

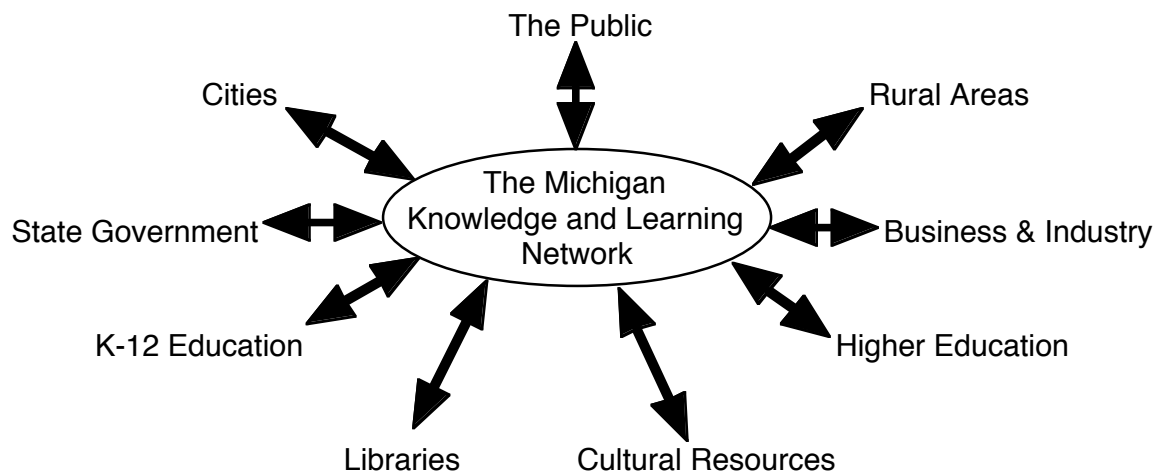
The Michigan Knowledge and Learning Network

A Proposal to Build the Infrastructure
Necessary for the State of Michigan to Compete
in an Emerging Global Knowledge Industry

Executive Summary

Four important themes are converging in the final decade of the 20th Century: i) the importance of knowledge as a key factor in determining security, prosperity, and quality of life; ii) the global nature of our society; iii) the ease with which information technology—computers, telecommunications, and multimedia—enables the rapid exchange of information; and iv) networking, the degree to which informal cooperation and collaboration among individuals and institutions are replacing more formal social structures, such as governments and nation-states. Together, these forces are stimulating the formation of a global knowledge industry.

To position itself for prosperity and social well-being in the 21st Century, we propose that the State of Michigan embark on a strategy to build the infrastructure necessary to become a leader in the emerging knowledge industry. This infrastructure, comprised of not only technological but also organizational and social components, will link together the people of the state and their social institutions with Michigan's very considerable knowledge and learning resources.



Here, it is important to realize that infrastructures such as the Internet are not just technology. They are profoundly human constructs, facilitating the formation and growth of networks of people who interact, share information, learn together, and create virtual communities online based upon their shared interests rather than any shared geography. In this sense, then, we propose that Michigan build both the physical and human infrastructure that will allow us to form learning communities of people, collaborating and the rich knowledge resources of the state and the world.

More specifically, this infrastructure will consist of three components:

- A state-of-the-art Internet knowledge network, linking the people of Michigan and their institutions with knowledge and learning resources within the state and beyond. This technology infrastructure, developed and funded through a public-private sector partnership, would link homes, businesses, and industry with public resources such as schools, college, universities, libraries, cultural centers, and government agencies. It would provide the community infrastructure for a range of functions such as learning, access to knowledge and cultural resources, public services, and electronic commerce.
- Organizations, policies, and programs designed to dramatically accelerate the transfer of knowledge--technology, education, training--to the private sector, including the formation new structures such as virtual schools and colleges, enhanced state support of efforts to attract major federal R&D grants and contracts, private funds for seed and venture capital, technology parks, and programs to assist in the transfer of technology from Michigan's universities and corporate research laboratories to business and industry; and
- Organizations capable of managing the network infrastructure and knowledge transfer process, providing the strategic vision necessary to exploit emerging technologies, and benchmarking Michigan's climate for economic growth. Examples of advisory bodies include a Michigan Board on Science and Technology and a Michigan Council on Competitiveness. In addition, new nonprofit structures might be formed to manage the evolving knowledge and learning infrastructures, drawing on strong partnerships with state and local government, higher education, Michigan foundations, and business and labor.

