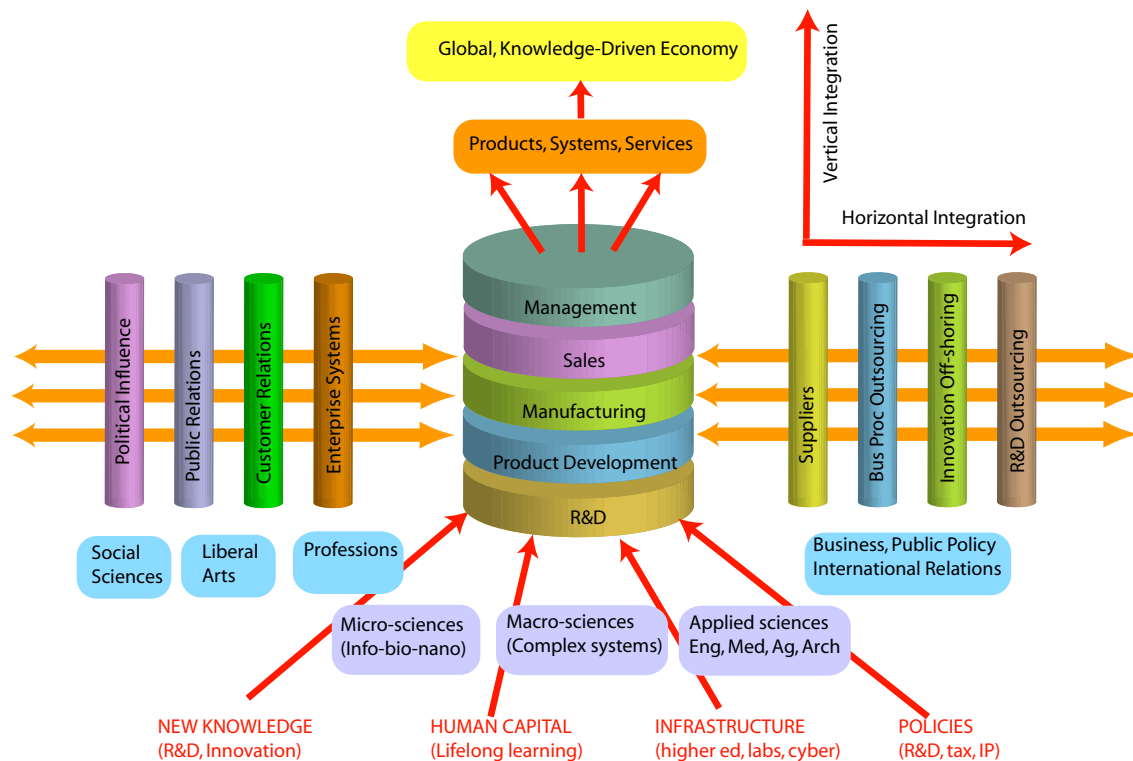


A Roadmap to Michigan's Future: Meeting the Challenge of a Global Knowledge-Driven Economy

A Strategic Roadmapping Exercise

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September, 2005



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Executive Summary

Michigan's old manufacturing economy is dying, slowly but surely, putting at risk the welfare of millions of citizens in our state in the face of withering competition from an emerging global knowledge economy. For many years now we have seen our low-skill, high-pay factory jobs increasingly downsized, outsourced, and offshored, only to be replaced by low-skill, low-pay service jobs—or in too many cases, no jobs at all and instead the unemployment lines. Preoccupied with obsolete political battles, addicted to entitlements, and assuming what worked before will work again, Michigan today is sailing blindly into a profoundly different future.

Thus far our state has been in denial, assuming our low-skill workforce would remain competitive and our factory-based manufacturing economy would be prosperous indefinitely. Yet that 20th-century economy will not return. Our state is at great risk, since by the time we come to realize the permanence of this economic transformation, the out-sourcing/off-shoring train may have left town, taking with it both our low-skill manufacturing jobs and many of our higher-paying service jobs.

Michigan is certainly not alone in facing this new economic reality. Yet as we look about, we see other states, not to mention other nations, investing heavily and restructuring their economies to create high-skill, high-pay jobs in knowledge-intensive areas such as new technologies, financial services, trade, and profes-

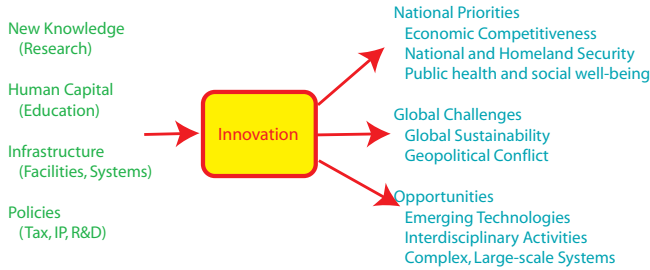
sional and technical services. From California to North Carolina, Bangalore to Shanghai, there is a growing recognition throughout the world that economic prosperity and social well-being in a global knowledge-driven economy require public investment in knowledge resources. That is, regions must create and sustain a highly educated and innovative workforce, supported through policies and investments in cutting-edge technology, a knowledge infrastructure, and human capital development.

Ironically, a century ago Michigan led the nation in building just such knowledge resources. It created a great education system aimed at serving all of its citizens, demonstrating a remarkable capacity to look to the future and a willingness to take the actions and make the investments that would yield prosperity and well-being for future generations. Yet today this spirit of public investment for the future appears missing. Decades of failed public policies and inadequate investment now threaten the extraordinary educational and knowledge resources built through the vision and sacrifices of past generations. Ironically, at a time when the rest of the world has recognized that investing in education and knowledge creation is the key to not only prosperity but, indeed, survival, too many of Michigan's citizens and leaders, in both the public and private sector, have come to view such investments as a low priority, expendable during hard times. The aging baby boomer population that now dominates public policy in our state demands instead expensive health care, ever more prisons, homeland security, and reduced tax burdens, rather than investing in education, innovation, and the future.

Beyond a commitment to educational opportunity, there is another key to economic prosperity: technological innovation. As the source of new products and services, innovation is directly responsible for the most dynamic sectors of the U.S. economy. Here our nation has a great competitive advantage, since our society is based on a highly diverse population, democratic values, and free-market practices. These factors provide an



Investing in human capital...and the future!



The Keys to Innovation

unusually fertile environment for technological innovation. Once again Michigan provided leadership in the 20th century, first putting the world on wheels and then becoming the arsenal of democracy.

However, history has also shown that significant public investment is necessary to produce the essential ingredients for innovation to flourish: new knowledge (research), human capital (education), infrastructure (facilities, laboratories, communications networks), and policies (tax, intellectual property). Other nations are beginning to reap the benefits of such investments aimed at stimulating and exploiting technological innovation, creating serious competitive challenges to American industry and business both in the conventional marketplace (e.g., Toyota) and through new paradigms such as the off-shoring of knowledge-intensive services (e.g., Bangalore, Shanghai). Yet again, at a time when our competitors are investing heavily in stimulating the technological innovation to secure future economic prosperity, Michigan is missing in action, significantly under-investing its economic and political resources in planting and nurturing the seeds of innovation.

Adequately supporting education and technological innovation is not just something we would like to do; it is something we have to do. What is really at stake here is building Michigan's regional advantage, allowing it to compete for prosperity, for quality of life, in an increasingly competitive world. In a knowledge-intensive society, regional advantage is not achieved through gimmicks such as lotteries and casinos. It is achieved through creating a highly educated and skilled workforce. It requires an environment that stimulates creativity, innovation, and entrepreneurial behavior. Specifically, it requires public investment in the ingredients of innovation—educated people and new knowledge. Put another way, it requires public purpose, policy, and

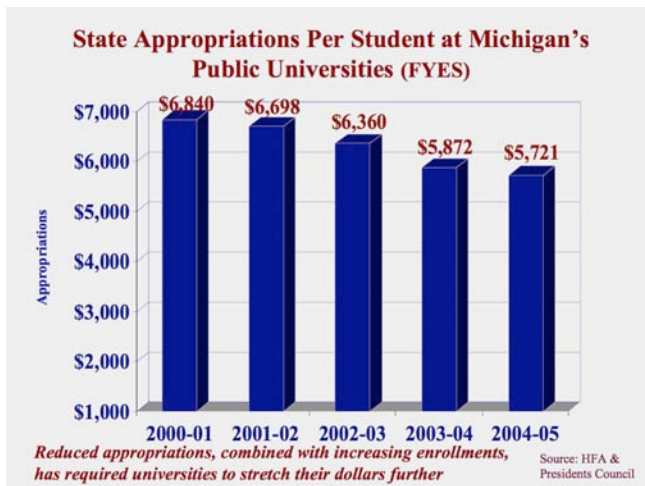
investment to create a knowledge society competitive in a global economy.

This study has applied the planning technique of *strategic roadmapping* to provide a framework for the issues that Michigan must face and the commitments that we must make, both as individuals and as a state, to achieve prosperity and social well-being in a global knowledge economy. The roadmapping process was originally developed in the electronics industry and is applied frequently to major federal agencies such as the Department of Defense and NASA. Although sometimes cloaked in jargon such as environmental scans, resource maps, and gap analysis, in reality the roadmapping process is quite simple. It begins by asking where we are today, then where we wish to be tomorrow, followed by an assessment of how far we have to go, and finally concludes by developing a roadmap to get from here to there. The roadmap itself usually consists of a series of recommendations, sometimes divided into those that can be accomplished in the near term and those that will require longer-term and sustained effort.

By any measure, the assessment of *Michigan today* is very disturbing. Our state is having great difficulty in making the transition from a manufacturing to a knowledge economy. In recent years we have led the nation in unemployment, and our leading city, Detroit, now ranks as the nation's poorest. Furthermore, the out-migration of young people in search of better jobs is the fourth most severe among the states; our educational system is underachieving with one-quarter of Michigan adults without a high school diploma and only one-third of



Michigan today: Still dependent on a factory economy as illustrated by automotive plant locations. (MDLEG)



Drastic cuts in state appropriations over the past five years are crippling the state's public universities.

high school graduates college-ready. Fewer than one-quarter of Michigan citizens have college degrees. Although Michigan's system of higher education is generally regarded as one of the nation's finest, the erosion of state support over the past two decades and most seriously over the past five years—with appropriation cuts to public universities ranging from 20% to 40%—has not only driven up tuition but put the quality and capacity of our public universities at great risk.

More generally, for many years Michigan has been shifting public funds and private capital away from investing in the future through education, research, and innovation to fund instead short term priorities such as prisons while inacting tax cuts that have crippled state revenues. And all the while, as the state budget began to sag and eventually collapsed in the face of a weak economy, public leaders were instead preoccupied with fighting the old and increasingly irrelevant cultural and political wars (cities vs. suburbs vs. exurbs, labor vs. management, religious right vs. labor left). In recent years the state's motto has become "Eat dessert first; life is uncertain!" Yet what Michigan has really been consuming is the seed corn for its future.

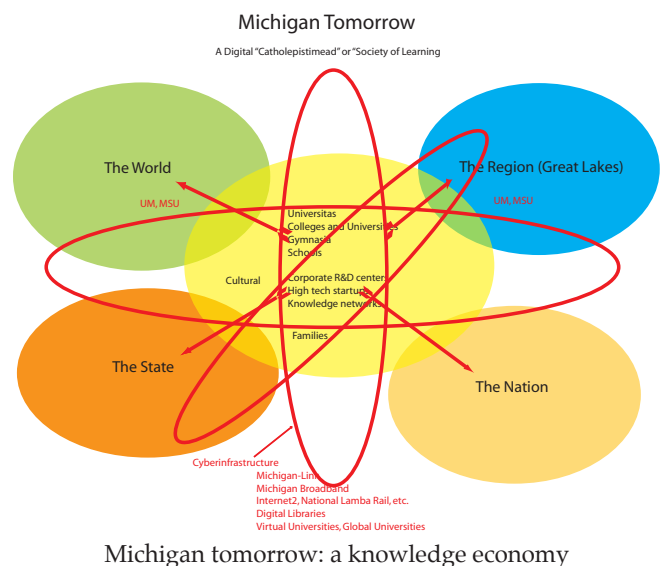
A vision for *Michigan tomorrow* can best be addressed by asking and answering three key questions:

1. *What skills and knowledge are necessary for individuals to thrive in a 21st-century, global, knowledge-intensive society?* Clearly a college education has become mandatory, probably at the bachelor's level, and for many,

at the graduate level. Beyond this goal, the state should commit itself to providing high-quality, cost-effective, and diverse educational opportunities to all of its citizens throughout their lives, since during an era of rapid economic change and market restructuring, the key to employment security has become continual, lifelong education.

2. *What skills and knowledge are necessary for a population (workforce) to provide regional advantage in such a competitive knowledge economy?* Here it is important to stress that we no longer are competing only with Ohio, Ontario, and California. More serious is the competition from the massive and increasingly well-educated workforces in emerging economies such as India, China, and the Eastern Bloc. For such knowledge workers, there is little distinction between work and education, since rapid technological change in a global economy requires the continuous improvement of workforce skills.

3. *What level of new knowledge generation (e.g., R&D, innovation, entrepreneurial zeal) is necessary to sustain a 21st-century knowledge economy, and how is this achieved?* Here it is increasingly clear that the key to global competitiveness in regions aspiring to a high standard of living is innovation. And the keys to innovation are new knowledge, human capital, infrastructure, and forward-looking public policies. Not only must a region match investments made by other states and nations in education, R&D, and infrastructure, but it must



recognize the inevitability of new innovative, technology-driven industries replacing old obsolete and dying industries as a natural process of “creative destruction” (*à la* Schumpeter) that characterizes a hypercompetitive global economy.

So *how far does Michigan have to travel* to achieve a knowledge economy competitive at the global level? What is the gap between Michigan today and Michigan tomorrow? This part of the roadmapping process does not require a rocket scientist. One need only acknowledge the hopelessness in the faces of the unemployed, or the backward glances of young people as they leave our state for better jobs, or the angst of students and parents facing yet another increase in college costs as state government once again cuts appropriations for higher education. To paraphrase Thomas Friedman, “The world is flat! Globalization has collapsed time and distance and raised the notion that someone anywhere on earth can do your job, more cheaply. Can Michigan rise to the challenge on this leveled playing field?”

So, what do we need to do? What is the *roadmap to Michigan’s future*? In a knowledge-intensive economy, regional advantage in a highly competitive global marketplace is achieved through creating a highly educated and skilled workforce. It requires an environment that stimulates creativity, innovation, and entrepreneurial behavior. Experience elsewhere has shown that visionary public policies and significant public investments in high-skilled human capital, research and innovation, and infrastructure are necessary to sustain a knowledge economy.

The Roadmap: The Near Term (...now!...)

For the near term our principal recommendations focus on changing policies for investing in higher education, research, and innovation, while providing our institutions with the capacity to become more agile and market-smart.

Human Capital

1. *Michigan simply must increase the participation of its citizens in higher education at all levels—community college, baccalaureate, and graduate and professional degrees. This will require a substantial increase in the funding of higher*

education from both public and private sources as well as significant changes in public policy. It will also likely require a dedicated source of tax revenues to achieve and secure the necessary levels of investment during a period of gridlock in state government, perhaps through a citizen-initiated referendum. This, in turn, will require a major effort to build adequate public awareness of the importance of higher education to the future of the state and its citizens.

2. *To achieve and sustain the quality of and access to educational opportunities, Michigan needs to move into the top quartile of states in its higher education appropriations (on a per student basis) to its public universities. To achieve this objective, state government should set a target of increasing by 30% (beyond inflation) its appropriations to its public universities over the next five years.*

3. *The increasing dependence of the knowledge economy on science and technology, coupled with Michigan’s relatively low ranking in percentage of graduates with science and engineering degrees, motivates a strong recommendation to state government to place a much higher priority on providing targeted funding for program and facilities support in these areas in state universities, similar to that provided in California, Texas, and many other states. In addition, more effort should be directed toward K-12 to encourage and adequately prepare students for science and engineering studies, including incentives such as forgivable college loan programs in these areas (with forgiveness contingent upon completion of degrees and working for Michigan employers). In addition,*



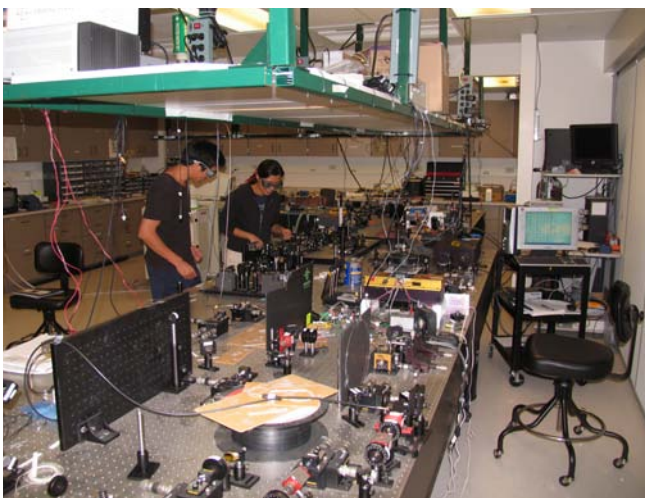
New engineering students

state government should strongly encourage public universities to recruit science and engineering students from other states and nations, particularly at the graduate level, perhaps even providing incentives if they accept employment following graduation with Michigan companies.

4. Colleges and universities should place far greater emphasis on building alliances that will allow them to focus on unique core competencies while joining with other institutions in both the public and private sector to address the broad and diverse needs of society in the face of today's social, economic, and technological challenges while addressing the broad and diverse needs of society. For example, research universities should work closely with regional universities and independent colleges to provide access to cutting-edge knowledge resources and programs.

New Knowledge (R&D, innovation)

5. The quality and capacity of Michigan's learning and knowledge infrastructure will be determined by the leadership of its public research universities in discovering new knowledge, developing innovative applications of those discoveries that can be transferred to society, and educating those capable of working at the frontiers of knowledge and the professions. State government should strongly support the role of these institutions as sources of advanced studies and research by dramatically increasing public support of research infrastructure, analogous to the highly successful Research Excellence



Ultra-high power laser laboratory

Fund of the 1980s. Also key will be enhanced support of the efforts of regional colleges and universities to integrate this new knowledge into academic programs capable of providing lifelong learning opportunities of world-class quality while supporting their surrounding communities in the transition to knowledge economies.

6. In response to such reinvestment in the research capacity of Michigan's universities, they, in turn, must become more strategically engaged in both regional and statewide economic development activities. Intellectual property policies should be simplified; faculty and staff should be encouraged to participate in the startup and spinoff of high-tech business; and universities should be willing to invest some of their own assets (e.g., endowment funds) in state- and region-based venture capital activities. Furthermore, universities and state government should work more closely together to go after major high tech opportunities in both the private sector (attracting new knowledge-based companies) and federal initiatives).

7. Michigan must also invest additional public and private resources in private-sector initiatives designed to stimulate R&D, innovation, and entrepreneurial activities. Key elements would include reforming state tax policy to encourage new, high-tech business development, securing sufficient venture capital, state participation in cost-sharing for federal research projects, and a far more aggressive and effective effort by the Michigan Congressional delegation to attract major federal research funding to the state.

Infrastructure

8. Providing the educational opportunities and new knowledge necessary to compete in a global, knowledge-driven economy requires an advanced infrastructure: educational and research institutions, physical infrastructure such as laboratories and cyberinfrastructure such as broadband networks, and supportive policies in areas such as tax and intellectual property. Michigan must invest heavily to transform the infrastructure for a 20th-century manufacturing economy into that required for a 21st-century knowledge economy. Of particular importance is a commitment by state government to provide adequate annual appropriations for university capital facilities comparable to those of other leading states. It is

also important for both state and local government to play a more active role in stimulating the development of pervasive high speed broadband networks, since experience suggests that reliance upon private sector telcom and cable monopolies could well trap Michigan in a cyberinfrastructure backwater relative to other regions (and nations).

Policies

9. As powerful market forces increasingly dominate public policy, Michigan's higher-education strategy should become market-smart, investing more public resources directly in the marketplace through programs such as vouchers, need-based financial aid, and competitive research grants, while enabling public colleges and universities to compete in this market through encouraging greater flexibility and differentiation in pricing, programs, and quality aspirations.

10. Michigan should target its tax dollars more strategically to leverage both federal and private-sector investment in education and R&D. For example, a shift toward higher tuition/need-based financial aid policies in public universities not only leverages greater federal financial aid but also avoids unnecessary subsidy of high-income students. Furthermore greater state investment in university research capacity would leverage greater federal and industrial support of campus-based R&D.

11. Key to achieving the agility necessary to respond to market forces will be a new social contract negotiated between the state government and Michigan's public colleges and universities, which provides enhanced market agility in return for greater (and more visible) public accountability with respect to quantifiable deliverables such as graduation rates, student socioeconomic backgrounds, and intellectual property generated through research and transferred into the marketplace.

The Roadmap (longer term...but within a decade...)

For the longer term, our vision for the future of higher education is shaped very much by the recognition that we have entered an age of knowledge in a global economy, in which educated people, the knowledge they produce, and the innovation and entrepreneurial skills they possess have become the keys to

economic prosperity, social well-being, and national security. Moreover, education, knowledge, innovation, and entrepreneurial skills have also become the primary determinants of one's personal standard of living and quality of life. We believe that democratic societies—including state and federal governments—must accept the responsibility to provide all of their citizens with the educational and training opportunities they need, throughout their lives, whenever, wherever, and however they need it, at high quality and at affordable prices.

To this end, the long-term roadmap proposes a vision of the future in which Michigan strives to build a knowledge infrastructure capable of adapting and evolving to meet the imperatives of a global, knowledge-driven world. Such a vision is essential to create the new knowledge (research and innovation), a skilled workforce, and the infrastructure necessary for Michigan to compete in the global economy while providing citizens with the lifelong learning opportunities and skills they need to live prosperous and secure lives in our state. As steps toward this vision, we recommend the following actions:

1. Michigan needs to develop a more systemic and strategic perspective of its educational, research, and cultural institutions—both public and private, formal and informal—that views these knowledge resources as comprising a knowledge ecology that must be allowed and encouraged to adapt and evolve rapidly to serve the needs of the state in a change driven world, free from micromanagement by state government or intrusion by partisan politics.



Diverse institutions for diverse needs.

2. Michigan should strive to encourage and sustain a more diverse system of higher education, since institutions with diverse missions, core competencies, and funding mechanisms are necessary to serve the diverse needs of its citizens, while creating a knowledge infrastructure more resilient to the challenges presented by unpredictable futures. Using a combination of technology and funding policies, efforts should be made to link elements of Michigan's learning, research, and knowledge resources into a market-responsive seamless web, centered on the needs and welfare of its citizens and the prosperity and quality of life in the state rather than the ambitions of institutions and political leaders.

3. Serious consideration should be given to reconfiguring Michigan's educational enterprise by exploring new paradigms based on the best practices of other regions and nations. For example, the current segmentation of learning (e.g., primary, secondary, collegiate, graduate-professional, workplace) is increasingly irrelevant in a competitive world that requires lifelong learning to keep pace with the exponential growth in new knowledge. More experimentation both in terms of academic programs and institutional types should be encouraged.

4. The quality and capacity of Michigan's learning and knowledge infrastructure will be determined by the leadership of its two AAU-class research universities, UMAA and MSU, in discovering new knowledge, developing innovative applications of these discoveries that can be transferred to society, and educating those capable of working at the frontiers of knowledge and the professions. In this sense, UMAA and MSU should be encouraged to evolve more toward a "universitas" character, stressing their roles as sources of advanced knowledge and learning rather than focusing on providing general education (or socialization) at the undergraduate level.

5. While it is natural to confine state policy to state boundaries, in reality such geopolitical boundaries are of no more relevance to public policy than they are to corporate strategies in an ever more integrated and interdependent global society. Hence Michigan's strategies must broaden to include regional, national, and global elements, including the possibility of encouraging the state's two flagship research universities, the University of Michigan and Michigan State University, to join together to form a true world university,

capable of assisting the state to access global economic and human capital markets.

6. Michigan's research universities should explore new models for the transfer of knowledge from the campus into the marketplace, including the utilization of endowment capital (perhaps with state match) to stimulate spinoff and startup activities and exploring entirely new approaches such as "open source – open content paradigms" in which the intellectual property created through research and instruction is placed in the public domain as a "knowledge commons," available without restriction to all, in return for strong public support.

7. Michigan should explore bold models aimed at producing the human capital necessary to compete economically with other regions (states, nations) and provide its citizens with prosperity and security. Lifelong learning will not only become a compelling need of citizens (who are only one paycheck away from the unemployment line in a knowledge-driven economy), but also a major responsibility of the state and its educational resources. One such model might be to develop a 21st-century analog to the G.I. Bill of the post WWII era that would provide—indeed, guarantee—all Michigan citizens with access to abundant, high-quality, diverse learning opportunities throughout their lives, and adapts to their ever-changing needs

8. Michigan should develop a leadership coalition—involving leaders from state government, industry, labor, education, and concerned citizens—with vision and courage sufficient to challenge and break the stranglehold of the past on Michigan's future!

Although this roadmapping exercise was for a specific state, we believe it offers a possible model of how regions can utilize the roadmapping process to develop their own unique paths to future prosperity, security, and social well-being for their citizens. We are currently engaged in further studies about how such regional technology roadmapping efforts can be applied to multiple-state regions or even nation-states. In an Epilogue section, we have suggested broadening this roadmapping activity to include the entire Great Lakes region, encompassing those states that once comprised the manufacturing center of the world. We suggest that



Roadmapping for the Great Lakes states
(Scott Swanm, CSCAR, 2003)

these states could build on the unique capacity of the region's flagship research universities to build strong regional advantage in a global, knowledge-driven economy. While such a regional plan would require considerable leadership at the level of both the state (governors) and higher education (university leaders), it could be the key to the economic future of the Great Lakes states.

Finally, a word about the target audience for this study. The Michigan Roadmap is intended in part for leaders in the public sector (the Governor, Legislature, and other public officials), the business community (CEOs, labor leaders), higher education leaders, and the nonprofit foundation sector. However, this report is also written for those interested, concerned citizens who have become frustrated with the deafening silence about Michigan's future that characterizes our public, private, and education sectors. The state's leaders, its government, industry, labor, and universities, have simply not been willing to acknowledge that the rest of the world is changing. They have held fast to an economic model that is not much different from the one that grew up around the heyday of the automobile era—an era that passed long ago.

Michigan is far more at risk than many other states because its manufacturing-dominated culture is addicted to an entitlement mentality that has long since disappeared in other regions and industrial sectors.

Moreover, politicians and the media are both irresponsible and myopic as they continue to fan the flames of the voter hostility to an adequate tax base capable of meeting both today's urgent social needs and longer-term investment imperatives such as education and innovation. As Bill Gates warned, cutting-edge companies no longer make decisions to locate and expand based on tax policies and incentives. Instead they base these decisions on a state's talent pool and culture for innovation—priorities apparently no longer valued by many of Michigan's leaders, at least when it comes to tax policy.

To be sure, it is difficult to address issues such as developing a tax system for a 21st-century economy, building world-class schools and colleges, or making the necessary investments for future generations in the face of the determination of the body politic still clinging tenaciously to past beliefs and practices. Yet the realities of a flat world will no longer tolerate procrastination or benign neglect. In Chapter 7 we have broadened the discussion to suggest several ideas for breaking this public policy logjam to facilitate the implementation of the recommendations of the Michigan Roadmap.

Finally, it should be acknowledged that much of the rhetoric used in this report is intentionally provocative—if not occasionally incendiary. But recall here that old saying that sometimes the only way to get a mule to move is to whack it over the head with a 2x4 first to get its attention. The Michigan Roadmap is intended as just such a 2x4 wake-up call to our state. For this effort to have value, we believe it essential to explore openly and honestly where our state is today, where it must head for tomorrow, and what actions will be necessary to get there. Michigan simply must stop backing into the future and, instead, turn its attention to making the commitments and investments today necessary to allow it to compete for prosperity and social well-being tomorrow in a global, knowledge-driven economy.

Recommendations

The Near Term

Today's Challenge: Enabling Michigan's transition to a knowledge-driven economy capable of providing prosperity, security, and social well-being in a hypercompetitive global economy.

Key Vision:
To invest more adequately, strategically, and intelligently.

Investment Goals:
... human capital (lifelong learning)
... new knowledge (research, innovation, entrepreneurship)
... infrastructure (institutions, labs, cyber)
... policy (tax, investment, intellectual property)

The Elements:

1. Increase participation of all citizens in higher education.
2. Move Michigan into top quartile in higher ed investments.
3. Targeted state investment in science and engineering.
4. Stress alliances among Michigan's colleges and universities.
5. Michigan should increase investments in university research infrastructure (similar to Research Excellence Fund).
6. Michigan universities should become more engaged in tech transfer and economic development.
7. Michigan should develop incentives (including tax policy) to stimulate private sector R&D and innovation.
8. Public investment in infrastructure such as broadband is critical.
9. Michigan should invest more in higher education marketplace (particularly need-based financial aid).
10. State funds should be used to leverage private and federal funds.
11. State universities should be provided with agility to adapt to market, subject to accountability measures.

The Longer Term

Tomorrow's Challenge: To provide all of Michigan's citizens with the education and training they need, throughout their lives, whenever, wherever, and however they desire it, at high quality, and affordable cost.

Key Vision: To develop a knowledge society capable of responding to the imperatives of a 21st century, global, knowledge-driven society.

Goal: A society of learning, capable of adapting and evolving rapidly to provide learning opportunities, knowledge, and innovation during a period of extraordinary change.

The Elements:

1. Michigan must develop a more systemic and strategic approach to its knowledge resources.
2. The state should encourage more diversity in institutions.
3. New paradigms for K-16 education should be explored.
4. UM and MSU should be encouraged to stress advanced education and research.
5. UM and MSU should be encouraged to develop capacity to access global markets.
6. Michigan's universities should explore bolder models of tech transfer, spinoffs, and startup activities.
7. Michigan should consider bolder models for producing human capital such as a 21st century version of the G.I. Bill that guarantees lifelong educational opportunities for all citizens.

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References

Acknowledgements

As noted earlier, the roadmapping process utilizes a series of expert panels to define key issues, and then refines appropriate strategies through focus groups and sustained dialog. In the case of the Michigan Roadmap, a guidance group was formed that met frequently to guide and shape the process and recommendations over the three-year period of the study. This group included Marvin Peterson, Dan Atkins, Kathy Willis, Carl Berger, Bruce Montgomery, Maurita Holland, and was ably assisted by graduate students Dana Walker and Laurel Park.

During this period numerous other experts participated in the process, including Michael Boulus, Doug Van Houweling, Doug Ross, Craig Ruff, Paul Dimond, John Austin, Lou Glazer, Donald Grimes, Dan Hurley, Elizabeth Gerber, and Philip Power. In addition, there was extensive interaction with the leadership, faculty, and staff of both public and independent colleges and universities in Michigan.

More broadly, this effort was coordinated with several other ongoing projects at the national level, including major projects of the National Academies chaired by the director of the Michigan Roadmap (JJD): the IT Forum studying the impact of information technology on the future of the research university, the Federal Science and Technology guidance group of the Committee on Science, Engineering, and Public Policy of the National Academies, and the Commission to Assess the Capacity of United States Engineering Research. Similarly, other projects involving the director also had influence on the Roadmap: the Strategic Planning Committee of the University of California, the Task Force to Develop a Higher Education Future for Kansas City, and participation with state and university groups in various regions (Texas, Colorado, Ohio, North Carolina, Arizona, Ontario, British Columbia). In addition, the director's involvement during this period in several international groups also informed the study (OECD, the Glion Colloquium).

The director of the Michigan Roadmap project wishes to acknowledge the contributions of these individuals and related studies. However it is also important to stress that this report, including its recommendations, while very much influenced by these groups, was au-

thored by the director, who accepts full responsibility for its language and conclusions—particularly the more provocative language and controversial recommendations.

Finally, it is important to state at the outset that this study was supported by an independent nonprofit foundation, the Atlantic Philanthropies, which has long been one of the most generous and effective patrons of higher-education research. We are deeply grateful for their support, encouragement, and guidance. We are also grateful for the independence enabled by their support that has allowed us to approach this project with a level of creativity and candor unusual in the public-policy arena.

JJD
Ann Arbor
September, 2005

Chapter 1

Introduction

*“It is not the strongest of the species that survive,
nor the most intelligent, but rather the ones
most responsive to change.” – Charles Darwin*

So what’s the problem? Why is there a need for yet another study of the future of the state of Michigan?

The reason is simple: Michigan’s old factory-based manufacturing economy is dying, slowly but surely, putting at risk the welfare of millions of citizens in our state, in the face of withering competition from an emerging global economy driven by knowledge and innovation. From California to North Carolina, Dublin to Bangalore, other regions, states, and nations are shifting their public policies and investments to support the new imperatives of a knowledge economy such as knowledge creation (research, innovation, entrepreneurial activities), human capital (lifelong learning and advanced education, particularly in science and engineering), and infrastructure (colleges and universities, research laboratories, broadband networks). As Thomas Friedman puts it, “The world is flat! Globalization has collapsed time and distance and raised the notion that someone anywhere on earth can do your job, more cheaply. Can we rise to the challenge on this leveled playing field?” (Friedman, 2005).

Yet in Michigan there is a deafening silence about the implications of a global, knowledge-driven global economy for our state’s future. There is little evidence of effective policies, new investments, or visionary leadership capable of reversing the downward spiral of Michigan’s economy. For whatever reason, leaders in the state’s public and private sectors continue to cling tenaciously to past beliefs and practices, preoccupied with obsolete and largely irrelevant issues (e.g., the culture wars, entitlements, tax cuts or abatements, and gimmicks such as lotteries and casinos) rather than developing strategies, taking actions, and making the

necessary investments to achieve economic prosperity and social well-being in the new global economic order. Preoccupied with obsolete political battles, addicted to entitlements, and assuming that what worked before will work again, Michigan today is sailing blindly into a profoundly different future.

For many years now we have seen our low-skill, high-pay factory jobs downsized by increasing productivity, shifted to lower cost states, or outsourced to low-wage countries. We have fallen behind the rest of the nation in adding high value-added service firms and jobs during the transition to a knowledge economy. According to a recent study at the University of Michigan, our state lost 254,000 jobs from 2000 to 2003, a 22% decline, including 163,000 manufacturing jobs. (Glazer, 2005). In 2004, Michigan had the worst performing state economy in the nation, ranking as the only state that has lost more jobs than it created, according to the Joint Economic Committee of Congress. Detroit has recently become the nation’s poorest city, with over one-third of its residents living below the federal poverty level (U.S. Census Bureau, 2005). Yet if we look about, we see other states, not to mention other nations, investing heavily and restructuring their economies to create high-skill, high-wage jobs in areas such as information services, financial services, trade, and professional and technical services.

For decades the leadership of this state—whether in state government, corporations, labor, cities, or colleges and universities—has been backing into the future, hoping in vain that our factory-based manufacturing economy would return. Yet that manufacturing economy, so dominant in a 20th-century world, has not returned,

and the risk of today's myopia is that by the time we have come to realize the permanence of this economic transformation, the out-sourcing and off-shoring train will have left the station, taking with it the rest of our good jobs.

Perhaps nowhere is this inability to read the writing on the wall more apparent than in our state's approach to the development of the human resources and new knowledge necessary to compete in a global, knowledge-driven economy. Michigan's strategies and policies with respect to advanced learning and knowledge production have been woefully inadequate, all too often political in character, and largely reflecting a state of denial about the imperatives of the emerging global economy.

Some Symptoms of Our Plight

During the last half of the 20th century, Michigan saw many of its low-skill, high-wage manufacturing jobs downsized as companies restructured to increase productivity and outsourced to lower wage states and nations to reduce costs. Today our state is beginning to experience the same phenomenon with higher-skill service jobs through off-shoring to emerging economies such as India, China, and the Eastern Bloc nations. While labor cost is certainly a factor, more important has been the determination of these regions to invest heavily in educating a highly skilled, high-quality workforce in key economic sectors. This has happened during a period when Michigan has been largely asleep at the wheel, assuming our low-skill workforce would remain competitive and our factory-based manufacturing economy would prosper indefinitely.

It may seem surprising that a state, which a century and a half ago led the nation in its commitment to building a great public education system aimed at serving all of its citizens, would be failing today in its human resource development. Perhaps it is ironic that a state with seemingly infinite resources of fur, timber, iron, and copper—a state with boundless confidence in the future—should have played such a leadership role in developing the models of higher education that would later serve all of America. The University of Michigan, while not the first of the state universities, is nevertheless commonly regarded as the “mother of public uni-

versities” (Kerr, 1963), responsible for and responsive to the needs of the people who founded it and supported it, even as it sought to achieve quality equal to that of the most distinguished private institutions. Michigan State University is also regarded as a national leader, the prototype of the great land-grant universities. And Wayne State University has provided an important model of the urban university, serving the needs of one of our nation's great cities. When these universities were augmented by the evolution of Michigan's comprehensive and regional universities, community colleges, and independent colleges, the state gained a justified reputation for one of the nation's most forward-looking and outstanding higher education systems.

