Leadership Network: Sunday, May 21, 1989

My Agenda

Attempting to get out, early in my tenure as president of the University, to meet with the leadership of this State...to listen and to learn...

In particular, I am interested in learning how you view the role of the University of Michigan... whether you believe we are responding to the needs of this state...indeed, this nation...

I would like to have a very candid discussion of the University...to see it from your perspective... ...you might say, to better learn about our consumers and shareholders...

But I also have another agenda...

To be blunt about it, I would like to know if you believe it would be possible to build a new type of coalition in this state...a coalition involving leaders from both the public and the private sectors... that would make an effort to elevate the priority given education in this state.

A coalition that, in a sense, would seek to shift our attention from the needs and desires fo the moment...to investing in our longer term well-being for the future by placing more emphasis on the development of human capital...

My own concerns...

As you know, I am a scientist and engineer by training and background...

I must also confess I tend to be one of those people who lives more in the future than in the present or the past...

Personal Introduction

As many of you know, I am a scientist by training and background...indeed, I am perhaps the worst of all types of scientists...a burned-out theoretical physicist.

I must also confess I tend to be one of those people who lives more in the future than in the present or the past...

I can remember that...

in the 1960s I was working out at Los Alamos on nuclear rocket engines designed to power the first manned mission to Mars...

in the 1970s I was working in an exotic area known as laser-induced thermonuclear fusion in which we were attempting to use super high powered lasers to compress matter to the incredible densities and temperatures found in the center of stars.. and create tiny thermonuclear explosions in the laboratory, hence providing a limitless source of power...

in the 1980s I refocused my efforts on building an Engineering College which I believed could trigger a major economic resurgence in this state...

And, now, entering the 1990s, I find myself looking once again to the future, facing the challenge of helping Michigan become the model of a University for the 21st Century...

As they say in the jargon of planning, I've been

spending a good deal of time "futuring"...gazing into the crystal ball in an effort to determine just where our university should head in the years to come.

Over the years, I have become increasingly convinced that education -- or more generally, the development of human capital -- will become the dominant issue for our state, just as it will be for our nation, in the 1990s and beyond.

Yet I also fear that few have realized the enormous changes that our society is going through as it approaches the 21st Century.

And, now, entering the 1990s, I find myself looking once again to the future, facing the challenge of helping to build a University able to serve our state and our nation in the 21st Century.

My personal agenda as president is to challenge the University of Michigan to once again play the leadership role is did during the 19th century, by, in effect, re-inventing the very nature of what a university must become to serve 21st Century America.

Introduction

A number of years ago, shortly after I became Dean of Engineering, a senior VP from GM pulled me aside and noted:
"You know, the American automobile industry will never be overtaken by those Japanese because we can put a car on the showroom floor for less dollars per pound than anybody else in the world."

Unfortunately, people don't buy cars by the pound... they buy them because of quality...

His comments were evidence of an alarming tendency we have as a people...
"to back into the future"...

To look back to the past and assume that because something worked then, it will work in the future.

As you know, I am a scientist and engineer by training and background...

I must also confess I tend to be one of those people who lives more in the future than in the present or the past...

And as I look to the future, I have sense the ever accelerating pace of change in our society, our nation, the world.

Yet I also fear that few have realized the enormous changes that our society is going through as it approaches the 21st Century.

In a very real sense, we are entering a new age... what has been termed, an "age of knowledge", in which the key strategic resource will become educated people and their ideas...

In fact, I have become increasingly convinced that the dominant issue of the 1990s and beyond will be the development of our human resources...

Or to put it another way, the investment we are willing to make in developing our human capital.

Themes of Change

Over the past year I have suggested that America today is undergoing profound change that will have major implications for higher education...

