring ideas, knowledge and new ways of thinking to people young and old, in schools, homes and workplaces. Satellites, data

compression technology, CD-ROM and speedier computers have all brought new worlds of information to ever-larger audiences. The prospects are limitless for students of any age, for training, retraining and pure knowledge enhancement..." He concludes that, "A combination of education and technology, made readily available to our school children, teachers and adults at home or in the workplace, represents the brightest opportunity for achievement and for the knitting together of an America too often divided by economic and cultural differences. Access to knowledge is the most lasting millennial idea of them all."

Levin (1993) discusses the idea of undereducating a significant proportion of our students which has serious economic consequences. Two criteria define undereducation: the level of attainment (years) that youngsters make in the educational system and their level of knowledge, values and behavior. "If young people do not have enough schooling for the labor force, if they do not have enough schooling to meet certain standards that the society sets, then we believe they are undereducated. If, at the same time, we find that they do not have the skills, the attitudes, the values and the knowledge that we expect, then we also say that they are undereducated even if they have many years of schooling. So the two criteria overlap to a substantial degree, but they are two, somewhat different, criteria." High school is a minimum requirement in years, but "there is considerably less agreement on what we mean by undereducation in terms of knowledge and skills, except when we get to an extreme," according to Levin.

Levin defines "at-risk" students as those who are unlikely to succeed in schools as schools are currently constituted because they do not have the experiences in the home and family on which school success is premised. "We know, simply based on children's origins and family background," Levin says, "which children are likely to succeed in schools, which children are not. Schools are not neutral with respect to the types of student backgrounds for which the existing curriculum and instructional practices offer success. Students who come from middle class and non-minority backgrounds with both parents present and who speak a standard version of English are much more likely to succeed educationally than those from poverty, minority, immigrant, non-standard English and single-parent backgrounds. At-risk students are caught in a mismatch between their home situations and what schools require for success. This is very important because the kinds of results that many school systems are getting today with at-risk students are not inevitable. They are heavily premised on the way that we think about schools and on a curriculum that builds on some children's experiences and either ignores, or even negates, the experiences of other children."

Levin believes that probably more than 35 percent of elementary and secondary students are in the at risk population, with California and Texas reaching over 50 percent. He estimates that by 2020, more than half of the elementary and secondary children will be in at-risk categories. The economic consequence is that these are the future employees who tend "to be very much undereducated relative to modern work force standards," and they " will not have the foundation typically required for regular employment or for further training. Unless we are able to intervene," cautions Levin, "unless we are able to get the resources, employers are going to face lagging productivity, higher training costs and competitive disadvantages at a time when there is a general concern in this nation about just such things."

There is also a forewarning for training as "there is a growing gap between the competencies technology professionals currently have and those they will need in the future" (Wendt, 1994). The pace of change "exceeds the capacity of their current skills acquisition process. To close the gap, management must balance the rates of change across people processes and technology so people develop new skills just in time to perform new processes and use new technologies."

Wakin (1994) suggests that the reasons for the gap are "more easily identified than corrected. Significant changes are overtaking people, processes and technology faster than ever before," Wakin says. "Employees in flattened organizations are becoming empowered, taking on new roles and straining to develop new skills. Work processes are being re-engineered and technology is evolving at breakneck speed." Not only does this put more pressure on information technology (IT) managers to develop appropriate training and development programs, but it adds another level to the gap between the haves and have nots, and the education that the haves are currently getting.

Watkin (1994) says that what is needed is a "continuous learning process one that can include delivery of training to desktop PCs, in-house seminars, performance support systems and coaching." He recommends that managers must stay in close touch with the progress of each employee and provide an environment that encourages and rewards professional development. Finding the time to train is a problem shared by IT managers and educators as the workload overwhelms training plans. This is further compounded by trying to anticipate changes in technology in existing technology and that which is still in the planning stage so that short-term and long-term planning can be revised continuously.

The warning is clear for education and training. We are at-risk of creating haves and have-nots in technological skills and even the haves are now at risk of having too few competencies. Certainly, this is yet another powerful argument for providing equitable access for all. Distance learning activities that are designed to improve equal educational opportunities can be funded in two ways: seed money or formula base (Tushnet, et al, 1993). Schools can receive seed money grants that allow them to modify facilities and purchase equipment to implement distance learning technologies. Seed money is particularly important for schools that serve low-income students because there is a relationship between the quality of the facilities and the income level of students. Schools should receive funding to support distance learning based on the needs of students. In rural areas, a measure of curriculum isolation can be derived from the size and geographic location of schools. It is more difficult to derive a formula for urban students, but viewing distance learning as an approach to supplementing instruction for educationally disadvantaged students provides one way of considering the problem. Money also can be allocated for gifted, low-income students. Congress should engage in broad consultation in order to develop an equitable formula (Tushnet, et al, 1993).

Problem-Based Learning

In problem-based learning students meet an "ill-structured problem" before they receive any instruction. "In the place of covering the curriculum, learners probe deeply into issues searching for connections, grappling with complexity and using knowledge to fashion solutions" according to Stephen and Gallagher (1993). As with real problems, students will not have most of the relevant information needed to solve the problem or know what actions are required for resolution. After they tackle the problem, the definition of the problem may change. And even after they propose a solution, the students will never be sure they have made the right decision. They will have had the experience of having to make the best possible decision based on the information at hand (Stephen and Gallagher 1993). Information access through computer modem, working with other students at a distance, or collaborating with experts by computer conferencing can bring more reality to problem-based learning. It also helps students weigh the relative value of information found on the Internet, other resources and the opinions of others. Not only do students find the information and process it, but they apply it. Through this process they develop information gathering skills, writing and communication skills and learn to work in collaborative teams.

They will also have had a stake in the problem (Stephen and Gallagher 1993). "In problem-based learning students assume the roles of scientists, historians, doctors or others who have a real stake in the proposed problem. Motivation soars because students realize it's their problem. By having a stake, they come to realize that no real-world problem is objective, that every point of view comes with a bias toward interpreting data in a certain way."

Teachers take on new roles in problem-based learning, too. First they act as models, thinking aloud with students and practicing behavior they want their students to use (Stephen and Gallagher 1993). "They familiarize students with metacognitive questions such as, What's going on here? What do we need to know more about? What did we do during the problem that was effective? Then they coax and prompt students to use the questions and take on the responsibility for the problem. As time goes on, students become self-directed learners. To encourage the students' independence, the teachers then fade into the background and assume the role of colleagues on the problem-solving team.

Students using technology in problem solving should have access to a variety of media. A variety of media ensure that all learning styles are met visual, verbal, written and hands-on so that every type of intellectual skill is exercised in solving the problem (Lane, 1992).

In the process of problem solving, students crisscross a variety of disciplines. They build substantial knowledge bases through increasingly self-directed study. Through collaboration with their classmates, students refine and enlarge what they know, storing their new knowledge in long-term memory in such a way as to promote transfer to new problems. As they move toward solutions, they identify conflicting ethical appeals. And when it is time for resolution, they present, justify and debate solutions, looking for the "best fit." Problem-based learning is apprenticeship for real-life problem solving. (Stephen and Gallagher 1993).

Electronic media make it possible for students to work with information interactively and proactively. Instead of passive viewing, good instructional design will engage the learner in proactive ways. Video may provide a general introduction and demonstrate or show information through electronic field trips or hypermedia and engage users in the creation of new media. The highest participation is gained through interaction with the work group where problems are solved.

Reganick (1994) reports that students with behavior problems 'overwhelmingly prefer the individual and immediate reinforcement that computers provide, rather than being taught by traditional methods." Technology can serve as the bridge as school reform moves the educational paradigm from passive to active learning where students are engaged in a curriculum that connects them to the real world. Our goal "is to facilitate significant changes in student achievement and behavior. Using computers in the classroom will help our students realize three objectives: significant improvement in academic achievement; improvement in behavior to a marked degree; and a reduction in interpersonal deficits." Means and Olson (1994) list five features of reformed classrooms. They are presented in the context of a project called Local Heroes which was created by the students.

- An authentic, challenging task is the starting point. Authentic tasks are completed for reasons beyond earning a grade. Students also see the activity as worthwhile in its own right.Students needed to earn money for a trip to camp. The students wanted to find more material about contemporary Hispanic leaders as their textbooks and libraries were limited to old material and the reading level was too high for ESL students. The students become convinced that there was a market for such materials in other schools. The Local Heroes multimedia project was born. Students needed technology to assemble their materials and produce copies of salable quality. They identified local heroes, conducted and videotaped interviews with them and composed written highlights from the interviews.
- All student practice advanced skills. Complex tasks involve both basic and advanced skills. Heroes involved student in a wide range of tasks, some of which called for high-level thinking. They prepared for interviews, wrote questions to elicit information and interesting responses, learned presentation techniques for the interview and taped and edited the interviews. The students learned and practiced complex skills in a variety of domains (cognitive, social, and technical).
- Work takes place in heterogeneous, collaborative groups. Three-member students conducted each interview (one asked questions, one videotaped and one took notes.) Afterwards, they discussed how to improve their technique for future interviews. They transcribed the interviews and notes and entered the text on a computer and each took responsibility for aspects of the work (typing, spelling).
- The teacher is a coach. This doesn't mean fading into the background, but providing structure and actively supporting students' performances and reflections. Moving among small groups to check on progress, monitoring students' practice, suggesting questions and helping groups improve their interviewing technique are part of the coaching job.
- Work occurs over extended blocks of time. Serious intellectual activity doesn't usually fall neatly into 50-minute periods.

Means and Olson (1994) observe that technology itself is not the driving force behind the learning in the Local Heroes Project, but rather the technology "amplifies what teachers are able to do and what they expect from students." Technology has this positive effect because:

- teachers see complex assignments as feasible
- technology appears to provide an entry point to content areas and inquiries that might otherwise be inaccessible until much later in an academic career
- technology can extend and enhance what students are able to produce
- selection and manipulation of appropriate tools appear to stimulate problem solving and other thinking skills
- technology lends authenticity to school tasks because the professional quality seems to make schoolwork real and important, thus students take pride in using the same tools as practicing professionals

- technology gives teachers the opportunity to become learners' again through the challenge of planning and implementing technology-supported activities
- technology provides a context in which an initial lack of knowledge is not regarded as cause for embarrassment teachers are eager to share their developing expertise and to learn from one another
- as teachers search out the links among their instructional goals, the curriculum and technology's possibilities, they collaborate more, reflect more and engage in more dialogue.

Means and Olson (1994) say that technology will not make the teacher's life simple because it requires teachers with multiple skills to deal with subject matter that is inherently challenging. Because technology is evolving and open-ended, it can never be totally mastered. "New roles pose many challenges, too. The teacher must be able to launch and orchestrate multiple groups of students, intervene at critical points, diagnose individual learning problems and provide feedback. Nevertheless, in classrooms where teachers have risen to this challenge, a profound change is occurring in the learning environment.

Evaluation -- Performance Based Assessment

During the last several years, there has been a national trend toward the use of authentic performance assessment the actual demonstration of learned abilities or outcomes. Teachers are moving away from multiple-choice, pencil-and-paper tests. While most educators feel that authentic assessment will create greater learning opportunities for students, it is very time consuming. Classroom teachers have little formal training in student testing and assessment. They are required, in many cases, to invent as they implement new assessments.

The key features of performance based assessment according to Smith and Cohen (1991) are that it requires examining the purposes of education, identifying skills we want students to master and empowering teachers. "Testing that requires a student to create an answer or a product that demonstrates his or her knowledge or skills" is the definition of performance assessment provided by the Office of Technology Assessment (OTA) of the U.S. Congress (1992). Rudner and Boston (1994) observe that a key feature of all performance assessments is that they require students to be active participants. "Rather than choosing from presented options, as in traditional multiple-choice tests, students are responsible for creating or constructing their responses. These may vary in complexity from writing short answers or essays to designing and conducting experiments and demonstrations or creating comprehensive portfolios."

Rudner and Boston (1994) and Herman, Aschbacher and Winters (1992) insist that to implement performance assessment fully, administrators and teachers must have a clear picture of the skills they want students to master and a coherent plan for how students are going to master the skills. They need to consider how students learn and what instructional strategies are most likely to be effective. They need to be flexible in using assessment information for diagnostic purposes to help individual students achieve. (Figure 8.1.3)

"No longer is learning thought to be a one-way transmission from teacher to students, with the teacher as lecturer and the students as passive receptacles. Rather, meaningful instruction engages students actively in the learning process. Good teachers draw on and synthesize discipline-based knowledge, knowledge of student learning and knowledge of child development. They use a variety of instructional strategies from direct instruction to coaching, to involve their students in meaningful activities...and to achieve specific learning goals" (Herman, Aschbacher, and Winters, 1992).

Dede (1991) observes that, "The act of learning is always constrained by the characteristics of the communications channel between the student and the content to be mastered. For example, the wider the bandwidth of a communications medium, the more immediate and rich a learning experience can be: seeing a videotape on how to ride a bicycle conveys more information than reading an article about that subject. The greater the interactivity of a medium, the more feedback can be communicated to motivate and individualize learning: having a friend teach you to ride a bike is more effective than is watching videotape on the topic."

Performance assessment techniques include projects, group projects, interviews/oral presentation, constructed-response questions, essays, experiments, demonstrations and portfolios (Rudner, 1991). Proponents believe that performance assessment can measures skills that have not traditionally been measured in large groups of students skills such as integrating knowledge across disciplines, contributing to the work of a group and developing a plan of action when confronted with a novel situation (Rudner and Boston, 1994). Performance based assessment is not new (Rudner and Boston, 1994) as ERIC has used "performance tests" as a descriptor since the birth of the ERIC system in 1966. What is new is the widespread interest in the potential. Proponents of "authentic assessment" make distinctions among the

various types of performance assessments, preferring those that have meaning and value in themselves to those that are meaningful primarily in an academic context. "In a chemistry class, students might be asked to identify the chemical composition of a premixed solution by applying tests for various properties, or they might take samples from local lakes and rivers and identify pollutants. Both assessments would be performance-based, but the one involving the real-world problem would be considered more authentic" (Rudner and Boston, 1994.

"Linking curriculum, instructional strategies and performance-based assessment encourages teachers to focus on higher order, integrated skills, communicate goals and standards and experiment with approaches to help students achieve them. An aligned curriculum that features meaningful learning and offers students choice in demonstrating their knowledge empowers them to be more responsible for their own education and increases their motivation," according to Rudner and Boston (1994). "Assessments can be used to provide diagnostic information about what individual students know and can do and where they need additional assistance. They can also alert teachers to necessary changes in classroom instructional strategies. Rudner and Boston contend that the act of assessment is a learning opportunity for students and use portfolio assessment as a case in point. "Most versions of portfolio assessment call for student self-reflection either in selecting pieces or in evaluating progress over the course of a semester or a year. Students are thus responsible for monitoring their own learning and for assessing the implications of their progress," applying thinking skills, understanding the nature of quality performance and providing feedback to themselves and others. "Students and teachers alike are empowered through the experience" (Rudner and Boston, 1994).

