# The Michigan Roadmap *Redux*

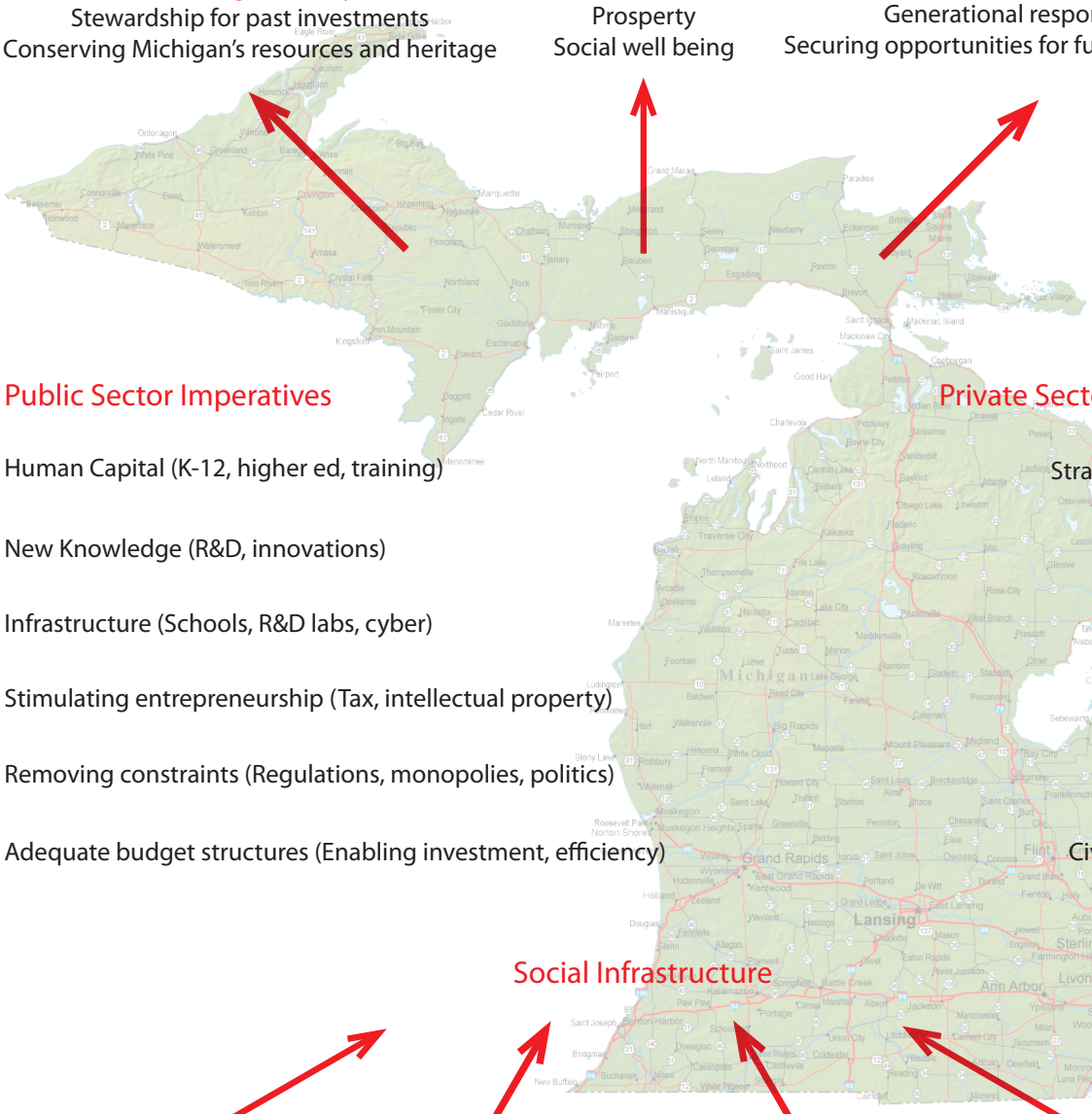
## A Call for Leadership

The Millennium Project
The University of Michigan
Spring, 2008

**Honoring Yesterday**
Stewardship for past investments
Conserving Michigan's resources and heritage

**Serving Today**
Prosperity
Social well being

**Investing for Tomorrow**
Generational responsibility
Securing opportunities for future generations




**Public Sector Imperatives**

Human Capital (K-12, higher ed, training)

New Knowledge (R&D, innovations)

Infrastructure (Schools, R&D labs, cyber)

Stimulating entrepreneurship (Tax, intellectual property)

Removing constraints (Regulations, monopolies, politics)

Adequate budget structures (Enabling investment, efficiency)

**Private Sector Imperatives**

Strategic (long term)

Innovative

Nimble

Globally Aware

Locally engaged

Civically responsive

**Social Infrastructure**

| Citizens | Families | Communities | States |
|---|---|---|---|
| Diversity | Schools | Public Health | Social Justice |
| | | | Equity |

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# Preface to the Michigan Roadmap, Redux

Over the past several years an increasing number of thoughtful and compelling studies and reports have appeared concerning the future of the State of Michigan, including an earlier version of this Michigan Roadmap report. While emerging from many different perspectives and sectors of our society, these studies have largely converged in recommending a series of actions that leaders of government, business, labor, and education must take if Michigan is to prosper once again in an intensively competitive, knowledge-driven, global economy. [In this regard, see Austin (2005), Bartik (2006), Clay (2007), Drake (2006), Glazer (2007), Hollins (2006), Ivacko (2007), Michigan Emergency Financial Advisory Panel (2007), Cherry (2004), Power (2006, 2007), Public Sector Consultants (2003), and Slemrod (2006).] Many of these reports not only identify the challenges facing our state today, but they have offered hope through their compelling visions for the future of our state. They have proposed actions for leaders of Michigan government, industry, and labor that could restore our economic strength and prosperity while sustaining the social and civil infrastructure so necessary to the welfare of our citizens. Their analyses draw on Michigan's remarkable history by demanding adequate investments in its people, their education, and their capacity to complete in an increasingly competitive global economy. If Michigan were to add to its considerable natural assets–the world's largest supply of fresh water, the nation's longest shoreline, and perhaps even eventually (with global warming) a mild climate–a diverse and educated population of world-class quality, it could once again achieve the global economic leadership and quality of life that characterized our state during the past century.

Yet these visions for Michigan's future, supported by such carefully considered and compelling studies and embraced by a growing number of citizens, have failed to stimulate the actions necessary to address the challenges facing our state. Little progress has been made in addressing the challenges facing Michigan. The state's public leaders remain moored to obsolete political philosophies and distracted by largely irrelevant issues, failing miserably in their responsibilities to work together to address the key issues of restructuring Michigan's government and tax system to enable the necessary investments in our future. Similarly too many leaders of Michigan business and industry continue to focus myopically on the near term, resisting the strategic changes necessary to allow their companies to thrive–or perhaps even survive–for the longer term in a hypercompetitive global, knowledge-driven economy.

By almost any measure, over the past several years Michigan has fallen even further behind other states–not to mention other nations–economically, socially, and culturally. Michigan currently ranks:

- 50th in the nation in personal income growth
- 50th in unemployment rate
- 50th in employment growth (in fact, as the only state with a decline)
- 50th in the index of economic momentum (e.g., population, personal income, and employment)
- 50th in the change of its support for higher education over the past six years
- 46th in the return of federal tax dollars

Moreover Detroit has now become the nation's poorest city. Several of our leading corporations face possible bankruptcy. And lest you think Ann Arbor is an oasis, immune from the challenges of the flattening world, in 2007 we learned that its largest employer, the huge Pfizer R&D laboratory (the place that invented Lipitor, perhaps the most profitable drug of the past decade) would be eliminated, taking 2,100 high-paying jobs with it. Michigan does lead in some areas: incarceration rates and prison costs, health and retirement benefits for both public and industrial employees, mortality rates from smoking (not surprising since the Legislature continues to allow the tobacco lobby to block efforts to ban smoking in public places, putting Michigan far behind other states and nations in this public health epidemic).

The list goes on and on, providing even more testimony to the bankruptcy of our state government–both literally in its finances and figuratively in its leadership. Indeed, partisan bickering and confrontational politics brought Michigan to the brink last fall as our elected representatives in Lansing came within hours of closing down state government because of their inability to agree on the tax increases and expenditure cuts necessary to balance the state's budget. This sorry situation was condemned by the headlines across the state: "Foolish politics ruins state. Welcome to the banana republic of Michigan. There have to be cuts. There must be a tax increase. And reforms have got to begin to take hold in the next 12 months to prevent this all from happening again." (Detroit Free Press, September, 2007) "Step up, lawmaker. Step up, governor. Step up, Democrats and Republicans, and deliver a budget that works for Michigan. Plunging the state into the chaos of a shutdown while you engage in name-calling and blame-gaming is unacceptable. We've all had a bellyful of inaction". (Detroit News, September, 2007) "No anecdotes capture the astonishing combination of incompetence, isolation, irresponsibility, and rank partisanship that have characterized our political system in Lansing over the past several weeks." (Power, September, 2007)

Many of Michigan's problems arise from the fact that the state has slipped far below the national average–and the Great Lakes region–in many measures critical to prosperity and social well-being in a global, knowledge-driven society:

- Michigan's tax burden and revenues have fallen below the national average and considerably below those characterizing states competitive in the new economy (e.g., the West Coast and New England). Michigan's current tax system is obsolete, regressive, inequitable, and totally inadequate to generate the resources necessary to invest in the state's future.

- The costs born by public agencies and private industry are much higher than in most other states, largely because of the legacy costs associated with excessively expensive health care and retirement benefits that have led to an entitlement culture, seriously misaligned with a hypercompetitive global marketplace.
- Public and private investments in assets critical to competitiveness in the global economy–e.g., higher education, civil infrastructure, cyberinfrastructure–have dropped far below the national average and lowest among the Great Lakes states.
- State government continues to be burdened by structural constraints, including overly restrictive term limits for public officials, a state constitution that is far too easy to manipulate by special interest groups and outside forces, and obsolete policies in key areas such as incarceration, redundant regional and municipal governance, maintaining critical infrastructure, and many other areas that drive up the costs and drive down the efficiency and quality of public services.
- Ill-informed voter referenda and questionable judicial decisions have reversed Michigan's long history of tolerance, equal opportunity, and social justice, at a time when both the state and the nation are becoming increasingly diverse.
- The Michigan Congressional delegation continues to be woefully inadequate in attracting federal resources to the state, currently ranked 46th in the nation in return of federal tax dollars.
- Despite the economic trauma experienced by the state, public awareness of the actions that need to be taken (higher, broader, and more progressive taxes; lower labor benefit costs; greater investment in human capital and knowledge resources) is still inadequate, more looking backwards to past entitlements than forward to future challenges and opportunities.

Today Michigan is rapidly becoming not only the poster child but perhaps even the basket case for the global knowledge economy. And what are state leaders doing about it?

1. State government remains an absolute disaster, paralyzed into rigor mortis by obsolete agendas and fueled by self-serving actions stimulated more by the personal goals of political power–and perhaps even survival in the face of term limits–as many elected public officials seem more concerned with their political careers than their public responsibilities.
2. Leaders of Michigan business, industry, and labor still suffer from a not-on-my-watch syndrome, myopically fixated on short-term agendas, defending obsolete products and cost structures, and inadequately investing in the future as their executives seem more concerned with personal wealth accumulation and retirement than the long term success–indeed survival–of their companies.
3. Much of the state's media is still largely tone-deaf, unable (or perhaps unwilling) to set aside narrow political agendas (e.g., tax policy) to sound the alarm as the state continues to sink further into economic collapse, with many publishers and editors more driven by obsolete political philosophies than civic responsibility.
4. And as recent surveys suggest, the public remains largely uninformed, still hoping

for the return of a world long since vanished and subject to manipulation by political demagogues with all too many Michigan families more committed to spending on personal desires rather than investing in opportunities for their offspring.

The grades are in. All of us, whether in government, business, labor, education, or as citizens, have failed miserably to turn things around. And our children will bear the brunt of our failures.

While public apathy (sometimes driven by despair), political pandering (perhaps driven by term limits), and corporate myopia (likely driven by greed) are all contributors to inaction, in the end it all boils down to an appalling absence of leadership characterizing our state at all levels and in all sectors–state and local government, business and industry, labor, education, and nonprofit foundations.

As Michigan citizens it is our right and our responsibility to state clearly what we expect, deserve, and demand from our leaders in both the public and private sectors. But beyond calling once again for enlightened, courageous, and committed leadership, it is time to go further and ask those in leadership positions either unwilling or unable to address Michigan's challenges to step aside and let others take the wheel. To continue to tolerate and perpetuate the current leadership vacuum is to dishonor the sacrifices of past generations and condemn the future for our descendants.

So, where to begin? Since the absence of leadership is at the crux of the state's challenges, perhaps the most direct approach is simply to demand a change at the helm, replacing those state leaders in both the public and private sector who have failed so miserably to turn things around. The most Draconian approach would be to launch a series of well-funded grass-roots petition drives aimed at recalling key leaders of state government who have failed to deliver (or blocked through political maneuvers) the changes necessary to allow adequate investment in Michigan's future, such as tax restructuring (e.g., broadening taxes to reflect the state's growing services economy, shifting to more progressive tax policies, and increasing tax levels sufficiently to support both needed serves and investment in the future), costs (employee benefits and incarceration rates), and key investments in the state's knowledge infrastructure (schools, universities, cyberinfrastructure). Perhaps we should go further and challenge the re-election of those members of the Michigan Congressional delegation who utilize their political influence to defend obsolete federal policies (e.g., emissions controls and fuel economy) rather that attracting badly needed federal programs and dollars back to our state. We should demand through shareholder actions the management changes in Michigan-based companies necessary to create globally competitive businesses with strong loyalty and civic responsibility to Michigan. Yet, while one could make a very strong case that most of these leaders have had their chance and have clearly failed, it is not obvious that replacing Michigan's leadership through the current political systems and corporate practices would yield anything better.

A more constructive approach might be to simply strive to return Michigan to national and regional averages in key characteristics under our direct control:

- Tax levels (and characteristics such as breadth, balance, and progressiveness)
- Legacy costs (such as employee benefits and incarceration rates)
- Investment in key knowledge resources such as higher education
- Public policies such as term limits and the ease with which special interests and outsiders can amend the state constitution
- Return of federal tax dollars to the state through federal programs and grants

In fact one might simply accept as the target for all of these parameters a regional average of the Great Lakes states. While this may not seem like an overly ambitious first step–since, after all, nobody really should strive to be merely average–it has nevertheless been a step that our current representatives in Lansing and Washington have been unable to achieve.

Similar objectives could be set for Michigan business and industry:

- To restructure legacy costs (e.g., health care and retirement benefits) to globally competitive levels.
- To break the dominance of big companies, big labor, and big lobbyists that tend to manipulate public policy, regulatory policy, and financial markets to choke off entrepreneurial activities key to the new economy (e.g., break the stranglehold of the big and old over the small and new).
- To resist the efforts of monopolies in key areas such as telecommunications and energy to stifle competition and innovation.
- To allow both the global marketplace and the Schumpeter process of creative destruction to work.
- While seeking global competitiveness, to also accept civic responsibility for local and regional welfare, understanding that this is key to attracting and retaining talented employees.
- To actively support through public and political influence the long term investments necessary for prosperity in the knowledge economy (e.g., higher education, R&D, cyberinfrastructure)

Yet, once again, these strategies, so obvious to companies that tend to thrive in the global, knowledge economy, seem a particular challenge to much of Michigan's current business sector.

Hence, we prefer a bolder approach, similar to that taken in the *Michigan Roadmap* effort of 2005. It is time to sound once again the alarm, to face up to the imperatives of our times, and to recommend a clear and compelling vision for the future of our state. In this document we suggest a vision for Michigan's future that involves a series of stretch goals–a *strategic intent*–that simply can not be accomplished by clinging to the status quo. To achieve this, we provide through the *Michigan Roadmap, Redux* a suite of actions capable of guiding our state toward this future.

# Executive Summary

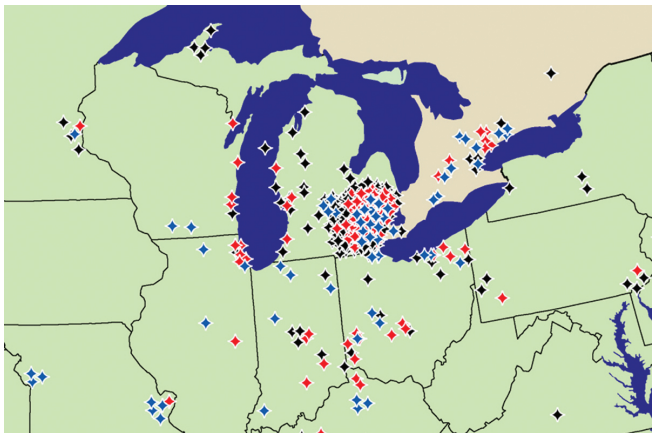
Throughout the 20th century both America and Michigan have been leaders in the world economy. The democratic values and free-market practices of the United States, coupled with institutional structures such as stable capital markets, strong intellectual property protection, flexible labor laws, and open 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. Vast natural resources provided the opportunities for prosperous agriculture, lumbering, and mining industries. Our ancestors made our farms and our factories the best in the world. Yet from the beginning Michigan believed in its people and invested heavily in their education and training, embracing the spirit of the Northwest Ordinance, which stated: "Religion, morality, and knowledge being necessary to good government and the happiness of mankind, schools and the means of education shall forever be encouraged."

There was broad recognition that Michigan's most valuable resources were its people. Hence investment in the knowledge, skill, and ability of its people was seen as key to Michigan's competitive edge in achieving global leadership in innovation, productivity, and trade. Michigan built a great education system of schools, colleges, and universities aimed at serving all of its citizens. It created and supported a social and civil infrastructure that was the envy of the nation. Michigan companies invested heavily in R&D and technological innovation, working closely with the state's 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. State leaders 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. And the payoff was enormous, as Michigan led the world in productivity and prosperity. It rapidly became the engine driving the nation's economy. During the last century it was Michigan that first put the world on wheels and then became the arsenal of democracy to defend freedom during two world wars.

But that was yesterday. What about Michigan today? Ironically, as never before, the prosperity and social well-being of our state today is determined by the skills, knowledge, and talents of our people. In the global, knowledge-driven economy, educated human capital is king. Yet here, the vital signs characterizing Michigan today are disturbing indeed. 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 their 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, to 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 generous retirement benefits, expensive health care, ever more prisons, and reduced tax burdens, rather than demanding that Michigan begin investing once again in education, innovation, and the future.

This neglect of adequate investment in human capital and knowledge infrastructure could not have happened at a worse time. As we enter a new century, Michigan's old industrial economy is dying, slowly but surely, putting at risk the welfare of millions of citizens



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

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. Michigan's inability to adapt to a rapidly changing world is reflected by the fact that today our state ranks 50th in the nation in almost every economic indicator–employment, job creation, growth in personal income, economic momentum, and return of federal tax dollars.

Preoccupied with obsolete and irrelevant political battles, addicted to entitlements, manipulated by lobbyists and special interest groups, and assuming what worked before will work again, Michigan today is sailing blindly into a profoundly different future. Today's policies embraced by state leaders are increasingly incompatible with the realities of the emerging global economy. Our current tax system is not only regressive and inequitable, but it is both structurally and strategically misaligned with the character of Michigan's increasingly knowledge-driven economy, unable to generate the revenues to sustain the necessary investments in our knowledge, social, and civic infrastructure. The legacy costs of obsolete and excessively burdensome retirement and health care benefits threaten to bankrupt both government and industry. Obsolete sentencing policies have burdened us with incarceration rates and prison costs that lead the nation. Our investment in key knowledge resources such as higher education has dropped to last in the nation. We have allowed external groups to persuade voters to cripple Michigan's efforts to secure equal opportunity and social inclusion for an increasingly diverse population. And special interest groups continue to block legislative efforts to bring Michigan in line with other states and nations on critical public health measures such as smoking and environmental protection.

Thus far our state has been in denial, assuming our low-skill workforce would remain competitive and our factory-based manufacturing economy would eventually be prosperous once again. 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 professional 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 and private 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.

However, history has also shown that significant 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

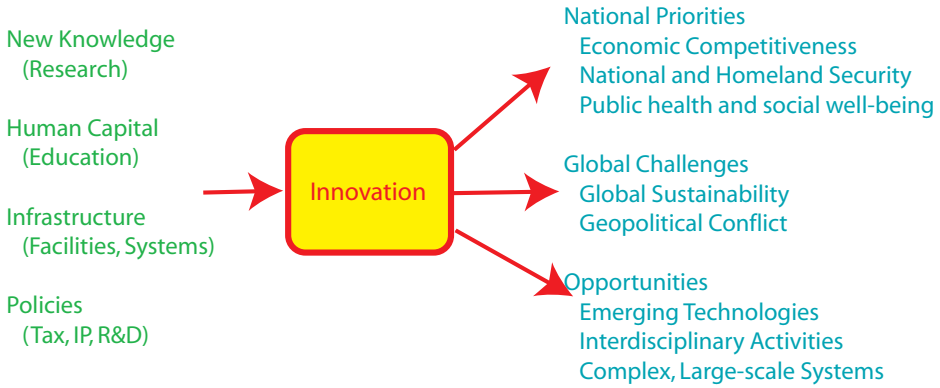
(e.g., Bangalore, Shanghai). Yet again, at a time when our competitors are investing heavily in stimulating the technological innovation to secure future economic prosperity, Michigan is missing in action, significantly under-investing its economic and political resources in planting and nurturing the seeds of innovation.

Adequately supporting education and technological innovation is not just something we would like to do; it is something we simply 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 investment in the ingredients of innovation–educated people and new knowledge. Put another way, it requires strategic vision, enlightened policies, and sustained investment to create a knowledge society that will be competitive in a global economy.

To this end, this study has applied the planning technique of *strategic roadmapping* to provide a framework for the issues that Michigan must face and to suggest the commitments that we must make, both as individuals, as institutions, 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. As we have noted earlier, Michigan has dropped to dead last–50th among the states–in most measures of economic momentum. Our leading city, Detroit, now ranks as the nation's poorest. Furthermore, Michigan leads the nation in population loss, with the out-migration of young people in search of better jobs 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. 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 six years–with appropriation cuts to public universities now ranked as the most severe in the nation and 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



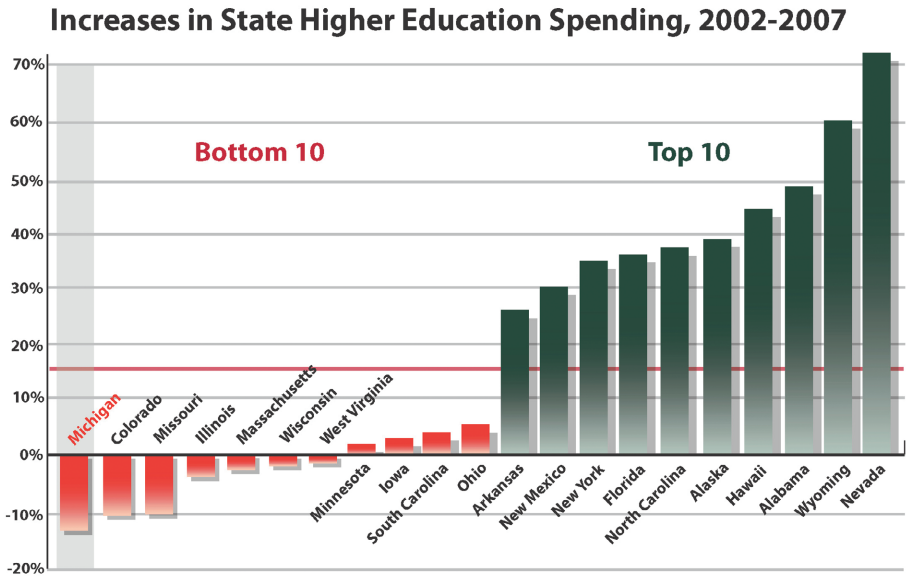

The Keys to Innovation

innovation to fund instead short term priorities such as prisons and excessive employee benefits while enacting 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 competencies 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. Hence the challenge is no longer to simply focus on the best and brightest, the economic and social elite, as in earlier eras, but instead to recognize that it will be the education, knowledge, and skills of Michigan's entire population that determine our economic prosperity and social well-being in the global economy. We must invest in learning opportunities for all of our citizens throughout their lives. And we must recognize that equal opportunity and social inclusion are no longer simply moral obligations but moreover strategic imperatives if we are to compete in the global economy.




*Michigan's higher education investment over the last five years has been the lowest in the nation, and well under the national average of 15.1 percent over that period. Some of the nation's fastest growing states are those leading the nation in higher education appropriations.*

*Source: Grapevine Web site, Michigan figures updated for May budget cuts*

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

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" (*a la* Schumpeter) that characterizes a hypercompetitive global economy. Yet it must also provide a safety net for those citizens caught in such economic transformations through inclusive social programs.

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. Yet this effort must also challenge the inability of Michigan's leaders to address the imperatives of the global economy, while building an awareness among Michigan parents that nothing will matter more to their children's future than their 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 strategic vision, enlightened public policies, and significant public and private investments in high-skilled human capital, research and innovation, and infrastructure are necessary to sustain a knowledge economy.

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

In the near term our principal recommendations focus on Michigan's most valuable resources, its people, investing in their education, skills, and creativity, and developing the knowledge infrastructure to enable their innovation and entrepreneurial zeal. Our recommendations are also aimed at providing the state's economic sectors and institutions–including government, industry, and education–with capacity, incentives, and encouragement to become more agile and market-smart.

### *Human Capital*

*1. The State of Michigan will set as its goal that all students will graduate from its K-12 system with a high school degree that signifies they are college ready. To this end, all students will be required to pursue a high school curriculum capable of preparing them for participation in post-secondary education and facilitating a seamless transition between high school and college. State government and local communities will provide both the mandate and the resources to achieve these goals.*

*2. Beyond the necessary investments in K-12 education and the standards set for their quality and performance, raising the level of skills, knowledge, and achievement of the Michigan workforce will require a strong social infrastructure of families and local communities, particularly during times of economic stress. To this end, state government and local government must take action both to re-establish the adequacy of Michigan's social services while engaging in a broad effort of civic education to convince the public of the importance of providing world-class educational opportunities to all of its citizens.*

*3. Michigan must create clearer pathways among educational levels and institutions while removing barriers to student mobility and promoting new learning paradigms (e.g., distance education, lifelong learning, workplace programs) to accommodate a far more diverse student cohort.*

*4. Higher education must become significantly more engaged with K-12 education, accepting the challenge of improving the quality of our primary and secondary schools as one of its primary responsibilities and highest priorities with the corresponding commitment of faculty, staff, and financial resources. Each Michigan college and university should be challenged to develop a strategic plan for such engagement, along with measurable performance goals.*

*5. Michigan must increase very substantially the participation of its citizens in higher education at all levels–community college, baccalaureate, and graduate and professional degree programs. 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. 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. 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.*

*6. 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 colleges and universities over the next five years.*

*7. 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). 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 such as forgivable loans if they accept employment following graduation with Michigan companies.*

*8. 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)*

*9. 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*

Investing in tomorrow's human capital

*supporting their surrounding communities in the transition to knowledge economies.*

*10. 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 and standardized; 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 and federal sectors (attracting new knowledge-based companies and federally funded R&D centers–FFRDCs).*

*11. 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.*


Boosting investments in cutting edge research such as that conducted in the University Research Corridor

*Infrastructure*

*12. 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 current infrastructure designed 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*

*13. 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.*

*14. 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.*

*15. 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 diversity, and intellectual property generated through research and transferred into the marketplace.*

*16. Michigan must recommit itself to the fundamental principles of equal opportunity and social inclusion through the actions of its leaders, the education of its citizens, and the modification of restrictive policies, if it is to enable an increasingly diverse population to compete for prosperity and security in a intensely competitive, diverse, and knowledge-driven global economy.*

## 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.

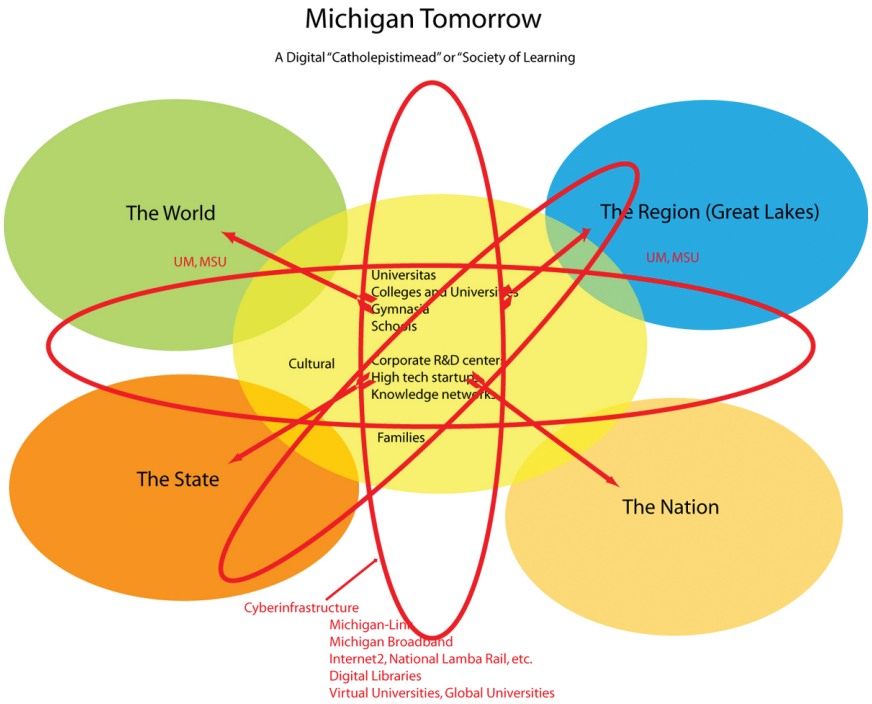
To this end, the long-term roadmap proposes a vision of the future in which Michigan strives to build a knowledge infrastructure–*a society of learning*–capable of adapting and evolving to meet the imperatives of a global, know-ledge-driven world. Such a vision is essential to create the new knowledge (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:


Diverse institutions for diverse students.