The State of Michigan is unusually well-positioned for leadership in a knowledge-driven society because of its unique knowledge and learning resources, the restructuring and streamlining of state and local governments that has occurred in recent years, and its remarkable economic strength through established business and industry. The challenge today is linking these extraordinary assets in a manner that responds to the rapid evolution in information technology and achieves leadership in the emerging global knowledge industry.

A Time of Challenge and Change

We are living in the most remarkable of times. A major restructuring of political and economic order is occurring with the end of the Cold War, the collapse of communism, and the emergence of Asia as a powerful economic force. Technological change continues to accelerate, with the emergence of pervasive digital technology and the rapid growth of global communication networks.

Many believe that we are going through a period of change in our civilization just as momentous as that which occurred in earlier times such as the Renaissance or the Industrial Revolution—except that while these earlier transformations took centuries to occur, the transformations characterizing our times will occur in a decade or less! This time of great change, of shifting paradigms, provides the context in which we must consider the future of our state. We must take great care not simply to extrapolate the past and, instead, examine the full range of possibilities of the future.

From a broader perspective, we find that four important themes are converging in the final decade of the 20th Century: i) the importance of knowledge as a key factor in determining security, prosperity, and quality of life; ii) the global nature of our society; iii) the ease with which information technology—computers, telecommunications, and multimedia—enables the rapid exchange of information; and iv) networking, the degree to which informal cooperation and collaboration among individuals and institutions are replacing more formal social structures, such as governments and nation-states.

We are experiencing a transition in which intellectual capital—that is, brain power—is replacing financial and fiscal capital as the key to our strength, prosperity, and social well-being. Industrial production is steadily switching away from material and labor-intensive products and processes to knowledge-intensive processes. The key element in this remarkable transformation is the emergence of knowledge itself as the new strategic commodity, as important as mineral ores, timber, and access to low-skilled labor were at earlier times. But, of course, this new commodity knows no boundaries. It is generated and shared wherever educated, dedicated, creative people come together. And, as we have learned, it spreads very rapidly. In a very real sense, we have entered a new age, *an Age of Knowledge*, in which the key strategic resource necessary for prosperity, has become knowledge; that is, educated people and their ideas.

In Michigan, in the industrial midwest, we have had a unique vantage point from which to view a particularly important feature of these changes. If there was one sector that most strongly determined the progress of the 20th Century, it was *transportation* and its related industries—cars, planes, trains, oil, space. Transportation determined prosperity; national security; and even our culture, with the growth of the suburbs, international commerce, and so on. During this period Michigan's automobile industry had no equal, and the state rapidly became one of the most prosperous and powerful industrial regions on earth.

Today things are very different. We have entered a new era in which the key human endeavor is shifting from transportation to *communication*, enabled by the profound advances we are now seeing in digital technology. We have entered an age in which hundreds of millions of computers can plug easily into a global information infrastructure. Digital technologies have increased vastly our capacity to know and to do things. They allow us to transmit information quickly and widely, linking distant places and diverse areas of endeavor in productive new ways.

While these new technologies make many things possible, they don't make things *happen*. Only people make things happen. And already we can see the distinct transformation of advanced nations into post-industrial societies with predominant sectors in service and high technology. Indeed, professional and technical services are the core of such post-industrial societies. In this sense then, a fundamental transformation is underway in our economy that is reshaping every product, every service, and every job in the United States. In our country, as in all developed nations, "knowledge workers" have already become the center of the labor force.

The Challenges Before Michigan

During the past several decades, our state, its economy, its institutions, and its people have experienced wrenching changes. In the past our industrial base, our economy, has relied on the fortunes of a few large companies—in fact, one large industry: the automobile industry. For most people, there was never any reason to be particularly

entrepreneurial or to worry about anything more than occasional uptakes and downturns in the economy. Only during the last decade have we begun to understand that the old economy is gone, never to return, that even if our traditional industries become more successful, the huge economic base upon which all of our policies were formed and investments were made will never return.