What is significant is that the strength of Michigan's capacity to build and sustain such extraordinary institutions—arose from our state's ability to look to the future, its willingness to take the actions and make the investments that would yield prosperity and well-being for future generations. Yet today this spirit of public investment for the future has disappeared. Decades of failed public policies and inadequate investment now threaten the extraordinary educational resources built through the vision and sacrifices of past generations. In our times, state government has come to view public higher education as low priority and expendable during hard times in preference to funding other social priorities such as prisons and politically popular tax relief. All too frequently the annual appropriation process is approached more as a political football game rather than as an opportunity for strategic investment in the future. It has become painfully evident that our current policies of inadequate state support for higher education is destroying Michigan's long-standing commitment to providing “an uncommon education for the common man,” in the words of James Angell, one of the University of Michigan's early presidents (Peckham, 1967).

Beyond educational opportunities, there is another key to economic prosperity: technological innovation. As the source of new products and services, innovation is directly responsible for the most dynamic areas of the U.S. economy. It has become even more critical to our prosperity and security in today's hypercompetitive, global, knowledge-driven economy. Our American culture—based on a highly diverse population, democratic values, and free-market practices—provides an unusu-

ally fertile environment for technological innovation. However, history has also shown that significant public investment is necessary to produce the essential ingredients for innovation to flourish: new knowledge (research), human capital (education), infrastructure (facilities, laboratories, communications networks), and policies (tax, intellectual property).

Again, the irony of our state's plight today is that Michigan led the world in technological innovation throughout much of the 20th century. The automobile industry concentrated in Michigan because of the skills of our craftsmen, engineers, technologists, and technicians and the management and financial skills of corporate leadership as the industry grew to global proportions. Michigan became the arsenal of democracy during World War II. While the workforce skills required by factory manufacturing required only minimal formal education, technological excellence and skillful management enabled Michigan corporations to achieve global impact. Basic research was also key, funded by industry in world-class laboratories such as the Ford Scientific Laboratory and the General Motors Research Laboratory. Michigan also benefited greatly from the presence of two world-class research universities, the University of Michigan and Michigan State University.

However, by the late 20th century, shareholders began demanding short-term strategies to increase quarterly earnings rather than longer-term investments in technology key to the future of industry. To be sure, cost-cutting, total quality management, lean manufacturing, and just-in-time supply chains were able to enhance productivity during the 1980s and early 1990s, albeit at the expense of hundreds of thousands of manufacturing jobs as companies restructured their workforces. Unfortunately, such restructuring also eliminated much of the corporate R&D function, constraining industry increasingly to technological progress at the margin rather than based on breakthrough technologies and innovations. This was compounded by management's increasing focus on near-term profits, even at the expense of longer-term market share. Michigan's Washington influence was used more to block federal regulation in areas such as emissions standards and fuel economy than attracting additional federal R&D dollars to the state, thereby ignoring the growing concerns about issues such as petroleum imports and glob-

al climate change, which would threaten the very viability of Michigan industry by 2000. As a consequence, at a time when other states and nations were investing heavily in stimulating the technological innovation to secure future economic prosperity, Michigan was missing in action, significantly under-investing in the seeds of innovation.

What is really at stake today is building Michigan's regional advantage, allowing it to compete for prosperity and quality of life, in an increasingly competitive global economy. In a knowledge-intensive society, regional advantage is not achieved through traditional political devices such as tax cuts for the wealthy, regulatory relief of polluters, entitlements for those without need, or tax-subsidized gimmicks such as lotteries, casinos, or sports stadiums. A knowledge-based, competitive economy is achieved through creating a highly educated and skilled workforce. It requires an environment that stimulates creativity, innovation, and entrepreneurial behavior. It requires public investment in the ingredients of innovation—educated people and new knowledge—and the infrastructure to support advanced learning, research, and innovation. Put another way, it requires strong public purpose, wise public policy, and adequate investment to create a true knowledge society.

Questions Concerning Michigan's Future

Creating a different economic engine that will be competitive in a knowledge-based, global economy also demands vision and leadership. It requires all of us to think about our future and where Michigan might fit into that future. To illustrate, consider several provocative questions concerning Michigan's future:

1. What will the economic engine for our state be 20 years from today? Does anybody know? Is anybody thinking about this? It certainly won't be manufacturing, at least that based on low-skill factory jobs. If this economic engine is the service sector of our economy, will these be high-skill, high-wage, knowledge-driven activities? Or will we be flipping burgers and mowing each other's lawns, while the most rewarding jobs have all flown off (rather, zipped off over the Internet) to other states, regions, and nations?

2. Although it may be blasphemy to suggest it, suppose the price of gasoline in the United States should move up to its actual cost without artificial subsidies (currently about \$5.00 per gallon in North America). Or suppose, even more boldly, that within the next two decades we pass over M. King Hubbert's peak in global oil production (and a decade or so later do the same with natural gas), as an increasing number of geologists are now predicting (Hirsch, 2005). Do we honestly believe that Detroit's automobile industry could survive a future where fossil fuels have either disappeared or have become too expensive to use in transportation? And if you still have confidence in that industry's technological ingenuity to come up with alternatives such as hydrogen-based fuels or electric vehicles (although with no fossil fuels, this would imply a massive commitment to nuclear power), then suppose further that information and communications technologies continue to evolve at the pace of Moore's Law, a thousand-fold within a decade, a million-fold within two decades, and so on. What is the role of transportation in a world in which we can faithfully replicate any aspect of human interaction—sight, sound, touch, taste, smell—with perfect fidelity at a distance (the “stim-sim” experience suggested by science fiction writers)? (Gibson, 1983)

3. As Michigan's population ages, what will our workforce look like? We already have seen the out-migration of young adults in the 25-44 age range, leaving behind an aging baby-boomer population demanding priorities such as expensive health care, even more prisons, homeland security, and reduced tax burdens, to the neglect of education—and the future (Kristof, 2005). Suppose human life span were to double during the 21st century, as it did during the 20th century (from 40 to 80 years). Beyond the challenge of maintaining an appropriate balance between consumption for our present desires and investment for our children's future with a retired generation, how can we provide educational resources capable of keeping our citizens competitive over working careers that may be several more decades in length? Certainly not by confining their education to their early years.

4. In *Alice Through The Looking Glass*, the Red Queen warns: “Now, here, you see, it takes all the running you

can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!” (Brown, 2003). And such is life in today's global, knowledge-driven economy where only world-class products and services survive. But just what Michigan assets are sufficiently world-class to compete, to run twice as fast, particularly if today's artificial barriers were removed (e.g., trade restrictions, tax subsidies, perhaps even time and space if Moore's Law remains valid)? Our companies? Our universities? The quality of our workforce? The quality of our business environment? The quality of our government? Our weather? Or none of the above?

Purpose of the Study

So, what to do? That is the goal of this study: to develop a plan for building a learning and knowledge infrastructure for a regional area such as the State of Michigan. The plan needs to address the life-long educational needs of its citizens and the workforce skills necessary to compete and flourish in a global, knowledge-intensive economy. In addition, we need to address how to build the sources of knowledge and innovation necessary to create world-class companies and a world-class living environment.

There are many approaches to such a study. Most common are strategic planning exercises, which progress through the usual sequence: 1) mission and vision, 2) environmental assessment, 3) goals, 4) strategic actions, 5) tactical implementation, and 6) assessment and evaluation. An alternative is scenario planning, in which one develops several scenarios or stories of possible futures that usually illustrate limiting cases while taking advantage of the power of the narrative.

But this study is somewhat different. In the first place, it is heavily based on technology—what exists today and what is likely to be available in the future. After all, since technology itself is contributing to many of our challenges—globalization, off-shoring, the obsolescence of our manufacturing companies and our low-skill workforce—it is understandable that we might want to examine technology as a possible opportunity as well as a certain threat.

In fact, the study itself has adopted a common technique used in industry and the federal government to

develop technology strategies: technology road-mapping. In a traditional technology roadmap, one uses expert panels to begin with an assessment of needs, then constructs a map of existing resources, performs an analysis to determine the gap between what currently exists and what is needed, and finally develops a plan or roadmap of possible routes from here to there, from now to the future. Although sometimes confused with jargon such as environmental scans, resource maps, and gap analysis, in reality the roadmapping process is quite simple. It begins by asking where we are today, then where we wish to be tomorrow, followed by an assessment of how far we have to go, and finally concludes by developing a roadmap to get from here to there. The roadmap itself usually consists of a series of recommendations, sometimes divided into those that can be accomplished in the near term and those that will require longer-term and sustained effort.

To provide context, we begin in Chapter 2 with an environmental scan of realities of the flat playing field of the global knowledge economy, where robust telecommunications connectivity has enabled billions of new knowledge workers to compete for jobs and prosperity, regardless of location or nationality, provided they have developed the skills and infrastructure. Although most of our analysis concerns the near-term challenges and opportunities of the knowledge economy, we include some brief speculation on possible trends and surprises for the longer term.

In Chapter 3 we turn to a discussion of Michigan today. Our state is having great difficulty in making the transition from a manufacturing to a knowledge economy. In recent years we have led the nation in unemployment; the out-migration of young people in search of better jobs is the fourth most severe among the states; our educational system is underachieving with one quarter of Michigan adults without a high school diploma and only one third of high school graduates college-ready. We review both our state's knowledge assets and liabilities. While Michigan still has, at least for the moment, a high-quality system of colleges and universities, including two of the nation's leading research universities, the erosion of state support over the past two decades and most seriously over the past four years has not only driven up tuition but put the quality and capacity of our public universities at great risk.

Primary and secondary education is of equal concern, not so much because of funding, which has been locked into state budgets by a constitutional amendment in the 1990s, but rather because of poor achievement, particularly in the preparation of students for higher education.

Next in Chapter 4 we turn to a vision for Michigan tomorrow, a knowledge society, serving the needs of all of our citizens, characterized by world-class innovation and a strategic utilization of the very technology that is reshaping our world. Put another way, we suggest those skills, knowledge resources, and educational opportunities needed by both 21st-century citizens and by a 21st-century workforce. In Chapter 5, by comparing this vision with the current reality, we can determine how far Michigan must travel to reach a prosperous future. We can also identify the resource gap that exists between what we have now and what we will need for the future, between the obsolete institutions, policies and programs of today and the globally competitive resources Michigan must build for tomorrow.

Finally, in Chapter 6 we conclude with the development of the Michigan Roadmap itself, a series of near-term and long-term recommendations designed to move our state toward this future. In a knowledge-intensive society, regional advantage is achieved by creating a highly educated and skilled workforce. It requires an environment that stimulates creativity, innovation, and entrepreneurial behavior. Experience elsewhere has shown that visionary public policies and significant public investment are necessary to produce new knowledge, human capital, and infrastructure to support a knowledge economy. Hence in the near term our principal recommendations focus on changing policies for investing in higher education, research, and innovation, while providing our institutions with the capacity to become more agile and market-smart. For the longer term, our roadmap proposes a vision of the future in which Michigan strives to build a knowledge society capable of adapting and evolving to meet the imperatives of a global, knowledge-driven world.

Several Caveats

There are numerous examples of similar planning efforts that have had remarkable impact. Perhaps the

most famous American example was the California Master Plan, developed in the 1950s and adopted in 1960 to provide a world-class educational system for a state facing profound economic and demographic change. Ireland's entry into the European Union was accompanied by an aggressive plan to ramp up major investments in advanced education and stimulate an entrepreneurial culture that has transformed a nation with a backward economy into the Celtic Tiger, now one of the most prosperous nations in Europe. Yet another example is provided by Finland, a nation with relatively limited natural resources, which has used strong investments in technology and education to leapfrog into perhaps the most high-tech economy in the world. Today we see the massive populations of India and China determined to make similar investments to become global economic powers in a knowledge economy.

This report, which has a similar objective for our state, is aimed at several audiences. To be sure, it is intended for leaders in the public sector (the Governor, Legislature, and other public officials), the business community (CEOs, labor leaders), higher-education leaders, and the nonprofit foundation sector. However, this report is also written for those interested and concerned citizens who have become frustrated with the deafening silence about Michigan's future that characterizes our public, private, and education sectors. It is difficult to address issues such as developing a tax system for a 21st-century economy, building world-class schools and colleges, or making the necessary investments for future generations in the face of the determination of the body politic and its political leaders to cling tenaciously to past beliefs and practices. Yet the realities of a flat world will no longer tolerate procrastination or benign neglect (Friedman, 2005). For this effort to have value, we believe it essential to explore openly and honestly where our state is today, where it must head for tomorrow, and what actions will be necessary to get there.

This report is also written for a broader audience of those interested in how one might analyze the challenges and opportunities of a region (state or nation), stimulated by and perhaps addressed by technology, through a roadmapping effort to develop both a vision of the future and possible paths toward that vision. While much of the detail of the report is Michigan-specific, the gen-

eral approach, the issues that arise, and many of the recommendations have broader validity and relevance.

It is important to acknowledge that while there are many components to transforming Michigan into a knowledge economy—tax policy, providing adequate social services, government restructuring, and, of course, political transformation—this report focuses particular attention on the role played by knowledge institutions such as universities, corporate R&D, and entrepreneurs. To be sure, these are the institutions most closely associated with the author's background—as a scientist, an engineer, and a university leader. But it also reflects the author's growing concerns about the challenges posed both to our state and nation, gained through leadership experience in national science and technology policy (e.g., chair of the National Science Board) and numerous assignments as chair of various National Academy of Sciences and Engineering task forces concerned with economic competitiveness and national security.

While some may question the particular attention given to the importance of Michigan's flagship research universities in the state's future, here one need only refer to a quote from Congressional testimony by Erich Bloch while director of the National Science Foundation (Bloch, 1988): "The solution of virtually all the problems with which government is concerned: health, education, environment, energy, urban development, international relationships, space, economic competitiveness, and defense and national security, all depend on creating new knowledge and hence upon the health of America's research universities." Nothing could be more important for the leaders and citizens of Michigan to bear in mind as they contemplate the future of our state.

Chapter 2

Setting the Context: An Environmental Scan

We live in a time of great change, in a global society bound together by pervasive communications and transportation technologies and driven by the exponential growth of new knowledge. It is a time of challenge and contradiction, as an ever-increasing human population threatens global sustainability; a global, knowledge-driven economy places a new premium on workforce skills through phenomena such as outsourcing and off-shoring; governments place increasing confidence in market forces to reflect public priorities even as new paradigms such as open-source software challenges conventional free-market philosophies; and shifting geopolitical tensions driven by the great disparity in wealth and power about the globe, national security, and terrorism.

As Tom Friedman stresses in his provocative book, *The World is Flat*, information and telecommunications technologies have created a platform “where intellectual work and intellectual capital can be delivered from anywhere—disaggregated, delivered, distributed, produced, and put back together again—in current business terms “global sourcing”—and this gives an entirely new freedom to the way we do work, especially work of an intellectual nature. Put another way, “The playing field is being leveled. Countries like India and China are now able to compete for global knowledge work as never before. And America [...and Michigan...] had better get ready for it” (Friedman, 2005). Today rapidly evolving technologies and sophisticated supply chain management are allowing global sourcing, the ability to outsource not only traditional activities such as low-skill manufacturing, but to off shore essentially any form of knowledge work, no matter how sophisticated, to whatever part of the globe has populations most capable and cost-effective to perform it. The impact of the flat world on Michigan has been disruptive, if not catastrophic, in many respects. Yet we have only experienced the first waves of the approaching global sourcing tsunami.

In the 20th century a few large companies—indeed, one mammoth industry—determined Michigan’s destiny. Economic growth and prosperity were taken for granted. There was little call for entrepreneurship. The focus of government was on expanding services, regulation, and entitlements, and enacting the taxation to pay for it all, while protecting Michigan industry from federal regulators. Today we find Michigan midway through a several-decades-long transition from a state dominated by a single industry and a few large companies to one with thousands of small, dynamic companies competing in a global marketplace. We are experiencing a transition from low-skill, high-pay jobs to high-skill, high-pay jobs (or, tragically, low-skill, low-pay jobs and unemployment); from a transportation-industry state to a knowledge-services state; from the industrial age to an age of knowledge in a global economy.

While many Michigan citizens understand that automobile production no longer dominates our state’s economy the way it once did, there are still voices suggesting that a robust manufacturing economy based on factory jobs remains the path to prosperity. To be sure, in the face of intense competition from Japan during the 1980s, Michigan companies did learn to streamline operations and cut costs, thereby becoming more competitive, albeit with some erosion in market share. However over the long term, such actions did not retain existing jobs, let alone create new ones, since productivity gains are linked to downsizing through efforts such as total quality management, shorter cycle times, and just-in-time inventory. In fact, increased productivity, coupled with the shift of manufacturing jobs to lower cost states and nations, have led to a major decline in low skill, high wage factory jobs in Michigan. Hence at best restructuring to enhance productivity can only preserve some existing jobs for a short time, although it can provide a valuable opportunity to restructure an industry for the new economy. Yet such has apparently

not happened in our state.

Although the median family income in Michigan began to rise again in the 1990s after two decades of decline, it lagged behind most other states. Michigan's economic growth during this period was among the lowest in the nation. More recently, Glazer and Grimes have noted that over the past three years Michigan has lost 163,000 manufacturing jobs, with the remaining 700,000 manufacturing jobs in this sector at considerable risk from further outsourcing (not to mention offshoring of high-tech services), even though the nation's three largest automotive companies remain headquartered in our state (Glazer, 2004).

Though Michigan added 450,000 jobs during the period from 1990 to 2003, the state lagged considerably behind the national average, growing both overall employment and per capita income only two-thirds as fast as the nation. Of more concern is the fact that employment in knowledge-intensive industries in Michigan grew only 16% during this period, compared to 26% nationally. When one recognizes that today less than 11% of our nation's jobs are in manufacturing, compared with 19% in knowledge-based industries, it is apparent that manufacturing is no longer a reliable path to prosperity in a global, knowledge-driven economy.

Paul Dimond states it well when he portrays Michigan as the frog in a slowly heated pot, insensitive to the increasing temperature until it is finally boiled. Michigan's older manufacturing firms have been losing market share, its high-value added service sector is growing more slowly, and the state simply does not enjoy an innovation infrastructure or an entrepreneurial culture. Indeed, Michigan's strong union presence, twice the national average at 20%, not only drives higher manufacturing costs but has created an entitlement culture. With the possible exception of Ann Arbor, Michigan has no region viewed as a major R&D center or seedbed for generating high-value added service jobs. (Dimond, 2005).

So what is next? What is the next economic engine for Michigan? It seems increasingly clear that new jobs in Michigan are not going to be spawned by existing industry but instead will be created by entirely new activities, e.g., biotechnology, information technology, global financial services, and other knowledge-intensive industries that will require new knowledge, new

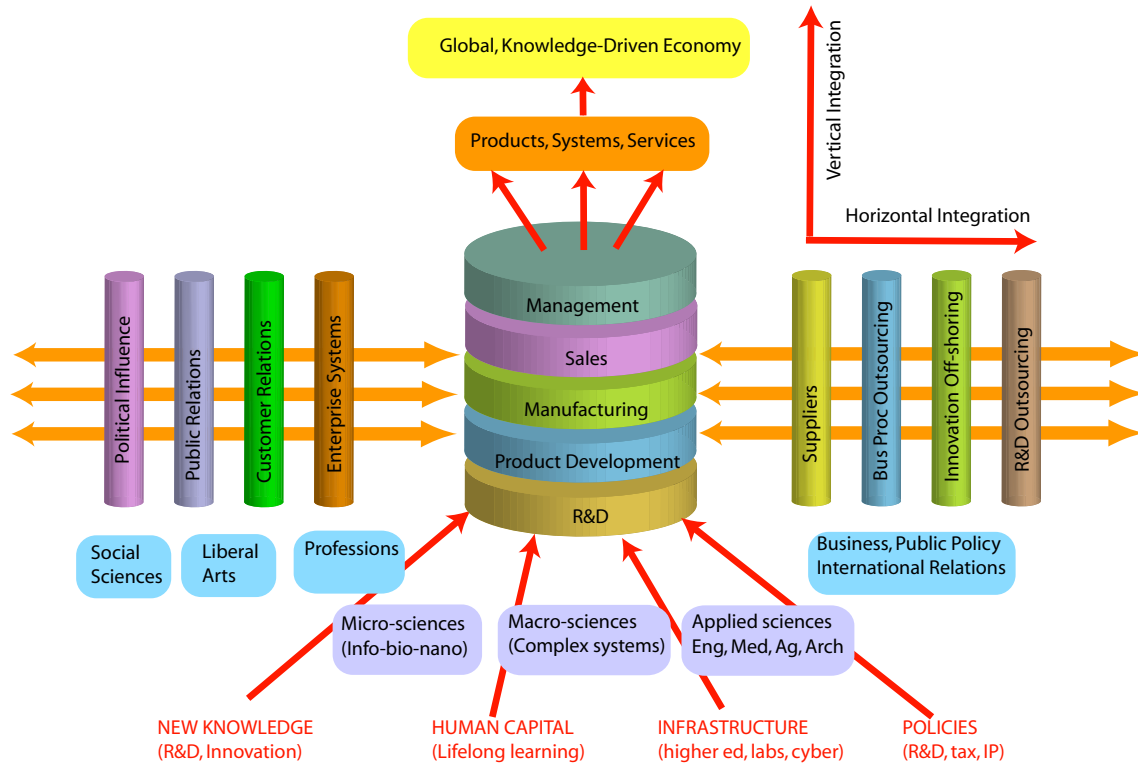
entrepreneurs, and new knowledge workers. In a global, knowledge-driven economy, Michigan's challenge is to build a world-class workforce, generate the innovative ideas, and apply them with entrepreneurial skill to create the new companies that will drive economic growth and competitiveness. The challenge is to enter into and be competitive in a global economy based on knowledge.

Challenge One: The Knowledge Economy

Looking back over history, one can identify certain abrupt changes, discontinuities, in the nature of our civilization. Clearly we live in just such a time of very rapid and profound social transformation, a transition from a century in which the dominant human activity was transportation to one in which communications has become paramount, from economies based upon cars, planes, and trains to one dependent upon computers and networks. We are shifting from an emphasis on creating and transporting physical objects such as materials and energy to knowledge itself; from atoms to bits; from societies based upon the geopolitics of the nation-state to those based on diverse cultures and local traditions; and from a dependence on government policy to an increasing confidence in the marketplace to establish public priorities.

Today we are evolving rapidly into a post-industrial, knowledge-based society, a shift in culture and technology as profound as the shift that took place a century ago when our agrarian societies evolved into industrial nations (Drucker, 1999). Industrial production is steadily shifting from material- and labor-intensive products and processes to knowledge-intensive products and services. A radically new system for creating wealth has evolved that depends upon the creation and application of new knowledge and hence upon educated people and their ideas and institutions such as research universities, corporate R&D laboratories, and national research agencies where advanced education, research, innovation, and entrepreneurial energy are found.

In recent testimony to Congress, Nicholas Donofrio, senior executive of IBM, described today's global knowledge economy as driven by three historic developments: "the growth of the Internet as the planet's operational infrastructure; the adoption of open technical



The Brave, New World of the Global, Knowledge-Driven Economy

standards that facilitate the production, distribution, and management of new and better products and services; and the widespread application of these to the solution of ubiquitous business problems. In this increasingly networked world, the choice for companies and governments is between innovation and commoditization. Winners can be innovators—those with the capacity to invent, manage, and leverage intellectual capital—or commodity players, who differentiate through low price economics of scale and efficient distribution of someone else’s intellectual capital” (Donofrio, 2005). Put another way, should Michigan emulate California or instead China? That is the choice before us!

In a very real sense, we are entering a new age, an age of knowledge, in which the key strategic resource necessary for prosperity has become knowledge itself—educated people and their ideas (Bloch, 1988). Unlike natural resources, such as iron and oil, that have driven earlier economic transformations, knowledge is inexhaustible. The more it is used, the more it multiplies and expands. But knowledge can be created, absorbed, and applied only by the educated mind. Hence schools in general, and universities in particular, will

play increasingly important roles as our societies enter this new age. The knowledge economy is demanding new types of learners and creators. Globalization requires thoughtful, interdependent and globally identified citizens. New technologies are changing modes of learning, collaboration and expression. And widespread social and political unrest compels educational institutions to think more concertedly about their role in promoting individual and civic development.

Nations are investing heavily and restructuring their economies to create high-skill, high-pay jobs in knowledge-intensive areas such as new technologies, financial services, trade, and professional and technical services. From Paris to San Diego, Bangalore to Shanghai, there is a growing recognition throughout the world that economic prosperity and social well-being in a global knowledge-driven economy requires public investment in knowledge resources. That is, regions must create and sustain a highly educated and innovative workforce and the capacity to generate and apply new knowledge, supported through policies and investments in developing human capital, technological innovation, and entrepreneurial skill. Nations both

small and large, from Finland to China, are beginning to reap the benefits of such investments aimed at stimulating and exploiting technological innovation, creating serious competitive challenges to American industry and business both in the conventional marketplace (e.g., Toyota) and through new paradigms such as the off-shoring of knowledge-intensive services (e.g., Bangalore).

And it is this reality of a hyper-competitive, global, knowledge-driven economy of the 21st Century that is stimulating the powerful forces that will reshape the nature of our society and our knowledge institutions.

Challenge Two: Globalization

Whether through travel and communication, the arts and culture, or the internationalization of commerce, capital, and labor, both our nation and our state are becoming increasingly linked with the global community. The world and our place in it have changed—with globalization determining not only regional prosperity but also national and homeland security. A truly domestic United States economy has ceased to exist. It is no longer relevant to speak of the health of regional economies or the competitiveness of American industry, because we are no longer self-sufficient or self-sustaining. Our economy and many of our companies are international, spanning the globe and interdependent with other nations and other peoples. Worldwide communication networks have created an international market, not only for conventional products, but also for knowledge professionals, research, and educational services.

As the recent report of the National Intelligence Council's 2020 Project has concluded, "The very magnitude and speed of change resulting from a globalizing world—apart from its precise character—will be a defining feature of the world out to 2020. During this period, China's GNP will exceed that of all other Western economic powers except for the United States, with a projected population of over 1.4 billion. India and Brazil will also likely surpass most of the European nations. Globalization—growing interconnectedness reflected in the expanded flows of information, technology, capital, goods, services, and people throughout the world—will become an overarching mega-trend, a force so ubiquitous that it will substantially shape all other

major trends in the world of 2020" (National Intelligence Council, 2004).

As Friedman notes, some three billion people who were excluded from the pre-Internet economy have now walked out onto a level playing field, from China, India, Russia, Eastern Europe, Latin American, and Central Asia. "It is this convergence of new players, on a new playing field, developing new processes for horizontal collaboration, that I believe is the most important force shaping global economics and politics in the early 21st century." Or as Craig Barrett, CEO of Intel, puts it: "You don't bring three billion people into the world economy overnight without huge consequences, especially from three societies like India, China, and Russia, with rich educational heritages" (Friedman, 2005).

In such a global economy, it is critical that states not only have global reach into markets abroad, but also have the capacity to harvest new ideas and innovation and to attract talent from around the world. Interestingly enough, perhaps the best way to do this is to invest in flagship research universities, since these are truly international institutions. They reflect a strong international character among their students, faculty, and academic programs. These institutions also stand at the center of a world system of learning and scholarship. They are the magnets regions can use to attract new talent, new industry, and new resources from around the world.

Challenge Three: Demographics

America's population is changing rapidly today. One of the most significant demographic trends is that our population is getting older; the baby boomers are approaching retirement, and the number of young adults is declining. In the United States, there are already more people over the age of sixty-five than teenagers in this nation, and this situation will continue for decades to come. In our lifetime the United States will not again be a nation of youth, in sharp contrast to the developing nations in Asia, Africa, and Latin America, where the average age is less than 20.

A second and equally profound demographic change is that the U.S. is rapidly becoming one of the most pluralistic, multicultural nations on earth. Those groups we refer to today as "minorities" will become the majority population of our nation in the century

ahead, just as they are today throughout the world and in an increasing number of states, including California, Texas, New Mexico, and Hawaii (and soon Arizona, New York, and Georgia). In this future, the full participation of currently underrepresented minorities will be of increasing concern as we strive to realize our commitment to equity and social justice. The achievement of this objective also will be the key to the future strength and prosperity of America, since our nation cannot afford to waste the human talent presented by its minority populations.

The increasing diversity of the American population with respect to race, ethnicity, gender and nationality is both one of our greatest strengths and most serious challenges as a nation. A diverse population gives us great vitality. However the challenge of increasing diversity is complicated by social and economic factors. Far from evolving toward one America, our society continues to be hindered by the segregation and non-assimilation of minority cultures. Many among us are challenging in both the courts and through referendum long-accepted programs such as affirmative action and equal opportunity aimed at expanding access to higher education to underrepresented communities and diversifying our campuses and workplaces (*The Economist*, 2005). If we do not create a nation that mobilizes the talents of all of our citizens, we are destined for a diminished role in the global community and increased social turbulence. Most tragically, we will have failed to fulfill the promise of democracy upon which this nation was founded.

Challenge Four: Exponentiating Technologies

The new technologies driving such profound changes in our world—technologies such as information technology, biotechnology, and soon nanotechnology—are characterized by exponential growth. When applied to microprocessor chips, this remarkable property, known as Moore's Law, implies that every 18 months computing power for a given price doubles. And for other elements of digital technology, such as memory and bandwidth, the doubling time is only 9 to 12 months. Scientists and engineers today believe that the exponential evolution of these microscopic technologies is not only likely to continue for the conceivable future, but in fact, the pace may be accelerating.

Put another way, digital technology is characterized by an exponential pace of evolution in which characteristics such as computing speed, memory, and network transmission speeds for a given price increase by a factor of 100 to 1000 every decade. Over the next decade, we will evolve from "giga" technology (in terms of computer operations per second, storage, or data transmission rates) to "tera" and then to "peta" technology (one million-billion or 10^{15}). To illustrate with an extreme example, if information technology continues to evolve at its present rate, by the year 2020, the thousand-dollar notebook computer will have a data processing speed and memory capacity roughly comparable to the human brain (Kurzweil, 1999). Furthermore, it will be so tiny as to be almost invisible, and it will communicate with billions of other computers through wireless technology.

For planning purposes, we can assume that by the end of the decade we will have available infinite bandwidth and infinite processing power (at least compared to current capabilities). We will denominate the number of computer servers in the billions, digital sensors in the tens of billions, and software agents in the trillions. The number of people linked together by digital technology will grow from millions to billions. We will evolve from "e-commerce" and "e-government" and "e-learning" to "e-everything," since digital devices will increasingly become predominant interfaces not only with our environment but with other people, groups, and social institutions.

Beyond acknowledging the extraordinary and unremitting pace of evolution of this technology, it is equally important to recognize that it is disruptive in nature. The impact on social institutions such as corporations, governments, and learning institutions is profound, rapid, and quite unpredictable. As Clayton Christensen explains in *The Innovator's Dilemma*, while many of these new technologies are at first inadequate to displace today's technology in existing applications, they later will explosively displace the application as they enable a new way of satisfying the underlying need (Christensen, 1997). If change is gradual, there will be time to adapt gracefully, but that is not the history of disruptive technologies. Hence organizations (including states) must work to anticipate these forces, develop appropriate strategies, and make adequate investments

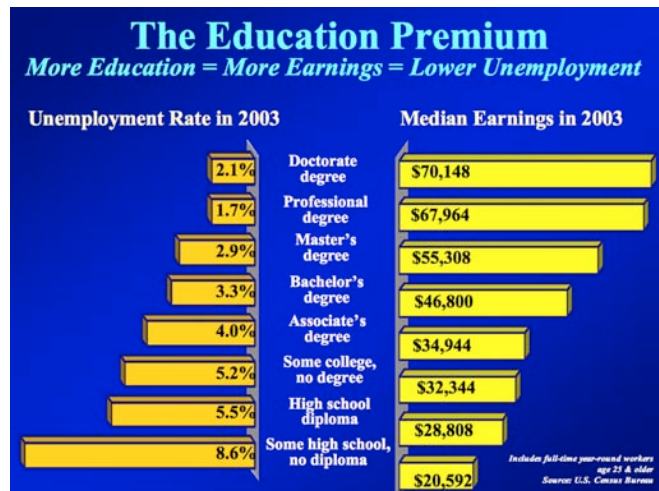
if they are to prosper—indeed, survive—such a period. Procrastination and inaction (not to mention ignorance and denial) are the most dangerous of all courses during a time of rapid technological change.

The Implications

Education for the New Economy

Today in a global, knowledge-driven economy, a college degree has become a necessity for most careers, and graduate education desirable for an increasing number. The pay gap between high school and college graduates continues to widen, doubling from a 50% premium in 1980 to 111% today (Moe, 2000). Not so well known is an even larger earnings gap between baccalaureate-degree holders and those with graduate degrees. This should not be surprising in view of the fact that in the knowledge economy, the key asset driving corporate value is no longer physical capital or unskilled labor. Instead it is intellectual and human capital. In fact, there is an even more pragmatic way to look at the importance of advanced education. Today we invest about \$100,000 of public funds to produce a high school graduate (K-12). Yet statistics indicate that the careers available to those with only a high school diploma will never repay in state and local taxes the cost of their education. It is only at the bachelor's-degree level and above that the public can expect to regain its investment in education from tax revenues (Wiley, 2003).

Although a growing population will necessitate growth in higher education to accommodate the projected increases in traditional college-age students, even more significant will be the growing demand of working adults, who increasingly realize that in the high-performance workplace, without further education they are only one paycheck away from the unemployment line. In fact, it is estimated that by 2010 more than 50% of college students will be working adults over the age of 25. We are shifting from “just-in-case” education, based on degree-based programs early in one's life, to “just-in-time” education, where knowledge and skills are obtained during a career, to “just-for-you” educational services, customized to the needs of the student. The student is evolving into an active learner and eventually a demanding consumer of educational services.



In fact, one of the most important lessons of the new knowledge economy is that one has to constantly upgrade one's skills to compete. To be sure, there will be plenty of good jobs for those with the knowledge and ideas to seize them. At least as long as one's knowledge and skills are continuously improved through lifelong learning.

There is another important point here: Politicians usually rationalize the current phenomenon of offshoring, the increasing trend for companies to export knowledge-intensive service jobs like engineering and information services to developing nations like India, China, and Eastern Europe, by suggesting that it is the low wage rates that shift jobs overseas (typically 20 cents on the dollar in India, for example). But increasingly companies are doing this because they get higher quality service in high-tech areas like computer software development. Why? Because many of these nations are making massive investments in higher education, particularly in technology-intensive areas like engineering and computer science to create a more highly skilled workforce, at a time when our nation and state have been throttling back such investments.

India was lucky, in a way, since it was already well positioned by major investments two decades ago to build a chain of Indian Institutes of Technology—their version of MIT—that now produce the talented scientists, engineers, and managers that fuel their rapidly evolving knowledge economy. China's leaders, while starting only a decade ago, are just as determined and even more focused to train young people in the science and technology skills necessary to produce world-class

scientists and engineers. Perhaps because most Chinese leaders have backgrounds in these disciplines themselves (unlike American leaders, with law and business backgrounds most prominent), they also place a far higher priority on building world-class research universities (Friedman, 2005).

Today Asia currently is producing three times as many scientists and engineers as the United States. Yet the number of jobs requiring technical training is growing five times as fast as other occupations in our nation, even while the average age of American scientists and engineers is approaching retirement, the number of new entrants into science and engineering programs is falling, and the public perception of these fields as exciting, important, and financially rewarding is declining. In the United States eroding student interest in science and mathematics and the weakness of K-12 education has led to a situation in which engineering students comprise less than 5% of U.S. college graduates, compared to 12% in Europe and over 50% in some Asian countries. The United States has traditionally been able to compensate for this domestic shortfall by using its high quality universities to attract talented students in science and engineering from other countries. However in the wake of 9-11, a tightening of immigration policies coupled with the increasing efforts of other nations to compete for foreign university students had threatened this supply (Duderstadt, 2005).

There are other implications of the global knowledge economy for education. Unlike the linear, vertical process for value creation characteristic of 20th-century industry—from R&D to product design to manufacturing to sales to distribution—today’s global supply chain depends on a horizontal process, in which each activity is globally sourced to wherever it can be performed at highest quality and acceptable costs, and then integrated back together again to produce products, services, and values. You can now source the best product or service or capacity or competency from anywhere in the world today because of the new knowledge infrastructure (Friedman, 2005). Such global sourcing changes quite dramatically the skills and knowledge required of those who are to function effectively in this new economy.

Little wonder that higher education is becoming a powerful political force, at least in rhetoric if not yet in actual public investment. Ask any governor about state

priorities these days and you are likely to hear concerns expressed about education and workforce training. The National Governors Association stresses that “The driving force behind the 21st Century economy is knowledge, and developing human capital is the best way to ensure prosperity.” Some governors are even taking the courageous step of proposing tax increases to fund new investments in higher education, research, and innovation.

The Importance of Technological Innovation

The National Intelligence Council’s 2020 Project concludes, “the greatest benefits of globalization will accrue to countries and groups that can access and adopt new technologies. Indeed, a nation’s level of technological achievement generally will be defined in terms of its investment in integrating and applying the new, globally available technologies—whether the technologies are acquired through a country’s own basic research or from technology leaders” (National Intelligence Council, 2004). This study notes that China and India are well positioned to become technology leaders, and even the poorest countries will be able to leverage prolific, cheap technologies to fuel—although at a slower rate—their own development. It also warns that this transition will not be painless and will hit the middle classes of the developed world in particular, bringing more rapid job turnover and requiring professional retooling. Moreover, future technology trends will be marked not only by accelerating advancements in individual technologies but also by a force-multiplying convergence of the technologies—information, biological, materials, and nanotechnologies—that have the potential to revolutionize all dimensions of life.