*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 adequately supported and allowed 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.*

*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 institutional 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 by age (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*




Michigan tomorrow: a society of learning

*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 research universities 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. Because of the importance of research and graduate education to the state's future, these universities should be encouraged to strike an appropriate balance between these activities, while undergraduate education remains the primary mission of Michigan's other colleges and universities.*

*5. 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.*

*6. 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 internationally prominent research universities, the University of Michigan and Michigan State University, to join together to create a true world university, capable of assisting the state to access global economic and human capital markets.*

*7. Michigan should explore bold new 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 work closely with other Great Lakes states facing similar challenges and opportunities to develop a regional agenda, both to facilitate cooperation and to influence national priorities.*

*9. 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!*

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 facing actions that partisan politics.

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.

It is time for leaders of state government, business, labor, education, and foundations to acknowledge and explain to the public that without the sacrifices we must make today to enable investments for tomorrow, 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. A civil society does require some degree of sacrifice on the part of all citizens, relative to their capacity and means. 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!

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.

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

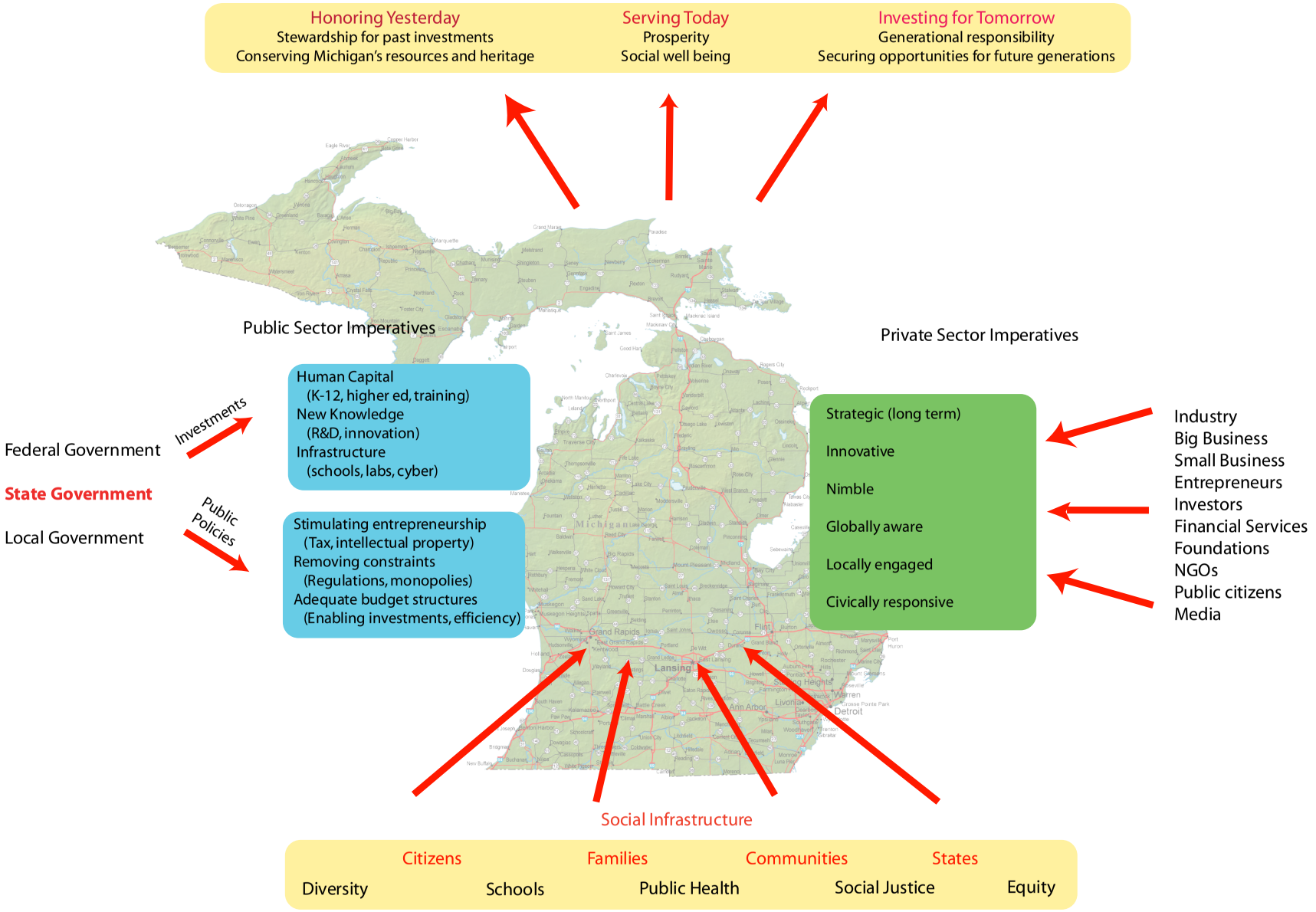
head for tomorrow, and what actions will be necessary to get there. Michigan simply must stop backing into the future and, instead, turn its attention to making the commitments and investments today necessary to allow it to compete for prosperity and social well-being tomorrow in a global, knowledge-driven economy.

Here a second caveat is important. Such roadmaps should be viewed as transient documents, since the Michigan landscape changes over time. As the world continues to change, and as thoughtful and creative people become more engaged in considering our state's challenges and opportunities, new paths to the future will become apparent. Hence it is important for readers to consider this particular effort as both organic and evolutionary. Feedback, criticism, and suggestions are strongly encouraged and these will reshape future versions of the Michigan Roadmap, just as the current Michigan Roadmap Redux was reshaped by the input of many of those who provided feedback on the earlier 2005 document.

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 public investment in the ingredients of innovation–educated people and new knowledge–and the infrastructure to support advanced learning, research, and innovation. It requires an environment that stimulates creativity, innovation, and entrepreneurial behavior. Put another way, it requires strong public purpose, wise public policy, and adequate investment to create a true society of learning. And these, in turn, require dedicated, visionary, and courageous leadership in government, business, education, and other areas of civic life.

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 needs to be rekindled to secure Michigan's future.

The challenge: develop a roadmap to Michigan's future




The Michigan Roadmap

# 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, with investments in people as the highes

Investment Goals:
…human capital (lifelong learning)
…new knowledge (research, innovation, entrepreneurism)
…infrfastructure (institutions, labs, cyber)
…policy (tax, investment, intellectual property)

The Elements:

1. All K-12 students will graduate college ready.
2. Priority will be given to the social infrastructure for learning.
3. Create clearer pathways among learning institutions.
4. Higher education will become more engaged with K-12 schools.
5. Increase participation of all citizens in higher education.
6. Move Michigan into top quartile in higher ed investments.
7. Targeted state investment in science and engineering.
8. Stress alliances among Michigan's colleges and universities.
9. Increase state investments in university research infrastructure.
10. Universities should become more engaged in tech transfer.
11. Incentives to stimulate private sector R&D and innovation.
12. Public investment in infrastructure such as broadband is critical.
13. Michigan should invest more in need-based financial aid.
14. State funds should be used to leverage private and federal funds.
15. Universities should be provided with agility to adapt to markets.
16. A recommitment to equity and social inclusion.

## 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 society of learning 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.

# Contents

## 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 John Austin, Lou Glazer, Philip Power, Donald Grimes, Doug Ross, Craig Ruff, Paul Dimond, Elizabeth Gerber, Paul Courant, Doug Rothwell, Tom Clay, Dwight Carlson, Lou Anna Simon, Mike Boulos, Dan Atkins, Doug Van Houweling, Chuck Vest, and Bill Wulf. 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 Spellings Commission on the Future of Higher Education in America, 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 (California, Texas, Massachusetts, Colorado, Ohio, Florida, 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 authored 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.

Ann Arbor
Spring, 2008

# 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? After all, over the past several years an increasing number of thoughtful and compelling studies and reports have appeared concerning the future of the State of Michigan, including an earlier version of this Michigan Roadmap report. While emerging from many different perspectives and sectors of our society, these studies have largely converged in recommending a series of actions that leaders of government, business, labor, and education must take if Michigan is to prosper once again in an intensively competitive, knowledge-driven, global economy. [In this regard, see Austin (2005), Bartik (2006), Clay (2007), Drake (2006), Glazer (2007), Hollins (2006), Ivacko (2007), Michigan Emergency Financial Advisory Panel (2007), Cherry (2004), Power (2006, 2007), Public Sector Consultants (2003), and Slemrod (2006).]

Many of these reports not only identify the challenges facing our state today, but they have offered hope through their compelling visions for the future. They have proposed actions for leaders of Michigan government, industry, and labor that could restore our economic strength and prosperity while sustaining the social and civil infrastructure so necessary to the welfare of our citizens. Their analyses draw on Michigan's remarkable history by demanding adequate investments in its people, their education, and their capacity to compete in an increasingly competitive global economy. If Michigan were to add to its considerable natural assets–the world's largest supply of fresh water; the nation's longest shoreline; a strategic location at the center of national and global trade and commerce; and perhaps even eventually (with global warming) a mild climate–a diverse and educated population of world-class quality, it could once again achieve the global economic leadership and quality of life that characterized our state during the past century.

Michigan's fundamental challenges are all too evident. The state's old factory-based industrial 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 today in Michigan there remains a considerable lack of public understanding of the implications of a global, knowledge-driven economy for our state's future. Furthermore, there has been both a deafening silence and a remarkable lack of cooperation, commitment, and courage on the part of Michigan leaders in taking the strong actions necessary to address today's challenges and provide hope and opportunity for future generations 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 meaningless political battles, manipulated by lobbyists and special interests, 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 creating high value-added service firms and jobs during the transition to a knowledge economy. Today Michigan has the worst performing state economy in the nation, ranking 50th among the states in key economic indicators such as job creation, personal income growth, employment, and other measures of economic momentum. 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). And Michigan's population continues to plummet–unique among the states in dropping by over 30,000 in 2007–driven primarily by the out-migration of more than 94,000 citizens, many of them young, college-educated, and fleeing Michigan's economy for better jobs and more hopeful futures elsewhere (Detroit News, 2007).

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. And where does Michigan choose to deploy its declining tax revenues? To sustain one of the nation's highest incarceration rates and most expensive prison systems, the unusually high health and retirement benefit costs of public employees, and one of the nation's few full-time legislatures. And what about the investment in key knowledge assets such as higher education? Michigan's public leaders have chosen instead to slash appropriations to the state's colleges and universities, year after year, to the point where the state currently ranks last, 50th in the nation, in its recent support of this critical resource for the knowledge economy.

For decades the leadership of this state–whether in state government, corporations, labor, cities, or education–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 that 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

Bangalore

Shanghai

The impact of the global economy on Michigan

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, ignoring key investments such as higher education, and stubbornly defending regressive public policies that have crippled our state's capacity to prosper in the future.

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 universities" (Kerr, 1963), responsible for and responsive to the needs of the people who founded 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.

Moreover, Michigan provided leadership in progressive social policies aimed at achieving equality of opportunity and social justice for all of its citizens. It accepted as its founding principle the proclamation of the Northwest Ordinance: "Religion, morality, and knowledge being necessary to good government and the happiness of mankind, schools and the means of education shall forever be encouraged." (A principle that remains chiseled today on the frieze of Angell Hall, the most prominent building on the University of Michigan campus.) Our state welcomed immigrants and minorities, providing them with jobs, opportunities, and a social infrastructure that became the envy of the nation and led to Michigan's extraordinary economic strength and leadership during the past century.

What is significant is that the strength of our state–its capacity to build and sustain such extraordinary institutions–arose from Michigan'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 resources built through the

vision and sacrifices of past generations. In our times, state government has come to view investments in its people, their skills, education, and opportunities, 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 appropriations for education and knowledge infrastructure, along with tax policies inadequate in magnitude and highly regressive in character along with ill-considered political actions such as the recent ballot proposition banning affirmative action are methodically 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 adequate investment in human capital 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 unusually fertile environment for technological innovation. However, history has also shown that significant 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 representatives gave higher priority to blocking 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 global climate change, which would threaten the very survival 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. And these, in turn, require dedicated, visionary, and courageous leadership in government, business, education, and other areas of civic life.

## 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 also requires engaged and informed citizens, concerned as much about the legacy they will leave their children as pursuing their personal desires of the moment. And 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 $10.00 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 (Science, 2007). 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, 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?


Which is the best investment for Michigan's future?
The MGM Grand Casino or the University Research Corridor?

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 create the sources of knowledge and innovation necessary to spawn world-class companies and a world-class living environment.

Educating the workforce of tomorrow

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 characterizing 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 factory-based industrial economy 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; various measures of economic momentum in Michigan have fallen to last among 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. 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 several 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 *society of learning*, 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 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 human capital, 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, China, and Southeast Asia 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 is 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.

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.

Here a second caveat is important. Such roadmaps should be viewed as transient documents, since the Michigan landscape changes over time. As the world continues to change, and as thoughtful and creative people become more engaged in considering our state's challenges and opportunities, new paths to the future will become apparent. Hence it is important for readers to consider this particular effort as both organic and evolutionary. Feedback, criticism, and suggestions are strongly encouraged and these will reshape future versions of the Michigan Roadmap, just as the current Michigan Roadmap Redux was reshaped by the input of many of those who provided feedback on the earlier 2005 document.

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 public investment in the ingredients of innovation–educated people and new knowledge–and the infrastructure to support advanced learning, research, and innovation. It requires an environment that stimulates creativity, innovation, and entrepreneurial behavior. Put another way, it requires strong public purpose, wise public policy, and adequate investment to create a true knowledge society. And these, in turn, require dedicated, visionary, and courageous leadership in government, business, education, and other areas of civic life.

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 needs to be rekindled to secure Michigan's future.

# 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 are driven by the great disparity in wealth and power about the globe, national security, and terrorism. Yet it is also a time of unusual opportunity and optimism as globalization erodes economic, political, and cultural boundaries and new technologies not only improve the human condition but allow the creation and flourishing of new communities and social institutions more able to address the changing needs of our 21st-century world.

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 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

High Tech industry in Bangalore, India

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, automobile manufacturing–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 taxes 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 considerable 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, since 2000 Michigan has lost 246,000 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, if in rather fragile financial condition. (Clay, 2007).

Though Michigan added 450,000 jobs in other areas 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.

From a broader perspective, while Michigan's older manufacturing firms have been losing market share and shedding jobs rapidly, its high-value added service sector has been growing more slowly than the national average, 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% of its workforce, not only drives higher manufacturing costs from legacy health and retirement benefits, but its long-standing success in negotiating generous labor agreements has created an entitlement culture. Although the statewide University Research Corridor, stretching from Detroit to Grand Rapids, holds future promise (Hollins, 2006), from a national perspective, only Ann Arbor and East Lansing currently have the major presence in basic research activity generally viewed as necessary for a center or seedbed for generating high-value added service jobs. (Dimond, 2006).

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 com-

puters 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 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 commodification. 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 seeking high skill, high wage, knowledge intensive jobs or instead China with low skill, low wage commodity manufacturing jobs? 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, which 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, through the arts and culture, or through the interna-

tionalization of commerce, capital, and labor, or our interconnectness through common environmental concerns, the United States is becoming increasingly linked with the global community. The liberalization of trade and investment policies, along with the revolution in information and communications technologies, has vastly increased the flow of capital, goods, and services, dramatically changing the world and our place in it. Today globalization determines not only regional prosperity but also national and homeland security. Our economy and companies are international, spanning the globe and interdependent with other nations and other peoples.

Yet globalization implies a far deeper interconnectedness with the world–economically, politically, and culturally. It is a process characterized by increasing economic openness, growing economic interdependence, and deepening economic integration in the world economy, establishing a world marketplace largely beyond the reach of the nation state. Such a market economy challenges conventional social norms and institutions. The "death of distance" associated with emerging information and communications technologies contribute to the rapid spread of cultures, particularly among young who are members of the net generation. Yet globalization is not a value-free concept, since its logic and ideology of an unfettered world market for labor, finance, and goods falls far short of geopolitical reality. It thrives on new forms of economic activity such as entrepreneurial capitalism, which challenge older, less nimble forms such as oligarchy, state-director, or big industrial firm capitalism. It can also be highly asymmetric, leading to interdependence among nations in the industrialized world while creating even more dependence among developing nations.

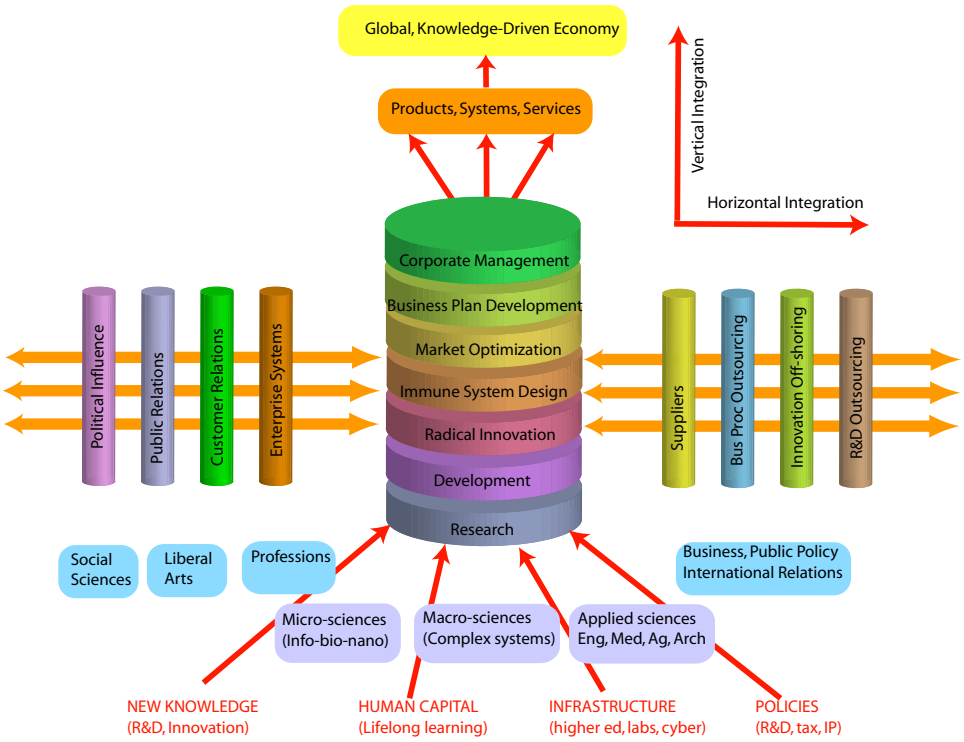
In such a global economy, it is critical that nations (and regions such as states or cities) not only have global reach into markets abroad, but also have the capacity to harvest new ideas and innovation and to attract talent from around the world. However, as former MIT president Charles Vest stresses, one must bear in mind four imperatives of the global economy: i) people everywhere are smart and capable; ii) science and technology advance relentlessly, iii) globalization is a dominating reality, and iv) the Internet is a democratizing force (Vest, 2005). 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 1.4 billion. India and Brazil will also likely surpass most of the European nations. Globalization–the growing interconnectedness reflected in the expanded flow 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).

Columnist Tom Friedman warns that "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" (Friedman, 2005). 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."

Of course, some would contend that rather than flattening, world economic activity is actually becoming more peaked about concentrations of knowledge-workers and innovation centers. Others suggest that rapidly evolving information and communications are enabling the participation of billions "at the bottom of the economic pyramid" through microeconomic transactions (Prahalad, 2005). But whether interpreted as a flattening of the global playing field or a peaking about concentrations of innovation, most nations have heard and understood the message about the imperatives of the emerging global knowledge economy.

The changing nature of the global economy is also




The way the world's knowledge economy works: global sourcing.

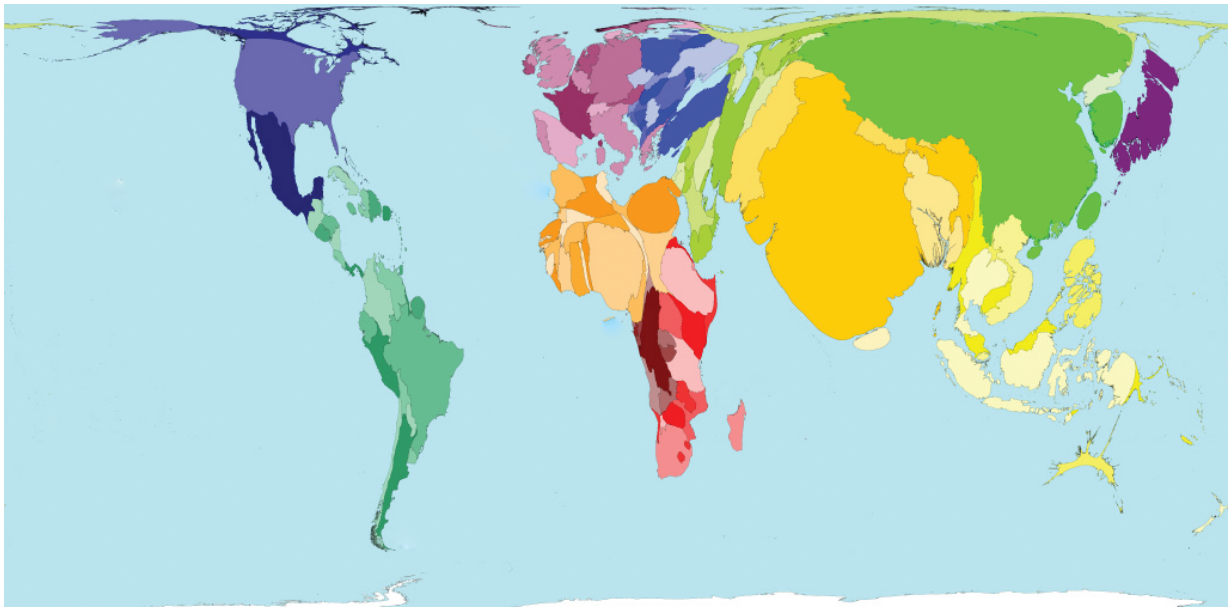
exerting new and powerful pressures on regional educational needs and capacity. The liberalization of trade policies coupled with the Internet revolution has allowed the emergence of global corporations characterized by weakening ties to regional or national priorities. The trend for out-sourcing of business processes and off-shoring of jobs has accelerated as many corporations are now beginning to distribute not only routine production but fundamental aspects of core business activities (e.g., design, innovation, R&D) on a global basis, leaving behind relatively little core competence in their countries of origin. While this can create new regions of high innovation, these too can out-source/off-shore activities to still less expensive, although competent, labor markets, leaving behind enterprises characterized by little value-added aside from financial management and brand name–no longer a solid foundation for a prosperous regional economy. From the United States to India to Viet Nam to Ghana, the out-sourcing/offshoring practices of the global corporation continue to distribute value-adding activities ever further, wherever skilled and motivated labor is available at highest quality and lowest cost.

Today's global corporation conducts its strategy, management, and operations on a global scale. The multinational organization has evolved far beyond a collection of country-based subsidiaries to become instead a globally integrated array of specialized components–procurement, management, R&D, manufacturing, sales, etc.–distributed through the world, wherever attractive markets exist and skilled workers can be found. Geopolitical borders are of declining relevance to global business practices. Global corporations are showing less loyalty to countries of origin and more to regions in which they find new markets and do business (Palmisano, 2006).

It is this reality of the 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 Three: Demographics

The populations of most developed nations in North America, Europe, and Asia are aging rapidly. In the United States, the baby boomers are beginning to retire, shifting social priorities to the needs and desires of the elderly (e.g., health care, financial security, low



The distribution of the world's population represented by the distorted size of nations. (Worldmapper, 2005)

crime, national security, low taxes) rather than investing in the future (e.g., education). In our nation today there are already more people over the age of 65 than teenagers, and this situation will continue for decades to come. Over the next decade the percentage of the population over 60 will grow to over 30% to 40% in the United States, Europe, and parts of Asia. In fact, half of the world's population today lives in countries where fertility rates are not sufficient to replace their current populations. For example, the average fertility rate in the EU has dropped to 1.45 while Japan is at 1.21, compared to the value of 2.1 necessary for a stable population. Aging populations, out-migration, and shrinking workforces are having an important impact, particularly in Europe, Russia, and some Asian nations such as Japan, South Korea, and Singapore (National Intelligence Council, 2004; Baumgardt, 2006).

In sharp contrast, in many developing nations in Asia, Africa, and Latin America, the average age is less than 20 (with over 2 billion teenagers in the world today). Their demand for education will be staggering since in a knowledge economy, it is clear to all that this is the key to one's future security. Yet it is estimated that today there are over 30 million people in the world who are fully qualified to enter a university but for whom no university place is available (Daniel, 1996). Within a decade there will be 100 million university-ready people. Unless developed nations step forward and help address this crisis, billions of people in coming generations will be denied the education so necessary to compete in, and survive in, an age of knowledge. And the resulting despair and hopelessness among the young will feed the terrorism that so threatens our world today.

Growing disparities in wealth and economic opportunity, frequently intensified by regional conflict, continue to drive population migration. The flow of workers across the global economy seeking prosperity and security presents further challenges to many nations. The burden of refugees and the complexity of absorbing immigrant cultures are particularly apparent in Europe and North America.

Immigration is the principal reason why the United States stands apart from much of the rest of the developed world with respect to our demographic challenges. Like Europe and parts of Asia, our population is aging, but our openness to immigration will drive continued growth in our population from 300 million today to over 450 million by 2050. Today differential growth patterns and very different flows of immigration from Asia, Africa, Latin America, the Caribbean, and Mexico are transforming our population. In fact, over the past decade, immigration from Latin America and Asia contributed 53% of the growth in the United

States population exceeding that provide by births (National Information Center, 2006).

As it has been so many times in its past, America is once again becoming a nation of immigrants, benefiting greatly from their energy, talents, and hope, even as such mobility changes the ethnic character of our nation. By the year 2030 current projections suggest that approximately 40% of Americans will be members of minority groups, many–even most–of color. By mid-century we will cease to have any single majority ethic group. By any measure, we are evolving rapidly into a truly multicultural society with a remarkable cultural, racial, and ethnic diversity. This demographic revolution is taking place within the context of the continuing globalization of the world's economy and society that requires Americans to interact with people from every country of the world.

The increasing diversity of the American population with respect to culture, race, ethnicity, 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. Today far from evolving toward one America, our society continues to be hindered by the segregation and non-assimilation of minority cultures. Many are challenging in both the courts and through referendum (e.g., Michigan's Proposition 2) 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. Yet 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. 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.

IBM's Blue Gene P supercomputer, currently the fastest in the world and as a precursor to an even more powerful computer soon to be installed at the University of Illinois.

## Challenge Four: Exponentiating Technologies

The new technologies driving such profound changes in our world–technologies such as information technology, biotechnology, and 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 even shorter–currently 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 may actually be accelerating (Reed, 2005; Kuzweil, 2006).

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 two decades, we will evolve from "giga" technology (in terms of computer operations per second, storage, or data transmission rates) to "tera" to "peta" and perhaps even "exa" technology (one billion-billion or $10^{18}$). 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 on the timescale of decades 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.

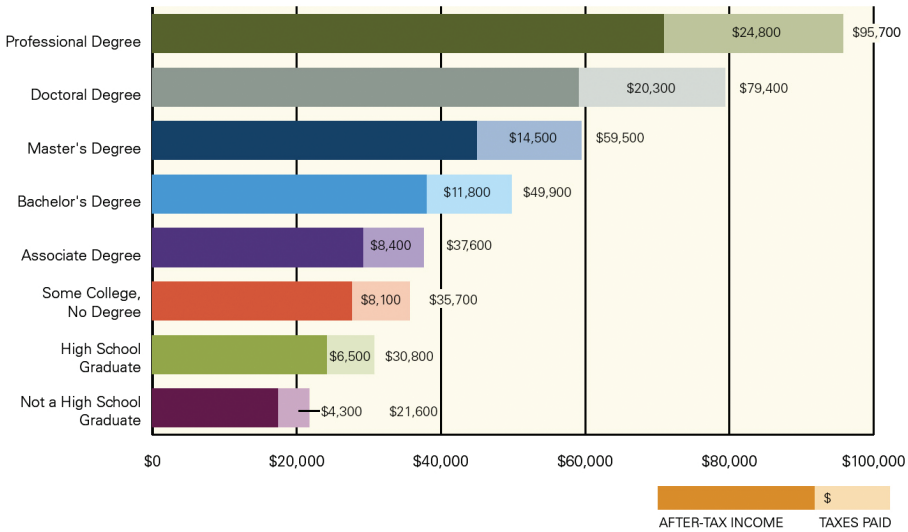
The information and communications technologies enabling the global knowledge economy–so-called *cyberinfrastructure* (the current term used to describe hardware, software, people, organizations, and policies)–evolve exponentially, doubling in power for a given cost every year or so, amounting to a staggering increase in capacity of 100 to 1,000 fold every decade. It is becoming increasingly clear that we are approaching an inflection point in the potential of these technologies to radically transform knowledge work. To quote Arden Bement, director of the National Science Foundation, "We are entering a second revolution in information technology, one that may well usher in a new technological age that will dwarf, in sheer transformational scope and power, anything we have yet experienced in the current information age" (Bement, 2007).