Michigan is midway through a several decade-long transition from a state dominated by a single industry and a few large companies to one increasingly dependent upon tens of thousands of small, dynamic companies competing in a broad spectrum of world markets. We are experiencing a transition from low-skill, high-pay jobs to high-skill, high-pay jobs (or, tragically, low-skill, "no" pay jobs); from a transportation industry state to an knowledge industry state; and, from the Industrial Age to the Age of Knowledge.

Until recently Michigan was not well-positioned to make this difficult transition since over the years our state tax policy, regulatory policy, social services, public investment strategy, and politics had evolved primarily to serve big business, big labor, and big government.

During the past several years, our state, led by Governor Engler and his colleagues in the Michigan Legislature, has taken important steps to break the stranglehold of the past and begin to prepare Michigan to face the future.

Step 1: Restructuring

It was clear that the first challenge was to *restructure* our state to create, attract, and support the tens of thousands of new companies on which our future would depend. We had to create an economic environment capable of enabling them to function in a rapidly changing, frighteningly competitive, and knowledge-intensive world marketplace. Michigan's challenge was not dissimilar to that faced by industrial corporations. We had to restructure ourselves to serve the future rather than simply perpetuate the past.

Michigan's problems were not partisan. Nor were they political. Michigan's problems were *structural*. Our political and economic system were no longer capable of producing the revenues needed to meet the demands placed upon it. As a result of this fundamental structural inadequacy, we were being forced to meet our urgent current needs, to protect invaluable resources such as our schools, and to balance our current budget by shifting burdens to future budgets, where they would become even more painful.

We were held hostage by outdated tax and regulatory policies and a disturbing lack of understanding of what knowledge could do in creating economic growth. In this state, we simply were not increasing our base of knowledge quickly enough nor were we investing adequately in funding knowledge creation.

Like much of American industry, state government had become too large and bureaucratic, no longer responsible to its citizens. In his first term as Governor, John Engler took the very difficult and painful steps to turn that around. In this effort, Governor Engler and his

colleagues cut away much of the undergrowth that was clogging government and the economy. While it has been painful, over the last several years Michigan has indeed been unique among the states in its capacity to eliminate a massive funding deficit while holding the line on taxes, downsizing unnecessary government, and protecting education as its highest priority.

However, restructuring state government, its institutions, policies, and laws, while necessary, was not enough. The state also needed to take a hard look at its investment strategy, to achieve a better balance between meeting the costs, needs, and desires of the present and making the necessary investments in Michigan's future. And among these investments, perhaps none has greater priority than education.

Step Two: Education

It is becoming increasingly clear that the key to long-term economic growth involves the development of our human resources through education. Education is the only enterprise that can save us from becoming a backwater economy. It is a point of "lift off" from which we can create new markets, processes, and skills.

In an age of knowledge it has become the skills of a region's work force and the quality of its infrastructure that give it the capacity to compete in the new world economy. Once again Michigan had made very considerable progress in recent years. The state has restructured and reformed the way we finance our schools, reformed the policies

that constrained them, and created remarkable opportunities for innovation and experimentation through the charter schools program. As a result, today we find ourselves closer to designing a system that lets students, teachers, and parents know what is expected of them—one that uses international benchmarks to compare our schools.

True, many challenges remain. But so, too, are there many opportunities. For example, the technology now exists to build a statewide learning environment that would make it possible for students and teachers to be connected to the rich knowledge resources of our state--and, indeed, the world--regardless of where they are located. Such a learning resource could truly ignite a renaissance in public education in Michigan.

Beyond the quality of our schools, there is yet even a greater challenge—and an extraordinary opportunity—for the long term. In a time in which knowledge has become not only the wealth of nations but also the key to one's personal quality of life, it has become the responsibility of democratic societies to provide their citizens with the education and training they need throughout their lives, whenever, wherever, and however they desire it, at high quality and at a cost they can afford. Lifelong learning has become not just a possibility but a necessity for all members of our society. Michigan faces the challenge of making learning available for anyone who wants to learn, at a time and place of their choice, without great personal sacrifice or cost.

Yet higher education is one of the few activities which has yet to evolve from the handicraft, one-of-a-kind mode of a cottage industry to the mass production enterprise of the industrial age. In a very real sense, the industrial age has largely passed by the university. Faculty continue to organize and teach their courses much as they have for decades—if not centuries. So, too, our societal institutions for learning—schools, colleges, and universities—continue to favor programs and practices based more on past traditions than upon contemporary needs.

