The Future of the University in the Digital Age

Last year, as I stepped down after 15 years as an academic administrator, I thought it best to come back up to speed in what students were learning these days. It was in that effort that I was a bit taken back by a flyer posted near my faculty office that advertised the following curriculum:

> "Students will begin by learning the C++ programming language and corresponding operating system on their choice of platforms, including Unix, Macintosh, and Windows-NT on state-of-the art systems including Pentium, Macintosh, Sun, and HP workstations and Convex Exemplar and IBM SP-2 supercomputers. In addition they will learn HTML, Javascript, and create a home page on the World Wide Web. They will explore computer graphics and animation, including still imagery and video with Macromedia Director and Photoshop. They will use these tools to explore the technological fields of robotics and artificial intelligence."

Sounds pretty advanced for college students, doesn't it? Perhaps. But this was not directed toward college students. Instead it was a poster advertising a summer camp run by the Michigan College of Engineering for high school students of ages 13 to 17! Needless to say, not only is the technology of computers and networks driving change in our world, but it is also changing substantially the knowledge base of the students we will be teaching.

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 rapid growth of global communication networks, advances in molecular biology, and the emergence of ubiquitous digital technology.

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 have entered an age in which knowledge itself--that is, educated people and their idea--has become a strategic commodity essential to our security, prosperity, and social well-being. But unlike other resources such as mineral ores, timber, and access to low-skilled labor, knowledge knows no boundaries. It is generated and shared wherever educated, dedicated, creative people come together. And it cannot be exhausted; the more it is used, the more it is generated.

The Challenge of the Digital Age

Rapidly evolving digital technologies are dramatically changing the way we collect, manipulate, and transmit knowledge. They have increased vastly our capacity to know and to do things. They allowed us to exchange information, to communicate, and to collaborate, free from the constraints of space and time. Needless to say, the implications of this technology for knowledge-intensive organizations such as universities are profound indeed.

One frequently hears the primary missions of the university characterized as teaching, research, and service. But, these activities can also be regarded as simply the 20th Century manifestations of the more fundamental roles of *creating, preserving, integrating, transmitting,* and *applying* knowledge. If we were to adopt the more contemporary language of information technology, the university might be regarded as a "knowledge server," providing knowledge services (i.e., creating, preserving, transmitting, or applying knowledge) in whatever form needed by contemporary society.

From this more abstract viewpoint, it is clear that, while the fundamental knowledge server roles of the university do not change over time, the particular realization of these roles do change–and change quite dramatically, in fact. Consider, for example, the role of "teaching," that is, transmitting knowledge. While we generally think of this role in terms of a professor teaching a class of students, who, in turn, respond by reading assigned texts, writing papers, solving problems or performing experiments, and taking examinations, we should also recognize that classroom instruction is a relatively recent form of pedagogy. Throughout the last millennium, the more common form of learning was through apprenticeship. Both the neophyte scholar and craftsman learned by working as apprentices to a master. While this type of one-on-one learning still occurs today, in skilled professions such as medicine, and in advanced education programs such as the Ph.D. dissertation, it is simply too labor-intensive for the mass educational needs of modern society.

The classroom itself may soon be replaced by more appropriate and efficient learning experiences. Indeed, such a paradigm shift may be forced upon the faculty by the students themselves. Today's students are members of the "digital generation." They have spent their early lives surrounded by robust, visual, electronic media–Sesame Street, MTV, home computers, video games, cyberspace networks, MUDs, MOOs, and virtual reality. They approach learning as a "plug-and-play" experience, unaccustomed and unwilling to learn sequentially–to read the manual–and, rather, inclined to plunge in and learn through participation and experimentation. While this type of learning is far different from the sequential, pyramid approach of the traditional university curriculum, it may be far more effective for this generation, particularly when provided through a media-rich environment.

Hence, it could well be that faculty members of the 21st Century university will find it necessary to set aside their roles as teachers and, instead, become designers of learning experiences, processes, and environments. Further, tomorrow's faculty may have to discard the present style of solitary learning experiences, in which students tend to learn primarily on their own through reading, writing, and problem solving. Instead, they may be asked to develop collective learning experiences in which students work together and learn together, with the faculty member becoming more of a consultant or a coach than a teacher.

