

The Michigan Challenge

Introduction

Today I would like to discuss the State of Michigan's strategy to achieve prosperity in the face of intense international competition and rapid technological change.

However it seems appropriate first to broaden our perspective a bit and view the challenge facing Michigan within the broader context of the major changes occurring in the very structure, the very fabric, of the world economy...

In a sense, Michigan's challenge is the challenge of dramatic economic change itself, being driven in large measure by technology ...

Background

To discuss this challenge, I am going to toss aside my hat as president of the University of Michigan, and instead return to my roots as a scientist and engineer.

Throughout my scientific career, I have been heavily involved in stimulating technological change...

In areas such as nuclear energy, lasers, thermonuclear fusion...indeed, I even worked on the Rover Project to develop a nuclear rocket in the 1960s...

In the 1970s, I switched my attention to areas such as supercomputers and computer networks....

I am going to put on a hat as former dean of the College of Engineering at Michigan...as one who has been involved for the past several years in attracting to our state a number of the nation's thought leaders, people such as Lynn Conway and Doug Van Houweling, who had the vision to steer Michigan Engineering in directions where we could have the most impact on the future of this State.

But there is one additional hat I would also like to put on... that of a member of the National Science Board...our nation's principal source of science policy... since, as you will see in few minutes, the theme of international competitiveness has become the cornerstone of our efforts to strengthen America's science and engineering base.

The view from Michigan..."the Rust Belt"...

While people generally look at the midwest as a relic of America's industrial past, let me suggest that in many ways, it can also be viewed as America's future.

For it is in the industrial midwest...in Michigan... that we have had to learn how to adapt to a brave, new world of intense economic competition...

We have learned through the school of hard knocks, as we have fought and scratched and clawed our way back from the economic brink to achieve prosperity.

We have had to build new coalitions involving
the public and private sectors...state government,
education, business, industry, and labor...to
develop an agenda appropriate to secure the
future prosperity of this state.

I am absolutely convinced that our State faces a very unusual
period of challenge in the decade ahead...a watershed,
in a sense, from which we can either emerge at a
national leader...or as an also run...
or perhaps even worse...as an Appalachia...

Quite frankly, the choice will be ours...whether we choose
to continue our tendency of recent years to spend our
resources only to meet the needs or desires of the moment...
or whether we can develop the vision, courage, and
discipline to invest in the future of this state...not just for
this year or next...but for the next generation...our children...

The Bad News of the past several years...

Familiar Ills which dominate the headlines

The budget deficit

The trade deficit

Displaced workers

Marginal Industries

More serious

Trade deficits show little improvement despite a sharp
drop in the dollar

Past areas of strength such as steel and durable goods
manufacturing are declining

Even industries like semiconductors and computers are

vulnerable to competition from abroad

Facts of life:

7-fold increase in international trade since 1970

Market for nearly all significant manufacturing industries
has become world-wide

70% of goods we produce now must compete against
merchandise from abroad

The bad news for Michigan is obvious...

Industries of great economic importance to our
nation such as steel and automobiles have
fallen victim to intense competition from abroad...

Plants have closed...our cities are filled with chronically
unemployed...

Michigan's per capita income has now dropped below
the national average...

Michigan has dropped to 20th in per
capita income (and at \$15,393 is now
slightly behind the national average
of \$15,481)

Our unemployment rate consistently is at the
top...

In Michigan we no longer worry about nuclear war and
and the bomb because we believe that

"The odds are greater that America will be bought up by the
Japanese than blown up by the Russians..."

What is happening?

The world economy is now in control

However, it is misleading to blame all our ills on

international competitiveness alone!

Something else is happening...

The Challenge of Change

1) THE CHALLENGE OF DRAMATIC ECONOMIC CHANGE

Traditional industry economy is shifting to a new knowledge-based economy, just as our industrial economy evolved from an agrarian society at the turn of the century.

The days of low interest rates, limited foreign competition, slow-moving technology, stable markets, and mass production processes that once allowed our industries to thrive in a sheltered environment have long since passed.

This change has gripped the Rust Belt...

A transition is occurring in which..

Intellectual capital has replaced financial and physical capital as key to economic development

The challenge today is to develop an agenda to achieve and sustain prosperity in a new environment of intense international competition and rapid technological change.

Some examples:

1. Industrial production is steadily switching away from material and labor intensive products and processes to knowledge intensive processes:

In a car, 40% materials, 25% labor...

In a chip, 1% materials, 10% labor, 70% knowledge!!!

2. Our nation's future has probably never been less constrained by the cost of natural resources. Future areas of growth are likely to come from the application of technologies

that require few natural resources. Indeed, OTA study suggests that the optimal use of new technology could result in a 40% to 60% decline in the use of natural resources, even when there is rapid economic growth."

3. Increasing manufacturing production has come to mean decreasing blue collar employment!

In the 1920s, 1 of 3 was a blue-collar worker

today 1 in 6 and dropping fast

probably to about 1 in 20 within a couple of decades...

Indeed, UM economic studies suggest that less than 5% of General Motors' work force will be unskilled labor by the year 2000.

4. Recent Office of Technology Assessment report:

40% of all new investment in plant and equipment goes to purchase information technology

Fundamental transformation underway in economy that is

"likely to reshape virtually every product, every service, and every job in United States."

In all developed countries, "knowledge" workers have already become the center of gravity of the labor force.

As Erich Bloch, Director of the National Science Foundation

puts it, we have entered a new age, an "Age of Knowledge in a Global Economy"

And in this age, the major force behind economic change is technology, itself.