Beyond acknowledging the extraordinary and unrelenting pace of such exponentially evolving technologies, it is equally important to recognize that they are disruptive in nature. Their 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 can 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 governments) 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%




Median earnings and tax payments by level of education
(College Board, 2005)

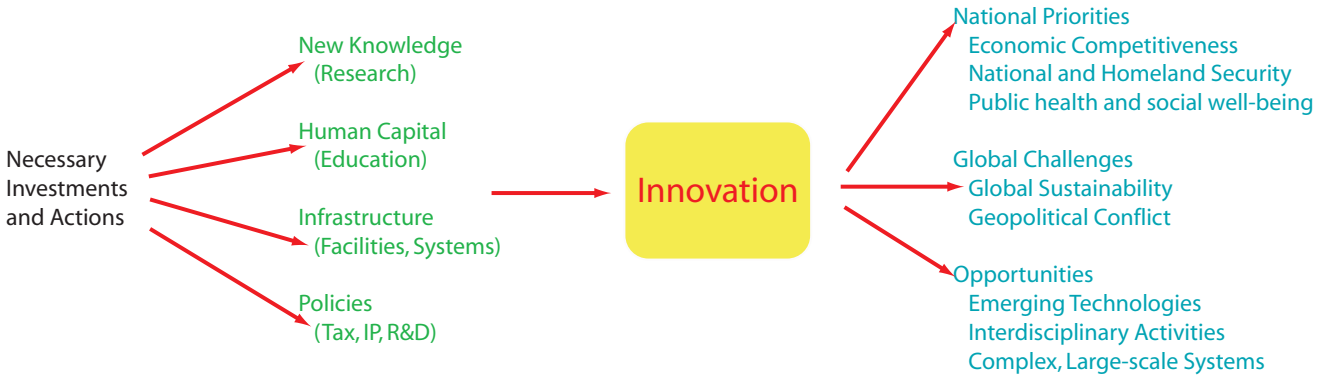
premium in 1980 to 120% today. Not so well known is an even larger earnings gap between baccalaureate-degree holders and those with graduate degrees (College Board, 2005). This should not be surprising in view of the fact that in the knowledge economy, the key asset driving corporate value is no longer 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 many states such as Michigan have been throttling back such investments.

India began making 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




Innovation: the key to prosperity, security, and social well-being in a knowledge-driven economy

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 human capital 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*

In its National Innovation Initiative, the Council on Competitiveness, a group of business and university leaders, highlight innovation as the single most important factor in determining America's success throughout the 21st century. "American's challenge is to unleash its innovation capacity to drive productivity, standard of living, and leadership in global markets. At a time when macro-economic forces and financial constraints make innovation-driven growth a more urgent imperative than ever before, American businesses, government, workers, and universities face an unprecedented acceleration of global change, relentless pressure for short-term results, and fierce competition from countries that seek an innovation-driven future for themselves. For the past 25 years we have optimized our organizations for efficiency and quality. Over the next quarter century, we must optimize our entire society for innovation" (Council on Competitiveness, 2005).

Of course innovation is more than simply new technologies. It involves how business processes are integrated and managed, how services are delivered, how public policies are formulated, and how markets and more broadly society benefit (Lynn, 2007).

However it is also the case that in a global, knowledge-driven economy, technological innovation–the transformation of new knowledge into products, processes, and services of value to society–is critical to competitiveness, long-term productivity growth, and an improved quality of life. 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" (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 warns 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 Academies 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" (Augustine, 2005).

Many nations are investing heavily in the foundations of modern innovation systems, including research facilities and infrastructure and a strong technical workforce. Unfortunately, the United States has failed to give such investments the priority they deserve in recent years. 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 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: the 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*

Yet the traditional institutions responsible for advanced education and research–colleges, universities, research institutes–are being challenged by the powerful forces characterizing the global economy: hypercompetitive markets, demographic change, increasing ethnic and cultural diversity, and disruptive technologies such as information, biological, and nanotechnologies. New technologies are evolving at an exponential pace, obliterating both historical constraints such as distance and political boundaries and enabling new paradigms for learning such as open educational resources, virtual organizations, and peer-to-peer learning networks that threaten traditional approaches to learning, innovation, and economic growth.

On a broader scale, the education investments demanded by the global knowledge economy are straining the economies of many states. 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 ad-

vanced education in this country at exactly the wrong time." (Selengo, 2003).

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. Aging populations demand highest priority for public funding be given to health care, security, and tax relief, forcing higher education systems to become more highly dependent on the private sector (e.g., student fees, philanthropy, or intellectual property). More fundamentally, in a knowledge-driven economy, many governments are increasingly viewing higher education primarily as a private benefit to students and other patrons of the university rather than a public good benefiting all of society, shifting the value proposition from that of government responsibility for supporting the educational needs of a society to university responsibility for addressing the economic needs of government–an interesting reversal of traditional responsibilities and roles.

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*

Markets characterized by the instantaneous flows of knowledge, capital, and work and unleashed by lowering trade barriers are creating global enterprises based upon business paradigms such as out-sourcing and off-shoring, a shift from public to private equity investment, and declining identification with or loyalty to national or regional interests. Market pressures increasingly trump public policy and hence the influence of national governments. Yet the challenges facing our world such as poverty, health, conflict, and sustainability not only remain unmitigated but in many respects become even more serious through the impact of the human species–global climate change being foremost among them. The global knowledge economy requires thoughtful, interdependent and globally identified citizens. Institutional and pedagogical innovations are needed to confront these challenges and insure that the canonical activities of universities – research, teaching and engagement – remain rich, relevant and accessible.

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.

Yet despite the fact that leading universities throughout history have been highly international in the nature of their students, faculty, and academic programs, they have yet to adapt to a global environment. To be sure, they are increasingly subject to influence by powerful global market forces and disruptive technologies. Markets and globalization influence universities, sometimes shaping education both in terms of what is taught and what is researched, and shifting both student interests and university offerings away from broader academic studies and toward narrower vocational programs. There is a discernable commercialization of universities, defining their purpose increasingly in terms of their role in economic development, sometimes at the

expense of more fundamental roles such as challenging the norms of society, securing and transmitting cultural heritage from one generation to the next, mentoring entrants into the professions, accrediting competency and skills, and striving to provide their students with personal understanding and the tools for societal transformation.

Part of the challenge is balancing the needs of various stakeholders in higher education–predominantly the state, students, and business–and keeping all three satisfied without distorting the fundamental purpose of the university. For example, there is a growing utilitarianism associated with the role of higher education in addressing the need for human capital that could overwhelm the university's traditional social and cultural impact on society and civilization–its transformative potential through the creation, retention, and dissemination of knowledge. We are witnessing across the globe a shift from general to vocationally orientated higher education aimed at supporting career development. The distinction between academic and vocational education is becoming increasingly blurred in a knowledge economy. There is a growing tendency for a range of stakeholders in higher education to use the language of 'useful knowledge' in the discourse about where resources should be deployed in research, teaching and knowledge transfer that offers a very limited and partial view of the transformative potential of higher education. Should we simply assume that the state would step in to support strategic and vulnerable programs such as the arts and humanities as greater numbers of students opted for more vocationally oriented subjects, driven in part by the financial burdens of increasing tuition levels as well as by employment opportunities? Or should this be the responsibility of university faculties and leadership?

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 imposing 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).

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 government 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? Or will leaders of government and higher education work together to use public policy and public investment to shape the global knowledge and learning marketplace to preserve the important values, traditions, missions, and purpose of the university?

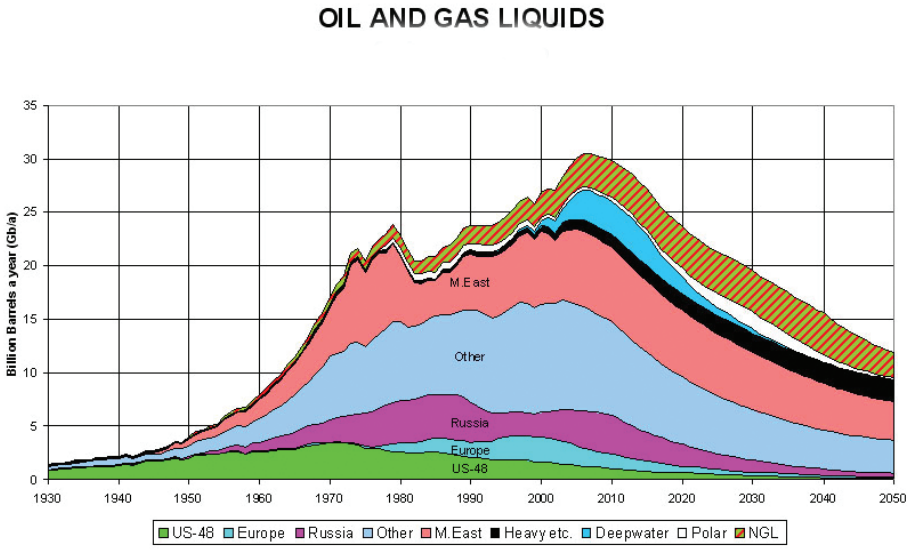
## Tomorrow's Horizon

Attempting to predict the future is always a hazardous 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*

There are few contemporary challenges facing our nation–indeed, the world–more threatening than the unsustainable nature of our current energy infrastructure. Every aspect of contemporary society is dependent upon the availability of clean, affordable, flexible, and sustainable energy resources. Yet our current energy infrastructure, heavily dependent upon fossil fuels, is unsustainable. Global oil production is expected to peak ("Hubbert's Peak") within the next several decades, with natural gas production peaking soon afterwards. While there are substantial reserves of coal and tar sands, the mining, processing, and burning of these fossil fuels poses increasingly unacceptable risk to both humankind and the environment, particularly within the context of global climate change. Furthermore, the security of our nation is threatened by our reliance on foreign energy imports from unstable regions of the world. Clearly if the federal government is to meet its responsibilities for national security, economic prosperity, and social well being, it must move rapidly and aggressively to address the need for a sustainable energy future for the United States. Yet time is not on our side.

Recent analyses of world petroleum production and known reserves suggest that global oil production could peak as early as the next decade (with gas production peaking roughly a decade later). "Holding off the peak until 2040 would require both a high–and much less certain–total oil resource and adding more production each year than ever before, despite having already produced all of the world's most easily extractable oil" (Science, 2007). The consequence of passing over the global production peak is not the disappearance of oil;




Will Michigan industry be able to survive the eventual peaking in global oil production?

roughly half of the reserves would remain. Rather it would be a permanent imbalance between supply and demand that would drive oil prices dramatically higher than today's levels–$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 (Goodstein, 2004).

A recent assessment by the U. S. Department of Energy 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). Other views are even more alarming: "I think there will be a catastrophe in the next five years, a catastrophe having to do with energy availability. Just a little more of a glitch in the Middle East and worldwide panic will set in because there is no oil available. I'm not so worried about the cost of fuel–I'm more worried about how ugly this world will get when fuel gets scarce. Most of us won't want to live in a world where people are really scared about where their energy is coming from!" (Gray, 2007)

The Great Lakes region, as nexus of energy-intensive industries such as manufacturing, agriculture, and transportation, is particularly dependent upon federal energy policy. Today the industries of the region utilize 38% of the nation's electricity, produced primarily from coal-fired plants. Should electrical power generation from fossil fuels be sharply curtailed or should prices skyrocket through regulatory requirements for carbon sequestration, there is little likelihood that our remaining industrial capacity would remain competitive in the global economy.

Furthermore, Michigan, as the hub of the nation's automobile industry, is at particular risk. Over 500,000 Michigan jobs, directly or as a multiplier, are dependent upon energy and related industries (e.g., transportation and electrical power generation). Spiking of gasoline prices to Asian and European levels (currently $7 per gallon and above) would likely obliterate what remains of the American automobile industry, since it is unlikely that domestic companies would be able to shift rapidly enough to the small, fuel-efficient cars produced by Asian manufacturers or adept enough to exploit hybrid, electric, or hydrogen fuel technologies. While it is certainly appropriate that the federal government implement far more aggressive fuel mileage standards, whether the goal for 2020 of a 20% improvement proposed by the administration or the 40% proposed by Congress, it is also increasingly clear that without massive federal investment in the energy R&D to develop

new technologies such as biofuels, advanced battery technology, hydrogen fuel cycles, or other low carbon propulsion systems, such standards by themselves will almost certainly amount to a death sentence for one of the nation's most important industries.

*Global Sustainability*

There is compelling evidence that the growing population and 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 change makes all too apparent.

Evidence of global warming is now incontrovertible–increasing global surface and air temperatures, receding glaciers and polar ice caps, rising sea levels, and increasingly powerful weather disruptions, all confirm that unless the utilization of fossil fuels is sharply curtailed, humankind could be seriously threatened. The recent Intergovernmental Panel on Climate Change concluded that: "Global atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values. The global increases in carbon dioxide concentration are due primarily to fossil fuel use and land-use change" (IPCC, 2007). Add to this the possibility of truly cataclysmic nonlinear events such as a massive release of carbon dioxide from melting Artic tundra or a change in the Earth's albedo from melting of the polar ice caps,

The greatest challenge of the 21st century: global sustainability.

and it is clear why Lewis characterizes our current energy practices as "the biggest experiment on Planet Earth than humans ever have done, and we get to do that experiment exactly once!" (Lewis, 2007)

Although there continues to be disagreement over particular strategies to slow global climate change–whether through regulation that restricts the use of fossil fuels or through market pressures (e.g., "cap and trade" strategies)–there is little doubt that energy utilization simply must shift away from fossil fuels toward non-hydrocarbon energy sources. Yet as John Holdren, president of the AAAS, puts it, "We are not talking any more about what climate models say might happen in the future. We are experiencing dangerous disruption of the global climate, and we are going to experience more. Yet we are not starting to address climate change with the technology we have in hand, and we are not accelerating our investment in energy technology R&D" (Holdren, 2007).

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 United States 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 will 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 consumption-dominated economies.

To be sure, there are some signs of optimism: a slowing population growth that may stabilize during the 21st century 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).

*Global Poverty and Health*

During the past several decades, technological advances such as the "green revolution" have lifted a substantial portion of the world's population from the ravages of poverty. In fact, some nations once burdened by overpopulation and great poverty such as India and China, now are viewed as economic leaders in the 21st century. Yet today there remain substantial and widening differences in the prosperity and quality of life of developed, developing, and underdeveloped regions; between the North and South Hemisphere; and within many nations (including the deplorable level of poverty tolerated in our own country).

It is estimated that roughly one-sixth of the world's population, 1.5 billion people, still live in extreme poverty–defined by Jeffrey Sachs as "being so poor you could die tomorrow", mostly in sub-Saharan Africa, parts of South America, and much of central Asia. Put in even starker terms, "More than 8 million people around the world die each year because they are too poor to stay alive. Malaria, tuberculosis, AIDS, diarrhea, respiratory infections, and other diseases prey on bodies weakened by chronic hunger, claiming more than 20,000 lives each day" (Sachs, 2004).

These massive global needs can only be addressed by both the commitment of developed nations and the implementation of technology to alleviate poverty and disease. The United States faces a particular challenge and responsibility in this regard. With just 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, 2003).

*Civil Infrastructure*

The new technologies of the 20th century were remarkable in their capacity to meet the needs of a rapidly growing global population, building great cities, transportation networks, and economic infrastructure. To be sure, they also led to horrific weapons of mass-destruction that laid to waste entire nations and their populations in global conflict. Yet eventually rebuilding occurred, and at least in much of the world, the infrastructure is in place to provide for societal well being and security.

Yet much of this infrastructure is aging, already inadequate to meet not simply population growth but growing economic activity. The patchwork approach used all too often to rebuild civic infrastructure–electrical distribution networks, water distribution systems, roads and bridges–has created new complexities poorly understood and even more difficult to address. These infrastructure challenges are intensified by demographic trends toward urbanization, where jobs and resources are found. A recent United Nation's study notes that for the first time in human history, more people are living in cities than rural areas. Over the next 30 years, more than two billion people will be added to the population of cities in the developing world, where within the next decade urban will exceed rural populations.

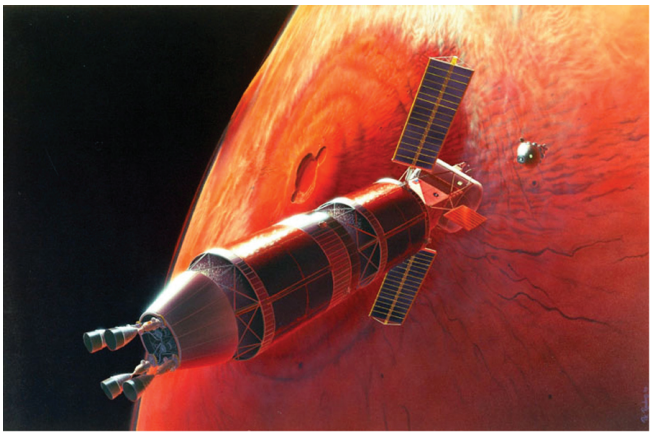
When combined with the incredible strain on urban systems in developing nations caused by population concentrations in mega-cities of tens of millions or transportation networks overwhelmed by the desire for mobility, it is clear that entirely new technologies and engineering approaches are needed to build and maintain the infrastructure necessary to accommodate a global population of 8 to 10 billion while preserving the capacity of the planet to support humankind.

Clearly new technologies are needed to address urgent needs for food, water, shelter, and education in the developing world. Yet even in our own country the increasing complexity of our society requires new levels of reliability and confidence. When levies fail in New Orleans, a bridge falls in Minneapolis, a blackout occurs in the Northeast, or a national computer network goes down under cyberattack, people become not only more aware of the impact of technology on personal safety and public health, but moreover question the competency of American industry to design and manage such complex systems. Such failures, both unavoidable and yet predictable, diminish our ability to contribute value to society, placing a high premium on reliability and, when necessary, recovery and forthright communication.

As economic activity shifts from exploitation of natural resources and the manufacturing of material goods to knowledge services, i.e., from atoms to bits, we will need entirely new intellectual paradigms to create value in the global knowledge economy. Just as two decades ago new methods such as total quality management and lean manufacturing reshaped our factories and companies while triggering entirely new forms of engineering, today we need to develop the new methods capable of creating innovation in a services economy characterized by extraordinarily complex global systems. Industry will be challenged to develop new and more powerful approaches to design, innovation, systems integration, and entrepreneurial activities in support of the global knowledge economy (Donofrio, 2005).

*Still More Possibilities*

Still other possibilities 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, between 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.



Perhaps humankind will once again launch an era of space exploration...to Mars and beyond.

Then, too, the unrelenting–indeed, accelerating–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.

The acceleration of technological progress has been the central feature of the past century and is likely to be even more so in the century ahead. But technology will also present new challenges that almost seem taken from the pages of science fiction. John von Neumann once speculated, "The ever accelerating progress of technology and changes in the mode of human life gives the appearance of approaching some essential singularity in the history of the race beyond which human affairs, as we know them, could not continue." At such a technological singularity, the paradigms shift, the old models must be discarded, and a new reality appears, perhaps beyond our comprehension. Some futurists such as Ray Kurzweil and Werner Vinge have even argued

that during this century we are on the edge of change comparable to the rise of human life on Earth. The precise cause of this change is the imminent creation by technology of entities with greater than human intelligence. For example, as digital technology continues to increase in power a thousand-fold each decade, at some point computers (or large computer networks) might "awaken" with superhuman intelligence. Or biological science may provide the means to improve natural human intellect (Kurzweil, 2006).

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

## Today (2005)

Globalization
- Transport + Commun
- Integrated Economies, Culture, Conflict

Demographics
- Population Growth
- Baby-boomers vs. Global Teenager
- Diversity

Exponentiating Technologies
- Info-bio-nano technology
- Complex systems

Explosion of New Knowledge

Implications

Hypercompetitive, global, knowledge-driven economy

Global disparity in wealth and power driving geopolitical conflict

Market forces dominating public policy

Obsolescence of existing social institutions (e.g., nation-state)

## Tomorrow (2010-2050)

Global Sustainability
- Population growth to 8 - 10 billion
- End of fossil fuels
- Global climate change
- Poverty, global health, infrastructure

Hypercompetitive, integrated, global economy
- China, India, Eastern Bloc
- Off-shoring

National/homeland Security
- Terrorism vs. freedom

Exponentiating Technologies

Possible surprises:
- Human lifespan doubles (or pandemics)
- Disappearance of work
- Artificial intelligence ("mind children")
- Close encounters of the third kind

## Michigan Challenges

Erosion of Traditional Economic Base
- Low-skill jobs (outsourcing) and high-skill jobs (off-shoring)
- No obvious candidate for future economic engine
- Current culture hostile to innovation

Increasing obsolescence of social institutions–but resistant to change
- Government, corporations, labor, education
- Political system, public opinion

Structural budget obsolescence
- Unfunded mandates (Medicaid, K-12, Corrections)
- Obsolete tax system (irrelevant to a service economy)

Inadequate Michigan leadership
- Sense of denial–hoping the past will return
- Lack of vision–and inability to develop one
- Clueless–today's political issues are meaningless
  - (gay marriage, affirmative action, creationism, stem cell ban)
- Current priorities are basically stupid
  - Detroit casinos, SUVs, Michigan football

Investments in higher education, research, and innovation are
- Woefully inadequate (lowest in Midwest)
- Blatantly political (Merit Scholarship Program, Life Sciences Corridor)
- Tragically ill-considered (Low tuition + low support = low quality + low access; targeting R&D investments to areas of weakness)

# Chapter 3

## Michigan Today: A Knowledge Resource Map

Throughout the 20th century both America and Michigan have been leaders in the world economy. 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. Vast natural resources provided the opportunities for prosperous agriculture, lumbering, and mining industries. Our ancestors made our farms and our factories the best in the world. Yet from the beginning Michigan believed in its people and invested heavily in their education and training, embracing the spirit of the Northwest Ordinance, which stated: "Religion, morality, and knowledge being necessary to good government and the happiness of mankind, schools and the means of education shall forever be encouraged."

There was broad recognition that Michigan's most valuable resources were its people. Hence investment in the knowledge, skill, and ability of its people was seek as key to Michigan's competitive edge in achieving global leadership in innovation, productivity, and trade. Michigan built a great education system of schools, colleges, and universities aimed at serving all of its citizens. It created and supported a social and civil infrastructure that was the envy of the nation. Michigan companies invested heavily in R&D and technological innovation, working closely with the state's 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. State leaders 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. And the payoff was enormous, as Michigan led the world in productivity and prosperity. It rapidly became the engine driving the nation's economy. During the last century it was Michigan that first put the world on wheels and then became the arsenal of democracy to defend freedom during two world wars.

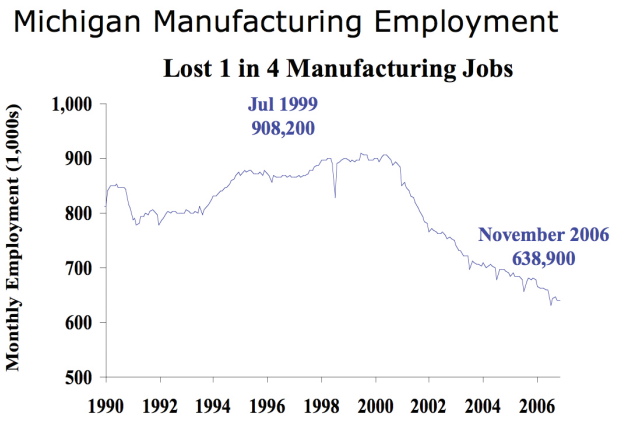
But that was yesterday. What about Michigan today? Ironically, as never before, the prosperity and social well-being of our state today is determined by the skills, knowledge, and talents of our people. In the global, knowledge-driven economy, educated human capital is king. Yet here, the vital signs characterizing Michigan today are disturbing indeed. 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 their 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, to 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 generous retirement benefits, expensive health care, ever more prisons, and reduced

tax burdens, rather than demanding that Michigan begin investing once again in education, innovation, and the future.

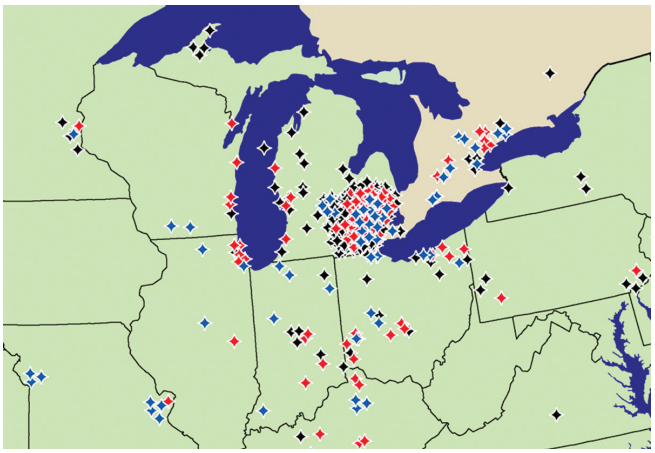
While a candid assessment of our state's current capacity to create a competitive workforce and knowledge infrastructure for today's global economy will likely ruffle some feathers of those clinging tightly to past successes and present policies, it is nevertheless imperative that we begin the roadmapping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

## The Michigan Economy

The economy of Michigan is approximately $308 billion per year, which ranks it 16th in the world, greater than Argentina, Belgium, Switzerland, and Russia. 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, with a particularly high concentration of automobile assembly plants. 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).

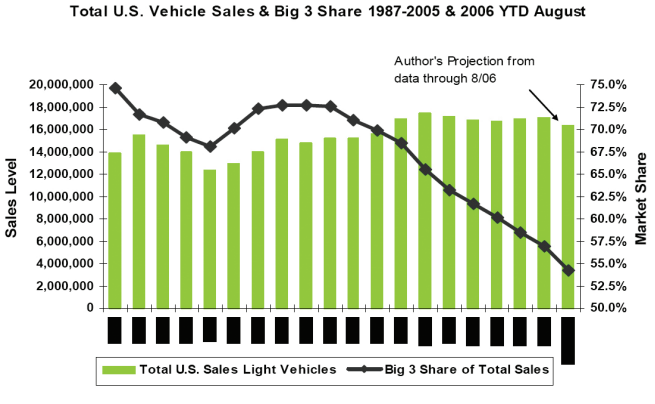



The loss of 25% of Michigan manufacturing jobs since 2000 (CRC, 2007)



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

There are many signs that the state is struggling to make the necessary transition from a manufacturing economy to a knowledge economy. Michigan has experienced six consecutive years of net job losses, the longest losing streak since the Great Depression. Since 2000 Michigan has lost one-quarter of its manufacturing jobs–246,000–and as the Big Three's share of domestic auto sales continues to plummet from 74% in 1993 to 49% in 2007 (and projected to decline further to 45% in 2011), the remaining 634,000 manufacturing jobs are clearly at risk. 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.




The rapid decline of domestic market share by GM, Ford, and Chrysler (CRC, 2007)

As low-skill, high-pay factory jobs were eliminated through enhanced productivity or shifted to lower cost states or nations, Michigan lost 465,000 jobs from 2000 to 2006, a 30% decline, among them 270,000 manufacturing jobs. In 2006 Michigan had the worst performing state economy in the nation, ranking as the only state that has lost more jobs than it created. 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 2006 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.

To summarize, over the past decade Michigan's economy has dropped to the bottom of the nation:

- 50th in personal income growth
- 50th in unemployment rate
- 50th in employment growth
- 50th in the index of economic momentum
- 50th in its support of higher education
- (And among the nation's leaders in incarceration rate and prison costs...)

Michigan has become, in effect, the poster child for what happens when a region ignores the imperatives of the global, knowledge economy. And yet some suggest that Michigan as yet to hit bottom. As David Littman, a senior economist for the Mackinac Center for Public Policy predicts, "We're in a secular decline here in Michigan. We're going to see Michigan sink to levels that no one has ever seen before. We're going to be looking at the highest unemployment rates in the nation for the next five to ten years." (CRC, 2007)

While many other states have also experienced significant declines in manufacturing employment, they are managing to replace these with knowledge-services jobs. Although Michigan has experienced some growth in the knowledge services sector, it 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 already evolved into post-industrial economies. By contrast, Michigan's 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

The old economy

The new economy

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).

## Human Capital

In a knowledge economy, educated and skilled human capital is the name of the game. Yet here Michigan's powerful manufacturing economy and prosperity during the past century, based upon highly compensated but low skill jobs, has created a blue collar culture in which education was rarely viewed as a necessity and high paying jobs were assumed to be an entitlement.

To be sure, Michigan has a large population, 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. Yet today in the face of a weak economy, Michigan's population is actually declining, dropping by more than 30,000 in 2007. Michigan leads the nation in out-migration, which has risen from 40,000in 2004 to more than 94,000 in 2007. Of particular concern is the anticipated loss of 12% in its 25- to 44-year old population from 2000 to 2025 as this group seeks job opportunities and quality of life in 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.

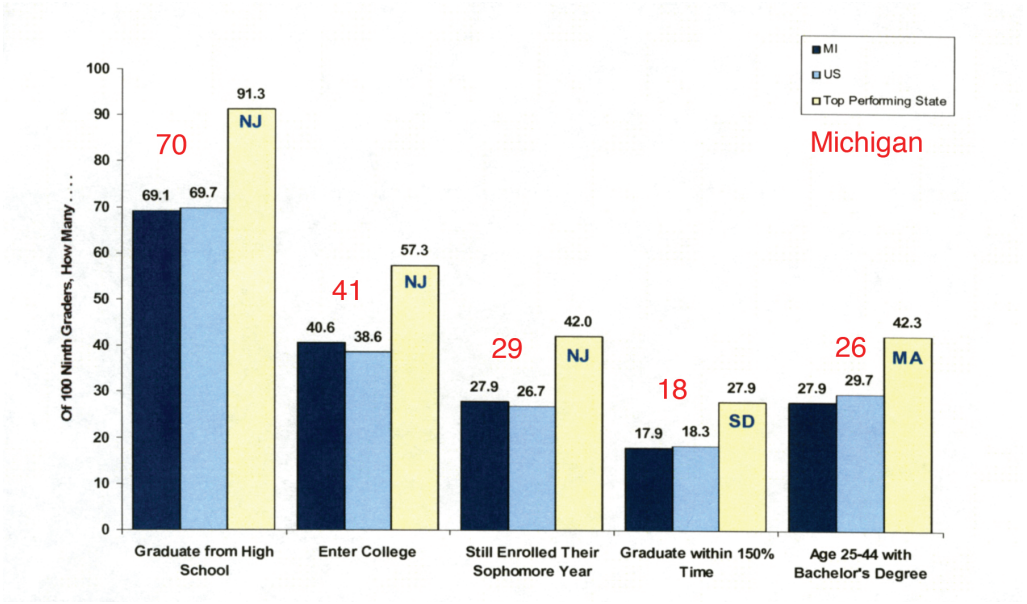
Michigan's population is aging rapidly. Over the next decade school age children (5 to 17) are projected to drop by more than 14%, while traditional college age students (18 to 22) will drop by 9% (although adult learner demand will almost certainly compensate for the latter decline). The Michigan labor force is projected to drop by 4%. Perhaps most striking, however, is a projected increase of 31% (413,000) in the senior population (over the age of 65), which will have major implications for health care costs, economic productivity, and public priorities (CRC, 2007). Of comparable concern is the trend for affluent elder citizens to leave Michigan as they retire in warmer climates, taking their accumulated wealth and support for the state's cultural assets with them.