There has been a fear that students would become frustrated by the technical demands of using technology. While using the technology is not a major problem for most students (Means, et al, 1993), students face other "kinds of challenges when they use technology to support themselves in activities, in inquiry learning which include: understanding their responsibilities as active learners; getting help with individual learning needs; and integrating their technology-supported inquiry learning with their larger school experience. Developing their own questions is the reversal of the role that students have traditionally played in schools. Because "learning is no longer a process in which a teacher who knows all passes on knowledge and students passively take it in," (Means et al, 1993), students need information about how the role of the teacher has changed and how their role must change.

Blanchard (1994) observes that putting learning into practice is a matter of focus. "We need to put ten times the amount of follow up on the application of training as we do on the training itself. In the past, trainers have been rewarded for the number of sessions they have done and the 'happiness' ratings those sessions have immediately produced. Increasingly, we need trainers to be focusing on the impact that managers will have in applying principles that are discussed." Blanchard says that for his own firm which provides seminars for others, they have moved to an assessment which demonstrates an "impact on business practices and the resultant savings in time and/or money."

New Ways to Think About the Use of Technology for Education

That technology has been used successfully in education, is no longer the question. How to use it to support educational systemic reform is now the question. A framework for thinking about technology has evolved in the business sector. As business sought to reinvent itself, those that wanted to make dramatic changes were found to be asking themselves a different question. Hammer and Champy, (1993) observed that those who were succeeding were asking "Why do we do what we do at all?" rather than "How can we do what we do better?" or "How can we do what we do at a lower cost?" They reported that they found many tasks that "employees performed had nothing at all to do with meeting customer needs that is, creating a product high in quality, supplying that product at a fair price and providing excellent service. Many tasks were done simply to satisfy the internal demands of the company's own organization" (p.4).

Certainly educational systemic reform requires the reinvention of education. As it has been for business, reinvention is not carried out in small steps. Hammer and Champy strongly suggest that "It is an all-or-nothing proposition that produces dramatically impressive results." Like companies, education has no choice but to gather our courage and do it. To paraphrase Hammer and Champy, "systemic reform is the "only hope for breaking away from the ineffective, antiquated ways of conducting" education "that will otherwise inevitably destroy" education.

If educational technologies and information technologies are to play a role in reinventing education, equating it with automation is not the answer. To date, we have looked for problems and then identified a technology solution. This has been called the "silo mentality" (West, 1994) where pockets of technology have been installed to meet the needs of one or two problems. The extension of the silo mentality is the situation which we have today. There are pockets of technology which are not connected to networks, few people have access to the technology and therefore few people have developed the skills to use the technology or the interest in using it because of the inconvenience.

If what we've been doing has not been productive, we need to think differently about the use of technology. It requires that we use a form of thinking which we teach inductive thinking where we recognize the powerful solution that technology can provide and then identify problems that it might solve. To date, we have used deductive thinking where we defined the problem, identified solutions and evaluated the relative merits of the solutions. We've looked at the technology and asked how it can help us to do what we do better? How can it teach more quickly? How can it help with drill and practice? How can it help take a teaching load off the teacher? We looked at the list of duties that went with teaching and administering education, and asked how technology could do it for us? Yes, technology can do those thing, but we should also be asking "How can we use technology to allow us to do things that we are not already doing? (Hammer and Champy, 1993). One of the hardest things to do is to recognize the "new, unfamiliar capabilities of technology instead of its familiar ones."

The larger point that Hammer and Champy (1993, p. 88) make is that "needs, as well as aspirations, are shaped by people's understanding of what is possible. Breakthrough technology makes feasible activities and actions of which people have not yet dreamed."

Take, for example, the technology of two-way video conferencing for education. The prime reason that two-way video conferencing has been successful to date is that it seems to recreate the traditional classroom. Because of that, it seems to make users more comfortable with the use of technology. But, the traditional classroom is not successful in moving learners from the industrial age, to the information age and into the Communications Age. The traditional classroom and its instructional methods have been roundly criticized as it does not provide a

facilitated learning environment or meet learning expectations. To recreate a situation that is not working through a costly technological solution seems pointless at best.

Two-way teleconferencing has also been valued because it provides a method of interaction that is valued in the traditional classroom. True interaction in the traditional classroom is seldom seen. Immediate interaction is a perception by the student and the teacher that the student can ask a question at any time and the teacher will be able to answer it. Teachers can also ask questions of the students; there has always been the perception that students could answer the questions. Education is using two-way video conferencing so that distance learning can be cost efficient; it allows one teacher to "teach" to several classes. Two-way video conferencing has also been utilized because it seems to provide equitable access to education for all students in classrooms capable of receiving the transmission. While this use may increase equitable access, the question of the quality of the learning still remains.

Those are some of the current reasons for using two-way video conferencing, and, basically, they are technological solutions to the old problems. They do not expand our ability to use technology in new ways.

Some of the new questions might be as follows. How might two-way video conferencing be used to invent new avenues for learning, to bring new resources into classrooms, to provide learning opportunities in settings other than the classroom? What are the advantages for students in using two-way video conferencing? How can we prevent students from becoming embarrassed because of the cameras? How can we increase their verbal communication skills through two-way video conferencing? Is there an advantage in having students together in the video conferencing classroom? How can the teachers learn from one another? What are the advantages of collaboration for students in distant classrooms? Are there other technologies that can augment two-way video conferencing? If students need time to think about new information, how can we provide that in the instructional design? How can we make hands-on demonstrations more realistic on video and how can they be recreated through other technologies or at the site perhaps through computer simulations? How do student created presentations increase learning? Is there something that makes two-way teleconferencing more valuable because it allows us to do something we have not done before? The real power of technology is not that it can make the old processes work better, but that it enables organizations to break old rules and create new ways of working" (Hammer and Champy, 1993, p 90).

Hammer and Champy also discuss "the disruptive power of technology, its ability to break the rules that limit how we conduct our work" that will give us an advantage. Breaking rules is the method that they recommend for people to learn to think inductively about technology. For example, two-way video conferencing breaks the rule that teachers can only work with a certain number of students. Using computer conferencing to turn in homework in an open class electronic forum breaks the rule that students can't see the work of other students and it results in students learning from one another and all having access to creating at the same standard level. Students writing for other students and sharing their work through computer conferencing breaks the rule that the students write only for the eyes of the teacher and that only the teacher can critique the work.

Hammer and Champy (1993, pp. 92-100) developed additional rules about how the organization of work can be broken by various information technologies. They are valuable in helping educators rethink the use of educational and informational technologies for teaching and learning. (Figure 8.1.4)

Gordon Aubaugh, executive director of the Council of Chief State School Officers (CCSSO) suggests keeping the focus on student and teacher needs. Work from what they need rather

than from what the technologies can do. Aubaugh (1994) suggests that we think about what it will "look like five or six years from now when perhaps, we would have every child and teacher going back and forth from school with a PowerBook, with a laptop, or box X, or whatever it's going to be, in a knapsack, rather than something else like a pile of books. What is it going to be when the learning can come just as well and equally from outside the school as it can go on inside the school. How is it that we think about it from the perspective of the student and teacher need, and then design out. How is it that we come together to shape market and to put the muscle in, in order to get the instruments of learning designed and built which service education," (Aubaugh, 1994).

Competing in the Global Economy

Much of the past argument for changes in education has been based on the needs of companies trying to survive in a global economy. While educators would not want to be called unpatriotic, they have resisted and resented the idea that the only worth of the educational services they provide is fodder for industry. The idea that humanities, arts, poetry, literature and music are worthless may be personally reprehensible to them and that worthlessness is underscored by reduced support or deletion of these content areas. The idea that they should teach only those skills which have been emblazoned through the SCANS Report and the ASTD Report is disagreeable. Certainly these views should be validated, but we cannot ignore the needs of the global economy if that means we lose our place in the world. Contemplating the effect on that in terms of democracy and human rights may help teachers reevaluate their position.

It seems that the reasonable course is to meet the needs of a global economy and the higher needs of education as well. The perception that the two are mutually exclusive is not based in the reality of what education needs to do to regain its previous reputation or to go on to greater excellence.

"Much of the current economy is there because of a lack of information," (Davidow and Malone, 1992). Information equals the things that it can replace economically. Those can include stores, retail clerks, consumption of gasoline. "If all the information you need is on your PC, you don't come into the office. That allows you to cut back on office space, secretaries and file cabinets which displaces the janitor, the heating bill, the construction worker."

Distance education is "more than just another attempt by the education community to respond to the rising chorus of criticism leveled at it by citizens, school boards and government," according to Ohler (1991). He asserts that "It is a discernible step in social evolution. It is an imaginative and yet practical attempt by society to invest itself with the survival skills needed in a highly competitive world that increasingly values the educated, cooperative, technologically competent citizen." Distance education provides a sorely needed fresh perspective. "It forces our thinking beyond the confines of the campus and out into the changing world about which we are supposed to be teaching and for which we are supposed to be preparing our students."

There are points to "accept about the march of digital technology and its effects on our lives in the new economy," says Huey (1994). "Nothing is going to stop it. You can't ignore its impact any more than an early 20th-century horse lover could ignore the intrusive onset of the automobile. Technology never advances without social consequences. So believe it: Life, especially work, will be different in the world emerging as it already is for many." The "job" itself may "disappear and be remembered only as an artifact of the industrial age, to be replaced by meaningful, market-driven work assignments in post-job organizations." Paul Saffo of the Institute for the Future notes that, "The Nineties are not a good time to work in a large organization;" the average size of the "effective organization is plummeting." Saffo contends that in this era, the model organization mirrors our networked information structure. It's a web, not a hierarchy. The big difference: In a hierarchy, your title determines your power; in a web, it's who you know."

Huey points to these other indicators of the entrenchment of the Information Society as part of the new economy: The old economy rewarded hierarchical organizations; the new economy rewards webs; the microchip drives the new economy as powerfully as the internal combustion engine drove the old one. Since W.W.II the military has driven the advancement of technology now the role is moving toward the entertainment industry where there is money, shot cycle time and people want to do things no one has done before. "Microsoft's near equaling of IBM in

market value in 1993 was another indicator of the coming of the new economy in which companies that are low on physical capital but intense in intellectual capital pure thought stuff can blow by those burdened with the role of stamping out machines. Software is America's fastest-growing industry; for four years US industry has spent more on computer and communications equipment than on all other capital equipment combined. The computer has evolved into a device that will be used as much for communication as computation (Huey, 1994).

New tools for using electronic multimedia are rapidly evolving. "Your mind can help shape these tools," says Wodtke (1993). "At the same time, these tools change the way you think. A new Renaissance is emerging that is, once again, relating the arts and the sciences and influencing design. There are exciting possibilities for using computers to learn the knowledge base of a discipline more easily, as well as to enhance your creative capacity." Wodtke observes that most of us realize that the way in which we gather and work with information is changing dramatically and that we're working through some far-reaching changes. "Presently, a shift from verbal to more visual modes of thinking and expression is occurring. Children around the world today are being exposed more and more to visual images. Perception of real-life experience is highly visual. This is now augmented by passively viewing TV. Through computers, however, both the audio and visual tracks are becoming interactive, tapping into a whole range of visual capabilities. Although verbal capabilities seem to be declining, visual capabilities seem to be increasing." What Wodtke finds interesting as an educator who teaches visual thinking and design communication, is how education will respond to the shift that is occurring. The challenge, he thinks, "might be to teach both verbal and visual literacy. This would provide children with a better base for effectively using the tools that are emerging."

Wodtke (1993) calls for a "mind primer" for computer literacy courses in primary and secondary schools so that computer literacy goes beyond teaching only which button to push. He wants students to learn creative and critical thinking skills that they can draw upon when they use electronic media. He concludes that "Consummate realism came with photography and video. Ironically, by dealing with realism people also became more aware of the power of abstraction working with simpler images. The mind will continue to evolve to make use of new technology. As tools and toys change, they reshape the way people work and play. This in turn changes the tools and toys people create."

Until recently, the industrial age model had us using resources such as materials and energy, rather than information. The information age model is to use information as our resources are essentially equal with the rest of the world. The factor that will contribute to the continuation of America's leadership during the information age is our ability to think and use information (Fitzsimmons, 1994). Fitzsimmons chronicles the changes saying that in the past "Americans were the highest paid workers in the world. We had more natural resources per capita by a factor of ten and better technology than the rest of the world. Through mass public universal education, workers could read, write and count. Today, Fitzsimmons says, all of that has changed. Raw materials are no longer part of the equation as they are 40 percent less costly today than in 1970. The new telecommunications/computer revolution has spawned global competition, but technology is no longer a guarantee of success as Japan is the market leader in technologies developed by U.S. companies. "The variables we can impact are the skills and education of our work force" asserts Fitzsimmons, but the development of U.S. skills and education are not globally competitive and 75 percent of Americans do not graduate from college. He warns that unless there is a dramatic change, we are in "danger of producing a third world economy with falling wages for the American work force."

Fitzsimmons (1994) points out that the industrial age learning system had three dominant elements which presented a consistent message to students that the character of the individual and the criteria for future success were substantially agreed to by society and were clearly

defined and communicated. In the communications age learning system, increasingly, learning takes place randomly and learners receive conflicting messages from home, church, formal education, cable TV, video games, personal computers, movies and other information sources. According to Fitzsimmons, a new society is evolving from radical new forms of learning that compose a new societal learning system. As there is no dominant element of learning, all elements can have equal influence on the individual learner. While Fitzsimmons does not call this the Communication Age, this description seems to embody a way of thinking about how humans are bombarded with communication.

Fitzsimmons (1994) describes the problem with the following group of factors that form a basis for making significant changes quickly through system reform;

Literacy: Today, 90 million adults cannot figure out a bus schedule or write a simple letter explaining a credit card error.

Drop Out: A student drops-out every eight second during the school day.

Investments: Public school's annual budget nationwide estimated at $200-$215 billion

Annually, the U.S. spends an average of $6,300 per student for education. In 1993-94, schools spent only $40-$45 per student on information technology

Education's investment in R&D comes to only .025 percent of total annual revenues.

Training: U.S. industry spends about $210 billion per year on training and education. One third of the major U.S. corporation must provide basic skills training for employees. Employers invest 300 times more of their total budgets in computer-based instruction than does public education. Small firms provide 35 percent of U.S. employment, but have no means to provide training. At the Fortune 2000 corporations, about 12 million workers use e-mail, increasing to about 27 million by 1995.

Implications for Education and Training and the U.S.: Although the current educational system is now a recognizable subsystem of the new society learning system, it is still expected to perform in a dominant role. Fitzsimmons believes that the cost to education is uneasy taxpayer support and wavering prestige of the teaching profession. He believes that because education is not functioning in real-time, up-to-date elements of the learning system are having a greater impact on the individual. He estimates that by 1995, 14 million Americans will be unprepared for the jobs that are available.

The implication for U.S. business and industry is to face the most serious shortage of qualified entry level workers by increasing the investment in training because workers are not prepared for the new workplace environment and do not possess life-long learning skills. It will take more time to find qualified job applicants, more time to train them and more time for new-hires to become fully productive. Fitzsimmons also observes that the concepts of quality and continuous improvements are foreign to the graduates of U.S. formal learning systems.

"We must take advantage of the technology revolution," says Fitzsimmons (1994). "Skills and education of the work force are the only sources of sustainable competitive advantage. There is no premium for natural resources. There is, however, a premium for a highly skilled work force of life-long learners." To support his contention that learning technologies work, Fitzsimmons sites a Hudson Institute review of twenty years of research on computer based instruction which indicates that there is 30 percent more learning, 40 percent less time, and at 30 percent less cost. He also chronicles the American Society of Training and Development (ASTD) survey which reports that business considers training technology to be the most cost effective method,

that Federal Express trains data processors with a 60 percent time savings, and that the Armed Services are heavily invested in training technology.