In summary, the 2020 Project stresses that “A nation’s or region’s level of technological achievement generally will be defined in terms of its investment in integrating and applying the new globally available technologies—whether the technologies are acquired through a country’s own basic research or from technology leaders. Nations that remain behind in adopting technologies are likely to be those that have failed to pursue policies that support application of new technologies—such as good governance, universal education, and market reforms—and not solely because they are poor.”

This has been reinforced by a recent study by the National Academy of Engineering that concludes, “American success has been based on the creativity, ingenuity, and courage of innovators, and innovation that will continue to be critical to American success in the twenty-first century. As a world superpower with the largest and richest market, the United States has consistently set the standard for technological advances, both creating innovations and absorbing innovations created elsewhere” (Duderstadt, 2005).

Many nations are investing heavily in the foundations of modern innovation systems, including research facilities and infrastructure and a strong technical workforce. Unfortunately, neither the United States in general, nor Michigan in particular, has given such investments the priority they deserve in recent years—a subject we will return to consider in more detail in Chapter 5.

The changing nature of the international economy, characterized by intense competition coexisting with broad-based collaboration and global supply chains and manifested in unprecedented U.S. trade deficits, underscores long-standing weaknesses in the nation’s and our state’s investment in the key ingredients of technological innovation: new knowledge (research), human capital (education), and infrastructure (educational institutions, laboratories, cyberinfrastructure). Well-documented and disturbing trends include: skewing of the nation’s research priorities away from engineering and physical sciences and toward the life sciences; erosion of the engineering research infrastructure; a relative decline in the interest and aptitude of American students for pursuing education and training in engineering and other technical fields; and growing uncertainty about our ability to attract and retain gifted science and engineering students from abroad at a time when foreign nationals constitute a large and productive fraction of the U.S. R&D workforce.

Shifting Public Priorities

Foremost on the minds of most university leaders these days are the devastating cuts in appropriations as the states struggle to cope with crushing budget deficits or the erosion of private support from gifts and endowment income associated with a weak economy. Of

course, the optimist might suggest that this is just part of the ebb and flow of economic cycles. In bad times, state governments and donors cut support, hoping to restore it once again in good times. But this time it may be different. As one state budget officer noted: “College leaders are fooling themselves if they think the end of this recession will be like all the others. What we’re seeing is a systematic, careless withdrawal of concern and support for advanced education in this country at exactly the wrong time.” (Selengo, 2003).

Why the doom and gloom? In Europe and Asia, the erosion of public support is seen as a consequence of massification of higher education, in which tax revenues once supporting only university education for the elite are now being stretched beyond capacity to fund higher education for an appreciable fraction of the population. In the United States, as mentioned previously, our current dilemma is somewhat different. As a nation that once viewed education as critical to national security, we seem more concerned with sustaining the social benefits (and tax policies) demanded by an aging baby boomer population, a situation unlikely to change for several decades.

This idea is particularly important for the leaders of America’s public universities. Today in the face of limited resources and more pressing social priorities, the century-long expansion of public support of higher education has slowed. While the needs of our society for advanced education can only intensify as we evolve into a knowledge-driven world culture, it is not evident that these needs will be met by further growth of our existing system of public universities. We now have at least two decades of experience that would suggest that the states are simply not able—or willing—to provide the resources to sustain growth in public higher education, at least at the rate experienced in the decades following World War II. In many parts of the nation, public universities will be hard pressed even to sustain their present level of state support.

The Importance of the Marketplace

These economic, social, and technological factors are stimulating powerful market forces that are likely to drive a massive restructuring of the higher education enterprise, similar to that experienced by other

economic sectors such as health care, transportation, communications, and energy. We are moving toward a revenue-driven, market-responsive education system because there is no way that our current tax systems can support the level of advanced education required by knowledge-driven economies, in the face of other compelling social priorities (particularly the needs of the aging). This is amplified by an accelerating influence of the market on higher education and a growing willingness on the part of political leaders to use market forces as a means of restructuring higher education in order to increase the impact of the competition. Put another way, market forces are rapidly overwhelming public policy and public investment in determining the future course of higher education.

Of course, higher education in the United States has always viewed itself as competitive, particularly compared to elsewhere in the world. In reality, however, the competition has been muted, more benign than ferocious, more focused on prestige than on quality or price. It has been restrained both by tradition and by government regulation. States have operated what are basically higher-education cartels of public institutions, each institution assigned specific roles, with regulations that govern price, funding, enrollment, operation, and the scope of programs. Yet today, in state after state—indeed, in nation after nation—governments are abandoning centralized planning and control of higher education and instead stimulating market competition, believing that market forces are far more effective in controlling costs and mission creep while demanding efficiency and quality. University leaders are demanding greater autonomy in order to compete and survive in the face of increasing market pressures (Newman, 2004).

This interest in market forces on the part of government does not come out of the blue, but rather is a further extension of a broader push toward the use of markets for a wide array of sectors, recognizing that in today's society, the marketplace may be a far more faithful reflection and arbiter of public needs than public policy and politicians. Legislators have grown impatient, and "accountability" has become a hot-button topic. As a result, many states are now seeking to transform their statewide systems of higher education into competitive markets, encouraging competition rather

than coordination.

Needless to say, there are some holdouts. After all, it is difficult for legislators to step back and encourage university autonomy and agility. The temptation to regulate is deep seated and pervasive. But the market forces driving the evolution of higher education are intensifying and will almost certainly sweep aside institutions unable to achieve the autonomy and agility so necessary to compete.

Public higher education is grappling with what is referred to as the "autonomy-accountability" tradeoff (Newman, 2004). Academic and political leaders are seeking to craft policies that provide the opportunity and the incentive for institutions to become more autonomous and entrepreneurial while holding institutions more accountable for performance. What state leaders need, and what would serve the public most effectively, is state control principally of two factors: mission and a range of workable means of assessing institution performance. What university leaders need is greater autonomy in operation of the institution in order to fulfill the agreed-upon mission.

Ironically, the current budget crisis has provided the opportunity for such negotiations in many states, and a new breed of public institutions is appearing with names such as "charter universities," "enterprise universities," "state-related universities," or "public corporations or authorities." Despite the widespread confusion about terminology, one thing seems clear: institutions, states, and nations are searching for ways of injecting more autonomy into the system after decades of building regulations. Discussions about changing the regulatory structure of higher-education systems are, ultimately, political discussions. The tradeoff between autonomy and accountability should leave all parties feeling that they get something out of the deal. Academic leaders get autonomy, and political leaders gain leverage for reinforcing public needs. Most importantly, this new relationship creates the conditions for a higher-education system that is flexible, entrepreneurial, customized, accountable, and able to meet the state's needs (Newman, 2004).

Tomorrow's Horizon

Attempting to predict the future is always a hazard-

ous activity. We generally overestimate change in the near term and underestimate it for the longer term, in part because we usually tend to extrapolate what we know today into a future that becomes increasingly beyond our imagination. It is very difficult to peer over the horizon. But there are some trends apparent today that will almost certainly influence the longer term.

The End of Oil

Michigan's economy—indeed, the United States economy—is based upon the availability of cheap energy. More specifically, our current transportation industry is heavily dependent on the availability of petroleum, over 60% of which is imported, predominantly from unstable regions such as the Middle East. Despite the increasing uncertainty of foreign markets, there has been relatively little effort in the United States to reduce dependence on foreign oil, as evidenced by the strong resistance of American automobile manufacturers to fuel-efficient designs. Yet the instabilities in oil pricing during summer of 2005, in which oil prices broke through the \$70 per barrel level, and gasoline prices exceeded \$3 per gallon at the pump in many regions, suggest the possibility of something more devastating: the peaking of global petroleum production (Maass, 2005).

In the 1970s, a petroleum geologist, M. King Hubbert, predicted that domestic U.S. oil production would peak in the late 1970s, leading to an imbalance between diminishing supply and growing demand that would lead to a major and permanent increase in foreign oil imports. (Goodstein, 2004). His prediction was right on target. Although the party line of big oil has been that global production would not peak until mid-century with new technology and unexplored reserves, more recent estimates have suggested that global oil production could peak within the next decade (with gas production peaking roughly a decade later). The consequence of passing over the global Hubbert peak is not the disappearance of oil; roughly half of the reserves would remain. Rather it would be a permanent imbalance between supply and demand that would drive oil prices through the roof—\$100/bbl, \$200/bbl, and beyond—with corresponding increases at the pump. The rapidly increasing oil and gas demands from developing economies such as China, India, and Latin America

make this imbalance even more serious, particularly when it is noted that the United States currently consumes 25% of world production.

Note here that the end of the oil era does not begin when the last drop of oil is consumed, but rather when oil producers are unable to continue increasing output to meet rising demand (Maass, 2005). At this point, supply- and demand-economics takes over, and oil prices spike into the stratosphere. A recent assessment by the U. S. Department of Energy in spring of 2005 warned, "The world has never faced a problem like this. Without massive mitigation more than a decade before the fact, the problem will be pervasive and will not be temporary. Previous energy transitions (wood to coal and coal to oil) were gradual and evolutionary; oil peaking will be abrupt and revolutionary" (Hirsch, 2005).

Beyond the fact that the impact of reaching the Hubbert peak in global oil production during the next decade or so would be traumatic to the United States economy, it would also very likely obliterate what remains of the American automobile industry. It is unlikely that our domestic companies would be able to shift rapidly enough to produce the small, fuel-efficient cars long dominated by Asian companies or adept enough to exploit hybrid, electric, or hydrogen fuel technologies. Needless to say, the consequences for Michigan would be serious indeed.

Global Sustainability

There is compelling evidence that the growing population and the invasive activities of humankind are now altering the fragile balance of our planet. The concerns are both multiplying in number and intensifying in severity: the destruction of forests, wetlands, and other natural habitats by human activities leading to the extinction of millions of biological species and the loss of biodiversity; the buildup of greenhouse gases such as carbon dioxide and their possible impact on global climates; the pollution of our air, water, and land. It could well be that coming to grips with the impact of our species on our planet, learning to live in a sustainable fashion on Spaceship Earth, will become the greatest challenge of all to our generation. We must find new ways to provide for a human society that presently has outstripped the limits of global sustainability.

This will be particularly difficult for the United States, a nation that has difficulty in looking more than a generation ahead, encumbered by a political process that generally functions on an election-by-election basis, as the current debate over global climate change makes all too apparent. There is little doubt among most scientists that the mean temperature of the earth is indeed rising, and that human activities are the dominant cause, despite the efforts of some politicians to portray this as a left-wing conspiracy. While some might view the projected doubling of atmospheric carbon dioxide concentrations by 2050 resulting in a global temperature increase of 4°C as not particularly disturbing—after all, some would prefer a Michigan climate more comparable to Mississippi—the consequences of such an increase would be catastrophic: more powerful storms, shifting drought patterns, and the disappearance of much of our coastline (including Florida) with the sea level rise associated with melting polar ice caps.

But global sustainability faces other challenges. In 2005 the United Nations projected the Earth's population in the year 2050 as 9.1 billion, 50% larger than today. Which of course raises the logical question: Can we sustain a population of that magnitude on Spaceship Earth? In fact, the basic premise of the U.S. free market system, which relies on steady growth in productivity and profits, based in part on similar growth in consumption and population, must be challenged by the very serious problems that result from a ballooning global population, such as energy shortages, global climate change, and dwindling resources. The stark fact is that our planet simply cannot sustain a projected population of 8 to 10 billion with a lifestyle characterizing the United States and other developed nations with our consumption-dominated economy.

To be sure, there are some signs of optimism: a slowing population growth that may stabilize during the 21st century, the degree to which extreme poverty appears to be receding both as a percentage of the population and in absolute numbers, and the rapid economic growth of developing economies in Asia and Latin America. Yet as a special report on global sustainability in *Scientific American* warned: "As humanity grows in size and wealth, it increasingly presses against the limits of the planet. Already we pump out carbon dioxide three times as fast as the oceans and land can absorb it;

mid-century is when climatologists think global warming will really begin to bite. At the rate things are going, the world's forests and fisheries will be exhausted even sooner. As E. O. Wilson puts it, we are about to pass through 'the bottleneck', a period of maximum stress on natural resources and human ingenuity" (*Scientific American*, 2005).

The United States faces a particular challenge and responsibility in addressing this issue. With just 4.5% of the world's people, we control 25% of its wealth and produce 25% to 30% of its pollution. It is remarkable that the richest nation on earth is the lowest per capita donor of international development assistance of any industrialized country. As the noted biologist Peter Raven observes: "The United States is a small part of a very large, poor, and rapidly changing world, and we, along with everyone else, must do a better job. Globalization appears to have become an irresistible force, but we must make it participatory and humane to alleviate the suffering of the world's poorest people and the effective disenfranchisement of many of its nations" (Raven, 2002).

Still More Possibilities

There are other possibilities that might be considered for the longer-term future. Balancing population growth in some parts of the world might be new pandemics, such as AIDS or an avian flu virus, that appear out of nowhere to ravage our species. The growing divide between rich and poor, the developed nations and the third world, the North and South hemispheres, could drive even more serious social unrest and terrorism, perhaps armed with even more terrifying weapons.

Then, too, the unrelenting pace of technology could benefit humankind, extending our lifespan and quality of life (although perhaps aggravating population growth in the process), meeting the world's needs for food and shelter and perhaps even energy, and enabling vastly new forms of communication, transportation, and social interaction. Perhaps we will rekindle our species' fundamental quest for exploration and expansion by resuming human spaceflight and eventually colonizing our solar system and beyond.

But technology will also present new challenges that

seem almost taken from the pages of science fiction. If digital technology continues to evolve at its current pace for the next decade, creating machines a thousand, a million, a billion times more powerful than those which are so dominating our world today, then phenomena such as the emergence of machine consciousness and intelligence become very real possibilities during this century. In fact some even suggest that we could encounter a “technological singularity,” a point at which technology begins to accelerate so rapidly (for example, as intelligent machines develop even more intelligent machines) that we lose not only the ability to control but even to predict the future (Kurzweil, 1999).

Clearly phenomena such as machine consciousness, contact by extraterrestrial intelligence, or cosmic extinction from a wandering asteroid are possibilities for our civilization, but just as clearly they should neither dominate our attention nor our near-term actions. Indeed, the most effective way to prepare for such unanticipated events is to make certain that our descendants are equipped with education and skills of the highest possible quality.

Hakuna Matata

When confronted with these concerns—particularly those associated with the challenge of a global, knowledge-driven economy to our national prosperity and security—some suggest that the emergence of a “flat world” is just another one of those economic challenges that arise every decade or so to stimulate American industry to bump up its competitiveness yet another notch. *Hakuna Matata*, not to worry! After all, many predicted doom and gloom in the face of Japanese competition in the 1980s. American industry found a way to adapt and compete. Just look at the difficulties Japan faces today.

It is certainly true that many of the characteristics of our nation that have made the United States such a leader in innovation and economic renewal remain strong: a dynamic free society that is continually renewed through immigration; the quality of American intellectual property protection and the most flexible labor laws in the world, the best regulated and most efficient capital markets in the world for taking new ideas and turning them into products and services, open

trade and open borders (at least relative to most other nations), and universities and research laboratories that are the envy of the world. If all of this remained in place, strong and healthy, the United States would continue to remain prosperous and secure, even in the face of an intensely competitive global knowledge economy. We would continue to churn out the knowledge workers, the ideas and innovation, and the products and services (even if partially outsourced) that would dominate the global marketplace. And, of course, the same could be said for a state like Michigan.

This, then, provides the context for an assessment of Michigan today.

Environmental Scans



Chapter 3

Michigan Today: A Knowledge Resource Map

Throughout the 20th century, both America and Michigan have been leaders in the world economy. As we have noted, the democratic values and free-market practices of the United States, coupled with institutional structures such as stable capital markets, strong intellectual property protection, flexible labor laws, and open trade policies, positioned our nation well for both economic prosperity and security. With a highly diverse population, continually renewed and re-energized by wave after wave of immigrants, America became the source of the technology and innovation that shaped the 20th-century global economy.

So, too, Michigan's history as a frontier state gave it a priceless legacy of pioneering spirit, gritty courage, and self-reliance. Our ancestors made our farms and our factories the best in the world. Michigan believed in its people, and invested heavily in their education and training, catapulting the state into a position of global leadership in innovation, productivity, and trade. There was broad recognition that it was our people, their character, knowledge, skill, and ability to innovate, that would give Michigan the competitive edge. A century ago, Michigan led the nation in building just such knowledge resources. State government created a great education system aimed at serving all of its citizens, demonstrating a remarkable capacity to look to the future and a willingness to take the actions and make the investments that would yield prosperity and well-being for future generations. Michigan companies invested heavily in R&D and technological innovation, working closely with the state's research universities. The leaders of our state understood well the importance of investing heavily with both public tax dollars and private capital in those areas key to prosperity in an industrial economy. And the payoff was enormous, as Michigan led the world in productivity, technology, and prosperity.

But that was yesterday. What about Michigan today? Here, the vital signs are disturbing. The spirit of public and private investment for the future appears to have vanished in our state. In recent decades, failed public policies and inadequate investment have threatened the extraordinary educational resources built through the vision and sacrifices of past generations. Michigan business and industry have reduced very significantly the level of basic and applied research and now focus their efforts primarily on product development based on available technologies rather than exploring innovative breakthroughs. Ironically, at a time when the rest of the world has recognized that investing in education and knowledge creation is the key to not only prosperity but, indeed, survival, too many of Michigan's citizens and leaders, in both the public and private sector, have come to view such investments as a low priority, expendable during hard times. The aging baby boomer population that dominates public policy in our state demands instead expensive health care, ubiquitous prisons, homeland security, and reduced tax burdens rather than investing in the educational resources and knowledge infrastructure essential to our state's future.

While a candid assessment of our state's current capacity to create a competitive workforce and knowledge infrastructure for today's global economy will likely ruffle some feathers of those clinging tightly to past successes and present policies, it is nevertheless imperative that we begin the roadmapping process by facing the realities of Michigan today.

The Michigan Economy

The state of Michigan has a population of about 10 million, ranking 8th in size nationally. Although the state's population increased about 7% from 1990 to 2000, it lagged considerably behind the 13% growth rate for

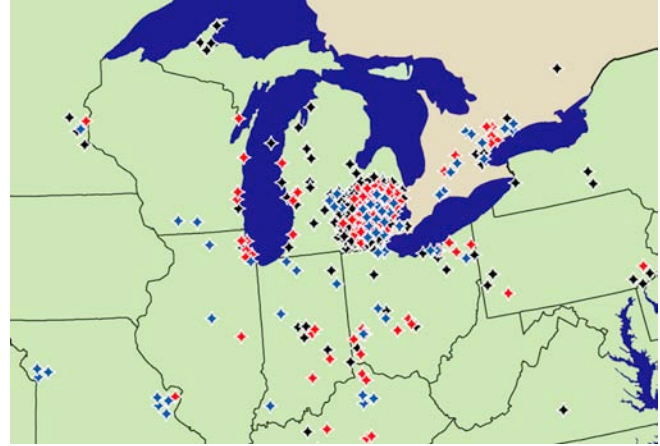
the nation as a whole (U.S. Census Bureau, 2004). Over one-quarter of this population growth has come from foreign-born immigrants.

More significant than population growth has been the aging of the state's population. Although in part due to the aging of the baby boomers, this has been aggravated by an anticipated loss of 12% in its 25- to 44-year old population from 2000 to 2025 as this group seeks new experiences and more dynamic regional economies outside of Michigan. This "brain drain" is the fourth largest percentage decline in the nation and will pose a very serious challenge to the Michigan workforce as it continues to age. Although not as dramatic, Michigan is expected to see a 4.2% decrease in the 18 to 24 age group, the ninth largest in the country.

The economy of Michigan is approximately \$308 billion per year, which ranks it 16th in the world, greater than Argentina, Belgium, Switzerland, and Russia. However there are many signs that the state is struggling to make the necessary transition from a manufacturing economy to a knowledge economy. Today Michigan's per capita personal income is \$30,296, 2.7% below the national average of \$30,941. According to a recent study at the University of Michigan, per capita income grew nearly 12% slower than the national average from 1969 to 2003, the fifth-worst record of income growth among the states over this three-decade-long period.

There are approximately 4.7 million workers in Michigan. While the national economy has seen the strong growth in the service sector (+32.7%), Michigan's economy is still highly reliant on factory-based manufacturing. The state's share of earnings from manufacturing is the third highest in the nation, while Michigan's share from high-paying, knowledge-based industries was 3.5% below the national level. Furthermore, Michigan is one of only 15 states where manufacturing provides a greater share of employment earnings than high-pay knowledge-based industries. Yet, in terms of actual employment, only 700,000 of Michigan jobs are in manufacturing, compared to over 2 million in knowledge-based industries (45% of total employment).

As low-skill, high-pay factory jobs were eliminated through enhanced productivity or shifted to lower cost states or nations, Michigan lost 254,000 jobs from 2000 to 2003, a 22% decline, among them 163,000 manufac-



Michigan's dependence on manufacturing can be seen in the high concentration of the auto industry (MDLEG, 2005).

turing jobs. In 2004 Michigan had the worst performing state economy in the nation, ranking as the only state that has lost more jobs than it created, according to the Joint Economic Committee of Congress. Michigan's unemployment rate leads the nation at over 7%, with little hope for reversal in the near term as major employers in manufacturing plan to close more plants and cut thousands of more jobs. Michigan's poverty rate is increasing, rising to 12.3% in 2004 as manufacturing jobs disappear. Its major metropolitan area, Detroit, has become the nation's poorest city, with one-third of its population living below the federal poverty level and nearly half of Detroit children living in impoverished homes. While many other states have also experienced significant declines in manufacturing employment, they are managing to replace these with knowledge-services jobs. Michigan has not been so fortunate and lags most of the rest of the nation in its effort to create new high-skill jobs.

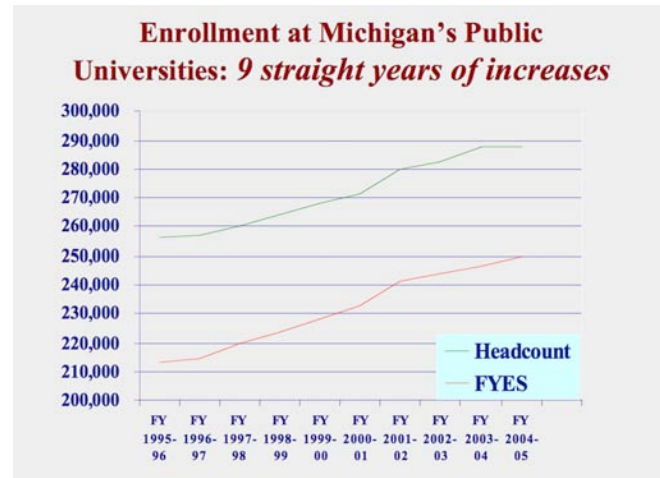
High concentrations in high-pay knowledge-based industries and a higher proportion of 25- to 44-year-old college graduates are associated with the high and rapidly growing per-capita income of the dominant regions of the more successful states. These regions are characterized by small concentrations of manufacturing, having evolved into post-industrial economies. By contrast, Michigan's two largest metropolitan regions have substantially lower per-capita incomes with far slower growth rates, more concentrated in manufacturing and less in high-pay knowledge industries, and lower in the portion of young college graduates.

Although one thinks first of economic difficulties experienced by the Detroit metropolitan area, ironically, the economy of Grand Rapids is even more industrial and less knowledge-intensive, with a per capita income nearly \$6,000 less than Detroit (and more than \$13,000 less than New York). This not only illustrates the importance of a post-industrial economy, but it also suggests that Michigan's efforts to retain manufacturing jobs may be at cross-purposes to achieving prosperity in the global knowledge economy. As Glazer and Grimes suggest, these data raise serious doubts about the wisdom of current strategies to save manufacturing jobs as the state's top economic priority. Beyond the difficulty in countering the powerful forces of trade and technology that are driving manufacturing jobs offshore, clinging to its manufacturing past could well leave the state a backwater in the developing knowledge economy (Glazer, 2005).

Educational Resources

Michigan has a rich heritage in higher education, with 15 four-year public universities, more than 50 independent colleges, universities and institutes, and 29 public two-year community colleges. The public four-year institutions span the breadth of university types and include two AAU-class research universities (UMAA, MSU), other research universities (WSU, WMU, MTU), and other four-year universities (EMU, OU, CMU, FSU, NMU, LSSU, GVSU, SVSU, UMF, UMD). These institutions enroll approximately 660,000 students (four-year publics: 275,810; two-year publics: 192,051; four-year privates: 98,436; 2-year privates: 1,334) (Almanac, 2004). Degrees awarded at these institutions in 2003 included: Associate: 19,534; Bachelor's: 46,115; Master's: 21,342; Doctorate: 1,403; Professional: 2,371.

The impact of these institutions is considerable. Beyond producing almost 90,000 graduates each year, detailed studies have indicated that these public universities have an extraordinary economic impact, estimated in 1999 to be over \$39 billion (Stanford Research Institute, 2002). Since the state appropriation for its public universities that year was \$1.5 billion, for each dollar the state invested, the economic impact was over \$26, a rather remarkable leveraging of state tax dollars. Today



this multiplier would be considerably larger, perhaps as high as 50-fold, both because of increasing value of the activities of Michigan's public universities in a knowledge-driven economy (e.g., the growth in R&D) and because of an erosion of over 25% in state appropriations during the past five years. In fact, since state appropriations provide less than 7% of the support of the \$4.5 billion/year budget of the University of Michigan (compared to roughly one-third of the support for the state's other public universities), this investment multiplier would be even larger for UM.

The state has also explored the use of information technology in creating Internet-based learning initiatives. Michigan Virtual University is a private, not-for-profit Michigan corporation established in 1998 to deliver online education and training opportunities to the Michigan workforce. The Michigan Community College Association has created a virtual learning collaborative (MCCVLC) among Michigan's community colleges. Finally, one of the most successful initiatives has been the Freedom to Learn program, a statewide initiative aimed at integrating technology skills into the 6th grade environment to re-engage children in learning with an individualized education plan.

The state boasts an array of museums numbering in the hundreds. Those museums range in size and scope and include such jewels as the nationally renowned Henry Ford Museum featuring one of the largest collections of its kind, dedicated to preserving America's technological and cultural progress (National Park Service, 2004); Cranbrook Institute of Science & Art; the Detroit Institute of Arts; the Flint Cultural Center; and the

Sloan Museum, to name a few.

Michigan has 387 main libraries, 277 branch libraries and 17 bookmobiles providing public library service in Michigan (Library of Michigan, 2002). Those libraries house more than 6500 public-access computers, about 5000 of which have Internet access. And, according to the Library of Michigan, Michigan public libraries are the “number one point of online access for people without an Internet connection at home, school or work. Computers were used 12.7 million times in 2001.” The state’s digital library, Michigan eLibrary is accessible to all Michigan residents. The digital library subscribes to more than 35 databases, hundreds of magazines and newspapers and more than 10,000 electronic books. In addition, Michigan has 104 postsecondary libraries at its public 4-year universities, independent colleges and universities and community colleges. And with the UM-Google project, aimed at digitizing and distributing online the collections of several of the world’s great libraries, every Michigan citizen may soon have direct access to much of the world’s knowledge in their home—or on their cellphone!

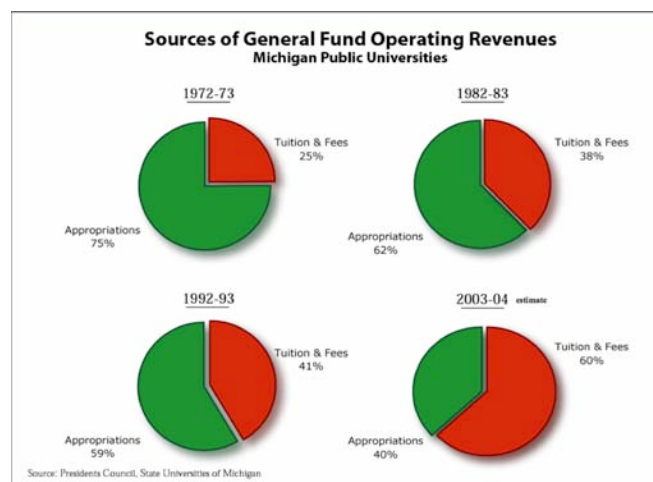
If the good news is that Michigan benefits from one of the leading higher-education systems in the nation, with extensive additional resources in its museums and libraries, the bad news is that a faltering state economy and misguided public policies have put these knowledge and learning resources at very considerable risk. For two decades state support of public higher education has been declining as a share of state tax expenditures, with a more precipitous loss of roughly 25% of state appropriations for the state’s public universities over the past four years. Furthermore, beyond the level

of funding, Michigan’s policies for funding higher education are badly flawed.

Although the state appropriates almost \$2 billion each year to higher education, in reality much of this is dispersed for political benefit rather than aimed at access to quality higher education. More specifically, in FY2004, Michigan appropriated \$1.53 billion to its public universities; another \$648 million to community colleges (\$379 from local property taxes and \$289 from state appropriations); and \$267 million for financial aid programs (\$130 million for merit-based aid and \$65 million to private colleges). But for each of the past several years, in the face of a serious budget crisis, the state has reduced funding for its public universities, to the point that in FY2004-2005 state support per student had dropped to \$5,721, compared to other Great Lakes states averaging \$6,735, and ranking in the bottom third in the nation.

The state’s public colleges and universities have been able to survive largely because of their constitutional autonomy, which gives them the control over decisions such as admissions policies, tuition and fees, faculty and staff compensation, procurement, and other areas sometimes micromanaged by state government. But, as a consequence of inadequate state support, several of these institutions are increasingly becoming “privately financed public universities.” In fact, the state’s flagship campus, the University of Michigan-Ann Arbor, now finds that state appropriations account for less than 7% of its operating budget, and this percentage is almost certain to drop still further in the years ahead.

Ironically, despite the precipitous decline in state support, Michigan’s public colleges and universities have remained highly affordable, due in very large measure to strong, need-based financial aid programs launched by the institutions themselves to preserve access. A recent study found that the average Michigan family is paying only 45% of the full tuition sticker price at Michigan’s 15 public universities. In fact, the real cost of public higher education in Michigan, when scholarships, grants, and federal tax credits are taken into account, has actually gone down since 1998 when adjusted for inflation, despite a 25% reduction in state support per student. However it is also clear that Michigan’s public universities have been pushed to the wall by state appropriations cuts, and tuitions (and real costs



to students and parents) are likely to rise dramatically in the next several years if these cuts are not restored by state government (PCSUM, 2004).

Human Capital

Although Michigan's age distribution is very much at the national average, there is an anticipated peak in high school graduates in 2008, with a slight drop from 2008 to 2011 (although adult-learner demand will almost certainly compensate for this). In postsecondary education, Michigan is very similar to the national average with a 56.5% women enrollment (the national average is 56.1%), although minority enrollment in higher education is lower than the national average with 17.9% in Michigan compared to 28.2% nationally (Almanac Issue, 2004). As we noted earlier, not only is Michigan's population aging, but the out-migration of our 25- to 44- year old population—the fourth most severe among the states—creates a brain drain with very serious implications.

Equally disturbing is the clear failure in achievement at all levels of our educational system. Despite the fact that Michigan ranks as a national leader in measures such as K-12 teacher salaries, the performance of our primary and secondary schools over the past several decades has been inadequate. An estimated 44% of Michigan adults currently function at a literacy level one or two in the national Adult Literacy Survey, levels considered too low to function adequately in today's society. 23% of Michigan's current adult population do not have a high school diploma. Only 73% of Michigan 9th graders graduate from high school four years later. Furthermore, only 42% of high school freshmen in Michigan enroll in college four years later, although 90% of 8th graders say they want to go to college, while only 32% of Michigan high school students graduate with college-ready transcripts, putting the state below the national average of 36% and well behind lead states at 49%.

Although Michigan's system of higher education is generally regarded as one of the nation's best, here too there are challenges. The state's college graduation rates rank below the national average and far below competitor states such as California, Massachusetts, and Minnesota. Although Michigan is home to over 100 col-

leges, universities, and vocational technical institutions with more than 660,000 students enrolled, half of the students entering Michigan's colleges will not complete a college degree (more than 300,000 dropouts!). Despite high graduation rates at its flagship universities (UM at 90% and MSU at 70%), all other public colleges are at less than 50%.

Michigan's current population has a 22% level of bachelor's or advanced degrees, 4% below the national average, ranking Michigan 34th nationally. Michigan ranks below the national average in the fraction of science and engineering degrees (27% compared to 30%), with this fraction continuing to decline in recent years. The share of its workforce trained in science and engineering is also below the national average (6.9% compared to 8.2%) and has been dropping over the past decade. Fortunately despite the out-migration of young knowledge workers, Michigan's research universities have demonstrated the capacity to attract science and engineering students from other states and nations. Furthermore, Michigan has a relatively high rate of retaining high-tech graduates of its universities (79% of instate and 55% of outstate graduates).

This latter statistic is very important. We have noted the growing evidence that a skilled-worker shortage, created by low birthrates, out-migration of young adults, and poor performance of our educational system, poses a serious threat to Michigan's economy. Michigan faces a serious shortage in the human capital required for a knowledge economy, particularly in areas such as science, engineering, information technology, and other knowledge-intensive disciplines. Michigan's research universities have demonstrated the capacity to compensate to some degree by utilizing their quality and reputation to attract and retain in the state both their graduates and those they attract from around the world. Yet all too often, state politicians object to Michigan universities enrolling students from other states or nations, apparently oblivious to the fact that over the longer term, the capacity of our academic institutions to attract talented students, knowledge workers, and companies from around the world is of extraordinary importance to our state.

Research and Development

Although federal statistics (National Science Board, 2004) portray Michigan's research and development activities as a proportion of gross state product as relatively high at 5.8%, compared to a national average of 2.5%, this metric is distorted by the very high level of product development activity in the automobile and pharmaceutical industries, in contrast to more fundamental basic and applied research, which has largely disappeared from most of Michigan industry with the effective demise of the Ford Scientific Laboratory and the General Motors Research Laboratories. In reality, Michigan industry conducts relatively little basic research, with most product innovation based on extrapolations of existing technology rather than upon breakthrough science. This is particularly important in view of the fact that new high tech industry is usually spawned by spinoffs from basic research, not product development.

Michigan's level of federally sponsored R&D has generally been among the lowest among the states (ranking at less than one-third the national average) because of the absence of major federal laboratories, the one notable exception being the R&D center of the U.S. Army Tank Command (TACOM) in Warren. This low level of federally sponsored R&D activity in the state is, in part, a consequence of the low priority given such efforts by the Michigan Congressional delegation, which has typically focused most of its efforts on fighting federal regulations that might threaten the automobile companies and organized labor in the state. Michigan historically has ranked at the bottom of the states in return of federal tax dollars.

Although Michigan's manufacturing industry is heavily technology-dependent, Michigan's high-tech sector is smaller than the national average (5.6% compared to 6.0% nationally). Perhaps of most concern, however, is the relative weakness in high-tech spinoffs and startups. But again this should not be surprising, since Michigan ranks at the bottom of the states in the availability of venture capital, currently at only one-tenth the level of the national average.

Michigan's level of academic research activity is more comparable to the national average, but this is primarily due to one institution, the University of Michi-

gan-Ann Arbor, which historically has ranked among the nation's leaders in federal research grants and contracts, with over \$750 million in research expenditures in 2004. Similarly, doctorate production in science and engineering is also somewhat above the national average, again because of the leadership of UMAA's graduate programs. While much of this research is quite basic in areas such as high-energy physics and molecular genetics, much of it is "use-directed basic research" in areas such as laser diagnostics, composite materials, and communications networks with direct implications for industrial applications.

The role played by the University of Michigan in the state's future does not go unnoticed by the public at large. In surveys and focus groups, when asked to name the most important asset of the state for its future, participants invariably mention the University of Michigan at the top of the list—above General Motors and Ford, state government, or urban areas. Ironically, the Michigan public may understand something that has been forgotten by state leaders.

State government has attempted to launch several initiatives in recent years aimed at stimulating high-tech economic development. The most visible such effort was the Life Sciences Corridor, funded initially by allocating \$50 million per year from the state's tobacco settlement funds, and intended to build a path of biotechnology development across southern Michigan, linking the state's universities (particularly UMAA, MSU, and WSU) with private research centers such as Grand Rapids' Van Andel Institute and the pharma-



University research facilities

ceutical industry (primarily Pfizer). More recently, this has been extended to become the Michigan Technology Tri-Corridor, focused on R&D and commercialization in the fields of life sciences, advanced automotive technology, and homeland security. In addition the state has established roughly a dozen “Smart Zones” with tax structures favorable to high-tech businesses and Business Accelerators to help companies incubate and commercialize products.

However such government efforts have yet to stimulate high-tech economic development at the level experienced in other regions such as the Silicon Valley, San Diego, the Research Triangle, Austin, or Route 128. Part of the problem has been the tendency to focus public funding in areas of declining economic activity (e.g., manufacturing or automotive technology) or where Michigan has little established strength (e.g., genomics, biotechnology, homeland security). It is also the case that state government seems to have forgotten that other successful high-tech regions evolved from world-class research universities (e.g., Stanford, MIT, the University of California, the University of Texas) that were generously supported by both tax dollars and private capital and instead has methodically underfunded public higher education in recent years.