Beyond demographics, Michigan's human capital is also threatened by the clear failure in achievement at all levels of our educational system. An estimated 44% of Michigan adults currently function at a literacy level considered too low to participate adequately in today's knowledge economy. One quarter of Michigan's current adult population does not have a high school diploma. Only 70% of Michigan 9th graders graduate from high school four years later. Although 90% of 8th graders say they want to go to college, only 41% of high school freshmen in Michigan enroll in college four years later, 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 leading 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 colleges, 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!).

Michigan's current population has a 22% level of bachelor's or advanced degrees, 4% below the national average, ranking Michigan 34th nationally. 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, many of whom remain in the state to work with Michigan companies.

This latter fact 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. This shortfall is particularly serious in areas such as science, engineer-




The Michigan education pipeline: Of 100 students entering high school, only 70 will graduate, while 41 will enter college, and only 18 will graduate within six years of admission.

ing, information technology, and other knowledge-intensive disciplines. Yet 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. While some state politicians object to Michigan universities enrolling students from other states or nations, 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.

## K-12 Education

Numerous studies have established that in the knowledge economy, education has become the key to not only to economic prosperity but as well to one's personal standard of living and quality of life. The breakpoint between those who graduate from secondary and continue on to succeed in college and those who fail is perhaps the most critical decision point in one's life (McPherson and Schapiro, 2005). Hence the Achilles heel of our nation's educational system has become K-12 education in general and secondary education in particular. As the recent National Commission on the Future of Higher Education in America (the so-called "Spellings Commission") concluded, access and success in higher education in the United States today is unduly limited by the complex interplay of inadequate preparation, lack of information about college opportunities, and persistent financial barriers (Miller, 2005).

Although the United States once ranked as a world leader in academic achievement and participation at both the K-12 and college level, today we have fallen behind many other nations. More specifically, when compared to the 30 OECD nations, the United States ranks 16th in high school graduation rates and 24th in learning proficiency for 15 year olds, with 25% of our students failing to graduate from high school, and the percentage continuing on to college stagnant at 60% for the past 20 years. The Spellings Commission stressed, "Too many Americans who could benefit from postsecondary education do not continue their studies at all, whether as conventional undergraduates or as adult learners furthering their workplace skills. While there are important actions that can be taken both by colleges and universities and by their patrons (state and federal government, private support) to improve access at the margin, major gains are not likely without a sustained improvement in secondary education. Dismal high school achievement rates nationwide have barely budged in the last decade. Close to twenty-five percent of all students in public high schools do not graduate – a proportion that rises among low income, rural, and

minority students."

Furthermore even the educational achievements of many of our young people who do complete high school are simply not high enough to allow them to succeed in college. According to the National Assessment of Educational Progress (NAEP), only 17% of high school seniors are considered proficient in mathematics and just 36% are proficient in reading. Although the average scores of Michigan students on national achievement tests (NEAP) are only slightly below the national average, they lag far behind the leading states. Only 9% of Michigan high school students take AP exams compared to 12% at the national level and 18% in the top states; 37% of Michigan 8th graders take algebra compared to 41% nationally and 56% in leading states.

Not surprisingly, the consequences of substandard preparation and poor alignment between high schools and colleges persist in college. Remediation has become far too common an experience for American postsecondary students. Some 40% of all college students end up taking at least one remedial course—at an estimated cost to the taxpayers of $1 billion. Additionally, industry spends significant financial resources on remediation and retraining.

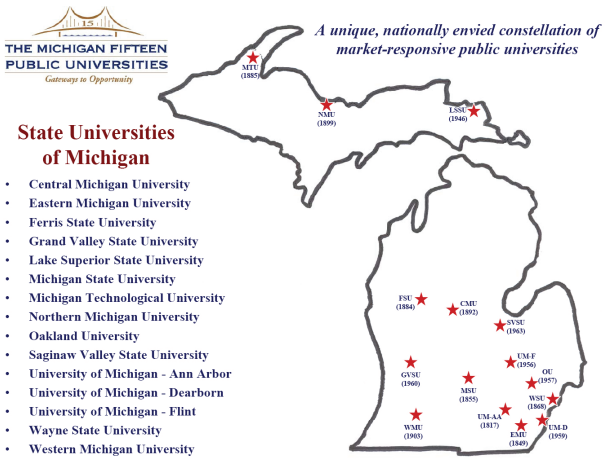
Access and achievement gaps disproportionately affect low-income and minority students. Historically these are the very students who have faced the greatest academic and financial challenges in getting access to or completing college. Many will be the first in their families to attend college. Regardless of age, most will work close to full-time while they are in college and attend school close to home. Despite years of funding student aid programs, family income and the quality of high school education remain major factors in college-level access and success. By age 25, about 34 of every 100 whites obtain bachelor's degrees, compared to 17 of every 100 blacks and just 11 of every 100 Latinos. Just as dismaying, low-income high school graduates in the top quartile on standardized tests attend college at the same rate as high-income high school graduates in the bottom quartile on the same tests. Only 36 percent of college-qualified low-income students complete bachelor's degrees within eight and a half years, compared with 81 percent of high-income students (Miller, 2005).

There is ample evidence to indicate that a key component of our national achievement problem is insufficient alignment between K-12 and higher education. Studies show the overwhelming majority of both college and high school faculty and administrators are unaware of the standards and assessments being used by their counterparts in higher education. For example, only eight states require high school graduates to take at least Algebra II—a threshold course for college-level success in math-based disciplines including engineering and science. Fewer than 22% of the 1.2 million students who took the ACT college-entrance examinations in 2004 were ready for college-level work in the core subjects of mathematics, English and science. Forty-four percent of faculty members say students aren't well prepared for college-level writing, in contrast to the 90 percent of high school teachers who think they are prepared.

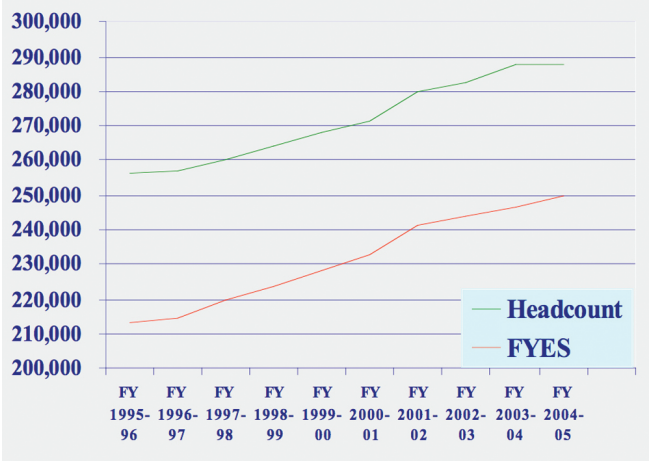
Here Michigan has made significant progress by adopting some of the most rigorous requirements for K-12 education in the nation. However the achievement of these goals will be a challenge for many of the state's school systems, particularly those in economically disadvantaged areas where poverty and job losses have taken a serious toll on schools and families. Clearly the scholastic achievement of students depends very heavily on the social communities in which they are imbedded. Poverty and jobs losses have taken a heavy toll on families in recent years, as has the erosion of social services as both state and community support has eroded. Particularly during 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 in Michigan, and we see the effects in our classrooms in the youth who fall by the wayside, their mindpower gone to waste.

## Higher Education

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,




Michigan's 15 public university campuses




Michigan universities have experienced signficant increases in student enrollment over the last decade.

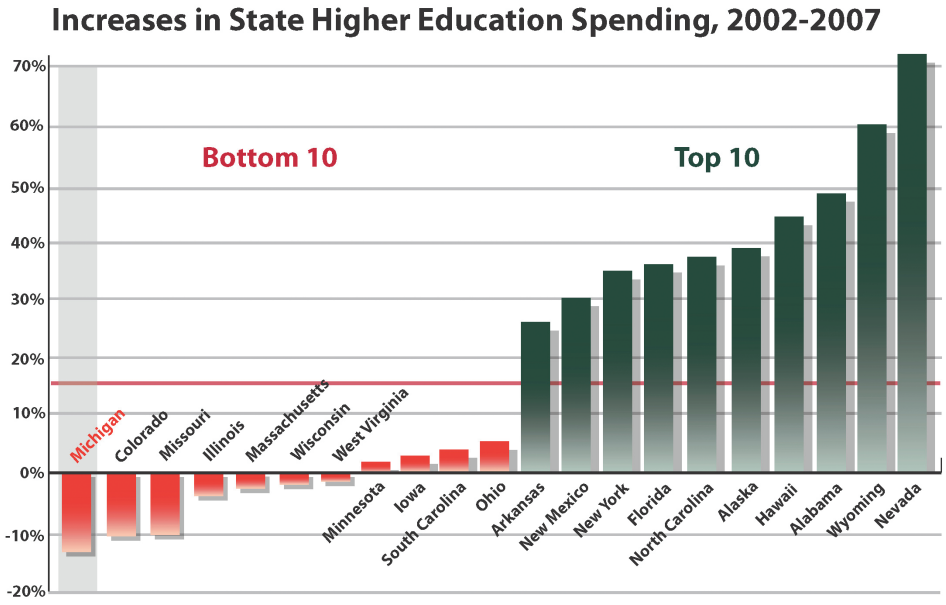
UMD). These institutions enroll approximately 660,000 students (four-year publics: 275,810; two-year publics: 192,051; four-year privates: 98,436; 2-year privates: 1,334) (Almanac, 2004). Degrees awarded at these institutions in 2003 included: Associate: 19,534; Bachelor's: 46,115; Master's: 21,342; Doctorate: 1,403; Professional: 2,371.

The impact of these institutions is considerable. Enrollments have been increasing quite rapidly over the past decade (roughly 30%), even as state support has been declining. 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.

Michigan institutions have also been very active in using information technology in creating Internet-based learning initiatives. The Michigan Virtual University, established in 1998 as a private, not-for-profit Michigan corporation, was one of the first such Internet-based universities 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. At the K-12 level, 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); Cranbook 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




*Michigan's higher education investment over the last five years has been the lowest in the nation, and well under the national average of 15.1 percent over that period. Some of the nation's fastest growing states are those leading the nation in higher education appropriations.*

*Source: Grapevine Web site, Michigan figures updated for May budget cuts*

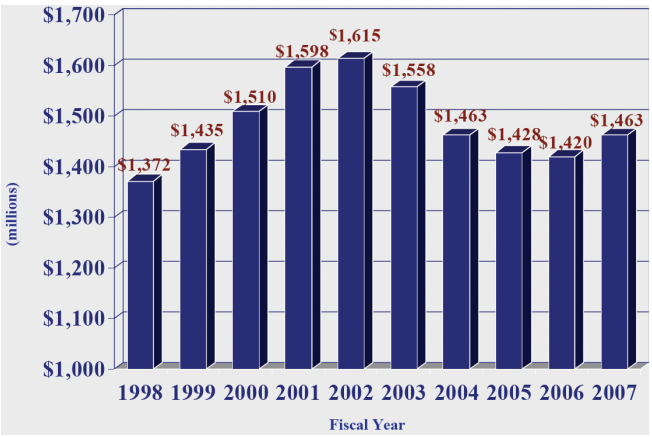
Despite the widespread recognition of the importance of the Michigan's universities to its future, state government has responded by slashing university appropriations to the point where Michigan now ranks last in the nation in its support of higher education over the past six years.

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 on their home computer or 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 30% of state appropriations for the state's public universities over the past six years, dropping Michigan to 50th in the nation–dead last–in the change of its support of higher education over this period. In absolute terms, state support per student has dropped from $6,840 in 2001 to $5,700 in 2007, ranking it last among the Great Lakes states (which average $6, 900) and in the bottom third of the nation. When adjusted for inflation, this amounts to a loss of $2,302 per student–a 28% loss in state support. In fact, over this period, the state has cut $300 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.

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 most highly ranked institution, 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




State appropriations to public universities


State appropriations per fiscal-year-equivalent student

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 actual tuition price at Michigan's 15 public universities (PCSUM, 2006). In fact, the actual cost to students 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 tuition (and real costs to students and parents) is likely to rise dramatically in the next several years if these cuts are not restored by state government.

## Research and Development

Although federal statistics (National Science Board, 2006) 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 classified as R&D, in contrast to more fundamental basic and applied research, which has largely disappeared from most of Michigan industry. 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.

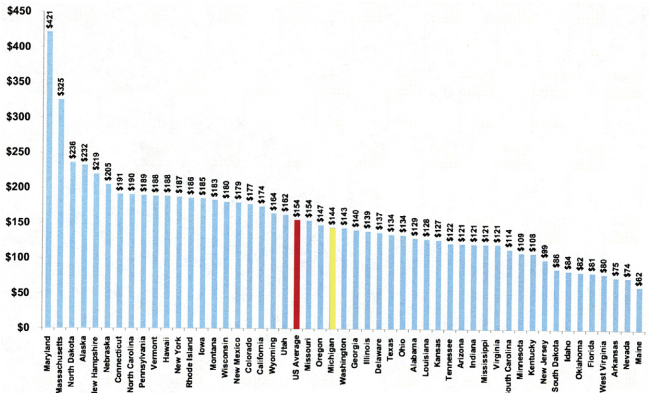
Although Michigan's manufacturing industry is heavily technology-dependent, Michigan's high-tech sector is smaller than the national average (5.6% compared to 6.0% nationally). Perhaps of most concern, however, is the relative weakness in high-tech spinoffs and startups. But again this should not be 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 and sustained by its three research universities: the University of Michigan (Ann Arbor), Michigan State University, and Wayne State University. Similarly, doctorate production

in science and engineering is also somewhat above the national average. The economic impact of this research on the state has been estimated at over $6.5 billion annually (Hollis, 2007). 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 Michigan's research universities 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 in recent years as they have slashed the budgets of these institutions.

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 pharmaceutical industry. The state has extended this concept to 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




State academic R&D per capital

dozen "Smart Zones" with tax structures favorable to high-tech businesses and Business Accelerators to help companies incubate and commercialize products.

Most recently Michigan's three research universities have created a new collaborative effort in a similar vein, the University Research Corridor. An independent analysis estimated that this effort has contributed over 68,800 jobs to the state's economy. Its economic impact is currently estimated at $12.8 billion, over 20 times the current state investment through annual appropriations in these three institutions (Hollis, 2007).

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 under-funded public higher education in recent years. So too, Michigan still suffers from the legacy culture characterizing its 20th century manufacturing industry–big business, big labor, big government, big financial institutions–which can inhibit the grown of small high-tech ventures.

Ironically, while Michigan still suffers from weak leadership and inadequate investment in knowledge resources, the federal government seems to be finally getting its act together. After many years of effort by many groups and individuals (e.g., the Science Coalition, the National Academies–particularly COSEPUP–the Council on Competitiveness, and of course, Mr. Friedman), the federal government has finally been persuaded to increase its investment in the knowledge and human capital essential to competitiveness and security in an innovation-driven global economy. In its National Innovation Initiative, the Council on Competitiveness, a group of business and university leaders, highlighted innovation as the single most important factor in determining America's success throughout the 21st century.

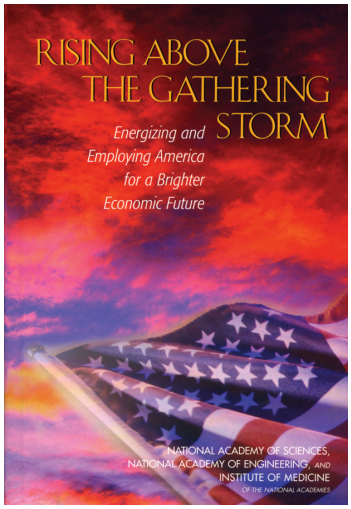
In a global, knowledge-driven economy, technological innovation–the transformation of new knowledge into products, processes, and services of value to society–is critical to competitiveness, long-term productivity growth, and an improved quality of life (CoC, 2004).

The concerns raised by leaders of industry, higher education, and the scientific community, culminating in the National Academies' Rising Above the Gathering Storm study, have stimulated the federal government to launch two major efforts aimed at sustaining U.S. capacity for innovation and entrepreneurial activities: the administration's American Competitiveness Initiative and Congress's America COMPETES Act (the latter being an awkward acronym for "Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science".) If fully implemented, over the next decade these efforts will involve doubling federal investment in basic research in physical science and engineering; major investments in science and engineering education; tax policies designed to stimulate the private sector in R&D; streamlining intellectual property policies; immigration policies that attract the best and brightest scientific minds from around the world; and building a business environment that stimulates and encourages entrepreneurship through free and flexible labor, capital, and product markets that rapidly diffuse new productive technologies.

Yet while the early effort has been impressive, successful implementation of these programs will require strong leadership over many years, just as did the successful effort to double NIH funding during the past decade. The delay of the program that occurred in the FY09 budget battle between the president and Congress provides a disturbing example of just how vulnerable such strategic actions are to political forces (Science, 2008).

## Other Assets

Michigan has other knowledge assets with major implications for the state's future. Although not widely recognized by either state leaders or Michigan 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




The National Academies report on the state of American R&D

public universities, joined with IBM and MCI in building NSFnet, the backbone national network for scientific research. This Michigan-managed network was later expanded as an "internetwork" to include other federal networks (DOD, DOE, NASA) and eventually was renamed the Internet. As network traffic continued to grow exponentially in the early 1990s, doubling every few months, Merit spun off management of the Internet backbone 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 technology companies.

Similar advanced information technology 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 25 of the world's great libraries (whose holdings are estimated to contain over 60% of the world's books), 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, natural re-

sources, and sustainable energy, stimulated by an earlier state investment in the Michigan Biotechnology Institute and MSU's strong international reputation in agricultural research and development. In 2007 MSU and the University of Wisconsin were awarded a $125 million grant from the Department of Energy to establish the Great Lakes Bioenergy Research Center to conduct research aimed at converting natural materials into energy.

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. 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 because of their high degree of automation compared to those in areas such as information or financial services.

Michigan's hopes of a strong life sciences industry suffered another major setback in 2007 when Pfizer announced its intent to close its Michigan research activities. Although the state 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) 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) made this huge

Pfizer Research Laboratories in Ann Arbor
(Closed in 2007...R.I.P.)

laboratory expendable during a recent financial downturn, and it was closed in 2007, eliminating over 2,400 high paying knowledge jobs in Michigan (and 2,100 in Ann Arbor). The disappearance of first UpJohn in Kalamazoo and then Pfizer in Ann Arbor has significantly weakened the Life Science Corridor effort.

## 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–a conclusion reached by 80% of Michigan citizens in recent polls (Detroit News, 2007). The state'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.

Many of Michigan's problems arise from the fact that it has slipped significantly below the national average–and the Great Lakes region–in many measures critical to prosperity and social well-being in a global, knowledge-driven society:

- While personal and corporate tax burdens are below the national average and considerably below those characterizing states competitive in the new economy (e.g., the West Coast and New England), so too has Michigan's tax revenue declined to levels inadequate to meet the state's need. Moreover from a policy point of view, Michigan's current tax system remains obsolete, regressive, inequitable, and totally inadequate, despite state government's replacement of the Single Business Tax in 2007.
- The costs born by public agencies and private industry are much higher than in many other states, largely because of the legacy costs associated with expensive health care and retirement benefits that have led to an "entitlement culture", largely insulated until recently from the global marketplace.
- Public and private investment in key resources critical to competitiveness in the global economy, e.g., higher education, civil infrastructure, cyberinfrastructure (e.g., broadband connectivity), have dropped far below the national average and lowest among the Great Lakes states.
- State government continues to be burdened by structural constraints, including overly restrictive term limits for public officials, a state constitution that is too easily manipulated by special interests and outside forces, and obsolete policies in key areas such as incarceration, redundant regional and municipal governance, maintaining critical infrastructure, and many other areas that drive up the costs and drive down the efficiency and quality of public services.
- Ill-informed voter referenda and questionable judicial decisions have reversed Michigan's long history of tolerance, equal opportunity, and social justice, at a time when both the state and the nation are becoming increasingly diverse.
- The Michigan Congressional delegation continues to be woefully inadequate in attracting federal resources to the state, currently ranked 46th in the nation in return of federal tax dollars.
- Despite the economic trauma experienced by the state, public awareness of the actions that need to be taken (higher, more progressive taxes; lower labor benefit costs; greater investment in human capital and knowledge resources) is still inadequate, more looking back to past entitlements than ahead to future challenges and opportunities.

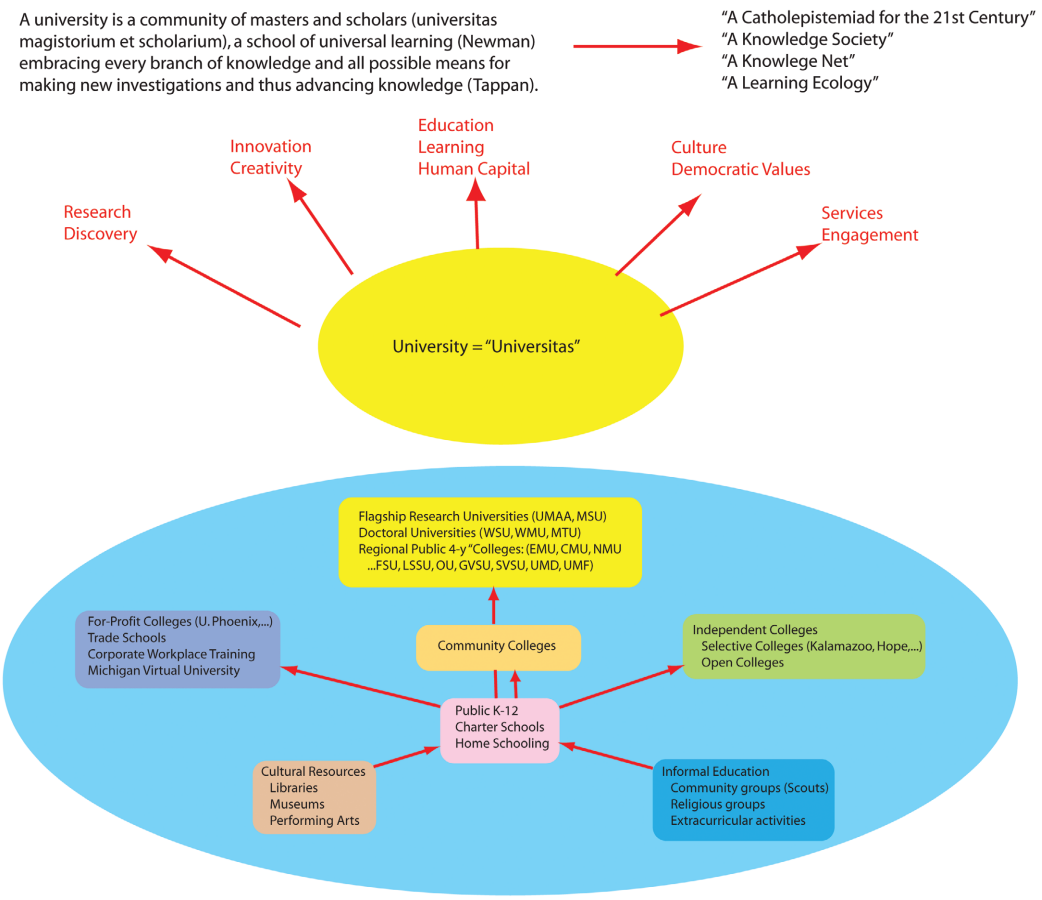
In fact, perhaps the first milestone for Michigan should be to simply return the state to the average level of other Great Lakes states in key parameters such as tax levels, employee benefits (for both the public and private sector), incarceration levels and costs, investment in key resources such as higher education, and public policy. While this may not seem like an overly ambitious first step, since, after all, nobody wants to stop at merely striving to be average, it has nevertheless been a

step that current leaders of state government, business, and labor have been unable to achieve.

Instead, however, we prefer to move beyond this to bolder goals that would re-establish Michigan as a leader in the new economy. To this end, we seek to establish a strategic intent for the state, goals sufficiently bold that they clearly cannot be accomplished within the status quo and instead will drive very fundamental change. And clearly, fundamental change is desperately needed in our state!

# Chapter 4

## Michigan Tomorrow: A Society of Learning




One possibility for Michigan's future:
a "society of learning"!

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 bold vision for Michigan's future. And key in this is a broader consideration of the educational and knowledge needs of our state. As Glazer stresses, "What really matters in better positioning Michigan and its regions for success in a knowledge-driven and entrepreneurial economy? The answer in a word: talent! The places with the greatest concentrations of talent win" (Glazer, 2006).

Hence 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 competencies 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?

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 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 learning and knowledge institutions are particularly profound. 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.

## The Educational Needs of a 21st-Century Citizen

Historically, people have always looked to education as the key to prosperity and social mobility. 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 schools, colleges, and universities evolved from the educational paradigms of the 18th century serving only the elite, to the public institutions of the 19th century serving the working class, and then once again to the knowledge-intensive institutions of the 20th century, such as the research university, 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 (i.e., entrepreneurship) 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.

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 are among the most valuable skills of all to be acquired in college.

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, neuroscience, 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.

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 adult 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 adult 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.

As we move further into an age of knowledge, the workforce will require even more sophisticated and sustained education and training to sustain its competitiveness. Today's graduates will change careers many 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. It is estimated 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 15 million 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, just as continuous improvement in manufacturing, will be a necessity for 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.

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 Challenges to K-12 Education

Today's younger students 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 game consoles, home computers, the Internet, and virtual reality. They learn by experimentation and participation, not by listening or reading passively. They embrace interactivity and the right to shape and participate in their learning. They 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.

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. Both young,

The digital generation
(students at UM's CyberCamp)

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.

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 to achieving economic prosperity and sustaining national security in a global, knowledge-driven economy. Yet while our schools are experienced in teaching the skills of analysis, we have far less understanding of the intellectual activities associated with creativity. In fact, the current disciplinary culture of our curricula sometimes discriminates against those who are truly creative, those who do not fit well into our stereotypes of students and faculty.

Our educational system 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 programs to programs placing more emphasis on integrating knowledge. Perhaps it is time to rip education out of the classroom and place it instead in the discovery environment of the laboratory or studio or the experiential environment of 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, K-12, college, or even graduate and professional 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 K-12 and college as just steps— 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.

## The Challenges to Higher Education

Higher education also faces profound challenges and opportunities as it enters a new millennium. As *The Economist* notes, the rise of the knowledge economy has driven the democratization of 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 in this country. 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 (appropria-

tions 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 individual 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).

## The New Paradigm of Lifelong Learning

The needs for lifelong learning opportunities in a knowledge society are manifold. The shelf life of education early in one's life, whether K-12 or higher education, is shrinking rapidly in face of the explosion of knowledge in many fields. Today's students and tomorrow's graduates are likely to value access to lifelong learning opportunities more highly than job security, which will be elusive in any event. They understand that in the turbulent world of a knowledge economy, characterized by outsourcing and off-shoring to a global workforce, employees are only one paycheck away from the unemployment line unless they commit to continuous learning and re-skilling to adapt to every changing work requirements. Furthermore, longer life expectancies and lengthening working careers create additional needs to refresh one's knowledge and skills. Even today's college graduates expect to change not simply jobs but entire careers many times throughout their lives, and at each transition point, further education will be required–additional training, short courses, degree programs, or even new professions. And, just as students increasingly understand that in a knowledge economy there is no wiser personal investment than education, many nations now accept that the development of their human capital through education must become a higher priority than other social priorities, since this is the only sure path toward prosperity, security, and social well-being in a global knowledge economy.

Of course, establishing as a state or national goal the universal access to lifelong learning would require not only a very considerable transformation and expansion of the existing post-secondary education enterprise, but it would also require entirely new paradigms for the conduct, organization, financing, leadership, and governance of higher education. For example, most of today's colleges and universities are primarily designed to serve the young–either as recent high school graduates or young adults early in their careers. Yet achieving the objective of universal access to lifelong learning would expand enormously the population of adult learners of all ages. Traditional university characteristics such as residential campuses designed primarily to socialize the young with resources such as residence halls, student unions, recreational facilities, and varsity athletics would have marginal value to adult learners with career and family priorities. Such universal lifelong learning could change dramatically the higher education marketplace, providing for-profit institutions already experienced in adult education with significant advantages. Furthermore, providing lifelong learning opportunities to adults with career and family responsibilities will likely require a considerable expansion of technology-mediated distance learning.

## A New Social Contract

Today the United States faces a crossroads, as a global knowledge economy demands a new level of knowledge, skills, and abilities on the part of our citizens. In earlier critical moments in our nation's history, federal initiatives aimed at expanding the role of education had great impact on America, e.g. the Land Grant Acts in the 19th century to provide higher education to the working class, universal access to secondary education in the early 20th century, and the G. I. Bill enabling the college education of the returning veterans of World War II. Today, as our nation undergoes a transition from an industrial to a knowledge-based economy, it is time for the United States to take bold action, completing in a sense the series of these earlier federal education initiatives, by providing all American citizens with universal access to lifelong learning opportunities, thereby enabling participation in the world's most advanced knowledge society.