Of course, we know that technology has played an increasingly important role for many years.

Technological innovation, achieved by applying new knowledge

created through basic research, has been responsible for nearly half of all US productivity gains since WWII. At another level, technologies of transportation and communication make possible an integrated economy. Tremendous new industries have been created by new technical knowledge: electronics is the obvious example of the last three decades; biotechnology may be the example for the coming three decades.

These industries depend on knowledge as the most critical resource.

But knowledge is highly mobile...it is not tied to geographic regions as coal or iron or oil.

Earlier historical periods that we remember with catch-phrases.. the "Age of Reason", the "Age of Revolution", the "Age of Discovery", were limited geographically to Europe. So was the Industrial Revolution since technology did not allow rapid dissemination of knowledge.

By contrast, the knowledge revolution is happening worldwide and at a very rapid rate.

That new technology means economic development and trade is widely understood in developed nations who have been sharply increasing their investments in science and technology.

But less developed nations are also learning the lesson and drawing knowledge from the developed world or generating it themselves.

Brazil, India, Korea are quickly advancing along the competitive path that Japan took 30 years before.

Example:

Over past two decades, India has increased its population of scientists and engineers by tenfold!!!

Note: As more countries understand that knowledge is now the critical resource, more are undertaking serious research programs. Our nation is already being challenged in the knowledge business itself.

The handwriting is on the wall...

Our economy is at a crossroads...and its future course rests on a disparate set of conscious choices.

Whether the economy moves on a path leading to stagnation, rising imports, and growing unemployment or on a path of rapid growth and technological change, will require "an unflinching reexamination of the way businesses are managed"

2) THE INTERNATIONALIZATION OF AMERICA

Some facts of life:

7-fold increase in international trade since 1970

Market for nearly all significant manufacturing industries has become world-wide

70% of goods we produce now must compete against merchandise from abroad

In slightly more than 5 years, US trade deficit has taken us from the world's largest creditor to its largest debtor nation.

Market for nearly all significant manufacturing industries has become worldwide

The fact is, a truly domestic US economy has ceased to exist.

Today, imports and exports represent about 10% of GNP...

70% of goods we produce compete directly with foreign goods.

Jack Welch, CEO of GE, noted last November:

"Within the next 2 to 3 years, at most, the most important alliances will be forced in every significant global industry--medical, autos, defense, materials, and so on. Those who are slow to recognize the emergence of these global alliances or to act in forming them will find themselves locked out of the game as we enter the 1990s."

American will no longer take its know-how and apply it to low-cost natural resources from third-world countries, turn it into products, and then sell it back to them--as we do in a hierarchical economy. Rather, we'll be only one member in a global dynamic economy with tremendous network interdependency between countries.

US is no longer self-sufficient or self-sustaining. We are not immune to the shocks of the world society. We have never been more vulnerable.

US is the destination of about half the world's immigrants

Probably 10 million this decade alone...

One-third of annual population growth is immigration

Indeed, now that native fertility rates have stood since mid-1970s at 1.8 (below replacement level of 2.0), immigration promises to become the main determinant of future population variability

America is evolving into the first true "world nation", shifting rapidly away from Eurocentricity into a society

with strong ethnic ties to all parts of the globe--
with a growing focus on the nations of the Pacific Rim.

3) THE NEW MAJORITY...

There seems little doubt that America of the 21st century will probably be the most pluralistic, multicultural nation on earth...and perhaps in history...

Our nation will face a challenge of diversity and pluralism in the years ahead that will determine our strength and vitality .

Today minorities comprise 14%...by 2000, 22% will be Blacks and Hispanics...by 2020, 30%...

Less than 15% of new people entering the labor force of the 1990s will be white males.

Put another way, unskilled minorities are a growing fraction of the workforce and unless their abilities are upgraded, the nation's overall skill level will not be sufficient for tomorrow's economy.

Presently minorities fill 21% of 115 M jobs.

Of the 21 M jobs appearing before 2000, 57% will be filled by minorities.

NOTE: We must make special efforts to expand participation by these groups...not just because that is good social policy, but because we cannot afford to waste their talents!

As both a microcosm and leader of society at large, higher education has a special challenge and responsibility to develop effective models of

multicultural, pluralistic communities.

In particular, we face the challenge of reaching out to increase the participation of those racial ethnic, and cultural groups who have faced serious inequity and discrimination in our society... to prevent them from becoming an "underclass"

But simply providing access and encouraging participation is not enough. We face the challenge of building supportive environments which embrace, and sustain diversity as essential to the future of our state!

Michigan faces the challenge of providing to all peoples, regardless of race, creed, or national origin, the opportunity to participate in a future of prosperity and fulfillment.

Clouds on the Horizon

Maintaining America's competitive edge requires attention to our traditional strength -- people and research -- and a strong offensive strategy based on these resources.

Taxes, trade, and fiscal policies influence economic competitiveness. But in the long run, a strong base of science and engineering research and education is more important.

Central theme is that education, broadly defined, will play a pivotal role in the coming economic transition and its impact on individuals.

Previous economic transformations were closely associated with major public investment in infrastructure such as

railroads, canals, electric networks, and highways.

In the coming economic transition, an equivalent infrastructure will be an educated population.

WARNING SIGN 1: America is slipping

No question that we have lost lead in many areas

Industrial productivity and heavy manufacturing

Steel, durable goods, ...

Moreover, key activities such as product design,

engineering, and software development increasingly

are likely to be done overseas.