Fitzsimmons concludes that the threat we face is the cultural lag between industry and education...and information is widening the gap. "What is in jeopardy are not the institutions of industry and education. What is in jeopardy is the American society that depends on them."

A possible solution is a computer system that provides just-in-time-learning. Also called an electronic performance support (EPS) system, a number of these sophisticated systems are in place in companies such as AT&T, Aetna Life & Casualty Inc. and Delotte & Touche, an accounting firm. Hequet (1994) describes EPS as a system that can answer questions by electronically bringing up the correct page in a manual, provides computer-based training to build employee confidence, offer guidance on ticklish decisions and is an "all-purpose reference" that workers can access as they do their jobs. Workers in the field can also access the systems as they work with sales questions or request other information. U S West's Learning Systems uses a system that helps trainers design and create training materials and analyze training trends. Hequet says that companies with EPS systems report very favorable reactions from workers using them.

EPS systems have been credited with remarkable changes. Aetna reports that the total development cost was $20,000 and it paid for itself in just weeks. IDS Financial Services Inc. of Minneapolis reported that an EPS system replaced 15 hours of classroom training with one hour on the EPS system, reduced "time to competency" from two-three months to four weeks, and error rates are down 50 percent (Hequet, 1994). "Enthusiasts say that, in certain areas, EPS has the potential to render training all but obsolete," according to Hequet. The goal is to stop filling people up with knowledge and skills and putting them back to work. With performance support we can give them real work to do and provide them with the support to learn while they work. Hequet warns against over reliance on EPS because it may not include critical thinking for problem solving. What will happen if the EPS system isn't right at hand, Hequet asks. He concludes that EPS systems have their place with other training.

Cohen (1994) observes that traditional training design and delivery cannot "continue to concentrate solely on training as a one-time event that takes participants away from the job where the information will be used. He sees instead, a learning process initiated in short segments, delivered on the job and facilitated by those closest to the participants; their business unit (or team) leaders." Training professionals will "initiate training that can be delivered by line personnel in brief meeting formats, in the workplace, within the work day, and in ways that allow and encourage participants to immediately apply the skills and tools involved with the line manager in an optimal position to evaluate progress and provide coaching."

During an on-line computer conference with Dr. Kenneth Blanchard (1994) and the faculty and students of the University of Phoenix Online Division, Blanchard drew a significant comparison between situational leadership and situational learning. "The comparisons are great," said Blanchard. For example in the learning environment at hand that we are using, all four styles of managing are being used: S1, Directing occurs when I gave you my initial perspective; S2, Coaching commences when we start to dialogue about the topic; S3, Supporting happens when you all carry on the conversation without me; and S4, Delegating occurs when each of you apply and use something we've discussed to make your life or job a bit more manageable."

When asked for help on how to make the transition to a new style of management in organizations when an old paradigm of management is dominant, Blanchard said, "Please do not fall victim in assuming that nothing can be done until the folks on top get enlightened and decide to empower us below. Life will pass you by." You have to remember that we are all groping together about what's happening in business today. And many of those upper

managers are the most scared because they seemingly have the most to lose. The attention then must be placed on what can be done to help them not to convince them that they are wrong. You need to catch your boss doing something right if you are lacking positional authority and build a personal power base from which you can then build to the point in which you can provide useful personal feedback to the manager as to how they can be more effective. Managers from the top down need to feel they are in a safe environment so that they can be open to change" (1994). Magnet (1994) agrees saying "managers have had a way of fighting hard to hold on to the information on which their power rested." Obviously, the same thing applies to educators.

Richman (1994) asserts that what it will take to provide workers with the attitudes and technical skills they need for the new economy include schools that are linked with employers to integrate classroom instruction with practical on-the-job experience. It will also take community colleges that offer the specialized training their local businesses demand, companies that find new ways to teach and motivate employees and government programs to steer dislocated people back into productive new careers. Magnet (1994) observes that there will be fewer people doing more work. "Those who survive must learn to master new information technologies...and then figure out how they fit into a new, more chaotic organizational structure. For productivity, growth directly affects the national standard of living, and the way we play the game may well determine the extent to which America can remain the dominate economic superpower in the years ahead."

Total Quality Management in Education

As Total Quality Management is adopted by schools, educators are discovering the natural fit that quality principles and practices have with their own aspirations for the continuous improvement of education (Bonstingl, 1992). Bonstingl has taken Deming's 14 points, Juran's Trilogy, Kaoru Ishikawa's Thought Revolution and has adapted the theories to education.

Bonstingl observes that teacher-students teams are the equivalent of industry's front-line workers. "The product of their successful work together is the development of the student's capabilities, interests and character. In one sense, the student is the teacher's customer, as the recipient of educational services provided for the student's growth and improvement. Viewed in this way, the teacher and the school are suppliers of effective learning tools, environments and systems to the student, who is the school's "primary customer." The school is responsible for providing for the long-term educational welfare of students by teaching them how to learn and communicate in high-quality ways, how to assess quality in their own work and in that of others, and how to invest in their own lifelong and 'life-wide' earning processes by maximizing opportunities for growth in every aspect of daily life."

In another sense, says Bonstingl, "the student is also a worker, whose product is essentially his or her own continuous improvement and personal growth. The school's stakeholders and "secondary" customers including parents and family, businesses, members of the community and other taxpayers have a legitimate right to expect progress in students' competencies, characters and capabilities for compassionate and responsible citizenship not for the direct and immediate gain of the stakeholders but, rather, for the long-term benefit of the next generation and of generations to come. Total quality in education, as in life, is essentially generative. Within a total quality school setting, administrators work collaboratively with their customers: teachers. Everyone in the organization must be dedicated to continuous improvement, personally and collectively. Deming suggests that we "abolish grades (A, B, C, D) in school, from toddlers up through the university. When graded, pupils put emphasis on the grade, not on learning" (Bonstingl, 1992).

Bonstingl (1992) contends that if schools are to be true learning organizations, "they must be afforded the resources, especially time and money, needed for training, quality circles, research and communication with the school's stakeholders: parents, students, businesses, colleges, community residents, taxpayers and others. Schools must also rethink practices that focus narrowly on students' limitations rather than their range of innate strengths. Howard Gardner has pointed out the self-defeating nature of a narrow academic focus, encouraging educators to acknowledge the existence of multiple intelligences and potentials within each student and to help students develop their many intelligences more fully day by day."

Barker (1992) identifies Total Quality Management as the most important paradigm shift of the twentieth century. He says that the paradigm "has created an epidemic of quality throughout the world" so that any organization that "doesn't catch this disease may have a very difficult time surviving the next twenty years." It is, he says, "a revolution of the human spirit" as it " brings back spirit to the workplace" and it " creates an attitude of constant innovation." Innovation takes us into "territories we have never been to before; and therefore, to be responsible to the future and to the things we value, we must develop a sense of anticipation of the implications of our innovations. This will allow us to pick from the many potential solutions to our problems and find the few that best support those values we wish to carry into the future."

Barker (1992) contends that with increased productivity and innovation comes a growing self-esteem in the workers which "often leads to the request to self-manage" as they realize that they can "be in charge of themselves far more effectively than a manager can." The result is a

flattening of the organization and the disappearance of the classic middle manager. That leads to middle management resistance to this paradigm. Logical. But, in the long term, useless," says Barker. "Self-management is the most democratic, most efficient and most powerful way to get things done. And it frees up those who are middle managers to use their intelligence for more productive and innovative purposes. No more pushing papers, protecting turf, building empires."

Using the National Information Infrastructure for Education and Training

"I knew we were on a solid rocket booster when I saw the growth rates in the Internet. It took off at 15 percent a month and it just kept going," says Douglas Van Houweling, vice-provost for information technology at the University of Michigan (Jacobson, 1994a). "When I saw that, I said to myself: Universities are about sharing knowledge and information, and what we're seeing now (with personal computing and networking) is about the same thing. The convergence here is going to be something we can't imagine." Jacobson sees signs that a growing number of institutions will soon be competing electronically in each other's back yards and that more and more students will be taking courses and full degree programs over computer networks without setting foot on a campus. Stanford University's President Gerhard Casper agrees that the latest technology will transform both the content and delivery of higher education to an extent not yet fully understood or appreciated on most campuses (Jacobson, 1994a). Casper says he has no idea what the impending changes will be like, but "we'd better start thinking about it. I am amazed about how little discussion seems to be taking place."

Some college officials say a technology-driven restructuring of academe is only five to ten years away (Jacobson, 1994a). Van Houweling says that the potential of the technology is moving much more rapidly than we are able to take advantage of. Nor have many organizations begun the process of "realigning the way they teach the way they create a learning environment, the way they reach out to students to take advantage of these new capabilities." Some of the questions are how will colleges respond when other institutions start offering electronic classes to their students? Are campuses necessary? How many faculty members will be needed? Will large lecture halls survive (Jacobson, 1994a)?

Carnegie Mellon is asking what might happen if technology made it routinely possible for anyone to send or receive anything electronically from or to any place at any time? The Fantasy and the Reality subcommittees provide the check and the balance. The Fantasy group is imagining a wireless world of ubiquitous, hand-held computers, communications devices and super-user-friendly software which might vastly expand the university's efforts in distance learning or lead to new collaborations with outside businesses and other organizations. "We see ourselves on the verge of potentially major technological advances," says Stephen W. Director, Dean of the School of Engineering. "We can see that the way we do computing, communicate with each other and interact with data and each other is changing. We want to "get in a position so that ten years from now we have what we need" (Jacobson, 1994a).

Stanford's Casper who proposed a three-year degree as a way of controlling education costs, has found affirmation for the idea in distance learning. He thinks some of the more quantitative courses may be delivered by distance learning in the future. John Bravman, chairman of a Stanford subcommittee focusing on technique and technology in teaching and learning, says that with two-way video and other options "one can imagine rethinking the whole purpose and structure and function of a university like Stanford." The committee recommended that Stanford establish a permanent group to coordinate efforts to bring technology to the classroom. Jacobson (1994a) observes that as the planning begins, universities know that two problems of the past decade will continue to inhibit the spread of technology: high costs and limited participation by many faculty members. Bravman says many institutions will soon experience nothing less than culture shock. "This is going to affect academic publishing, teaching, the way we do research everything that we do. People are either going to jump into this very fast moving stream or they're going to get left behind."

In 1994, the first (ever) technology conference was held by the U.S. Department of Education. For the first time the chair of the Federal Communications Commission (FCC) addressed a conference sponsored by the Department of Education. In his remarks, FCC Chair Reed Hundt

said there are many ways in which all adult Americans already have contact with the Information Highway. "There is only one group, of course, that does not have access. Forty-five million people a day from the beginning of the day to the end of the day who basically are outside the scope of these networks who basically do not participate in the Information Superhighway the way that almost all adult Americans already do. I'm speaking, of course, of our children in the classrooms" (Hundt, 1994).

"Now the potential of the Information Highway is what led to the President of the United States mentioning it and our classrooms in the same sentence in the State of the Union speech. The first time that education and communications were ever mentioned by a president in the State of the Union together and I hope not the last time because I hope it marks the continuing attention to what the communications world brings to education and what education can, through communications, mean in terms of changing our country for the better. That potential, I think, consists of at least three things. It consists of the educators using the Information Highway to have access to information. It consists of educators using the Information Highway as a source of new techniques for teaching. And third, it consists of the Information Highway facilitating communication itself so that in the act of communication, all children, can, in fact, learn" (Hundt, 1994).

"It is so much easier to pierce the walls of the classroom with interactive communication," Hundt said. "It is so much easier, with fingertips to show the children how to go to every art exhibit in the world to see every painting of every painter brought to life in perfectly clear pixels on the computer screen. This is available, even today. For anyone who has ever used Mosaic, a computer program to navigate the Internet. There is literally no reason why that tool cannot be available to all the children in all the classrooms, except we don't have the lines into the rooms yet " (Hundt, 1994).

Hundt said that he had run into some people who said, " This sounds like the latest gee whiz gismo that won't work out and will cost lots of money." Hundt doesn't think so. "I believe those who tell me that putting the networks into the classrooms will free teachers to work with students who need individualized attention. I believe those who tell me that putting the networks into the classrooms will permit students and teachers to learn from anyone, anywhere, anytime. I believe those who tell me that putting the networks into the classrooms will allow students from different backgrounds and even different countries to learn from, and to teach each other, and to build community across our country. I believe those who tell me that putting the networks into the classroom will allow for the creation of new communities of learning among students. Any parent with a television, any teacher, knows the power of visual images in their building to create a community of interest. The power of those visual images has yet to be fully tapped and will not be until we can extend our networks into our classrooms" (Hundt, 1994).

In testimony before the Senate Commerce Committee, U.S. Department of Education Secretary Richard Riley testified that "it will be absolutely impossible to educate the coming generation of young people to high standards of excellence if their access and use of the NII is seen as a secondary consideration to broad based commercial purposes." Riley said it was his "very strong belief that free connections to the NII may not be enough. If we want young people to actively use the technology of the future so it becomes second nature to them then we must go a step further and provide our schools with free usage of the telecommunications lines that will connect school children and young people to new sources of knowledge. The principle of 'free' public education for all children is the bedrock of our democracy. Not cheap, inexpensive or available for a fee, but in its very essence 'free.' We believe in this basic American principle because we know its long term value for society as a whole. This is something every business person in this room should understand. Every year millions, if not billions of dollars are being spent by business, our community colleges and our public universities on remedial education" (Riley, 1994a).

Riley said, "If we want to get out of the business of remedial education, if we want to create a well-educated and world-class work force, this is the time to get it right...to raise our standards and give our young people the access and the tools they need to get a world-class education. While nearly every school has computers, school traditions frown on teachers having telephone lines in their classrooms. Opportunities for teachers and school staff to learn how to use new technology and integrate it into instruction are all too scarce. Few schools budget adequately for ongoing technical support for these new tools. Only when these and other steps are taken will we truly be able to end the isolation of our nation's classrooms" (Riley, 1994).

The National Coordinating Committee on Technology in Education and Training (NCC-TET) is the largest, most diverse coalition of organizations to take up the task of defining the requirements to be met if the National Information Infrastructure (NII) is to support education and training. The National Education Association believes that education and training will provide people with the skills they need to use and develop the NII, but will do this only if the NII also serves their needs (Yrchik, 1994).

Yrchik asserts that we must ensure that all Americans have affordable access to the NII. "Accessing the best information to do a job or perform a task must become a cultural norm by the end of the century. Given the fact that at the present time, about 90 percent of K-12 classrooms lack even basic access to telephone service, this is a formidable challenge. The goal of connecting every classroom and home to the NII should be set for the year 2000. Rural and poor populations which have traditionally been undeserved must have special attention given to them to make sure they have access to the network. This is the point at which we as a society choose whether we want to grow together or grow apart into the information rich and the information poor. The issue is equity. The issue is the vitality of our democracy. It is therefore imperative that we ensure that the NII is accessible in a variety of learning environments. The vision of the NII is one in which learning occurs in a variety of environments throughout the course of one's life in homes, workplaces, schools, universities, libraries, museums and community centers. People should have access to information they want where they want it and when they want it. This sensibility should guide the design of all federally funded NII-related education and training programs" (Yrchik, 1994).