Other Assets

Michigan has other knowledge assets with major implications for the state’s future. Although not widely recognized by either state leaders or industry, the state’s universities played a major role in building the Internet that today drives much of the global economy. In the 1980s, the Merit computer network consortium, located in Ann Arbor, and operated by Michigan’s public universities, joined with IBM and MCI in building NSFnet, the backbone national network for scientific research. This Michigan-managed network was later expanded to include other federal networks (DOD, DOE, NASA) and eventually was renamed the Internet. As network traffic began to grow exponentially in the early 1990s, doubling every few months, Merit spun off the Internet to commercial providers. But today in Ann Arbor, a successor organization, Internet2, is developing the next generation of Internet technology, leading a consortium of hundreds of research universities and tech-

nology companies. Internet2 has recently also assumed the management of the National LambdaRail, an ultra high-speed national network for advanced Internet applications and research.

Similar advanced IT development activities are being led by the University of Michigan through the SAKAI project, a consortium of research universities (led by UM, MIT, Stanford, Indiana, and Oxford) that is developing the middleware architecture for university instruction, research, and enterprise systems. Together with the recently announced UM-Google library digitization project, which aims at digitizing and placing both on line and searchable the entire contents of several of the world’s great libraries (UM, Stanford, Harvard, Oxford, New York Public Library), the University of Michigan is rapidly establishing itself as a leader in advanced information technology and software development.

The state has also benefited very significantly from the leadership of Michigan State University in the application of biotechnology to agriculture and natural resources, stimulated by an earlier state investment in the Michigan Biotechnology Institute and MSU’s strong international reputation in agricultural research and development.

Although Michigan has long been a leader in the pharmaceutical industry, with established companies such as UpJohn, Parke-Davis, and Warner Lambert, a series of recent acquisitions (UpJohn by Pharmacia and then Pharmacia and Warner Lambert by Pfizer) has focused these efforts into a major Pfizer R&D complex in Ann Arbor. While this center has provided strong leadership for the pharmaceutical industry in the past, e.g., through the development of the anti-cholesterol drug Lipitor, the presence of yet another major Pfizer R&D center in North America (Connecticut) raises concerns that in the next downturn of the industry it could be at some risk.

Another important state asset in the life sciences area, in addition to the activities of UM, MSU, and WSU, is the Van Andel Institute in Grand Rapids, a privately financed effort to build a world-class research institute in biomedical research. In fact, this institution plays a major role as the Western Michigan anchor for the state-funded Life Science Corridor, stretching across southern Michigan. Yet here too there is are cautionary notes.



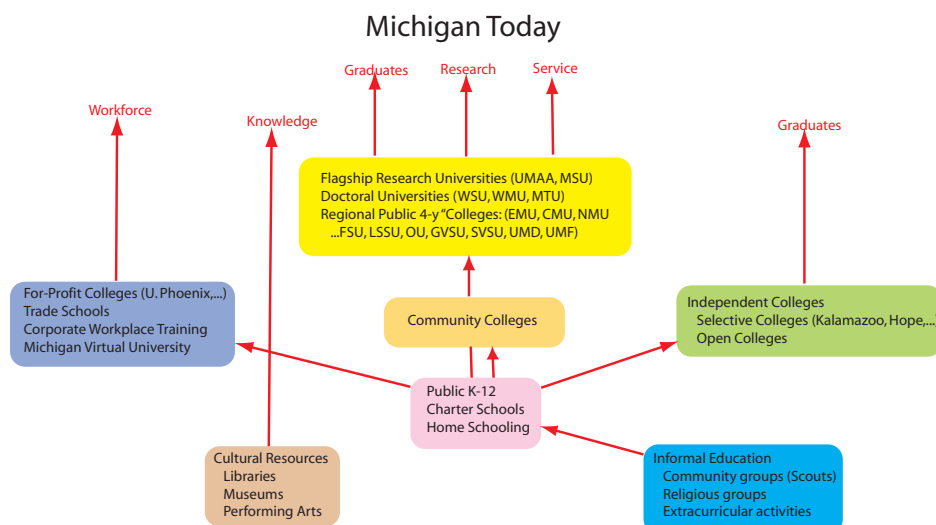
Pfizer Research Laboratories in Ann Arbor

First, the traditional strength of biomedical research in Michigan has been in applied areas such as pharmaceutical and clinical research, not in the more fundamental areas of genomics and proteomics. The difficulty that the UM Life Sciences Institute has encountered recruiting world-class talent in these latter areas suggests that Michigan faces a considerable challenge to catch up with more established basic research efforts in other regions (e.g., San Diego, San Francisco, Seattle, Boston, Washington). Furthermore, although biotechnology is an exciting and rapidly evolving technology, the actual employment by biotechnology companies is quite modest compared to those in areas such as information or financial services (think chemical processing plants).

The Writing on the Wall

Clearly any candid appraisal of Michigan's current situation does not inspire confidence that the state is headed in the right direction. Michigan's under-investment in advanced education, research, and innovation, coupled with short-sighted public policies and corporate strategies that further constrain efforts to build a high-skill workforce and generate the research, innovation, and entrepreneurial zeal necessary to achieve a knowledge economy, should be a matter of great concern to state leaders. The keys to economic growth in a global, knowledge-driven economy are a world-class workforce and a knowledge infrastructure capable of stimulating innovation. These are the assets that will save Michigan from becoming a backwater economy, providing a point of lift off, from which we can create new markets, processes, and skills.

Learning and knowledge generation are becoming a powerful political force throughout our nation and around the world, as competitiveness in a global, knowledge-driven economy depends increasingly on a highly educated workforce, new knowledge, and innovative products and services. Just as the space race of the 1960s stimulated major investments in research and education, there are early signs that the skills and innovation race of the 21st Century may soon be recognized as the dominant policy of our times. But there is an important difference here. The space race galvanized public concern and concentrated national attention on educating "the best and brightest," the elite of our society.



The skills race of the 21st Century will value instead the skills and knowledge, the innovation, and the capacity for adapting to change our entire workforce as a key to economic prosperity, security, and social well-being.

Hence the primary challenge to Michigan today becomes very much one of restoring an adequate balance between meeting today's desires of an aging population and investing in the state's future through building and sustaining a world-class learning and knowledge infrastructure for Michigan tomorrow. The challenge to state leaders is to develop visionary policies, outstanding institutions, and world-class infrastructure that will produce the knowledge workers, the educated professionals, and the new knowledge necessary to build and attract new knowledge-based industries capable of driving future economic growth.

Chapter 4

Michigan Tomorrow: A Knowledge Society

The next stage in the roadmapping process, after assessing where our starting point is, i.e., Michigan today, is to figure out where we need to head. The task is to develop a vision for Michigan's future. And key in this is a broader consideration of the educational and knowledge needs of our state.

A vision for *Michigan tomorrow* can best be addressed by asking and answering three key questions:

1. What skills and knowledge are necessary for individuals to thrive in a 21st-century, global, knowledge-intensive society?
2. What skills and knowledge are necessary for a population (workforce) to provide regional advantage in such a competitive knowledge economy?
3. What level of new knowledge generation (e.g., R&D, innovation, entrepreneurial zeal) is necessary to sustain a 21st-century economy, and how is this achieved?

In a sense, these are similar to the questions addressed by the recent Lt. Governor's Blue Ribbon Commission on Higher Education and Economic Growth:

- How does a state build a dynamic workforce of employees who have the talents and skills needed for success in the 21st century?
- How could Michigan double the percentage of citizens who attain post-secondary degrees or other credentials that link them to success in the Michigan economy?
- How can the state better align Michigan's institutions of higher education with emerging employment opportunities in the state's economy?

(See Appendix A for a more detailed comparison.)

Of course, there are more subtle questions: What does it mean to be "an educated person" in the 21st century? What does it mean to be "literate"? What will be our needs for the deeper purposes of the university, such as its capacity to generate new knowledge, to preserve and transfer the cultural achievements of our civilization from one generation to the next, to serve as a constructive social critic, and to produce the human capital and innovation necessary for prosperity and security? Yet here our primary focus in this study must concern those aspects of higher education and other knowledge resources key to the future prosperity of the State of Michigan.

Clearly, the implications of a global, knowledge-driven economy for discovery-based learning and knowledge institutions are particularly profound. The relationship between societal change and the institutional and pedagogical footing of research universities is clear. The knowledge economy is demanding new types of learners and creators. Globalization requires thoughtful, interdependent and globally identified citizens. New technologies are changing modes of learning, collaboration and expression. And widespread social and political unrest compels educational institutions to think more concertedly about their role in promoting individual and civic development. Institutional and pedagogical innovations are needed to confront these dynamics and insure that the canonical activities of universities – research, teaching and engagement – remain rich, relevant and accessible.

The Educational Needs of a 21st-Century Citizen

Historically, people have always looked to education as the key to prosperity and social mobility. Higher education in America has been particularly responsive to the changing needs of society during major periods of social transformation: from a frontier to an agrarian

society, then to an industrial society, through the Cold War tensions, and to today's global, knowledge-driven economy. Our universities evolved from the collegiate model of the 18th century serving only the elite, to the public university of the 19th century serving the working class, and then once again to the research universities of the 20th century critical to the economic prosperity, public health, and security of the nation. As our society changed, so too did the necessary skills and knowledge of our citizens: from growing to making, from making to serving, from serving to innovation, and today from innovating to creating. With each social transformation, an increasingly sophisticated world required a higher level of cognitive ability—manual skills to knowledge management, analysis to synthesis, reductionism to the integration of knowledge, and finally creativity itself.

Now more than ever, people see education as their hope for leading meaningful and fulfilling lives. The level of one's education has become a primary determinant of one's personal economic security. Just as a high school diploma became the passport for participation in the industrial age, today, a century later, a college education has become the requirement for economic security in the age of knowledge.

Yet most people—and politicians—continue to think of a college education almost as a high school experience, with young students listening to professors lecturing about history or literature. It is important to challenge these old-fashioned perspectives with a dose of the current realities, e.g., students studying intricate subjects such as software engineering, biotechnology, neurosurgery, or global supply chain management, since these are the majors of today of students preparing for rewarding careers tomorrow. The skills of these disciplines are not mastered in the lecture hall but in the laboratory, surgery suite, or through international experience. Clearly such advanced education does not come cheap. But it also has never been more necessary.

Today over 65 percent of the new jobs created by our knowledge-driven economy require education at the college level, and for many careers, a baccalaureate degree will not be enough to enable graduates to keep pace with the knowledge and skill-level required for their careers. The knowledge base in many fields is growing exponentially. In some fields the knowledge taught to students becomes obsolete even before they

graduate! Hence a college education will serve only as a stepping stone to a process of lifelong education. The ability to continue to learn and to adapt to—indeed, to manage—change and uncertainty will be among the most valuable skills of all to be acquired in college.

There is also a serious misconception on the part of the public about those served by today's college and universities. Less than 20 percent of today's college students fit the stereotype of eighteen- to twenty-two-year-olds living on campus and attending college full-time. Most college students are adults—in fact, one-quarter are over the age of thirty. A college degree has become key to a decent job in our knowledge-driven society, and most of today's students see a college education as critical to their future quality of life, the key to a good job, financial security, and well-being. Most students have definite career objectives and are majoring in professional or pre-professional programs. And while they may have strong academic abilities and enjoy learning, both financial and family responsibilities motivate a far more utilitarian approach to their education. Since the residential college experience is not as central to their lives, they seek a different kind of relationship with the university, much as they would other service providers such as banks or filling stations. They approach their education as consumers, seeking convenience, quality, relevance, and low cost.

Today's younger students also do not fit traditional stereotypes. They are citizens of the digital age. They have spent their early lives surrounded by robust, visual, interactive media—not the passive broadcast media, radio and television of our youth, but rather Nintendo, home computers, the Internet, and virtual reality. They learn by experimentation and participation, not by listening or reading passively. They seem to embrace interactivity and the right to shape and participate in their learning and are comfortable with the uncertainty that characterizes their change-driven world. These students will increasingly demand new learning paradigms more suited to their learning styles and more appropriate to prepare them for a lifetime of learning and change.

As Percy puts it, today's students are no longer the people our educational system was designed to teach. Rather they are "digital natives" comfortable learning, working, and living in the digital world, unlike those

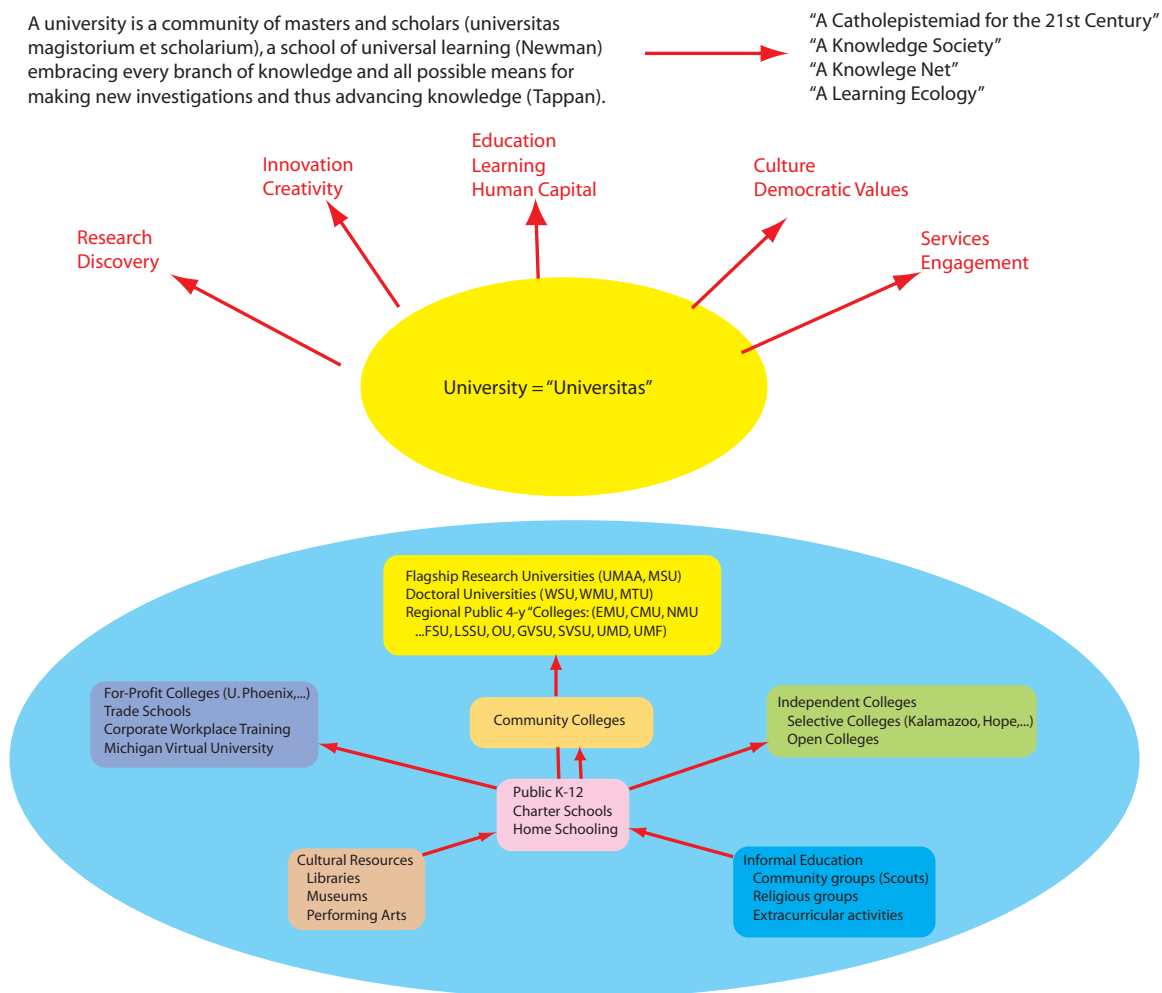
of us who are “digital immigrants” who are struggling to keep pace with digital technologies (Pensky, 2001). This is not an easy task for educators, who for the most part remain reluctant to embrace the new technologies in their teaching and hence are increasingly detached from today’s students (Gura and Percy, 2005).

New knowledge media is forcing us to rethink the nature of literacy. We have seen the definition of literacy shift before in history, from the oral tradition to the written word to the images of film and then television and now to the computer and multimedia. Of course there are many other forms of literacy: art, poetry, mathematics, science itself, etc. But more significantly, the real transformation is from literacy as “read only, listening, and viewing” to composition in first rhetoric, then writing, and now in multimedia.

From a broader perspective, our society increasingly values not just analysis but synthesis, enabled by the

extraordinary tools of the digital age. Increasingly, we realize that learning occurs not simply through study and contemplation but through the active discovery and application of knowledge. From John Dewey to Jean Piaget to Seymour Papert, we have ample evidence that most students learn best through inquiry-based or “constructionist” learning. As the ancient Chinese proverb suggests “I hear and I forget; I see and I remember; I do and I understand.” To which we might add, “I teach and I master!!!”

But here lies a great challenge. As noted earlier, creativity and innovation are key not only to problem solving but more generally to achieving economic prosperity and sustaining national security in a global, knowledge-driven economy. Yet while universities are experienced in teaching the skills of analysis, we have far less understanding of the intellectual activities associated with creativity. In fact, the current disciplin-



ary culture of our campuses sometimes discriminates against those who are truly creative, those who do not fit well into our stereotypes of students and faculty.

The university may need to reorganize itself quite differently, stressing forms of pedagogy and extracurricular experiences to nurture and teach the art and skill of creation and innovation. This would probably imply a shift away from highly specialized disciplines and degree programs to programs placing more emphasis on integrating knowledge. Perhaps it is time to integrate the educational mission of the university with the research and service activities of the faculty by ripping instruction out of the classroom—or at least the lecture hall—and placing it instead in the discovery environment of the laboratory or studio or the experiential environment of professional practice.

Today, learning has become a lifelong activity since a changing world will demand that students continue to learn, through both formal and informal methods, throughout their lives. Of course, a college education was never intended to provide all of the knowledge needed for a lifetime. But in years past, most of the additional knowledge necessary for a career could be acquired informally, through on-the-job learning or self-study. Today, however, both rapid growth of knowledge and the multiple career transitions facing graduates demand a more strategic approach to lifetime learning. We need to rethink educational goals from this lifetime perspective. We should view a college education as just one step—an important step to be sure—down the road of a lifetime of learning. This would allow us to better match learning content and experiences with both the intellectual maturation and the needs of the learner.

In a world driven by knowledge, learning can no longer be regarded as a once-is-enough or on-again/off-again experience. People will need to engage in continual learning in order to keep their knowledge base and skills up to date. Given this need, the relationship between a student/graduate and the university may similarly evolve into a lifetime membership in a learning community.

Building a Competitive Workforce

As we move further into an age of knowledge, the workforce will require more sophisticated education

and training to sustain its competitiveness. We have entered an era when both the need and the demand for advanced education and learning opportunities will grow rapidly. Increasingly, the education and skills of individuals are seen as the key to both their personal quality of life and the broader strengths of their society. Furthermore, the need for the ongoing education of the existing workforce has created a rapidly growing market for adult education at the college level.

Today's college graduates will change careers several times during their lives, requiring additional education at each stage. Furthermore, with the ever-expanding knowledge base of many fields, along with the longer life span and working careers of our aging population, the need for intellectual retooling will become even more significant. Even those without college degrees will soon find that their continued employability requires advanced education. Some estimate that just to keep an individual on pace with evolving workplace skills and knowledge will require a time commitment of roughly one day of education per week (Dolence, 1995). This translates to one-fifth of the workforce in college level educational programs at any time, or roughly 28 million full-time-student equivalents—compared to the 12.1 million full-time-equivalent students currently enrolled in our colleges and universities.

Knowledge workers are likely to make less and less distinction between work and learning. In fact, continuous learning will be a necessity for continued work relevance and security. Employers will seek individuals who can consistently learn and master new skills to respond to new needs. They will place less emphasis on the particular knowledge of new employees than on their capacity to continue to learn and grow intellectually throughout their careers. From the employee's perspective, there will be less emphasis placed on job security with a particular company and more on the provision of learning opportunities for acquiring the knowledge and skills that are marketable more broadly.

Both young, digital-media savvy students and adult learners will likely demand a major shift in educational methods, away from passive classroom courses packaged into well-defined degree programs, and toward interactive, collaborative learning experiences, provided when and where the student needs the knowledge and skills.

The increased blurring of the various stages of learning throughout one's lifetime—K-12, undergraduate, graduate, professional, job training, career shifting, lifelong enrichment—will require a far greater coordination and perhaps even a merger of various elements of our knowledge infrastructure.

The Importance of Technological Innovation

The creativity, ingenuity, and courage of innovators will be critical to our nation and our state in the 21st century. As a superpower with the largest and richest market in the world, the United States has consistently set the standard for technological advances, both creating innovations and absorbing innovations created elsewhere. From Neil Armstrong's walk on the Moon to cellular camera phones, engineering and scientific advances have captured people's imaginations and demonstrated the wonders of science. In fact, groundbreaking innovation was the driving force behind American success in the last century. An endless number of innovations—from plastics to carbon fibers, electricity generation and distribution to wireless communications, clean water and transportation networks to pacemakers and dialysis machines—has transformed the economy, the military, and society, making Americans more prosperous, healthier, and safer in the process (Duderstadt, 2005).

Future breakthroughs dependent on research and innovation will have equally powerful impacts. Sustainable energy technologies for power generation and transportation could halt, and someday even reverse, the accumulation of atmospheric carbon dioxide and ozone. Low-cost, robust pumps, microfilters, and diagnostic tests could ensure that clean water is available to all and wipe out waterborne illnesses. Preventing terrorism could be greatly improved when vigilant sensors as small as grains of sand can activate autonomous robots to respond to security breaches. Technological innovations already under development can make all of these things possible.

The innovations that flow from advanced education and research are not simply nice to have, like high-definition television; many are essential to the solutions of previously intractable challenges. Research in materials, electronics, optics, software, mechanics, and many

other fields will provide technologies to slow, or even reverse, global warming, to maintain water supplies for growing populations, to ameliorate traffic congestion and other urban maladies, and to generate high-value products and services to maintain our standard of living in a world of intense competition. To meet these and other grand challenges, Michigan must be an innovation-driven state that can capitalize on fundamental advances in life sciences, physical sciences, and engineering.

Michigan is part of a global economy, and research and development are performed worldwide. Our multinational corporations manage their R&D activities to take advantage of the most capable, most creative, and most cost-efficient engineering and scientific talent, wherever they find it. Smaller firms without global resources are facing stiff competition from foreign companies with access to talented scientists and engineers—many of them trained in the United States—who are the equals of any in this country. Relentless competition is driving a faster pace of innovation, shorter product life cycles, lower prices, and higher quality than ever before.

To meet the demands of global competition, other states and nations are investing heavily in the foundations of modern innovation systems, including research facilities and infrastructure and strong technical workforces (National Science Board, 2004). Some of the innovations that emerge from these investments will be driven by local market demands, but many will be developed for export markets. As other regions develop markets for technology-laden goods and international competition intensifies, it will become increasingly difficult to maintain a globally superior innovation system. Only by investing in research and advanced education can Michigan retain its competitive advantage in high-value, technology-intensive products and services, thereby encouraging multinational companies to keep their R&D activities in this country.

Colleges and universities have a long history of contributing to U.S. preeminence in technological innovation. Research universities are particularly critical to generating new knowledge, building new infrastructure, and educating innovators and entrepreneurs. The Land-Grant Acts of the nineteenth century and the G.I. Bill and government-university research partnerships

of the twentieth century showed how federal action can catalyze fundamental change. In the past, universities dealt primarily with issues and problems that could be solved either by a disciplinary approach or by a multidisciplinary approach among science and engineering disciplines. To meet future challenges, however, universities will need a new approach that includes schools of business, social sciences, law, and humanities, as well as schools of science, engineering, and medicine. Solving the complex systems challenges ahead will require the efforts of all of these disciplines.

By combining research with education, universities not only tap into the creativity of young people, but also train them in critical thinking, research methodologies, and solid engineering skills. Because of the high quality of the people and tools provided by American universities, industries have chosen to locate their facilities in the United States, and emerging industries have tended to cluster around major engineering research universities (e.g., Silicon Valley, Route 128, Research Triangle, etc.) where they have access to a continuous supply of technical talent. An academic campus is one of the few places where precompetitive, use-inspired, long-term basic research can be conducted without the constraints of quarterly earnings. In partnership with industry and national laboratories, universities can bring together experts from many disciplines to investigate problems related to agency missions or meet specific product/service goals. At the same time, university students can learn systems thinking and gain an understanding of market forces through internships and participation in research projects.

In spite of severe fiscal constraints, several large states have recognized that research and technology-development capacity are key elements in restoring their economic prosperity in an intensely competitive, global, technology-driven marketplace. California, Texas, Ohio, Wisconsin, and other states have either made or are planning to make major investments in their research universities in specific technological areas, including nanotechnology, biotechnology, and information systems and communications (Ohio 3rd Frontier Project, 2004; CAL-ISI, 2004; Seely, 2004; State of Texas, 2004). The governor of Texas, for example, recently announced plans to invest \$150 million in regional centers of innovation and commercialization to

house collaborative projects between universities and private industry (State of Texas, 2004). In California, centers have been created throughout the University of California system to focus resources on advanced technology development (CAL-ISI, 2004). Many other state governments have acknowledged the importance of technology-based economic development and the critical role of universities, particularly schools of engineering, in their economic development strategies.

Leadership in innovation will require commitments and investments of funds and energy by the private sector, federal and state governments, and colleges and universities. Michigan can and must take control of its destiny and conduct the necessary research, capture the intellectual property, commercialize and manufacture the products, and create the high-skill, high-value jobs that define prosperity in a 21st-century knowledge economy.

The Future of Public Higher Education

Higher education faces many challenges and opportunities as it enters a new millennium. As *The Economist* notes, the rise of the knowledge economy has driven the democratization of higher education, as an ever larger fraction of the workforce will need to have access to postsecondary education. As knowledge has replaced physical resources as the driver of economic growth, universities have become the most important engines of the knowledge economy. This is happening throughout the world, not only in developed nations in North America, Europe, and Asia, but in all regions—developed, developing, and underdeveloped— aspiring to prosperity and security in an intensely competitive global, knowledge-driven economy. And here, market competition extends far beyond traditional business and trade to include knowledge resources such as human capital, R&D, and innovation, all both key products and assets of the contemporary university (*The Economist*, 2005).

But this raises an important challenge to balance the twin demands of mass access, necessary for a competitive workforce, and excellence, necessary to provide the new knowledge and innovation essential for a knowledge economy. As *The Economist* notes, “We already possess a successful model of how to organize higher

education: America's. That country not only has almost a monopoly on the world's best universities, but also provides access to higher education for the bulk of those who deserve it. America's system of higher education is the best in the world. That is because there is no system!" Governments play only a limited role, since almost two-thirds of the support for American higher education come from the private sector, e.g., tuition and philanthropy, rather than federal or state government, yielding a highly market-driven and diverse array of colleges and universities, evolving and adapting to serve the ever-changing and diverse needs of American society. To conclude, *The Economist* stresses: "There is no shortage of things to marvel at in America's higher education system, from its robustness in the face of external shocks to its overall excellence. However what particularly stands out is the system's flexibility and its sheer diversity."

Key in the achievements of both excellence and access in American higher education has been the public university, which today educates 80% of all college students. With an expanding population, a prosperous economy, and compelling needs such as national security and industrial competitiveness, the public was willing to make massive investments in higher education during the 20th century. While elite private universities were important in setting the standards and character of higher education in America, it was the public university that provided the capacity and diversity to meet our nation's vast needs for postsecondary education.

Today, however, in the face of limited resources and more pressing social priorities, this expansion of public support of higher education has slowed. While the needs of our society for advanced education will only intensify as we evolve into a knowledge-driven world culture, it is not evident that these needs will be met by further expansion of our existing system of public universities. The terms of the social contract that led to these institutions are changing rapidly. The principle of general tax support for public higher education as a public good and the partnership between the federal government and the universities for the conduct of basic research are both at risk. These changes are being driven in part by increasingly limited tax resources and the declining priority given higher education in the face of other social needs (Zemsky, 1998).

There is a paradox here. Both state governments and the public at large call on public universities to achieve greater access, quality, and cost savings. Yet they also encourage—indeed, expect—them to draw an increasing share of their resource base from non-state sources. Public universities are challenged to demonstrate that they are not solely dependent upon the state, that they can increase faculty productivity and lower costs, all the while improving educational quality. In a sense, higher education funding policy in many states has shifted from tax-support of the public university as a public good to a philosophy of procuring low-cost educational services (Slaughter, 1997).

Little wonder that public university leaders and governing boards are increasingly reluctant to cede control of their activities to state governments. Some institutions are even bargaining for more autonomy from state control as an alternative to growth in state support, arguing that if granted more control over their own destiny, they can better protect their capacity to serve the public.

Most states are moving toward a revenue-driven, market-responsive higher education system for two key reasons: First, there is no way that a tax system can support the massification of higher education required by knowledge-driven economies, in the face of other compelling social priorities (particularly the needs of the aging). And second, there is a growing realization that the way we currently finance public higher education is highly regressive, essentially providing massive subsidies for the rich at the expense of educational opportunity for the poor.

Today, even as the need of our society for postsecondary education intensifies, we also find erosion in the perception of education as a public good deserving of strong societal support (Zemsky, 2005). State and federal programs have shifted priorities from investment in the higher-education enterprise (appropriations to institutions) to investment in the marketplace for higher-education services (loans or tax benefits to students and parents). Whether a deliberate or involuntary response to the tightening constraints and changing priorities for public funds, the new message is that education has become a private good paid for by the individuals benefiting most directly—the students. This shift from the perception of higher education as a public good to an in-

dividual benefit has another implication. To the degree that higher education was a public good, benefiting all (through sustaining democratic values, providing public services), one could justify its support through taxation of the entire population. But viewed as an individual benefit, public higher education is, in fact, a highly regressive social enterprise since, in essence, the poor subsidize the education of the rich, largely at the expense of their own opportunities.

More precisely, if one views state support as providing essentially the discounted price from the true costs of the college education provided to state residents, one might well question why this should be distributed equally to all, rich and poor. If a fundamental objective of public higher education is access to educational opportunity, then a far more progressive social policy would be to distribute the state subsidy based on need, either through charging tuition prices closer to the true cost of an education and using state funding to provide need-based financial aid, or by setting tuition levels based on the ability to pay, with the consequent discount covered by state support—so-called high-tuition, high-financial-aid policies. This will clearly require a different social contract between the state and its public universities (Newman, 2004).

A New Social Contract

Even more fundamentally, as we enter the new millennium, there is an increasing sense that the social contract between the university and American society may need to be reconsidered and perhaps even renegotiated once again. In an age of knowledge, 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, and today's emerging generation of cyberspace universities. But we now will need new types of

colleges and universities with new characteristics:

1. Just as with other social institutions, our universities must become more focused on those we serve. We must transform ourselves from faculty-centered to learner-centered institutions, becoming more responsive to what our students need to learn rather than simply what our faculties wish to teach.
2. Society will also 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 the costs of higher education, 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.
3. In an age of knowledge, the need for advanced education and skills will require both a personal willingness to continue to learn throughout life and a commitment on the part of our institutions to provide opportunities for lifelong learning. The concepts of student and alumnus will merge.
4. 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.
5. 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. In a society of learning, people would be continually surrounded by, immersed in, and absorbed in learning experiences, i.e., ubiquitous learning, everywhere, every time, for everyone.
6. The great diversity characterizing higher education

in America will continue, as it must to serve an increasingly diverse population with diverse needs and goals. But it has also become increasingly clear that we must strive to achieve diversity within a new political context that will require new policies and practices.

It is clear that the access to advanced learning opportunities is not only becoming a more pervasive need, but it could well become a defining domestic policy issue for a knowledge-driven society. Higher education must define its relationship with these emerging possibilities in order to create a compelling vision for its future as it enters the new millennium.

Over the Horizon

As we look even further into an unknowable future, the possibilities and uncertainties become even more challenging. How will wealth be created and value added, in this global, knowledge-driven economy? While many regions (e.g., Bangalore, Shanghai) will prosper with exceptionally high-quality specialization in knowledge-intensive services and low cost commodity manufacturing, the United States is unlikely to be competitive here, whether because of our high standard of living (and high wage) requirements or population limitations. Instead we will have to stress our capacity to innovate and create, derived from an unusually diverse, market-driven, democratic culture. Although we will still “make things,” we will do so by organizing the financial and human capital on a global level.

Will increasingly robust communications technologies (always on, always in contact, high-fidelity interaction at a distance) stimulate the evolution of new types of communities (e.g., self-organization, emergence, collective intelligence, “hives”)? Suppose info-bio-nano technologies continue to evolve at the current rate of 1,000-fold per decade. Can we really prepare today’s kids for the world of several decades from now when technologies such as neural implants, AI “mind children”, stim-sim, and such may actually exist? During the 20th century, the lifespan in developed nations essentially doubled (from 40 to 80 years). Suppose it happens again in the 21st century?

More generally, it is clear that as the pace of change

continues to accelerate, learning organizations and systems will need to become highly adaptive if they are to survive. Here, we might best think of future learning environments as learning ecologies that, like natural ecologies, not only adapt but mutate and evolve to serve an ever-changing world.

So what might we anticipate as possible future forms of the university? The monastic character of the ivory tower is certainly lost forever. Although there are many important features of the campus environment that suggest that most universities will continue to exist as a place, at least for the near term, as digital technology makes it increasingly possible to emulate human interaction in all the sense with arbitrarily high fidelity, perhaps we should not bind teaching and scholarship too tightly to buildings and grounds. Certainly, both learning and scholarship will continue to depend heavily upon the existence of communities, since they are, after all, highly social enterprises. Yet as these communities are increasingly global in extent, detached from the constraints of space and time, we should not assume that the scholarly communities of our times would necessarily dictate the future of our universities. For the longer term who can predict the impact of exponentiating technologies on social institutions such as universities, corporations, or governments, as they continue to multiply in power a thousand-, a million-, and a billion-fold?

The growing and changing nature of higher education needs will trigger strong economic forces. The weakening influence of traditional regulations and the emergence of new competitive forces, driven by changing societal needs, economic realities, and technology, are likely to drive a massive restructuring of the higher-education enterprise. From our experience with other restructured sectors of the economy such as health care, transportation, communications, and energy, we can expect to see a significant reorganization of higher education, complete with the mergers, acquisitions, new competitors, and new products and services that have characterized other economic transformations. More generally, we may well be seeing the early stages of the appearance of a *global knowledge and learning industry*, in which the activities of traditional academic institutions converge with other knowledge-intensive organizations such as telecommunications, entertainment, and

information service companies (Peterson, 1997).

Many undoubtedly would view with derision or alarm the depiction of the higher-education enterprise as an “industry” or “business.” After all, higher education is a social institution with broader civic purpose and has not traditionally been driven by concerns about workforce training and economic development. Furthermore, the perspective of higher education as an industry raises concerns that short-term economic and political demands will dominate broader societal responsibilities and investment. Yet in an age of knowledge, the ability of the university to respond to social, economic, and technological change will likely require a new paradigm for how we think about postsecondary education. No one, no government, is in control of the emerging knowledge and learning industry; instead it responds to forces in the marketplace. Universities will have to learn to cope with the competitive pressures of this marketplace while preserving the most important of their traditional values and character.

Today the higher-education enterprise consists of a constellation of traditional institutions, research universities, four-year colleges and universities, two-year colleges, proprietary institutions, and professional and specialized institutions. However the postsecondary enterprise of tomorrow will also contain computer hardware and software companies, telecommunications carriers, information services companies, entertainment companies, information resource organizations, and corporate and governmental educational organizations.

Yet, regardless of who or what drives change, the higher education enterprise is likely to be dramatically transformed over the next decade. In this rapidly evolving knowledge business, the institutions most at risk will not be of any particular type or size but rather those most constrained by tradition, culture, or governance.

In many ways the education industry represents the last of the economic sectors dominated by public control and yet at risk because of quality, cost-effectiveness, and changing demands. As information technology breaks apart monopolies and opens up the market by releasing students from the constraints of space and time, competition between both existing and newly emerging institutions is intensifying. Just as with health care, the higher-education enterprise is entering a pe-

riod in which market forces could well lead to massive restructuring.

To view higher education only from the perspective of its traditional constituencies, however, is to miss the point of the transformation that must occur as we enter an age of knowledge. For example, if lifetime education becomes a necessity for job security—as it has in many careers already—the needs for college-level education and training will grow enormously. So too American higher education could well be one of this nation’s most significant export commodities, particularly if we can take advantage of emerging technologies to deliver high-quality educational services on a global scale. Higher education could be—should be—one of the most exciting growth industries of our times, but this will depend on the development of new models of higher education that utilize far more effective systems for financing and delivering learning services.

A Vision for Michigan’s Future: A Knowledge Society

Lifelong access to advanced educational opportunities will become the defining domestic policy issue for a knowledge-driven society. This will clearly require the development of new paradigms 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 this will not be enough. 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 should instead aspire to a society 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. Both governments and higher education must define their relationship with these emerging possibilities in order to create a compelling vision for its future as it enters the next millennium.

While some may continue to debate, to suggest that the status quo will remain intact, to others the choice has become clear. We can either accept the risks and the uncertainties of attempting to transform the higher education enterprise to serve a changing society with new needs and new imperatives. Or we can wait for the market to reshape our institutions, perhaps even relegating them to a backwater role in the emerging global knowledge economy. Clearly, embracing the status quo, treading water, also has very real risks. After all, there are many commercial sharks swimming just below the surface.