Yet, it may be quite wrong to suggest that higher education needs to evolve into a mass production or broadcasting mode to keep pace with our civilization. In a sense, this was the evolutionary path taken by K-12 education, with disastrous consequences. Besides, even industry is rapidly discarding the mass production approach of the 20th Century. Perhaps a more appropriate future for higher education—indeed, all of education—is that of a ubiquitous, pervasive learning environment.

Fortunately, today's digital technology is rapidly breaking the constraints of space and time. Through computers, networks, and new *asynchronous learning* technology, we have the capacity to provide quality education anytime, anyplace, to anyone. The barriers are no longer cost or technology but rather perception and habit.

But this may not be enough. Instead of asynchronous learning, perhaps we should instead consider a future of *ubiquitous learning*—learning for everyone, every place, all the time. Indeed, in a world

driven by an ever-expanding knowledge base, continuous learning like continuous improvement has become a necessity of life.

To prepare Michigan for *an age of knowledge*, perhaps we should aspire to build *a culture of learning*, in which people are continually surrounded by, immersed in, and absorbed in learning experiences. Actually, this is not far from the environment experienced by a very young child, in which every stimulus becomes a learning opportunity. Information technology has now provided us with a means to create learning environments throughout one's life. These environments are able not only to transcend the constraints of space and time, but they, like us, are capable as well of learning and evolving to serve our changing educational needs.

Step Three: Knowledge-Driven Economic Development

While current industry strives to improve competitiveness to increase market share and retain jobs, it is important to realize that in an age of knowledge, new knowledge itself is necessary to create new jobs. Many of the new jobs for Michigan's future will be spawned by entirely new fields such as biotechnology, software engineering, multimedia, and knowledge-based manufacturing. And even those jobs in established industries will require ever-increasing levels of training and skills.

From this perspective, it is clear that Michigan's major research laboratories, both on our university campuses and in our

corporations, may become among our most powerful economic engines. Why? The key ingredients in technology-based economic development are technological innovation, technical manpower, and entrepreneurs. Research universities and corporate R&D laboratories produce all three. Through their research, they generate the creativity and ideas necessary for innovation. Through their faculty and staff efforts, they attract the necessary "risk capital," much of it through massive federal R&D support. Through their education programs they produce the scientists, engineers, and entrepreneurs to implement new knowledge. And they are also the key to knowledge transfer, both through traditional mechanisms, such as graduates and publications, as well as through more direct contributions such as faculty / staff entrepreneurs, the formation of start-up companies, strategic partnerships, and so on.

The impact of this new knowledge on economic strength in a knowledge-driven society cannot be overstated. Economic studies have noted that, while the average rate of return on capital investment in the United States today ranges from 10 percent to 14 percent, the private rate of return of R&D investment is estimated to be 25 percent to 30 percent, and the social rate of return, that is, the rate that accrues to society more generally, is estimated to be as high as 50 percent to 60 percent—roughly four times the rate for other types of investment.

A Technology Strategy for Michigan

America is not alone in recognizing the importance of knowledge and education to economic prosperity and social well-being. Throughout the world, nations are creating the institutions and making the investments necessary to provide both knowledge and learning services to their citizens. In fact, there are many signs that a global knowledge industry is beginning to form. With the emergence of new competitive forces and the weakening influence of traditional regulations, it is evolving like other “deregulated” industries, e.g., communications or energy. It is strongly driven by changing technology. And, as our society becomes ever more dependent upon new knowledge and educated people, upon “knowledge workers,” the knowledge business clearly must be viewed as one of the most active “growth industries” of our times.

To respond both to this challenge and this opportunity, we propose that the State of Michigan develop and execute an aggressive strategy to achieve leadership in this emerging enterprise, based upon the following themes:

- Developing the knowledge and learning infrastructure necessary to link together the state’s assets with its people, its communities, and its institutions.
- Accelerating the transfer of knowledge—ideas, technology, and skills—to the marketplace.
- Providing state government with an ongoing source of counsel concerning the role of science and technology in Michigan’s future.

The Infrastructure for Building Learning Communities

While we generally think of the players in the global knowledge industry as traditional organizations such as schools, colleges, and universities, there are signs that the knowledge industry will stimulate entirely new social structures and institutions. A good example is provided by the evolution of the public library a century ago, which became the nexus of public culture in our communities. In every town and city in America, the public library, as a central and valued community meeting space, became the civic integrator, the focal point of culture, knowledge, and learning available to all.