Whether automobiles or refrigerators, computers or

microchips, nuclear power or energy transmission

systems, the likelihood is increasing that the systems are

assembled from components designed, engineered,

manufactured, and shipped from all parts of the world.

US trade deficit is only a symptom of America's lagging

competitiveness. It means that the US economy has been

living beyond its means.

The most serious long term problem is low productivity

growth, however. With productivity growing at less

than 1% per year, the American standard of living

is falling relative to those in most industrialized nations.

Our wages are already below those in Europe and Japan.

Over the long haul productivity growth is the main determinant

of trends in living standards, and no amount of fiscal ledgerdmain

can obscure a basic weakness.

The necessity for lower wage growth in US is result of lagging

US productivity--that is, a lower rate of growth in physical

output per worker and a declining advantage in technology and quality.

To do this, all the major inputs into our economy--quality of workforce, amount of capital investment, level of technology, and skills of managers--must be as good as the equivalent inputs going into the economics of our major competitors.

Key input, however, is quality of the workforce.

Our principal competitors are simply producing workers better capable of absorbing modern production skills. The lack of these skills is preventing us from achieving the productivity gains that we should be getting.

WARNING SIGN 2: We are seriously underinvesting in R&D and Education

For over two decades, US investment in civilian R&D has dropped while that of our competitor nations has risen rapidly. US investment in civilian R&D as a percent of GNP is now less than that of any other developed nation (and only 60% that of Japan and West Germany...)

Almost all growth has gone into military research (70% of federal R&D budget)

Support of basic research has dropped significantly (as has support of research in C&S)

We need a major commitment by the federal government and industry to research on understanding how people learn and to the development of new educational technologies.

"If the fraction of gross expenditures invested in research

were the same for education as for the average privately owned business in the United States, about \$9 billion a year would be spend on educational research--60 to 90 times more than the present allocation"

Note: While midwestern states such as Michigan and Ohio have undertaken many important new initiatives, we still lag considerably behind areas such as California and New England in our investment in knowledge-based resources such as education. We've come a long ways in the past few years, but we still have one hell of a long ways to go.

WARNING SIGN 3: The S&E Pipeline Problem

Today, an unprecedented explosion of knowledge marks the onset of a new era. Since people are the source of new knowledge, we will rely increasingly on a well-educated and trained work forced to maintain our competitive position in the world and our standard of living at home.

Yet the US faces a S&E manpower crisis of unprecedented proportions

0. Indeed, today the United States awards the smallest proportion of university degrees in science and engineering of any industrialized nation!
1. Proportion of graduating seniors who major in science and engineering is smaller today that it was in 1970s (5%). Particularly severe drops in physical sciences and mathematics. (Fallen by 40% over past decade)
2. Per capita production of US engineers lowest among

industrialized nations:

US: 72,000 (3%) (7 in 1,000 graduates)

Japan: 85,000 (21%) (40 in 1,000 graduates)

USSR: 300,000 (35%)

Japan has doubled its technical workforce in past decade...

7 of 1,000 American students receive engineering degrees

40 of 1,000 Japanese -- indeed, Japan with less than half

the population is producing far more scientists and engineers!

President of Sony:

"In US you produce 4 lawyers for every engineer.

In Japan, we graduate 4 engineers for every lawyer!"

3. More than 60% of engineering PhDs are now foreign

Indeed, foreign students account for nearly 85% of growth.

It is bad policy to be dependent on an unpredictable resource and not to be able to meet more of our needs with American talent.

But things are going to get MUCH rougher: NSF Study

1. Demand for S&E likely to go up

Population is growing

S&E share of workforce is growing

Industry is becoming more scientific

Most experts predict growth in S&E jobs

2. Supply will probably fall off dramatically simply due to demographics...

Number of 22 year olds is a major driving force in determining BS S&E degrees

Traditional source of S&E college students is declining

25%-30% falloff in HS graduates by 1992

Assuming that same fraction (4.8%) choose to enter S&E,

and assuming constant demand (very conservative),

drop will be from 197,000 (83) to 152,000 in 1996;

there will be a cumulative shortfall of 930,000

by 2010!

To put it another way, fraction of students choosing

S&E majors will have to increase by 40% to maintain

even present level of graduates.

3. Trends in Intended Majors:

But this situation may become even worse:

Over period from 1966 to 1987, proportion of students

who intended to major in physical sciences has

dropped from 3% to 1.3%; in mathematics, the

decline was from 4% to less than 1%.

Recent trends in engineering also show softening.

Applications to most engineering schools are

down by 10-20% this year. (USC 30%)

Interest in computer science is always waning. Drop

from 4% in 1983 to below 2% in 1987.

Note: dramatic increase in proportion of freshmen

interested in business majors--now up to 25% and

rising rapidly

Furthermore, the dropout rate is extraordinary...

From 8th grade through PhD, the half-life of

students in the mathematics curriculum is one year!

That is, if we begin with 32 million students in junior

high school, we lose 50% each year until only a few hundred attain the PhD.

4. Composition of college age population is also changing...

In 1966 44% of college freshmen were women; today 52%.

By 2020 30% will be composed of Blacks and hispanics...

students who have not traditionally chosen S&E careers.

Indeed, by the turn of the century, over 50% of K-12 students will be Black or Hispanic.

Less than 15% of new people entering the

labor force of the 1990s will be white males.

The fastest growing pool of youths has the lowest participation rate in college and the highest dropout rate in high schools -- not the mention the least likelihood to study science and math.