One can easily identify other similarly profound changes occurring in the other roles of the university. The process of creating new knowledge–of research and scholarship–is also evolving rapidly away from the solitary scholar to teams of scholars, perhaps spread over a number of disciplines. Indeed, one might well question whether the concept of the disciplinary specialist is relevant to a future in which the most interesting and significant problems will require "big think" rather than "small think". Who needs specialists in an age where intelligent software agents are available to roam far and wide through robust networks containing the knowledge of the world, instantly and effortlessly extracting whatever a person wishes to know?

So, too, there is increasing pressure to draw research topics more directly from worldly experience rather than predominantly from the curiosity of scholars. Even the nature of knowledge creation is shifting somewhat away from the analysis of what has been to the creation of what has never been–drawing more on the experience of the artist than upon analytical skills of the scientist.

The preservation of knowledge is one of the most rapidly changing functions of the university. The computer–or more precisely, the "digital convergence" of various media from print-to-graphics-to-sound-to sensory experiences through virtual reality–has already moved beyond the printing press in its impact on knowledge. Throughout the centuries, the intellectual focal point of the university has been its library, its collection of written works preserving the knowledge of civilization. Yet, today, such knowledge exists in many forms–as text, graphics, sound, algorithms, and virtual reality simulations–and, it exists almost literally in the ether, distributed in digital representations over

worldwide networks, accessible by anyone, and, certainly, not the prerogative of the privileged few in academe. The role of the library is becoming less that of collecting and more that of a knowledge navigator, a facilitator of retrieval and dissemination. In a sense, the library and the book are merging.

Finally, it is also clear that societal needs will continue to dictate great changes in the applications of knowledge it excepts from universities. Over the past several decades, universities have been asked to play the lead in applying knowledge across a wide array of activities, from providing health care, to protecting the environment, from rebuilding our cities to entertaining the public at large (although it is sometimes hard to understand how intercollegiate athletics represents knowledge application.) It is difficult to imagine the roles society will ask the university to play in the century ahead; we can only be certain they will be different than the roles we play today.

The Implications for Higher Education

It is clear that although the digital age will provide a wealth of opportunities for the future, we must take great care not simply to extrapolate the past, but instead to examine the full range of possibilities for the future.

But here we face a particular dilemma. Both the pace and nature of the changes occurring in our world today have become so rapid and so profound that our present social institutions--in government, education, the private sector--are having increasing difficulty in even sensing the changes (although they certainly feel the consequences), much less understanding them sufficiently to respond and adapt. It could well be that our present institutions, such as universities and government agencies, which have been the traditional structures for intellectual pursuits, may turn out to be as obsolete and irrelevant to our future as the American corporation in the 1950s. There is clearly a need to explore new social structures capable of sensing and understanding the change, as well as capable of engaging in the strategic processes necessary to adapt or control change.

Universities are supposed to be at the cutting edge of both knowledge generation and transmission. Yet their primary activity, teaching, is conducted today much as it was a century ago. Technologies which were supposed to drive radical change--television, computer-assisted-instruction, wireless communications-- have bounced off the classroom without a dent.

Yet, today there are good reasons to believe that digital technology will indeed transform the university, perhaps beyond recognition. Why? What is different? Is it the ability of the new technology to cut the bonds of space and time? Is it its ubiquitous nature? No, rather it is the ability of the rapidly evolving digital technology to enable new forms of human interaction, to mediate communication, to stimulate the formation of new types of human communities.

Of course, the use of information technology is already quite pervasive in higher education. Courses are increasingly being offered, both on campus and off, via

the Internet. Students in geographically dispersed virtual communities meet together electronically. Yet, it is also clear that in most cases, these current uses of information technology represent extensions rather than transformations of how we learn and teach.

An example of such extensions of traditional paradigms is the so-called "virtual university," most commonly conceived as the Internet extension of conventional distance learning. For many years universities have utilized passive telecommunications technology such as television to extend teaching to people unable or unwilling to attend campus-based classes. In its simplest form, such distance learning is really a "talking heads" paradigm, in which faculty lectures are simply delivered at a distance, either through live transmission or videotape. Although there have been efforts to broadcast such instruction through "sunrise semester" efforts, augmented by written correspondence, the more effective approach utilizes onsite teaching assistants to work directly with the students. More recently, technology has allowed the use of feedback via electronic mail or two-way video interaction.