Today, as knowledge becomes an ever more significant factor in determining both personal and societal well-being, and as rapidly emerging information technology provides the capacity to build new types of communities, one might well see the appearance of new types of social structures. Perhaps we will see a new nexus of our public culture, a structure capable of linking and connecting social institutions such as schools, libraries, museums, hospitals, parks, media, computer networks, and the growing universe of information providers on the Internet. Perhaps a new “life form” will evolve to provide community education and information networks that are open and available to all. These might evolve from existing institutions such as libraries or schools or universities. They might be a physically located hub or virtual in character. However, they also might appear as entirely new constructs, quite different than anything we have experienced to date.

In fact, there are some interesting trends in technology suggesting that new types of “community knowledge structures” may, in fact, appear that will not be derivative of traditional institutions such as schools or libraries. One such trend is the evolution of global computer networks such as the Internet. In addition to their ability to link people together into electronic communities, they link us as well to increasingly diverse and rich sources of knowledge. In a sense, they have become “knowledge and learning networks,” giving us the capacity to build communities with access to vast intellectual resources.

Already there are a number of efforts either well-established or in the planning phase that could lay the foundation for this infrastructure:

MichNet (and the Merit Computer Network)

Michigan Instructional Television Network (MITN)

Michigan Information Network (MIN)

Charter School Program

MSU Extension Service

UM School of Information

Advanced Network Services, Inc.

Michigan Virtual Auto College (MVAC)

Environmental Research Institute of Michigan (ERIM)

Industrial Technology Institute (ITI)

Kellogg Foundation Alliance for Community Technology

Rural Datafication Project

Virtual Community College

Virtual High School (with national center to be established in Ann Arbor)

Internet II--GigaPOP

NSF Supercomputer Center (with University of California)

UM-Online

Auto Internet

Open Virtual University for Jewish People (UM Leadership role)

UAW-Ford University

UM-Detroit Public Schools Partnership

National Efforts (Community Infrastructure, Internet II)

For example, the Michigan Virtual Automobile College will be coming on line early this spring, not only providing Internet-based instruction to the automobile industry, but also providing a model for the launching of other types of "virtual universities". Michigan will almost certainly become a site for Internet II with a so-called GigaPOP (a "point of presence" regional network with speeds thousands of times faster than today's networks). The automobile industry is deep into a process to create what will be an "auto internet", a rich, broadband network linking together the Big Three and suppliers. The Kellogg Foundation is leading a major effort, known as the Alliance for Community Technology, that will build key organizational structures.

We propose that the State of Michigan build on these and other efforts to become a leader among the states in building the physical infrastructure (digital communications networks); organizations

(such as MichNet); and policies to facilitate linking citizens, communities, and institutions together with the knowledge resources both of the state and the world. More specifically, we believe that the state should move rapidly to establish, in a partnership with Michigan foundations and universities, a 501 (c) 3 corporation to build a Michigan Knowledge and Learning Network.

Accelerating the Transfer of Knowledge to Society

It is important that we accelerate the development and commercialization of new technologies in Michigan, if we are to compete in a global knowledge economy. In the past most states have taken a more passive approach to this enterprise, assuming that the knowledge created in campus- or corporate-based research laboratories would trickle down to the private section. However, experience suggests that this is not the case and that a successful strategy must first consider the needs of the private sector.

We propose that the state, in partnership with higher education, industry, and financial institutions, take a more strategic approach to stimulating and growing technology-based businesses. Such companies need access to research, talented human resources, a continuum of growth capital, and a professional infrastructure. We believe that Michigan can build an environment in which such resources are more readily available.

For example, universities can take steps to accelerate their efforts in technology transfer and become better at teaming with

entrepreneurs. In particular, universities should be encouraged to make more faculty appointments of individuals with experience in the private sector, so-called “professors of practice,” who have proven capability in technology transfer and business development. (Here, it should be noted that such individuals would also play a significant role in enhancing the education of students in professional schools such as engineering and business administration.) Business schools could be encouraged to play a more active role in evaluating business start-up opportunities. Entrepreneurial leadership centers could be located in university campuses to provide education on entrepreneurship and the other skills necessary to build an entrepreneurial enterprise.