Furthermore, virtually none of the Black college

freshmen who score highest on the SAT intend to major in mathematics or the physical sciences

Among engineering students, 70% complete school...

but completion rate among Blacks is 30%; Hispanics 40%.

Indeed, while Blacks and Hispanics account for 20% of total population, they account for less than 2% of scientists and engineers!

NOTE: We must make special efforts to expand

participation by these groups...not just because that is good social policy, but because we cannot afford to waste their talents!

Conclusions:

i) If we couple demographics with student preferences, we have

got a timebomb on our hands...

ii) Indirect effects, since smaller enrollments in S&E will mean less justification for investments in faculty and facilities...

iii) We must act rapidly...

First to plug up the leaks in the pipeline...

Then, over the longer term, to adapt the education system in American to a changing population

WARNING SIGN 4: Undergraduate S&E Education

NSB Report:

"Serious problems, especially problems of quality, have developed during the past decade in the infrastructure of college-level education in the United States in mathematics, engineering, and the sciences."

"The NSB concludes that the NSF must become a strong leader of a nation-wide effort to enhance the quality of UGS&E education, an effort that will require participation by public and private bodies at all levels."

Engineering Education

At the UG level, concern is primarily one of quality rather than quantity.

Extraordinary quality of students attracted to engineering has masked the decline in the quality of instructional programs.

Few academic institutions have taken steps to re-establish a balance between engineering enrollments and resources through major internal reallocation or limits and reductions of enrollments.

While American industry has been a driving force in the intense

demand for engineering graduates, it has been slow to accept

a corresponding responsibility for supporting engineering at a level adequate to meet this demand.

Finally, federal programs have tended to focus on K-12 and graduate

level education and research, largely ignoring the fact that the critical limiting factors in the supply of engineering graduates are at the UG level.

Industry did the same by focusing support on graduate education

and research that was more closely related to corporate interests.

Nature of the crisis:

1. Faculty shortages

2,000 vacant faculty positions...

50% foreign national

Things are only going to get worse...

greying of engineering faculty...

return of foreign nationals...

demographics coupled with declining student preferences...

2. Facilities

Few schools have managed to maintain either the quantity or quality of facilities necessary to respond to surging enrollments and sophisticated technology

Absence of federal programs to assist in construction

3. Instructional Laboratory Equipment

Deterioration in lab equipment is a national scandal

NSF surveys indicate that only 16% is state-of-the-art

Backlog exceeds \$4 billion...

Similar investment in computing environment...

4. Curriculum

Growing vocational focus of engineering curriculum as
more and more specialization occurs

Inadequate exposure to engineering practice--particularly
in areas such as design, synthesis, and systems
integration

Inadequate exposure to practicing engineers due to
research

focus and limited industrial experience of faculty

Traditional approach to instruction along discipline line is
unable to keep pace with intellectual evolution of
engineering

practice which tends to be cross-disciplinary in nature

General concern that entry degree should be M.S. degree

Haddad Report:

"Today's four-year baccalaureate engineering curriculum is
largely obsolete. It does not provide adequate depth in
engineering subjects, adequate breadth in engineering
science and mathematics, or adequate exposure to
engineering practice. Furthermore, the largely
vocational

focus of most undergraduate programs deprives
today's

student, characterized by broader interests and career
objectives than in the past, of the liberal education so
necessary to adapt to technological change and
assume

leadership roles in our society."

NSF Study Groups:

"The NSF program should be designed to deliver a good
2x4 shot across the buttocks of engineering
education..."

"NSF's role should be to encourage and support the
intellectual

effort necessary to restructure the curriculum and
teaching

methods in the light of present day and near future
technical realities. This should be a process of
"bottom-up"

rather than "top-down" direction of a program from the
federal level."

NSF Response to Date:

NSB Report recommend +\$42 M in FY88 and +\$92 M in
FY89

targeted across a variety of programs in curriculum
development,

laboratory instrumentation, faculty development, and
so on.

Yet, in the aftermath of the December deficit reduction
actions:

+\$8 M in FY88

+\$18 M in FY89 (although this is still at risk)

Hence, despite the rhetoric from the NSF, we still have a
very

long ways to go...

WARNING SIGN 5: PhD Education: our Future Faculty

of 10,000 HS sophomores, fewer than 20 receive PhD's

Hence US PhDs will decline due to reduced BS graduates

Foreign PhDs are beginning to return...

US universities are becoming less attractive...

we've become complacent

Like balance of trade problem--we are building our

infrastructure (including faculty) on foreign nationals

All multinational companies are going after US-trained

foreign nationals to be based in their home countries

PhD shortage in faculty...

Compensation (in constant dollars) was constant from 1964 to 1984

It has gone up by 21% in past 5 years and will accelerate even

more rapidly as the real PhD shortages appear late in the
1990s

WARNING SIGN 6: Technological Illiteracy

We really haven't appreciated impact of technology.

Today we are witnessing an unprecedented explosion of
knowledge.

Technology doubles every 5 years in some fields!

Graduates are obsolete by the time they graduate!

Technological change is a permanent feature of our environment

Examples of just the past few months:

i) hole in the ozone layer over Antarctica

ii) new supernova in the heavens

iii) new high temperature superconductor

iv) a new theory suggesting that all matter is composed

of infinitesimal "superstrings" rather than point particles

Yet, at the same time public ignorance is extraordinary!

A recent NSF survey indicated that only 18% of those

asked said they knew how a telephone works -- and

only half of these gave the right answer.

Yet more than half of those surveyed indicated they believed we were being visited by aliens from outer space!

And yet, our education system has not responded...

