

## **NSF/MSF Conference**

### **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 from abroad...

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.

### **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

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...

In Michigan we no longer worry about nuclear war 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**

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.

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

Some examples:

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

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

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

### **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?:

Produce talented engineers to implement new technology  
Through research produce creativity necessary for innovation  
Attract "risk capital" through massive federal R&D support  
Key to technology transfer

Traditional: graduates, publications  
Entrepreneurs  
Startups

A fact of life:

Only world-class research universities are capable of major impact  
Must play in the big leagues...with MIT, Stanford, Berkeley...  
To attract the outstanding faculty and students  
and massive resources necessary for technological leadership

Development of Unique State-University Partnership

Universities committed themselves to:  
Strategically realigning activities into key thrust areas  
of major importance to State...  
Attracting leading scientists, engineers, and professionals  
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 thrust areas  
Developing novel institutions to act as catalysts in these activities

**State Actions:**

Vision 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:**

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, Saturn  
But these are just tip of the iceberg!!!  
A fascinating and unique convergence of technology...  
The chip, computers, AI, new materials, mech systems  
Driven by money (investment) and need (competitiveness)  
Michigan-->nation's source of emerging industrial technology  
Hence, we chose as our thrust areas...  
Complex manufacturing systems  
CRIM - ITI -- The Center for Research on Integrated  
Machine Intelligence  
CMI - EDS -- The Center for Machine Intelligence, an exciting  
Advanced electronics and optics technology  
Center for Advanced Electronics and Optics Technology  
Information Technology  
Goal: To use the University as a gigantic laboratory to  
design the knowledge-based organization of the 21st Century  
Center for Information Technology Integration  
Center for Collaboration Science and Technology  
Cognitive Science and Machine Intelligence Laboratory  
Health Sciences  
\$500 M capital investment in Medical Center  
(R&D growing at 20-25% per year)  
Particular thrusts:  
Molecular Medicine  
Cancer Center  
Geriatrics Center  
Substance Abuse Center

## 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...

## 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. Research Excellence Fund has created nationally recognized centers in:  
Complex manufacturing technology  
NSF believes we now have best faculty in nation in these areas  
Machine intelligence  
Advanced electronics  
Information technology  
These programs already have attracted three major national research  
centers funded at \$27 M.
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 \$40  
million per year.
3. 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
6. 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 impact on state's economy that totals in the billions of dollars.

### **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.

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 assocaited 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: 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.

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)

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 2: 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)
3. More than 50% 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...
  - 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.
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, almost half of K-12 students will be Black or Hispanic.
  - The fastest growing pool of youths has the lowest participation rate in college and the highest dropout rate in high schools -- not to mention the least likelihood to study science and math.
  - 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 3: 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 4: 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  
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  
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."

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 5: Labor force of Michigan is becoming obsolete!**

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  
Unskilled labor will lose relevance in a world dominated by microelectronics, computers, and automation.  
An example: Expert systems  
The "expert system" craftsman...

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. High school graduates "illiterate" in science and mathematics will be condemned for the remainder of their lives to low-level service employment ... IF they can find jobs at all!  
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?

**A 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 public 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 schools?  
How many are willing to make sacrifices to pay 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.  
Few parents take an active interest in their children's education.  
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?

Is it simply an aging electorate?  
Is it the "Me Generation" of the 1960s now growing up into mature Yuppieshood?  
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 make 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 fall further and further behind those very nations now challenging our economic strength and prosperity.

The attitude we have taken toward our most precious resource, our youth, is both callous an 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 eyars 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 if Michigan -- indeed, if our nation -- is to face the challenge of the age of knowledge.

### **Conclusions**

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...