I have focused in particular on three classes of change:

i) It will be future in which our nation becomes a truly
multicultural society, with a cultural,
racial, and ethnic diversity that will be extraordinary
in our history
In which those groups we refer to today as
minorities will become the majority population of
our nation in the century ahead...
In which women take their rightful place as leaders
of America...

ii) It will be a future in which America will become "internationalized"...
in which every one of our activities must be viewed within
the broader context of participation in the global community...
Whether through travel and communication, the arts and
culture, the internationalization of commerce, capital,
and labor, we will become increasingly interdependent on
other nations and other peoples.
Further, as the destination of roughly half the world's
immigrants, the United States is rapidly becoming a "world nation"
with not simply economic and political but strong ethnic
ties to all parts of the globe.

iii) The Age of Knowledge
But there are even more profound changes underway...
Looking back over history, one can identify certain
abrupt changes, discontinuities, in the nature,
the very fabric of our civilization...
The Renaissance, the Age
of Discovery, the Industrial Revolution
There are many who contend that our society is
once again undergoing such a dramatic shift in
fundamental perspective and structure.
Today we are evolving rapidly to a new post-industrial,
knowledge-based society, just as a century ago our
agrarian society evolved through the Industrial Revolution.
In a sense, we are entering a new age, an age of knowledge,
in which the key strategic resource necessary for our
prosperity, security, and social well-being has become
knowledge--educated people and their ideas.

Concerns...

Needless to say, these same challenges of pluralism,
of globalization, and of this age of knowledge
that is our future will pose great challenges and
demand similar changes in our state.
Indeed, I am personally convinced that our nation faces a very unusual
period of challenge in the decade ahead...a watershed,
in a sense, from which we can either emerge as a
world leader...or as an also run...an economic backwater
My central theme is that education, broadly defined, will
be the pivotal issue in determining which of these two
alternative futures will be America's.
Indeed, I am absolutely convinced that the dominant issue of
the 1990s will be the development of our human resources.
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.
But here we face very serious challenges...
...clouds on the horizon...

WARNING SIGN 1: America's S&E lead is slipping
The Bad News of the past several years...
Familar Ills which dominate the headlines

The budget deficit
The trade deficit
Displaced workers
Marginal Industries

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 cronically 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..."

No question that US has lost lead in many areas

Industrial productivity and heavy manufacturing
Steel, durable goods, ...
Energy
Electronics

Also serious signs that lead is slipping rapidly in
Computers
Aerospace

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 likehood is increasing that the systems are assembled from components designed, engineered, manufactured, and shipped from all parts of the world.

WARNING SIGN 2: The "Pipeline Problem"

But there is an even more ominous cloud on the horizon and it involves the knowledge and skills of our people

Introduction

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 here we are in real difficulty, because we are not educating enough new people to keep our economy competitive.

Further, there are serious signs that the education of the present American workforce is simply inadequate to meet the demands of the next century.

Key input to a competitive economy is quality of the workforce. Our principal competitors are simply producing workers better capable of absorbing modern production skills.

This has become known as the "pipeline problem", since it involves the full spectrum of education, from preschool through K-12 through higher education to lifelong education.

- K-12 Education
  - By any measure, K-12 is in serious trouble.
    - We are "A Nation At Risk"...
  - Our education system simply has not responded to the challenges of the age of knowledge...
    - 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
  - Yet, in the face of this knowledge explosion, it is clear that both the knowledge and skills of the graduates of our primary and secondary education systems continue to deteriorate.
  - Note: it is bad enough that...
    - 10% of Americans are illiterate
    - 25% now fail to complete high school
  - Our students bring up the rear in most international comparisons
    - Compared to students in 15 other nations, US high school seniors scored among the bottom fourth on calculus and algebra achievement tests.
    - 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."
  - Science and mathematics education
    - But the coins of the realm in the age of knowledge will be science, mathematics, and technology...
    - Knowledge is cumulative, especially in math, science, and engineering. Without basic skills, a student cannot advance his studies.
    - But most American high school students are not developing these skills. Only 7% of the 17 year-olds tested are prepared for college-level science courses.
    - Nearly 30% of nation's high schools offer no courses in physics, 17% offer none in chemistry, and 70% offer none in earth or space science.
    - 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
    - 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.

A particular challenge to Michigan:
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!
The education of the Michigan workforce is inadequate to the demands of the next century.
Yet, we continue to be paralyzed in our efforts to come to grips with school finance reform or major structural changes necessary to achieve quality in public education.
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!