For another goal, to develop and disseminate NII guidelines for education and training applications, (Yrchik, 1994) says that instructional standards would ensure that educational and training applications of the NII help us attain the National Education Goals. He adds that to promote a teaching profession experienced in the effective use of technology, national teacher certification standards and credentialing requirements should be expanded to include applications of educational technology. Yrchik notes that many schools of education do not require training in the use of education technologies. "Without effective training programs for educators, the information highway will quickly become a dead end. Educators must be given training on how to use the equipment. But, as importantly, training should include teaching strategies that incorporate a wide variety of technologies. If educators are interested in collaborative learning, for example, they should be given the training to create collaborative learning environments that use telecommunications technologies to extend teaching and learning across district, state and national boundaries."

Another goal calls for emphasizing interactive, broadband transmission of voice, video and data for education and training. The need for a broadband NII is a critical need for education and training is critical for the widespread use of interactive video in education according to Yrchik (1994). He contends that this will open new dimensions in the learning process that are not possible with voice and data transmission alone. Electronic field trips, simulations and sensory immersion in new kinds of learning environments could become commonplace. "The wall that separates schools from the world outside a wall that exists because of the technological

deprivation of schools must be dismantled" said Yrchik. "The ability to transmit voice, video and data with relative ease across networks will extend teaching and learning beyond traditional school walls, opening classrooms to the world outside. Students should have the opportunity to interact directly with the world's experts on a variety of subjects, to share their ideas and experiences with their peers from other districts or countries, to produce their own multimedia products and distribute them to their peers around the country or world. Teachers should be able to do the same. This will irrevocably change the way education is experienced and organized."

Ease of use is another goal recommended by the NCC-TET. Yrchik believes that the user interfaces in education must be easy to use and as consistent as possible across computer platforms, individual databases, information services and other applications. "The enormous complexity of such a system must be hidden from the user. The user should be encouraged to build rapport with it," Yrchik says. He believes that the use of intelligent software agents, knowledge robots (know-bots) represent one of the most promising directions because in response to a query, the software agent would enter numerous computers and databases and provide a single easy-to-understand response.

The NCC-TET also recommends that the NII support user collaboration for training and educational organizations of the future. Effective people-to-people communication is open-ended Yrchik says, and it requires a wide variety of data types including voice, video, audio, graphics, still pictures, text and animation. "It takes place in many different configurations and contexts between two people or two groups, between an individual and a group, in work, at home and on the road. It's both synchronous and asynchronous. It occurs at the same time and at different times. Managing this communication in a way that simulates actual physical proximity is a challenging task, but an important one. Increasingly, education and training will take place in geographically distributed environments. Of all the potential uses of the NII, its use in education and training is the most important. Education and training applications alone will provide individuals with the skills and knowledge to make use of and further develop our National Information Infrastructure. In time, the National Information Infrastructure may become one of our national treasures" (Yrchik, 1994).

In a working paper, the Information Infrastructure Task Force (IITF) (1994) discusses the objectives for the future uses of technology and education. Among them are instructional delivery which will provide workers with a "Ph.D. in a pocket." Instruction and job performance aiding will be delivered on a device that resembles a pocket calculator. Every complex device will include sufficient embedded training and user assistance to make it easily usable. Instructional intelligence will support integrated individualized tutoring that integrates goal setting, instruction, job performance aiding and decision aiding into a single package. Natural language interaction will be an essential feature of this capability. The IITF believes that institutional integration will be the most difficult challenge to meet as the new instructional capabilities will first have to be integrated into the routine, daily practice of our current instructional and workplace institutions. "Just-in-time and just-enough training that is universally available will not only change the way people are treated in the workplace but the workplace itself."

IITF notes (1994) that instructional programs, simulations, materials and databases can all be accessed over the NII and delivered to schools, homes, libraries and workplaces wherever and whenever it is desirable to do so. Currently, there are massive exchanges of software, databases and files using the Internet, but relatively little of this activity occurs in the service of education, training and lifelong learning.

The NII will provide the backbone for a lifelong learning society (IITF, 1994) "Education and training communities will better accommodate an enormous diversity of learners in an equally

diverse variety of settings. In addition to schools and work places, interconnected, high-performance applications will extend interactive learning to community centers, libraries and homes. Education, training and lifelong learning applications available from the NII may include:

- Multimedia interactive learning programs delivered to homes to immigrant children and their parents to learn English as a second language.
- Comprehensive interconnectivity for students that allows them to receive and complete assignments, collaborate with students in distant locations on school projects and interact with teachers and outside experts to receive help, hints and critiques.
- Simulated learning activities such as laboratory experiments and archeological digs.
- Universal access interfaces for computers and telecommunications devices for students, workers and others with disabilities to allow access to the NII.
- Affordable, portable personal learning assistance that tap into the NII from any location at any time and provide multimedia access to any NII information resource.

The NII, will be the vehicle for improving education and lifelong learning throughout America in ways we now know are critically important. Our nation will become a place where students of all ages and abilities reach the highest standards of academic achievement. Teachers, engineers, business managers and all knowledge workers will constantly be exposed to new methods, and will collaborate and share ideas with one another (IITF, 1994).

The NII will give teachers, students, workers and instructors access to a great variety of instructional resources and to each other. It will give educators and managers new tools for improving the operations and productivity of their institutions. The NII will remove school walls as barriers to learning in several ways. It will provide access to the world beyond the classroom. It will also permit both teachers and students access to the tools of learning and their peers outside the classroom and outside the typical nine to three school day. It will enable family members to stay in contact with their children's schools. The NII will permit students, workers and instructors to converse with scientists, scholars and experts around the globe (IITF, 1994).

Workplaces will become lifelong learning environments, supporting larger numbers of high skill, high wage jobs. Printed books made the content of great instruction widely and inexpensively available in the 18th Century. The interactive capabilities of the NII will make both the content and interactions of great teaching universally and inexpensively available in the 21st Century (IITF, 1994).

The NII will provide a powerful tool to address many of the learning needs the country is facing according to the Computer Systems Policy Project (CSPP) (1994), an affiliation of chief executive officers of American computer companies that develop, build and market information processing systems, software and services. These include tailoring curriculum and instruction methods to meet the needs of individual students; providing teachers with the resources they need to improve their skills and update their knowledge; providing a means for Americans to continually acquire the knowledge to adapt to new or changed career objectives; providing better access to information that affects our quality of life and cultural awareness.

CSPP (1994) believes that the enhanced NII will provide many opportunities to better prepare the population for the work place of the future. For example, they cite the following contributions:

- Computers will make learning complex ideas easier by providing learning environments that closely approximate real work environments or experimental apparatus.
- Students interconnected via networks will be able to collaborate as teams, even though members of the team are geographically separated. Teachers and school and college

administrators from around the country will be able to communicate electronically to exchange ideas and build a sense of community.

- Instruction will be tailored to the specific learning needs of individuals, particularly adults re-entering a training environment, minorities, women people with disabilities and others that may benefit from customized approaches to instruction.
- People who do not have direct access to a wide variety of opportunities, either because they live in remote areas or because of the demands of work or family responsibilities, will be able to access information from other locations in a variety of formats and media, obtain degrees from distant colleges and access facilities with unique learning resources.
- Information technologies, such as visualization, will provide new ways to learn difficult concepts and data.
- Information technologies will reduce the burden of record keeping and other paper work that consumes so much of teachers' and administrators' time.

CCSP (1994) suggests ways that the NII has the potential to move learning at any age, from "beyond the four walls of a classroom to a broad community of learners and to help meet Goals 2000." It can assist with helping children start school ready to learn (Goal 1, 8). Through links to the home, the NII can provide parents with the necessary tools to expand their roles in their children's education and better prepare their children to enter schools ready to learn. Through computers linked to social agencies, assistance with specific problems can be provided directly and confidentially to parents, or to schools, to help teachers and administrators deal more effectively with learning difficulties caused by social problems. Parents will be able to access high-quality and developmentally appropriate preschool education materials to use with their children, which promotes inter-generational literacy and strengthens communications between parents and educators very early on. Parents will be able to access nutritional and health care information and services, find model programs for early childhood care, and find customized information for children with special problems or circumstances. An interactive "Ask the Experts" electronic bulletin board could provide insights on all types of developmentally related issues.

The NII can play a crucial role in enhancing the linkages to make learning more exciting and hands-one and relevant which increase the high school graduate rate (Goal 2). The NII can allow student access to scientists, researchers, journalists, entertainers and members of Congress. Students will see through firsthand interaction, skills and education being applied in relevant situations, which will help them gain an understanding of the benefits of staying in school. Career counselors and mentors can provide interactive information about career options and education requirements. Instruction will be more exciting and better tailored to students' interests, and needs, through the use of networked multimedia, speech recognition, intelligent tutors and tools and curricula that integrate voice, video, data and text. This will help enhance retention and provide the flexibility to meet the varying learning styles of students.

"In a global, knowledge-based economy, skills in generating, accessing, manipulating and managing information will be paramount" (CCSP, 1994). "Information and the base of knowledge about any particular subject are growing so quickly that a person can no longer expect to 'know' all there is to know about a subject. Instead, workers and students will need to know how to find the information they need quickly and in the right format. While tools and software will help make the NII easier to use and navigate, information technology-based education techniques will still require learners to conceptualize a problem, use critical thinking skills, access distant resources and collaborate with fellow students, all while using basic reading and writing skills" (Goal 3). Integrated curricula supported by information technology will move learning beyond memorizing "facts" like the periodic table, to inquiry-driven, on-line, interactive sessions, such as discussions with NASA researchers, collaborations with oceanographers or writing reports using images downloaded from the Voyager satellite. Global

networking capabilities will enable students to interact with students and teachers around the world, bringing current events into the classroom. Projects like the National Geographer's "Kids Net" move lessons from static textbooks and outdated maps to powerful, interactive exchanges with students from cultures and countries around the globe and the resources those countries provide. "Understanding and appreciating diversity, whether different countries, races, cultures or languages, will be essential for American students and workers operating in an increasingly interconnected, global environment."

Through the NII, information technologies have a huge potential to reinvigorate how science and mathematics are taught, used and learned by students (Goal 5). With network-supported simulated experiments, project-based learning and authentic problem solving exercises, students can generate their own scientific data, which they can share with researchers which makes students active participants in their education rather than passive observers. With electronic access to resources, teachers will be able to develop exciting, up-to-date curricula. Students will be able to collaboratively participate in student-conducted work that will provide hands-on experience in statistics, architecture, sample gathering, testing, design, assessment and forecasting. Tools and resources such as super computers, visualization and statistics software will bring difficult mathematics functions, including modeling, simulation, probability and finite analysis alive and within the reach of many students.

The global economy is moving to one driven by information and knowledge. High-wage jobs, quality of life and competitive advantage will be based on the ability to create, manipulate and deliver information quickly to the right person and place. Literacy, or technological fluency, will require the skills to acquire knowledge and to adapt to emerging technologies and work methods (Goal 6). Networked services and resources drawn from academia, business and the community will provide lifelong learning opportunities for workers, students and teachers. Distance learning technologies will enable innovative retraining initiatives, designed and adapted to meet the needs of mid-career and other non-traditional students. Expanded citizen access to federal, state and local information and the ability to learn at home, at work or other convenient places will make learning literacy skills easier (CCSP, 1994).

Technology will not cure societal problems but it can help create an environment in which the preconditions for drugs and violence are minimized (Goal 7). Students who are "excited, engaged and challenged by the education system are less likely to turn to destructive behavior" (CCSP, 1994). Innovative student assistance programs implemented with electronic support can provide anonymous and accurate information about specific problem areas to curious students or students-at-risk. An array of drug prevention and counseling techniques can be made available electronically to parents and teachers. Linking schools with community organizations, the police and other public safety agencies will facilitate communication among these agencies and assist in identifying trouble spots or issues before they erupt into classroom violence.

Instructor In-Service and Pre-Service

"Researchers studying teacher development have found that beginning teachers progress through a series of stages: survival, mastery and impact" (Fuller, 1969; Hall and Loucks, 1979). Teachers focus on themselves first, concentrating on issues such as controlling student behavior. They become better able to anticipate and solve problems after they gain confidence, and gradually their focus shifts to their impact on students' achievement and attitude. Little is known about classroom management techniques in mediated environments. The research literature offers few suggestions for teachers with classrooms filled with computers, networks, laser discs, printers and other technological tools. Most studies have concentrated on computer laboratories or classrooms with one or two computers (Amarel, 1983; Ragsdale, 1983; Hoffman, 1984).

As teachers encounter new instructional methods, facilitation, systemic reform, Goals 2000 and technology, the three-stage model is useful in understanding the development of experienced teachers who are implementing educational innovations. Data from Apple Classrooms of Tomorrow (Dwyer, et al, 1990) support the assumption that experienced teachers entering high-access-to-technology classrooms also move through these stages.

One of the outcomes of systemic reform has been the recognition that teacher education both in-service and pre-service is not addressing the need to provide teachers with professional development that allows in-depth study of facilitation, constructivism, andragogy, technology and develop personal skill in instructional methods which support these theories. "As a result, reformers have sought to restructure schools to produce conditions that address these concerns. These restructured schools will make new demands on teachers, as well as provide them with new opportunities" (Abdal-Haqq, 1989).

Only now have people begun to realize that just putting computers in classrooms, even plugging them into the Internet, won't improve education unless the teachers understand how the computer revolution can be fully exploited, according to Dolores Gore at Austin Peay State University, TN (Wilson, 1993). She says she has embraced the technology as the only way to solve the nation's ills such as illiteracy, joblessness and crime. Many of these problems can be traced to inadequate and antiquated teaching methods starting with kindergarten and running through high school says Gore. Instead of rote memorization, Gore says students must be taught how to locate and retrieve information and to navigate through the vast quantities of data that the computer will make available to them. "We need to teach children how to learn. The technology gives us an opportunity to address all these problems" (Wilson, 1993).

When we think of teachers using technology, we tend to "focus primarily on their need to learn how to operate hardware and software" (Means, et al, 1993). Certainly this is a critical component, but teachers also need to develop skills in developing curriculum, allocating resources among students, managing instruction within the classroom using technology, keeping abreast of new technologies and finding out about the "potential power each technology application has with respect to inquiry-based teaching and learning. "Any technology integration requires that teachers engage in rethinking, reshifting and reshaping their curriculum."

Restructuring schools not only changes the character of school culture but also creates a need for a nontraditional approach to in-service teacher education. Ongoing professional development replaces the sporadic, short-term staff development activities that constitute typical in-service education at present (Holmes Group, 1990). Traditional teacher pre-service programs have done little to prepare teachers for the demands or opportunities of restructured schools (Levine, 1988; Mahlios et al., 1987).

The U.S. Senate Committee on Labor and Human Resources has requested the Office of Technology (OTA) to investigate the "availability and quality of staff-development programs offered at the pre-service and in-service teaching level which encourage the use of technology in an integrated fashion across the curriculum" (Charp, 1994). The report which is due at the end of 1994, includes questions regarding pre-service teaching programs such as: Do programs concentrate primarily on operational procedures or are creative applications discussed? Are pre-service training programs a part of the school of education's courses or are the programs offered as electives as part of the computer science department? Is there increasing interest among schools of education in offering more technology-based instruction training? Are there model technology education courses in place at the nation's colleges and universities that could be emulated by others? Do any states license exams measure a prospective teacher's knowledge of technology? Are most in-service technology training courses offered at the school or at another site, and who provides the training? Are states developing statewide plans for coordinated integration of technology into the curriculum and if so, are teacher training programs crucial to the plans? What is the proper federal role in providing professional development to teachers regarding the role of technology in the classroom?