Note: it is bad enough that...

10% of Americans are illiterate

25% now fail to complete high school

Scientific Literacy of K-12 Teaching Force

Only 30% have had college chemistry

Only 20% have had college physics

Less than 50% have had calculus or computers

International Association for Evaluation of Educational Achievement (IEA)

Grades 4, 8, and 12

US was 8th of 17 for 4th graders

US was 14th of 17 for 8th graders

US was 11-13 of 17 for 12th graders

Bottom 25% of US students were scoring at chance level, indicating that they were scientifically illiterate

(Top scores were Japan, Korea, Hungary

"For a technologically advanced country, it would appear that a reexamination of how science is presented and studied is required...in the United States."

More than half of all our high school graduates have not had even one year of science.

Face it, gang:

The tragedy is not simply our poor showing relative to other nations.

Science, mathematics, and computer literacy will increasingly become a requirement for almost all employment.

We are condemning an entire generation to a lifelong estrangement from the very technology that will inevitably govern their lives.

WARNING SIGN 7: Michigan's Work Force is Becoming Obsolete

The education of the Michigan workforce is inadequate to the demands of the next century.

Each year, 700,000 drop out of HS and 700,000 graduate without functional literacy;

1,000,000 immigrants must be added to this.

Hence each year we have 2.5 million persons entering our complex economy annually with limited language and work skills

Yet our adult functional illiteracy rate is 13%--our high school graduate rate is down to 72%--and our high school graduates perform poorly relative to students in the rest of the world.

Michigan is undergoing dramatic change in industry...

Away from low-skill, blue-collar workers

The factory of the future will have NO low skill workers

Statistical quality control and just-in-time inventory

systems require production workers with mathematical abilities that are far beyond the present level.

Unskilled labor will lose relevance in a world dominated

by microelectronics, computers, and automation.

An example: Expert systems

The "expert system" craftsman...

About 45% of the job growth between 1980 and 1986 was in professional and managerial occupations, and almost 50% of the new jobs created between 1983 and 1986 went to people with at least 3 years of college.

Of the net increase of 25 M jobs to be created by 2000, 40% will be professional or technical positions; 58% will be marketing and sales, administrative or supervisory.

Serious concern:

1. The present generation of blue-collar workers does not have the formal education to be retrained!!!
2. Little sign that education system is adapting to this future.

Key input, however, is quality of the workforce.

Our principal competitors are simply producing workers better capable of absorbing modern production skills. The lack of these skills is preventing us from achieving the productivity gains that we should be getting.

In the past few decades we have neglected education's collective economic function. Whatever its individual payoff, it determines the human quality of the team on which every American plays.

It is bad enough to face the prospect of a significant fraction of our labor force becoming permanently unemployable because

of an inadequate education. Do we want to condemn their children...OUR children...to a similar fate? Can we afford it?

The economic challenge, in simplest terms, requires upgrading the skills of 25 million American workers by 40% by the end of the century. A strong back and willing hands will no longer suffice.

Some observations:

Claim: We are rapidly becoming a nation of illiterates ... in science and technology, no longer able to comprehend or cope with the technology that is governing our lives. Public's knowledge and understanding of science has not kept pace with technology

In the past few decades we have neglected education's collective economic function. Whatever its individual payoff, it determines the human quality of the team on which every American plays.

If, in the final analysis progress depends on having the generations who follow us be smarter and better educated than we are, it is evident that we are sliding backwards rapidly!

A National Response

NOTE: Taxes, trade, and fiscal policies influence economic competitiveness in the short term. But in the long run, a strong base of science and engineering research and education is more important.

Maintaining America's competitive edge requires attention to our traditional strength -- people and research -- and a strong offensive strategy based on those resources.

People must be the major focus...

People -- not equipment or buildings -- are the source of creativity.

They generate the knowledge that makes the technological innovation possible. They are the workforce that makes society run.

They are our researchers and teachers, our leaders, managers, and decisions makers in modern technological society.

Two-fold challenge

1. Achieve basic scientific literacy among all our citizens
2. Provide enough scientists and engineers for industry and academe

For this reason, the administration has chosen as its highest priority in the year ahead major new initiatives aimed at strengthening the source of intellectual capital in this nation.

Hopefully, Congress will join in with strong support of this national imperative!

The State of Michigan Response

What has been the response of Michigan to the challenge of change -- to the Age of Knowledge in a Global Economy...

The Michigan Strategy

Blessed with public leaders that recognized the challenge...
had the vision to develop a forward-looking strategy to respond...
and the courage and skills to implement this strategy...

Economic prosperity lies not in tearing down our old industrial base for a different kind of economy, but in helping that base

make the changes necessary to compete in a new economic environment.

The goal: Michigan must become America's factory of the future... its source of emerging industrial technology...

Our ability to innovate will become our principal economic advantage... innovation will be the energy that drives change

To position Michigan as the nation's source of emerging industrial technology, we recognized we must move along three fronts:

1. To enhance the growth of R&D in Michigan
2. To accelerate the transfer of technology into Michigan industry
3. To develop a strong coalition within Michigan among government,

industry, labor, and universities to create a "venture culture"

As we look to the knowledge-intensive future of Michigan, we recognize as

have so many other states that it will be our great research universities

that will hold the key to our collective prosperity.

Why?:

Key factors in technology-based economic development

Technological innovation

Technical manpower

Entrepreneurs

Produce talented engineers to implement new technology importance to State...

Attracting leading scientists, engineers, and professional staff to staff these programs.