College Education
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!"
As Americans take degrees in law and business, foreigners are replacing them in graduate science and engineering programs.
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 tealent.
But things are going to get MUCH rougher: NSF Study
Dominant factor controlling BS degree supply is the size of the college-age population, which will decline until the late 1990s

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 675,000 by 2000!
        - 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:
    - Long term data suggest that percent of college age population receiving BS degrees is unlikely to be over 5%
    - This is compounded by the declining preference of college students for NS&E majors
    - Annual Freshman Survey: K. C. Green (UCLA)
        - Overall interest in science majors has dropped by half between 1966 and 1988, from 11.5% to 5.8%
        - Interest in biological sciences is sustained only by large number of pre-med students who major in biology
        - Largest decline has occurred in mathematics:
            - Dramatic decline in freshman interest in math majors.
            - From 1966 to 1988, dropped from 4.6% to 0.6%, almost a factor of 10!!!
            - Trends for men and women are similar
            - Note the implications, not only for technical careers, but also for pool of future graduate students and secondary school teachers!
        - Decline in physical sciences from 3.8% to 1.6%!!!
        - While women enrollment increased during 70s and 80s, it now appears to be dropping:
        - Interest in engineering is also declining
            - After recording big increases during late 70s and early 80s (increasing to 12%), now has dropped by almost one-third since 1982 (now down to 8.6%).
            - Again, decline is occurring among both men and women.
            - Puzzling, since no precipitating event in labor market demand helps to explain this drop.
                - The shift in student interests must be driven by other factors.
                - Clearly these declines point to potential problems in future supply of newly trained engineers.
        - Freshman plans to pursue computing careers is down more than two-thirds since 1982, from 8.8% down to 2.2%.
        - Where are they going?
            - Business is not the most popular major and career among college freshman, having doubled since the late 1960s.
            - One-fourth (24.8%) of the 1988 class plan to major in business, up from 16.4% in 1966.
            - The proportion of freshman women has increased by a factor of 6, from 3.3% to 21.2%.

- More women plan to pursue accounting careers (6.4%) than men (5.6%). NOTE: Total interested in math is only 0.6%, almost ten times less!!! (My daughter says she can believe this, since accountants can make money and mathematicians cannot.)

After a 14 year decline, freshman interest in teaching has almost double over past 6 years, from 4.7% in 1982 to 8.8% in 1988.

- Even with these recent increases, far fewer freshmen plan to pursue teaching careers than 20 years ago (23.3% in 1968).
- Futhermore, recent gains have not off-set the dramatic decline in freshman interest in secondary school teaching.
- Far fewer freshman entering teaching plan to study liberal arts fields than two decades ago.
  - Virtually all aspiring teachers are education majors!!!

All S/E fields have experienced a decline in the proportion of aspiring freshman major four-year institutions:

- Biology: -21%
- Engineering: -9%
- Physical Sciences: -39%
- Pre-Med: -20%

- In contrast, business is up 22% since 1978.

Humanities majors have increased 10% over past decade...

...social science is up 20%

Survey data provide some evidence that minority participation has increased in past several years.

- Corporate, governmental, and institutional investment in fostering minority interest in science is beginning to show a return.
- Gains in front of pipeline do not automatically translate into more minority graduates, however.

Some good news, however:

- Over past decade, fraction of freshman planning to earn graduate degrees rose by 20%, from 49% to 58.7%.
- Proportion of women planning to earn PhDs increased from 6.5% to 11.7%.
- NOTE: These date suggest that students no longer view the BS as adequate preparation for the demands of the labor market in the 21st Century.

More bad news:

- Increased in college teaching has dropped by more than 3/4 over past two decades, from 1.8% to 0.4%.
- Preference for research careers has fallen from 3.5% to 1.6%.
- Why get a college education:
  - Get a better job: 70% to 85%
  - Get a general education: 70% to 60%
  - Earn more money: 50% to 75%

Note shift in life goals:

- "Developing a meaningful philosophy of life": 85% to 35%
- "Being very well off financially": 35% to 80%

Other tidbits:

- Larger proportion of S/E majors spent significant time on homework and studying than peers in other majors.
- S/E freshmen rake higher on academic skills.

Some obsersations:

- The 1960s were a period of social upheaval; the 1980s are an era marked by economic upheaval
- Today's students:
  - Have less confidence in their academic skills....

Came of age during a period of continuing economic upheaval...
inflation, recession, restructuring
See the middle-class "goodies" as being difficult to attain,
now requiring real wealth.

But this situation may become even worse:

Over period from 1966 to 1987, proportion of students who intended to major in physicsal sciences yas 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.

Number of freshman planning to major in computer science has dropped by two-thirds since 1982. Intersting in engineering, which increased during late 1970s, has dropped by a quarter in 1980s.