As we enter the new millennium, there is an increasing sense that the social contract between our educational institutions 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 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. 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.

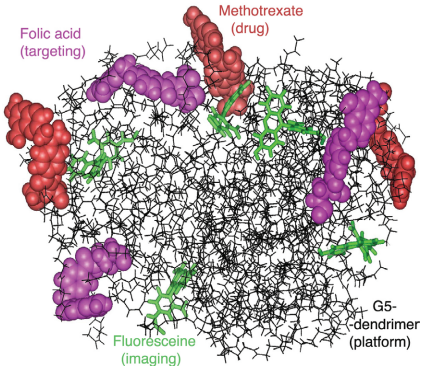
## The Importance of Technological Innovation

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 funda-

Information technology
(IBM supercomputer)




Biotechnology
(UM designed macromolecule)

Nanotechnology
(UM nanotechnology lab)

mental 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.

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.

## 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 es-

sentially 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.

For example, 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 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- 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 the education sector, 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 education enterprise as an "industry" or "business." After all, schools and colleges are social institutions with broader civic purpose and have not traditionally been driven by concerns about workforce training and economic development. Furthermore, the perspective of 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 education sector 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; it responds to forces in the marketplace. Educators will have to learn to cope with the competitive pressures of this marketplace while preserving the most important of their traditional values and character.

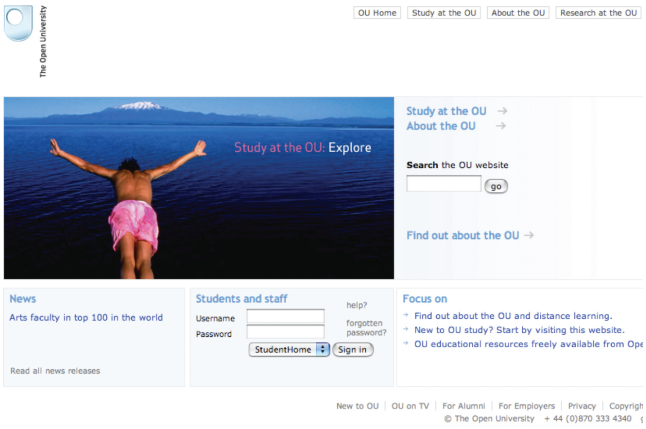
In many ways the education industry represents the last of the economic sectors dominated by public control and yet at risk because of quality, cost-effectiveness, and changing demands. As information technology breaks apart monopolies and opens up the market by releasing students from the constraints 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 period in which market forces could well lead to massive restructuring.

Today's forces of change–changing demographics, globalization, an accelerating knowledge base, market pressures–could so transform our education requirements and our educational institutions–schools, colleges, universities, learning networks–over the next generation as to be unrecognizable within our current understandings and perspectives. (Duderstadt, 2005; Brown, 2006) Let us illustrate with several possibilities:

The Global University: The emergence of a global knowledge economy is driven not only by pervasive

transportation, information, and communications technologies but also by a radically new system for creating wealth that depends upon the creation and application of new knowledge and hence upon advanced education, research, innovation, and entrepreneurial activities. There is a strong sense that higher education is similarly in the early stages of globalization, through the efforts of an increasing number of established universities to compete in the global marketplace for students, faculty, and resources; through the rapid growth in international partnerships among universities; and through for-profit organizations (e.g., Apollo, Laureate) that seek to expand through acquisition into global enterprises.

Of course there has long been a tradition of international higher education through the exchange of students, faculty, and ideas and the development of international partnerships among institutions. Yet globalization implies a far deeper interconnectedness with the world–economically, politically, and culturally. This is important because all too often in their efforts to achieve international scope, universities from developed nations adopt a colonial approach, establishing relationships or even campuses abroad in an effort not only to provide international experiences for their students but to tap the intellectual talent of other nations. While universities must be responsive to the imperatives of a global economy and attendant to their local responsibilities, they must also become responsible members of the global community. To this end, some suggest instead the need for a new class of universities that increasingly define their purpose beyond regional or national priorities to address global needs such as public health, environmental sustainability, and international development–what one might call "universities in the world and of the world". Such "universities in the world and of the world" might form through consortia of existing institutions, new paradigms (but as the increasingly global and technology-intensive character of the United Kingdom's Open University), or perhaps even existing institutions that evolve beyond the agenda or influence of their region or nation-state to assume a truly global character.

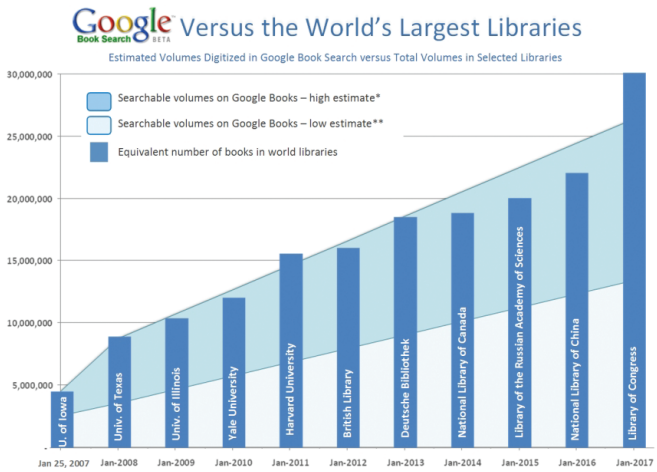



The UK's Open University, perhaps the best current example of a truly global university.

The Meta University: Some of the most interesting activities in higher education today involve an extension of the philosophy of open source software development to open up opportunities for learning and scholarship to the world by putting previously restricted knowledge into the public domain and inviting others to join both in its use and development. MIT led the way with its OpenCourseWare (OCW) initiative, placing the digital assets supporting almost 1,800 courses in the public domain on the Internet for the world to use. Today over 150 universities have adopted the OCW paradigm to distribute their own learning assets to the world (Vest, 2006). Furthermore, a number of universities and corporations have joined together to develop open-source middleware to support the instructional and scholarly activities of higher education, already used by several hundred universities around the world (Sakai Project, 2006; Moodle, 2006).

Perhaps the most exciting–and controversial–effort is the Google print library project in which a number of leading universities (including UM and MSU) have joined together with Google to digitize a substantial portion of their library holdings, making these available for full-text searches using Google's powerful Internet search engines (Google, 2006). While there are still many copyright issues that need to be worked through, it is the hope that we will soon be able to provide full access to a significant fraction of this printed material to scholars and students throughout the world. When one recognizes that the combined holdings of the libraries joining Google in this project amounts to over half the estimated books in the world, in over 400 languages, it becomes apparent just how profound full-text search access (and eventually perhaps direct online text ac-


MIT's OpenCourseWare initiative




The estimated growth of Google's Book Scan project

cess) would be.

Open source, open content, open learning, and other "open" technologies become the scaffolding on which to build truly global universities–what Charles Vest terms the "meta" university (Vest, 2006). As he observes, "the incredibly large scale of education world wide; the huge diversity of cultural, political, and economic contexts; and the distribution of public and private financial resources to devote to education are too great." Instead Vest suggests that "through the array of open paradigms, we are seeing the early emergence of a Meta University – a transcendent, accessible, empowering, dynamic, communally-constructed framework of open materials and platforms on which much of higher education world wide can be constructed or enhanced."

Universal Access to Knowledge and Learning: Imagine what might be possible if all of these pieces could be pulled together, i.e., Internet-based access to all recorded (and then digitized) human knowledge augmented by powerful search engines, open source software (SAKAI), learning resources (OCW), open learning philosophies (open universities), new collaboratively developed tools (Wikipedia II, Web 2.0); and ubiquitous information and communications technology (e.g., Negroponte's $200 laptop computer or, more likely, advanced cell phone technology). In the near future it could be possible that anyone with even a modest Internet or cellular phone connection has access to all the recorded knowledge of our civilization along with ubiquitous learning opportunities. Imagine still further the linking together of billions of people with limitless access to knowledge and learning tools enabled by a rapidly evolving scaffolding of cyberinfrastructure increasing in power one-hundred to one thousand-fold every decade.

Hence, one can imagine that within decades—and certainly within the lifetimes of today's students–we are likely to see the linking together of billions of people with limitless access to knowledge and learning tools, all enabled by a rapidly evolving scaffolding of cyberinfrastructure continuing to increase in power one-hundred to one-thousand fold every decade. In fact, we may be on the threshold of the emergence of a new form of civilization, as billions of world citizens interact together, unconstrained by today's monopolies on knowledge or learning opportunities (Atkins, 2007; Kelly, 2006).

Ironically, Michigan finds itself in a leadership in many of these areas. The University of Michigan plays the lead role in the Google library digitization project, with the complete digitization of its massive library projected for 2010 providing the nucleus of what might be a 21st century version of the great Library of Alexandria. The headquarters of the next generation internet, Internet2, is located in Ann Arbor. Michigan's long history of addressing the social needs of a rapidly changing society suggest that the state is well positioned to develop the new paradigms for social infrastructure appropriate for the new economy–provided it accepts the reality that the status quo is no longer an option.

## A Vision for Michigan's Future: A Society of Learning

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. 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.

Rather than simply patching up our existing educational systems and institutions to adapt to the requirements of a global, knowledge-driven economy, perhaps Michigan should look beyond this and aspire to create a true *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 educators must define their relationship with these emerging possibilities in order to create a compelling vision for its future as it enters the next millennium.

# Chapter 5

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

As we now turn our attention to the development of a roadmap to Michigan's future, we first need to determine just how far we must travel in order to build a knowledge society capable of facing the imperatives of the 21st-century global economy. Here 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 leaders, government, 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 the state's system of higher education is generally regarded as one of the nation's best, over the past six years Michigan has fallen to the bottom of the nation–dead last–in its support of higher education. Yet at the same time it has risen to national leadership in its incarceration rate, with prison costs exceeding its investment in higher education.

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 near-term obligations such as prisons, Medicaid and expensive health and retirement benefits for public employees, and tax abatements for declining industries even as it reduced state revenues still further through tax cuts that benefit primarily the affluent at the expense of the social services so critical to our less fortunate citizens–not to mention our children. And all the while, as the state budget began to sag and eventually collapsed in the face of a weak economy, Michigan leaders continued to fight 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 inadequate investment in research in both the public and private sector; the erosion of American leadership in scientific and technological infrastructure (laboratories, broadband access; the declining interest of American students in science, engineering, and other technical fields; and the 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. The nation suffers from the lack of a bold vision, strategy, and commitment for in-

vesting in those activities key to prosperity and security in a knowledge economy, i.e., education, research, innovation, and entrepreneurial skills.

From this perspective, the vision we have proposed for Michigan tomorrow as a society of learning seems very distant indeed. The road ahead looks long, perilous, and uncertain.

## Michigan's Challenge: Economic Transformation

Today Michigan is experiencing a transition as fundamental as its 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 underrepresented groups into a majority of the workforce.

We are learning the hard way that if we want to fully prosper in this new world, we must take the long view, and invest in people and learning institutions, making available life-long education and training while similarly investing in research and the technological innovation it produces. Michigan's major sectors—government, business, labor, and education–must be dramatically restructured to serve us better in the new century. We simply must cease financing our current needs and desires by shifting the cost to future generations.

Today and in the future, it is our people, their character, knowledge, skill, and ability to innovate, that when allied with developing technologies that 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.

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 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 throughout the nation and 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.

Michigan also must make 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 factory-based industries did manage 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 schools, colleges, and universities, since these institutions are the primary source of all three essential elements of the knowledge economy.

## K-12 Education: The Crippling Gap

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. To be sure there have been recent bright spots in Michigan systems of public education, including the adoption by the state in 2006 of some of the more rigorous requirements for K-12 education in then nation. Setting standards is a good start. Today, we are closer to designing a system in which students, teachers, and parents know what is expected of them. However the achievement of these goals will be a challenge for many of the state's school systems, particularly those in economically disadvantaged areas where poverty and job losses have taken a serious toll on schools and families.

Furthermore, 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 socioeconomic issues such as the deterioration of the family and community environment for learning and the student (and family) motivation for academic achievement. Too many parents and citizens are still willing to accept less than the best for our children. Michigan's students now may be able to compete with children from Ohio, but they are far behind children in Asia and Europe.

Inadequate high school preparation is compounded by poor alignment between high schools and colleges, which often creates an "expectations gap" between what colleges require and what high schools produce. The result is a high level of remediation by colleges (and by employers), a practice that is both costly and inefficient. Michigan's human capital is also threatened by the clear failure in achievement at all levels of our educational system. The fact remains that too few Michigan citizens prepare for, participate in, and complete the educational programs capable of preparing them for the knowledge economy, especially those underserved and nontraditional groups who make up an ever-greater proportion of our population. More generally, the leakage from our current education pipeline from primary education through secondary school and college into knowledge-intensive employment is clearly unacceptable.

Of comparable importance is the teaching work-

force 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.

## Higher Education in Michigan: A Critical Asset at Great Risk

It is at the level of higher education that Michigan may be at the greatest risk, since for too long it has taken its public colleges and universities–perhaps the most critical assets of the knowledge economy–for granted. Study after study have highlighted the importance of higher education to the future of Michigan. All agree 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. For example, 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).

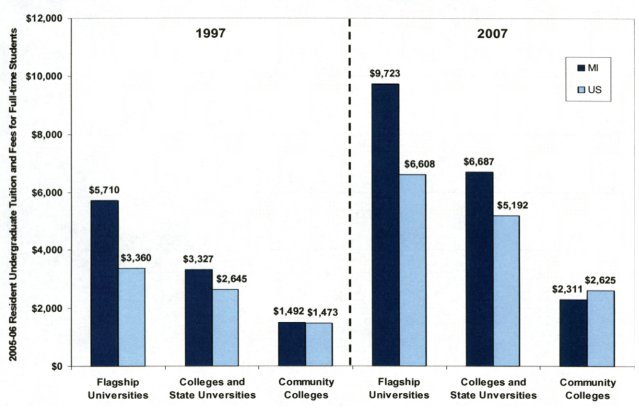
The governor's own commission, chaired by Lt. Governor Cherry, concluded that "the state must ensure that its residents are the best educated in the world and prepared for a lifetime of learning" (Cherry, 2004). The Cherry Commission recommended that Michigan double the percentage of high school graduates that went on to college–but, unfortunately, they failed to discuss how to pay for this, and higher education in Michigan continues to suffer from serious underfunding.

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. Unlike the rest of the nation, where recently most states have restored and increased still further their appropriations for higher education, Michigan's public universities have continued to suffer 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 (SHEEO, 2007).

Michigan today spends an average of $5,700 a year on a public university student, significantly below the national average of $6,600 and a statewide average of $7,300 for each K-12 student (Boulus, 2005). But even more disturbing is that after a massive prison building boom in the 1980s, today Michigan spends almost 30% more on locking people up ($1.9 billion, corresponding to $34,000 per inmate) than it does on educating them in our public colleges and universities, a truly tragic statement of our state's priorities.

| University | Percent change in per student appropriation, 2000-2005 | Percent change in per student appropriation, adjusted for inflation, 2000-2005 |
|---|---|---|
| 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 |

State appropriation cuts for Michigan universities



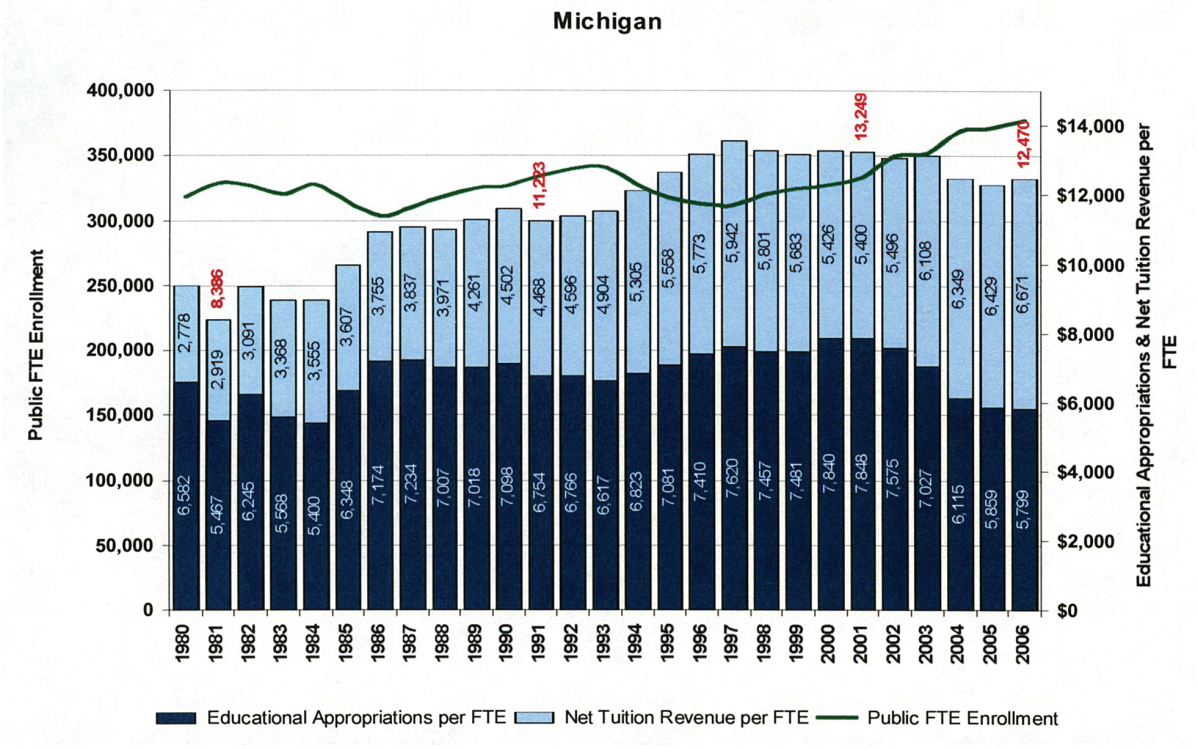

A comparison of Michigan and U.S. tuition trends over the past decade. (SHEEO)

During much of this period, state universities strained to hold tuition increases in check. In fact, when financial aid and inflation are included, the net tuition levels for public higher education in Michigan have actually declined over the past decade (PCSUM, 2006). 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 and state legislators continue to blast these tuition increases, pandering to the fears of students and parents, even as state government plans 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 mi-




Despite the tuition increases driven by declining state support, Michigan's public universities still have had to cope with an erosion in the resouces available to their education programs.

gration of some of the best professors from public to private institutions. Further erosion has occurred in the value of pension plans, medical benefits, life insurance, housing, and other benefits key to faculty recruiting and retention.

To compound these challenges, state government continues to threaten the autonomy of the Michigan's public universities, guaranteed by the state constitution, by attempting to influence admission policies, curriculum, facilities funding, and personal policies. Particularly insidious has been the impact of recent statewide referenda that now prohibit policies such as affirmative action critical to the ability of Michigan's universities to serve its increasingly diverse population.

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 Michigan'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" (Boulus, 2005).

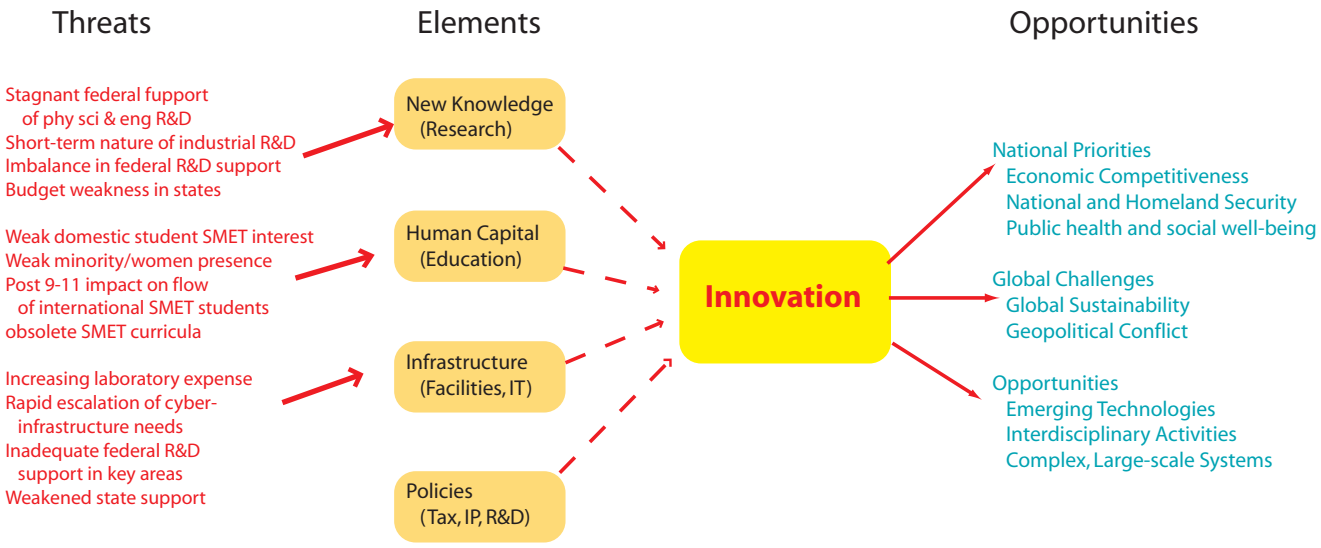
Little wonder that after the cavalier treatment higher education has received from state leaders over the past several years, the governing boards with fiduciary responsibility for the welfare of Michigan's public universities have begun to lose confidence in state government as a reliable partner in 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 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 and the new companies entrepreneurs found on innovative technologies.

A recent study by the National Governors Association finds growing a awareness of these imperatives: "Governors realize that investments in research and development can spur not only new ideas, new products and new technologies, but can increase a state's talent pool, economic bottom line and its success in national and global markets. Innovation can't be left to change–every state needs a clear strategy for success that applies lessons learned from their peers and from abroad. Innovation." The study found that the most successful state strategies rely heavily on their core assets: their research universities and their proximity to industries. (NGA, 2007)

From this perspective, it is clear that the most powerful economic engines in Michigan are likely to be its public research universities. Research universities produce all three of the key ingredients in technology-based economic development are technological innovation, technical manpower, and entrepreneurs. 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. They are also the key agent of 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. One 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 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 ($1 billion), soon to disappear as a consequence of the decision to close their Ann Arbor laboratories. 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.

In sharp contrast, the University Research Corridor established through the collaboration of Michigan State University, Wayne State University, and the University of Michigan is already estimated to have created over 68,000 jobs last year while contributing $12.8 billion to the state's economy, all for a state investment of roughly $800 million–although, of course, these appropriations were also needed to educate the 120,000 students enrolled in these three institutions). Indeed, from this perspective, state government's effort to balance the state budget by cutting higher education is foolish in the extreme, since it is threatening the research capacity of these institutions and hence the geese that lay the golden eggs!

## 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 Austin. 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 Cor-

poration 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!

## Knowledge 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 abroad. 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.

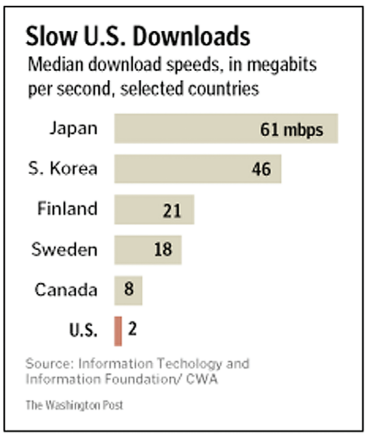
Today, digital technology has become the infrastructure necessary for the commerce of a knowledge economy. Our rapid evolution into a knowledge-based, global society has been driven in part by the emergence of powerful new information technologies such as digital computers and communications networks. Modern digital technologies have vastly increased our capacity to know and do things and to communicate and col-

laborate 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. 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. (Friedman, 2005) 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 both the nation and the state are falling further behind the rest of the world in providing this key infrastructure for the knowledge economy. Again to quote Friedman: "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 telcom 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.

Michigan has fallen even further behind, ranking 24th among the states in the growth rate of deployed broadband lines and very last in 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, concluding that, "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" (Gartner, 2001).




Access to high-speed broadband connectivity in the U.S. lags far behind that of other industrialized nations. (Washington Post, 2007)


What is lacking is 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 "cyberinfrastructure" 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 be-

hind other states and nations in building the infrastructure necessary for its future prosperity.

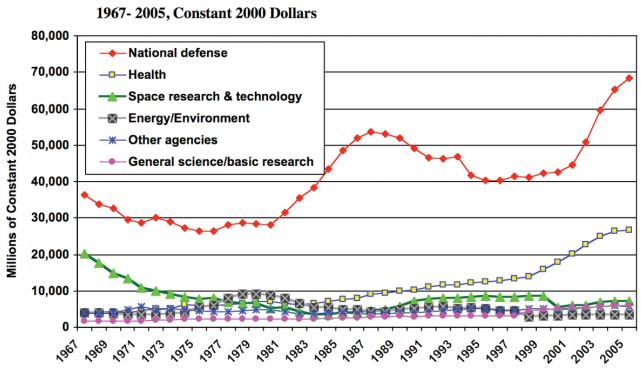
While the recent efforts by both local communities and the state to create wireless hubs are commendable (e.g., "wireless Michigan" or "wireless Oakland County"), thus far these are being proposed on the cheap, without significant public financing. Furthermore, it is clear that a term-limited legislature 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-AT&T'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 throughout the world.

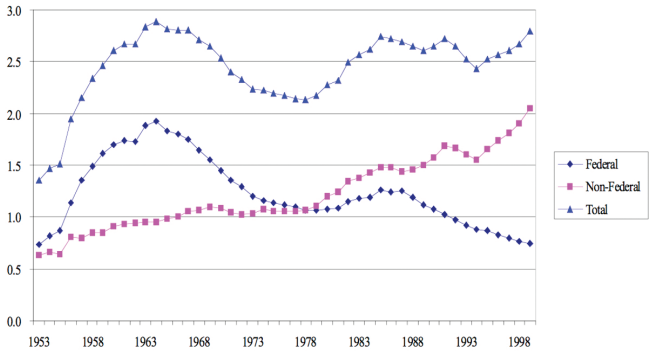
## Challenges at the Federal Level

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




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




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.

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 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 FY2009 (AAAS, 2008). 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 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.

## Broader Public Policy Issues at the State Level

A key objective of any policy discussion 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. Here 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 and sustaining 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 access 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, the broadest possible base and mix of taxable activities, and the most equitable tax burdens, while reducing those costs of government that are excessive when compared to best practices in other states.

To be sure, many of the challenges of today–globalization, demographic change, a knowledge-driven economy, and ruthlessly competitive markets–driving the tsunami engulfing our state are simply the imperatives of a new age. Yet perhaps the greatest and most threatening gap between the trauma and tragedy of Michigan today and the promise of what it might become (indeed, must become) tomorrow is unique to our state: the absolute vacuum of leadership we are currently experiencing.

*State Government*

Clearly many of the policy issues reflected in our analysis are closely related to important challenges in Lansing itself–a state government unwilling to provide adequate leadership in addressing the issues (e.g., tax increases and expenditure restructuring) necessary to allow adequate investment in the future, overly constraining institutional actions necessary to cope with an increasingly competitive marketplace (e.g., eliminating affirmative action and bans on stem cell research), 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 oblivious to 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 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, stem cell research, creationism) that are distracting public leaders and public attention from what really matters in a 21st-century global economy. As the Michigan economy crashes to the bottom of the states, our elected public leaders continue to back into the future, clinging to the practices and expectations of an obsolete past, instead of facing 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).

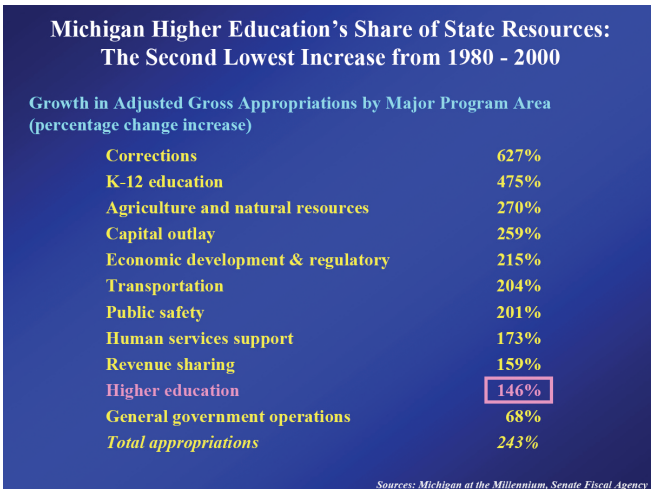
*State Budgets and Tax Policy*

Particularly 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).

Yet Michigan's budget problems are largely self-inflicted: the combination of tax cuts without corresponding spending cuts, failure to confront overdue government and structural reforms, a pattern of using one-time funds to handle real structural deficits, and the extreme stress placed on the state's manufacturing industry–particularly the automobile industry. Study after study has addressed the misconception that Michigan is a high-tax state, demonstrating instead that our tax burden both for citizens and business has now declined significantly below the national average, although some would prefer that it crash to the bottom along with states such as Mississippi and Alabama (notably those planning to retire in Florida, leaving their children to endure the consequences of the resulting erosion of the state's intellectual, social, and civic infrastructure).

Strategic actions by state government has largely been thwarted by lobbyists and political ideologies moored to the past, resulting in seven years of spending cuts of critical services, over $8 billion of one-time resources used as bandaids to cover the fundamental imbalance between tax revenues and growing expenditures such as corrections and public employee benefits. 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 54 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 has become one of the largest uncontrolled mandates for state tax dollars. Moreover, strong political pressure from unions has dissuaded state leaders




State government's priorities are revealed by the relative funding growth over the past 20 years

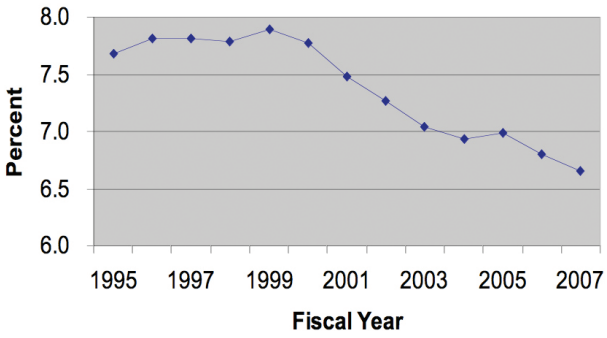
from taking strong action to restructure public employee benefits (both state employees and teachers) to levels more comparable to the rest of the nation. Michigan's school finance reform effort of the 1990s created K-12 education as yet another funding mandate, which along with Medicaid and prisons, leaves little left 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–a glaring sign of the lack of strategic vision on the part of state leaders.