New educational organizations such as the Michigan Virtual Auto College provide both an opportunity and an important paradigm capable of developing the human resources necessary for such activities. This concept can not only be extended to a far-broader “Michigan Virtual University”, but it could also provide a framework for building virtual primary and secondary schools--essentially state-wide virtual charter schools.

A range of growth capital opportunities could be developed, including a more organized effort to recruit “angel” investors with both experience and interest in the technology-based company formation. A research commercialization fund could be formed to provide catalytic funding for embryonic and seed-stage companies. Existing organizations such as MERRA could be grown to assist start-

up companies in obtaining support, via federal programs, angel network investments, or established venture capital funds.

The State has already taken important action to launch a venture capital fund since it recognizes Michigan's weakness in attracting venture capitalists who provide access nationwide to capital, strategy alliances, investment banking, and other resources. In addition, Michigan's technology commercialization infrastructure is lacking seed funds that provide capital, management, and marketing assistance to start-up companies.

Finally, there should be a more concerted effort to link Michigan's established industrial base to technology-based companies to increase the utilization of technology innovations. Examples include the Auto Body Consortium, the Michigan Auto Alliance, and the MMTC.

Providing Strategic Advice and Guidance

It is critical that state government avail itself of the very best advice and guidance on the broad range of issues relating to education, science, technology, and economic development. To this end, we propose the formation of two bodies: a Michigan Science and Technology Board to provide advice in the areas of science and technology, and a Michigan Council on Competitiveness that would help to benchmark the quality of Michigan's environment for economic development.

The economic prosperity and social welfare of the state are increasingly dependent on newly emerging technical areas such as digital technology, optoelectronics, knowledge-driven manufacturing, biotechnology, materials processing, and software engineering. It is important that state government avail itself of the very best advice and guidance on the broad range of issues relating to science and technology.

To this end, we propose that the Governor appoint a board of distinguished advisors on science and technology drawn from industry, higher education, and perhaps other sectors. This body would be similar to the National Science Board (NSB) at the federal level. It would provide advice and counsel on a broad range of issues, including technology-based industrial development, science education and human resource development, and technology transfer.

In addition, the state should rely more heavily on the expertise provided by some of the rapidly evolving programs in its colleges and universities, such as the new School of Information at the University of Michigan. Such programs can provide valuable insight into both the challenges and opportunities associated with the emerging knowledge industry.

In addition, we propose that the state form a Michigan Council on Competitiveness, analogous to the similar federal body, that would assess the quality of the state's business climate. This would be a benchmarking organization, that would compare Michigan with

other states (and perhaps nations) to assess our relative competitiveness with respect to business and industrial development. It would help to identify best practices elsewhere, and make recommendations to the Governor and the Legislature. Its members would be drawn from business, higher education, and elsewhere, appointed by the Governor, and confirmed by the Michigan State Legislature.

A Culture of Learning

Whether one refers to our times as the Information Age or the Age of Knowledge, it is clear that educated people and the knowledge they produce and utilize have become the keys to the economic prosperity and well being of our society. One's education, knowledge, and skills have become primary determinants of one's personal standard of living, the quality of one's life. We are realizing that, just as our society has historically accepted the responsibility for providing needed services such as military security, health care, and transportation infrastructure in the past, today education has become a driving social need and societal responsibility. Today it has become the responsibility of democratic societies to provide their citizens with the education and training they need, throughout their lives, whenever, wherever, and however they desire it, at high quality and at an affordable cost.

Of course, this has been one of the great themes of higher education in America. Each evolutionary wave of higher education has aimed at educating a broader segment of society, at creating new educational forms to do that—the public universities, the land-grant universities, the normal and technical colleges, the community colleges. But today, we must do even more.

The dominant form of higher education in America today, the research university, was shaped by a social contract during the last fifty years in which

national security was regarded as America's most compelling priority, as reflected in massive investments in campus-based research and technology. Today, in the wake of the Cold War and at the dawn of the age of knowledge, one could well make the argument that education itself will replace national defense as the priority for the 21st Century. Indeed, one might suggest that this will be the new social contract that will determine the character of our educational institutions, just as the government-university research partnership did in the latter half of the 20th Century. We might even conjecture that a social contract based on developing and maintaining the abilities and talents of our people to their fullest extent could well transform our schools, colleges, and universities into new forms which would rival the research university in importance.