4. Later effects

Further, there is an alarming loss of students in the early college years due to difficult courses, bad teaching, and declining interest. Only 40% of NS&E freshman survive to BS.

And of those getting BS, fewer than half are in NS&E jobs within 5 years because of reward structure biased toward management

5. Compositionof 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!

At all the key decision points during a student's career, blacks, hispanics, and women fall away from the sciences, math, and engineering at a steeper rate than the rest of the population.

At sophomore level, 20% of all students are interested in science, but only 10% of minorities.

1988 Engineering enrollments:

Women: 15% BS, 12% MS, 7% PhD, 2% faculty

Blacks: 3% BS, 0.3% PhD (14 total, nationwide)

Last year only 10 Blacks received PhDs in math and only 12 received PhDs in Engineering. Hispanics were not much better: 9 and 24, respectively. Of 4,614 doctoral degrees awarded in physical sciences, 41 were awarded to Blacks. This number is declining, down from 60 a decade ago.

Among women, despite significant increased in the number enrolled in graduate programs, they earn fewer than 15% of al technical degrees.

We must reverse this now, because women and minorities are the key human resource of the future and they need extra encouragement to pursue technical careers.

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

Graduate Education

Over the next two decades, PhD replacement needs will double in all sectors (academic, industry, government)

For example, 25% of engineering faculty will retire in next 6 years

On the basis of BS production alone, PhD production will decline by 20% in the decade after the mid-1990s.

Already symptoms: 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

If one looks at the ratio of BS to doctorate degrees over next decade, one sees a precipitous decline. The stabilization is only becasue of the rapid growth in foreign citizens receiving US degrees. While we can be pround our universities attract so many foreign students, we should not be blind to the fact that, increasingly, American students are not pursuing careers in S&E. Depending on foreign students is a dubious substitute for growing our own.

Foreign PhDs are beginning to return...

Strong evidence that foreign students are beginning to return home.

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

We have created a situation in which we are highly dependent on a resource over which we have little control.

The PhD production rate simply cannot respond quickly to market signals.

Salary increases, now projected at doubling during the 1990s, will increase production, but response will be quite delayed.

Further, the increasing number of foreign PhD graduates will reduce salary inflation, thereby reducing the number of Americans pursuing PhD degrees.

Must focus on currently enrolled college students to affect PhD shortfall in late 1990s.

Time to Degree

Average length of time from BS to PhD (past 20 years)
All Fields: 7.9 to 10.4 y
NS&E: 6.7 to 7.9 y
Market forces will probably lower NS&E
However, a successful effort to accelerate PhD achievement could increase degree production up to 25% for several years
Key factors to shorten:
Minimize field and institution switching
Long-term financial support commitments

WARNING SIGN 3: Scientific Illiteracy

Importance of Science
US remains leading nation in science. Americans still dominate world scientific literature. Large numbers of foreign students still flock to our universities.
Science pays: it is essential for attacking the major diseases of manking, to competing for global markets in advanced technologies, to better understanding the ills of our society such as environmental change.
An exercise: Think over a typical day, from the moment when your digital alarm clock wakes you up until your VCR shuts itself off as you doze off in the evening... and try to imagine what you life would be like without science and technology.
The social rate of return on academic research--how much society receives in benefits from an investment-- was recently estimated at 28% (Edwin Mansfield-1988)
Technological innovation accounts for 44% to 77% of increased productivity
We really haven't appreciated impact of technology.
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 mater is composed of infinitesimal "superstrings" rather than point particles
v) global warming...greenhouse effect...biodiversity
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 survyed indicated they believed we were being visited by aliens from outer space!
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
Public attacks on science are now routine...
Environmental impact
(Yet, what pray tell, will save the environment...)
Fraud and scientific misconduct...
Congressional hearings are taking on the spectre of witchhunts (almost a McCarthist tone)
Attacks on the research university: Profscam
Few seem to realize that during the decades following WWII the US built the strongest research base in the world in science and technology by asking its universities to play the key role in basic research.
Yet, perhaps in part because we have been so

successful, we are now subject not simply to attact but suggestions that we should cease research and focus exclusively on teaching.
Q: If we do so, then whom, pray tell, will sustain the scientific and technological strength of our nation?

The State of Michigan Response

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

The handwriting is on the wall...

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.

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

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.

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.