The structural deficiencies in the state budget were compounded during the 1990s. 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–and continued to do so long after the rest of the nation halted this practice in favor of beginning to reinvest in the priorities of the knowledge economy. This has created a permanent budget deficit became worse 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, drove Medicaid burdens into the stratosphere.

Michigan finds itself simply unable to meet both its obligations for the present (e.g., Medicaid, corrections, K-12 education, public employee benefits) while in-

vesting 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 new knowledge-driven businesses capable of competing in tomorrow's global economy.

Numerous studies have demonstrated that Michigan's tax burden–both for private citizens and business–has now fallen significantly below the national average, although it remains one of the nation's most regressive and inequitable tax systems. 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).




State taxes as a percentage of personal income: Michigan's obsession with tax cuts over the past decade has crippled the state's capacity for investment in the future.

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 and public expenditures, 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. The blue-ribbon, bipartisan Michigan Emergency Financial Advisory Panel, led by former governors William Milliken and James Blanchard, rapidly reached an agreement on what state leaders must do to stop Michigan's precipitous decline:

- Move rapidly to enact fundamental reform of both spending and taxes.
- Create a modern tax structure that abandons the focus on the economic system of the 20th century and looks to the developing knowledge economy of the new century.
- End the disinvestment in education and those other assets that define the quality of life that knowledge-based workers seek–cultural offerings, natural resources, and vibrant cities; and
- Develop a fiscal plan that includes a combination of revenue increases, spending cuts, and reform of how public services are delivered.

And how did Lansing respond: By allowing partisan politics and self-interest to paralyze state government as Michigan careened toward the cliff of a budget meltdown in fall of 2007 that would have shut down state services. While the governor and legislature finally came to an agreement that averted disaster only hours from the budget deadline, this was largely a patchwork affair that put off once again the necessary structural reforms in state expenditures and tax policies, suggesting that such trainwrecks will happen yet again in the near future–that is, unless Michigan voters wake up to the haplessness of their elected representatives in Lansing.

*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 pander 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 partisan agendas."

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

## Diversity and Social Inclusion

A distinguishing characteristic and great strength of our state has been its growing commitment over its history to serve all segments of our pluralistic society. We have never needed such inclusiveness and diversity more than today when differential growth patterns and very different flows of immigration from Asia, Africa, Latin America, the Caribbean, and Mexico are transforming our population. By the year 2030 current projections indicate that approximately 40 percent of all Americans will be members of minority groups, many—even most—of color. By mid-century we may cease to have any one majority ethnic group. By any measure, we are evolving rapidly into a truly multicultural society with a remarkable cultural, racial, and ethnic diversity. This demographic revolution is taking place within the context of the continuing globalization of the world's economy and society that requires Americans to interact with people from every country of the world. These far reaching changes in the nature of the people we serve and the requirements of global responsibility demand far-reaching changes in the nature and structure of higher education in America.

Our rapidly diversifying population generates a remarkable vitality and energy in American life and in our educational institutions. At the same time, it gives rise to conflict, challenging our nation and our institutions to overcome at last our long history of prejudice and discrimination against those groups who are different, particularly and most devastatingly, those groups identified by the color of their skin. Tragically, race remains a significant factor in our social relations that profoundly affects the opportunities, experiences, and perspectives of those discriminated against as well as those who discriminate. To change this racial and cultural dynamic, we need to understand better how others think and feel and to learn to function across racial and cultural divisions. We must replace stereotypes with knowledge and understanding. Slowly, we Americans are learning but there remains a great distance to go.

In Michigan we face a particular challenge. Despite

the fact that the landmark Supreme Court cases in 2003 involving the University of Michigan's affirmative action program reaffirmed the fundamental principle that "student body diversity is a compelling state interest that can justify the use of race in admissions", in 2006 Michigan voters approved a constitutional referendum to ban the use of affirmative action in public institutions. Already Michigan's public colleges and universities are seeing early declines in social diversity on campus. Unfortunately, this confusing–and many believe ill-considered–referendum, Michigan has been placed at a considerable disadvantage both in developing its human capital and competing in an increasingly diverse global economy.

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

Despite the actions of state government, special-interest-driven referenda, 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 investing in the state's future. In recent surveys over 80% of citizens express a serious lost of confidence in the leaders of state government. Michigan voters believe that the state's public universities are critical to the state's economy, providing job training, economic development, and research that will determine the state's future prosperity.

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 Michiganians 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.*

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. 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.

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).

That's the good news. Now for the bad news. A Detroit News poll in spring of 2005 and repeated in 2007 found that just 27% of parents consider a good education essential for a success, and nearly half believe that their children can still get a good job with only a high school diploma. 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" (Detroit News, 2007).

Most recently, additional polling revealed that with the economy worsening, fewer Michigan residents see education as the way out. "Instead, they want their public schools to prepare students for the low-skill jobs of the past." 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, Detroit News, December 9, 2007).

## Cultural Challenges

Even if we manage to break the stranglehold of obsolete perspectives and practices upon state government, there are even deeper issues that must be addressed if Michigan is to once again prosper as a national leader. In the effort 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 residence halls as well as in all the youth who fall by the wayside, their mind-power 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 of the blame game, 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. 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. 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." 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.

4. 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?

5. An entitlement culture: 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 Prius 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 cuts and 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.

6. 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 $4 and up? Let's introduce a few more big SUV and truck models since surely there are 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 because of global warming…)

Michigan's current challenges are structural, not cyclical, and hence are likely to continue unless bold actions are taken. Glazer stresses that Michigan's decline has been caused, in large part, because the state–its citizens, enterprises, and communities–have been slow to adapt to a rapidly changing global economy. "It is clear to us that the only way to reverse these trends is to let go of the past–no matter how good it was to us–and embrace the future, a future where successful communities will be far more knowledge-driven and entrepreneurial" (Glazer, 2006).

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

Which is headed toward Michigan's future?

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.

# Chapter 6

# The Michigan Roadmap

We now turn to the final phase of the roadmapping process: the Michigan Roadmap itself (rather the Michigan Roadmap *Redux*). This is designed as an organic and 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.

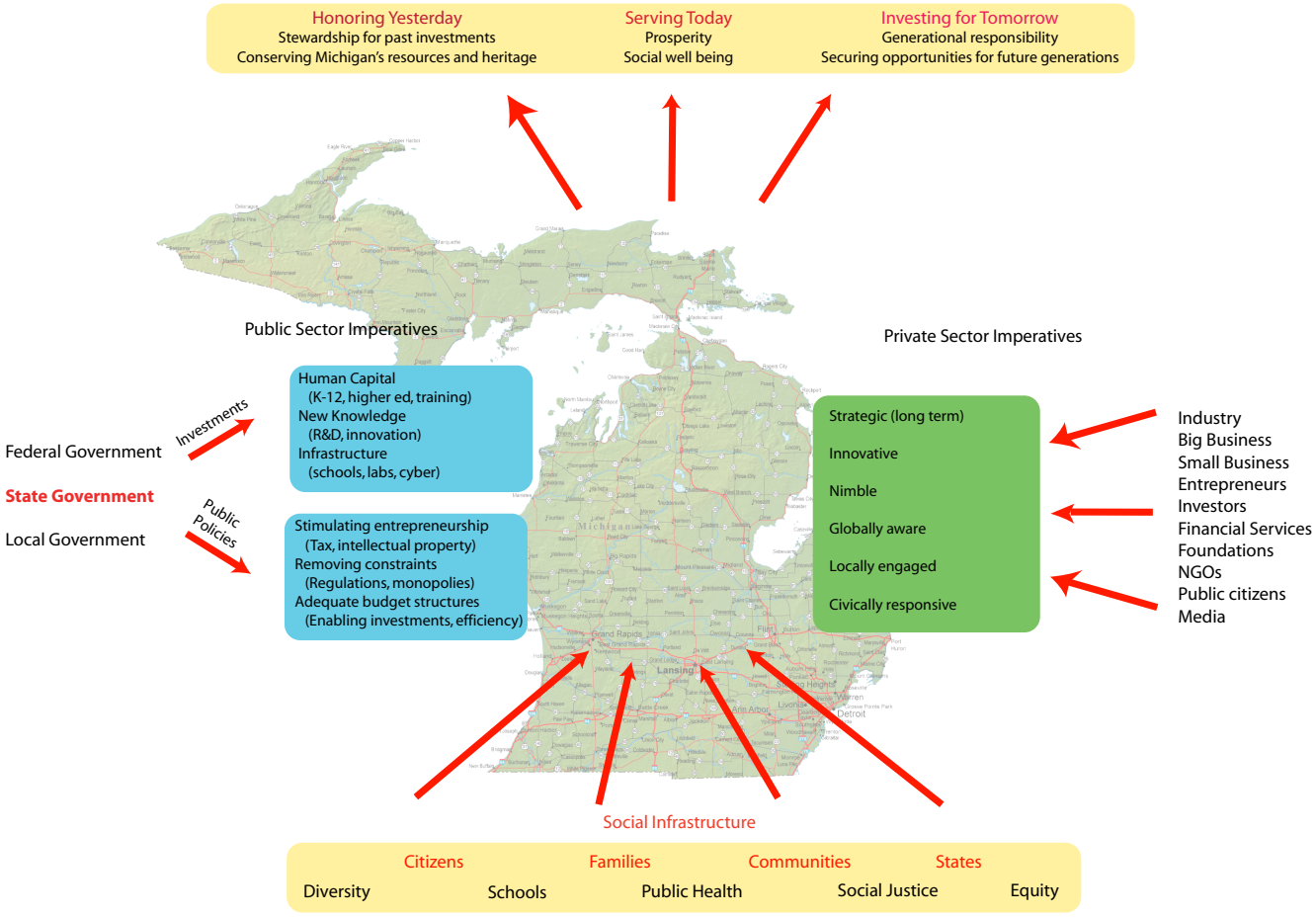
We begin with a simple premise: *the key to Michigan's future lies with its people*, with their skills, character, creativity, innovation, and entrepreneurial spirit. The quality and diversity of our workforce is our greatest asset. In the past Michigan has exploited its vast natural wealth–its forests, minerals, lakes, and location–to achieve economic strength and global leaders. But this has happened largely because of the pioneering spirit, gritty courage, and self reliance of the people who have been attracted to the state by these assets. It was our people who made our farms and factories the best in the world. Over generations we have learned that if we believe and invest in them and those who come to our state–in their education, health, and social well-being–Michigan's people will keep us at the forefront of innovation, productivity, and trade.

And this is even more true today since, 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 an entrepreneurial spirit. 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 and private 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 to address these goals, divided into recommendations for the near term that would be reasonable objectives for the next several years, followed by a series of more ambitious recommendations for the longer term aimed at transforming Michigan into a true knowledge society.

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 setting and achieving higher goals in K-12 education, restoring adequate public investments in the state's colleges and universities, stimulating the production of more scientists and engineers, and facilitating the technology transfer 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 world-class opportunities for lifelong education, training, and cultural enrichment to all Michigan citizens while demanding, achieving, and sustaining the necessary institutions at the very highest level of excellence.

For the longer term, there can be no more compelling




The Michigan Roadmap

priority with a higher rate of return than investment in our people through public support of educational opportunities at all levels and throughout their lives. Michigan must build and sustain a world-class education system, a *society of learning*, spanning the full range of educational opportunities, from pre-school to K-12 to higher education, to graduate and professional education, to lifelong learning. It must augment this with further public and private investments in institutions capable of generating new knowledge through R&D and then transferring this into innovate products, processes, and services in the global marketplace. To be sure, this will be challenging, since it will demand substantial new investments–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 require both the public and private sector to address those legacy costs (e.g., corrections, health care, retirement) that have become excessive and clearly out of line with the best practices of leading states. It will demand new standards for excellence and accountability for institutions, students, and families. It will both encourage and demand the new paradigms for learning, knowledge creation, innovation, and entrepreneurial that are characterized by the world-class quality, ability, and accountability to compete in the global economy. And it will require a restoration of Michigan's historic commitment to social services and inclusion for those caught in the inevitable maelstrom of the creative destruction of the global economy as new industries appear to replace the old.

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

In the near term our principal recommendations focus on Michigan's most valuable asset, its people, investing in their education, skills, and creativity, and developing the knowledge infrastructure to enable their innovation and entrepreneurial zeal. Our recommendations are also aimed at providing the state's economic sectors and institutions–including government, industry, and education–with capacity, incentives, and encouragement to become more agile and market-smart.

### *Human Capital*

We begin by addressing the primary concerns about both Michigan's and the nation's educational system: the complex interplay of inadequate preparation, lack of information about educational opportunities, and persistent financial barriers that impede the ability of students to pursue their education to the advanced level required by the knowledge economy–particularly for low income and under-represented minority students. Inadequate primary and secondary education not only deprives too many children of the knowledge and skills necessary to compete in the global, knowledge economy but it fails to prepare them adequately for further study at the postsecondary level necessary to provide the knowledge and skills essential both for a globally competitive workforce and personal quality of life.

*1. The State of Michigan will set as its goal that all students will graduate from its K-12 system with a high school degree that signifies they are college ready. To this end, all students will be required to pursue a high school curriculum capable of preparing them for participation in post-secondary education and facilitating a seamless transition between high school and college. State government and local communities will provide both the mandate and the resources to achieve these goals.*

The Spellings Commission has proposed as a national goal that every student in the nation should have the opportunity to pursue postsecondary education (see Appendix A). This imperative for the global knowledge economy will require an unprecedented effort to expand higher education access and success by improving student preparation and persistence at the national, state, and local level, addressing non-academic barriers and providing significant increases in aid to low-income students (Miller, 2005). A high school degree should signify that a student is college and/or work ready. The effort is underway in a number of states including Michigan to better align K–12 graduation standards with college and employers, but we are suggesting that the bar should be set even higher: All students enrolling in our K-12 schools should be prepared for further–indeed, lifelong–learning at the postsecondary level as an absolute requirement for the knowledge economy. No child–or school–should be left behind and forced to settle for anything less than a rigorous college preparatory education!

*2. Beyond the necessary investments in K-12 education and the standards set for their quality and performance, raising the level of skills, knowledge, and achievement of the Michigan workforce will require a strong social infrastructure of families and local communities, particularly during times of economic stress. To this end, state government and local government must take action both to re-establish the adequacy of Michigan's social services while engaging in a broad effort of civic education to convince the public of the importance of providing world-class educational opportunities to all of its citizens.*

As we have noted earlier, Michigan's social priorities have become seriously distorted in recent years, placing more emphasis on locking people up or providing tax benefits to the affluent than investing in educational opportunities and welfare of its citizens. A striking example here is provided Michigan's merit scholarship programs, which primarily channel state resources to economically advanced students attending well-supported schools in affluent areas at the expense of the financial aid necessary to provide educational opportunities to the less fortunate. It is imperative that these merit-based programs be restructured with a strong need requirement if the state is to target public resources where they are likely to have the most impact on Michigan's future workforce.

Furthermore, since the educational standards demanded by the global economy require strong families and communities in addition to schools, Michigan must

recommit itself to adequately supporting the necessary social programs and policies to enable all of its citizens–including those disadvantaged by economic dislocation or discrimination–to access educational opportunities.

Here part of the challenge is public awareness. Many student and parents don't understand the steps needed to prepare for college and the system fails to address this information gap. State and local government needs to partner with schools and colleges to provide resources for early and ongoing college awareness activities, academic support, and college planning and financial aid application assistance. Such efforts should include developing students' and parents' knowledge of the economic and social benefits of college through better information, use of role models and extensive career exploration.

Beyond the disturbing fact that the major of Michigan parents still do not understand the imperatives of postsecondary education for the children's future, it is also clear that an aging population has yet to realize their generational responsibility to invest adequately in Michigan's future. Higher education should partner with business to raise public awareness of the educational and social imperatives of the global economy and the necessary commitments that both parents, citizens, and governments must make to secure their future.

*3. Michigan must create clearer pathways among educational levels and institutions and removing barriers to student mobility and promoting new learning paradigms (e.g., distance education, lifelong learning, workplace programs) to accommodate a far more diverse student cohort.*

The key objective here is to greatly expand college participation and success by outlining ways in which postsecondary institutions, K–12 school systems, and state policy makers can work together to create a seamless pathway between high school and college. Both students and the state could be well served by a higher degree of coordination, particularly in facilitating the transition among various sectors (e.g., K-12, community college, undergraduate, graduate, professional, lifelong learning) and elements (public, private, for-profit, corporate training) of education. The absence of coordination and articulation agreements can be a serious hurdle to students attempting the transition from one education level or institution to another. While competition among institutions is important, particularly in a marketplace increasingly funded from private sources, so too is sufficient coordination to allow a smooth, transparent transitions from one stage or institution to the next in a future increasingly dependent upon lifelong learning. Put another way, the state's education enterprise needs to be better coordinated and integrated vertically, while preserving the strong market competition horizontally.

Standards for transfer of credit among higher education institutions should be reviewed and revised, subject to rigorous standards designed to ensure educational quality, to improve access and reduce time-to-completion. Of importance here is the development of a student record system, capable of statistically tracking the flow and progress of students throughout postsecondary education, as well as the development of incentives at the state and local level for institutional coordination and cooperation among all elements of the education sector.

*4. Higher education must become significantly more engaged with K-12 education, accepting the challenge of improving the quality of our primary and secondary schools as one of its highest priorities with the corresponding commitment of faculty, staff, and financial resources. Each Michigan college and university should be challenged to develop a strategic plan for such engagement, along with measurable performance goals.*

Although the quality of American higher education is heavily dependent upon the quality of K-12 education, most colleges and universities have limited their engagement with K-12 education to teacher training. A few have gone farther, to create and manage charter schools, much in the spirit of the clinical "university schools" characterizing schools of education in the 20th century. But most of higher education has largely viewed the challenges faced by K-12 education in America as somebody else's problem and tended more to criticize the quality of our schools and the preparation they provide to college-bound students than to work with them to correct their deficiencies.

In particular, higher education needs to be far more tightly coupled to primary and secondary education.

Recent studies have revealed the ill-preparedness of high school graduates for college work, along with poor success of higher education in addressing student deficiencies in written and quantitative literacy. Colleges and universities need to work closely with K-12 education, aligning high school curricula with college standards and providing feedback to prospective students about their readiness for college work. In particular, the senior year of high school (12th grade), currently regarded as an educational wasteland by many, should be used by colleges and secondary schools both to introduce advanced students to college-level work while providing the remedial education necessary to repair deficiencies in student preparation for further study. It should also be observed here that the commitment to lifelong learning could provide yet additional opportunities for addressing the diversity in K-12 learning experiences and student learning readiness that today leads to all-too-frequent failure at the college level.

Since our schools hold the key to the quality of students entering postsecondary education, our workforce, and higher education itself, Michigan's colleges and universities have a very strong and vested interest in becoming strongly engaged with K-12 education in this state. They also have a major responsibility, since the low priority many of our institutions have given teacher education, the misalignment of K-12 and college curricula and entrance standards, and the confusing signals they have conveyed to schools, students, and parents about the preparation necessary for success in college have at times made our universities more a part of the problem than the solution to quality in primary and secondary education.

One of the strongest and most important recommendations of the Spellings Commission was to demand a major new and more strategic engagement of higher education with K-12 education, with the aim not only of improving our primary and secondary schools, but furthermore creating a seamless web of educational opportunities and progress for all students. Among the possible elements are efforts to give a much higher priority to teacher education, elevating the status of schools of education to enable them to attract top college students; assisting both state agencies and secondary schools in aligning curricula with university admission and program requirements; developing methods to assess the progress of college-readiness for secondary school students; and launching major civic education programs for secondary school students and parents so that they understand both the academic requirements and financial opportunities for attending college.

However more is needed. For example, there are many secondary school students who are ready for college-level work. Hence colleges and universities could consider actually offering college courses–for credit and taught by university faculty–in secondary school to accelerate the educational opportunities for students, to create more awareness among students and secondary school teachers of the nature of contemporary college curricula, and to create a more seamless transition from school to college. The rapid evolution of online education and resources such as the Open CourseWare initiation, iTunes U, and other open education resources provide powerful tools to this end. In fact, some institutions such as MIT are already providing sophisticated web portals to assist K-12 teachers and students in utilizing their online materials.

It is particularly important to develop programs that bring together secondary school and college faculty in peer-to-peer relationships. In the past the federal government used to sponsor summer workshops on the campuses for K-12 teachers that helped in such efforts, particularly in key areas such as STEM education (science, technology, engineering, and mathematics). In the absence of such federal programs, state government should consider assuming this role, perhaps in partnership with business and the philanthropic community.

The key here is to challenge each of Michigan's colleges and universities to develop a high priority strategic plan for engagement with K-12 education that is both university-wide (perhaps reporting directly to the president or provost of the institution) and characterized by measurable performance objectives. This is simply too important an activity to simply relegate to schools of education. It must involve the commitment of the entire institution.

*5. Michigan must increase very substantially the participation of its citizens in higher education at all levels–community college, baccalaureate, and graduate and professional degree programs. 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. 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. 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.*

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, market agility, and accountability. 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 remains inadequate for this purpose. Tax cuts implemented during the economic boom-times 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 tax policies and cost structures appropriate for a 21st century knowledge economy gives us pause.

A key step on the road to a future of prosperity is to restore adequate funding for Michigan's universities. Without this step, all else will fail....

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 partisan politics.

*6. 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 colleges and 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 $5,700 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.

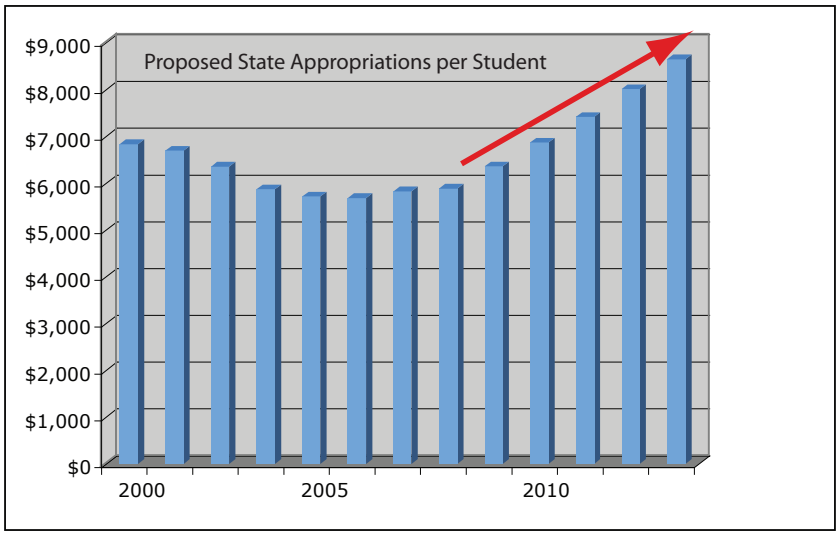
It is important to set appropriate benchmarks for critical investments such as public higher education. If Michigan aspires to return to a position of national economic leadership, it follows that it must be prepared to

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 20% 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.

*7. 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). 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 such as forgivable loans 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. For example, to compete in a global economy, all companies today must be competent in 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, today's companies are instead choosing to locate where knowledge workers already are. The implications to Michigan are extremely serious with its relative weakness in the production of scientists, en-




Michigan should set and ***achieve*** firm targets to restore support of its public universities to levels comparable to those of leading states

gineers, and technology. 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 fraction 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 two decades.

Other states are making major efforts to increase their science and engineering workforce by making major investments in science and engineering education, particularly at the college level. For example, California's Governor Schwarzenegger has recently launched the state's Engineering Initiative aimed at bringing 20,000 to 24,000 new engineers into the state's workforce over the next decade through new partnerships with schools, colleges, and the private sector. This plan will launch a new Engineering Education Council, designed to attract private funds to help guide math and science students into engineering programs at state colleges and universities and expanding STEM programs (science, technology, education, and mathematics) at the K-12 level.

Although Michigan is more at risk in this area than many other states, this is a national problem as well. A 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" (Barrett, 2004). 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).

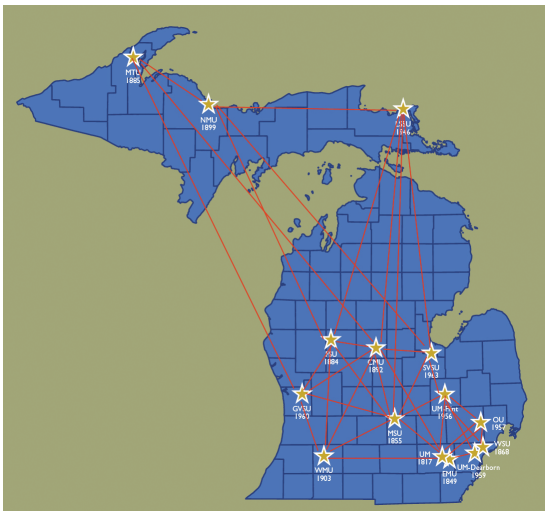
The State of Michigan has not invested significantly in its colleges of engineering for over two decades, in sharp contrast to most other states (and nations)!

*8. 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 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 undergraduate education while protecting their unique capacity to conduct the graduate pro-

grams and 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, and WSU), comprehensive public universities (WMU, MTU, 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 independent 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.




It is important to encourage collaboration among the state's colleges and universities.

*New Knowledge (R&D, innovation)*

*9. 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 universities. 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. (Gates, 2005)

Although today Michigan tends to focus its efforts more on public relations (Michigan First) and gimmicks (lotteries, casinos) 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. This effort invested $25 million a year for a seven-year period in the research capacity of its public universities. The impact of this investment was quite extraordinary:

the production of cutting edge research, products, and methodologies in manufacturing, biotechnology, advanced materials, and information technology, resulting in the spinoff of dozens of successful companies, numerous technologies adopted by Michigan industry, the involvement in research of hundreds of Michigan companies that became partners in the research centers, and a ramping up of federal research funding leveraged by 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 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…

*10. 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 and standardized; 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 and federal sectors (attracting new knowledge-based companies and federally funded R&D centers–FFRDCs).*

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., biofuels, hydrogen and hybrid technologies), nanoscale biotechnology, and information systems.

As we noted in Chapter 3, there are very encouraging signs in this direction as Michigan's research universities (MSU, UM, and WSU) have joined together to create the University Research Corridor, aimed both at cooperating in the conduct of basic and applied research, and joining with Michigan industry, entrepreneurs, and the investment community to spin off new discoveries into commercial applications capable of driving economic growth. While in the long run such a consortium will be successful only if Michigan restores adequate public support of these institutions, in the near term each participating institution has committed major resources to launch the effort.

*11. 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 educa-

tion, state and federal government. Just as state government must begin to reinvest in the capacity of its public colleges and universities to produce knowledge workers and research, it must also provide strong incentives to reestablish longer-term R&D as a priority for Michigan industry. 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 legislation to direct the establishment of major federal research centers in Michigan. (Here an example of such a research initiative, a Great Lakes Energy Research Network, is provided in Appendix B.)

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.

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 obsolete 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*

*12. 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 current infrastructure designed for a 20th-century industrial 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 appropriation for academic facilities on campuses for almost two decades, 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 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. By way of comparison, in 2007 California voters approved $42 billion of bonds for new construction in K-12, higher education, and other needed civil infrastructure. Many other states have made similar commitments. Michigan has been silent…

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. 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 (telecoms 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. The Michigan Economic Development Corporation 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).

Michigan must end its two-decade-long moratorium on investing state dollars in university capital facilities.

During this period, most new academic facilities, such as the UM Ross Business School, have required funding entirely from private sources.

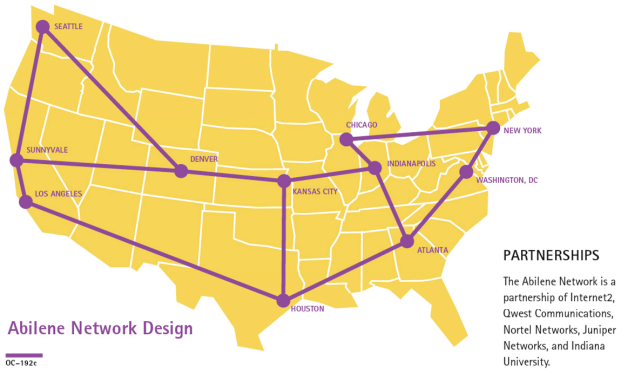
*Policies*

*13. 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, deploy tax dollars primarily 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.