Here it is important to stress once again that while America's colleges and universities may indeed evolve as a component of a global knowledge and learning industry, it would be both misleading and dangerous to view higher education through an industrial model. Universities serve broader civic purposes such as transmitting our cultural heritage and undergirding our democracy, purposes essential to recognize and preserve, and yet highly vulnerable to market forces. Furthermore, most will acknowledge that the conventional university campus provides a unique and extraordinarily rich environment for learning and scholarship. But if market forces alone are allowed to determine the future of higher education, we could well find ourselves facing a future in which only the rich and privileged would have the opportunity for campus-based learning, while the majority of our population would be relegated to media-based, standardized educational experiences.

The learners of our future society will demand that their educational experiences prepare them for a lifetime of learning opportunities, fused both with work and with life. They will seek just-in-time and just-for-you learning through networked organizations. They

will seek the integration of timeless and timely knowledge.

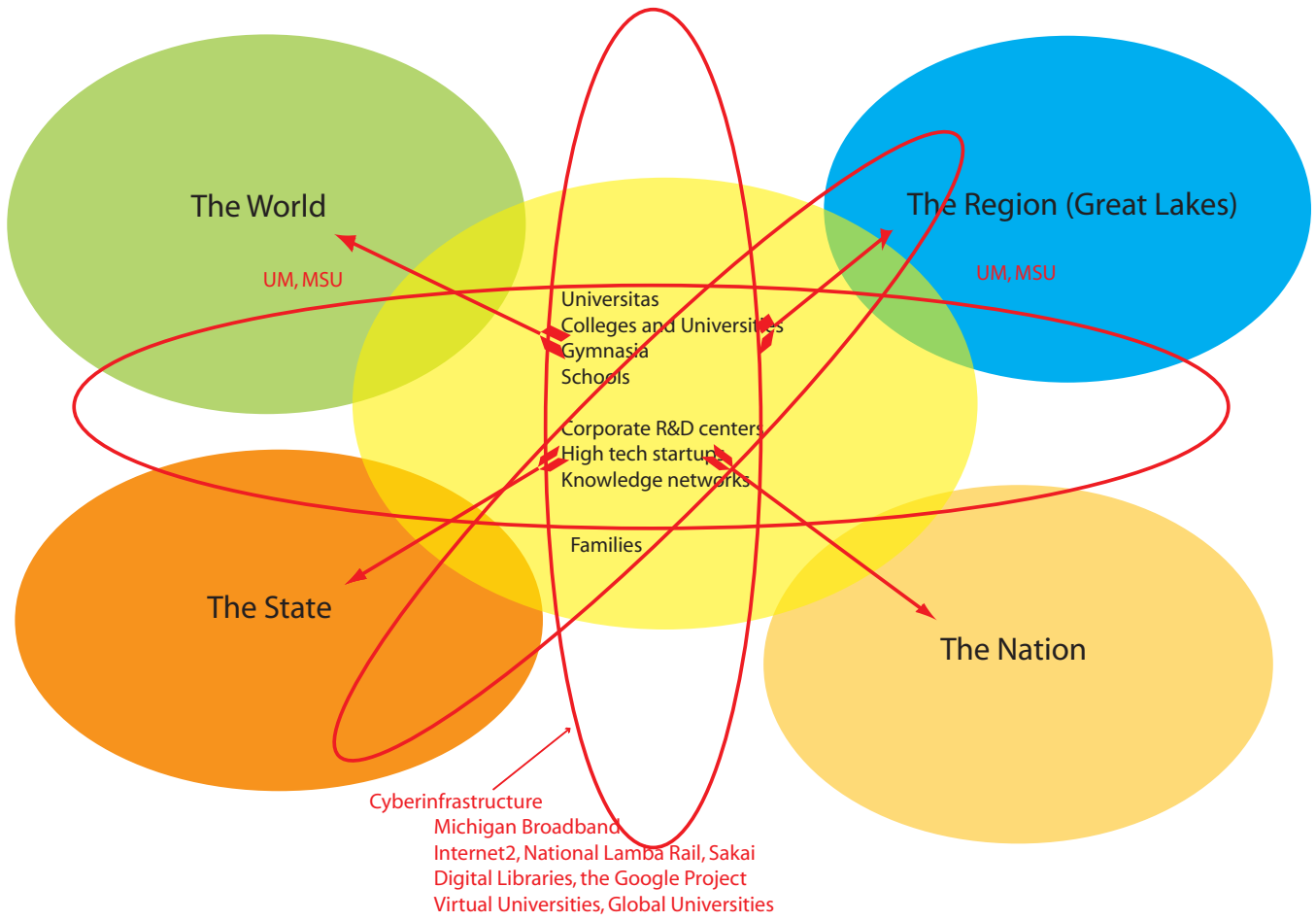
The systems of higher education that emerge in the decade ahead will almost certainly be far different from today's. Higher education will either transform itself or be transformed as financial imperatives, changing societal demands, emerging technologies, and new competitors reshape the knowledge enterprise, changing in the process how colleges and universities organize and deliver learning opportunities as well as how they structure and manage their institutions.

For most of our history, the growth of higher education in America has been sustained by tax dollars, either directly through state or federal appropriation, or indirectly through favorable tax policy. As a result, higher education has been strongly shaped by public policies and public agendas, from Jefferson's writings to the land-grant acts, from the GI Bill to Pell Grants, from the government-university research partnership to the Equal Opportunity Act. Public investment has both determined and protected the public purpose of higher education in America.

Today, however, there is an increasing sense that the growth of higher education in the 21st century will be fueled by private dollars. Public policy will be replaced increasingly by market pressures. Hence the key question: Will leaders of government and higher education attempt to use public policy and public investment to shape global knowledge and learning marketplace to preserve the important values, traditions, missions, and purpose of the university? Or will they continue to burden these institutions with archaic, politically motivated, and cumbersome policies and regulations, crippling higher education's capacity to adapt to the realities of the marketplace and serve society in the dramatically different circumstances of an age of knowledge.

Michigan Tomorrow

A Digital "Catholepistimead" or "Society of Learning"



Chapter 5

How Far Do We Have To Go?: A Gap Analysis

In this chapter we turn to a consideration of the road ahead, how far Michigan must travel in order to build a knowledge society capable of facing the imperatives of the 21st-century global economy. We will continue following the roadmapping process by utilizing a *gap analysis* to compare where Michigan is today with what it must become tomorrow. In this effort, we must continue to bear in mind that in the flat world of a global, knowledge-driven economy, the key to prosperity lies not in low taxes, cool cities, and great weather. Rather it requires educated people, new knowledge, innovation, and an entrepreneurial spirit. This, in turn, requires visionary public policies and public and private investments that look toward the future rather than clinging to the past. The challenge to Michigan, its public leaders, its business, industry, and labor, its educational and cultural institutions, and its citizens is to invest in the production of the human capital, infrastructure, new knowledge, and innovation necessary to achieve prosperity and social well-being in a 21st-century world.

By any measure, the assessment of *Michigan today* provided in Chapter 3 is very disturbing. Our state is having great difficulty in making the transition from a manufacturing to a knowledge economy. In recent years we have led the nation in unemployment; the out-migration of young people in search of better jobs is the fourth most severe among the states; our educational system is underachieving with one quarter of Michigan adults without a high school diploma and only one-third of high school graduates college-ready. Although Michigan's system of higher education is generally regarded as one of the nation's best, the erosion of state support over the past two decades and most seriously over the past four years has not only driven up tuition but put the quality and capacity of our public universities at great risk.

More generally, for many years Michigan has been shifting public funds and private capital away from in-

vesting in the future through education, research, and innovation to fund near-term obligations such as prisons and Medicaid, even as it reduced state revenues still further through tax cuts. And all the while, as the state budget began to sag and eventually collapsed in the face of a weak economy, public leaders were instead preoccupied with fighting the old and increasingly irrelevant cultural and political wars (cities vs. suburbs vs. exurbs, labor vs. management, religious right vs. labor left). Preoccupied with the political rhetoric and social demands of the past, Michigan has been consuming its seed corn for its future.

Yet our state is not alone. Although many current measures of technological leadership—the percentage of gross domestic product invested in R&D, absolute numbers of researchers, labor productivity, high-technology production and exports—still favor the United States, a closer look reveals a mosaic of concerns suggesting that our nation may have difficulty maintaining its global leadership in innovation over the long term. These well-documented trends include: (1) a large and growing imbalance in federal research funding between the engineering and physical sciences on the one hand and biomedical and life sciences on the other; (2) increased emphasis on applied R&D in industry and government-funded research at the expense of fundamental long-term research; (3) erosion of the engineering research infrastructure due to inadequate investment over many years; (4) declining interest of American students in science, engineering, and other technical fields; and (5) growing uncertainty about the ability of the United States to attract and retain gifted science and engineering students from abroad at a time when foreign nationals account for a large, and productive, component of the U.S. R&D workforce.

From this perspective, the vision we have proposed for Michigan tomorrow seems very distant indeed.

Michigan's Challenge: Economic Transformation

Today Michigan is experiencing a transition to a postindustrial society as fundamental as the transformation from a farming society to an industrial society a century ago, driven by the emergence of an economy based on knowledge—educated people and their ideas—powered by breathtakingly rapid development of new technologies; the globalization of the world's economy and culture enabled by technologies of communication and travel; and the demographic changes in the American population bringing hitherto under-represented groups into a majority of the workforce.

Too many of our people and our institutional leaders are floundering, on the defensive, desperately clinging to the past, to the habits and expectations of an earlier era when we were a leading industrial power not just of America but of the entire world. Many among us look for scapegoats—foreign workers and industries, immigrants, business, labor, politicians, ...even universities. Some take a “this too shall pass” attitude, almost as if by closing our eyes we could make change stop. Others demand entitlements, no longer secure in a rapidly changing world.

To be sure, economic and social upheaval of the magnitude we are living through is unprecedented. It challenges our basic assumptions about how we are to live our lives; it changes the rules in mid-game. It displaces and hurts far too many. But the almost certain consequence of this continuing widespread denial of and resistance to change would be to condemn Michigan to a future of decline that would soon be irreversible. Why? Because such denial violates a fundamental law of nature that all living systems must continually adapt to their changing environment or risk extinction. To survive let alone prosper, Michigan has to summon the courage and strength to face up to reality, to see change not as a threat but to seize the opportunities it offers to make a better world for ourselves and our children.

Today we find Michigan midway through very difficult transition from an industrial into a knowledge economy. We're learning the hard way that if we want to fully prosper in this new world, we must take the long view, invest in people and learning institutions—in making available life-long education and training

and similarly invest in research and the technological innovation it produces. Michigan's major sectors—government, business, and labor—must be dramatically restructured to serve us better in the new century. Michigan today faces fiscal collapse as we continue to fund our current needs and desires by shifting the cost to future generations.

Today and in the future, it is people, their character, knowledge, skill, and ability to innovate, that when allied with developing technologies, give us the competitive edge in the world economy. The keys to economic growth are education and innovation, not tax cuts and entitlements. Glazer and Grimes state it well: “These days the keys to economy success are a well-educated workforce, technical know-how, high levels of capital investment, and entrepreneurial zeal—all of which countries can acquire with the help of supportive governments, multinational firms, and international investors. If the United States is to meet the challenge posed by a truly global economy, it will have to insure that its scientists are the most creative, its business leaders are the most innovative, and its workers are the most highly skilled—not easy when other nations are seeking the same goals” (Glazer, 2004). And such is also the important lesson for our state.

Michigan also must make additional investments to create the new jobs to employ better educated graduates. Thus far, too few jobs of this kind—dependent on skill and knowledge—exist in our state. The old economy is gone, never to return. Furthermore, even if our traditional industries made something of a comeback in the 1990s, they can never dominate our economy again. The productivity gains made through efforts such as total quality management and lean manufacturing unfortunately come at the expense of jobs—and perhaps also at the expense of the R&D necessary to achieve technological innovation and sustain market share.

It seems increasingly clear that new jobs in Michigan are not going to be spawned by existing industry but instead will be created by entirely new activities dependent upon technological innovation, both in high-tech areas such as biotechnology, information technology, and nanotechnology, and in knowledge intensive services. They will require skilled knowledge-workers, technological innovation, and energetic, risk-taking entrepreneurs. And it is from this perspective that the

most significant players in building Michigan's new economy could well turn out to be its colleges and universities, since these institutions are the primary source of all three essential elements of the knowledge economy.

Yet it is from this perspective that Michigan may be at the greatest risk, since for too long it has taken public higher education—perhaps the most critical assets of the knowledge economy—for granted.

Higher Education in Michigan: A Critical Asset at Great Risk

Study after study have highlighted the importance of higher education to the future of Michigan. Most recently, the University Investment Commission, chaired by former Speaker of the Michigan House of Representatives Paul Hillegonds, stressed that "For every problem facing Michigan—the need for high quality and affordable health care, stronger K-12 student achievement, more and better-paying jobs, environmental protection, agricultural productivity, and urban revitalization—public universities contribute to solutions through leadership, talented graduates, loan of academic talent, and research" (PCSUM, 2003).

The Commission went further, noting that in a future in which skills, knowledge, and technology will determine economic success, higher education not only provides the key educational opportunities so necessary for a high quality of life, but also the production of new knowledge through research and entrepreneurial stimulus and innovation necessary for new industry. Moreover, talented faculty and students, companies, and highly skilled workers from all over the world come to Michigan to be on or near our campuses. Universities are essential to cultural life in our state, contributing the intellectual stimulation from their educational and scholarly activities, and adding to the quality of life in Michigan through their performing and visual arts (not to mention the entertainment provided through their athletic programs).

Many other studies have agreed that the single most important investment that state government could make in the future of Michigan is to invest in the state's public colleges and universities. Since these will be the key source of an educated workforce, research

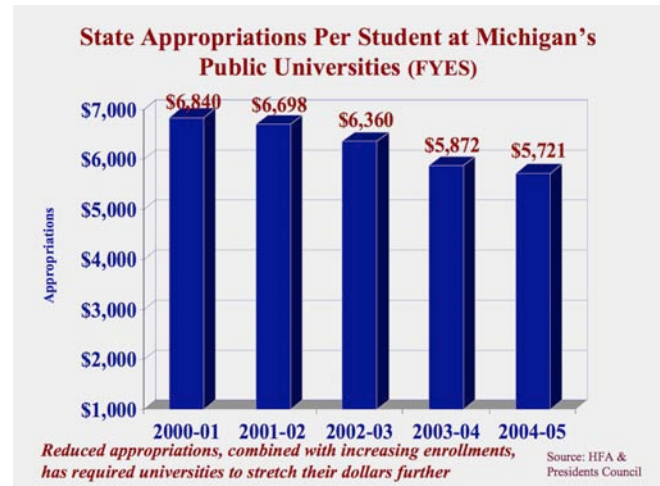
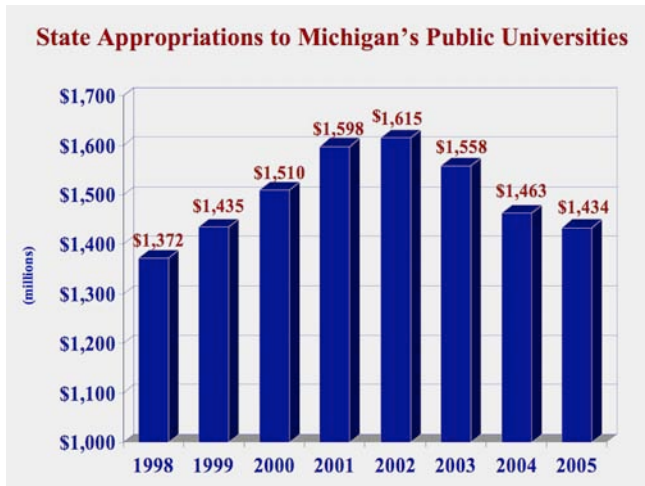
and innovation, and entrepreneurial activity, these should be at the top of the state's priority list. There is already strong evidence of this new reality. A study by the Stanford Research Institute (SRI, 2002) estimated in 1999 that the state's investment of \$1.5 billion in public higher education generated \$39 billion in economic impact—over 12% of our gross state product—a multiplying factor of 25-fold, clearly unmatched by any other state investment.

Yet, ironically, there continue to be signs that state leaders still do not recognize the importance of Michigan's colleges and universities as a strategic investment, either in the magnitude or the nature of the deployment of public funding relative to other states. Over the past five years, Michigan's public universities have suffered massive cuts in state appropriations, with most universities seeing reductions in state support per student of 25% to 40% during this period, ironically at a time when enrollments have been increasing.

Michigan today spends an average of \$5,600 a year on a public university student compared with an average of \$7,300 for each K-12 student (Boulus, 2005). But even more disturbing is that after a prison building boom in the 1980s, today Michigan spends almost 30% more on locking people up (\$1.9 billion, corresponding to \$30,000 per inmate) than it does on educating them in our public colleges and universities, a truly tragic statement of our state's priorities (Milliken, 2005).

More specifically, appropriations to Michigan's public universities have declined from \$1.62 billion in FY2002 to \$1.43 billion in FY2005, with further budget cuts on the horizon in FY2006. State appropriations per student have dropped from \$6,840 to \$5,600 over this period, amounting to a 25% loss in state support when inflation adjusted. This level of state support not only has fallen into the bottom third in the nation, but Michigan ranks at the bottom of the Great Lakes states, which average \$6,735. In fact, over the past two years alone, the state has cut \$260 million from the higher-education budget, an amount equal to the combined support of seven state universities, forcing the elimination of 2,000 university jobs and denying the opportunity for a college education to many thousands of students.

During much of this period, state universities strained to hold tuition increases in check. In fact, when financial aid is included, the net tuition levels for pub-



lic higher education in Michigan have actually declined over the past decade (PCSUM, 2004). But with the most recent cuts, occurring after state government abrogated an earlier agreement to restore funding cuts if the universities would hold tuition increases below inflation, the universities had no choice but to begin to raise tuition levels at double-digit rates. Perhaps indicative of state government's myopia, the governor blasted these tuition increases, pandering to the fears of students and parents, even as state government was planning to cut higher education still further.

More specifically, while all of the state's public universities have seen declines in inflation-adjusted state appropriation of 25% or more, Michigan's research universities have been particularly hard hit. Because of strong enrollment increases, Michigan State University has seen an effective decline of 40% in state support. State support of the University of Michigan's Ann Arbor campus has now declined to less than 7% of its operating budget.

Michigan also lags far behind other states in providing state support of needed academic buildings on university campuses. Since the 1980s, there has been relatively little state capital outlay for higher education. In fact, the state has currently seen a decade-long drought with no appreciable funding of university facilities, ranking Michigan lowest in the nation in this important criterion.

Today there are increasing signs that both the quality and capacity of Michigan's public universities are beginning to suffer, at just that moment when the challenges of a global, knowledge-driven economy have

positioned our universities as among our most important assets. Student-to-faculty ratios and workloads have been increasing, eroding not only the quality of classroom instruction but also constraining research university faculty from conducting the research critical to economic development in a knowledge economy increasingly dependent upon technological innovation. Faculty salaries at our public universities have fallen 20% behind those at private universities (compared to 1980 when they were roughly even), leading to a migration of some of the best professors from public to private institutions. Other erosion has occurred in the value of pension plans, medical benefits, life insurance, housing, and other benefits key to faculty recruiting and retention (Kane, 2003).

The harsh manner in which state government has treated higher education in recent years demonstrates in a convincing fashion that our public leaders simply don't get it. They fail to understand the imperatives of the new economy for Michigan's future. But even in the short term, considering the economic impact of Mich-

University	Percent change in per student appropriation	Percent change in per student appropriation adjusted for inflation
Central Michigan University	-20.31%	-31.31
Eastern Michigan University	-17.56	-28.56
Ferris State University	-22.60	-33.60
Grand Valley State University	-23.84	-34.84
Lake Superior State University	-12.19	-23.19
Michigan State University	-29.46	-40.46
Michigan Technological Univ.	-9.61	-20.61
Northern Michigan University	-22.35	-33.35
Oakland University	-21.88	-32.88
Saginaw Valley State University	-19.87	-30.87
University of Michigan	-15.06	-26.06
University of Michigan – Dearborn	-20.18	-31.18
University of Michigan – Flint	-9.31	-20.31
Wayne State University	-12.28	-23.28
Western Michigan University	-23.95	-34.95

igan's colleges and universities, cutting higher education is clearly penny-wise and pound-foolish! Michael Boulos, executive director of the President's Council of State Universities of Michigan, captured the sense of most Michigan's higher education leaders when he warned, "The state is not living up to its responsibilities to students, their families, or Michigan's future. Without top-flight universities, our state will be unable to make the transition from a brawn to a brain economy and draw the intellectual talent necessary to attract new companies to Michigan" (Boulos, 2005).

Little wonder that after the cavalier treatment higher education has received from state leaders over the past several years, the governing boards with fiduciary responsibility for the welfare of Michigan's public universities have begun to lose confidence in state government as a reliable partner in providing adequate support for this critical state asset. Term-limited legislators and governors, political parties controlled by narrow special-interest groups, and a body-politic addicted to an entitlement economy simply cannot be trusted. Instead, governing boards are relying more heavily on the autonomy provided by the state constitution, which gives them control over decisions such as admission, tuition and fees, faculty and staff compensation, procurement, and other areas sometimes micromanaged by state government. In fact, as a consequence of inadequate state support, several of Michigan's public universities are rapidly becoming predominantly "privately financed public universities," facing the challenge of sustaining their public purpose and service to Michigan citizens by competing in the marketplace rather than depending primarily upon adequate state support.

The declining confidence in the will of state government to adequately support education has motivated a coalition of concerned citizens to launch an initiative to force the Michigan State Legislature to consider legislation that would lock in to the state budget annual funding increases at the inflation rate for K-16 public schools, colleges, and universities. The K-16 Coalition for Michigan's Future has notified the Legislature that if they fail to pass this initiative, they are prepared to bypass them and go directly to the voters on the 2006 ballot. In view of the unwillingness of state government to adequately fund public higher education in the state in recent years, such a voter-driven initiative may be

the only way to break the political logjam and begin to re-invest in the state's future, even if it would likely force the state to adopt tax increases to adequately fund education. (K-16 Coalition, 2005).

Broader Human Capital Concerns

As we have noted in Chapter 3, Michigan faces serious challenges in producing the human capital—the educated population, the knowledge workers, the scientists, engineers, and other professionals—that will enable it to compete. Not only is our population aging, but the out-migration of our 25- to 44- year old population—the fourth most severe among the states—creates a brain drain with very serious implications. To be sure, our educational institutions have demonstrated the capacity to compensate to some degree by utilizing their quality and reputation to attract and retain both their graduates and those they attract from around the world. Yet all too often, state politicians object to Michigan universities enrolling students from other states or nations, apparently oblivious to the fact that over the longer term, the capacity of our academic institutions to attract talented students, knowledge workers, and companies from around the world is of extraordinary importance to our state.

Equally disturbing is the clear failure in achievement at all levels of our educational system. The performance of our K-12 system over the past several decades has been inadequate, as evidenced by the fact that almost half of all Michigan adults are currently hindered by a literacy level too low to function adequately in today's knowledge-driven society. Furthermore, one-quarter of Michigan citizens do not have a high school diploma, while only one-third of high school students graduate with college-ready transcripts (Austin, 2004). Although Michigan's system of higher education is generally regarded as one of the nation's best, here too there are challenges. Although our two flagship universities, UM and MSU, have high graduation rates (90% and 70%, respectively), the rest of Michigan's public universities graduate fewer than 50% of their students (corresponding to roughly 300,000 Michigan students that will enter college only to fail to graduate).

Hence there is growing evidence that a skilled-worker shortage—created by low birthrates, out-migration of

young adults, and poor performance of our educational systems—poses a serious threat. Beyond these current challenges, it is also the reality that a global, knowledge-driven economy is continuing to raise the bar for educational achievement. In sharp contrast to a recent state report which suggested that “a vast majority of the emerging high-wage, high-skilled jobs available in Michigan require a level of skill that can be obtained at the community college or technical school level and do not require a bachelor’s degree” (MEDC, 2002), the reality is that a bachelor’s degree is already almost a mandatory credential for a job in the new economy, and soon advanced degrees—or at least lifelong learning—will become a necessity.

We must take great care not to repeat the mistakes of the 20th century when we doomed generations to poverty by restricting their educational opportunities to only the level they needed for the low-skilled jobs of that time. The educational demands of a changing world are moving ever higher.

The Production of New Knowledge: Research and Innovation

New jobs in Michigan are not going to be spawned by existing industry but instead will be created by entirely new activities, e.g., biotechnology, information technology and computer networking, lasers and ultra-high-speed technology, and an array of knowledge-intensive services such as systems integration and software development. These new jobs will be created by innovation based on research and development and requiring post-graduate education at the masters and doctorate level.

It is estimated the average rate of return on capital investment in the United States today ranges from 10% to 14%. In contrast, the private rate of return of R&D investments is now estimated to be 25% to 30%, twice as high. Furthermore, the social rate of return of R&D investments, that is the rate of return that accrues not just to one firm, but to many firms, industries, and consumers in the society, is typically 50% to 60%, almost four times the rate for other types of investment (NSB, 2004)

From this perspective, it is clear that the most powerful economic engines in Michigan may well turn out

to be its public research universities. Why? Because the key ingredients in technology-based economic development are technological innovation, technical manpower, and entrepreneurs. Research universities produce all three. Through their on-campus research, they generate the creativity and ideas necessary for innovation. Through their faculty efforts, they attract the necessary “risk capital” 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, and through more direct contributions such as faculty / staff entrepreneurs, the formation of start-up companies, strategic partnerships, and so on.

There is ample evidence to support the impact of world-class research universities. We need only look at MIT’s impact on the Boston area, Stanford and UC-Berkeley’s impact on Northern California, Caltech’s impact on Southern California, and the University of Texas’ impact on Austin. These successful examples offer an important lesson. Only world-class research universities are capable of major impact through technology-driven economic development. A university must be able to play in the big leagues, to compete head-to-head with institutions such as MIT, Stanford, and Berkeley—as well as Beijing’s Tsinghua University, France’s Ecole Polytechnic, Germany’s Max Planck Institutes, and India’s IITs—if it is to attract the outstanding faculty and students and massive resources necessary for technological leadership. Fortunately, today Michigan already has two world-class research universities, the University of Michigan and Michigan State University, along with other universities (Wayne State University, Michigan Technological University, and Western Michigan University) with considerable activity in research and graduate education, that could serve as the source of new knowledge, innovation, and entrepreneurs necessary to act as powerful job creation machines. The state need only support them adequately.

Yet there are several particular caveats. The first concerns the imbalance in R&D investments in our state. In decades past, largely because of the great prosperity of Michigan’s manufacturing industry in the automotive sector, our Michigan Congressional delegation had

relatively little incentive to go after the massive federal investments in R&D sought by other states, preferring instead to give priority to protecting Michigan industry from intrusive federal regulation. Hence the massive federal investments in R&D facilities stimulated by the Cold War flowed to other states such as California and Texas, leaving Michigan behind and ranked at the bottom of the states both in return of federal tax dollars and in federal R&D. Today we suffer from this past practice, since most of Michigan's industrially funded R&D tends to be aimed at product development rather than the cutting-edge basic research funded by the federal government (Gray, 2005).

Second, it is important to recognize that while research and scholarship are appropriate activities for all universities, in truth a state can afford only a limited number of world-class research universities capable of competing for the very best students, faculty, and public and private support. David Ward, former chancellor of the University of Wisconsin and a distinguished geographer by discipline, estimates that it takes the tax base provided by a population of 5 million to support a single public research university of world-class quality, perhaps best measured by membership in the Association of American Universities (AAU). This rule of thumb appears to work in most states—and most nations—e.g., Wisconsin with its one AAU-class university in Madison, California with the six AAU campuses of the University of California, and Michigan, with its two AAU campuses in Ann Arbor and East Lansing. There is ample evidence that political attempts to feed ambitious attempts at mission creep are not only doomed to failure, but this tendency creates a leveling effect in which all institutions are pushed toward a least common denominator of quality.

Third, it is important to deploy public resources in both a visionary and effective manner. For example, while the Life Sciences Corridor, funded by a portion of Michigan's tobacco-settlement funds, has been promoted as "a billion-dollar investment" in life sciences research, in reality, the \$30 million generated annually for this purpose is modest in scope compared with both federally funded research in Michigan universities in biomedical research (currently over \$400 million annually) and industrial R&D investment in Michigan laboratories such as Pfizer in Ann Arbor (\$1 billion an-

nually). Further, it falls considerably short of the investments that other states are making in R&D activities at their research universities, e.g., California's commitment of \$300 million to build several major research centers on its university campuses or the successful referendum to commit \$3 billion over the next ten years for stem cell research.

Finally, while it is true that the soaring commercial value of the intellectual property produced through academic research holds great potential for economic development, particularly in the life sciences and information technology, it also poses risks. The lure of riches has stimulated many universities to adopt aggressive commercialization policies and to invest heavily in technology transfer offices to encourage the development and ownership of intellectual property that sometimes interfere with the traditional open sharing of scholarly results with the broader scientific community (Press, 2000).

Entrepreneurs, Startups, and High-Tech Economic Development

Although Michigan is fortunate in having a high quality higher education system, including two world-class research universities, it has not benefited from high-tech economic development to the degree of other regions such as Austin, San Diego, or Seattle. This failure has not been for lack of trying. Faculty members with strong entrepreneurial experience have been recruited from high tech communities. Management talent has been lured to the state to lead startup efforts. Universities have invested their own resources in areas such as the life sciences and information technology with regional economic development as an objective. Yet still technology-driven economic development has not taken off. Why?

In part it is due to climate. No, not the weather in "good, gray Michigan," but rather the economic culture—the availability of venture capital funds, a risk-taking philosophy on the part of financial institutions, and a network of entrepreneurs. Michigan does not benefit from the level of available investment capital characterizing other regions such as California or Texas. Furthermore its industrial and political culture continues to be driven very much by the automobile industry and

dominated by companies that are not knowledge-driven but instead dependent on mature technologies.

It is interesting to compare Michigan with the experience of other more successful regions such as Boston's Route 128, North Carolina's Research Triangle, San Diego, and Austin. Just as "all politics is local," one could maintain that "all high-tech economic development is regional." In each of these success stories, the trigger event was the spinoff startup company from faculty research at a world-class university that was wildly successful, creating the wealth (and the wealthy entrepreneurs) that could be plowed back as venture capital into the next round of startups, e.g., DEC (Ken Olsen) in Boston, SAS (Jim Goodnight) in North Carolina, Qualcomm (Irwin Jacobs) in San Diego, and Dell Computers (Michael Dell) in San Diego. There were notable differences, of course. The Austin miracle involved a partnership between the University of Texas and state government, along with public funding, to attract key research organizations (the Microelectronics and Computer Corporation and Semitech); San Diego relied primarily on private capital; Stanford and Austin both made a strategic asset of their substantial land holdings.

However at the core of all of these efforts were world-class research universities that served as magnets to attract top talent, along with the high quality of life characterizing their surrounding communities that kept talent in the region. These universities were characterized both by focused excellence, as well as intellectual breadth that allowed them to span many fields, engaging in both basic and applied research of the highest quality. In each case, university, industry, and government leadership were well aligned and capable of working together at the highest level. Each situation began with a "big hit" that then provided both the role model and the venture capital stream for subsequent startups.

There is one more key feature of these success stories that may explain much of the frustration occurring today in university-industry relations. In each case, ownership of key intellectual property was critical to attracting the necessary private capital for successful startups. Both universities and faculty entrepreneurs were aggressive in capturing and retaining intellectual property rights. An interesting counter example is provided by Johns Hopkins University, which developed

an important cancer treatment drug during the same period as these other economic success stories, but in altruistic fashion, decided it was too important to restrict the drug through patents and instead put it into the public domain, thereby undercutting further economic development in the Baltimore area.

The research universities in these high-tech hot spots have embraced a sophisticated, nonlinear model of knowledge transfer, where they increasingly view their primary missions—and their greatest rewards—as creating new industries rather than supporting old companies. Clearly, these universities see their greatest value to society and their greatest institutional payoff in Schumpeter's "creative destruction," building the new industries that will eventually devour the old. Little wonder then that established companies seeking cooperative relationships are increasingly frustrated by the priorities such universities give to spinoffs and startups requiring aggressive negotiations to retain the intellectual property rights necessary to attract private investment. Although some companies have adopted a near-term strategy of off-shoring their R&D activities to nations with less aggressive intellectual property demands, over the longer term this will deprive them of access to many world-class research universities.

More cynically, one might even question the strategy that many established companies have adopted to dismantle their own internal capacity for R&D and instead outsource R&D through cooperative relationships with research universities. Rather than welcoming them with open arms, many American universities are negotiating with them just as other companies would, insisting on beneficial intellectual property rights and adequate support of research costs. Cooperative arrangements with universities will have to have sufficient benefits to compete with spinoffs, either through direct financial support of the university by industry or through indirect support through industry's ability to influence government policies for investing in R&D and higher education. This brave, new world of peer-to-peer university-industry relationships has been a shock to many companies that have long viewed support of higher education as philanthropy rather than a quid pro quo strategic technology alliance!

Infrastructure

In the last half of the 20th century, state and federal efforts to build the transportation networks necessary for the shipment of goods and services were key to the economic prosperity of our state. The interstate highway system and the expansion of major airports were key elements in connecting Michigan's cities and industries to other economic centers both in the United States and the world. Detroit became a great economic center, in part, because of its highway and rail linkages to other centers (Chicago, Cleveland, Toronto) and its air linkage to the world.

Today, digital technology has become the infrastructure necessary for the commerce of a knowledge economy. Our rapid evolution into a knowledge-based, global society has been driven in part by the emergence of powerful new information technologies such as digital computers and communications networks. Modern digital technologies have vastly increased our capacity to know and do things and to communicate and collaborate with others. They allow us to transmit information quickly and widely, linking distant places and diverse areas of endeavor in productive new ways. This technology allows us to form and sustain communities for work, play, and learning in ways unimaginable.

We live in a networked world, in which ubiquitous, high-bandwidth connectivity has become essential not only for economic prosperity but for full participation in a knowledge society. The value of networks increases as the square of the number of its participants (Kahn's law), leading to the formation of new knowledge communities and innovative business, and unleashing global competition. In fact the Gartner Group has estimated that the economic benefit of a ubiquitous broadband infrastructure for the State of Michigan would be in the range of \$300 to \$500 billion over a 10-year period (Gartner, 2001).

Yet here again Michigan has fallen behind, ranking 24th among the states in the growth rate of deployed broadband lines and very last in ILEC per-line investments. Gartner estimates that the current lag in access penetration, if not addressed, represents a \$440 billion shortfall in gross state production over the next decade. Gartner concludes, "It is certainly not the lack of interest in the technology that is creating the gap between

Michigan and the U.S. as a whole. Price and ability to pay may be a contributor. But lack of ubiquitous access to a broadband network may be a root cause, particularly in higher socioeconomic levels."

What is lacking is a visionary public policy. In the case of the interstate highway system or air transportation, government recognized the public-good nature of providing the necessary infrastructure for transportation and therefore provided public support and regulation. In contrast many states and the federal government have largely left it to the private sector—primarily the telcoms and cable industry—to provide the "cyber-infrastructure" necessary for the knowledge economy. Unfortunately, the financial incentives and regulatory structure have not stimulated the necessary private investments, and as a result Michigan has fallen far behind other states and nations in building the infrastructure necessary for its future prosperity.

While the recent efforts by both local communities and the state to create wireless hubs are commendable (e.g., "wireless Michigan" or "wireless Oakland County"), thus far these are being proposed on the cheap, without significant public financing. Furthermore, it is clear that a term-limited legislature is particularly susceptible to lobbying by the telcoms and cable companies to block these efforts, even though it has been the reluctance of these companies to invest adequately in Michigan's broadband infrastructure that is putting our state at risk. (Here one need only compare the broadband resources of San Antonio, SBC's corporate headquarters, with those of Detroit!)

This is an extremely serious issue. It has become clear that without strong action by state government, either through public investment in statewide network connectivity at a level similar to the interstate highway system, or through regulatory pressures exerted through the Michigan Public Service Commission on the telcoms and cable companies to force them to install high-bandwidth for every Michigan citizen and every Michigan business, we will simply not be able to close the high-speed access gap for the citizens of the state. Imagine how the Michigan automotive industry would have evolved if our people had been forced to drive along one-lane dirt roads. That is precisely the situation we now face for the electronic commerce that is evolving through the world.