Developing new mechanisms for technology transfer...

State government committed itself to:

Establishing higher education in general and the state's

research universities as a high priority

▯ - Providing seed resources to sustain key

hrust areas

Developing novel institutions to act as catalysts in these activities

State Actions:

Wision and courage of leaders in public and private sector

Recognized the importance of technology to Michigan's future...

Also were willing to make the investments today necessary

for Michigan's prosperity tomorrow...

1. Research Excellence Fund

\$25 into building key research areas within research universities

2. Centers of Excellence

Industrial Technology Institute

Michigan Biotechnology Institute

Michigan Materials Processing Institute

3. Michigan Strategic Fund

4. New coalitions and partnerships

Fraser-Iacocca Commission on Jobs and Economic Development

University of Michigan Actions:

Background

Since the birth of our state 150 years ago,

there has been a strong bond between the

people of Michigan and their university,

the University of Michigan.

Generation after generation of Michigan citizens

have reaffirmed their commitment to provide in

Ann Arbor an institution capable of:

providing to their sons and daughters an

education equal to the best
attracting to Michigan the most outstanding
scholars, scientists and engineers,
doctors, lawyers, and teachers, and
other professions so essential to our
prosperity and well-being
creating through its research and scholarship
the new knowledge so necessary to
economic growth and development
addressing through a myriad of public
service activities the many challenges
facing our state.

This sustained public investment and confidence
in the University over the years has enable it
to serve the state in all of these ways and more.

Through this unique partnership, the University and
its activities in education, research, and public
service have served our state and its citizens well.

Today our state faces new challenges that will canl
once again on the vast resources of its University.

1. Michigan faces ` perhod of dramatic economxc
cjange, during which it must evolve from a
resource)intensive to a knowledge-ibtensive
economy, in which intellectual capital will replace
financial and physicao capital as the key to
economic development and prosperity.

Our state will become ever more dependent on
key knowle ge resources such as the UM

as it faces the challenge of intense competition and rapid technological change/ as it enters the age of knowledge in a global economy that will be its future.

2. Michigan also faces the challenge of providing to all peoples, regardless of race, creed, or national origin, the opportunity to participate in a future of prosperity and fulfillment.

Here, too, the UM must play a critical role, in reaching out to underrepresented minorities and other groups facing inequities in our society and providing them with the opportunity for full participation.

This demands a renewed commitment to increase the participation of those racial, ethnic, and cultural groups not adequately represented among our students, faculty, and staff.

The University!

must serve as a model in its effort

to build a multicultural, pluralistic community on its campus which achieves new levels of understanding, tolerance, and mutual fulfillment for peoples of diverse backgrounds.

3. The University will also be a key in address the particular needs and concerns of impoverished areas throughout our state.

It intends to focus its considerable resources in the social sciences and professions on the problems

faced by Michigan's cities.

It intends to use its vast resources in basic and applied science to develop and transfer the new technologies capable of economic development and growth to all regions of the state, from the metropolitan Detroit area to the Upper Peninsula.

The University views itself as a partner with state government, business, industry, and labor in addressing the needs of the State of Michigan.

Key:

Began to think and act strategically...how to better position ourselves

Recognition:

Michigan is where our nation makes things...

Cars, refrigerators...machines that make cars ...

Surrounded by excitement of industry in transition

"factory of the future"

robotics, machine intelligence, animate systems

EDS,

Hughes
[grid of small squares]
[grid of small squares]
[grid of small squares]
[grid of small squares]
[grid of small squares]
[grid of small squares]ead 2 + Hence, we chose as our thrust areas...]

head 3 + Complex manufacturing systems
CRIM - ITI -- The Center for Research on K

tegrated

Manufacturing, responsible for the basic research and instruction necessary to sustain the Industrial Technology Institute...and to maintain the momentum of Automation Alley now developing in Michigan`

Machine Intelligence

CMI - EDS -- The Center for Machine Intelligence, an exciting new venture formed with the participation of k

dustry and

federal government to explore the whole new technology of thinking machines -- machines which can perceive their environment, think, and act. First applications will be in manufacturing. However next generation of thinking machines will be designed and built by intelligent machine!!! (Note address ... s 2001 Commonwealth)

Advanced electronics and optics technology

CAEOT -- The Center for Advanced Electronics and Optics

Technology, aimed at research into the marriage of electronics and optics -- located on a ship. It is now the largest university laboratory in the nation specializing in t

tra high speed, high frequency electronic devices and advanced electronic materials such as gallium arsenide.

Information Technology

Goal: To use the University as a gigantic laboratory to design the knowledge-based organization of the 21st Century
CITI -- The Center for Information Technology Integration, essentially a skunkworks operation exploring the forefront of modern computer telecommunications with several of the leading companies in the nation. The U of M itself has become the laboratory, the "test bed", for this exciting venture.

Center for Collaboration Science and Technology
Cognitive Science and Machine Intelligence Laboratory
Merit and NSFnet
MITN

Health Sciences

\$500 M capital investment in Medical Center
(R&D growing at 20-25% per year)
Drug industry in Michigan (Upjohn, Warner-Lambert)
Particular thrusts
Molecular Medicine
Cancer Center
Geriatrics Center
Substance Abuse Center
Hughes Medical Research Institute

Social Sciences

UM has perhaps the strongest set of social sciences of any university in nation...
Institute of Social Research...

Directing attention toward the nature of rapid economic change...

Social Work and Education

Focusing on problems of urban environment...