Abdal-Haqq, (1989), identified a number of promising emerging trends in teacher education. These included (1) research based, reflecting a reform trend that roots school improvement efforts in theoretical soil; (2) preparing teachers to examine and assess their own practice, to become inquiring, reflective practitioners; (3) emphasizing collegiality; (4) preparing teachers to participate in decision making on varied school issues; and (5) helping teachers to qualify for professional advancement through differentiated staffing programs. Abdal-Haqq did not reference any use of technology in this review.

Monk (1989) reviewed the use of technology and distance learning in small rural schools and concluded that teacher training was the most substantive problem in the use of technology to improve curriculum.

Means et al (1993) observed that there are a number of challenges for teachers using technology as a critical part of an inquiry-oriented learning-teaching process. "Challenges include learning how to use a variety of technology applications; using, adapting, and designing technology-enhanced curricula to meet students' needs; expanding content knowledge; taking on new roles; and responding to individual students. None of theses challenges stand alone; they are tightly interrelated." They (Means, et al ,1993) recommend that technology use should force teachers to pose questions such as: What does the technology offer my students in terms of developing concepts and content? How does it help them to carry out inquiry processes? How will they work together collaboratively or cooperatively? What is the relationship between the technology and other instructional materials? What knowledge, processes and skills do students need before using the technology? What new knowledge of my content or discipline, of teaching or of technology do I need in order to foster new learning in my students?"

When teachers become facilitators and develop inquiry-based curricula that integrate technology, "their role in the classroom becomes more that of a coach, or facilitator of student learning (Means, et al, 1993). In inquiry-based learning, teachers set the context, help students pose questions to explore, stimulate problem solving and give students tools and resources to use so that the students can construct knowledge. The knowledge construction process takes place within an individual student; it is highly individualistic because of the knowledge maker's prior knowledge, experience, skills and talent. Teachers cannot and should not expect to have a total grasp of the content related to every topic. What they do need to know is how to help guide students through the meaning-making process: how to ask probing questions, how to connect students to relevant resources, how to organize students into cooperative learning groups, and how to give them tools to store, manipulate and analyze information."

Teachers may feel awkward in this new situation. One does not move from being a teacher to a facilitator overnight, although this is often the expectation. "They feel vulnerable as they take the risk of shifting from a more comfortable knowledge transmission mode of teaching to inquiry-based teaching" (Means, et al, 1993). The conclusion (Means, et al, 1993) is that our initial enthusiasm for technology (especially computers) and the prediction that teacher's jobs would be easier so that they could spend time with students was naive. "Teachers are nearly unanimous in concluding that in the early stages of technology implementation, at least, their job becomes harder." Yet teachers continue to use technology "because they sense that their students are learning more and approaching their classroom activities with a heightened level of motivation. The skills that teachers acquire and the "satisfaction of facing a challenge and overcoming it, add to teachers' sense of professional growth."

Russell, Sorge and Brickner (1994) contend that their experience has clearly delineated the steps necessary to successfully change the way technology is used in schools. Mandates have "often forced teachers into premature use of technology for the sake of using it rather than because it performed a genuine instructional functions." The steps include:

- Workshops distributed throughout the academic year that demonstrate integration of emerging technologies in education, cooperative learning techniques and strategies for implementing technology in classrooms;
- On-site visits between workshops, which include interaction with teachers, classroom observations, assistance with instruction and modeling of technology implementation;
- Proposal development to obtain funds for further implementing technology;
- Workshop goals are to equip teachers to select, implement and assess the effectiveness of technology in teaching; assist schools in the grassroots integration of technology into their curricula and to develop a plan for technology implementation; discuss the process of implementing technology; demonstrate strategies for successful technology implementation; present the effective uses of various types of technology; and describe student-assessment techniques that are appropriate for use with various technology initiatives.
- Teachers are taught to implement instructional technology using the ASSURE Model (Heinrich et al, 1993), "A Model to Help ASSURE Learning" a mimetic device that means:

A Analyze Learners

S State Objectives

S Select Media and Materials

U Utilize Media and Materials

R Require Learner Participation

E Evaluate and Revise

Sammons (1994) reports on a program at Wright State University that began in 1991, but still had only about four percent utilization by faculty in early 1994. Sammons asserts that, "Higher education has lagged behind primary and secondary education in incorporating multimedia into both teaching and learning. The literature suggests that college faculty in general are slow to integrate new technology into the instructional process. Studies also indicate that the traditional faculty lecture mainly relies on the blackboard and overheads with occasional slides." In a survey, faculty reported that they were reluctant to use multimedia because they perceived they

did not have equipment, lack of time to develop materials, lack of knowledge about multimedia or how it will help in the teaching and learning process and uncertainty about which material to incorporate into a multimedia lecture. Sammons recommends making the equipment more visible, providing hands-on seminars that last about two hours, provide time to produce multimedia...and start with simple computer presentations that allow faculty to grow into their use of multimedia.

Beatty and Fissel (1993) reported that after four years of operation of the Ball State University Video Information System which provides classrooms with a voice, video and data system, the faculty "have adapted to the new technology and many have added visual components to class material traditionally taught by straight lecture. System use has grown each year as faculty discovered new ways to employ technology in the classroom." They also say that on the whole, teachers were less dependent on linear forms of pedagogy and searched for cooperative learning strategies that took advantage of the information system. Beatty and Fissel believe that when educational technology is supported by far-sighted administration, it can "empower faculty to achieve classroom successes that no one anticipated." Faculty have determined curriculum development and the technology evolved as dictated by their needs. "The impetus has come from the teachers" and "student evaluation of the system has helped assess the pedagogical value of faculty innovations" so that "teachers and students are, together, creating the campus of the future."

Hirschbuhl and Faseyitan (1994) assert that faculty "should be trained in the use of computers and demonstrate a willingness to adopt computers for instructional purposes before the university launches a technology project. Instructor training should include a specific focus on how to design instructional content for the intended media; this is especially true for multimedia projects as the requirements for integrating video, audio, animations and graphics are fairly technical. Once having successfully finished one project, an educator's confidence and enthusiasm will increase exponentially and less support will be required. Decision makers should heed this 'train first' principle."

The Center for Professional Development and Technology at Southwest Texas State University has assessed the teacher training projects conducted there. Various evaluative studies have assessed the impact of the center on teacher preparation, professional growth and student learning. They report (Curtin, et al, 1994) that technology alters teaching. Project teachers report more independent student work, a transition to more student-centered classrooms, and more cooperative efforts among students. The evaluation showed that technology can serve teachers. Regardless of current skill levels, teachers see the technological skills that they have learned as very applicable to their job requirements. They report that technology invigorates learning. Elementary students believe that after technology was incorporated into their classes, the classes were different and more fun assignments were done faster and better, and more resources were available. One teacher said that students "were especially excited about coming up with their own things to do." Another teacher said that "the computer especially helps the slower kids, getting them excited about learning and introducing other avenues for them." The evaluation also showed that parents support the use of technology and were very aware of the technological advances that their children were using. Parents believed that the children were achieving more academically than in past years. One parent said, "My child cannot be more enthusiastic about school and learning than she is now."

In 1994 (DeLoughry) reported on the American Association for Higher Education's (AAHE) new interest in determining how computer and other technologies can help bring about the teaching reforms it has long sought. DeLoughry says the Association's new thinking is significant because "it promises to bring advocates for technology who have operated on the periphery of higher education together with the faculty members, provosts and presidents who have influence over teaching and who are involved in the organization's conferences and other

activities." It is the first large-scale effort on the part of a leading higher-education group to deal with issues related to technology. DeLoughry cites CAUSE and EDUCOM as other organizations involved with these issues. Stephen Gilbert, AAHE director of technology projects, said he believes that info tech will be embraced "eventually by higher ed, but that we need to facilitate that process by focusing first on the educational and scholarly needs of faculty." According to information collected by AAHE, only about one-third of all college campuses have teaching improvement centers; many were not established until after 1988.

DeLoughry (1994) observes that other organizations are "clamoring behind" AAHE as technology becomes more of a mainstream topic in higher education. "The Association of American Colleges and Universities had several sessions related to technology at its annual meeting in January. The National Association of State Universities and land-Grant Colleges has an information-technology council that has been involved in monitoring federal legislation that could affect the growth of computer networks in academe. The Association of American Universities has been working with the Association of Research Libraries to explore the potential impact of technology on scholarly publishing. And the American Association of State Colleges and Universities is conducting a poll of its members to determine what kinds of technology they have and how they are using them. Honey and Henriquez (1993) studied the impact of telecommunications on teaching. Slightly more than two thirds of the educators felt that integrating telecommunications activities into their teaching has made a real difference in how they teach. However, when compared to the difference that integrating computers into teaching made for educators in the "Accomplished Teachers" study (Sheingold and Hadley, 1990), the impact of telecommunications on how teachers teach was less pronounced. In the earlier study, 88 percent of the sample indicated that computers made a difference in their teaching, compared to 68 percent in the telecommunications survey.

In the earlier study (Sheingold and Hadley, 1990) , most respondents reported that computer technology had an impact on multiple aspects of their teaching. Teachers' expectations of their students' ability to pursue independent work increased; they spent more time working with individual students; and they were more comfortable with students' working independently. They reported that computers allowed them to present more complex material to students and tailor students' work to individual needs. When these same questions were posed to educators in the telecommunications survey, the impact of this technology on their teaching practices was significantly different from the Accomplished Teachers study (Sheingold and Hadley, 1990). There are at least two possible explanations for this difference (Honey and Henriquez, 1993).

One explanation is that educators' use of telecommunications technology directly affects what students learn as well as the quality of teachers' professional lives, and does not affect as directly teachers' pedagogical practices. And indeed, the most highly rated incentives for using telecommunications for student learning and professional development support this assertion. Telecommunications broadens students' perspectives on the world, and provides access to information that would not otherwise be available. Telecommunications has an impact on what teachers teach, not necessarily how they teach. One teacher wrote that, "Topics are of a more global significance. I require students to apply higher level thinking skills of analysis and synthesis." A second explanation centers on their sophistication with computer technology. The majority of these respondents have been using computers in teaching for years and may have already undergone significant changes in the way they teach. To the extent that they have taken place, changes in these educators' pedagogical practices came with the integration of computers into their teaching (Honey and Henriquez, 1993).

Current approaches to general staff development implicitly use a model of experts giving teachers information (Tushnet, et al, 1993). Distance learning technologies allow all teachers to have access to expensive consultants and lower costs to each. At the same time, as now used, the technology facilitates imparting information to teachers as passive recipients. The

effectiveness of staff development is likely to increase if projects provide intermediate support to participating schools and provide for more interaction among teachers and other school staff. Such support can come in the form of technical assistance from distance learning providers who can use the interactive aspects of the technologies to foster "learning communities." Computer networks may support teleconferencing and other approaches to staff development.

Within the Star Schools Program, at least three Funding Cycle One and Two projects have worked to demonstrate the uses of varieties of distance learning technologies to reform education (Tushnet, et al, 1993). This focus is even more evident in Cycle Three. One finding from the first year of the Star Schools study is that using technology to support educational reform requires a different approach from using technology to equalize educational opportunity. In the latter instance, personnel at the receiving school need moderate amounts of technical support, which all Star Schools projects provided with a high degree of professionalism and attention to the field. In contrast, using technology to reform education requires greater amount of support at the school site. The approach requires collaboration with teachers so they become comfortable with the technology, understand the cognitive and pedagogical demands of the reform and are able to use the curriculum and instructional methods to advance student learning.

Projects working on reform require time to develop educational applications of technology (Tushnet, et al, 1993). When they bring innovative technology to teachers, it should be as "bug free" as possible, which entails fairly extensive field tests. The materials and approaches also must meet high standards, which rely on rigorous quality control that includes content experts. In addition, because educational reform rests on teachers' approaches to curriculum and instruction, they should be supported in their efforts to use technology and change educational practice. Regular and intensive staff development provides such support. Indeed, among the Star Schools-sponsored activities that aimed at educational reform, the most successful projects used well-developed technology and provided fairly intensive ongoing support at the site level.

Just as we expect students to go through a process of learning, we should also allow teachers the same privilege. The reality is that teachers receive limited in-service that is counted in days per year, and their pre-service experiences in a school of education were provided by faculty members who were role models for the traditional stand-up and lecture role model. Providing meaningful in-service in the new instructional methods and uses of technology has been a problem. However, research emanating from the TEAMS Star Schools Program in Los Angeles County has presented a significant new model (Lane, Cassidy, and Lake, 1994). This Three-Tier Distance Learning Staff Development Model developed for TEAMS Distance Learning by Sheila Cassidy in 1990 includes:

- **Theoretical Training**: information, theory, demonstration and two-way communication about the theoretical basis of the instruction and training.
- **Implementation Training**: theory, demonstration, practice and peer discussion of curriculum and instructional methods involved in the student programming, providing training to implement the student programs.
- **Simultaneous Teacher Training and Student Instruction:** teacher training through in-class experience, practice and support from the studio team-teacher, through live, interactive student instructional programs.

The pattern that emerged during the evaluation has the potential to create a new model for teacher pre-service and in-service, because the model actually creates change in the classroom, as can be seen from a summary of the results.

TEAMS teachers reported in the survey that they viewed the TEAMS television teacher as a role model (on a scale of one to four where four was high, first year mean 3.9; second year mean 3.6; third year mean 3.7).

First year TEAMS teachers reported that there was a great deal of preparation for TEAMS. First year TEAMS teachers who used the program on videotape usually previewed the tape. First year TEAMS teachers reported that they felt that the TEAMS programs required a lot of work on their part to learn the new instructional methods, but they felt it was worthwhile because their students were learning so much more.

Second year TEAMS teachers reported that they had to prepare less for TEAMS programs as they now knew what the programming contained and understood the instructional methods. During this year, they reported a higher comfort level with the instructional methods, so much so that they used the same methods collaborative learning, hands-on, and discovery methods in the other content that they presented to students for math or science. Many teachers reported that the TEAMS television teacher was a role model who provided step by step guidance in presenting material to students. Teachers reported that they received more usable information on new instructional methods through TEAMS programming than through in-service seminars.

Third year TEAMS teachers reported that they were very comfortable with TEAMS programming and instructional methods. They spent very little time gathering the materials for the class for TEAMS programs, and felt that the instructional methods had become natural components of their teaching style. They had become so immersed in the new methods that they used the methods in all content areas that they taught.

Using TEAMS has effectively provided teachers with new methods which they use because they have watched the TEAMS television teacher demonstrating the methods and have had opportunities to practice them in their own classrooms with their own students before, during and after the student programs. These results were reported across the United States at all evaluation sites as well as in the surveys. Principals also noted these changes in TEAMS teachers saying that TEAMS teachers showed more enthusiasm for math/science, a higher use of interactive and hands-on methods and that teachers were more confident of their ability to teach math and science. The survey question that dealt with planning and preparation for TEAMS also showed that teachers were increasingly comfortable with TEAMS.