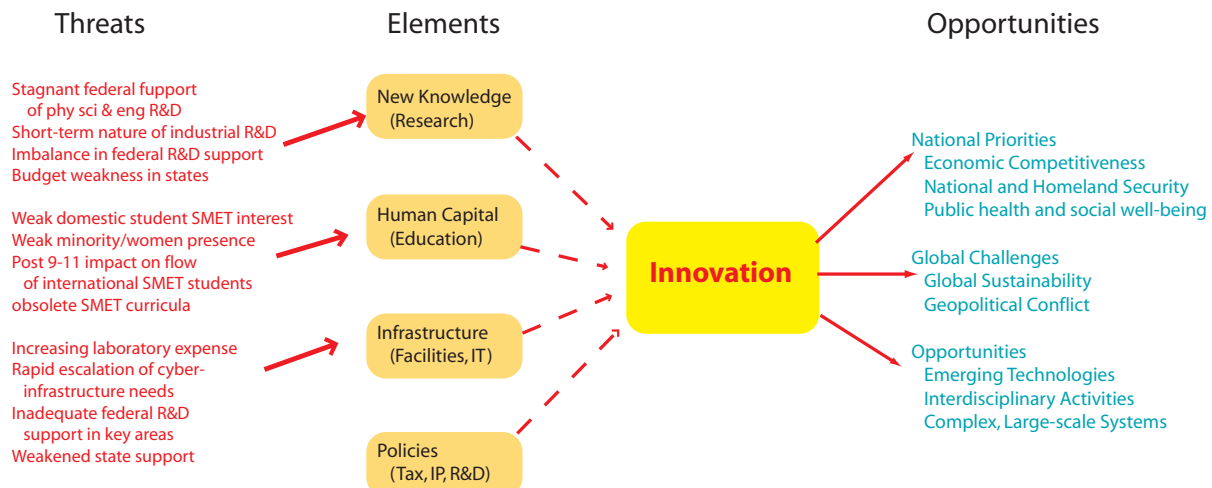
Challenges at the Federal Level

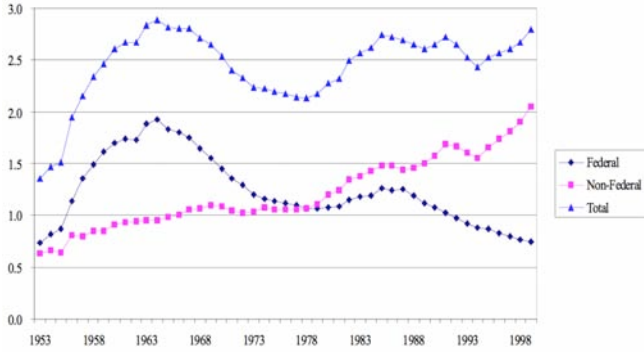
The United States is part of a global economy, and research and development (R&D) are performed worldwide. Multinational corporations manage their R&D activities to take advantage of the most capable, most creative, and most cost-efficient engineering and scientific talent, wherever they find it. Smaller U.S. firms without global resources are facing stiff competition from foreign companies with access to talented scientists and engineers—many of them trained in the United States—who are the equals of any in this country. Relentless competition is driving a faster pace of innovation, shorter product life cycles, lower prices, and higher quality than ever before. To meet the demands of global competition, other countries are investing heavily in the foundations of modern innovation systems, including research facilities and infrastructure and strong technical workforces (NSB, 2003). Some of the innovations that emerge from these investments will be driven by local market demands, but many will be developed for export markets. As these and other countries develop markets for technology-laden goods and international competition intensifies, it will become increasingly difficult for the United States to maintain a globally superior innovation system.

Even though current measures of technological leadership—percentage of gross domestic product invested in R&D, absolute numbers of researchers, labor productivity, high-technology production and exports—still favor the United States, a closer look at the engineering research and education enterprise and

the age and makeup of the technical workforce reveals several interrelated trends indicating that the United States may have difficulty maintaining its global leadership in technological innovation over the long term. The large, growing imbalance in federal funding for research between engineering and physical sciences on the one hand and biomedical and life sciences on the other, combined with a shift in funding by industry and federal mission agencies from long-term basic research to short-term applied research, raises concerns about the level of support for long-term, fundamental engineering research. The market conditions that once supported industrial investment in basic research at AT&T, IBM, RCA, General Electric, and other giants of corporate America no longer hold. Because of competitive pressures, U.S. industry has downsized its large, corporate R&D laboratories in physical sciences and engineering and reduced its already small share of funding for long-term, fundamental research. Although industry currently accounts for almost three-quarters of the nation's R&D expenditures, its focus is primarily on short-term applied research and product development. In some industries, such as consumer electronics, even product development is increasingly being outsourced to foreign contractors.

Consequently, federal investment in long-term research in universities and national laboratories has become increasingly important to sustaining the nation's technological strength. But just as industry has greatly reduced its investment in long-term engineering research, mission agencies that have traditionally been engineering-intensive have also shifted their focus to





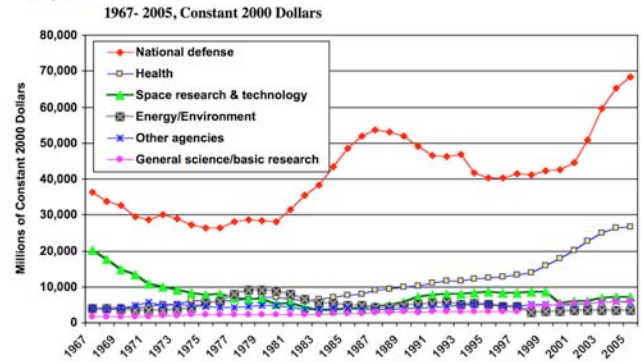
The fraction of R&D provided by the federal government has dropped to less than 30%, resulting in a major shift away from basic research toward applied development.

short-term research. For example, U.S. Department of Defense (DOD) funding for both basic and applied research has fallen substantially from peak levels in the 1990s, and cuts of more than 20 percent in 6.1, 6.2, and 6.3 budget categories are projected for FY2006 (AAAS, 2005). Given the importance of DOD funding to engineering research in key disciplines—DOD funds about 40 percent of engineering research at universities and more than 50 percent of research in electrical and mechanical engineering—these reductions have had a significant impact on the level of fundamental research conducted in a number of engineering fields (NRC, 2005).

The stagnating federal investment in research and research infrastructure has weakened the human-capital foundation of the American research enterprise. An innovation-driven nation will require a large cadre of scientists, engineers, and innovators with the depth of knowledge and creativity to create breakthrough technologies and systems. In addition to solid grounding in fundamental engineering concepts, these knowledge professionals must have the ability to address complex systems in multidisciplinary research environments.

The country is at a crossroads. We can either continue on our current course—living on incremental improvements to past technical developments and gradually conceding technological leadership to trading partners abroad—or we can take control of our destiny and conduct the necessary research, capture the intellectual property, commercialize and manufacture the products, and create the high-skill, high-value jobs that define a prosperous nation. The United States has the proven ability and resources to maintain the global lead

Federal R&D Obligations by Budget Function



Federal R&D is increasingly dominated by defense and biomedical research, corresponding to a significant erosion in physical science and engineering research.

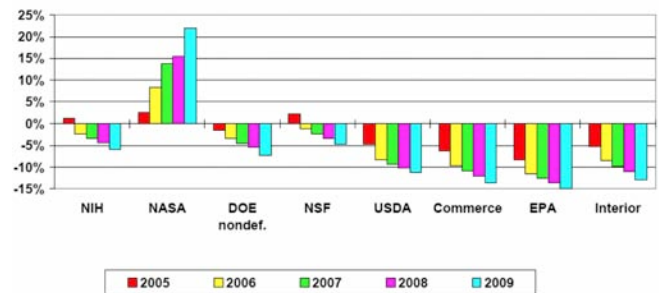
in innovation. Yet the question remains as to whether its leaders have the vision and the resolve to make the necessary investments in the nation’s future.

Public Policy

Michigan’s leaders have not been willing to acknowledge that the rest of the world is changing. They have, instead, held fast to an economic model that is not much different from the one that grew up around the very early automobile era—an era that passed long ago. Michigan industry, labor, and government continue to be addicted to an entitlement mentality that has long since disappeared in other economic sectors that have recognized the realities of a flat world.

Compounding this difficult situation is a state gov-

Projected Nondefense R&D in the President’s Budget, FY 2004-2009
% change from FY 2004 funding level in constant dollars



The Bush Administration is proposing even deeper cuts in federal R&D over the next several years.

ernment constrained by term limits (for both legislators and governor) that erode experience and perspective and a political environment where party priorities are increasingly dictated by ideology rather than strategy. State policies also continue to be dominated by the obsolete agendas of big government, big industry, big labor, and, at times, big universities, who all too frequently are willing to sacrifice the long-term welfare of the public (e.g., through investments in education) in an effort to obtain tax breaks or regulatory concessions.

State government is burdened with an unwillingness to think outside the box. Public leaders still promote old ideas and old philosophies from the past, a different time, totally irrelevant to today. The baby boomer priorities—health care, corrections, homeland security, reduced tax burdens, to the neglect of education—will cripple the state’s future.

Unable (or unwilling) to read the handwriting on the wall, Michigan continues to grasp at straws such as legalized gambling (our state now ranks among the nation’s leaders in the number of casinos, horse tracks, and other betting venues), tax abatements for dying yet politically influential industries, infrastructure fluff like casinos and professional sports stadiums, or tax cuts, primarily targeted to the wealthy, rather than investing in the key future of the state, its educational opportunities and its people. As a recent newspaper editorial put it, “State government treats Michigan’s 15 public universities the way I treat my roof, putting off repairs to fund other desires, and then paying heavily later when the roof falls in.”

Economists single out higher education as the best way to address the nation’s economic challenges. They point to the fact that not only does a college degree double the earnings capacity of a high school graduate, but that the knowledge-intensive jobs that are key to economic growth in the 21st century require such advanced learning and skills. One need only look at the relative economic health of various regions of the nation (not to mention the world) to see a very direct correlation between the percentage of college graduates and the prosperity of a region.

Bill Gates stresses that cutting-edge companies base their decisions to locate and expand in states more on their talent pool and culture for innovation than on tax policy. Asked what will be more important to eco-

nomics development, education or low taxes, Gates said companies with breakthrough technologies will “be far more sensitive to the quality of the talent instead of the tax policy.” Hence states should look at their education policies, both K-12 and higher education, as one of their highest priorities. Where top universities are located is where new companies dealing with the biosciences and other high technology projects will locate, Gates stresses. Having topflight universities also presents an advantage in drawing intellectual talent to a region. Being an “IQ magnet is a self-enforcing thing.” (Gates, 2005).

Yet for several decades, Michigan’s policies for public higher education have been directed toward the lowest common denominator of institutional quality, perhaps most recently illustrated by the announced goal to double the number of college graduates in Michigan, but without any plan to provide the necessary additional resources to a higher education system already reeling from several years of deep budget cuts. Instead of providing adequate appropriations to sustain quality programs for Michigan citizens, state government has chosen to gain political support by attacking universities for the tuition increases that are inevitably a consequence of state budget cuts and earlier tuition constraints. Moreover, state leaders have chosen to focus the limited additional funds provided by the tobacco settlement on merit-based scholarship programs, which predominately benefit upper-income families, rather than providing the need-based financial aid that most states (and scholars) have found to be the key to access. Put more bluntly, Michigan state government has not given high priority to funding higher education for almost three decades, preferring instead to build prisons, casinos, or sports stadiums or to subsidize the wealthy through tax cuts, low public university tuitions, and merit-driven financial aid programs.

We need to take a hard look at state spending policy generally, to ask the important question: What is the role of state government and how should resources be allocated? For decades Michigan was fabulously wealthy. We developed a culture of expensive practices and expectations: employee benefits, health care, social services, and litigation. Yet today, we continue to deploy our tax resources—already limited both by a weak economy and tax relief commitments made in more prosperous times—to pay for the past rather than in-

vesting in the future by creating new knowledge, new skills, and new jobs.

Not investing in knowledge generation, research, and education is absolute lunacy in a knowledge-intensive society. Although many public leaders ignore this reality of the age of knowledge, they do so at risk not only to Michigan's future, but increasingly to their own political survival as public awareness of the importance of investment in learning and knowledge resources grows.

Michigan is far more at risk than many other states because its manufacturing-dominated culture is addicted to an entitlement mentality that has long since disappeared in other regions and industrial sectors. Moreover, politicians and the media are both irresponsible and myopic as they continue to fan the flames of the voter hostility to an adequate tax base that is capable of meeting both today's urgent social needs and longer-term investment imperatives such as education and innovation. As Bill Gates warned, cutting-edge companies no longer make decisions to locate and expand based on tax policies and incentives. Instead they base these decisions on a state's talent pool and culture for innovation—priorities apparently no longer valued by many of Michigan's leaders, at least when it comes to tax policy.

Public Attitudes: Half Right (Essentially) and Half Wrong (Terribly!)

Despite the actions of state government, and the platforms of the state's political parties, public surveys reveal a far more enlightened perspective on the part of the electorate with respect to the importance of higher education. In recent surveys Michigan voters say public universities are critical to the state's economy, providing job training, economic development, and research that will determine the state's future prosperity. While families value higher education for the educational opportunities Michigan's colleges and universities provide to their sons and daughters, in today's highly competitive global economy, the public values our universities even more because of their capacity to create new jobs and stimulate the economy. Despite the rhetoric of state government, higher tuition levels are not really a major concern of the public, who understand

that as state support erodes, higher tuition levels are inevitable if quality is to be sustained. And they accept that quality and access are the highest priorities at this point in the state's history—not bargain-basement prices for bargain-basement quality (PCSUM, 2004).

As the University Investment Council observed:

Michigan housed a public university 20 years before it gained statehood, and 20 years after statehood it invented the land grant commitment of public service, expanded class offerings, and access to everyone. Generations of families have built loyalty to one or more public universities. Generations of taxpayers and private donors have given generously to the campuses. Hardworking Michiganders who never attended college nonetheless root for their teams, stroll their campuses and museums, and hope that one day their child will enter and graduate from the university. It is very much part of the American Dream. Michigan's public universities have powered our economy and lifted us up culturally. We are a stronger, more civil society for them. They have added immeasurably to our social progress. Today's university and political leaders can strengthen higher education. We all will benefit greatly from that. So too, will generations to come.

The public realizes this. Recent polling suggests that the Michigan public may be far ahead of our political leaders in sensing that the primary role of higher education in our state has become job creation rather than simply providing a place to send the kids (PCSUM, 2004). They understand, like most economists, that the real cure to globalization, outsourcing, off-shoring, and technological change is the availability of advanced educational opportunities.

That's the good news. Now for the bad news. A Detroit News poll in spring of 2005 found that just 27% of parents consider a good education essential for a successful life, and nearly half don't agree that everybody should go to college. As pollster Ed Sarpolus summarized the results, "This is still a state that believes in the university of hard knocks. We still believe that sweat, not brains, will get us ahead." Furthermore, only 3% of parents see engineering or computers as a likely career path for their children. As Nolan Finley, a Detroit news editor, summarized the implications of these depressing statistics, "Michigan is doomed to be the new

Mississippi. A backward state locked to a last-century industry, awash in ignorance and unprepared to seize the opportunities presented by new technologies and scientific advances" (Finley, 2005).

The Absence of a National Agenda

The future of public higher education is of immense importance to the United States. Beyond the fact that three-quarters of all college students are enrolled in public universities, the increasing dependence of our nation on advanced education, research, and innovation compel efforts to both sustain and enhance the quality of our public colleges and universities. Yet, the current structure for financing public higher education may no longer be viable. Traditionally, this has involved a partnership among states, the federal government, and private citizens (the marketplace). In the past the states have shouldered the lion's share of the costs of public higher education through subsidies, which keep tuition low for students; the federal government has taken on the role of providing need-based aid and loan subsidies. Students and parents (and to a much lesser extent donors) pick up the rest of the tab.

This system has become vulnerable as the states face the increasing Medicaid obligations of a growing and aging uninsured population, made even more difficult by the state tax-cutting frenzy during the boom period of the late 1990s. This is likely to worsen as a larger percentage of young people and working adults seek higher education while the tax-paying population ages and health care costs continue to escalate. As Kane and Orzag conclude, "the traditional model of higher education finance in the U.S. with large state subsidies to public higher education and modest means-tested grants and loans from the federal government is becoming increasingly untenable." (Kane, 2003).

Little wonder then that many are calling upon national leaders to articulate a national agenda for higher education in America, similar to other national agendas in K-12 education such as "A Nation At Risk" and "No Child Left Behind". Of course, we have had such national higher education agendas before during times of major national challenge and opportunity. The Land-Grant Acts of the 19th century addressed the needs of an emerging industrial nation and the

importance of education to the working class. The government-university research partnership, proposed by Vannevar Bush in 1944 and implemented following WWII, along with the G.I. Bill and the recommendations of the Truman Commission, established the principle of federal support of research and graduate education on the campuses while launching the massification of higher education in America. The National Defense Education Act of the late 1950s and 1960s established investments in higher education as critical to national security during the height of the Cold War.

Yet since that time, for almost four decades, the nation really has had no agenda for higher education in America. Little wonder that at times we appear to be drifting aimlessly, with changing social priorities putting at great risk that the very institutions that earlier generations built and supported so strongly as key to the future of a great nation. Here part of the challenge is a profound misunderstanding of the relationship among the cost, price, and value of a college education by both students and parents and by elected public officials. The funding of higher education by state and federal government support (including tax benefits), philanthropy, and other various revenue streams not only disguise true costs but make pricing, e.g., tuition, largely fictitious, since all students, rich and poor, in public and private institutions receive very substantial subsidies. In some ways the financing of higher education is reminiscent of health care, where third-party payers (insurance companies, Medicare and Medicaid) also decouple the consumer from the marketplace. However in health care, at least one can estimate the costs of medical treatment and patients can assess the value of their health care, in contrast to higher education where true costs are difficult to estimate and the benefit of a college education is usually assessed only many years later.

One might approach this as an appropriate challenge to the federal government. After all, in some ways it was federal inaction that created the current dilemma, crippling state budgets with unfunded federal mandates such as Medicaid, through federal inaction on national priorities such as universal health care, and shifting philosophies of federal financial aid programs. It is also the federal government's responsibility to invest adequately in providing for economic prosperity and

national security, particularly in the new flat world characterized by phenomena such as outsourcing and off-shoring characterizing a hypercompetitive, global, knowledge-driven economy increasingly dependent upon knowledge workers, research, and technological innovation. (Friedman, 2005).

Chapter 6

The Michigan Roadmap

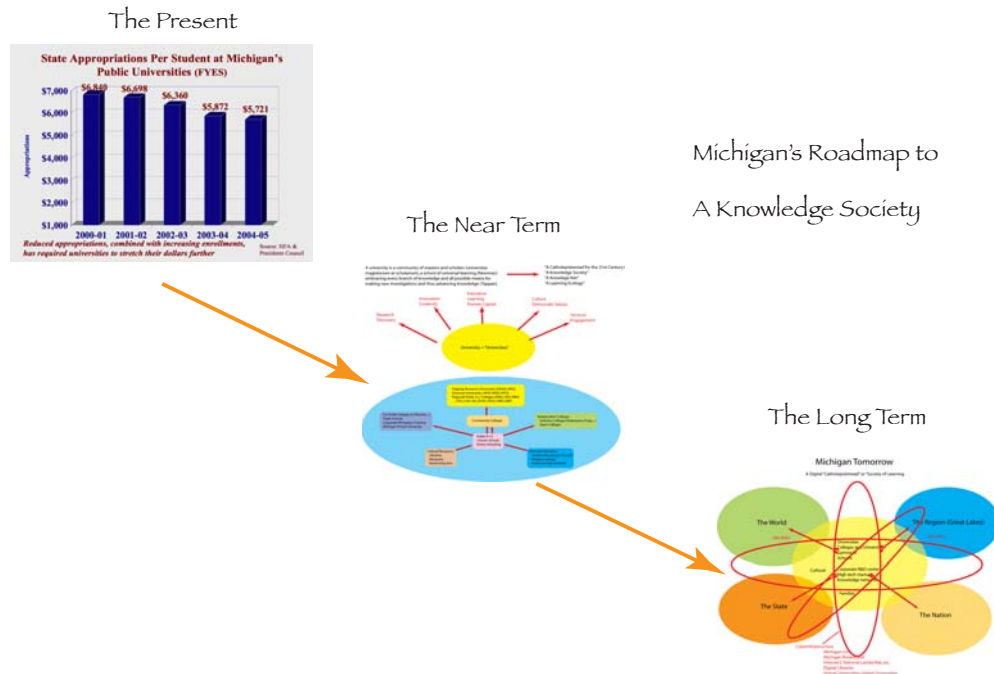
We now turn to the final phase of the roadmap-ping process: the Michigan Roadmap itself. This is designed as an evolving plan to suggest the path our state might take to transform itself from the deteriorating industrial economy of Michigan today to a vibrant, knowledge economy of Michigan tomorrow, capable of competing in a global economy and providing our citizens with prosperity, social well-being, and security. As we have stressed throughout this report, in a knowledge-intensive society, regional advantage is achieved through creating a highly educated and skilled workforce that is competitive on a global level. It requires an environment that stimulates creativity, innovation, and entrepreneurial behavior. It also requires supporting infrastructure—world-class schools and universities, research laboratories and cyberinfrastructure, tax and intellectual property policies. And it requires vision, commitment, and leadership in both the public and private sectors.

There is ample experience from elsewhere, from California to North Carolina to Ireland to India—not to mention Michigan’s own history—to demonstrate that visionary public policies and significant public investment are necessary to produce the necessary human capital, new knowledge, and infrastructure to support a knowledge economy. Hence the recommendations in the Michigan Roadmap are framed toward these goals, divided into recommendations for the near term that would be reasonable objectives for the remainder of this decade, followed by a series of more ambitious recommendations aimed at transforming Michigan into a true knowledge society.

Among the essential elements for a knowledge economy—human capital, new knowledge, and infrastructure—it is our belief that investments in Michigan’s capacity to generate new knowledge through research, innovation, and entrepreneurial activities will have the

highest payoff in the short term. Hence in the near-term recommendations we have stressed major public investments in the state’s research universities, the production of scientists and engineers, technology transfer, corporate R&D, and high-tech business startups, aimed at creating the new industries that will eventually replace Michigan’s declining factory-based manufacturing industries. However even in the near term, bold steps to begin to build the necessary knowledge-based workforce are both imperative and appropriate, although it will take time to achieve the necessary progress. Investing in building the necessary infrastructure will also be essential to support and sustain both innovation and workforce development. The challenge will be to provide ample opportunities for postsecondary education to all Michigan citizens while achieving and sustaining the world-class universities capable of providing graduate education, research, and innovation at the very highest level of excellence.

For the longer term, there can be no more compelling priority with a higher rate of return than investment in our people through public support of educational opportunities at all levels. Michigan must build and sustain a world-class education system, spanning the full range of educational opportunities, from pre-school to K-12 to higher education, to graduate and professional education, to lifelong learning. To be sure, this will be challenging, since it demands substantial new investments in education—both in individuals (e.g., financial aid, vouchers) and institutions (appropriations)—that will almost certainly require new taxes and a significant restructuring of Michigan’s tax policies and tax base. It will also demand new standards for excellence and accountability for institutions, students, and families. But our citizens deserve these lifelong educational opportunities—and today’s hypercompetitive global economy demands it!



A Roadmap from Michigan Today to Michigan Tomorrow.

The Roadmap: The Near Term (...now!...)

In the near term our principal recommendations focus on developing policies and making the necessary investments in education, innovation, and infrastructure in a manner that takes advantage of strong market forces and leverages both federal and private investment. Our recommendations are also aimed at providing public institutions—including state government itself—with capacity, incentives, and encouragement to become more agile and market-smart.

Human Capital

1. *Michigan simply must increase the participation of its citizens in higher education at all levels—community college, baccalaureate, and graduate and professional degrees. This will require a substantial increase in the funding of higher education from both public and private sources as well as significant changes in public policy. It will also likely require a dedicated source of tax revenues to achieve and secure the necessary levels of investment during a period of gridlock in state government, perhaps through a citizen-initiated referendum. This, in turn, will require a major effort to build adequate public awareness of the importance of higher education to the future of the state and its citizens.*

As we have stressed throughout this report, the most urgent near-term challenge facing our state's higher education system is the need to develop more enlightened policies and strategies that enable us to invest sufficient public funds in higher education while providing our academic institutions with the incentives and agility to respond to market pressures. In order to ensure sufficient investment, we need to follow the guiding principles of quality, access, diversity, and market agility. It is only through an investment in knowledge resources and innovation—education, research, and the infrastructure to support them—that Michigan citizens will be able to compete in this global economy. Simplistic solutions that merely try to increase degree production without addressing quality or funding requirements are clearly both incomplete and inadequate.

However, we also acknowledge that Michigan's current tax base is inadequate for this purpose. Tax cuts implemented during the boom-days of the 1990s have created a dysfunctional state budget, no longer adequate to address current obligations such as K-12 education, corrections and unfunded federal mandates such as Medicaid, while investing adequately in Michigan's future, particularly during periods of a weak economy—which, without new investments, are likely to become both more frequent and more severe for our

state. Yet the current inability of state government to develop and implement a tax policy appropriate for a 21st century knowledge economy in the face of public resistance from an aging baby boomer population gives us pause.

While flexibility in state budget and tax policy is always desirable, particularly during periods of major social change, we are convinced that investments in education, innovation, and infrastructure are simply too critical to be subject to the year-to-year pressures of a dysfunctional state budget process and an electorate still embracing an entitlement mentality from Michigan's industrial past. Hence we recommend serious consideration be given to funding public higher education, and perhaps knowledge generating activities such as research, innovation, and supporting infrastructure, from a dedicated tax revenue stream secure from tampering by state government. This will likely require a citizen-driven initiative (as it has in several other states), and to this end we strongly support the efforts of the recently formed K-16 Coalition for Michigan's Future to achieve just such a mechanism (K-16 Coalition, 2005).

2. To achieve and sustain the quality of and access to educational opportunities, Michigan needs to move into the top quartile of states in its higher education appropriations (on a per student basis) to its public universities. To achieve this objective, state government should set a target of increasing by 30% (beyond inflation) its appropriations to its public universities over the next five years.

There is ample evidence that Michigan's current investments in public higher education are simply inadequate, whether compared with other states, other nations, or in light of the current and future challenges faced by the state. Today, Michigan's annual appropriations to higher education, at a level of \$5,600 per FYES, have not only fallen below the national average, but declined to become lowest in the Great Lakes region. Michigan simply cannot compete without a highly skilled workforce, and that workforce is dependent on the availability of advanced educational opportunities.

It is important to set appropriate benchmarks for critical investments such as public higher education. If Michigan aspires to return to a position of national eco-

nomical leadership, it follows that it must be prepared to invest adequately to create a workforce and stimulate the innovation required for such economic prosperity in a global knowledge economy. In higher education, just as in other economic sectors, quality and access require investment. Insisting on bargain-basement prices, as tax-paying citizens or tuition-paying parents, will inevitably lead to bargain-basement quality, which would likely doom our state's capacity to transform itself into a 21st-century knowledge economy.

More specifically, simply moving to the average of other Great Lakes states would require additional support of Michigan's public universities by a 10% increase in state appropriations per student (after inflation). To move into the top quartile of the states would require a 30% increase, while moving to the level of support provided in states with strong knowledge-based economies such as California, North Carolina, Texas, and Massachusetts, would require an increase of 40%. We recommend an intermediate objective of moving to the top quartile of the states by increasing state appropriations per student by 30% (beyond inflation) over the next five years, with possible further increases after that to allow Michigan to compete with the leading high-tech states.

3. The increasing dependence of the knowledge economy on science and technology, coupled with Michigan's relatively low ranking in percentage of graduates with science and engineering degrees, motivates a strong recommendation to state government to place a much higher priority on providing targeted funding for program and facilities support in these areas in state universities, similar to that provided in California, Texas, and many other states. In addition, more effort should be directed toward K-12 to encourage and adequately prepare students for science and engineering studies, including incentives such as forgivable college loan programs in these areas (with forgiveness contingent upon completion of degrees and working for Michigan employers). In addition, state government should strongly encourage public universities to recruit science and engineering students from other states and nations, particularly at the graduate level, perhaps even providing incentives if they accept employment following graduation with Michigan companies.

Industries and firms, even those that are based in

a more traditional economy, are organizing their work around technology. To be successful, all companies are forced to focus on using advanced information technology. Where will the human capital for such advanced technology deployment come from? In the old economy, workers often followed companies, so public policies such as tax abatements to attract large firms made sense. However, as knowledge workers become more important factors in production, companies are often locating where knowledge workers already are. The implications to Michigan are extremely serious with its relative weakness in the production of scientists, engineers, and technologies. Advocates from nearly every industrial sector are calling on government to respond to the growing competitiveness challenge by increasing public investments in science and engineering education and basic research and development.

Michigan ranks relatively low among the states in the penetration of science and engineering degrees among its college-educated workforce. Moreover, because of their intensive capital needs for laboratory facilities and equipment, science and engineering programs tend to suffer comparatively more damage than less technology-dependent programs during periods of inadequate state appropriations such as the past several years. This is aggravated by Michigan's inability to provide tax dollars for badly needed campus academic facilities for over a decade.

Although Michigan is more at risk in this area than many other states, this is a national problem as well. As Friedman has stressed, the generation of scientists and engineers motivated to go into science by Sputnik and the Apollo program is now approaching retirement. Yet the fraction of American 18-24 year olds who receive S&E degrees has fallen to 17th in the world. In the United States eroding student interest in science and mathematics and the weakness of K-12 education have led to a situation in which engineering students comprise less than 5% of U.S. college graduates, compared to 12% in Europe and over 50% in some Asian countries. The United States has traditionally been able to compensate for this domestic shortfall by using its high quality universities to attract talented students in science and engineering from other countries. However in the wake of 9-11, a tightening of immigration policies coupled with the increasing efforts of other nations to

compete for foreign university students has threatened this supply. As Intel CEO Craig Barrett warns: "We are not graduating the volume of scientists and engineers, we do not have a lock on the infrastructure, we do not have a lock on the new ideas, and we are either flat lining, or in real dollars cutting back out investments in physical science."

Michigan should heed Friedman's warning: "It takes 15 years to create a scientist or engineer. We should be embarking on an all-hands-on-deck, no-budget-too-large crash program for S&E education immediately. The fact that we are not doing so is our quiet crisis. Scientists and engineers don't grow on trees. They have to be educated through a long process because this really IS rocket science." (Friedman, 2005)

4. Colleges and universities should place far greater emphasis on building alliances that will allow them to focus on unique core competencies while joining with other institutions in both the public and private sector to address the broad and diverse needs of society in the face of today's social, economic, and technological challenges while addressing the broad and diverse needs of society. For example, research universities should work closely with regional universities and independent colleges to provide access to cutting-edge knowledge resources and programs.

One of the ironies of the increasingly competitive global marketplace is the need to cooperate through alliances. This is an important approach that should also be adopted by higher education. Here the key is to encourage far more mission differentiation among institutions, where colleges and universities develop strong capacity in unique areas and then form alliances with other institutions, cooperating and sharing resources, to meet the broader needs of the state. For example, the state's flagship research universities (UMAA, MSU) will be under great pressure to expand enrollments to address the expanding populations of both college-age and adult students, possibly at the expense of their research and service missions. It might be far more constructive for these institutions to form close alliances with regional universities and community colleges to meet these growing demands for educational opportunity while protecting their unique capacity to conduct the cutting-edge research critical to an economy

increasingly dependent on technological innovation. Another example would be alliances between research universities and independent colleges that take mutual advantage of the learning-intensive environment of the latter and the vast intellectual resources of the former.

The experience of successful higher-education associations suggests that the key coordination point for such interactions should be the chief academic officers, the provosts, since they are, in effect, the chief operating officers for their institutions and somewhat less pressured into a competitive mode. Such an organization already exists through the Presidents Council of State Universities of Michigan, but similar organizations should be developed for Michigan's independent colleges. Furthermore, there should be separate organizations for the state's research universities (UMAA, MSU, WSU, and MTU), comprehensive public universities (WMU, EMU, CMU, NMU, OU, GVSU, SVSU, FSU, LSSU, UMD, and UMF), community colleges, and independent colleges. However there should also be alliances among institutions with differing roles and missions (e.g., partnering research universities with liberal arts colleges and community colleges) as well as between higher education and the private sector (e.g., information technology and entertainment companies). Differentiation among institutions should be encouraged, while relying upon market forces rather than regulations to discourage duplication.

New Knowledge (R&D, innovation)

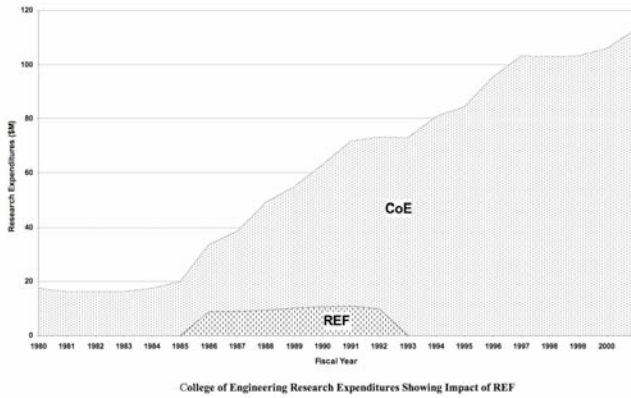
5. *The quality and capacity of Michigan's learning and knowledge infrastructure will be determined by the leadership of its public research universities in discovering new knowledge, developing innovative applications of those discoveries that can be transferred to society, and educating those capable of working at the frontiers of knowledge and the professions. State government should strongly support the role of these institutions as sources of advanced studies and research by dramatically increasing public support of research infrastructure, analogous to the highly successful Research Excellence Fund of the 1980s. Also key will be enhanced support of the efforts of regional colleges and universities to integrate this new knowledge into academic programs capable of providing lifelong learning opportunities of world-class quality while supporting their surrounding communities in the transition*

to knowledge economies.

While adequate investment in quality educational opportunities is essential, this by itself will not create the new knowledge-intensive jobs demanded by the global economy. As Bill Gates has noted, cutting edge companies no longer make decisions to locate and expand in states based on tax policies and incentives. Instead they base their decisions on a state's talent pool and culture for innovation, with particular focus on world-class research university. Gates notes that California provides a perfect example of a state that saw huge growth in the high tech industries despite a relatively unfavorable tax climate, and it continues to benefit today by sustained public investment in the University of California system and the launch of a series of major state-funded R&D centers in key technologies (biotechnology, communications technology) on university campuses.

Although today Michigan tends to focus its efforts more on public relations (Michigan First) and gimmicks (lotteries) while cutting support for research universities, during the 1980s the administration of Governor James Blanchard supported a highly successful effort to invest in the research capacity of its universities through the Research Excellence Fund. As a case study, approximately \$10 million a year for a seven-year period was focused on three major research centers in the University of Michigan's College of Engineering: The Center for Research on Integrated Manufacturing, The Center for Advanced Electronics and Optics Technology, and The Center for Machine Intelligence. The impact of this investment was quite extraordinary: the production of cutting edge research, products, and methodologies in manufacturing, information technology, microelectronics, optics, MEMS, and biotechnology; the spinoff of 16 successful companies; numerous technologies that were adopted by Michigan industry; the involvement in research of hundreds of Michigan companies that became partners in the centers; and a ramping up of federal research funding attracted by the UM College of Engineering by a factor of seven-fold, from \$18 million a year to over \$140 million a year, leveraging the state investment by over a factor of 10.

Unfortunately, after seven years of funding, politics and a new governor and state legislature eliminated the Research Excellence Fund. Yet today this state program



A demonstration of the remarkable impact of the Research Excellence Fund of the 1980s, stimulating a ten-fold growth in federal research, spinning off numerous startup companies, and providing key technologies to Michigan industry.

provides quite strong evidence of precisely the type of investment of state tax dollars necessary to “support high quality research and applied technology development at Michigan public colleges and universities as a means for making existing Michigan businesses more competitive and creating new jobs and businesses based on newly developed products and successes,” in the words of the original Research Excellence Fund legislation. Many other states have learned from and since imitated this program. Unfortunately Michigan did not...

6. *In response to such reinvestment in the research capacity of Michigan’s universities, they, in turn, must become more strategically engaged in both regional and statewide economic development activities. Intellectual property policies should be simplified; faculty and staff should be encouraged to participate in the startup and spinoff of high-tech business; and universities should be willing to invest some of their own assets (e.g., endowment funds) in state- and region-based venture capital activities. Furthermore, universities and state government should work more closely together to go after major high tech opportunities in both the private sector (attracting new knowledge-based companies) and federal initiatives.*

As we noted earlier, there are numerous examples in which universities have not only encouraged faculty, student, and staff participation in high tech startups,

but also provided or attracted substantial investment capital for such activities (e.g., CONNECT in San Diego). This creates a virtuous cycle of economic growth and reinvestment in the subsequent waves of high tech development.

Furthermore, close cooperation between state government and research universities has also led to major success in attracting both high tech industry and major federal investments (e.g., the Research Triangle and Centennial Campus in North Carolina, MCC and STC in Austin, and Silicon Valley in California). Ironically, in the 1980s, Michigan formed just such a partnership, but then undermined its efforts through cuts in higher education, chasing away major opportunities that later located in Texas and California. Both state government and Michigan research universities need to recommit themselves to such partnerships for the long term, seizing on current opportunities such as alternative energy sources for the transportation industry (e.g., hydrogen and hybrid technologies), nanoscale biotechnology, and information systems (Internet2 and the National LambdaRail).

7. *Michigan must also invest additional public and private resources in private-sector initiatives designed to stimulate R&D, innovation, and entrepreneurial activities. Key elements would include reforming state tax policy to encourage new, high-tech business development, securing sufficient venture capital, state participation in cost-sharing for federal research projects, and a far more aggressive and effective effort by the Michigan Congressional delegation to attract major federal research funding to the state.*

While the development of human capital is the primary responsibility of the state’s educational institutions, the generation of new knowledge—R&D, innovation, entrepreneurial activities—and infrastructure will require a partnership among business, higher education, and state government. Just as state government must begin to reinvest in the capacity of its public universities to produce knowledge workers and research, it must also provide strong incentives to reestablish longer-term R&D as a priority for Michigan companies. The state should support private sector investment in joint university-industry collaborative research (e.g., through tax credits) and assist in meeting the cost-

sharing requirements for federally sponsored research grants and contracts.