Importance of Research Universities

Importance of world-class research universities

Look around:

New England: --> MIT
Bay area-Silicon Valley --> Stanford & UCB
Southern California --> Caltech
Austin --> U. Texas

Why?:

Through research produce knowledge necessary for competiveness
Produce talented professionals to implement new knowledge
Attract "risk capital" through massive federal R&D support
Key to knowledge transfer

Traditional: graduates, publications
Entrepreneurs
Startups

Development of Unique State-University Partnership

Universities must commit 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 must commit 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 activites

University of Michigan Actions

The Unversity must view 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

Hence, we chose as our thrust areas...

Complex manufacturing systems

Machine Intelligence
Advanced electronics and optics technology
Information Technology
Health Sciences
Applied Social Sciences

Other steps

1. Recruiting key engineers and scientists
2. Modifying ways we interact with outside world...
   Strengthened interactions with industy
3. Intellectual property policies
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, entreprenureal 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 $40 million per year.
3. 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.
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 impact on state's economy that totals in the billions of dollars.
8. The growth of a $4 B industry in industrial automation in 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.

WARNING SIGN 4: The Dangers of Underinvestment

Perhaps the most ominous dark cloud on the horizon of all is the increasing evidence that we as a people we have not yet recognized either the nature or the magnitude of the investments we must make to achieve prosperity in an age of knowledge.

While we all give the "age of knowledge" lip service, the evidence suggests that in reality, we long for a return to the agricultural and manufacturing economies that once made us reach...

1. 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...)
   (US: 1.8%, Japan, 2.7%, Germany, 2.5%)
   As a percent of GNP, US R&D spending has been flat at 2.8% for a long time. Meanwhile, Japan's spending has increasted two fold, while West Germany's has increased three-fold over the last 25 years.
   Almost all growth has gone into military research (70% of federal R&D budget)
2. Over the past several years, numerous studies have suggested that Michigan is seriously underinvesting in its "knowledge infrastructure"...by as much as 30% to 40% relative to other states.
   Interestingly enough, studies performed by both the Democratic adminstration and the Republican Senate agree with this prognosis...and yet nothing has happened...and we slip even further behind!
3. Particular concern has been focused on the "education pipeline" in Michigan...from pre-school through K-12 education through higher education to lifelong education.
   Two-thirds of new jobs are in professional, managerial, and sales area...just 5% go to unskilled workers...as Michigan economy shifts from manufacturing to knowledge-based and service jobs.

3.5. Preschool

The plight of the poor in this state continues to worsen, as inadequate state tax revenues (due to voter resistance) and an out-of-control corrections program threaten those programs designed to protect the young.

"Studies show that high-quality preschool programs for at-risk children resulted in higher literacy, employment and educational attainment, and lower levels of school dropouts, public assistance dependence, and arrests."

4. The challenges faced by K-12 education were well-summarized in a recent editorial in a Detroit paper:

"If Michigan is to prepare tomorrow's workers for tomorrow's jobs, major structural changes are needed in public education, both in classroom quality and in the adequacy and fairness with which the system is financed."

"What is required is a strengthened commitment in Lansing to school finance reform and improving the quality of basic and higher education, and a greater political willingness to stand up to special interests who would thwart those long-term goals to pursue short-term objectives. The opportunity to eliminate chronic unemployment in Michigan may be never more within our graps than between now and the end of the century. The alternative is a growing mis-match of job opportunities and job training that threatens not only the state's recent prosperity, but its very solvency."
(Free Press editorial, 1/5/89)

Earlier this year we learned that Michigan ranks 48th in the nation in the rate of retention to H.S. graduation.

I cannot believe that we as a people can accept that kind of performance.

Yet, we continue to be paralyzed in our efforts to come to grips with school finance reform or major structural changes necessary to achieve quality in public education.

5. The situation is somewhat different yet no less acute for higher education in our state.

While the quality of Michigan higher education today is very high, the long term prognosis remains guarded...

The Investment in Higher Education

Our state has dropped from 6th in the nation in its support of higher education to 35th over the past two decades... into the bottom third!!!

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

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!

Over the past 10 years, high tech states such as California, New Jersey, Massachusetts, and New York have seen real dollar increases in higher education appropriations of roughly 20 to 30%. In sharp contrast, over this period Michigan has declined by 4.5%...

Certainly these states are prosperous...but they are also investing substantially more of their resources in higher education...in preparation for a knowledge-based future...than are we.