So what might we expect over the longer term for the future of the university? It would be impractical and foolhardy to suggest one particular model for the university of the 21st Century. The great and ever-increasing diversity characterizing higher education in America makes it clear that there will be many forms, many types of institutions serving our society. But there are a number of themes which will almost certainly factor into at least some part of the higher education enterprise.

- *Learner-centered*: Just as other social institutions, our universities must become more focused on those we serve. We must transform ourselves from faculty-centered to learner-centered institutions.
- *Affordable*: Society will demand that we become far more affordable, providing educational opportunities within the resources of all citizens. Whether this occurs through greater public subsidy or dramatic restructuring of our institutions, it seems increasingly clear that our society—not to mention the world—will no longer tolerate the high-cost, low productivity paradigm that characterizes much of higher education in America today.
- *Lifelong Learning*: In an age of knowledge, the need for advanced education and skills will require both a willingness to continue to learn throughout life and a commitment on the part of our institutions to provide opportunities for lifelong learning. The concept of student and alumnus will merge. Our

highly partitioned system of education will blend increasingly into a seamless web, in which primary and secondary education; undergraduate, graduate, and professional education; on-the-job training and continuing education; and lifelong enrichment become a continuum.

- *Interactive and Collaborative:* Already we see new forms of pedagogy: asynchronous (anytime, anyplace) learning that utilizes emerging information technology to break the constraints of time and space, making learning opportunities more compatible with lifestyles and career needs; and interactive and collaborative learning appropriate for the digital age, the plug-and-play generation.
- *Diverse:* Finally, the great diversity characterizing higher education in America will continue, as it must to serve an increasingly diverse population with diverse needs and goals.
- *Intelligent and Adaptive:* Knowledge and distributed intelligence technology will increasingly allow us to build learning environments that are not only highly customized but adapt to the needs of the learner.

We will need a new paradigm for delivering education to even broader segments of our society, perhaps to all of our society, in convenient, high quality forms, at a cost all can afford. Fortunately, today's technology is rapidly breaking the constraints of space and time. It has become clear that most people, in most areas, can learn and learn well using asynchronous learning, that is, "anytime, anyplace, anyone" education. Lifetime education is rapidly becoming a reality, making learning available for anyone who wants to learn, at the time and place of their choice, without great personal effort or cost. With advances in modern information technology, the barriers in the educational system are no longer cost or technological capacity but rather perception and habit.

But even this may not be enough. Perhaps we should instead consider a future of "ubiquitous learning"—learning for everyone, every place, all the time. Indeed, in a world driven by an ever-expanding knowledge base, continuous learning, like continuous improvement, has become a necessity of life.

Rather than "an age of knowledge," we could instead aspire to a "culture of learning," in which people are continually surrounded by, immersed in, and absorbed in learning experiences. Information technology has now provided us with a means to create learning environments throughout one's life. These environments are able not only to transcend the constraints of space and time, but they, like us, are capable as well of learning and evolving to serve our changing educational needs. Higher education must define its relationship with these emerging possibilities in order to create a compelling vision for its future as it enters the next millennium.

Concluding Remarks

The knowledge industry is developing at an unprecedented pace. While there is indeed a good deal of hype and exaggeration about implications of the digital revolution for the very near term, it is clear that we are only beginning to understand how truly extraordinary will be the impact of digital technology on our society and its institutions for the longer term. As William Mitchell, Dean of Architecture at MIT, puts it, "the information ecosystem is a ferociously Darwinian place that produces endless mutations and quickly weeds out those no longer able to adapt and compete. The real challenge is not the technology, but rather imagining and creating digitally mediated environments for the kinds of lives that we will want to lead and the sorts of communities that we will want to have."

It is vital that we in Michigan commit ourselves today to taking the actions, to making the investments, necessary to become leaders as this new era dawns. We have the resources: world-leading

companies, universities, foundations; exceptional ability and experience at the level of state, regional, and community governance; and most important of all, a people with a long tradition of leadership. By building the infrastructure—technological, organizational, and political—to link our people, their communities, and their institutions, with the knowledge and learning resources of Michigan, the nation, and the world, we can insure a future of prosperity and leadership for our state.