The simplest conception of the virtual university proposes using multimedia technology via the Internet to enable distance learning. Such instruction could be delivered either into the workplace or the home. In one form, this Internet-mediated instruction would be synchronous, in real-time, in which the instructor and the students would be interacting together. But the more interesting teaching paradigms of the virtual university involve asynchronous interactions, in which students and faculty interact at different times. In a sense, this latter form would resemble a correspondence course, with multimedia computers and networks replacing the mailing of written materials.

The initial driving force behind the formation of virtual universities is related both to cost and market. By using an inexpensive delivery mechanism such as the Internet to reach a potentially vast audience, many hope that a virtual university can provide instruction at costs far lower than campus-based instruction. There have been even been some early efforts by for-profit entities to enter the higher education marketplace through virtual university structures, thereby competing directly with traditional colleges and universities.

However, many believe that effective computer-network-mediated learning will not simply be an Internet extension of correspondence or broadcast courses. Brown and Daguid suggess that this model of the virtual university overlooks the nature of how university-based learning actually occurs. They suggest that it is a mistake to think of learning as information transfer, the act of delivering knowledge to passive student receivers. Rather learning relies on social interactions. More specifically, they suggest that learning is rooted both in experience and social interaction. It requires the presence of communities.

It core competency of the university is not simply transferring knowledge, but rather developing it within intricate and robust networks and communities, it becomes evident that the simple distance learning paradigm of the virtual university is inadequate. Rather, the key is to develop computer-mediated

communications and communities that are released from the constraints of space and time.

Asynchronous learning paradigms interactions are ideally suited to such objectives, since they allows low cost ways to hold many-to-many conversations among people who are distributed in both space and time. Indeed, beyond simple interactions through E-mail and bulletin boards, role playing games such as MUDs, MOOs, and MUSEs seem ideal for learning. These software constructions not only provide a virtual environment where interactions occur, but they also provide common objects for participants to observe, manipulate, and discuss. Furthermore, they allow open learning, in which the student decides when, where, and how to interact with the learning community.

The Knowledge Industry

Increasingly, the education and skills of a person are seen as the key to both their personal quality of life and the broader strengths of their society throughout the world. Hence, higher education is evolving rapidly to respond to this emerging importance and demand for its products and its services.

In the past, most colleges and universities served local or regional populations. While there was competition among institutions for students, faculty, and resources--at least in the United States--the extent to which institutions controlled the awarding of degrees, that is, credentialing, led to a tightly controlled competitive market.

Today, universities are facing new competitive forces. As the need for advanced education becomes more intense, some institutions are moving far beyond their traditional geographical areas to compete for students and resources. There are hundreds of colleges and universities that increasingly view themselves as competing in a national or even international marketplace. Even within regions such as local communities, colleges and universities which used to enjoy a geographical monopoly now find that other institutions are establishing beachheads through extension services, distance learning, or even branch campuses. Furthermore, with advances in communications, transportation, and global commerce, several universities, in the United States and abroad are increasingly viewing themselves as international institutions, competing in global marketplace.

A Growth Industry

But beyond competition among colleges and universities, there are new educational providers entering the marketplace. Sophisticated for-profit entities such as the University of Phoenix or the National Technological University are moving into markets throughout the United States, Europe, and Asia. It has been estimated that today there are over 1,000 corporate training schools in the United States providing both education and training to employees at the college

level. It is only a matter of time before more of these enter the marketplace to provide educational services more broadly.

Universities have long enjoyed a monopoly over advanced education because of geographical or degree requirements and their monopoly on credentialing through the awarding of degrees. However today all of these market constraints are being challenged, as information technology eliminates the barriers of space and time and as new competitive forces enter the marketplace to challenge credentialing.