Indeed, one measure of the importance of higher education in the state budget is the ratio of tax dollars per enrollment ratio... a measure by which Michigan ranks 47th in the nation!

It seems clear that higher education faces a serious challenge in Michigan. Our present level of public support is clearly inadequate to maintain a system that is competitive on a national basis.

We are attempting to compete in this knowledge-intensive future

with an underfunded public system of higher education... and no private capacity (such as a Stanford, MIT, or Caltech).

Only the autonomy granted to our public universities have allowed then to "overachieve" their public support through higher tuition and other sources of financial support.

This has given public higher education in Michigan some capacity to face the devastating impact of the past decade...but it is rapidly losing this capacity...and there seems little doubt that the quality of our system will probably be gone in the next 10 to 20 years if the present trends of inadequate state support coupled with tuition constraints continue.

Whether measured in terms of state appropriation per student or fraction of our tax dollars directed toward higher ed, it is clear that in comparison with other states, our present level of public support is simply inadequate to maintain over the long run a system of higher education that is competitive on a national basis.

Despite herculean efforts by the Governor and the State Legislature in recent years to restore adequate support for higher education in Michigan after the devastating cuts of the early1980s, we continue to fall further behind the national average in state support.

And what will then happen to Michigan. We will become a "have not" state, competing in low wage industries in dying industries. We will have rejected the age of knowledge!

6. Prisons

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 higer ed...that is, we spend more money putting people into jail than we do in keeping them out of jail!

Over the past 5 years, the Corrections budget has increased by 141%, compared to a 25% increase for higher education.

Michigan has now embarked on yet another program to build 26 new prisons by 1991. Portion of state GF budget allocated to corrections has risen from 2.8% to 6.9% over past decade (now approaching $800 M per year). At the same time, human services fell from 53.2% to 49.6% while K-12 education fell from 36.6% to 20.0%.

Corrections will be $633 in FY88-89 (compared to $1,137 M for higher ed and $2,144 M for social services), but projected to grow to $2 B in 1990s.

Each of 25,000 inmates require $22,000 per year...

Furthermore, we have spent over $1.3 B to build new prisons...every penny of new construction funds... and now appear prepared to launch a second wave of prison construction, even though demographics suggest that many of these prisons will remain empty.

Further, while state revenues are projected to increase 5% in the year ahead, the exploding corrections budget ($140 M additional just to operate the new prisons) will eat up this growth, thereby crippling other state priorities such as education and social services.

Recent study by Joan Abbey and Ira Schwarz:

"Spending on prison construction and operation will have serious consequences on efforts to reduce infant mortality, treat drug dependence, monitor child care facilities, and care for the mentally ill...not to mention

education."

Michigan's corrections policies are threatening the state's future by inadequately financing the educational, medical, social, and other efforts needed to raise the living conditions of poor people in Michigan.

While prison construction has been politically popular, these investments will lock Michigan into a vicious cycle wherein limited state resources will be consumed for the operations and maintenance costs of these buildings."

"Strategic investments in programs for children, including schools, child care, and health care, will pay valuable dividends in the future."

"Studies show that high-quality preschool programs for at-risk children resulted in higher literacy, employment and educational attainment, and lower levels of school dropouts, public assistance dependence, and arrests."

7. Gimmicks

One of the curses of the American people has been their gullibility...in our rush to find quick fixes, simple solutions to complex problems, we are frequently sold placebos which actually aggravate the problem.

Example 1: The Michigan Lottery

Instead, we continue to rely on gimmicks...such as the State Lottery, which in effect robs from those most in need of state assistance...

Furthermore, since these Lottery funds flow into the General Fund, and since state support of education has clearly not tracked the increase in lottery revenues, it is clear that lottery revenues are, in effect, going to build and operate more prisions (the only part of the state budget which has growth at this pace).

Some irony here, since the Lottery, in effect, is transferring funds from the deprived components of our population..

Example 2: The Michigan Education Trust

Good Intent...but in serious need of modification

i) Seriously underfunded...

- Impact of tax rulings
- Requires long term real return of over 15%!
- First round of contracts will cause $100 million shortfall ...who will pay? The taxpayer or the institutions?
- Indiana model: Redeemable SCH

ii) Highly regressive social income transfer program:

- Takes both tax dollars and financial aid dollars from those who can least afford higher ed and transfers them, in effect, to high income families (Note Zip Code information)

iii) Convey false perception of real costs of education

- Not tuition ($12,000 per year less than car...)
- Rather room, board, books, supplies
- E.G. At UM, budget is $8,500 Tuition is $3,000 (or 35%)

Concerns on REF

In the spirit that every good thing can be improved...