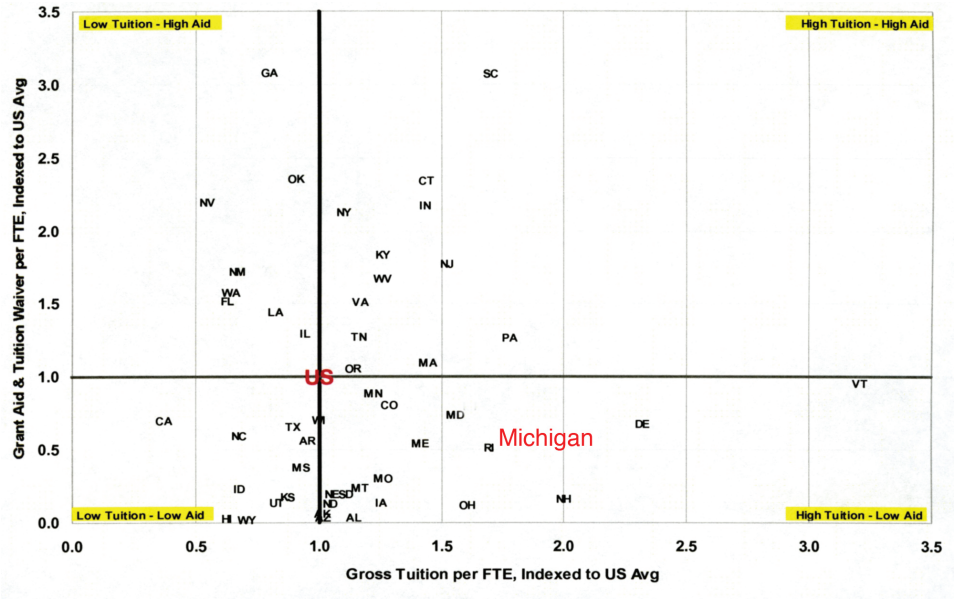

An important asset of Michigan: the presence of the headquarters of Internet2 in Ann Arbor, which operates Abilene, the fastest computer network in the world.

*14. 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.

Efforts to constrain tuition levels at the state's public universities have the perverse effect of failing to capture 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 six years, institutions that have already optimized cost structures over the past two decades to accommodate earlier ero-




Low state funding has forced Michigan's universities to operate in high-tuition, low-financial-aid quadrant.

sion in state support have only two options: increase tuition or reduce quality. Reducing the level of university 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 responsibilities to serve the needs of the state.

*15. 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 diversity, 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 micromanage 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 leaders of state government and higher education 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 and fiduciary responsibility 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 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 socioeconomic 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).

*16. Michigan must recommit itself to the fundamental principles of equal opportunity and social inclusion through the actions of its leaders, the education of its citizens, and the modification of restrictive policies, if it is to enable an increasingly diverse population to compete for prosperity and security in a intensely competitive, diverse, and knowledge-driven global economy.*

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 state and 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. Our society is challenging in both the courts and through referendum long-accepted programs as affirmative action and equal opportunity aimed at ensuring social inclusion.

Michigan simply must recommit itself to achieving new levels of understanding, tolerance, and mutual fulfillment for peoples of diverse racial and cultural backgrounds both on our campuses and beyond. We need to shift our attention from simply access to educational opportunity to success in achieving educational objec-

tives. The recent Supreme Court decisions in the Michigan cases have now not only reaffirmed the importance of this fundamental commitment but also clarified the path we may take to achieve diversity. Unfortunately, Michigan citizens stepped back from this commitment through a recent constitutional referendum (Proposition 2) that could crippled the state's ability to achieve social justice and equal opportunity. This issue must be readdressed and rectified if Michigan is to prosper.

## The Roadmap: The Longer Term (…But Within a Decade…)

For the longer term, our vision for the future of Michigan 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. 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 adequately supported and allowed 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 its knowledge and learning infrastructure, 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 and burdensome legacy cost structures (e.g., based on a 1950s manufacturing economy rather than a 21st-century knowledge-services economy), driven more by political ideology and 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 forces. 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, freed from the tyranny of leg-

islative 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 roundtables have proven effective, and such groups are increasingly essential to Michigan's future (Power, 2006).

*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 institutional and political leaders.*

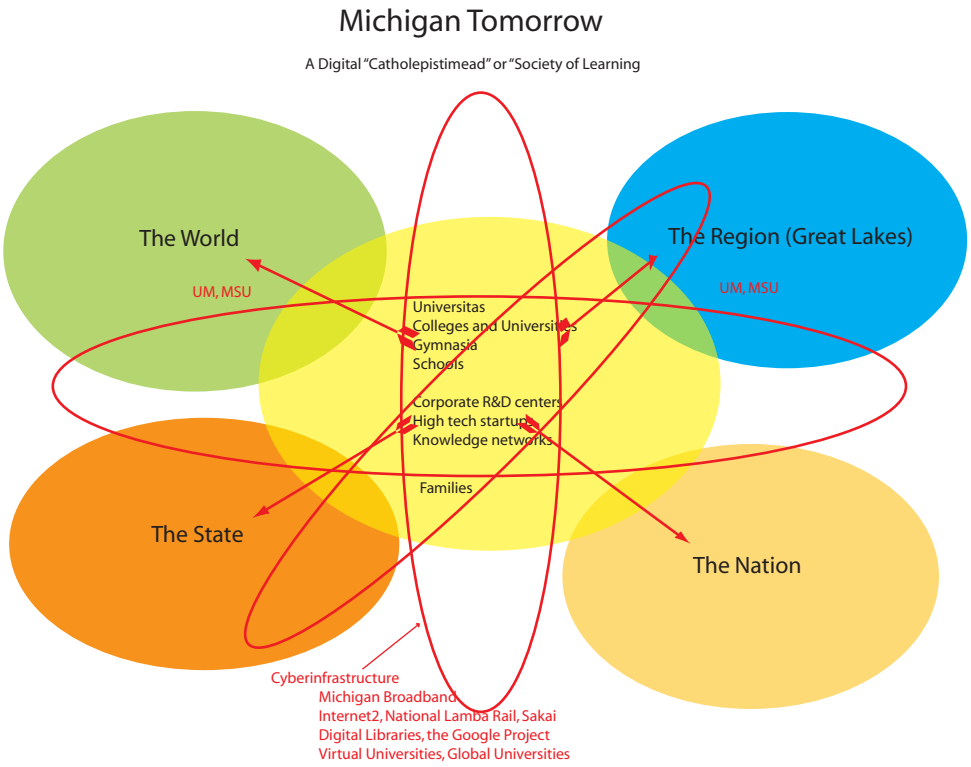
The state needs to give more strategic consideration to the diversity among its public colleges and universities, e.g., how many world-class public research universities it can afford, whether regional universities should become more focused on pre-professional education, and how to build better linkages 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 7% of its operating budget. For example, the state might redefine UMAA as a "state-related" institution (since it is clearly no longer a "state-supported" university) 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 by age (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 experiment with 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 community colleges, regional universities, 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




Michigan needs to develop a more strategic perspective of its knowledge resources.

have the resources to provide the advanced learning opportunities of a major research university. Hence 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 research universities 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. Because of the importance of research and graduate education to the state's future, these universities should be encouraged to strike an appropriate balance between these activities, while undergraduate education remains the primary mission of Michigan's other colleges and universities.*

Michigan is fortunate to have three nationally recognized research universities, UMAA, MSU, and WSU. While these 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 its research university for advanced training, research, and innovation 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. 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" (*Economist*, 2005).

*6. 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 internationally prominent research universities, the University of Michigan and Michigan State University, to join together to create 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 20th 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. 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.

*7. Michigan should explore bold new 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 polices 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.

For example he needs for lifelong learning opportunities in a knowledge society are manifold. Yet providing such opportunities will require not only a very considerable transformation and expansion of the existing post-secondary education enterprise, but it would also require entirely new paradigms for the conduct, organization, financing, leadership, and governance of higher education. One approach would be to utilize a combination of transportable education savings accounts and loans (e.g., Lifelong Learning Accounts or LiLa's), perhaps indexed to future earnings much like Social Security by mandatory earmarking of a portion of an individual's earnings over their careers as a source of funds for their education. Here, in contrast to Social Security that amounts to saving over a career for one's relatively unproductive golden years, instead one would be borrowing and investing on the front-end to enhance their personal productivity and hence prosperity throughout their lives through future education. By making such education savings accounts mandatory, again like Social Security, one would create a sense of ownership on the part of students, thereby making it more likely that they would seek to take advantage of the educational opportunities provided by their account. A variation on this theme would be to access the capital markets by using the government (either federal or state) to borrow money at low interest rates to be loaned to students, and then provide strong tax incentives to employers to assist students in paying off these loans during employment. Note employer participation would bring another very important consumer to the table, since clearly employers (private or public) would want to demand high quality learning experiences in disciplines of importance to their enterprise if they are going to pay off the student loans of their employees.

As a second example, many recent studies have revealed the degree to which access to higher education in America has become increasingly stratified according to student financial circumstances, thereby undercutting the fundamental principles of equity and social justice. Today even the most academically talented students in the lowest economic quartile are significantly less likely to have access to the benefits of higher education than the least academically qualified students

in the top quartile–a situation clearly intolerable for a democratic society.

Part of the challenge arises from the patchwork character of current federal, state, and institutional financial aid programs, which have evolved over the years more as a consequence of the political process than any defined purpose or accountability with respect to impact or efficiency in achieving student access or success in higher education. Today a very significant fraction of public funding for post-secondary education go primarily to benefit affluent students with modest economic needs, at a time when close to a quarter of Americans are disproportionately and severely deprived of educational opportunity at colleges and universities.

There has been inadequate effort to integrate and restructure the system into a cohesive policy-driven program, despite the obvious benefits and cost savings. As a consequence, while the current system does benefit affluent students, the lending industry, and political objectives, it is both extraordinarily inefficient and ineffective with respect to key objectives such as higher education access, retention, and debt burden. It needs to be replaced with a strategically-oriented, results-driven, and greatly simplified program of grants, loans, and tax benefits that demonstrably works to serve clearly-articulated goals.

As a consequence of both the inadequacy and complexity of existing financial aid programs, many economically disadvantaged students (and parents) no longer see higher education as an option open to them but rather as a privilege for the more affluent. As a result, these students do not have the incentive to perform well in K-12 (nor do their parents have the incentive to support them), hence falling behind early or dropping out of the college-bound ranks.

To address this alarming injustice and provide strong incentives for college preparation, the idea would be to provide every student with a "529 college savings account", a "Learn-Grant" when they begin kindergarten. Although this account would be owned by the students (although invested in the equity market by the federal government or its agents), its funds could only be used for post-secondary education upon the successful completion of a high school college-preparatory program. Each year students (and their parents) would receive a statement of the accumulation in their account, with a reminder that this is their money, but it can only be used for their college education (or other post-secondary education). An initial contribution of, say, $10,000 (e.g., $5,000 from the federal government with a $5,000 match from the states) would accumulate over their K-12 education to an amount that when coupled with other financial aid would likely be sufficient for a four-year college education at a public college or university.

Beyond serving as an important source of financial aid, the Learn Grants would provide a very strong incentive for succeeding in K-12 and preparing for a college education, since the account would be something students own but would lose if they did not continue their education beyond secondary school (after some appropriate grace period). The program might be funded from any of a number of sources, e.g., from a federal plus state match, the revenue from the auction of the digital spectrum (most analogous to the Land Grant Act), etc. Although the Learn Grants would be provided to all students when entering K-12 (in order to earn broad political support), they could be augmented with additional contributions from public, private, or parental sources during their pre-college years, based on need and/or performance.

It is imperative both as a matter of social justice and economic competitiveness that the nation and the states address and remove those factors that have created a strong dependence of access and success in education upon socioeconomic status. America should aspire to the ideal where family income is nearly irrelevant to the ability of a student to access educational opportunities best matched to his or her talents, objectives, and motivation. The proposed Learn Grant program would provide a powerful stimulus to building the world-class workforce necessary for America's prosperity and security in an ever more competitive global, knowledge-driven economy.

*8. Michigan should work with other Great Lakes states facing similar challenges and opportunities to develop a regional agenda both to facilitate cooperation and to influence national priorities.*

As a more detailed discussion in the next chapter will suggest, political boundaries characterizing state or local governance are of little relevance to competitive-

ness in a global, knowledge-driven economy. The Great Lakes states, once the economic engine of the world, today faces very similar challenges in transforming themselves from industrial to knowledge economies. Only by adopting a regional perspective and developing a collaborative strategy will they be successful.

*9. 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 for this recommendation!

# Chapter 7

## A Broader Perspective: The Great Lakes Region

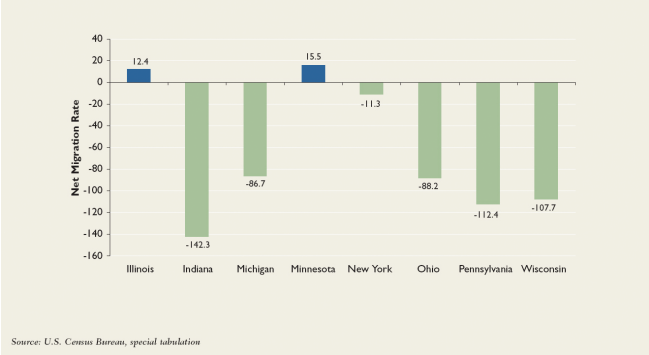
Michigan is not alone in facing the challenge of disruptive economic and technological change. From Pennsylvania to Minnesota, Cleveland to Detroit to Chicago, the questions are the same: In an increasingly knowledge-driven global economy, what will replace factory-based manufacturing and agriculture as the economic engine of future prosperity for the Great Lakes region. The impact of the flat world on the industrial Midwest has been disruptive, if not catastrophic in many respects. Our states and cities, once the industrial heartland of the nation, the economic engine of the world, and, indeed, the arsenal of democracy, face the very real possibility of becoming an economic backwater in the global knowledge economy. While this region benefited greatly during the 20th century in being the manufacturing center of the world, today's global phenomena such as outsourcing and off-shoring have destroyed the viability of low-skill, high-wage manufacturing jobs-and even threaten to displace many high-skill service activities-as a source of prosperity and social well-being. As John Austin and his colleagues characterized it in a recent Brookings Institution study of the region, "Today the economic giant of the Great Lakes region stands with one foot planted in a waning industrial era and its other foot striding toward the emerging global knowledge economy" (Austin, 2006).

Clearly, this region remains of great importance to the nation. With a population of 97 million and one of the largest industrial production centers and consumer marketplaces in the world, this region is comparable in scale and impact to other global economic regions such as North Central Europe, the West Coast, and the Northeast corridor. Furthermore its political clout as a collection of swing states is evident, deciding the past two presidential elections and likely the nation's primary political battleground in the upcoming 2008 elections. This regional economic and political power should be viewed as an important asset, since it transcends the efforts of individual states and cities to develop and advocate for federal policies and investments for their particular constituencies. In fact, it is likely that several of the Great Lake states that have been particularly traumatized by the global economy, Michigan among them, no longer have the economic and political wherewithal to bootstrap themselves back to prosperity. They will require and must embrace a regional strategy.

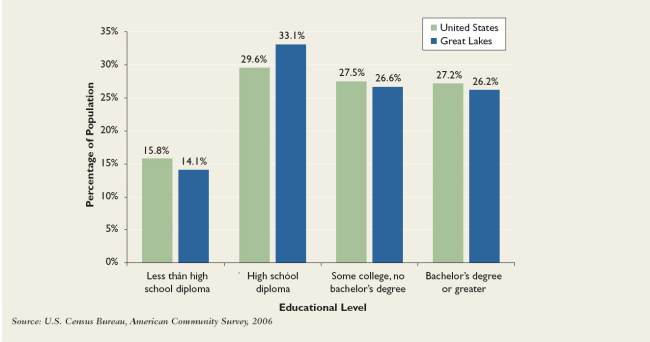
The Great Lakes Region

Of course an assessment of today's status of the Great Lakes region is disturbing. Its states are having great difficulty in making the transition from a manufacturing and agricultural to a knowledge economy. The Brookings Institute study summarized these challenges as follows (Austin, 2006):

- Still heavily reliant on mature industries and products, its aging workforce lacks the education and skills needed to fill and create jobs in the new economy.
- Its entrepreneurial spirit is lagging, hampering its ability to spur new firms and jobs in high-wage industries.
- Its metropolitan areas are economically stagnant, old and beat up, and plagued with severe racial divisions.




The outflow of college-educated young adults.
(Austin and Britany Affolter-Caine, 2006)



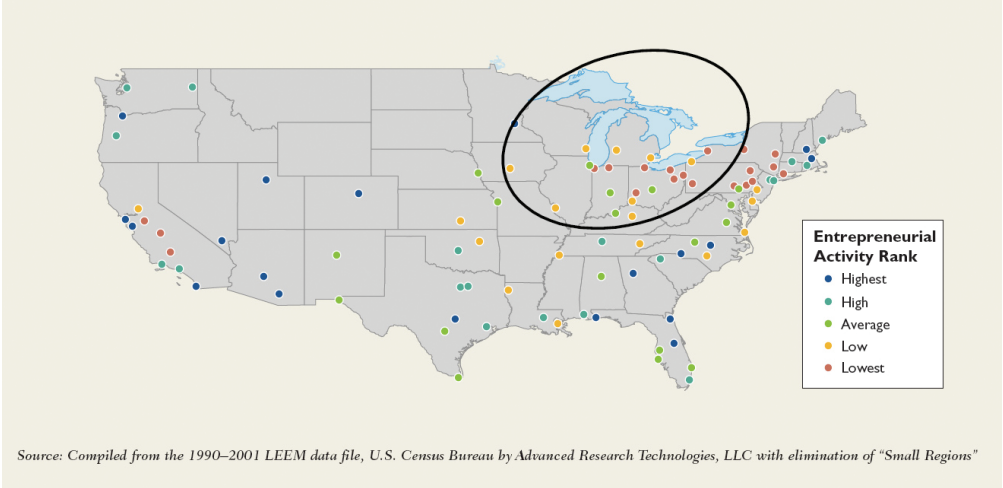

Education levels in the Great Lakes states
(Austin and Britany Affolter-Caine, 2006)

- Its landscape is dotted with emptying manufacturing towns, isolated farm, mining, and timber communities.
- It continues to bleed young, mobile, educated workers seeking opportunities elsewhere.
- Its legacy of employee benefits, job, and income security programs-many of which the region helped pioneer-has become an unsustainable burden, putting its firms at a severe competitive disadvantage in the global economy.
- And most important, the culture of innovation that made it an economic leader in the 20th century has long since vanished.

These weaknesses are disturbing, since in a knowledge-intensive society, 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.

So what are the assets of this region. What provides hope for prosperity in a flattening world? Returning once again to the Brookings study, the Great Lakes states provide:

- A strong research, innovation, and talent cultivation infrastructure.
- Critical mass and expertise in emerging industries from advanced manufacturing to health care.
- Global firms and universities that are significant players in the worldwide exchange of ideas, people, products, and services.
- The tremendous amenity and resource of the lakes and their waterways.

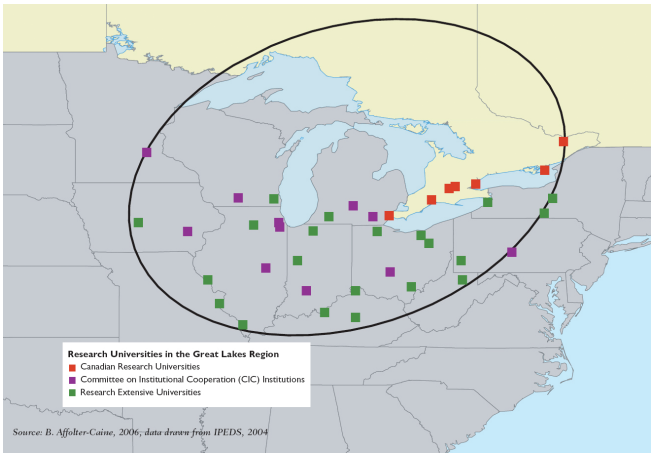



The relatively low level of entrepreneurial activity.
(Austin and Britany Affolter-Caine, 2006)

Which of these assets might we use in a roadmap to the future of the Great Lakes region? Perhaps our natural resources, since the fresh water resources of the Great Lakes could be an asset in areas such as tourism (the "North Coast" strategy). Unfortunately, human capital is not currently an asset for our region, both because of aging (and perhaps declining) populations and the relatively low priority given to education by a manufacturing economy–and unfortunately for many of our citizens and political leaders. 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. At its core are the Big Ten universities, or more correctly, the C. I. C. (Committee on Institutional Cooperation) group, which consists of the eleven 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. More specifically, they conduct over $6 billion/year of R&D, enroll over 300,000 undergraduates and 76,000 graduate students, award roughly one-fifth of the nation's doctorates in fields such as engineering, chemistry, mathematics, and computer science. When one adds to these institutions other leading research universities of the Great Lakes regions such as Washington University, Cornell, Carnegie Mellon, Pittsburgh, Case-Western Reserve, and Iowa State, one has a significant fraction of the world's top research universities.

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. 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,




Major research universities in the Great Lakes region (Austin and Britany Affolter-Caine, 2006)

Wisconsin and Michigan in engineering, the natural and social sciences, and biomedical science, Northwestern in medicine and business administration, and Chicago in the humanities and 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. The rapid evolution of digital technologies provide 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., Minnesota's pioneering work in networking ("Gopher"), Illinois's development of the browser (Netscape), Michigan's role in developing the Internet (NSFnet), and Indiana's management of Internet2.

While the flagship public research universities in the Great Lakes region face similar challenges today as their state's budgets struggle to cope with staggering costs for health care, corrections, security, and infrastructure in the face of political forces demanding tax relief, this has made them lean and mean. 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 (Zemsky, 2005).

Perhaps most important, 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. 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.

This spirit of collaboration continues today with the recent creation of the Great Lakes Computing Consortium, which recently won the largest award of the National Science Foundation's National Petascale Program, a $400 million grant to build the world's largest computer. An even bolder consortium of these research universities is now develop the plan for a Great Lakes Energy Research Network, a coordinated network of major federally funded laboratories sprinkled among the universities to conduct energy R&D in areas such as alternative fuels, transportation energy, renewable energy sources, conservation, and electrical power generation. Since the economy Great Lakes states continues to be highly dependent upon energy-intensive industries–manufacturing, agriculture, transportation–such research is not only vital to securing the sustainability of the nation's energy supply but also to the future of the Great Lakes region. A more detailed description of this initiative is provided in Appendix B.

More broadly, it seems natural to suggest that any strategic effort to better position the Great Lakes region for the global, knowledge economy must include these remarkable institutions as essential assets. Because of many generations of strong support and stewardship, today the Great Lakes states have a collection of flagship research universities not only comparable to but superior in many characteristics-quality, capacity, breadth, global presence-to those of the California 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 in a global, knowledge-driven economy.

Put another way, while the Great Lakes region provided the muscle for the manufacturing economy that powered the 20th century, today its research universities give it the capacity to become the brains of the 21st century knowledge economy. Provided, of course, that the great value of these remarkable institutions is recognized and sustained through adequate investment by leaders in the public and private sectors.

# Chapter 8

# A Call for Leadership

A roadmap is just that: a set of possible directions to future destinations. 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 reclothed 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 even more so 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. Strategic public policies and strong public and private investment 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 to heed these imperatives will become economic backwaters.

Since public commitments and government action are the longer-term keys, 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, investment, 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 an equitable tax structure and cost accountability sufficient to provide the necessary public services for the present while making the critical investments in the future.

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 automobile industry during the last century–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 states that have recognized the realities of a flat world.

Compounding this difficult situation is a state government 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 also burdened with an unwillingness or perhaps an inability to think outside the box. Public leaders still promote old ideas and old philosophies from the past, a different time, totally irrelevant to today. 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.

Economists single out 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.

Today's students deserve better from state government if they are to build Michigan's future economy.

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. Bill Gates notes that topflight universities present an advantage in drawing intellectual talent to a region. Being an "IQ magnet is a self-enforcing thing" (Gates, 2005). Where top universities are located is where new companies dealing with the biosciences and other high technology projects will locate, Gates stresses.

Yet for decades, Michigan's policies for public 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 improvements in K-12 education or restore adequate support of a higher education system already reeling from several years of deep budget cuts. Instead state government has chosen all too frequently to gain political support by attacking universities for the tuition increases that are inevitably a consequence of state budget cuts and earlier tuition constraints. They 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 tuition, and merit-driven financial aid programs.

We need to take a hard 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 and expectations: employee benefits, health care, social services, and litigation. Yet today, we continue to

deploy our resources–already limited both by a weak economy and commitments made in more prosperous times–to pay for the past rather than investing in the future by creating new knowledge, new skills, and new jobs.

Not investing in education and research is not only irresponsible but, indeed, is tantamount to economic suicide 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. And, of course, without regard to the damage they are doing to their children's future.

## 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 the sacrifices we must make today to enable investments for tomorrow, 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. A civil society does require some degree of sacrifice on the part of all citizens, relative to their capacity and means. 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.

The grades are in. All of us, whether in government, business, labor, education, or as citizens, have failed miserably to turn things around. And our children will bear the brunt of our failures.

While public apathy (sometimes driven by despair), political pandering (perhaps driven by term limits), and corporate myopia (likely driven by greed) are all contributors to inaction, in the end it all boils down to an appalling absence of leadership characterizing our state at all levels and in all sectors–state and local government, business and industry, education and labor.

As Michigan citizens it is our right and our responsibility to state clearly what we expect, deserve, and demand from our leaders in both the public and private sectors. But beyond calling once again for enlightened, courageous, and committed leadership, it is time to go further and ask those in leadership positions either unwilling or unable to address Michigan's challenges to step aside and let others take the wheel. To continue to tolerate and perpetuate the current leadership vacuum is to dishonor the sacrifices of past generations and condemn the future for our descendants.

In summary, as both a nation and a state, we should reaffirm that education represents one of the most important investments a society can make in its future, since it is an investment in our people. Although we take pride in Michigan's educational assets, particularly its world-class system of public universities, we must keep in mind that this 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.

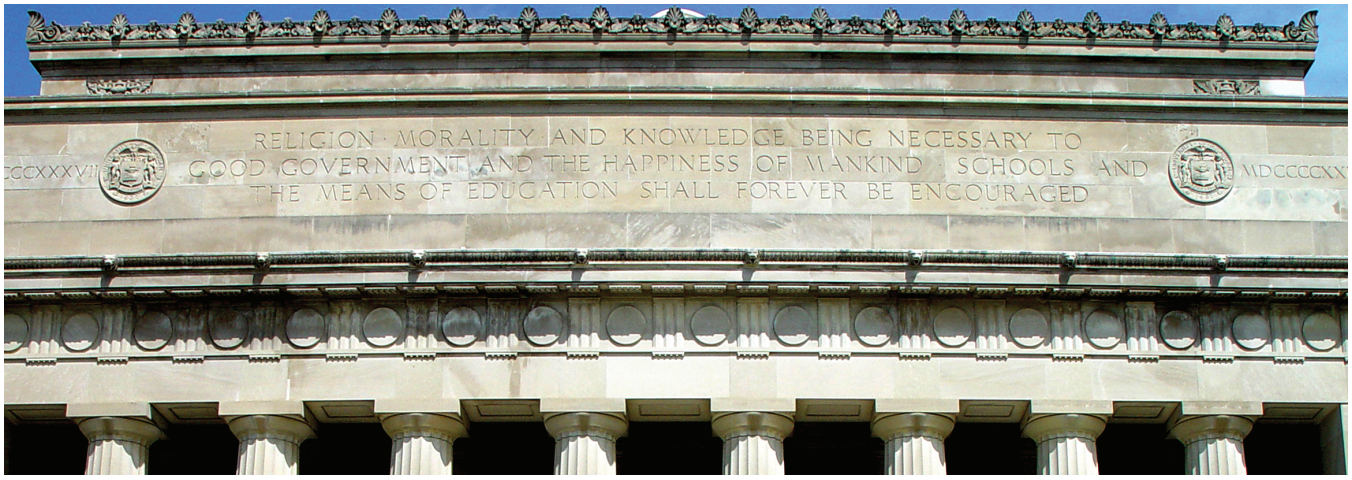
We have inherited these institutions because of the commitments and sacrifices of previous generations. Today it is our obligation as responsible stewards—and as responsible parents—to sustain these institutions to serve our children and our grandchildren. It seems clear that if we are to honor this 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.

## A Final Request

Documents such as this *Michigan Roadmap Redux* should be viewed as transient documents, since the Michigan landscape changes over time. As the world continues to change, and as thoughtful and creative people become more engaged in considering our state's challenges and opportunities, new paths to the future will become apparent. Hence it is important for readers to consider this particular effort as both organic and evolutionary–and also perhaps as a bit too harsh, although after 40 years of living in and serving this state while enduring its all too frequent lapses in leadership and wisdom, some outspoken criticism seems highly warranted.

But other citizens have important views that must be heard and heeded. Hence feedback and suggestions concerning this document are strongly encouraged. They will reshape future versions of the Michigan Roadmap, just as the current Michigan Roadmap Redux was reshaped by the input of many of those who provided feedback on the 2005 draft. After all, when the territory ahead is uncertain, a combination of dead-reckoning, exploration, and mid-course correction may be the best approach to map-making!




Leaders of our state must never forget the fundamental principle upon which Michigan was founded: "Religion, morality, and knowledge being necessary to good government and the happiness of mankind, schools and the means of education shall forever be encouraged" (Northwest Ordinance, 1787)

# Appendix A

## The Spellings Commission

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 in an effort to 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 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 chal-

lenge 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).

In recent years, numerous studies sponsored by government, business, foundations, the national academies, and the higher education community have suggested that the past attainments of American higher education may have led our nation to unwarranted complacency about its future. Of particular importance here was the National Commission on the Future of Higher Education (the "Spellings Commission"), launched in 2005 to examine issues such as the access, affordability, accountability, and quality of our colleges and universities (Miller, 2006). This unusually broad commission–comprised of members from business, government, foundations, and higher education–concluded that "American higher education has become what, in the business world would be called a mature enterprise: increasingly risk-averse, at times self-satisfied, and unduly expensive. It is an enterprise that has yet to address the fundamental issues of how academic programs and institutions must be transformed to serve the changing educational needs of a knowledge economy. It has yet to successfully confront the impact of globalization, rapidly evolving technologies, an increasingly diverse and aging population, and an evolving marketplace characterized by new needs and new paradigms."