In a very real sense, higher education is evolving from a loosely federated system of colleges and universities serving traditional students from local communities to, in effect, a post-secondary *knowledge industry*. Since nations throughout the world recognize the importance of advanced education, this industry is global in extent. 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 higher education business must be viewed clearly is one of the most active "growth industries" of our times.

While many in the academy would undoubtedly view with derision or alarm the depiction of the higher education enterprise as an" industry", operating in a highly competitive, increasingly deregulated, global marketplace, this is nevertheless an important perspective that will require a new paradigm for how we think about postsecondary education. Furthermore, it is clear that no one, no government, is in control of the higher education industry. Instead it responds to forces of the marketplace.

Unbundling

The modern university has evolved into a monolithic institution controlling all aspects of learning. In a sense, the faculty has long been accustomed to dictating what it wishes to teach, how it will teach it, and where and when the learning will occur. Students must travel to the campus to learn. They must work their way through the bureaucracy of university admissions, counseling, scheduling, and residential living. If they complete the gauntlet of requirements, they are finally awarded a certificate to recognize their learning--a college degree.

Today comprehensive universities, at least as full-service organizations, are at considerable risk. These institutions have become highly vertically integrated. They provide courses at the undergraduate, graduate, and professional level; support residential colleges; professional schools; lifelong learning; athletics; libraries; museums; athletics; entertainment; and on, and on, and on... Yet today we are already beginning to see the growth of differentiated competitors for many of these activities. Universities are under increasing pressure to spin off or sell off or close down parts of their traditional operations in the face of this new competition.

The most significant early impact of a deregulated higher education "industry" will be to break apart this monolith, much as other industries have been broken apart through deregulation. As universities are forced to evolve from "faculty-centered" to "student-centered," they may well find it necessary to unbundle their many functions, ranging from admissions and counseling to instruction to certification

An example might be useful here. We have discussed earlier the concept of a "virtual university", a university without a campus or faculty that provides computer-mediated distance education. The virtual university might be viewed as the "Nike approach" to higher education. Nike, a major supplier of athletic shoes in the United States and worldwide, does not manufacture the shoes it markets. It has decided that its strength is in marketing, and that it would outsource shoe manufacturing to those who could do it better and cheaper. In a sense, the virtual university similarly stresses marketing and delivery. It works with the marketplace to understand needs, then it outsources courses, curriculum, and other educational services from established colleges and universities--or perhaps individual faculty--and delivers it through sophisticated information technology.

This same phenomenon of focusing on one's strengths and outsourcing the rest is commonplace in many industries. Consider, for example, the computer industry, in which webs of alliances exist among hardware developers, manufacturers, software developers, and marketers of hardware and software. These are constantly being created and modified in response to competitive dynamics.

Perhaps a more direct analog to higher education is the telecommunications industry. In the past, this was vertically integrated and dominated by a few large companies (AT&T, GTE, MCI). However, here, too, as the industry became increasingly deregulated, companies realized the value of outsourcing major elements of their business system, once again creating webs through alliances.

From a Cottage Industry to Mass Production

Throughout most of its history, higher education has been a cottage industry, Individual courses are a handicraft, made-to-order product. Faculty members design from scratch the courses they teach, whether they be for a dozen or several hundred students. They may use standard textbooks from time to time--although most do not--but their organization, their lectures, their assignments, their exams are developed for the particular course at the time it is taught.

Yet, just as the classroom form of pedagogy may be receding, so, too, the handicraft approach to higher education may also disappear. Our ability to introduce new, more effective avenues for learning, not merely new media in which to convey information, will change the nature of higher education. This will bring with it new modes of organization, relationships among universities and between universities and the private sector. The individual "handicraft"

model for course development may give way to a much more complex method of creating instructional materials. Even the standard packaging of an undergraduate education into "courses", in the past required by the need to have all the students in the same place at the same time, may no longer be necessary with new forms of asynchronous learning. But shifting away from a handicraft culture will stimulate major changes.

An example will illustrate. Universities--more correctly, faculty--are skilled at creating the content for educational programs. Indeed, we might identify this as their core competency. But they have not traditionally been particularly adept at "packaging" this content for mass audiences. To be sure, many faculty have written best-selling textbooks, but these have been produced and distributed by textbook publishers. In the future of multimedia, Net-distributed educational services, perhaps the university will have to outsource both production and distribution from those most experienced in reaching mass audiences--the entertainment industry.