Here the Michigan Congressional delegation should be encouraged to support legislation to provide strong federal tax incentives and policy support to stimulate increased industry investment in R&D. It should also be directed to play a far more active role in attracting federal research dollars to Michigan universities and industry as one of its most important responsibilities. Michigan Congressional representatives should also seek committee leadership positions and influence necessary to direct the establishment of major federal research centers (FFRDCs) in Michigan.

State government must also play a stronger role in stimulating high tech development. As we have noted, while Michigan has the capacity to attract the technologists and management necessary for startups, it is sadly lacking in adequate private capital, particularly venture capital, necessary for these activities. Here, state incentives should be provided for the investment of both private capital and public assets (e.g., state pension fund, university endowment funds). The state can also play a leadership role in encouraging the partnerships between large, established companies and new startups as well as coordinating university technology development programs and technology transfer activities.

To its credit, Michigan has chosen to deploy a component of its tobacco settlement funds into high-tech areas (the Life Sciences Corridor). Most recently it has proposed securitizing the tobacco revenue by selling \$1 billion of bonds to fund economic development (the "Get Michigan Working" plan). Unfortunately, however, such large sums are frequently diverted by lobbyists to activities with little impact on long-term economic development. The lesson learned from other states is to invest through partnerships with higher education and industry in high-tech research, innovation, and startups that build upon areas of established strength (e.g., alternative energy sources, advanced transportation systems, biotechnology, information systems and services) rather than play catchup in areas where Michigan currently has no core competency.

Finally, there is a critical need to revise state tax policy to be more supportive of small business startup activities. As in so many other areas such as education, the state continues to be seriously constrained by an ob-

solete tax system, designed to favor a 20th-century factory-based manufacturing economy rather than a 21st-century knowledge economy. The state's tax code must be modernized so that it does not penalize and stifle the growth of the companies of the future to subsidize the industry of the past.

Infrastructure

8. Providing the educational opportunities and new knowledge necessary to compete in a global, knowledge-driven economy requires an advanced infrastructure: educational and research institutions, physical infrastructure such as laboratories and cyberinfrastructure such as broadband networks, and supportive policies in areas such as tax and intellectual property. Michigan must invest heavily to transform the infrastructure for a 20th-century manufacturing economy into that required for a 21st-century knowledge economy. Of particular importance is a commitment by state government to provide adequate annual appropriations for university capital facilities comparable to those of other leading states. It is also important for both state and local government to play a more active role in stimulating the development of pervasive high speed broadband networks, since experience suggests that reliance upon private sector telcom and cable monopolies could well trap Michigan in a cyberinfrastructure backwater relative to other regions (and nations).

We have noted earlier the toll taken on higher education in Michigan by the serious erosion in state support of its public colleges and universities. Of particular note here is the absence of any strategic plan for maintaining the capital facilities infrastructure of state universities, e.g., laboratories, libraries, and classroom facilities. Michigan is unique among the states in providing no sustained capital outlay for almost a decade, in contrast to most other states that provide hundreds of millions of dollars for this purpose each year. When one considers that a rule of thumb for the renewal or replacement of university capital facilities is based on a 30 or 40 year amortization, the benign neglect of public university capital needs by state government puts at great risk the capacity of these institutions to meet the growing needs of the state for advanced education and research.

However of equal concern here is the inadequacy of

the new types of infrastructure required for prosperity in an era increasingly dominated by the rapid evolution of computer and communications technology. As Friedman has noted, the emergence of the Internet, coupled with the massive overinvestment of billions of dollars in fiber networks during the dot-com bubble, has driven down the cost of transmitting voice, data, and images to practically zero, bringing people-to-people and business-to-business connectivity to a whole new level. Today almost one billion people are connected through broadband, driving the emergence of the global, knowledge-driven economy. But he goes on to note that “while a huge amount of fiber was laid to connect India and American, virtually none was laid to connect American households due to a failure of the 1996 telecom deregulation to permit real competition between the telcoms and the cable companies.” (Friedman, 2005). Today the United States is the only industrialized nation without an explicit national policy for promoting broadband, and as a consequence, our nation has dropped from 4th to 13th place in the global ranking of broadband Internet use.

In the 20th century, public investments in transportation infrastructure such as the Interstate Highway System and international airports were the key to building and sustaining Michigan’s manufacturing economy. In the 21st century, cyberinfrastructure—computer resources, broadband networks, and digital libraries—have become the key infrastructure necessary to build and sustain a knowledge-based economy. Other states and nations are investing heavily in the infrastructure (e.g., Ohio’s OhioLINK) necessary to support a competitive learning and knowledge environment. Greater bandwidth is crucial because it allows faster transmission of knowledge—important for business and for individuals who can then engage in distance education, telecommuting, and e-commerce. Michigan should achieve a better balance between its investments of public funds in institutions (colleges and universities) and in infrastructure (the connective tissue linking institutions and citizens).

Today it has become clear that public action is needed to compensate for the inadequate effort of the private sector (telcoms and cable companies) to provide the necessary connectivity for Michigan citizens and businesses. To wait on the private sector to respond

while other states and nations rush ahead with publicly funded network infrastructures puts at risk perhaps a million state jobs, as well as the necessary educational infrastructure.

Proposals have been made in the past encouraging state investment in building major broadband networks such as LinkMichigan (Gartner, 2002). The Michigan Economic Development Corporation has recognized the need for a statewide network that could provide links to non-profit organizations, government entities, private industry and residents of the state. MEDC urged that, “Access to high-speed telecommunication services is the most important state infrastructure issue for the new century. Whether for business, government, healthcare, or educational purposes, higher-speed access is increasingly becoming a necessity—not a luxury” (MEDC, 2001).

Policies

9. As powerful market forces increasingly dominate public policy, Michigan’s higher-education strategy should become market-smart, investing more public resources directly in the marketplace through programs such as vouchers, need-based financial aid, and competitive research grants, while enabling public colleges and universities to compete in this market through encouraging greater flexibility and differentiation in pricing, programs, and quality aspirations.

As we enter a new century, there is an increasing sense that the marketplace is not only a more accurate measure of public priorities than the ballot box or public policy but also a more effective mechanism for allocating both public and private investments. For example, as the economic benefits of advanced education in a knowledge society soar, and higher education is increasingly viewed by society (and its elected governments) as a private benefit rather than a public good, it is important to allow market forces rather than public policy to drive the learning enterprise. Hence at both the state and federal level, government is shifting public investment away from base support of institutions and instead into the marketplace through voucher systems, student financial aid programs, and competitive research grants.

Yet this must be done in a sophisticated manner, else

the most fundamental responsibilities of government will be abandoned. For example, economists have long known that the most effective way to achieve access to public higher education is through state or federal need-based financial aid programs since this targets limited tax dollars to those who most need assistance to attend college. Merit-based scholarship programs and low tuition at public universities, while politically popular, primarily use tax dollars to benefit higher-income students who usually need little incentive or financial assistance in attending college. The same is true for those programs providing tax incentives for college expenditures, since these primarily benefit those with sufficient incomes to incur substantial tax liabilities. Since few state residents will pay sufficient state income taxes to cover the costs of educating their children in public universities (based upon the portion of state tax revenue going to support higher education), it becomes clear that merit-based scholarships, low tuition, and tax incentives represent an extremely regressive social policy—in a blunt sense, welfare for the rich at the expense of educational opportunity for the poor.

10. Michigan should target its tax dollars more strategically to leverage both federal and private-sector investment in education and R&D. For example, a shift toward higher tuition/need-based financial aid policies in public universities not only leverages greater federal financial aid but also avoids unnecessary subsidy of high-income students. Furthermore greater state investment in university research capacity would leverage greater federal and industrial support of campus-based R&D.

Although public universities are state institutions, they are supported largely by resources other than state appropriations: private payments (e.g., tuition), federal support (e.g., student financial aid, research grants), gifts, and market-driven auxiliary activities (e.g., licensing income, executive education, intercollegiate athletics). Indeed, nationwide, almost two-thirds of the support for American higher education comes from private sources with another one-sixth from the federal government. Hence it is imperative that Michigan strategically target its tax dollars to leverage both federal and private sector investment in advanced education and research, compatible of course with fundamental

objectives such as broad access to and quality of educational opportunities.

Earlier we discussed an excellent example of such leveraging: the Research Excellence Fund of the Blanchard administration. Through a relatively modest investment (\$10 million per year) in the UM College of Engineering, the state reaped the benefit of over \$140 million per year in federal and industrial research investments—not to mention the spinoff of numerous startup companies, technology transfer, and the production of high-quality engineering graduates.

Similarly, efforts to constrain tuition levels at the state's public universities have the perverse effect of not capturing the full benefit of federal financial aid programs, which have actually been designed to support, in part, the far higher tuition levels at private universities. Furthermore, low tuition levels provide unnecessary subsidies for those affluent families who clearly have the capacity to afford the costs of a college education, as evidenced by the fact that they frequently send their children instead to private colleges and universities with costs several times that of public universities.

It is also important here to remind readers that efforts to constrain tuition during a period of eroding state support, while politically popular, can seriously damage institutional quality. When state government cuts appropriations per student at Michigan public universities by 25% to 40%, as it has over the past five years, institutions that have already optimized cost structures over the past two decades to accommodate earlier erosion in state support have only two options: increase tuition or reduce quality. Reducing activity (e.g., enrollments or research) is not an option for most, both because of their increasing dependence upon tuition and research grants and their sense of public purpose.

11. Key to achieving the agility necessary to respond to market forces will be a new social contract negotiated between the state government and Michigan's public colleges and universities, which provides enhanced market agility in return for greater (and more visible) public accountability with respect to quantifiable deliverables such as graduation rates, student socioeconomic backgrounds, and intellectual property generated through research and transferred into the marketplace.

It is increasingly likely that market forces will dominate public policy and public investment in determining the future of most public universities, particularly as state support continues to become a smaller and smaller component of their revenue base. To micro-manage or constrain the options of public universities during what might be a several-decade period of weak public support could not only seriously damage their quality but also hinder their capacity to serve the public during this era of a market-driven higher-education enterprise. Hence state and university should seek an appropriate balance between accountability to public purposes and the autonomy necessary to enable the flexibility to adapt to market forces. For example, there should be agreed-upon and measurable objectives to ensure public accountability, e.g., student enrollments, degree success rate, socioeconomic distribution of students, technology-transfer activities, and sponsored research funding in return for state government respecting the constitutional autonomy of the institutions and the authority of their governing boards.

While Michigan's public universities are legally owned by the people of the state, they are enduring social institutions with a duty of stewardship to generations past and a moral obligation to take whatever actions are necessary to build and protect its capacity to serve future generations. Unlike governments and companies that exist from election to election or quarter to quarter, universities span generations, connecting the past with the future. Even though their actions might conflict from time to time with public opinion or the prevailing political winds of state government, Michigan's constitution clearly provides its public universities with the capacity to set their own course to serve this public purpose. When it comes to objectives such as program quality or access to educational opportunity, university governing boards have always viewed these as long-term institutional decisions rather than succumbing to public or political pressures of the moment.

Yet it is also safe to say that the deep cuts in state appropriations for Michigan public universities, at a time when enrollments are growing along with Michigan's need for advanced education, research, and innovation, have raised serious questions about whether state government is a reliable partner in the role of public

higher education's role in building a knowledge economy. Governing boards, faculty, alumni, students and parents, and the media are all beginning to question whether term-limited elected state officials, responsive to the increasingly narrow agendas of Michigan's political parties, can be trusted to act wisely or responsibly in the state's long-term best interests.

Similar concerns in other states have stimulated a reconsideration of the social contract between public higher education and state government, seeking to provide public universities with the agility they need not simply to respond to growing market forces, but to finance themselves increasingly from the marketplace as state support continues to decline as a proportion of their operating budgets. In return, state universities are willing to be held increasingly accountable for achieving measurable outcomes such as graduation rates, the socio-economic character of their students, technology transfer, and other state priorities.

Across the nation numerous experiments are underway redefine the nature of public higher education. Some states such as Virginia and Colorado have created new types of public universities that function more as public corporations or authorities rather than state agencies, allowing universities greater flexibility to draw support from the private marketplace, in return for more visible measures of accountability. In fact, Colorado has even implemented a voucher system to fund higher education, in which students are provided portable grants taken with them to the institution of their choice. Other states such as South Carolina and Virginia have allowed the privatization of selected higher education programs, e.g., professional schools such as law and business. Several states such as Pennsylvania have moved to performance contracting, in which universities are redefined as state-related rather than state-owned and negotiate a contractual relationship with state government to receive state funds for specific purposes (e.g., educating a certain number of state residents). Perhaps the most interesting experiment is in Ohio, where Miami University has been allowed to set tuition levels for Ohio residents at private (out-of-state) levels, then discount this by the state appropriation per student, and still further with need-based financial aid, making quite transparent the relative dependence of tuition on state support (Breneman, 2005).

In fact, this last approach is increasingly finding favor in many quarters. As a 2004 editorial in the New York Times explained, “With government support so shaky, state colleges are going to need to raise their rates. A more moderate approach might be to permit tuition to rise to the levels now charged to out-of-state students, while protecting those with less ability to pay with need-based financial aid programs.” The NYT editorial concludes, “State colleges must find a way to fulfill the mission they were created to perform. Since state governments have taken to starving them, their best hope is to increase tuition for those who can afford to pay” (NYT, 2004).

The Roadmap: The Longer Term (...But Within a Decade...)

For the longer term, our vision for the future of higher education is shaped very much by the recognition that we have entered an age of knowledge in a global economy, in which educated people, the knowledge they produce, and the innovation and entrepreneurial skills they possess have become the keys to economic prosperity, social well-being, and national security. Moreover, education, knowledge, innovation, and entrepreneurial skills have also become the primary determinants of one’s personal standard of living and quality of life. We believe that democratic societies—and state and federal governments—must accept the responsibility to provide all of their citizens with the educational and training opportunities they need, throughout their lives, whenever, wherever, and however they need it, at high quality and at affordable prices.

To this end, the long-term roadmap pursues a vision of the future in which Michigan strives to build a knowledge infrastructure capable of adapting and evolving to meet the imperatives of a global, knowledge-driven world. Such a vision is essential to create the new knowledge (research and innovation), skilled workforce, and infrastructure necessary for Michigan to compete in the global economy while providing citizens with the lifelong learning opportunities and skills they need to live prosperous and meaningful lives in our state. As steps toward this vision, we recommend the following actions:

1. Michigan needs to develop a more systemic and strategic perspective of its educational, research, and cultural institutions—both public and private, formal and informal—that views these knowledge resources as comprising a knowledge ecology that must be allowed and encouraged to adapt and evolve rapidly to serve the needs of the state in a change driven world, free from micromanagement by state government or intrusion by partisan politics.

State education policy is far too fragmented, with widely differing perspectives and philosophies depending on the educational sector, e.g., K-12 responsible to local communities and the State Board of Education, public higher education largely the responsibility of politically determined governing boards, private higher education quite autonomous, and an array of cultural organizations (museums, libraries), industrial resources (workplace training programs, corporate R&D), and informal learning opportunities largely out of sight, out of mind. In a similar sense, state funding of education tends to run on automatic pilot, determined more by the increasingly inadequate resources provided by Michigan’s obsolete tax structure (e.g., based on a 1950s manufacturing economy rather than a 21st-century knowledge-services economy) and political patronage than carefully designed as a strategic investment in the state’s future. It is essential that leaders of state government, higher education, business, industry, labor, and the public at large (through the media) view higher education in a far more systemic and strategic fashion as a critical resource for Michigan’s future.

Here we are certainly not recommending the creation of more state bureaucracy such as the state higher education coordinating boards characterizing many other states. In fact, Michigan’s higher education “anarchy,” guaranteed by institutional autonomy granted by the state constitution, has proved remarkably effective over the years in providing public colleges and universities with the agility they need to adapt to changing conditions such as the decline of public support and the rise of market pressures. Many states look at Michigan with considerable envy concerning the quality, diversity, and cost-effectiveness of its higher-education system, despite its relatively low level of state support over the past two decades.

Rather we believe that more policy attention needs

to be given to the strategic evolution of knowledge resources in the state, set apart from the tyranny of legislative committees and political election cycles and more responsive to the long-term needs of the state. In other states, citizen groups such as business/higher education associations have proven effective.

2. Michigan should strive to encourage and sustain a more diverse system of higher education, since institutions with diverse missions, core competencies, and funding mechanisms are necessary to serve the diverse needs of its citizens, while creating an knowledge infrastructure more resilient to the challenges presented by unpredictable futures. Using a combination of technology and funding policies, efforts should be made to link elements of Michigan's learning, research, and knowledge resources into a market-responsive seamless web, centered on the needs and welfare of its citizens and the prosperity and quality of life in the state rather than the ambitions of institutions and political leaders.

The state needs to give more strategic consideration to the diversity among its public colleges and universities, e.g., how many world-class public research universities it can afford, whether regional universities should become more focused on pre-professional education, and better linkages between independent colleges and public universities that exploit the unique characteristics of each. It is important to encourage a highly diverse educational enterprise, recognizing that a diverse population with diverse needs will require diverse institutions. It would be folly to force all institutions to some lowest common denominator of quality and capacity.

Of particular importance is achieving a better balance between public and private higher education, a balance that is more capable of riding out the inevitable ebb and flow of public and private support. While Michigan has a strong group of independent colleges, the absence of a major private research university leaves it more vulnerable to fluctuations in the state's economy than other states. Perhaps the state should explore a different funding process for institutions such as the University of Michigan-Ann Arbor, which has seen its state appropriation drop below 10% of its operating budget. For example, the state might redefine UMAA as "state-related" or as a public corporation or public authority

(similar to public entities such as hospital systems or transportation authorities), providing state funding for specific purposes on a performance contracting basis, e.g., to support a certain number of Michigan resident students in given fields at a fixed tuition level or research projects in areas of key importance to the state, and then allow the institution to determine other characteristics that best optimize its public purpose and market competitiveness (Newman, 2004).

3. Serious consideration should be given to reconfiguring Michigan's educational enterprise by exploring new paradigms based on the best practices of other regions and nations. For example, the current segmentation of learning (e.g., primary, secondary, collegiate, graduate-professional, workplace) is increasingly irrelevant in a competitive world that requires lifelong learning to keep pace with the exponential growth in new knowledge. More experimentation both in terms of academic programs and institutional types should be encouraged.

Much of the concern about the quality of higher education arises from the general education/transitional years, grades 11-14, when both the emotional and intellectual maturation of students occurs. Michigan should consider new paradigms of post-secondary "general education." An example is a reconfiguration of K-16 education so that secondary school grades 11-12 would be merged with community college and lower-division university programs focused on general education and socialization, much like the gymnasium system in Europe or the Fourth Form in the United Kingdom. This would allow research universities to focus on disciplinary, graduate, professional, and lifelong education, while general education and socialization would be provided by regional or independent colleges.

There is some evidence that the highly supportive, learning-intensive residential experiences offered by independent colleges may be the optimum learning environment for most young students. Liberal arts colleges seem to have the best success at this stage, providing both a nurturing and learning-intensive environment. Yet it is also the case that such colleges simply do not have the resources to provide the advanced learning opportunities of a major research university. Michigan should experiment with the development of a "virtual

Oxbridge," using technology to link independent colleges with its major research universities.

4. *The quality and capacity of Michigan's learning and knowledge infrastructure will be determined by the leadership of its two AAU-class research universities, UMAA and MSU, in discovering new knowledge, developing innovative applications of these discoveries that can be transferred to society, and educating those capable of working at the frontiers of knowledge and the professions. In this sense, UMAA and MSU should be encouraged to evolve more toward a "universitas" character, stressing their roles as sources of advanced knowledge and learning rather than focusing on providing general education (or socialization) at the undergraduate level.*

Michigan is fortunate to have two world-class research universities, UMAA and MSU, both highly regarded as elite members of the Association of American Universities. While these two institutions enroll large numbers of students in high quality undergraduate programs, their unique value to the state arises because of their unusual capacity to conduct cutting-edge research and provide advanced education at the graduate and professional level, along with well-established programs of outreach and public service ranging from medical care to economic development. As the state attempts to expand the number of college graduates, particularly during a period of limited resources, it is absolutely essential that the capability of UMAA and MSU for research and advanced training be protected, since in the end, it will be the new knowledge produced on these campuses, along with the scientists, engineers, and other professionals trained at the advanced level, that will create the new jobs that the graduates from Michigan's other colleges and universities will fill.

5. *While it is natural to confine state policy to state boundaries, in reality such geopolitical boundaries are of no more relevance to public policy than they are to corporate strategies in an ever more integrated and interdependent global society. Hence Michigan's strategies must broaden to include regional, national, and global elements, including the possibility of encouraging the state's two flagship research universities, the University of Michigan and Michigan State University, to join together to form a true world university,*

capable of assisting the state to access global economic and human capital markets.

An array of powerful economic, social, and technological forces is reshaping the very nature of the 21st-century university. The emergence of a global, knowledge driven economy has intensified the need for broad access to advanced education and training (massification). The economic value of the knowledge produced by research universities continues to escalate. The rapid emergence of low-cost yet highly sophisticated technical services in large developing markets (e.g., India, China, Russia) has triggered a serious concern about the nature of university education necessary to sustain the high standard of living of wealthy economies. Yet, even in the face of such trends, the aging populations of many developed nations are depending increasingly on market forces and private funding rather than public policy and tax support to determine the future of their higher education systems.

Of particular interest is the way that such forces have stimulated a number of universities—and university organizations—to consider seriously expanding beyond the bounds of their nation-states to become universities both of the world and in the world, accepting a far broader responsibility to understand and serve both the social needs and marketplace of the global community. Key in such strategies is the rapid evolution in information, communication, and transportation technologies, which are enabling entirely new global learning and knowledge structures.

Again quoting *The Economist*, "the most significant development in higher education is the emergence of a super-league of global universities. This is revolutionary in the sense that these institutions regard the whole world as their stage, but also evolutionary in that they are still wedded to the ideal of a community of scholars who combine teaching with research. The great universities of the 19th century were shaped by nationalism; the great universities of today are being shaped by globalization. These top universities are citizens of an international academic marketplace, with one global academic currency, one global labor force, and increasingly, one global language, English. Von Humboldt's university with its emphasis on research was one of the transformative institutions of the 19th century. The

emerging global university is set to be one of the transformative institutions of the current era. All it needs is to be allowed to flourish." (*The Economist*, 2005)

The State of Michigan is fortunate in having two such global universities, the University of Michigan and Michigan State University. We believe the state should utilize these institutions to build a global presence—not simply to explore global markets for Michigan products and services, but also to attract talent to our state from around the world. Both universities have long histories of international programs of considerable distinction and great impact. Michigan State was an important force in the “green revolution” bringing modern agricultural technology to the world. The University of Michigan has had a long international presence, producing much of the academic leadership for Asia (including Japan and China), along with strong ties to Europe and Latin America. These institutions are well positioned to become major players in the global marketplace, accepting responsibility to address many of the great challenges characterizing our world such as global sustainability, international conflict, and human capital development.

Furthermore, the leadership these institutions have provided in developing and exploiting new technologies such as the Internet, the Michigan Virtual University, and more recently the new generation of middleware represented by the Open CourseWare initiative, the Sakai Project, and Internet2, coupled with the vast resources that will soon be available through the Google library digitization project, raise the possibility of building a “meta” university, international in extent and both accessing and propagating knowledge skills and services in a global marketplace.

6. Michigan’s research universities should explore new models for the transfer of knowledge from the campus into the marketplace, including the utilization of investment capital (perhaps with state match) to stimulate spinoff and startup activities and exploring entirely new approaches such as “open source – open content paradigms” in which the intellectual property created through research and instruction is placed in the public domain as a “knowledge commons,” available without restriction to all, in return for strong public support.

Clearly universities have an important responsibility to transfer the knowledge created on their campuses into broader society to address its needs and priorities. Transferring university-developed knowledge to the private sector fulfills a goal of publicly funded research by bringing the fruits of research to the benefit of society. With this important technology transfer come increasingly close relationships between industry and universities.

The traditional models for such technology transfer involve establishing ownership of intellectual property through copyright or patent and then using licensing or startups, coupled with a strong entrepreneurial spirit and adequate venture capital, to stimulate economic development. This linear approach to technology transfer has several compelling success stories: Silicon Valley, Route 128, and the North Carolina Research Triangle.

The federal government has encouraged such activities with legislation such as the Bayh-Dole Act that permits ownership and licensing of the intellectual property resulting from federally funded research. In the wake of Bayh-Dole, universities have mounted aggressive efforts to capture, patent, and license intellectual property resulting from their scholarly and instructional activities, relying on armies of lawyers to defend this ownership. Yet the primary intent of such government policies has been to promote utilization of new knowledge, not to maximize financial returns for institutions or individuals. There remains considerable uncertainty concerning just how universities should approach the commercialization of the intellectual property associated with campus-based research and instruction.

Ironically, it has been the freedom of universities from market constraints that is precisely what has allowed them in the past to nurture the kind of open-ended basic research that led to some of the most important (and least expected) scientific discoveries. Beyond the traditional triad of teaching, research, and service (or in more contemporary language, learning, discovery, and engagement), it is useful to consider the products of the university as educated people, content, and knowledge services. Yet content, that is intellectual property, cannot be bottled and marketed like other commercial products. It exists in the minds of people, the faculty, staff, and students of the university. As such, it can simply walk out the door.

While disclosure, patenting, and licensing intellectual property may be appropriate for some areas such as the product-orientation of biomedical research, it may not be an effective mechanism for very rapidly evolving areas such as information technology or instructional content. Today the increasing pace and changing character of knowledge generation (e.g., in digital forms), coupled with the hypercompetitive environment of a global, knowledge-driven economy, suggest that Michigan should not rely entirely on catching up with other regions through conventional mechanisms, but in addition explore entirely new models of technology transfer.

So what other models might universities consider for technology transfer? One of the more interesting is provided by the “open source movement” in software development. In this model, a user community develops and shares publicly available intellectual property (e.g., software source code), cooperating in its development and improvement and benefiting jointly from its use. Perhaps the leading example is the development of the Linux operating system, now evolving as a major competitor to proprietary systems such as Microsoft Windows and Unix. This “gift economy” represents an emergent phenomenon free from a community working together with no immediate form of recompense except for social capital intertwined with intellectual capital.

Suppose public universities could be persuaded that in return for strong public support, they would regard intellectual property developed on the campus through research and intellectual property as in the public domain. They could encourage their faculty to work closely with commercial interests to enable these knowledge resources to serve society, without direct control or financial benefit to the university, perhaps by setting up a “knowledge commons” environment adjacent to the campus (either geographically or virtually) where technology transfer was the primary objective. This might be just as effective a system for transferring technology as the current Bayh-Dole environment for many areas of research and instruction. Furthermore, such an unconstrained distribution of the knowledge produced on campuses into the public domain seems more closely aligned with the century-old spirit of the land-grant university movement. In fact a recent issue of *The Economist* mused that “some zealots even argue

that the open-source approach represents a new, post-capitalist model of production.”

7. Michigan should explore bold models aimed at producing the human capital necessary to compete economically with other regions (states, nations) and provide its citizens with prosperity and security. Lifelong learning will not only become a compelling need of citizens (who are only one paycheck away from the unemployment line in a knowledge-driven economy), but also a major responsibility of the state and its educational resources. One such model might be to develop a 21st-century analog to the G.I. Bill of the post WWII era that would provide—indeed, guarantee—all Michigan citizens with access to abundant, high-quality, diverse learning opportunities throughout their lives, and adapts to their ever-changing needs.

Of course, major undertakings in anticipation of opportunities are always difficult, but the United States has a history of rising to such occasions. At least twice before in times of great challenge and opportunity, the federal government responded creatively with novel programs that not only served the needs of society, but also reshaped institutions. In the 19th century the Land-Grant Acts not only modernized American agriculture and spearheaded America’s response to the industrial revolution, but also led to the creation of the great public universities that have transformed American society. Following World War II, the G.I. Bill and the government-university research partnership were instrumental in establishing the nation’s economic and military leadership and creating the American research university, which has sustained U.S. leadership in the production of new knowledge and the creation of human capital.

The current challenges to Michigan’s prosperity and social well-being call for a bold initiative of similar magnitude. It is not enough to simply build upon the status quo, for example by doubling the number of post-secondary degree recipients or guaranteeing at a minimum a community college education for all. Instead, we suggest that Michigan consider a bolder vision that would provide all Michigan citizens with pervasive opportunities for education, throughout their lives, which address both their needs and aspirations while reflecting the imperatives of a rapidly changing

world. While such a commitment would challenge existing public policies and politics, only an effort to build a true society of learning for the 21st century can recapture the economic and social leadership that Michigan possessed in earlier times.

The key would be to develop portable benefits and opportunities for lifelong learning, consistent with the need to make workers mobile and adaptable during an era in which career-long employment with a particular company or even in a particular career becomes increasingly unlikely. Given that reality, argues Robert Lawrence at Harvard, it becomes increasingly important for society, to the extent possible, to make benefits and education, the two key ingredients of employability, as flexible as possible. Just as creating legal and institutional frameworks for the universal portability of pensions and health care was the key to Social Security and Medicare, a similar goal might be posed for 21st-century lifelong learning, e.g., establishing a 401(k) tax-deferred savings program for further education (Friedman, 2005).

To this end, a first step would be for Michigan to top off the federal Pell and Hope scholarship aid with state-funded scholarships so that any student in a family earning less than \$100,000 (or perhaps under top 10% in income) will have access to the first two years of higher education free, at the level of cost of the lowest public university (with no discrimination whether student/family chooses public or private school), with any amount not used by the student made available to help pay for the last two years. Given the very large returns to individual/family (as well as state and nation from each year of higher education) this would at least provide one way to assure full access for two years without regard to income and then require students/families to bear more of the cost for reaping benefits for going on with higher education. If this were funded by a separate stream of dedicated funding (along with match for higher education research, whatever base funding from state to publics, and letting tuition and in-state/out-state numbers float at the discretion of each institution), it would send the signal that the state's money was invested in higher education opportunities while providing appropriate autonomy to each institution. (Dimond, 2005).

Peter Drucker has suggested an alternate approach

to financing a college education: "The basic problem of American higher education is that traditionally it has been priced no differently from the way food, soap, or shoes are priced. Customers pay in full when they take delivery of the merchandise. But a college education is not a consumer good that will be used up and gone within a short time. It is a long-term investment in the lifetime earning power of the graduate" (Drucker, 1991).

To the degree that a college education is in reality a long-term investment in the future, perhaps we should look at it as we would other major investments we make in our life. For example, we borrow money to buy an automobile and a house, and we pay off these loans over long periods of time, even as we enjoy the purchase. A college education seems to fit this model, since not only does it improve one's quality of life, but it enhances one's earning capacity, thereby enabling the borrower to better pay off the loan.

Drucker proposes shifting the payment for a college education from the "front end," when most students have no money and next to no earning power, to a later period when their incomes are sizable and rapidly rising (Drucker, 1991). In particular, those students choosing to pay later rather than at the time of enrollment would agree to have the installments paid through payroll deduction. They also would be required to take out twenty-year term life insurance for the amount of the outstanding liability; premiums for such insurance at the age of young college students are minimal.

With these steps, the repayment claim for the investment made by the college in the future earning power of the student becomes a marketable security, bearing little risk and a fair rate of return. The former student, now a wage earner, could carry the annual payment. The graduate's family would have little or no financial burden at all. The college could be certain of being paid, and it could charge what it needs to build faculty and curriculum and still not price itself out of the market.

To carry this one step further, perhaps as a society we should look upon a college education as we do our Social Security system. We could restructure federal student loan programs to facilitate payment through payroll deduction, just as we do today for Social Security programs. An alternative would be to use payroll tax mechanisms, using the Internal Revenue Service as the

collection agency. The basic idea is to shift the burden for the support of higher education from the previous generation to the generation of students that benefit most directly, but at a time in their lives when they can afford these costs.

In a sense, the Higher Education Act of 1992 did just this with the Ford Direct Lending Program. This program allows students to receive their education loan funds directly from the federal government via their colleges and universities, thereby eliminating much of the cost and bureaucracy of the commercial loan industry. But equally significant is the fact that the direct lending program provides an opportunity to base repayment rates on future income and repayments collected through income tax withholding, thereby reducing much of the risk associated with financing a college education. Like the national service initiative launched by the Clinton administration in 1996, income-contingent loan repayment is designed to ease the debt burden on college graduates, perhaps encouraging them to seek employment in fields of urgent national need such as teaching, public health, and community development.

Of course such approaches require a major change in public attitudes toward the value of a college education. The direct lending program, although supported by students and parents, was strongly opposed by the banking industry. Yet in the end it has survived, in part because of the recognition that the increasing value of a college education, both to an individual and society more broadly, requires the exploration of new financing mechanisms.

In summary, as both a nation and a state, we should reaffirm that higher education represents one of the most important investments a society can make in its future, since it is an investment in our people. We are fortunate today to have one of the finest systems of higher education in the world, but we also remember this has resulted from the willingness of past generations to look beyond the needs and desires of the present and to invest in the future by building and sustaining educational institutions of exceptional quality—institutions that have provided many of us with unsurpassed educational opportunities.

We have inherited these institutions because of the commitments and sacrifices of previous generations.

Today it is our obligation as responsible stewards—and as responsible parents—to sustain these institutions to serve our children and our grandchildren. It seems clear that if we are to honor this responsibility to future generations, we must reestablish the priority of both our personal and our public investments in education, in the future of our children, and in the future of our state.

Clearly it is in Michigan's interest to provide educational opportunity to all with the desire and the ability to learn. If we are to achieve this object, we must halt the erosion in public support of higher education and once again reaffirm the commitment from one generation to the next that has characterized our state.

One Final Recommendation: A Call for Leadership

8. Michigan should develop a leadership coalition—involving leaders from state government, industry, labor, education, and concerned citizens—with vision and courage sufficient to challenge and break the stranglehold of the past on Michigan's future!

This is such an obvious need that no further comment is necessary...

Chapter 7

A Broader Agenda

A roadmap is just that: a set of possible directions to the future. But leaders in both the public and private sector require a more definitive operational plan that addresses key questions such as: What are the first steps to be taken? What policy actions are necessary? Are there follow-on studies that need to be commissioned? Furthermore, while our effort has focused on developing a roadmap for building a regional knowledge economy in Michigan, it is clear that our vision and our recommendations are highly dependent upon issues in other areas, e.g., federal policy, market forces, and the global economy. Finally, we acknowledge that this roadmapping study has been stated in straightforward—sometimes even blunt—terms. To survive in the political environment of state (and federal) policy, it must be re clothed in more Machiavellian garb.

The initial goal of this roadmapping effort is to shift the public conversation away from distracting issues such as Balkanized state politics, culture wars, and bitterly partisan battles to focus instead on the imperatives of a knowledge economy: lifelong learning, research and innovation, and knowledge-age infrastructure. Our message is deceptively clear:

1. Knowledge and innovation are the drivers of the global economy today and tomorrow.
2. The key inputs to knowledge and innovation are: lifelong learning (human capital), new knowledge creation (R&D, innovation), and the infrastructure that supports these two (schools, colleges, research centers, cyberinfrastructure).
3. Public policy and public investment at the state level are critical in developing each of these three capacities. The states and regions that understand this imperative and do it best will be best positioned to succeed in the future. Those that fail will become economic backwaters.

Since public commitments and government action are the longer-term key, it is important to lay out a possible agenda for state leaders, the more specific the better. It is important that state policy makers begin to consider new financing and governance issues within the context of future state needs and priorities rather than past political party ideologies.

Most important, state government has to begin by getting its fundamental responsibilities aligned with the needs of a knowledge economy:

1. Empowering families, students, workers with the responsibility and the resources to choose lifelong learning opportunities that they determine will be best for themselves, including early childhood, K-12, postsecondary, and continuing education.
2. Providing the infrastructure and the investments necessary to attract federal and private research funding and stimulate innovation and entrepreneurial activities.
3. Developing a tax structure that generates revenues adequate to fund both current obligations and the necessary investments in the future with the lowest tax rates and broadest base and mix of taxable activities.

In this chapter we first explore some of these related areas. We begin with several of the policy areas that are key to the effectiveness of the roadmapping effort.



Related Policy Issues

State Government

Clearly many of the policy issues reflected in the roadmap are closely related to important challenges in Lansing itself—a state government unwilling to provide adequate leadership or investment in the future, overly constraining institutional actions necessary to cope with an increasingly competitive marketplace, and apparently characterized by an almost total lack of understanding of the realities and role of education and innovation in a knowledge society—with most of the state’s private sector leadership and media sitting on the sidelines, largely silent if not clueless concerning the key challenges facing Michigan.

Related to these issues is the increasing irrelevance of Michigan’s political parties to the realities of our present and the challenges for the future. Both political parties are largely trapped in the past, driven by the desire to protect old sacred cows (e.g., big business, big labor, big government, and wealthy campaign contributors) or by “value-morality” ideologies (abortion, gay rights, creationism) that are distracting public leaders and public attention from what really matters in a 21st-century global economy. As citizens, we simply must demand that our public leaders stop backing into the future, clinging to the practices and expectations of an obsolete past, and instead face up to the actions, commitments, and sacrifices that will be necessary to rebuild Michigan’s strength and prosperity in a radically different future.