The survey included one question which asked how well prepared teaches felt to use a variety of methods due to their TEAMS experiences and prior to their TEAMS use. Teachers reported an increase in the ability to teach heterogeneous groups, teach math/science in an active learning environment, manage a class of students who are using manipulatives, use cooperative learning in math/science instruction, involve parents in their child's math/science education, use the textbook as a resource rather than as the primary instructional tool, use a variety of alternative assessment strategies and follow national mathematics standards/science recommendations.

TEAMS was chosen by districts, principals and teachers for a variety of reasons including the fact that it was based on the mathematics and science standards/recommendations, hands-on procedures and distance delivery, which would enhance teaching and learning. Schools and teachers continued to use TEAMS in the second and third years because it fulfilled its original promise.

Students are learning from TEAMS. There are increases in skills in math and science content that TEAMS teachers can directly attribute to students viewing TEAMS programming and using TEAMS materials. Teachers reported that students who had difficulty learning about mathematics and science through other methods, were now learning from the TEAMS hands-on

methods and manipulatives. Students revealed in student focus groups that it was fun to learn with TEAMS as opposed to the "other" way which seemed to be the "hard" way. Teachers reported a positive change in student behavior even with normally disruptive students. Teachers reported increased self-esteem, increased attendance and an increased interest by girls in math/science.

Teachers reported that students became comfortable in using scientific inquiry, increased participation in science fairs and many selected a TEAMS topic for their science fair projects. Teachers reported that students are more interested and motivated to do math, including students who were lower achievers in math. They felt that there was more retention of math skills.

TEAMS has effectively provided teachers with new instructional methods by viewing the TEAMS television teacher during the student programming. The TEAMS model has changed the teaching styles and the instructional methods of TEAMS teachers by the time teachers have used TEAMS three years. The most significant changes in TEAMS teachers were achieved by those who used TEAMS on regular basis. Based on the information emerging from the TEAMS evaluation, it is possible to identify how the TEAMS program can be most successfully adopted by a district and its school.Teachers' ability increased in a variety of ways. Because of the TEAMS teaching model they reported increased skills in teaching heterogeneous groups, teaching math/science in an active learning environment, managing the student use of manipulatives, using cooperative learning in math/science instruction, involving parents in their child's math/science education, using the textbook as a resource rather than as the primary instructional tool, using a variety of alternative assessment strategies and following national mathematics standards/science recommendations.

Teachers, students, principals and TEAMS site coordinators reported that they liked TEAMS programming and that it was increasing the time allocated to math and science in the classroom. Teachers increased their class time in math and science by an average of four hours per week.

TEAMS motivates students to learn math and science because they enjoy it and because it maintains their enthusiasm through interaction with the TEAMS television teachers and the use of hands-on manipulatives for learning. TEAMS is also used as a taped program and the student learning in these classes is equivalent to that of the students who view the program live.

In a research study on interactive technologies for Apple Classrooms of Tomorrow (ACOT), students and teachers were provided with technology to use for a year in the classroom and at home. Part of the study focused on the evolution of classroom management in ACOT high-tech classrooms. Analysis of data suggested a three-stage model of development that reflects teacher concerns about classroom management: survival, mastery and impact (Dwyer, et al, 1990).

In the survival stage, according to the ACOT study, teachers are "preoccupied with their own adequacy. The concerns center on their ability to control the class and they spend considerable time reacting to problems instead of anticipating and avoiding them. In the mastery stage, they begin to anticipate problems and develop strategies for solving them. Finally, in the impact stage, teachers focus on the effects of their teaching on students' achievement and attitudes, and begin to use the technology to their advantage" (Dwyer, et al, 1990).

"Evidence of moving from stage to stage is not always clear cut, however, as individuals may vacillate between phases. For instance, in this study, by the second year, most teachers had learned to expect occasional technological problems, such as disk failures or network bombs,

and planned accordingly. Yet, when new software, hardware or students arrived on the scene, many teachers temporarily reverted back to the survival stage" (Dwyer, et al, 1990).

The Education Coalition (TEC) Staff Development Model: The TEC Staff Development Model is a unique and unprecedented collaboration between the TEC Schools of Education, K-12, broadcast, cultural and historical Affiliate Agencies. This collaborative model provides an environment for these Affiliate Agencies to work together to design distance learning program series and courses for pre-service and in-service teachers, students, parents and community (Lane and Cassidy, 1994).

The series and courses integrate live-interactive teleconferences with computer-based conferencing and information access and audio conferencing. This model provides for national resources of many types to be used for local training and development. The TEC model, incorporating inter-agency collaboration and multiple technologies, is an expansion of the Three-Tier Distance Learning Staff Development Model used by TEAMS Distance Learning, including: theoretical training; implementation training; and simultaneous teacher training and student instruction.

Overall, this approach answers many of the problems related to traditional staff development design, in that it:

- is long term, sequential training
- fosters immediate transfer of learning, with skills becoming a part of the teacher's repertoire of instructional methods
- is conducted mostly in the teacher's own classroom during the school day
- creates immediate changes in the roles of the teacher and student
- provides opportunities for teachers to see their own students being successful with a rich and challenging curriculum, allowing them to change their attitudes and behaviors related to instruction and expectations of their students
- provides motivation for teachers to participate in other staff development after the regular school day because it is directly related to their classroom program

This model is based on research and practice in the fields of staff development and adult learning, as well as national and state standards and guidelines. The basis of the staff development research is formed by the work of Joyce and Showers (1988), Cassidy and Taira (1988, 1989) and the Rand Corporation (Berman and McLaughlin, 1978). The adult learning principles are summarized in work by Jones and Woodcock (1984) and Knowles (1975, 1984).

The staff development research (Joyce & Showers, 1988) provides insights on the relationship between training outcomes and specific training components. They analyzed the training outcomes of knowledge, skill and transfer of training for participants engaged in training programs options providing:

- information
- theory
- demonstration
- theory and demonstration
- theory and practice
- theory, demonstration and practice
- theory, demonstration, practice and feedback
- theory, demonstration, practice, feedback and coaching in participants

Their research clearly shows that training which provides only information and theory produces only increased knowledge. That by encompassing any of options four through eight shows greater knowledge and skill outcomes. Option eight provides the greatest outcomes in knowledge, skills and transfer of training. Practice, feedback and coaching can be considered an in-classroom, on the job, experiential and support component.

This model provides a distance learning alternative to option eight. It clearly provides theory, demonstration and practice. Although distance learning cannot provide a full face-to-face feedback and coaching component, part of what feedback and coaching provides is an in-class support system. That is provided through the in-class team teaching with the studio instructor.

In retraining of teachers, Cassidy and Taira (1988, 1989) found that teachers reported the factors which contributed to their success were: a sound theoretical basis; experience and practice with the particular curriculum and instruction being adopted/adapted; a support system designed specifically to their needs; convenience, with training during the school day and at their site when possible; training with no expense to teachers. The simultaneous in-class training component meets all of these criteria. The Rand Corporation found that successful projects had these common characteristics for staff development (Berman and McLaughlin, 1978):

- training is concrete, continual, and tied to the world of the teacher
- local resource personnel provide direct follow-up assistance
- peer observation and discussion provide teachers with reinforcement and encouragement
- school leader participates in staff development
- regular meetings held with teachers for problem solving and adapting techniques and skills of the innovation
- release time used for teacher staff development
- staff development planned with teachers prior to and during the project

Cassidy (1985) reviewed programs with findings similar to the Rand study but with additional information.

- individualized staff development activities are more effective than large-group activities
- programs incorporating demonstrations, trials and feedback of ideas are more effective than lecturing and reading of ideas
- staff development programs are more successful when teachers are active planners and help each other.

During an investigation by Lane (1993), the Three-Tier approach was shown to be highly successful with changing attitudes and behaviors of students and teachers. In an earlier national investigation, Lane (1989) found that distance learning educators were not using self-directed learning, facilitation, hands-on or other elements of constructivism or andragogy in either selecting distance learning programs or in developing such programs. A second national study (Lane, 1992, p 211-215) ultimately led to national standards which won the Teleconference Magazine "Most Significant Advance in Distance Learning Overall 1991." Based upon the results of that research, program providers would need to meet at least 85 percent of the criteria in each section to meet national quality standards. The educational objectives included providing specific learning experiences and skill transfer, small group work, learning outcomes, andragogy and a variety of presentation techniques to reach varied learning styles (visual, auditory, experiential, tactile). In research on audio conferencing for instruction (Lane, 1992, p 224-231) it was shown that this medium provides a useful method of interaction with the facilitator in structuring national programming.

Conclusions

Systemic reform of education and training is built upon a number of converging events. This study reviewed the literature in the areas that directly affect systemic reform, and concludes with recommendations that will enable technology to play a significant role in this movement. Literature from the following areas were reviewed: paradigms, change strategies, systemic reform, constructivism, student empowerment, andragogy, Goals 2000, legislation, equitable access, current use of technology in education, technology as a force for systemic reform, technology's potential as a partner and tool for systemic reform, new ways to think about the use of technology for education, problem-based learning, competing in the global economy, total quality management in education, evaluation through performance based assessment, using the national information infrastructure for education and training and instructor in-service and pre-service.

Paradigm Shift: Teaching and learning in American schools looks very much as it did a century ago, leaving students and society economically and socially at risk. We have entered a time of great societal and technological change which indicates a paradigm shift. We have moved into the Information age and may have moved into the Communications Age. These changes will continue to impact our educational institutions in ways of ever increasing magnitude, making systemic reform inevitable. Total Quality management and theory are a part of systemic reform.

Change Models and Change Agents: There are a variety of change models which can be used to plan for systemic reform. Just as young scientist, "outsiders," are instrumental in scientific paradigm shifts, conceptualization of educational systemic reform will be influenced by those inside as well as those outside of our traditional educational institutions. Change agents looking at education in non-traditional ways will play a vital role in the conceptualization of a vision for second order change.

Learning Models: Constructivism, student empowerment and andragogy models for learning provide a basis for systemic reform. Each of these models views the learner as responsible and able to learn, capitalizing on strengths, rather than working from deficits. Even though andragogy is an adult learning theory, younger learners should be thought of as developing on a continuum, coming closer and closer to adult learning. Therefore, the principles of andragogy may be applied to younger learners to the extent that is developmentally appropriate. Students should be taught about the learning models so that they understand their responsibilities in becoming self-directed, proactive learners. Students who are suddenly moved from a teaching style to a facilitation style will need time to process this information, learn new behaviors and understand what is expected of them. Cognitive dissonance is common during the transition period as they have come to expect certain things from teachers that will not be done with facilitation. This is true for all learners regardless of their age. Problem based learning, authentic learning and authentic assessment are integral parts of these learning models. Educational technology is an excellent way to support and enhance these models.

Learning Styles: It has become accepted that students learn in different ways and that teachers must provide instructional methods that reach the learning styles of all students. Students should be taught about their learning style preferences and guided in selecting materials that will help them learn. Students should also be encouraged to develop methods that will help them learn in their non-preferred learning style. Teachers should know what their personal learning style is and what their teaching style is so that they can avoid a mismatch in working with students. Parents should also have information about their child's learning style and how they can guide the child in learning. Educational technology is an excellent way to support and enhance students' learning styles.

Policy and Legislation: Goals 2000 and The Goals 2000: Educate America Act provide a framework for movement toward national systemic reform. Passage of the legislation has brought greater understanding to the problems education has faced and the importance it carries in continuing to transform national fiscal goals into reality. The legislation carries with it significant funding that will enable education to meet goals in the short term. Long term funding for education is in question. The 1994 Communications Act provides a significant quantity of information access, but funding to pay for the equipment and access charges will come from local and state legislation.

Equitable Access: Equity of access and opportunities to learn will continue to be the driving force in providing technology to learners so that a nation of haves and have-nots does not further burden the tax system. The uses of educational technologies for adult literacy programs, immigrants, workplace skills for those on welfare and education for the prison population are promising, but these populations are virtually untouched by educational technologies. Once educational technology is accepted and the research continues to mount in its favor, it is anticipated that these populations will be the next recipients of the benefits of educational technologies.

Educational Technology: Technology is both a force pushing us toward systemic reform and a partner and tool in reform. The environment has been set to create the paradigm shift, but to maintain the forward thrust, other factors must be in place. There must be a clear understanding that technology changes the context in which education takes places. It allows educators to think differently about how and where learning takes place and what "basic education" needs to be in a world driven by technology but where terms such as distance education and computer mediated learning still have to be explained to otherwise enlightened members of society.

Systemic reform necessitates:

- Redefinition of the educational community, the roles and relationships between the partners in that community
- Restructuring of curriculum, instruction and assessment
- Redefinition of the structures and technologies of "school," recognizing that it is one player in the educational process
- Redefinition of where learning takes place and what it means to be "educated"
- Time for teachers to learn to use technology, to experiment with its use and to create effective lesson plans that contribute to the learning needs of students.
- Consistent access to a range of similar technologies at all levels of education for teachers and students, in schools, individual classrooms, libraries, home and the workplace
- Ongoing needs assessment and evaluation of technology use, with recommendations for continuing improvement to meet the needs of the community and the workplace.

National Information Infrastructure (NII): The National Information Infrastructure will provide vast opportunities for learning and collaboration for learners when they gain access. Continuing improvement and innovation will lead to a convergence of media video, data, audio and document manipulation, simulations and virtual environments will become dominant. Ease of use through user interfaces will attract more users.

Competing in the Global Economy: Educators need to fully understand the needs of employers. Collaborative planning for local needs between employers and educational institutions will enhance understanding, support planning and lead to curricula that support these needs as well as academic pursuits. Students should have access to the same types of

technologies as those used in the work place. Ongoing analyses and evaluation of graduates should lead to curricula that meet the changing needs of the workplace. Trainers should use adult education instructional methods, and focus on programs that develop employees ability to learn (learning how to learn), self-directed and proactive learning with intrinsic rather than extrinsic reward systems.

Instructor Pre-Service and In-Service: K-12 teachers and faculty at colleges, universities and other adult education programs need to receive education about the academic theory of distance education, effective uses of educational technologies, learning styles, learning models and systemic reform. These should be provided by schools of education. Just as teachers perform a practicum in the real classroom, they should also perform a practicum where they work with all forms of educational technologies. Educational technologies and their effective use should be required core courses provided by schools of education. Certification should be required in educational technology in all certification areas. Colleges and universities should include effective use of educational technologies as a requirement for tenure and continuing employment for full-time and adjunct faculty. College and university faculty should act as role models for new instructional methods that support systemic reform and the use of educational technologies.

Systemic Reform: The model that has emerged for technology to have a significant impact on systemic reform is multi-faceted. A number of forces must continue, and others must be successfully operationalized for technology to impact systemic reform. Without operationalizing all of these factors, educational technologies will continue on the periphery of education as alternative education. If the factors move into place and begin to develop a synergy, educational technologies will move into the mainstream of education and training and will be a powerful force and partner in how we learn in the future. In order to use technology wisely for systemic reform, we need to project answers to the following questions.

Technology

- Will the technology continue to improve?
- Will the cost of technology continue to drop?
- How can the pace of technology adoption by industry and education be brought more closely together?
- How fast will technology change society?
- Have we underestimated the magnitude of technologies' eventual effects?