Restructuring

The perception of the higher education enterprise as a deregulated industry has other implications. As we have noted, there are over 3,600 colleges and universities in the United States, characterized by a great diversity in size, mission, constituencies, and funding sources. Not only are we likely to see the appearance of new educational entities in the years ahead, but as in other deregulated industries, there could well be a period of fundamental restructuring of the enterprise itself. Some colleges and universities might disappear. Others could merge. Some might actually acquire other institutions.

For example, the Big Ten universities (...actually there are 12, including the University of Chicago and Penn State University...) have already merged many of their activities, such as their libraries and their federal relations activities. They are exploring ways to allow students at one institution to take courses--or even degree programs--from another institution in the alliance in a transparent and convenient way. Could one imagine the Big Ten universities becoming a unified university system for "the heartland of America".

One might also imagine affiliations between comprehensive research universities and liberal arts colleges. This might allow the students enrolling at large research universities to enjoy the intense, highly personal experience of a liberal arts education at a small college while allowing the faculty members at these colleges to participate in the type of research activities only occurring on a large research campus.

Indeed, one might even imagine "hostile takeovers", in which a Darwinian process emerges such that some institutions devour their competitors. All such events have occurred in deregulated industries in the past, and all are possible in the future we envision for higher education.

Some Operational Issues for Universities

All universities face major challenges in keeping pace with the profound evolution of information and its implication for their activities. Not the least of these challenges is financial, since as a rule of thumb, most organizations have found that staying abreast of this technology requires an annual investment roughly comparable to 10 percent of their operating budget. (For a very large campus, such as the University of Michigan, this amounts to about $300 million per year!)

It seems useful to set out some possible guidelines for such investments, learned from many years of experience at Michigan and other universities:

Invest in "Big Pipes"

While the processing power of computers continues to increase, of far more importance to universities is the increasing bandwidth of communications technology. Clearly both Internet access to off-campus resources and intranet capability to link students, faculty, and staff together are the highest priority. The key theme will be connectivity, essential to the formation and support of digitally-mediated communities.

Universities are straining to keep up with the connectivity demands of students. Today's undergraduates are already spending hours every day interacting with faculty, students, and home while accessing knowledge distributed about the world. Simply keeping pace with an adequate number of modem ports to meet the demands of off-campus students for access to campus-based resources and the Internet is overloading many universities. Installing a modern on-campus network--a "wire plant"--has become one of the most critical capital investments.

Strive for a Multi-Vendor, Open Systems Environments

Universities should avoid hitching their wagons to a small set of vendors. As information technology becomes more of a commodity marketplace, new companies and equipment will continue to spring forth. Furthermore, the great diversity in needs of various parts of the university community will require a highly diverse technology infrastructure. Humanists will seek robust network access to digital libraries and graphics processing. Scientists and engineers will seek massively parallel processing. Social scientists will likely seek the capacity to manage massive databases, e.g., data warehouses and data mining technology. Artists, architects, and musicians will require multimedia technology. Business and financial operations will seek fast data processing, robust communications, and exceptionally high security.

It will be an ongoing challenge to link together these complex multi-vendor environments, characterized not only by different equipment being used for diverse purposes, but also diverse software and operating systems. For this reason, it is important to insist on open systems technology rather than relying

on proprietary systems. Fortunately, most information technology is moving rapidly away from proprietary mainframes ("big iron") to client-server systems based on standard operating systems such as Unix or Windows-NT. Further, there is a vast array of commercial off-the-shelf software available for such open systems.

Furthermore, as digital technology becomes increasingly ubiquitous, universities will face the challenge as to just what components they will provide, and which should be the personal responsibility of members of the community. For example, while networks and specialized computing resources will continue to be the responsibility of the university, other digital devices such as personal communicators will almost certainly be left to individual students, faculty, or staff members.

Student Participation

There continues to be an ongoing debate about whether students should be required to purchase their own computers. In reality, the majority of students entering college these days already have computers. Universities should be prepared to support the personal computing efforts of students by providing robust network linkages both in residence halls and student commons areas. Furthermore, they should negotiate with community telecommunications companies--both telephone and cable television companies--to facilitate off-campus communications, while providing sufficient network communication ports to facilitate off-campus students.