1. Must recognize importance of long-term focus...
   ...particularly in basic research initiatives...
   (Indeed, this is where Japanese frequently beat us since they have the persistance and patience)
2. Must get away from temptation to micromanage from Lansing...

Washington learned long ago that the best results came from bottom up activities

3. Must pay more attention to interaction of REF with rest of higher ed appropriation.
   For example, it is clear that the Legislature has made adjustments to compensate for the REF distribution, so that in fact, it has now been folded into the normal base appropriation.
   In effect, this first phase of the REF has not resulted in incremental resources available for research, but merely earmarking a part of the usual appropriation for specific purposes.
   Two implications are important here:
      i) Because of this fact, efforts to modify or halt the program in effect amount to direct base budget cuts of higher education.
      ii) Even with the REF, the State of Michigan continues to seriously underfund higher education.
4. Real problem:
   Michigan has not yet faced up as a State to providing adequate support either of the knowledge infrastructure or educational quality necessary for prosperity in the 21st Century.
   President's Council, in an extraordinary joint effort, has noted with alarm the deterioration of state support over past 20 years, during which Michigan dropped from 5th to bottom third.
   In fact, in most recent data, Michigan ranks 40th in state support over past decade...so things are continuing to deteriorate.
      4. T
   Clear that the REF is absolutely essential...and necessary...but it is not sufficient in itself.
5. General Observations
   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.
   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, nuture, and educate that most precious of resources, our people.
   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.

A different way to look at it:

The Investment in Human Capital...

The real issue here is not the investment in education... it is the priority that we as a nation place on investing in our children.

We should feel both embarrassed and ashamed for robbing
our youth to pay for our own excesses...
But let's take the cynical view that responsibility and stewardship will
simply not be a compelling enough argument to reprioritize the
importance of investing in human capital...in our youth.
There is another viewpoint, however...
If we do not invest in the youth of today, they will not become a
sufficiently productive workforce to keep the checks coming
to those of us who retire in future years!!!
By 2000, there will be only three workers to support each
retiree...and one of these will be minority!
Look at it another way...which is the better investment...
$3000/y to keep a preschool kid on track
$5000/y to achieve a strong K-12 education
$10,000/y to sustain strong college education
or $25,000/y to put someone in jail...

What has happened to our priorities?

What is wrong here???
Who is to blame???
Our schools and colleges???
Certainly they must take stronger actions to improve
quality...and strive harder to operate in a more cost-effective
manner...
But their present situation reflects as much as anything
else our own personal priorities...
...as parents
...as volunteers...
...as citizens and voters...
What about our elected public officials???
It is certainly not their fault!!
Listen to their recent messages...
whether it be the Governor's State of the State address...
...or the response from the state Republican leadership...
...or the President's State of the Union address last week...
It is clear that our elected leaders, whether in Washington
or Lansing or our local communities...
Would like nothing better than to make education their
highest priority.
To become
...the Education Governor
...or the Education Party
...or the Education President
They understand clearly the importance of investing in our
human resources, and they are searching valiantly
for creative ways to improve the quality of our schools
and provide adequate and equitable financial support.
But they also face formidable constraints, since in the
end they must be responsive to the wishes of the
electorate...and face it, gang...the electorate today
says:
i) no more taxes...
ii) no more crime...
iii) no more cuts in social services or national defense...
and our public officials have no choice but to respond.
No, the real finger of blame for the crisis we face in education should be pointed,
as Michael Jackson would say, at "The Man in the Mirror"...
...at you and at me...
We are the ones who fail to demand the highest quality
in our educational institutions in Michigan...
We are the ones who steadfastly resist a tax base adequate
to support both our needs and desires...and provide an