Policy/Legislation and Funding

- Will the National Information Infrastructure be built to include education as a major partner?
- Will legislation for systemic reform continue to be supported by sufficient funding?
- Will the administration and government continue to support technology in general and educational technology in particular?
- Will education be treated as a system which includes parents as first teachers, pre-school programs, college and continuing education for lifelong learning?
- How can we ensure that media are not used to shape instructional messages in unwanted ways?

Teaching

- Will schools of education embrace new instructional methods and technology and act as the role model for faculty and students?

- Will the use of technology receive grass roots support from educators?
- Will education successfully adopt the innovation of technology?
- Will educators receive sufficient training, time and continuing support in uses of ed technology?

Learning - Technology Applications

- Will research continue to support the use of technology as an effective educational method?
- Will educational technologies change the place where education is delivered from the school to the home and workplace?

Futuring

- What other factors should be included to sustain the paradigm shift?
- Are we encountering a significantly quickened pace between Ages?
- How can change be easier to accept
- Will the Millennium have the expected impact?
- What other questions should be asked?

It is obvious that the technology will continue to improve and the costs will continue to drop as more units move to the end user. It is likely that the use of technology for education will continue to be sustained through research that shows learning does take place as well through technology as it has through traditional methods.

There is no current evidence to support the hope that all schools of education will embrace the use of technology. The Goals 2000 legislation will need to be re-authorized in the future. Goals 2000 includes a technology component, but there is not enough legislated funding to support full use of technology in all classrooms. The in-service for educators is minimally supported now and new legislation does not provide substantial amounts of funding to provide sufficient in-service for all educators. As such, it is doubtful that a true grass roots movement for the use of technology will be supported by rank and file faculty members. The problem here is that the use of technology represents a personal change (re-learning), an increase in personal productivity through technology, insufficient release time to learn the technology and new instructional methods, and a personal threat to the importance of the job of teaching. Because few teachers have made the change to becoming facilitators of learning (sage on the stage, to the coach on the side), they perceive the use of technology and facilitation as a loss of personal empowerment - rather than the more positive side - where students are empowered to construct their own knowledge.

While future administrations and government will continue to support technology and build a National Information Infrastructure, it is doubtful that the 1994 Communications Act will enable the use of the NII to the extent that it could be used for education. Congress will not impose more than a token amount of wiring for education on the telecommunications companies. Lower rates for telecommunications services will enable more use of technology for education. The true problem for most schools will be wiring the buildings with sufficient bandwidth to provide access for learners and teachers. Most schools have only two telephone lines at this writing and it is unlikely that this will increase to ten telephone lines in the near future. The question of universal access comes into play here. The 1934 Communications Act, required that universal access be provided throughout the United States - except to schools. As a result, sixty years later, schools do not have the same universal access that the rest of the country enjoys.

It does seem likely that education will be perceived and treated as a system rather than the fragmented components that make up the system now. Pre-school, elementary, middle school, junior high, high school, community colleges, vocational education, universities, continuing education, and industry training make up the largest pieces of the pie now. There is a jumble of administration offices to deal with education including the local school, district, county, region, and state department of education. Many collaborations have been put into place because they "are rooted in the belief that the two entities need each other to achieve the goals they hold in common" (Ishler, 1994). Ishler states that if students are not given the proper foundation in the first twelve years, there is no prospect that they can be successful when they enter college.

Each higher education system is fragmented as well. While a local community college may be autonomous, part of a community college district, or part of a statewide system, a state's university system is also fragmented between the land-grant university system, and the state college system with each vying for the minimal funds distributed by the state for higher education. Vocational education is also a part of the mix, as are the schools managed by the Bureau of Indian Affairs, and the defense schools for children of military personnel. Special education plays a significant part in the mix along with adult basic education (ABE), general equivalency degree programs (GED) and English as a second language (ESL) programs. Private educational institutions are involved at all levels.

At the corporate and industry level, training department have characterized their operations as being the trainer of last resort in providing basic skills programs and re-training programs. The downsizing of the military has also heaped additional pressures on an already overworked system.

Poverty programs operate within the educational system with notable programs such as Chapter I and Chapter II programs, Pell grants provide funding within the system for students or provide funding to pay into the system for tuition.

Arguably, all elements of education are not included in the previous paragraphs. The question is, how will all of these groups be treated equally so as to provide equitable access and how will they begin to work together? How will each of these groups use technology to promote and advance their movement through systemic reform? As students move into and out of each system, what guarantee is there that the technology will be consistently available so that students will be able to move easily through the system?

Within the next ten years technological advances will be monumental. Four factors which should impact the learning environment are:

- voice, data and video delivered into homes, community learning centers, workplaces via cable television
- access to worldwide information via telecommunications
- access to worldwide dialogue via telecommunications
- learning through entertainment-like devices

To date, it is clear that technology has played a minor role in changing schools in what Conley calls renewal activities -- helping schools to do what they already do better or more efficiently. It is also evident that technology has played an even lessor role in the restructuring of schools.

It is time to let the genie out of the bottle -- to transform education as it is transforming the world in which we live. It is time for the broad American educational community to be creative in what it wishes for to reinvent the educational system, and to specify how technology can be used as a powerful force to create it! The technological genie provides a need, opportunities and

resources for truly "break the mold" systemic reform. In the larger sense, the genie is creating a global learning environment in which "schools" of some type will play an important role, but one which will take on different dimensions, new structures, new relationships, and new practices. Schools are but one of the places and ways in which learning occurs. Soon -- as the genie advances-- homes, libraries, community centers, workplaces, and recreational areas will provide opportunities for greater educational access -- if we meet the challenges to use them for truly educational purposes. Schools will change as technology changes the world in which they exist. It's even possible that schools won't exist as they do today, and that we may call that a cause for celebration.

Under the command of effective instructors, the technological genie can lessen the isolation and unidimensionality of schools as we now know them. It can provide opportunities for access, dialogue and resources for learners of all ages from rural to urban America as well as global study groups. It can help to create a seamless, lifelong process of education, with public and private agencies working together to provide an array of learning opportunities and a multitude of learning options. Teachers and students will learn together through sharing of resources and interacting with peers and experts in a variety of fields. Individuals from a variety of agencies will be able to work together on issues of common concern. K-12 educators need not be separated from post-secondary educators -- all can work to better meet the needs of a growing and diverse student population. Education will become an open road map for learners to explore rather than a one lane road that all must travel.

Through multiple technologies learners will have access to real-world problems, thus providing them with an environment rich for exploration and use of problem-based learning, with students and teachers working as colleagues on the problem-solving teams. Learners will assume the role of investigators --bringing to bear interdisciplinary content information to the solution of the problems. They will contribute their ideas for solutions to those formulated by others throughout the country and world.

Distance learning brings a new model for teacher training, teacher support and systemic reform. It can now provide easy access through television and computer conferencing to course work to prepare teachers in the use of instructional applications of technology, in moving into systemic reform, in developing new expertise in problem-based learning, in developing authentic instruction and assessment moving students toward lifelong learning outcomes, and to provide a support structure of and for teachers throughout the country.

All of these are at hand. Now is the time to envision what is possible, unleash the power of the genie, and direct the use of technology toward the accomplishment of these ends. Distance learning has changed. It is being used more extensively by more organizations and learners. It is using more technologies.

Dede (1991) said that "Advanced information technologies are transforming society, altering our conceptions of quality, effectiveness, and intelligence. These shifts require profound changes in every aspect of our current educational model. Because new functionalities are altering the characteristics of the communications channel between student and subject, distance learning is particularly affected." He suggests that even our "paradigm for distance learning must evolve so that we can replicate the workplaces and communities of the future" in schools to help students master, filter, and interpret the "complex, pervasive informational environments that sophisticated media are creating in society." He contends that distance learning is not only a "method of delivering instructional services" but students familiarity with technology-permeated experience is vital for coping with the world tomorrow."

Starting is the hardest part, but we have over thirty years of demonstration projects and pilot programs behind us. The excitement that we wanted to bring to education through the use of

technology and new instructional methods that met all learning styles has now eclipsed us with its own synergy. The excitement is truly systemic reform, and its goals and those of educational technologists are well aligned. The old basic beliefs have been challenged and found to be lacking. Technology is a vehicle that helps us continue to challenge our beliefs and do things differently because it empowers the student and enables success for all learners.

References

Abdal-Haqq, Ismat (1989). The Influence of Reform on In-service Teacher Education. ERIC Digest. Clearinghouse Number: SP032647, Accession Number: ED322147

Amarel, Marianne (1983). Classrooms and computers as instructional settings.Theory into Practice, 22 (4), 260-266.

Anderson, R. D., Anderson, B. L., Varanka-Martin, M. A, Romagnano, L., Bielenberg, J., Flory, M., Mieras, B., and Whitworth, J. (1994). "Issues of Curriculum Reform in Science, Mathematics and Higher Order Thinking Across the Disciplines." Studies of Education Reform Program, US Department of Education, Office of Educational Research and Improvement, Office of Research. Washington, DC.

Aubaugh, Gordon (May, 1994) Address to the U.S. Department of Education, Secretary's Technology Conference, Washington, DC.

Bank, David (June 20, 1994). "Schools Look to Future," San Jose Mercury News. San Jose, CA., 1a, 15a.

Barker, Joel (1992). "Paradigms: The Business of Discovering the Future." New York, Harper.

Beane, James. (October 1991) "The Middle School: The Natural Home of the Integrated Curriculum." Educational Leadership 49,2, 9-13.

Berman, Paul and McLaughlin, M. (1978). The Rand Corporation.

Beatty, Thomas R. and Fissel, Mark C. (October, 1993). "Teaching With a Fiber-Optic Media Network: How Faculty Adapt to New Technology." T.H.E. Journal, 82-84

Betts, Frank (April, 1994). "On the Birth of the Communication Age: A Conversation with David Thornburg." Educational Leadership.

Blanchard, Kenneth (February, 1994). Personal communication, Seminar, University of Phoenix, Online Division, San Francisco, CA.

Bonstingl, John Jay (1992). "The Quality Revolution in Education." Columbia, MD.

Bugliarello, George (1990). "Hyperintelligence: Humankind's Next Evolutionary Step." In Rethinking the Curriculum: Toward an Integrated, Interdisciplinary College Education, edited by Mary E. Clark and Sandra A. Wawrytko. New York: Greenwood Press

Borrell, Jerry. (September 1992). "America's Shame: How We've Abandoned Our Children's Future." MacWorld 9, 9

Cassidy, Sheila (1985). Unpublished manuscript.

Cassidy, Sheila and Taira, Susan. (1988). "Study of Bilingual Teacher Training Programs in California." Rancho Palos Verdes, CA; Educational Development Network.

Cassidy, Sheila and Taira, Susan. (1989) "Follow-Up to the 1988 Study," Rancho Palos Verdes, CA; Educational Development Network.

Cassidy, Sheila. (1990). "Three-Tier Distance Learning Staff Development Model for Teachers." TEAMS Handbook 1993-94.

Coates, Joseph F. (1977). "Aspects of Innovation: Public Policy Issues in Telecommunications Development," Telecommunications Policy, 1(3):11-13.

Cobb, P., Wood, T., Yackel, E. and McNeal, B. (1992). "Characteristics of Classroom Mathematics Traditions: An interactional Analysis. American Educational Research Journal, 29(3), 573-604

Cohen, D. K. (1988). "Educational technology and school organization. In R. S. Nickerson and P. P. Zodhiates (Eds.), Technology in education: Looking toward 2020 (pp. 231-264). Hillsdale, NJ: Erlbaum.

Collins, A., Brown, J. S., and Newman, S. E. (1989. Cognitive apprenticeship: Teaching the craft of reading, writing, and mathematics. In L. B. Resnick (Ed.), Knowing, learning, and instruction: Essays in honor of Robert Glaser (pp. 453-494). Hillsdale, NJ: Erlbaum.

Collins, Allan. (September 1991) "The Role of Computer Technology in Restructuring Schools." Phi Delta Kappan 73,1 : 28-36.

Cohen, Herb (May 1994) . "State of the Art: 1999," Training, S10. Computer Systems Policy Project (March, 1994). "Information Technology's Contribution to Lifelong Learning." Computer Systems Policy ProjectComputer Systems Policy Project, Washington, D.C.

Confrey, J. (1990). "What Constructivism Implies for Teaching." In R. B. Davis, C.A. Maher and N. Noddings (Eds.), Constructivist Views on the Teaching and Learning of Mathematics: Journal for Research in Mathematics Education, Monograph No. 4 (107-122). Reston, VA. NCTM.

Conley, David T. (1992) "Some Emerging Trends in School Restructuring. ERIC Digest, Number 67.

ERIC Clearinghouse on Educational Management, Eugene, OR. Office of Educational Research and Improvement (ED), Washington, DC. EDO-EA-91-9, ED343196

Conley, David T. (1993) Roadmap to Restructuring, ERIC Clearinghouse on Educational Management, University of Oregon.

Corporation for Public Broadcasting Spring (1991). " Study of School Uses of Television and Video." Alexandria, VA.

Cuban, L. (1986) "Teachers and machines: The classroom use of technology since 1920. New York: Teachers College Press.

Cummins, Jim (1989). "Empowering Minority Students." California Association for Bilingual Education. Sacramento, CA.

Curtin, Pat, Cochrane,Lucy, Avila, Linda, Adams, Laura, Kasper, Susan and Wubbena, Curtis (April, 1994). "A Quiet Revolution in Teacher Training." Educational Leadership.

David, Jane L. (September, 1991) "Restructuring and Technology: Partners in Change." Phi Delta Kappan 73, 1

Davidow, William H. and Malone, Michael S. (1992). The Virtual Corporation, New York, HarperColins.

Davis, R. B., Maher, C.A. and Noddings N. (1990) (Eds.), " Constructivist Views on the Teaching and Learning of Mathematics: Journal for Research in Mathematics Education, Monograph No. 4. Reston, VA. NCTM.

Dede, Christopher J. (March, 1991). "Emerging Technologies: Impacts on Distance Learning." In The Annals of the American Academy of Political and Social Science: Electronic Links for Learning. 146-158

DeLoughry, Thomas J. (May 11, 1994). "Stamp of Approval." The Chronicle of Higher Education

Dwyer, David C., Ringstaff, Cathy, Sandholtz, Judith Haymore (1990). "Teachers Beliefs and Practices Research Summary #8, Part I: Patterns of Change," Cupertino, CA, Apple Computer, Inc.

Elkmer-Dewitt, Philip. (May 20, 1991) "The Revolution That Fizzled." Time 137, 20

Farrell, Rod and Gring, Stephen (November, 1993). "Technology Strategically Planned: A Dismal or Bright Future?" T.H.E. Journal, 119-122.

Fitzsimmons, Ed (April 21, 1994) Presentation to TEAMS Distance Learning, Office of Science and Technology Policy, Executive Office of the President, Washington, DC.

Fletcher, Dexter J. (1994). "Effectiveness and Cost of Interactive Videodisc Instruction in Defense Training and Education." Institute for Defense Analyses, Alexandria VA

Fletcher, J. D. (1991). "Effectiveness and cost of interactive videodisc instruction. Machine Mediated Learning," 3, 361-385.

Fletcher, J. D., Hawley, D. E., and Piele, P. K. (1990). "Costs, effects, and utility of microcomputer assisted instruction in the classroom." American Educational Research Journal, 27, 783-806.