Problems of underclass

Other steps

1. Recruiting key people...
2. Modifying ways we interact with outside world...
 - Strengthened interactions with industry
 - Research Partnership Programs...
 - Break down the ivy-covered walls surrounding the campus
3. Intellectual property policies
 - Allowed ownership by faculty and staff
 - Allowed equity interest by university
 - Building a high quality IPO organization...service oriented
4. Michigan Information Technology Network...

Cultural Changes

Reaffirmation of the importance of individual achievement, of excellence...We have once again recognized the ability of talented people to do great things -- if we will only get out of their way and let them!

Importance of establishing an intense, entrepreneurial environment...a no-holds barred, go-for-it culture...in which individual initiative, achievement, and the quest for excellence are dominant elements

Already clear evidence of payoff...

1. Darling of the national press...
 - Hardly a week goes by without some reference to the phenomena

occurring in "Automation Alley"...from Warren to Ann Arbor...
an area now clearly identified as the hot spot of action in
technology for the next two decades...

California dreamin'

Places like Silicon Valley and Route 128 are buzzing about
Michigan...we are now raiding their best talent...

We've become a showplace: Bobby Inman, Governors,...

2. University's federal research increased by 25% each of the
past two years to over \$200 million per year.

Industrially sponsored research has increased by 50%

Engineering research has more than doubled, to over \$400
million per year.

3. Research Excellence Fund has created nationally recognized centers on:

head 3 + Complex manufacturing technology

NSF believes we now have best faculty in nation in these areas

Machine intelligence

head 3 - Advanced electronics

Information technology

These programs already have attracted three major national research centers funded at \$27 M.

4. Beginning to win a few...

Howard Hughes Research Institute

DOD URIs (lion's share)

High Speed Electronics and Optics (Army)

Ship Propulsion and Hydrodynamics (Navy)

Expres

NASA Center of Excellence for Space Commercialization

National Center for Manufacturing Science

NSFnet

NASA ERC (Remote Sensing)

IBM/DEC/Apollo/Apple/Northern Telecom/....

Many other smaller activities

Several other major initiatives presently brewing...

too early to announce, however

5. National Image

U.S\$ News and World Report...

UM was ranked 8th in the nation in the

quality of its UG education-- UM

and Berkeley were only public

universities in the top 10...along

with schools like Stanford, Harvard,

Yale, and Princeton

Professional Schools:

Law: 3rd

Engineering: 6th

Business: 7th

Medicine: 11th

- 6. Confidence in University, buoyed by the new priority given by higher education by the state, have enable use to attract to our faculty many of the world's leading scholars and teachers, scientists and engineers.**
- 7. And, at the same time, the University has continued to leverage the state's investment.** attracting \$2 from outside the state for every \$1 in state appropriation. Moreover, activities of our graduates and applications of our reserach have an impa{t on statl's economy that totals in the billions of dollars.
- 8. The growth of a \$4 B industry in industrial automation hn the Detroit-Ann Arbor corridor has been traced directly to UM!**
- 9. In 8 states bordering the Great Lakes, there are 16,000 companies** producing high text equipment, including robotics, optics, biomedicine, computer software, and electronics.

The Local Response

The real power to influence the education at the level

But here, we as parents and citizens have abdicated our political responsibilities.

We have not demand that our publically elected officials respond to the seriousness of our ever-weakening system of education.

While it is true that our school districts have suffered

serious damage from an erosion in publxc support, the responsibility for education does not rest with the schools alone.

How many parents commit themselves to working with their children?

How many support the millages necessary to build strong schoolsè

How many are willing to make sacrifices to say for college?

Perhaps it (is the lack of commitment of the American

public, in general, and American family in particular which so contrasts us with other nations such as Japan.

Now parents take an active interest in their children's education.
`head 3 + Few save toward a college education...

...whether due to an unrealistic expectation of public support...

...or a preference for expensive cars, vacations, snowmobiles...

Time after time, when given a choice, we vote against good schools`

We complain about taxes necessary to support education...

Even try to roll back taxes, even as education continues to starve

Why?

3 - Is it simply an aging electorate?

Is the "Me Generation" of the 1960s now growing up into mature

Yuppiehood?

No...root causes lie much deeper.

WE have ceased investing in our future!

We have chosen instead to mortgage this future to pay for mistakes
made in our past.

Six-month planning horizon...desire for immediate results...inability
to identify the investments which have to be made today to yield
the objectives for tomorrow.

Education always falls at the bottom of the list of social
needs.

Even though surveys indicate public supports education, our
elected public officials do not seem to listen. They prefer
to fund roads or prisons or football stadiums rather than
the education of our youth!

Indeed, Michigan, a state with one of the highest per capita

incomes in the nation, continues to slip further and further behind! In its investment in education -- just as our nation continues to

now challenging our economic strength and prosperity. 3 + The attitude we have taken toward our most precious resource,

our youth, is both callous and alarming.

I simply cannot accept the excuse that "we can no longer afford this investment in the educational opportunities we offer our youth.

To be sure, the immense social needs for welfare assistance, medical care, prisons, and all of the other programs that drain our tax dollars are compelling.

However, by choosing to meet these needs with resources taken away from our system of public education rather than through reforms in our tax structure or political system, we have in reality mortgaged our future by withdrawing the educational opportunities from our youth.

We seem to have forgotten the commitments that past generations of citizens have made to build educational institutions of exceptional quality -- institutions that have provided many of us for years with unsurpassed educational opportunities.

We simply must re-establish the importance of both our personal and public investments in education, in the future of our children, in our own future, at the local level in Michigan -- indeed, if our nation -- is to face the challenge of the age of knowledge.