A recent statement from the Michigan League of Women Voters states our current dilemma well: “Government is becoming increasingly irrelevant as it shrinks due to reductions in tax rates and revenues. Essential services are being cut and citizens are losing hope in the prospect that government will protect and support opportunities for people to improve their lives. This trend erodes citizens access to government more than any development we have observed since we began this series of reports.” (Milliken, 2005).

Little wonder then that a coalition of concerned citizens has recently launched an initiative aimed at forcing the Michigan State Legislature to consider legislation that would lock in to the state budget annual funding increases for K-16 public schools, colleges, and universities at the inflation rate. The K-16 Coalition for Michigan’s Future (K-16 Coalition for Michigan’s Future, 2005) has notified the Legislature that if they fail to pass this initiative, they are prepared to bypass them and go directly to the voters on the 2006 ballot. In view of the unwillingness of state government to adequately fund public higher education in the state in recent years, such a voter-driven initiative may be the only way to break the political logjam and begin to re-invest in the state’s future, even if it would force the state to adopt tax increases to adequately fund education.

State Budgets and Tax Policy

Equally serious is the need to restructure an obsolete tax system, designed for a 1950s factory-based manufacturing economy rather than a 21st-century knowledge

economy, and restore both integrity and responsibility to the state budget process. To be sure, a weak economy coupled with the burden of unfunded federal mandates has destabilized the state budget process. Of particular concern is the rapidly growing burden of Medicaid, a consequence largely of the federal government's inability to come to grips with a growing uninsured population and the urgent need for universal health care in our nation. As recent studies have suggested, the economic burdens of the unfunded Medicaid mandates passed onto the states by the federal government have now surpassed the entire public education budget (both K-12 and higher education) in the majority of the states. (Kane, 2003).

But much of the damage to Michigan's budget was self-inflicted. As PCSUM president Michael Boulos notes, "Contrary to popular belief, the cuts in state spending of the last five years are not really the result of our state's economic decline. They are primarily the results of decisions to cut taxes and cut investments in Michigan's intellectual, social, and physical infrastructure—and our future" (Boulos, 2005).

During the 1980s, Michigan launched a massive prison construction program, in response both to ill-considered sentencing guidelines and pandering to public concern about crime. In the early 1980s, Michigan had 15 public universities and 8 prisons; today we still have 15 public universities, but now 35 prisons. In fact today the average cost per inmate is roughly five times that of the state appropriation per student in Michigan's public universities. As a result, state spending on prisons surpassed that for higher education in the early 1990s and today sits as yet another effective mandate for state tax dollars. Similarly, Michigan's school finance reform effort of the 1990s created K-12 education as yet another funding mandate, which along with Medicaid and prisons, leaves little for higher education, which is still treated as a discretionary budget item. As a consequence, over the last several years, no state activity has been cut as much as the funding for public higher education.

The structural deficiencies in the state budget were compounded during the 1990s, when during a period of relative prosperity that should have provided state government with the opportunity to restructure its antiquated tax system and begin to invest in its future by

restoring funding for key priorities such as higher education and infrastructure, Michigan instead decided to cut its tax rate. This has created a permanent budget deficit that is likely to worsen each year as Michigan's foundering economy continues to weaken, while an aging population and a growing population of uninsured, coupled with the rapid increases in health care costs, drive Medicaid burdens into the stratosphere.

Today Michigan is spending a smaller percentage of its total personal income on government than it has at any time in the last decade. Again to quote Boulos, "Some of our political leaders say tax cuts are needed to make the state more competitive, because they contend that Michigan is a high tax state. That is just not true. Michigan's 2005 total state and local tax burden is 10.2%, ranking it 21st in the nation, in the middle of the pack." While it is true that some states like Mississippi, Alabama, and Arkansas have lower taxes, economic powerhouses like California, New York, and Massachusetts have higher taxes. Put another way, Michigan has consciously chosen to cut taxes, cut government, cut support of education, and cut its investment in the future. (Boulos, 2005)

Michigan finds itself simply unable to meet both its obligations for the present (e.g., Medicaid, corrections, K-12 education) while investing adequately in its future (e.g., higher education, research and innovation, knowledge infrastructure). A term-limited state government, increasingly manipulated by special interests and subject to the narrow agendas of political parties, has been unable to restructure an obsolete tax system, designed for a factory-based industrial economy that is no longer dominant in our state. Even today most of Michigan's economic activity involves knowledge-intensive services—e.g., financial services, health services, and professional services such as law and management, generating revenue that is not included in Michigan's tax base. All too frequently both state and local governments tend to use tax abatements to bail out or attract traditional industries rather than investing in the creations of the new knowledge-driven business capable of competing in tomorrow's global economy.

From a more cynical viewpoint, there is absolutely no evidence whatsoever that cutting state taxes has a positive economic impact—although to be sure in the current anti-tax climate, it may generate votes. What is

certain however, is that cutting investments in education, innovation, and knowledge infrastructure is crippling in a knowledge economy. As Bill Gates stresses, “The IT and biotech industries are far more sensitive to quality of talent than incentives. California is No. 1 not because they have the most friendly tax policies there. If you’re coming up with a breakthrough in medicine, it doesn’t matter if you’re paying a little more in taxes.” (Gates, 2005).

While any discussion of the “t” word is usually banned in Lansing, it has become increasingly clear that without a major restructuring of state tax policy, Michigan will simply be unable to balance the obligations created by mandates for state funding with the necessary investments in its future. Future generations will bear the burden of our indecision and myopia.

Politics As Usual?

In a speech remarkable for its wisdom and its courage, former Governor William Milliken challenged a gathering of political, civic, and cultural leaders at the 2005 meeting of the Detroit Regional Chamber on Mackinac Island about the “anger, bitterness, and noise that were leaving Michigan in the dust”. Milliken deplored the divisive politics that increasingly have dominated both state and federal government, swamping efforts to develop good public policy. As he observed, “We have seen a growth of meanness, of bitterness, and of excessive partisanship that can only work to the detriment of the region, the state, and the nation. The focus has turned to winning elections rather than to developing responsible public policy. Too often the focus on winning boils down to just raising the most money and appealing to the worst instead of the best in people.” (Milliken, 2005).

Governor Milliken gave numerous examples of partisan politics digging Michigan into even a deeper hole: the 1980s overexpansion of the state’s prison system driving an explosion in the costs of corrections (\$1.9 billion), the ill-considered tax cuts of the 1990s that have permanently unbalanced the state budget, the devastating cuts in appropriations to public universities (20% to 40%), and the inability to develop a vision and implement a strategy to invest in Michigan’s future. In fact, the current political gridlock in Lansing has become so

entrenched that many public leaders have simply given up, assuming that serious tax reform or achieving a better balance between current obligations (e.g., prisons) and investments (e.g., higher education) was out of the question.

As Governor Milliken observed, “We have developed a culture in our society in which some politicians pand endlessly and shamelessly to cut taxes. Then, when we run into a budget crunch, we start cutting the absolutely vital and essential services this state needs to compete effectively in the 21st-century world. We think it would be political suicide to suggest the need for additional resources to preserve the level of excellence that we have known in the past and that we must have in the future. Too many people in public life are so obsessed with being re-elected that they are paralyzed in addressing urgent issues.”

He concluded by noting further that “When an election is over, it is over. There is nothing in the U.S. or state constitutions that call upon elected officials to be total partisans. Instead, those documents implore us to recognize that if we hold public office, we should be about the people’s business, and not personal partisan agendas.

This is strong medicine. However it is badly needed to remedy the partisan gridlock that is crippling our state.

K-12 Education

Clearly the quality and performance of K-12 education is a very critical issue for our state. As the resource map of Michigan’s educational capacity makes painfully apparent (Chapter 3), our state’s educational achievement at this level is seriously inadequate and must be improved dramatically if Michigan is to build a workforce of world-class caliber. While state initiatives such as charter schools and federal accountability measures (“No Child Left Behind”) will have some impact, these are largely at the margin because of far more significant socio-economic issues such as the deterioration of the family and community environment for learning and the student (and family) motivation for academic achievement. Of comparable importance is the teaching workforce itself. It is here that higher education (and our society) simply must do a better job of attracting

the best and brightest into teaching careers and providing them with the quality education, attractive pay, and support necessary for these important roles.

Although these are issues that go beyond the range of the Roadmap, we do suggest that there may need to be serious consideration given to a restructuring of both K-12 and early undergraduate education. For example, the United States is unique in ending secondary education at the 12th grade and relying on college to provide both the socialization and intellectual maturation necessary for true college level work, generally packaged in a general education program in the first two years of undergraduate studies. In Europe and Asia, secondary education is extended (e.g., the gymnasium system in Germany or the Fourth Form system of England) to provide the opportunity for socialization and general education studies so that students enter the university already prepared for advanced work in the disciplines. This allows their universities to be “knowledge-centered” rather than “student-development-centered,” an important characteristic that aligns well with the demands of a global, knowledge-driven economy. It also places the university more strategically into the context of a lifelong-learning approach.

Broader Educational Policy Issues:

Who Pays? Who Benefits?

There are an array of broader issues of educational policy that require careful consideration and debate within our state. Among the most important are the classic questions of “Who pays?” and “Who benefits?” For example, as the economic return on a college education continues to rise in the knowledge economy, do we need to consider a different mix of sharing in paying for college between students (and parents), the state, the federal government, and employers (business and industry)? One might well argue that those who benefit most—the student and perhaps even employers—should accept more responsibility for investment in higher education, perhaps aided by effective state or federal loan programs, rather than viewing higher education as a social good primarily supported by tax dollars (which applies, of course, for BOTH public and private universities because of tax policies on charitable giving). Even today two-thirds of all support for higher education in

America comes from private sources (e.g., tuition and charitable giving), creating a strong market influence on colleges and universities.

There is a deeper issue here. The American university has been seen as an important social institution, created by, supported by, and accountable to society at large. The key social principle sustaining the university has been the perception of education as a *public good*--that is, the university was established to benefit all of society. Like other institutions such as parks and police, it was felt that individual choice alone would not sustain an institution serving the broad range of society’s education needs. Hence public policy dictated that the university merited broad support by all of society, rather than just by the individuals benefiting from its particular educational programs, through direct tax subsidy or indirect tax policies (e.g., treatment of charitable giving or endowment earnings).

Yet, today, even as the need of our society for post-secondary education intensifies, we also find an erosion in the perception of education as a public good deserving of strong societal support. State and federal programs have shifted from investment in the higher education enterprise (appropriations to institutions or students) to investment in the marketplace for higher education services (tax benefits to students and parents). Whether a deliberate or involuntary response to the tightening constraints and changing priorities for public funds, the new message is that education has become a private good that should be paid for by the individuals who benefit most directly, the students. Government policies that not only enable but intensify the capacity of universities to capture and market the commercial value of the intellectual products of research and instruction represent additional steps down this slippery slope. Our society seems to have forgotten the broader purposes and benefits of the university as a place where both the young and the experienced could acquire not only knowledge and skills, but the values and discipline of an educated mind, so essential to a democracy; an institution that defends and propagates our cultural and intellectual heritage, even while challenging our norms and beliefs; the source of the leaders of our governments, commerce, and professions; and where new knowledge is created through research and scholarship and applied through social engagement to

serve society.

To survive in this brave new world of constrained state support with quality intact, a situation likely to last for at least a generation, many of the best public universities have decided to move toward high-tuition, high-financial-aid policies in which state support becomes correctly viewed as a tax-supported discount of the price of education that should be more equitably distributed to those with true need. The leading public universities may increasingly resemble private universities in the way they are financed and managed. They will use their reputation, developed and sustained during earlier times of more generous state support, to attract the resources they need from federal and private sources to replace declining state appropriations. Many institutions will embrace a strategy to become increasingly privately financed, even as they strive to retain their public character. Not that those public universities with the political capacity to move to high-tuition high-aid models will suffer, since the marketplace teaches us that high quality is frequently far more competitive than low cost (the Lexus sells better than the Neon!).

It is important here to get the key issues onto the table and into public discourse. How can a state responsibly and effectively maintain high quality colleges and universities, which are distinctive in terms of their mission to provide the needed education, research, and service to Michigan citizens, when an aging population insists on other social priorities (health care, prisons, tax cuts)? How can a state simultaneously sustain these universities' comprehensiveness in terms of student body, programs, and statewide responsibility? What happens when the state becomes a truly minority shareholder in the university, contributing 10% or less of its resources or capital facilities? Do state taxpayers then deserve to own the university and dictate its role, character, and quality? Will such privately supported public universities have the necessary autonomy, integrity, and freedom from political interference and bureaucratic controls? Or will the centrifugal forces of political and educational regionalism, the tempting but destructive urge to involve higher education in partisan politics, prevail, allowing the distinctive role of the public research university to deteriorate, and pulling down as well the quality of all public higher education in the state.

Yet it must also be acknowledged that without some form of accountability to the body politic, the public purpose of the university is also at risk. If as a state or a nation we are to balance the importance of values and public purpose in the face of the market-driven priorities of profit, one needs to get this on the table for public consideration. But this will not happen until public leaders first recognize that they must allow higher education to adapt to the demands of the marketplace (e.g., by acknowledging the inevitability of high-tuition/high-financial-aid models for public research universities), and to recognize further that they have the capacity to influence these markets to value once again the public purpose and social engagement of our institutions. They must strive for a better balance between autonomy and accountability, at least for flagship public research universities, else the marketplace will sweep over them, eroding away their quality and capacity to serve, established long ago during more prosperous—and enlightened—times.

Cultural Challenges

Even if we manage to close the gap between Michigan today and our vision for tomorrow, there remains one very serious threat standing in the way of our continued progress. As the cartoon character, Pogo, once observed: "I have seen the enemy, and he is us!" Along with our strengths, Michigan continues to have some serious weaknesses—some embedded in our history.

1. Deteriorating social foundations: In a period of intense change, all of us, and especially our children, need the security of strong families and communities. Yet these foundations continue to erode and we see the effects in our classrooms and dorms as well as in all the youth who fall by the wayside, their mindpower gone to waste.

2. Divisions: Nothing is more corrosive of our way of life than the growing divisions in our society—by race, ethnicity, class, age, religion, political beliefs, and socioeconomic class. These are taking an increasing toll on our ability to study, work and live together and to take part in productive civil discourse. If we do not address continuing inequality, persistent poverty, mutual

distrust, nothing else we do can possibly succeed. Furthermore, at a time when we are engaged in an historic debate about America's and Michigan's future, our public discussion too often is distorted by noise blame, paranoia, wishful thinking, stridency, unreasoning rage, and even at times pure hate. If we want to make sound and reasoned decisions, we have to lower our voices and restore mutual trust.

3. Populism: We also may be experiencing the same forces of populism that rise from time to time to challenge many other aspects of our society—a widespread distrust of expertise, excellence, and privilege (the Forrest Gump syndrome). Dr. William Hubbard, former CEO of Upjohn, used to point to one of the great character flaws of the Midwest as “our extreme intolerance of extraordinary excellence.” Unfortunately, many universities, faculty, university administrators have made themselves easy targets by their arrogance and elitism.

4. Commitment to excellence: Americans are addicted to a pernicious vice. Especially in hard times. Too often we are suspicious of, even hostile to, excellence and high achievement, particularly intellectual achievement. We settle for the lowest common denominator rather than honoring and supporting achievement. You would think that the one lesson we should have learned during the 1980s—in Michigan of all places—is the importance of quality in everything we do, in everything we buy, sell, and produce. It is this culture of competence—a set of attitudes, expectations, and demands—that is often missing in America today. Ultimately, competence requires that people and institutions be held accountable for their performance. Competition helps improve performance. But too often we spend our time trying to protect ourselves from accountability and competition.

5. Still penny-wise but pound-foolish: We also see these character flaws when it comes to key investments in our people, such as education and worker training. We seem hell-bent on insisting on bargain-basement prices, even if it means bargain-basement quality in the performance of our institutions or products and services. A few years back—at the time of another administration in Lansing, a prominent state official once

proclaimed that quality was a luxury that students had no right to expect from a *public* university. If students and parents wanted quality, they could pay the extra price to go to a private university. Worth noting is the guy who said this had gone to Harvard, suggesting that this was his version of “let them eat cake.” This is a long way from the Jeffersonian ideals of our founders, who believed that only the best was good enough for their children, whatever their background or social status, so long as they had the ability and will to achieve. We can no longer afford the luxury of mediocrity in anything we do. Our competitors in the flat world will cut us no slack! Isn't it time, as the Ford ad used to say, we make quality “job number one” in other critical aspects of life such as in educating our children?

6. An entitlement culture: We also need to take a harder look at state spending policy more generally, to ask the important question: What is the role of state government and how should resources be allocated? For decades Michigan was fabulously wealthy. We developed a culture of expensive practices, entitlements, and expectations: employee benefits, health care, social services, litigation. Yet today, as Michigan's economy attempts to adjust to the brave, new world of a knowledge-driven society, it still attempts to support a Cadillac appetite on a Ford income. We are still not investing our resources strategically. We are tending to deploy them to pay for past sins (corrections, social services, entitlements), to sustain and perpetuate the past (tax abatements), or to sustain our personal desires (through the tax cuts that have decimated state budgets and services) rather than investing in the future by creating new skills, new knowledge, and new jobs. This is a burdensome habit for which we can blame no one but ourselves. We are consuming today the resources that will be needed for tomorrow. Too few are willing to make the sacrifices necessary to secure the future in the way that our ancestors made to provide us with opportunity, prosperity, and security.

7. The “Not on My Watch” syndrome:

It is alarming how few of Michigan's leaders in the public or private sectors are willing to step forward to address the looming challenges or take the actions

necessary to secure our state's future. "Defer, delay, procrastinate." Those are the watchwords of today. No need to deal with tax reform now. Let the next Legislature deal with it. Gas prices zooming to \$3 and up? Let's introduce a few more big SUV and truck models since surely there are a few folks out there who don't mind paying a big fraction of their paycheck at the pump. The next team of executive officers at GM (or Ford or Chrysler) can handle the challenge of restructuring our company to build fuel-efficient cars. Besides, by the time that federal fuel efficiency requirements or the marketplace demands 50 mpg cars—or the inability of tax revenue to adequately fund both obligations and investments forces Michigan still further down an economic spiral toward Mississippi—we'll be long-gone, retired and playing golf in Florida. It will be someone else's problem. (Unless, of course, Florida is under water by then...)

Some Lessons from the Past

Our state and nation have called upon some generations more than others for exceptional service and sacrifice, to defend and preserve our way of life for future generations, from taming Frontier America and the Revolutionary War to the Civil War, securing through suffrage the voting rights of all of our citizens, World Wars I and II, and the Civil Rights Movements. Americans have always answered the call. Now no less than in those earlier struggles, our generation must rise to the challenge to serve. To understand better what we must do, it is interesting to remind ourselves of Michigan's past, perhaps best articulated by passages from Bruce Catton's *Centennial History of Michigan* (Catton, 1962):

"Michigan as a state grew up in the belief that abundance is forever. Michigan's abundance of furs brought the early trappers and traders. An abundance of forests drew lumberjacks who reduced the pines to stumps and sawdust. The state held an abundance of iron ore and copper and developed new means to move men and goods at an ever-faster pace, until it too ran out, and the mines closed. Then cheap labor and mass production led to the birth of a new industry, automobiles, that dominated the state for over a century, until it also encountered other

parts of the world that were just as inventive, and had even cheaper (and higher quality) labor.

The idea that abundance was "inexhaustible"—that fatal Michigan word—dominated thinking about the state from its earliest days. Unrestrained exploitation of natural resources, from beavers to pine trees to iron and copper ore, led eventually to unrestrained exploitation of human beings. A belief in unlimited resources simply creates a set of unlimited desires. This is the incalculable, explosive fact that lies just below the surface in American life.

In Michigan, perhaps more clearly than in other states, can be seen the enormous increase in the speed of society's movement, the pressures that come when a society adjusted to one era is suddenly compelled to shape itself to an entirely new one, the torment of modern man torn by the astounding discovery that the things he makes have taken charge of his life. Without intending anything of the kind, man discovers that he is involved in an enormous revolution, simply because the power in his hands is so vast that its mere existence turns the world upside down.

Fully characteristic of a society whose desires became ever more insistent as the possibility of satisfying them increased was a demand for more speed and flexibility of movement. Michigan was above all other things a prodigal society; inevitably so, in view of the base on which it was built. The bounty was going to last forever, and if you threw something away, you could always replace it with something better.

Nothing was planned; people just took a chance. Here was the state that gave away great forests and iron ranges, with the carefree liberality of a sailor on shore leave, in order to get railroads built, with the abiding that everything would be justified in a great tomorrow. The problem is characteristic. The whole organization of society is keyed to a means of transportation that must, some day, run out of gas.

A society whose lusty tradition of individualism and firm belief in the equality of all men were both based on that frontier ability is likely to flounder when conditions change. A society that is based on a firm conviction that there is a blessed abundance of good things and that the supply will never fail is under the most profound pressure to justify its faith by good works. If it fails to do this, it will explode. For the modern world is one in which all stakes are raised to infinity; win it all or lose it all, in this

or the next generation."

A Final Challenge

To be sure, it is difficult to address issues such as developing a tax system for a 21st-century economy, building world-class schools and colleges, or making the necessary investments for future generations in the face of the determination of the body politic to cling tenaciously to past beliefs and practices. Yet this is what leadership is all about. It is time for state government and leaders in the public and private sector to admit to themselves and explain to the public that without a restoration of an adequate tax base, Michigan is well on its way to becoming Mississippi, a backwater filled with the rusting hulls of a obsolete manufacturing economy while other states and nations make the investments to move into the knowledge economy. After all, taxes are the price we all must pay for a civil society. To be sure, this might infuriate some—particularly among the affluent who benefit most from this “cut my taxes now; I’ll worry about my kids later” mentality, and who will eventually pack off and retire in Florida, taking their tax-cut windfalls with them. It might also lose some votes. But what is the purpose of leadership if all one does is leave behind a legacy of poverty and hopelessness?

Unlike most states, Michigan has no alliance of business, labor, higher education, and public leaders to push for the future of the state. Instead, narrowly focused special-interest groups have captured control of the political parties and public policy process (e.g., labor-left, religious-right, neo-cons). They are running the train off the track, blocking any effective efforts of strategic action. Only the narrowest of political initiatives is able to get any traction (e.g., bans on gay marriages or affirmative action).

It is time that someone sounded the alarm: Michigan is falling apart! It is rapidly losing its ability to compete in the economy of the future. We have only a short time to make the moves that will allow us to stay competitive!

To face the opportunities, challenges, and responsibilities of an increasingly uncertain future, Michigan needs to rekindle the spirit of adventure, creativity, innovation, and boundless hope in the future that has

characterized its history. During its early years, its frontier spirit was sustained by a sense of optimism and excitement about the future and a relish for change. Today this same spirit seems most appropriate for Michigan’s future.

Chapter 8

Epilogue

Michigan is not alone in facing the challenge of disruptive economic and technological change. From Pennsylvania to Minnesota, Cleveland to Detroit to Chicago, the questions are the same: In an increasingly knowledge-driven global economy, what will replace factory-based manufacturing as the economic engine of the midwestern states? While these states benefited greatly in the past from being the manufacturing center of the world during the 20th century, today's global phenomena such as outsourcing and off-shoring have destroyed the viability of low-skill, high-wage manufacturing jobs—and even many high-skill service activities—as a source of prosperity and social well-being, at least in developed nations such as the United States.

In today's economy, any metropolitan region in the world can be a locus for knowledge work. In a wired, interdependent global village that allows people to choose where to live and work and where to make goods and services, metropolitan regions are now engaged in a pitched battle to identify and nurture their unique economic advantages. An emerging and less understood reality is that macro-economic regions are increasingly the locus of economic might, exemplified by the world's strongest economic regions: North Central Europe, the West Coast, and the Northeast Corridor in the U.S. As Michel Rivoire, a biotech executive, notes, "Today it takes 20 million people to make a good fight in the world" (Austin, 2005).

The Great Lakes region—the "necklace" of states and metropolitan areas that rim the lakes' shores and anchors the Midwest—was once the economic engine of our nation and the world. Today, as a recent Brookings Institution study put it, "this economic giant stands with one foot planted in a waning industrial era, another foot striding the emerging global knowledge economy." One can make a case for a Great Lakes regional identity and actions by member states and potentially



The Great Lakes Region
(Scott Swanm, CSCAR, 2003)

the region.

Common demographic, economic, and development trends affecting these states, the competitive fiscal and social consequences of these trends; the real and potential assets of the region; all provide a unique regional identity. The region faces the challenge of building on its current assets as a center of corporate leadership, an immigrant gateway to the nation, and perhaps the finest collection of research universities in the world, to achieve prosperity and economic leadership once again (Austin, 2005).

So what are the assets of these states as they look to the future? Probably not natural resources, although the fresh water resources of the Great Lakes might temporarily be an asset in areas such as tourism. Unfortunately, human capital is also not currently an asset, both because of aging (and perhaps declining) populations and the relatively low priority given to education by a manufacturing economy. The current infrastructure of these states—both physical such as highways and industrial facilities and policies such as tax structure and public priorities—evolved to serve a manufacturing rather than a knowledge economy. Today this infrastructure

represents more of a liability than an asset.

Yet there is one very unusual—indeed, unique—asset possessed by this region: the strongest concentration of flagship research universities in the world, as represented by the Big Ten, or more correctly, the C.I.C. (Committee on Institutional Cooperation) group, which consists of the Big Ten universities plus the University of Chicago. These twelve universities conduct more research, produce more scientists and engineers, doctors and lawyers, business executives and teachers, than any collection of universities in the world, including the University of California, the Ivy League, Oxford and Cambridge, and the other leading universities in Europe and Asia. Moreover, there is a long-standing tradition of cooperation among these institutions (in addition to their highly visible competition through the Big Ten Athletic Conference). They work together on both regional and national agendas, merging library and research resources, and sharing curricula and instructional resources with faculty and students. Because of their land-grant traditions, they also have a long history of public service and extension, not only within their states but throughout the world.

Hence it seems natural to suggest that this roadmapping exercise might be extended beyond a single state (Michigan) to encompass a region facing similar challenges and characterized by similar educational assets. In fact, one might liken such an effort to that undertaken by California in the 1950s, when the challenge and opportunities afforded by a changing economy and population stimulated the development of the California Master Plan, a bold vision, which created a system of universal post-secondary education, with the University of California campuses at the helm, augmented by the California State University System and the California Community College System that together provided a very unusual combination of world-class quality with broad access. Today most agree that the California Master Plan played a very critical role in providing the state with exceptional regional advantage, creating the strongest regional economy in the world.

Through generations of strong support and stewardship, today the Great Lakes states have a collection of flagship research universities not only comparable but superior in many characteristics—quality, capacity, breadth, global presence—to those of the California



Research Universities in the Great Lakes States
(Scott Swanm, CSCAR, 2003)

institutions. Hence it is natural to question whether a similar planning effort could be launched to weave these formidable assets into a strategy to build regional advantage. To be sure, working across state boundaries and politics poses certain challenges, although California faced similar challenges (North vs. South, urban vs. agricultural interests). In fact, one might well consider extending this regional study to international scope by adding Ontario, a province with very similar economic and demographic characteristics, with a world-class flagship public research institution in the University of Toronto.

The possibilities of such a regional planning activity aimed at building regional advantage in a global, knowledge-driven economy through a consortium of world-class flagship public research universities are intriguing:

1. As the flagship universities of their states, these institutions already set the pace for broader educational activities, both at the post-secondary and K-12 levels.
2. Each of these universities has built world-class excellence in unique areas (e.g., Illinois in computer technology, Minnesota in chemistry and chemical technology, Ohio State in materials science and technology, Michigan State and Penn State in agricultural technology, Wisconsin and Michigan in engineering, the natural and social sciences, and biomedical science, Northwestern in medicine and business administration,

and Chicago in the sciences). Aggregating these “spires of excellence” by linking these institutions would give the region the world’s leading programs in a broad range of key knowledge areas.

3. There is already a strong tradition of cooperation among these institutions (through the Big Ten and C.I.C.) across a broad array of activities, ranging from academic to international to political (and, of course, athletic).
4. These institutions are characterized by a long tradition of global outreach and international development that might enable them to coalesce into a true “world university,” reaching into all parts of the globe to open up new markets and access world-class human capital.
5. The rapid evolution of digital technologies provides powerful new paradigms to integrate together the programs and activities of these institutions. These institutions have long played important leadership roles in developing these technologies (e.g., supercomputing, the Internet and successors such as Internet2, tools such as browsers). Today entirely new technology paradigms such as the complete digitization of library collections and faculty research and instructional activities (e.g., the Google-Michigan project) hold out the potential of the ages-long dream of universal access to knowledge.
6. These institutions also face very similar challenges today as their states’ budgets struggle to cope with staggering costs for health care, corrections, security, and infrastructure in the face of political forces demanding tax relief. In effect, all of these institutions have already managed to become predominantly privately supported public institutions and developed the flexibility and entrepreneurial skills to compete in an increasingly aggressive marketplace, with their quality and capacity essentially intact.

Hence, as the next stage in the roadmapping activity, we propose broadening the analysis to a regional area comprised of the “Big Ten” states (and perhaps including Ontario) to develop a plan to transform what was once the manufacturing center of the world economy

into what could become its knowledge center. Put another way, while this region provided the muscle for the manufacturing economy that powered the 20th century, we believe it has the capacity to become the brain of the 21st-century knowledge economy.

Appendix A

A Comparison: The Lt. Governor's Commission on Higher Education and Economic Growth

(Contributed by Laurel Park, Center for the Study of Higher and Post-Secondary Education, University of Michigan)

The Cherry Commission was convened through an executive order by Michigan Governor Jennifer Granholm in 2003. The Commission was charged with the task of identifying strategies aimed at doubling the number of Michigan residents with degrees, or other “credentials of value,” within the next decade. As such, the Commission functioned in a highly political environment. While Commission and workgroup members were drawn from a variety of organizations (educational, political, social, non-profit, technical, service), workgroup discussions and consideration of strategies were ultimately driven by the “degree/credential of value” agenda.

The report of the Cherry Commission differs from the Technology Roadmap in several key respects. These differences are by no means absolute but they represent the philosophical and conceptual frameworks that guided the development of each:

Context: As noted above, the Cherry Commission was a political entity created to implement a political agenda. In contrast, the Michigan Roadmap was developed through the support of an independent non-profit foundation, thus allowing more freedom for creative and innovative thinking.

Environment: The Cherry Report is constrained to a great extent by both the political environment in which it was created and the social and economic

environments in which its audience reside. As an independent exercise conducted primarily within academe, the Roadmap is free from those constraints.

Goals: The Cherry Report is primarily output-oriented: degrees or credentials of value. In contrast, the Michigan Roadmap is both process- and outcome-oriented: develop a “knowledge society,” enabling Michigan’s transformation to a knowledge economy. While it could be argued that some aspects of the Michigan Roadmap are also output-oriented, this planning effort focuses more on broad, long-term strategies capable of adaptation and evolution rather than policies targeted to a specific end. This distinction is further reinforced by the Cherry Report’s emphasis on “credits” (representing knowledge) versus the Michigan Roadmap’s emphasis on “competencies” (representing learning and innovation).

Perspective: The Cherry Commission places the responsibility for meeting the state’s future educational needs primarily in the hands of its secondary and post-secondary institutions. While the role of the state and society are acknowledged, the majority of the Commission’s recommendations require action or innovation on the part of high schools, colleges and universities. While the Michigan Roadmap clearly identifies the role of educational institutions in creating a populace that is prepared for a global, knowledge-driven economy (particularly the flagship research universities), it takes a broader

view of education and places it within a social/societal perspective.

Focus: Technology. While the Cherry Report acknowledges the impact of technology on the state's economy, it does not make this impact the focal point of its analysis or recommendations. In fact, within the Cherry Report technology receives the most attention in the "Economic Benefits" section but it is regarded as a dependent variable - an outcome to aspire to - rather than an independent variable - a factor affecting societal change. The Michigan Roadmap focuses on technology and technological innovation as key to the development of a society of learning.

Scope: The Cherry Report focuses exclusively on Michigan. The Michigan Roadmap encompasses a regional and even global perspective.

The Cherry Report differs from the Michigan Roadmap in other areas as well:

- The Report is focused on a specific, defined timeframe and its recommendations are pegged to that timeframe (the next decade). The Roadmap focuses on both immediate and long-term strategies.
- The Report does not directly address the impact of immigration on Michigan's economy and society.
- The Report does not consider the mechanism for implementing its proposals; in particular, funding to do so. It also does not consider state and national social or economic policies and the potential impact on education caused by changes to those policies.
- The Report does not explicitly acknowledge that the state's current economic and labor environments are not static but rather "moving targets" which could change significantly over the next ten years.
- The Report and the Roadmap differ on the directionality of the causal relationship between education and economic growth. The Report sees education (and, specifically, higher education) as the key

to attracting entrepreneurial and technological activity to the state while the Roadmap encourages recruitment of, and investment in, high-tech and entrepreneurial activity to partner with and augment Michigan's world-class universities.

- While the Report envisions some overlap of educational levels and institutional types (e.g., encouraging concurrent high school-college study and advocating the creation of applied baccalaureate degrees in community colleges), for the most part it assumes that the current educational structure (secondary and post-secondary) will remain essentially unchanged for the foreseeable future.
- While the Report acknowledges the emergence of new and proprietary educational providers (e.g., University of Phoenix), it does not fully investigate the potential impact of these providers on "traditional" higher education institutions.
- While the Report suggests the educational institutions would benefit from the development of strategic alliances with non-educational entities, it does not view this as a critical measure to the extent that the Roadmap does.

There are, however, a few issues in which the Cherry Report and the Roadmap are in at least partial agreement:

- Both acknowledge the impact and importance of technology and technological innovation in the future economy.
- Both acknowledge the importance of an educated workforce to participate in a technology-driven economy (although the definition of "educated" differs significantly between the Report and the Roadmap).
- Both focus on economic prosperity, and the role of education and the development of entrepreneurial skills as key factors for prosperity.
- Both acknowledge the leading role that Michigan's

flagship universities will play in the development of the new knowledge-based economy (although the Report includes Wayne State University on par with UM and MSU).

- Both espouse the transfer of knowledge and innovation from the campus to the marketplace, although as noted above, the Report and the Roadmap differ on the directionality of that transfer.
- Both call for new educational paradigms, although for the most part the Report sees this shift occurring within the current educational structure.
- Both suggest assessing current human resource and physical infrastructure capacities with the state's colleges and universities.
- Both espouse public accountability among colleges and universities.
- The Report's call to establish a set of "minimum core competencies" among high school and college students mirrors somewhat the Roadmap's recommendation to teach the skills necessary for "synthesizing" information. Again, however, the Report's proposal is geared to the goal of producing more degrees/credentials of value.

Appendix B

The Millennium Project



The Millennium Project
The University of Michigan

The Millennium Project

The Millennium Project at the University of Michigan is a small research center concerned with identifying key technological, economic, and social forces driving major change in society and then launching research projects to better understand these forces, their potential impact, and shaping strategies and public policies to address them. It functions both as an “over-the-horizon” futures scanning effort as well as a “skunkworks” laboratory where actual prototyping experiments are conducted. For example, the Millennium Project played an important role in launching the Michigan Virtual Auto College (later the Michigan Virtual University), a CyberCamp for high school students, and a series of studies concerning the impact of rapidly evolving digital technology on the American research university. More recent activities include an assessment of the implications of current U.S. basic research capacity on national leadership in technological innovation, the development of new metrics for determining and assessing federal R&D priorities, launching a new re-

search program on advanced energy sources for transportation applications in a post-hydrocarbon economy (including hydrogen-based fuels), and stimulating the evolution of global university alliances.

James J. Duderstadt

Dr. James J. Duderstadt is President Emeritus and University Professor of Science and Engineering at the University of Michigan. Dr. Duderstadt received his baccalaureate degree in electrical engineering with highest honors from Yale University in 1964 and his doctorate in engineering science and physics from the California Institute of Technology in 1967. He joined the faculty of the University of Michigan in 1968 as professor of nuclear engineering, later becoming Dean of the College of Engineering in 1981 and Provost and Vice President for Academic Affairs of the University in 1986. He became President of the University of Michigan in 1988 and served in this role until July, 1996. He currently holds a university-wide faculty appointment as University Professor of Science and Engineering and also directs the University’s program in Science, Technology, and Public Policy

Dr. Duderstadt’s teaching and research interests have spanned a wide range of subjects in science, mathematics, and engineering, including work in areas such as nuclear fission reactors, thermonuclear fusion, high-powered lasers, computer simulation, science policy, higher education, and information technology. During his career, Dr. Duderstadt has received numerous national awards for his research, teaching, and service activities, including the E. O. Lawrence Award for excellence in nuclear research, the Arthur Holly Compton Prize for outstanding teaching, the Reginald Wilson Award for national leadership in achieving diversity, and the National Medal of Technology for exemplary service to the nation. He has been elected to numerous

honorific societies including the National Academy of Engineering, the American Academy of Arts and Science, Phi Beta Kappa, and Tau Beta Pi.

Dr. Duderstadt has served on and/or chaired numerous public and private boards. These include the National Science Board; the Executive Council of the National Academy of Engineering, the Committee on Science, Engineering, and Public Policy of the National Academy of Sciences; the Nuclear Energy Research Advisory Committee of the Department of Energy; the Big Ten Athletic Conference; the University of Michigan Hospitals; Unisys; and CMS Energy. He currently chairs several major national study commissions in areas including federal science policy, higher education, information technology, and engineering research.

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