Fuller, Frances F. (1969). "Concerns of teachers: A developmental conceptualization." American Educational Research Journal, 6 (2), 207-226.

Hall, Gene E., & Loucks, Susan (1979). Teacher concerns as a basis for facilitating and personalizing staff development. In A. Lieberman and L. Miller (Eds.). Staff development: New demands, new realities, new perspectives. New York: Teachers Press.

Hammer, Michael and Champy, James (1993). "Regineering the Corporation. " New York, HarperCollins.

Hancock, Vicki, and Betts, Frank (April 1994). "From the Lagging to the Leading Edge." Educational Leadership.

Harasim, L. M. (1989). "Online Education: A New Domain." in R. Mason and A. Kaye (Eds). Mindweave, Communication, Computers and Distance Education. New York: Pergamon.

Harmon, Willis (1970). "An Incomplete Guide to the Future." New York, W. W. Norton.

Hawkins, Jan (March, 1991) "Technology-Mediated Communities for Learning: Designs and Consequences." In The Annals of the American Academy of Political and Social Science: Electronic Links for Learning. 159-174.

Hedegaard, Terri (1994). Learning online and on campus: A comparison of adult students' professional attitudes and values. Thesis, University of Phoenix, San Francisco, CA.

Heinrich, R., Molenda, M. and Russell, J.D. (1993). "Instructional meia and the New Technologies of Instruction (4th Ed.), New York, NY, Macmillan.

Hequet, Marc (May, 1994). "Should Every Worker Have a Line in the Information Stream." Training, 99-102.

Herman, J. L., Aschbacher, P. R., and Winters, L. (1992). "A Practical Guide to Alternative Assessment, Alexandria, VA: Association for Supervision and Curriculum Development, ED 352 389

Hirschbuhl, John J. and Faseyitan, Sunday O. (April, 1994). "Faculty Uses of Computers: Fears, Facts and Perceptions." T.H.E. Journal.

Hoffman, Ruth I. (1984). Recommended changes in the teacher preservice program to reflect computer technology and its impact on education. Educational Perspectives, 22 (4), 21-23.
Holmes Group. (1990). "Tomorrow's schools: Principles for the design of professional development schools." East Lansing, MI: Author.

Honey, M. and Henriquez, A. (1993). "Telecommunications and K-12 Educators: Findings from a National Survey." New York, NY: Bank Street College of Education.

Hsu, E. Y. F. (1990) "Running Management Game in a Computer Mediated Conferencing System: A Case of Collaborative Learning." Proceedings of the Third Symposium on Computer Mediated Communication. Guelph, Canada: University of Guelph.

Huey, John (June 27, 1994). "Waking Up to the New Economy." Fortune, 36-46.

Hundt, Reed (May 10, 1994) Speech to U.S. Department of Education, Secretary's Conference on Technology, Washington, DC.

Information Infrastructure Task Force (1994). "A Transformation of Learning: Use of the NII for Education and Lifelong Learning." Washington, DC.

International Society for Technology in Education (October, 1990). "Vision: Test. Final Report, Eugene OR: ISTE.

Investor's Business Daily (February 17, 1994)

Ishler, Richard E. (1994) "Together We Can make A Difference: Collaboration Between Schools and Universities," National Forum, The Phi Kappa Phi Journal, Spring 1994, Vol. Lxxiv, No. 2.

Jacobson (April 27, 1994a). "The Coming Revolution." The Chronicle of Higher Education.

Jacobson (July 6, 1994b) "Extending the Reach of 'Virtual' Classrooms." The Chronicle of Higher Education.

Johnstone, Sally (March 1991) . "Research on Telecommunicated Learning: Past, Present, and Future."

In The Annals of the American Academy of Political and Social Science: Electronic Links for Learning. 49-57.

Jones, John E. and Woodcock, Michael. (1984) "A Manual of Management Development"; Aldershot, Hampshire, England. Gower Publ. Ltd.

Joyce, Bruce & Showers, Beverly. (1988) "Student Achievement through Staff Development." New York: Longman, Inc.

Knowles, Malcolm (1975). "Self-directed learning: A guide for learners and teachers. "New York, Cambridge

Knowles, Malcolm (1984). "Andragogy in Action." San Francisco, Jossey-Bass Kuhn, Thomas S. (1970). "The Structure of Scientific Revolutions." Chicago: University of Chicago Press.

Kunin, Madeleine (May 10, 1994). Address at the U. S. Department of Education, Secretary's Conference on Technology, Washington, DC.

Lane, Carla (1989) "Development of a pre-adoption evaluation instrument for distance education telecourses."

Lane, Carla (1990) "Use of Audio Interaction in a Telecourse Offered by Satellite: Foundations of Adult Basic Education." Proceedings of the Midwest Research to Practice Conference.

Lane, Carla (1992) In "A Technical Guide to Tele-conferencing & Distance Learning." Portway, P. and Lane. C (Eds), Applied Business teleCommunications, San Ramon, CA.

Lane, Carla (1993) "1993 Evaluation of TEAMS (APOLLO 2000)."

Lane, Carla (May 25, 1994a) Testimony before the Senate Commerce Committee on S.1822, 1994 Communications Act.

Lane, Carla (1994b) First Year Evaluation of the TEAMS Program, 1992-93. Far West Laboratory, San Francisco, CA.

Lane, Carla and Cassidy, Sheila (June, 1994). "The Education Coalition (TEC) Staff Development Model ." The Education Coalition Quarterly, McLean, VA

Levin, Henry (May 1993). "The Economic Consequences of Undereducation": address to the second annual NEA Education Finance Workshop, Washington, DC.

Levine, M. (July-August, 1988). Professional practice schools: Teacher education reform or school restructuring, or both? Radius, 1(2), 1-7.

Levinson, Eliot. (October 1990) "Will Technology Transform Education or Will the Schools Co-Opt Technology?" Phi Delta Kappa 72, 2

Magnet, Myron (June 27, 1994). "The Productivity Payoff Arrives" Fortune, 79-84.

Mahlios, M., Moore, C., Barnes, D., Bell, H., Kachur, D., and Bettis, N. (1987, February). Master teacher model development program. Paper presented at the AACTE Annual Meeting, Washington, DC. ED 277 699

Majkowski, Charles (1990). "Developing Technology Applications for Transforming Curriculum and Instruction," Technology in Today's Schools, Association for Supervision and Curriculum.

Malley, Kenneth (May 25, 1994) Testimony before the Senate Commerce Committee, Washington, DC.

Melmed, Arthur (June 1993). "A Learning Infrastructure for All Americans." Fairfax, VA: Institute of Public Policy, George Mason University.

Martin, Lynn. (1991) "On Achieving Necessary Skills." U.S. Labor Secretary's Commission Report, Washington, DC.

Mason, Robin, (1989). Mindweave. Ed. R. Mason and A. Kaye. New York: Pergamon Press

Meyer, Alan; Geoffrey Brooks; and James Goes. Environmental Jolts and Industry Revolutions: Organizational Responses to Discontinuous Change. Strategic Management Journal 11 (1990)

Means, Barbara; Blando, John; Olson, Kerry; Middleton, Teresa; Morocco, Catherine Cobb; Remz, Arlene R; Zorfass, Judith. (1993) Using Technology to Support Education Reform, Office of Research, U.S. Department of Education, Washington, DC.
Means, Barbara and Olson, Kerry (April, 1994). "The Link Between Technology and Authentic Learning." Educational Leadership.

Milken, Michael (May 11, 1994). "Perspectives on Education Technology Married to Learning: a Millennial Wedding." Los Angeles Times.

Miller, Rockley L. (Date unknown) "Learning benefits of interactive technologies." The Videodisc Monitor.

Monk, David H. (1989) Using Technology To Improve the Curriculum of Small Rural Schools. ERIC Digest. Clearinghouse Number: RC017156. Accession Number: ED308 056

Naisbitt, J. (1982) Megatrends. New York: Warner Books.

National Council on Disability (March 4, 1993). "Study on the Financing of Assistive Technology Devices and Services for Individuals with Disabilities: A Report to the President and the Congress of the United States," Washington, DC

National Education Commission on Time and Learning (April, 1994). "Prisoners of Time" Report of the National Education Commission on Time and Learning, Washington, DC

Noddings, N. (1990). "Constructivism in mathematics education." In R. B. Davis, C.A. Maher and N. Noddings (Eds.), Constructivist Views on the Teaching and Learning of Mathematics: Journal for Research in Mathematics Education, Monograph No. 4. Reston, VA. NCTM.

Office of Technology Assessment, Congress of the United States (1992). Testing in American Schools: Asking the Right Questions. Washington, DC.: Government Printing Office. ED 340 770.

Ohler, Jason (March, 1991). "Why Distance Education?" In The Annals of the American Academy of Political and Social Science: Electronic Links for Learning. 22-34.

Orlansky, J., & String, J. (1979). "Cost-Effectiveness of Computer Based Instruction in Military Training, " (IDA Paper P-1375). Institute for Defense Analyses, Alexandria, Virginia.

Pearson, Virginia (1990). "Strategic Planning for Distance Education Programs." Dissertation, Oklahoma State University.

Peck, Kyle, L. and Dorricott, Denise (April, 1994). "Why Use Technology." Educational Leadership, 11-14.

Piele, P. K. (1989). The politics of technology utilization. In D. E. Mitchell & M. E. Goetz (Eds.), "Education politics for the new century: The twentieth anniversary yearbook of the Politics of Education Association (pp. 93-106). London: Falmer Press.

Princeton Survey Research Associates. (Spring, 1993) NEA Communications Survey.

Quinn, C. N., Mehan, H., Levin, J. A., and Black, S. D. (1983). "Real Education in Non-Real Time: The Use of Electronic Message Systems for Instruction." Instructional Science, 11, 322-324.

Ragsdale, Ronald G. (1983). Integrating computers into the curriculum. Paper presented at the Canadian Symposium on Instructional Technology, Winnipeg, Canada.

Ratzki, Anne, and Angela Fisher. (December-January, 1989-90) "Life in a Restructured School." Educational Leadership; 46,4 :46-51. EJ 400 500.

Reganick (June, 1994). "Using Computers to Initiate Active Learning for Students with Severe Behavior Problems." T.H.E. Journal, 72-74.

Resnick, L. B. (1987). Education and learning to think. Washington, DC: National Academy Press.

Richman, Louis S. (June 27, 1994). "The New Work Force Builds Itself." Fortune, 68-76 .

Riley, Richard (May 25, 1994a) Testimony before the Senate Commerce Committee, Washington, DC.

Riley, Richard (May 25, 1994b) Address to Goals 2000 Conference, Washington Hilton, Washington, DC.

Rudner, L. M and Boston, C. (Winter, 1994). "Performance Assessment." Eric Review, Vol. 2 Issue 1.

Russell, James D, Sorge, Dennis, and Brickner, Dianna (April, 1994). "Improving Technology Implementation in Grades 5-12 With the ASSURE Model." T.H.E. Journal

Sammons, Martha C. (February, 1994). "Motivating Faculty to Use Multimedia as a Lecture Tool." T.H.E. Journal, 88-90.

San Jose Mercury News (June 20, 1994). "Professors call students unprepared."

Schnell, Thomas (Summer, 1994). "A New Lesson Plan for Teachers." UM St. Louis.

Shapiro, B. L. (1989). What children bring to light: Giving high status to learners' views and actions in science. Science Education 73(6), 711-733.

Sharp, Sylvia (April,1994). "Editorial." T.H.E. Journal.

Sheingold, Karen. (1990) "Restructuring for Learning with Technology: The Potential for Synergy." Restructuring for Learning with Technology, pp. 9-27

Sheingold, Karen and Hadley, M. (September, 1990). "Accomplished Teachers: Integrating Computers into Classroom Practice." New York: Center for Technology in Education, Bank Street College of Education.

Sheingold, Karen. (September 1991a). "Restructuring for Learning with Technology: The Potential for Synergy." Phi Delta Kappan 73, 1.

Sheingold, Karen (October, 1991b). "Toward an alternative teaching environment (Draft for Technology Leadership Conference, Council of Chief State School Officers, Dallas).

Smith, Adam (1975). "Power of the Mind." New York: Ballantine Books.

Smith, M., and Cohen, M. (September, 1991) "A National Curriculum in the United States?" Educational Leadership, 49 (1): 74-81.

Smith, M. S., and O'Day, J. (1990). "Systemic School Reform." In Politics of Education Association Yearbook, edited by R. S. Nickerson and P. P. Zodhintes. London: Taylor and Francis.

Interactive Educational Systems Design (1993). "Report on the Effectiveness of Technology in Schools 1990-1992," Software Publishers Association, p. 2.

Stephen, William and Gallagher, Shelagh (April, 1993). "Problem-Based Learning: As Authentic as it Gets.' Educational Leadership, Volume 50, Number 7 Association for Supervision and Curriculum Development

Stearns, M. S., David. J. L., Hanson, S. G., Ringstaff, C., and Schneider, S. A. (January, 1991). "Cupertino-Fremont Model Technology Schools Project research findings: Executive summary (Teacher-centered model of technology integration: End of year 3). Menlo Park, CA: SRI International.

Thoman, Elizabeth (Spring, 1993). "Educating for Today--and Tomorrow." ASCD Curriculum/Technology Quarterly, Vol. 2, No 3 , Association for Supervision and Curriculum Development, Alexandria, VA.

Treese, Win (December ,1993). "Internet Index."

Tough, Allen. (1979). "The adult's learning projects." Toronto: Ontario Institute for Studies in Education.

Tushnet, N. C., Bodinger-de Uriarte, C., Manuel, D., van Broekhuizen, D., Millsap, M. A., Chase, A. (1993). "Star Schools Evaluation Report One," Southwest Regional Laboratory (SWRL) and Abt Associates.

University of Phoenix Institutional Research Department (1992). "Management of Academic Quality in Distance Learning Environments: Report on Education Processes and Outcomes of the Online Campus. Report IR-SR92.10.3. Phoenix, AZ.

UM St. Louis (Summer, 1994). "A New Lsson Plan for Teachers." The Magazine of the University of Missouri - St. Louis St. Louis, MO

von Glaserfeld, E. (1987). Learning as a Constructive Activity. In C. Janvier (Ed.). Problems of Representation in the Teaching and Learning of Mathematics, 3-18. Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Wakin, Edward (July/August, 1994). "Training for Tomorrow Today," Beyond Computing. P 55-56.

Wendt, Nancy (July/August, 1994). "Training for Tomorrow Today," Beyond Computing. P 55-56.

West, Tom (May, 1994). Presentation at the Alliance for Distance Education in California Conference, Long Beach, CA.

Whetzel, Deborah (1992). "The Secretary of Labor's Commission on Achieving Necessary Skills. ERIC Clearinghouse on Tests, Measurement, and Evaluation, Washington, DC. ED339749

White, Mary Alice (1990). "A Curriculum for the Information Age," Technology in Today's Schools, Association for Supervision and Curriculum Development.

Wilson, David L. (December 1, 1993). "Producing Computer-Literate Teachers." The Chronicle of Higher Education.

Wodtke, Mark von (1993). "Mind Over Media: Creative Thinking Skills for Electronic Media." New York, McGraw-Hill.

Yrchik, John (1994). "The National Information Infrastructure & Education." Address. National Education Association, Washington, DC.