Michigan is on the move!

State has taken strong first steps to rebuild capacity of its research universities to provide the knowledge-based resources so necessary to our long term well-being and prosperity.

The people and ideas...

the outstanding graduates, scientists, and engineers;
doctors, lawyers, teachers, and other professionals;
and leading edge research and service activities.

Indeed, Michigan is rapidly becoming a model for the nation of the advent of an exciting new competitive age.

The state has assembled its tremendous assets and its people into a winning team involving state government, Michigan's colleges and universities, business, labor, and industry.

BUT, Michigan's efforts have just begun...

We still have far to go to counteract the crippling deterioration of public support experienced in the 1970s and 1980s.

1. While Michigan ranks 5th in tax revenue, we rank only 32th in appropriations per student and only 37nd in percentage of total appropriations allocated to higher education.

Indeed, we have dropped to 32nd in
tax revenue for higher ed--7.8%
compared to 11.4% for California!

2. SRI Study suggests that we presently are underinvesting by as much as 30% in the knowledge infrastructure necessary to secure our state's future leadership and prosperity.

We are being outspent by 30 - 40%
in state support per student...

Not simply by prosperous states like
California...but by neighbors such as

Indiana and Ohio!

3. In fact, the only area where we now lead the nation is in our prison system...

We are now investing more in prisons than in higher ed...that is, we spend more money putting people into jail than we do in keeping them out of jail!

If we fail to increase the rate of investment, Michigan will not only risk falling behind other midwestern states, but regions such as California and New England will pull even farther ahead...and pull our industry with them!

Intense international competition, turbulent markets, rapid technological change present new challenges to our future.

To stand still...to fail to make the investments in our research universities so necessary for tomorrow...is to lose the race for future prosperity and well-being of our citizens.

We really have no choice but to forge ahead, to pick up the pace, and to increase these investments in order to secure once again the position of leadership to which our state has long been accustomed.

Importance of staying the course...

The renewed investment in higher education of recent years has taken extraordinary vision, courage, and determination on the part of state government, particularly during a period with many other competing demands and pressures.

However, it also seems clear that in the knowledge-intensive future that our state faces, we really have no choice but to sustain and increase these investments.

In the long run it will be our investments in the most

important resources of all, in people and ideas, that will determine the future prosperity and well-being of our state.

Michigan should not...indeed, it must not...rest until we have secured our position of leadership so critical to our state's future by restoring the capacity and competitiveness of our research universities.

The citizens of this state will demand nothing less!

The Dangers...

Is our state willing to make the investments necessary today...
to build the prosperity we desire for tomorrow?

Education always falls at the bottom of the list of social needs.

Even though surveys indicate public supports education, our elected public officials do not seem to listen. They prefer to fund roads or prisons or football stadiums rather than the education of our youth!

Is this because of an aging electorate?

Is it the "Me Generation" of the 1960s now growing up into mature Yuppies?

No. Rather it is the fact that for many years now we simply have not been willing to invest in our future...and the future of our children...

We have chosen instead to mortgage this future to pay for mistakes made in our past.

Six-month planning horizon...desire for immediate results...inability to identify the investments which have to be made today to yield the objectives for tomorrow.

The old T-shirt expression: "Eat dessert first, life is uncertain"

reflects our present tax policy.

The attitude we have taken toward our most precious resource, our youth, is both callous and alarming.

I simply cannot accept the excuse that "we can no longer afford this investment in the educational opportunities we offer our youth".

To be sure, the immense social needs for welfare assistance, medical care, prisons, and all of the other programs that drain our tax dollars are compelling.

However, by choosing to meet these needs with resources taken away from our system of public education rather than through reforms in our tax structure or political system, we have in reality mortgaged our future by withdrawing the educational opportunities from our youth.

We seem to have forgotten the commitments that past generations of citizens have made to build educational institutions of exceptional quality -- institutions that have provided many of us for years with unsurpassed human societies embodying to endow their children with an enriched and enriched culture, for transmission to their successors.

If it is not to be our young people and their work that will gain us a secure place among nations and our better life for

Q - our citizens, then what will it be instead? And if we fail
in the successor generation, then

what kind of caretakers of our heritage and their will they turn out to be?

We are a nation that has always believed deeply in generational improvement--in the prospect that things will be better for

our children.

Americans must put aside their suspicions and answer that

call, because the result of failure will be that 40 years from now a generation will stand where we are today and know that things are, for the very first time in history, worse than they were for their fathers and mothers.

At center of problem is inability to formulate and pursue

a strategy of investment.

The most highly leveraged expenditures we can make are

those on the young.

We simply must re-establish the importance of both our

personal and public investments in education, in the future of our children, in our own future, at the local level if Michigan -- indeed, if our nation -- is to face the challenge of the age of knowledge.

Courage...

The renewed investment in higher education of recent years

has taken extraordinary vision, courage, and determination on the part of state government, particularly during a period with many other competing demands and pressures.

However, it also seems clear that in the knowledge-intensive future that our state faces, we really have no choice but to sustain and increase these investments.

In the long run it will be our investments in the most important resources of all, in people and ideas, that will determine the future prosperity and well-being of our state.

As we enter the Age of Knowledge, our ability to sustain the

strength of our nation...to achieve the quality of life for our citizens...will be determined by, more than any other factor, how we develop, nurture, and educate that most precious of resources, our people.

We simply must provide them with the most outstanding education possible to prepare them for the age in which knowledge will hold the key to prosperity and quality of life...