Perhaps more controversial is the role that universities can play in negotiating deep discounts with hardware manufacturers for student personal computers. Local retailers will sometimes complain that this represents unfair competition (although, in reality, most will benefit significantly from consequent software and peripheral sales). However it is my belief that universities have an obligation to assist students in acquiring the hardware and software increasingly essential for their education.

However, even as personal computer technology saturates the student body, universities should continue to build and maintain public computer sites where students can have access to more powerful technology. In a very real sense, these computer cluster sites are becoming analogous to the role that libraries played in the past. They provide students not only with the technology necessary for their studies, but also places to study, gather, and collaborate.

Cultural Issues

One of the important strategic issues facing most universities will be the degree to which the evolution of information technology should be carefully coordinated and centralized or instead allowed to flourish in a relatively unconstrained manner in various units. Perhaps because of our size and highly decentralized culture, at Michigan we have long preferred the "let every flower bloom" approach. More to the point, we have encouraged islands of innovation,

in which certain units are strongly encouraged to move out ahead, exploring new technologies, perhaps moving into leadership roles and serving as pathfinders for the rest of the university.

Yet another cultural issue involves just who within the university community will drive change. Our experience has been that it will not be the faculty or staff but rather the students. As members of the "digital generation," they are far more comfortable with this emerging technology. Furthermore, they represent a "fault-tolerant" population, willing to tolerate the inevitable bugs in "Version 1.0" of new hardware and software.

As one example of this phenomenon, it is clear that many students are already moving rapidly to embrace Net-based learning and take increasing control of their own education. Although enrolled in traditional academic programs and participating in time-tested pedagogy such as lecture courses, homework assignments, and laboratory experiments, when unleashed, many students approach learning in quite different ways when they work on their own. They use the Net to become "open learners," accessing world-wide resources and Net-based communities of utility to their learning objectives.

The Need for Experimentation

No one knows what this profound alteration in the fabric of our world will mean, both for the university and for our entire society. As William Mitchell, Dean of Architecture at Harvard, stresses, "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 begin to experiment with the new paradigms that this technology enables. Otherwise, we may find ourselves deciding how the technology will be used without really understanding the consequences of our decisions.

Some examples currently underway at the University of Michigan illustrate both the nature and scale of such experiments:

The School of Information

Several years ago, at the University of Michigan, we became so convinced of the potential impact of information technology for the future of our institution that we thought about launching a "skunkworks" operation to explore and develop various paradigms for what a 21st Century university might become. Rather than building an independent research center, we, instead, decided to take our smallest academic unit, the former School of Library Science, and put at its helm one of our most creative scientists, Dan Atkins, with the challenge of developing new academic programs in "knowledge management." The result has been the

rapid evolution—indeed, revolution—of this unit into a new School of Information.

Put simply, this school is committed to developing leaders for the information professions who will define, create, and operate facilities and services that will enable users to create, access, and use information they need. It intends to lead the way in transforming education for the information professions through an innovative curriculum, drawing upon the strengths of librarianship, information and computer science, business, organizational development, communication, and systems engineering. Its activities range from digital libraries to knowledge networks to virtual educational structures.

The Media Union and the Millennium Project

At the University of Michigan we have launched just such an experiment: a fascinating new center known as the Media Union. It is designed to be a laboratory, a testbed, for developing, studying, and perhaps implementing the new paradigms of the university enabled by information technology. It will give us the chance to try out different possibilities before they become widespread realities, helping us avoid potentially expensive or even dangerous mistakes while maximizing the extraordinary capacities of our new tools.

More specifically, this 250,000 square foot facility contains almost 1,000 workstations for student use. It houses a 1,000,000 volume library, but perhaps more significantly, it is the site of several of our major digital library projects. It also contains a sophisticated teleconferencing facility, design studios, visualization laboratories, and a major virtual reality complex. Since art, architecture, and music students work side-by-side with engineering students, the Media Union contains sophisticated recording studios and electronic music studios. It also has a state-of-the-art sound stage for "digitizing" performances, as well as numerous galleries for displaying the results of student creative efforts. To respond to intense student interest and activity, the Media Union is open twenty-four hours a day, seven days a week, throughout the year.