The Commission agreed that higher education in the United States is characterized both by its great diversity and an unusual degree of institutional autonomy–understandable in view of the limited role of the federal government in post-secondary education. It benefits from a remarkable balance among funding sources, with roughly 25% from the federal government, 20% from the states, and 55% from private sources (tuition, philanthropy). To quote The Economist: "It is all too easy to mock American academia. But it is easy to lose sight of the real story: that America has the best system of higher education in the world!" (Economist, 2005)

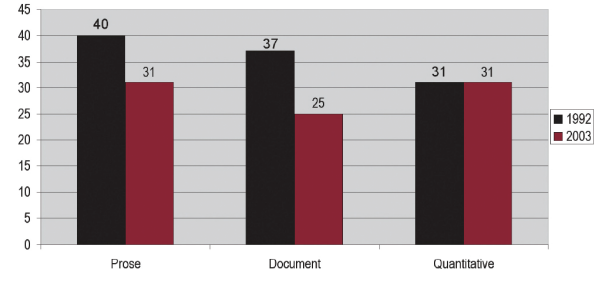

Secretary of Education Margaret Spellings addressing the meeting of the National Commission on Higher Education

Yet, while this remains true in selected areas such as research and graduate education, many other aspects of higher education in the United States raise serious concerns: an increasing socioeconomic stratification of access to (and success in) quality higher education; questionable achievement of acceptable student learning outcomes (including critical thinking ability, civic participation, communication skills, and quantitative literacy); cost containment and productivity; and the ability of institutions to adapt to changes demanded by the emerging knowledge services economy, globalization, rapidly evolving technologies, an increasingly diverse and aging population, and an evolving marketplace characterized by new needs (e.g., lifelong learning), new providers (e.g., for-profit, cyber, and global universities), and new paradigms (e.g., competency-based educational paradigms, distance learning, open educational resources). Furthermore, while American research universities continue to provide the nation with global leadership in research, advanced education, and knowledge-intensive services such as health care, technology transfer, and innovation, this leadership is threatened today by rising competition from abroad, by stagnant support of advanced education and research in key strategic areas such as physical science and engineering, and by the complacency and re-

| Distribution of Family Income | | | | |
|---|---|---|---|---|
| Type of Institution | Lowest Quartile 2003 (1992) | 2nd Quartile 2003 (1992) | 3rd Quartile 2003 (1992) | Highest Quartile 2003 (1992) |
| Public Two-Year | 37% (29%) | 19% (15%) | 13% (13%) | 7% (6%) |
| Public Four-Year | 47% (41%) | 26% (22%) | 18% (16%) | 11% (10%) |
| Private Four-Year | 83% (60%) | 41% (33%) | 29% (25%) | 19% (17%) |

Lowest quartile: $0-$34,000; 2nd quartile: $34,000-$62,000; 3rd quartile: $62,000-$94,000; Highest quartile: $94,000+. (Source: College Board, 2005.)

Percentage of family income needed to cover net costs after college grant aid by type of institution.




Source: U.S. Department of Education, National Center for Education Statistics, 1992 National Adult Literacy Survey and 2003 National Assessment of Adult Literacy.

Percentage of college graduates proficient in prose, document, and quantitative literacy.

sistance to change of the American research university (Augustine, 2005).

More specifically, the Commission raised two areas of particular concern about American higher education: social justice and global competitiveness. Too few Americans prepare for, participate in, and complete higher education. Notwithstanding the nation's egalitarian principles, there is ample evidence that qualified young people from families of modest means are far less likely to go to college than their affluent peers with similar qualifications. America's higher-education financing system is increasingly dysfunctional. Government subsidies are declining; tuition is rising; and cost per student is increasing faster than inflation or family income.

Furthermore, at a time when the United States needs to be increasing the quality of learning outcomes and the economic value of a college education, there are disturbing signs that suggest higher education is moving in the opposite direction. Numerous recent studies suggest that today's American college students are not really learning what they need to learn (Bok, 2006). As a result, the continued ability of American post-secondary institutions to produce informed and skilled citizens who are able to lead and compete in the 21st century global marketplace may soon be in question. Furthermore, the decline of public investment in research and graduate education threatens to erode the capacity of America's research universities to produce the new knowledge necessary for innovation.

The Commission issued a series of sweeping recommendations to better align higher education with the needs of the nation:

1. *Removing the barriers to access and success:* Every student in the nation should have the opportunity to pursue postsecondary education. The Commission recommended, therefore, that the U.S. commit to an unprecedented effort to expand higher education access and success by improving student preparation and persistence, addressing non-academic barriers and providing significant increases in aid to low-income students.

While there are important actions that can be taken both by colleges and universities and by their patrons (state and federal government, private support) to improve access at the margin, major gains are not likely without a sustained improvement in secondary education. A high school degree should signify that a student is college and/or work ready. States must adopt high school curricula that prepare all students for participation in postsecondary education and should facilitate seamless integration between high school and college.

2. *Restructuring student financial aid:* To address the escalating cost of a college education and the fiscal realities affecting government's ability to finance higher education in the long run, the Commission recommended that the entire student financial aid system be restructured and new incentives put in place to improve the measurement and management of costs and institutional productivity.

Here the key is to focus financial aid at the national, state, and institutional level primarily to address need, rather than subsidize the well-to-do (as much of it does today through "merit" aid and tax benefits). The Commission proposed replacing the current maze of financial aid programs, rules and regulations with a system more in line with student needs and national priori-

ties. That effort would require a significant increase in need-based financial aid and a complete restructuring of the current federal financial aid system. Its recommendations call for consolidating programs, streamlining application processes, and emphasizing grants over loans.

The federal government, states and institutions should significantly increase need-based student aid. To accomplish this, the present student financial aid system should be replaced with a strategically oriented, results-driven system built on the principles of (i) increased access, or enrollment in college by those students who would not otherwise be likely to attend, including non-traditional students; (ii) increased retention, or graduation by students who might not have been able to complete college due to the cost, (iii) decreased debt burden, and (iv) eliminating structural incentives for tuition inflation. Federal grant programs should be consolidated to increase the purchasing power of the Pell Grant. Whatever restructuring of federal financial aid takes place, the Pell Grant will remain the core need-based program.

Policymakers and higher education leaders should develop, at the institutional level, new and innovative means to control costs, improve productivity, and increase the supply of higher education. At the same time, the Commission opposed the imposition of price controls. Federal and state policymakers and accrediting organizations should work to eliminate regulatory and accreditation barriers to new models in higher education that will increase supply and drive costs down. Federal and state policymakers should relieve the regulatory burden on colleges and universities by undertaking a review of the hundreds of regulations with which institutions must comply and recommend how they might be streamlined or eliminated.

3. *Restoring transparency, accountability, and public purpose:* To meet the challenges of the 21st century, higher education must change from a system primarily based on reputation to one based on performance. The Commission urged the creation of a robust culture of accountability and transparency throughout higher education. Every one of its goals, from improving access and affordability to enhancing quality and innovation, will be more easily achieved if higher education institutions embrace and implement serious accountability measures.

To restore public trust and confidence, it suggested that higher education should emulate the capital markets through transparency and accountability that demonstrates their public purpose, e.g., agreeing on how to measure costs, prices, and values (analogous to FASB) and full public disclosure of both learning outcomes and financial performance (analogous to Sarbanes-Oxley). To this end it recommended the creation of a consumer-friendly information database on higher education with useful, reliable information on institutions, coupled with a search engine to enable students, parents, policymakers and others to weigh and rank comparative institutional performance. In addition to this new consumer-oriented database, more and better information on the quality and cost of higher education is needed by policymakers, researchers and the general public.

The Commission reinforced the principle that faculty must be at the forefront of defining educational objectives for students and developing meaningful, evidence-based measures of their progress toward those goals, but also that the philanthropic community and other third-party organizations are urged to invest in the research and development of instruments measuring the intersection of institutional resources, student characteristics, and educational value-added. Furthermore, accreditation agencies should make performance outcomes, including completion rates and student learning, the core of their assessment as a priority over inputs or processes.

4. *Investing in Innovation:* With too few exceptions, higher education has yet to address the fundamental issues of how academic programs and institutions must be transformed to serve the changing needs of a knowledge economy. The Commission recommended that America's colleges and universities embrace a culture of continuous innovation and quality improvement by developing new pedagogies, curricula, and technologies to improve learning, particularly in the area of science and mathematical literacy.

It urged broad federal support of innovation in higher education from multiple agencies (Departments of Education, Energy, Labor, Defense, and Commerce;

the National Science Foundation; the National Institutes of Health; and the National Aeronautics and Space Administration) in order to align and coordinate federal investment of innovation in higher education. The Commission encouraged the creation of incentives to promote the development of information-technology-based collaborative tools and capabilities at universities and colleges across the United States, enabling access, interaction, and sharing of educational materials from a variety of institutions, disciplines, and educational perspectives. Both commercial development and new collaborative paradigms such as open source, open content, and open learning will be important in building the next generation learning environments for the knowledge economy.

5. *Commit to lifelong learning opportunities*: America must ensure that all citizens have access to high quality and affordable educational, learning, and training opportunities throughout their lives. The Commission recommended the development of a national strategy for lifelong learning that helps all citizens understand the importance of preparing for and participating in higher education throughout their lives.

Just as in earlier critical moments in our nation's history when federal initiatives expanded the role of education, e.g. the Land Grant Acts in the 19th century to provide higher education to the working class, universal access to secondary education in the early 20th century, and the G. I. Bill enabling the college education of the returning veterans of World War II, today a major expansion of educational opportunity could have extraordinary impact on the future of the nation. The Commission believes it is time for the United States to take bold action, completing in a sense the series of these earlier federal education initiatives, by providing all American citizens with universal access to lifelong learning opportunities, thereby enabling participation in the world's most advanced knowledge and learning society.

6. *Responding to the imperatives of the global knowledge economy:* The United States must ensure the capacity of its universities to achieve global leadership in key strategic areas such as science, engineering, medicine, and other knowledge-intensive professions. The Commission recommended increased federal investment in areas critical to our nation's global competitiveness and a renewed commitment to attract the best and brightest minds from across the nation and around the world to lead the next wave of American innovation.

It supported increasing federal and state investment in education and research in critical areas such as science, engineering, teaching, nursing, biomedicine, and other professions along the lines recommended by the American Competitiveness Initiative, Rising Above the Gathering Storm, and the National Innovation Initiative. Moreover, in an effort to retain the best and brightest students and professionals from around the world, it urged the federal government to restructure and simplify immigration policies specifically aimed at international students.

Since the report of the Spellings Commission was released in fall of 2006, there have been concerted efforts both at the federal and state level and among higher education organizations to begin to implement the tactical actions necessary to achieve these goals during the remaining months of the current administration. Yet these six broad recommendations define a framework that could frame both policy and action for many years go come–provided, of course, that leaders from government and higher education set aside their political and philosophical persuasions and keep the interests of the nation foremost in mind.

# Appendix B

# Great Lakes Energy Research Network: A Proposal

An excellent example of what might be accomplished by linking together the knowledge assets of the Great Lakes States is the proposed Great Lakes Energy Research Network, a major effort to address the sustainability of the nation's energy supply. This effort also happens to target a major challenge of immense importance to the Great Lakes states, including Michigan in particular, because of the energy-intensive nature of its industrial base–manufacturing, agriculture, transportation. By deploying the unique assets of the region's research universities, the most powerful regional group of research institutions in the world, we could address not only the most significant threat facing our nation and the world, but also lay the foundation for the Great Lakes region's future economic strength and prosperity.

## The Challenge

The United States economy, our national security, and the well-being of our citizens are dependent upon the availability of clean, affordable, flexible, and sustainable energy resources. Yet our current energy infrastructure, heavily dependent upon fossil fuels, is unsustainable. Global oil production is expected to peak within the next several decades. While there are substantial reserves of coal and tar sands, the mining, processing, and burning of these fossil fuels poses increasingly unacceptable risk to both humankind and the environment, particularly within the context of global climate change. Furthermore, the security of our nation is threatened by our reliance on foreign energy imports from unstable regions of the world. Clearly energy independence must become among the highest priorities of the federal government if it is to meet its responsibilities for national security, economic prosperity, and social well-being.

Unfortunately, current federal energy strategies, policies, and investments seem woefully inadequate when balanced against the urgency, complexity, and scale of the challenges in building a sustainable energy infrastructure for the nation. Alternative energy technologies such as electric or hybrid cars, hydrogen fuels, nuclear power, and renewable energy sources such as solar, wind, or biofuels still require considerable research and development before they evolve to the point of massive utilization. The scale of the necessary transformation of our energy infrastructure is immense. It is estimated that over $16 trillion in capital investments over the next two decades will be necessary just to expand energy supply to meet growing global energy demands, compared to a global GDP of $44 trillion and a U.S. GDP of $12 trillion.

Yet over the past two decades, energy research has actually been sharply curtailed by the federal government (75% decrease), the electrical utility industry (50% decrease), and the domestic automobile industry (50% decrease). Today the federal government effort in energy R&D is less than 20% of its level during the 1980s! To gain a better sense of the priority given today to energy research, one might compare the $2.7 billion proposed for the President's Advanced Energy Initiative with the $17 billion NASA budget, the $30 billion NIH budget, or the $83 billion R&D budget for DOD. More specifically, of the current annual $23 B budget of the Department of Energy, only $6.1 B goes for basic scientific research and technology development related to energy.

How much should the federal government be investing in energy R&D? A comparison of the size of the energy sector ($1.9 T) compared to health care ($1.7 T) and national defense ($1.2 T) would suggest annual R&D investments in the range of $40 to $50 B, roughly ten times the current investments. Clearly Washington has yet to take the energy crisis seriously-and as a consequence our nation remains at very great risk.

Beyond scale, there are few technology infrastruc-

tures more complex than energy, interwoven with every aspect of our society. Moving to sustainable energy technologies will involve not simply advanced scientific research and the development of new technologies, but as well complex issues of social priorities, economic and market issues, international relations, and politics at all levels. Little wonder that one commonly hears the complaint that "The energy crisis is like the weather; everybody complains about it, but nobody does anything about it!"

There is growing concern that our existing paradigms for federal energy research are just not up to the task. Currently the lead federal agency for energy research is the Department of Energy, with the bulk of its research conducted by its national laboratories. Yet the SEAB Task Force warns: "The Department of Energy has an historically poor reputation as badly managed, excessively fragmented, and politically unresponsive. The current organization of the Department is not appropriate to the magnitude and centrality of scientific and advanced technological research required by our energy challenges." (Vest, 2005) The organizational separation of DOE's basic and applied energy research programs makes the migration of basic research findings to applied research solutions undisciplined, more difficult, and often, serendipitous. The DOE R&D programs are organized around fuel sources, e.g., coal, oil, gas, nuclear renewables, but this leads to stove-pipe organizations that focus on incremental or discrete technologies as opposed to systems that integrate R&D needs from supply to distribution to end use. The DOE stovepipes are all too frequently risk-adverse and parochial, tending to seriously misjudge the potential for new high-risk, technologically-enabled opportunities and threats (ARPA-E Testimony, 2007).

Furthermore the DOE mission-focused divisions and national laboratories are relatively isolated from higher education, aside from the DOE Office of Science. They do not have a significant role in human resource development (e.g., the education of scientists and engineers), which is the most effective technology transfer mechanism through the knowledge and skills carried by graduates.

In summary, it is clear that a federal research program are far from adequate to respond to the urgency, scale, and complexity of the nation's needs for a sustainable energy infrastructure. They will require not only a massive increase in funding but as well a quite different research paradigm characterized by highly multidisciplinary scientific research, the development of highly innovative technologies capable of rapid transfer into the marketplace, and great agility to respond to ever changing challenges and opportunities. Such programs must involve an intimate partnership among multiple players-federal agencies, research universities, established industry, entrepreneurs, and the investment community-from the get-go. A new research culture must be developed based on the nonlinear flow of knowledge and activity among scientific discovery, technological innovation, and entrepreneurial business development.

While the national laboratory model has been effective in developing large scale scientific research and technology development in areas such as high energy physics and nuclear energy, the isolated, laboratory-centric culture has not proven particularly effective either in technology transfer into the commercial marketplace or in human resource development through the education of scientists and engineers. In years past, large corporate R&D laboratories such as Bell Labs and IBM Research Labs have been more effective at developing commercial technologies, but today investor pressures on near-term bottom line results has shifted most corporate activity away from basic research and toward product development. Traditional research programs within universities suffer from disciplinary silos and insular culture of national laboratories, although their education mission does provide a highly effective technology transfer mechanism through their graduates and faculty consulting.

## A New Research Paradigm: Discovery Innovation Institutes

Over the years an array of new research and technology development paradigms have been explored such as the Defense Advanced Research Projects Agency (and the proposed ARPA-E), SEMATECH for the electronics industry, the Advanced Technology Program of NIST, the Small Business Innovation Research grant programs, and the In-Q-Tel effort to simulate innovation in the development of technologies for the intelli-

gence community. However each of these also seems to fall somewhat short of scale, complexity, and urgency of addressing the energy research needs of the nation.

To this end, it seems appropriate to consider a new research paradigm proposed by the National Academy of Engineering: discovery-research institutes (NAE, 2005). A recent NAE task force on engineering research and American competitiveness stressed that to meet challenges such as energy sustainability and global markets, the United States needed new paradigms based not only upon new organizational structures but more robust relationships among various institutional sectors such as federal and state governments, established and startup business and industry, investors, foundations, and academia. To this end, the NAE task force recommended the establishment of multidisciplinary discovery-innovation institutes (DIIs) capable of linking fundamental scientific discoveries with technological innovations to create the products, processes, and services needed by society and funded by a consortium of federal and state governments, industry, foundations, venture capital and investment community, and universities. The discovery-innovation institutes would be the foci for long-term, applications-driven research spanning an array of academic and professional disciplines including the natural sciences, engineering, social sciences, and professional disciplines such as business administration, law, and medicine.

With the participation of many scientific disciplines and professions, as well as various economic sectors (industry, government, states, and institutions of higher education), discovery-innovation institutes would be similar in character and scale to academic medical centers and agricultural experiment stations that combine research, education, and professional practice and drive transformative change. As experience with academic medical centers and other large research initiatives suggests, discovery-innovation institutes could stimulate significant regional economic activity, such as the location nearby of clusters of start-up firms, private research organizations, suppliers, and other complementary groups and businesses.

Discovery-innovation institutes would require the active involvement of industry and federal research organizations such as national laboratories to fulfill their missions of conducting long-term research to convert basic scientific discoveries into innovative products, processes, services, and systems. They would stimulate the creation of new infrastructure, encourage (in fact, require) interdisciplinary linkages, and lead to the development of educational programs that could produce new knowledge for innovation and educate the scientists, engineers, innovators and entrepreneurs of the future. Discovery-innovation institutes would be characterized by partnership, interdisciplinary research, education, and outreach.

On the federal level, the discovery-innovation institutes could be created as university-managed FFRDCs and funded jointly by agencies such at the Departments of Energy, Commerce, and Defense with responsibilities for application-driven research addressing major national priorities such as energy. States could be encouraged to contribute to the institutes (perhaps by providing capital facilities). Industry would provide challenging research problems, systems knowledge, and real-life market knowledge, as well as staff who would work with university faculty and students in the institutes. Industry would also fund student internships and provide direct financial support for facilities and equipment (or share its facilities and equipment). Universities would commit to providing a policy framework (e.g., transparent and efficient intellectual property policies, flexible faculty appointments, responsible financial management, etc.), educational opportunities (e.g., integrated curricula, multifaceted student interaction), knowledge and technology transfer (e.g., publications, industrial outreach), and additional investments (e.g., in physical facilities and cyberinfrastructure). Finally, the venture capital and investment community would contribute expertise in licensing, spin-off companies, and other avenues of commercialization.

Here it should be noted that the proposed creation of such discovery-innovation institutes in key areas of national priority has received unusually strong support by the membership of the National Academy of Engineering-particularly noteworthy since 50% of the Academy membership is drawn from industry. Furthermore, language to establish such institutes was included in Senate bills introduced in both 2006 (S. 2197 - Protecting America's Competitive Edge through Energy Act) and 2007 (S. 771 The American COMPETES Act). Here we should note that this proposed national energy research

network would also be quite consistent with existing Congressional legislation, such as H.R. 1300 aimed at "strengthening national security and promoting energy independence".

## A Proposal: A Great Lakes Network of Discovery Innovation Institutes for Energy Research

As we have noted earlier, the region of the United States most vulnerable to the unsustainable nature of our current energy infrastructure is the concentration of energy-intensive manufacturing, agricultural, and transportation industries surrounding the Great Lakes. Not only does this region comprise the nation's largest energy consumer, but its industry and business contributes a very significant fraction of the nation's economic activity, employment, and trade-not to mention 30% of the electoral votes that determined the last two presidential elections. During the 20th century the Great Lakes states became not only the economic engine of the global economy but also the arsenal of democracy that sustained the nation through two world wars. Yet, ironically, to date federal energy policy and investments in energy R&D-or, rather, the lack thereof-have had the most negative impact on this region. Inadequate investment in the development of new energy technologies accompanied by the passive regulation and massive subsidy of the petroleum industry have transferred jobs and wealth from the manufacturing and transportation centers of the Great Lakes to the oil-centric economics of the Sunbelt (e.g., Texas). Hence one could well argue that the federal government has a particular responsibility to redress this era of neglect and address energy vulnerability of the Great Lakes region through R&D investments-even more so considering the region's considerable importance to the economic strength and security of the nation and its political influence on the 2008 election (Austin, 2006).

Yet beyond these challenges, there are important opportunities that also motivate such an investment. There is one very unusual-indeed, unique-asset possessed by this region: the strongest concentration of flagship research universities in the world. At its core are the Big Ten universities, or more correctly, the C. I. C. (Committee on Institutional Cooperation) group, which consists of the eleven 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. More specifically, they conduct over $7 billion/year of R&D, enroll over 300,000 undergraduates and 76,000 graduate students, and award roughly one-third of the nation's doctorates in fields such as engineering, chemistry, mathematics, and computer science. When one adds to these institutions other leading research universities of the Great Lakes regions such as Cornell, Carnegie Mellon, Pittsburgh, Case-Western Reserve, Iowa State, and Washington University, one has a significant fraction of the world's top research universities.

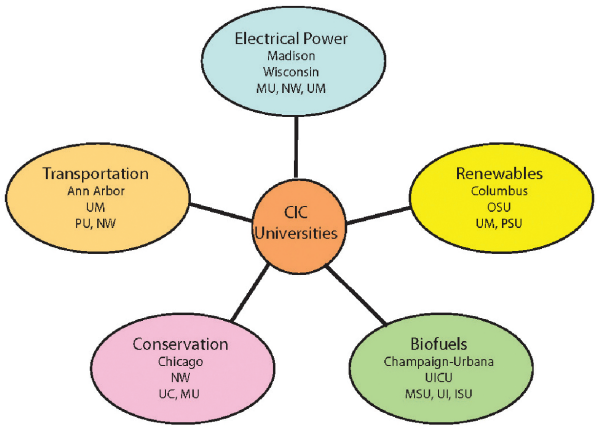
As the flagship universities of their states, these institutions already set the pace for broader educational activities, both at the post-secondary and K-12 levels. Each of these universities has built world-class excellence in unique areas (e.g., Illinois in computer technology, Minnesota in chemistry and chemical technology, Ohio State in materials science and technology, Michigan State, Iowa, 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 humanities and 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.

Equally important, 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. 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 ac-

cess world-class human capital.

Hence it seems natural to propose that the first effort to build an Apollo program level national commitment to energy R&D should consist of creating a highly coordinated network of energy discovery-innovation institutions (DIIs) located adjacent to key research universities in the Great Lakes states. More specifically, we propose the launch of five DII centers as FFRDCs, each with a particular theme such as transportation energy, biofuels, electrical generation, renewables, and conservation. Each DII center would have core support from multiple federal agencies at a level growing to $250 million per year (i.e., $1.25 B/y in total), with significant additional funding from state, industry, foundation, and university sources. Each DII would have numerous participants and affiliates from industry, federal and state agencies, and other research universities from around the nation. Although each individual DII center would be managed as an FFRDC by a lead research university, the integrated Great Lakes Energy Research Network would be managed collectively by the CIC (Big Ten) university consortium with strong industrial participation.

To illustrate the approach, we have given one example of a possible network of energy DIIs based at CIC institutions, with typical inter-CIC linkages and broader affiliations below. To provide an even more specific example, the Michigan-based energy discovery innovation institute would be directed at research on transportation technologies and managed by a consortium of the state's research universities (University of Michigan, Michigan State University, and Wayne State University) and partnering with Michigan business and industry. The sector of our economy that both exhibits the greatest vulnerability to energy and presents the greatest risk to our nation is the transportation industry. Currently the United States 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, which not only is subject to increasingly violent price fluctuations but is a major factor in triggering geopolitical conflict, such as the current war in Iraq. Furthermore as the source of 25% of the carbon dioxide emissions of our nation, the heavy dependence upon fossil fuels of the transportation industry in general and the automotive industry in particular poses a serious threat to both our nation and the world through driving global climate change.




A possible network of energy research discovery innovation institutes in the Big 10 universities.

To respond to these challenges, a discovery-innovation institute would be created in Michigan, adjacent to the nation's largest concentration of transportation industries, with a focus on both fundamental scientific research and technology development concerned with the needs of the transportation industry, including alternative fuels and propulsion systems, hybrid and electric vehicles, hydrogen technologies, and fuel efficiency and emissions control. This would be a highly multidisciplinary R&D center, spanning not only many scientific and engineering disciplines but also economic and policy activities, including professional disciplines such as business administration and law. Although the transportation energy DII would stress long-term, applications-driven research, it would partner closely with industry in technology development and with government in policy development. Of particular interest would be the importance of strong partnerships with the automotive industry accompanied by major efforts to stimulate spin-off industries in key areas such as emission control, fuel synthesis, and systems development.

Here it is very important to understand that the Great Lakes Energy Research Network would be characterized not only by the novel research paradigm of discovery-innovation institutes, but perhaps even more by its highly integrated character as a research network.

Under girded by powerful information and communications technology, i.e., cyberinfrastructure, (much of it developed by the CIC university consortium itself), and overlaid by a network of virtual organizations involving scientists, engineers, industrial management, and federal participants, the Great Lakes Energy Research Network would provide a powerful test-bed for the new types of research organizations enabled by rapidly evolving cyberinfrastructure (Atkins, 2005).

The proposed Great Lakes Energy Research Network would nucleate activities from government, academia, large and small business, and the investment community, marking the beginning of a knowledge revolution that will augment the manufacturing and transportation industries of the Great Lakes region. It would also begin to move the federal government toward more progressive energy policies and new research paradigms that will lead to an integrated effort to address the nation's challenge of sustaining energy infrastructure.

But perhaps equally significant, the Great Lakes Energy Research Network is proposed as the first step toward the National Academy vision of a national network of discovery-innovation institutes addressing the major challenges facing our nation in the years ahead.

## A Time for State, Regional, and Federal Action

The National Academy of Engineering has recommended that to address national priorities such as energy sustainability, a national network of roughly 100 discovery-innovation institutes be developed and funded at a level building to $4 to $5 billion annually. While this may seem ambitious in view of current federal budget constraints, it is modest indeed compared to the federal R&D funding provided other federal priorities such as health care ($30 B/y), defense ($80 B/y) and spaceflight ($12 B/y). Furthermore it is only 10% of the roughly $40 B/y to $50 B/y that we believe will be necessary for federal energy R&D if we are to achieve energy independence and sustainability in this nation.

The proposed Great Lakes Energy Research Network, based on five such discovery-innovation institutes established as FFRDCs with total federal funding of $1.25 B/y, represents an important test-bed to develop this new paradigm of a tightly integrated network of energy research centers addressing key issues (transportation energy, biofuels, electrical generation, renewables, and conservation) through a partnership among the federal government, research universities, industry, the states, and the investment and entrepreneurial community. Furthermore it represents a major federal investment in building the R&D capacity of the Great Lakes region of the nation, most vulnerable to the looming energy crisis because of its strong dependence upon energy-intensive industry, e.g., manufacturing, agriculture, and transportation.

In earlier times the federal government stepped up to the plate with massive investments in the nation's research capacity during periods of great challenge or opportunity. The Land Grant Acts of the 19th century created through the great land-grant universities the capacity to assist the nation's transition from an agricultural to an industrial economy. The Manhattan Project developed the nuclear technology to protect the nation during a period of great international peril. The Apollo Program fulfilled mankind's dream to conquer space by sending men to the moon. Today, an increasing fragile and damaging energy infrastructure based on fossil fuels simply must be replaced with new technologies, before America not only loses its economic prosperity and national security but perhaps puts the very existence of life on earth at risk. It is time once again for the federal government to make a major commitment to investing adequately in the energy technologies that will secure prosperity and security for future generations while protecting the sustainability of Planet Earth.

The Great Lakes Energy Research Network represents an important first step toward this objective.

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# Appendix A

# 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 research 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.

## Biographical Profile

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. After a year as an Atomic Energy Commission Postdoctoral Fellow at Caltech, he joined the faculty of the University of Michigan in 1968 in the Department of Nuclear Engineering. Dr. Duderstadt became Dean of the College of Engineering in 1981 and Provost and Vice President for Academic Affairs in 1986. He was elected 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, co-chairing the University's program in Science, Technology, and Public Policy and directing the Millennium Project, a research center exploring the impact of over-the-horizon technologies on society.

Dr. Duderstadt's teaching and research interests have spanned a wide range of subjects in science, mathematics, and engineering, including nuclear fission reactors, thermonuclear fusion, high-powered lasers, computer simulation, information technology, and policy development in areas such as energy, education, and science. He has published extensively in these areas, including over 20 books and 150 technical publications.

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 or chaired numerous public and private boards including the National Science Board; numerous committees of the National Academies including its executive committee and the Committee on Science, Engineering, and Public Policy; the National Commission on the Future of Higher Education; the Nuclear Energy Research Advisory Committee of the Department of Energy; and business organizations such as the Big Ten Athletic Conference, the University of Michigan Hospitals, Unisys, and CMS Energy.

He currently serves on several major national boards and study commissions in areas including federal science policy, higher education, information technology, energy sciences, and national security including the National Science Foundation's Advisory Committee on Cyberinfrastructure, the Glion Colloquium (Switzerland), and the Intelligence Science Board.

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