The Michigan Virtual Automobile College

In 1996 we participated in the creation of a new institution, the Michigan Virtual Auto College (MVAC), designed to explore the implications of digital technology for higher education. This is a collaborative effort among the University of Michigan, Michigan State University, the State of Michigan, the state's other colleges and universities, and the automobile industry. It was formed as a private, not-for-profit, 501(c)3 corporation aimed at developing and delivering technology-enhanced courses and training programs for the automobile industry, including the Big 3 and Tier 1, 2, and 3 providers. The MVAC serves as an interface between higher education institutions, training providers, and the automotive industry. It works to facilitate the transfer of credits between and among institutions to facilitate certificate and degree attainment for those participating in courses and training programs offered under its auspices. It is designed as a "green field" experiment where colleges and universities can come

together to test capabilities to deliver their training and educational programs at a distance and asynchronously. It will eventually serve as a platform for the State of Michigan to build an education export industry.

The Ubiquitious University

Clearly, the digital age poses many challenges and opportunities for the contemporary university. For most of the history of higher education in America, we have expected students to travel to a physical place, a campus, to participate in a pedagogical process involving tightly integrated studies based mostly on lectures and seminars by recognized experts. Yet, as the constraints of time and space--and perhaps even reality itself--are relaxed by information technology, one might questionthe degree to which the university as a physical place will continue to hold its relevance.

To be sure, the current concept of distance learning, even if implemented via the Internet through virtual universities, is still bound to traditional ideas and approaches. But as true learning communities are constructed in cyberspace, traditional educational institutions will feel increasing competition and pressure to change.

Yet many questions remain unanswered. Who will be the learners served by these institutions? Who will teach them? Who will administer and govern these institutions? Who will pay for them?

Where will they be? How will they function? When will they appear? The list goes on...

Our consideration of the challenges facing higher education has not led us to suggest a particular form for the university of the 21st Century. Indeed, 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 our discussions have identified a number of themes that will likely characterize the higher education enterprise in the years ahead:

- *Lifelong Learning,* requiring both a willingness to continue to learn on the part of our citizens, and a commitment to provide opportunities for this lifelong learning by our institutions
- *A Seamless Web*, in which all levels of education not only become interrelated, but blend together.
- *Asynchronous* (anytime, anyplace) *Learning*, breaking the constraints of time and space to make learning opportunities more compatible with lifestyles and needs.
- *Affordable*, within the resources of all citizens, whether through low cost or societal subsidy.
- *Interactive and Collaborative*, appropriate for the digital age, the "plug and play" generation.

- *Diversity*, sufficient to serve an increasingly diverse population with diverse needs and goals.

Yet there is an even broader theme. In the age of knowledge, it has become increasingly clear that not only has knowledge become the wealth of nations, it has also become the key to one's personal standard of living, the quality of one's life. Hence, we might well make the case that 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 a cost they can afford.

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--the public universities, the land-grant universities, the normal and technical colleges, the community colleges.

But there is even more. Today, we find that higher education is more important than ever. But once again we need a new paradigm for delivering it to even broader segments of our society. Just as with other resources, such as food, energy, and transportation, that soon became necessities of modern life and therefore the responsibility of a society, today education itself has become a similar need.

Fortunately, today's technology is rapidly breaking the constraints of space and time. It has become clear that most people can learn and learn well using asynchronous learning technology. The barriers are no longer cost or technology but rather perception and habit. Perhaps "asynchronous education--that is, "anytime, anyplace" education-- will one day become so commonplace that only the a small segment of our population will still rely on conventional schools.

But perhaps even an enterprise dominated by asynchronous learning--anytime, anyplace, anyone--may be only a transitional stage to a more radical future for higher education. Perhaps a more appropriate future for higher education--indeed, all of education--is that of a ubiquitous, pervasive learning environment--learning for everyone, everyplace, 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", perhaps we should aspire instead to building 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.

Perhaps this is the real future of the university in the digital age.