adequate level of support for quality education in this state.
We are the ones who block any effective efforts to achieve equitable financing of education in Michigan.
We are the ones who generally are too busy to help our own children in their studies or participate in their activities.
And we are the ones who insist on building more and more prisons, even when we know that this investment comes out of the hide of education and social services-- which are, of course, the only true long term solutions to crime!
We are the ones who complain about higher tuition costs at our public institutions, even though we know that these fees represent only one-third to one-fourth of the actual costs of an education on our campuses...
and that our colleges provide adequate financial aid to offset the burden of even these modest costs to those in need...
Indeed, there is a particularly tragedy in this disturbing recent trend, because when combined with the serious limits on public support which now exist in our state, successful efforts to prevent adequate tuition levels for those who can afford to pay them, will not only undercut our capacity to provide financial aid to those less fortunate, but beyond that, will force our institutions down a path of towards mediocrity.
Let there be no doubt about it...
In higher education, as in every thing else in life, if you want bargain basement prices...you will eventually end up with bargain basement quality...
If there is one common theme to these trends, it can be summarized by that old T-shirt expression:
"Eat dessert first, life is uncertain"
We have become a "live for the moment society"
The "Me Generation" of the 1960s has now up into mature Yuppiehood?
We have ceased investing in our future!
We have chosen instead to mortgate 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.
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 mortgate this future to pay for mistakes make in our past.
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, prisions, 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.
Michigan has had a long tradition of wealth and a caring attitude for its populace. But it seems clear that if priorities are not changed, Michigan will become poorer and poorer and finally it will not be able to meet the "caring needs" of its

people. It will then have become a "have not" state.

We see ourselves caring about the future, but we are not preparing for it.

Scientific and technological decay, political neglect of education, increasing poverty among young are all related...all form a trend in America's political economy that could pull our society down.

At center of problem is inability to formulate and pursue a strategy of investment.

Should examine our patterns of national expenditures more carefully, with an eye to how they treat human resources and favor the future.

The most highly leveraged expenditures we can make are those on the young.

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 our citizens, then what will it be instead? And if we fail to invest adequately in the successor generation, then what kind of caretakers of our heritage and theirs will they turn out to be?

Yet the writing on the wall could not be clearer:

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

Hence, let me conclude my brief remarks by tossing at you--and at me-- several challenges:

Possible Solutions:

General Observations

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.

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, nuture, and educate that most precious of resources, our people.

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.

Pipeline Problem

Solutions:

1) Investment

Long term trends tell us two things about our human resource base:

One is that we have not been investing in our human capital sufficiently to prepare ourselves for the future. Knowledge, in the modern competitive world, is the new critical commody just as natural resources and access to low skilled labor were until just a few decades ago.

The second ting that long term trends tells us is that important demographic changes are taking place in this country and that these changes sharply increase the importance of attracting

- women and minorities into knowledge-based careers.
- We must avoid a dangerous myopia on two fronts:
  - We must avoid replicating the British experience where a failure by industry to support and take advantage of a first class research/education system has contributed to economic decline
  - We must guard against the illusion that basic research and advanced education is a luxury on which we can economize.

2) Cooperation
- Although Americans tend to equate competition with all that is good--progress, efficiency, high quality goods and services at affordable prices--this competitive attitude has serious drawbacks when carried to an extreme.
- Zealous competition can lead to a myopic defense of prerogatives and turf at the expense of indentifying and achieving common goals.

3) Education
- K-12 Level
  - Better prepared teachers
  - A better reward system for teaching--salaries and other recognition
  - Better curriculum and delivery system
  - Instructional equipment and access to well-equipped laboratoreis
  - Lengthen shcool year from 180 days to 240 days
    (note this would also achieve higher teacher salaries)
    (It also eases child care needs)
  - All world-class industrial nations have some post-secondary skill training system for noncollege bound. Only US has nothing.
  - State governments now subsidize every student that gets a college degree. How about a federal subsidy for noncollege bound?
- Also
  - More demanding requirements
  - Higher standards
  - Better communication between science and mathematics teachers and University faculty
  - Intensive teachinger involvement
  - Parental support and commitment
  - A conviction in our communications that education is the key to personal success.
- Needs
  - More programs at grade school level to excite children about science
  - Better programs at high school level to raise students to standards of our international competitors
  - Innovative programs to encourage, mentor, and support women and minority students in science
  - Relevant, well-equipped science programs at UG level to give graduates the skills they will need in workplace
  - Well-financed programs at graduate level to attract and support American students in study and research.
- Challenge
  - Our education system is complex and decentralized and the primary responsibility is located at the state and local level.
  - There is no simple solution...we must push on all fronts.
- We must weave a strategy of many strands--a stratedy that places existing programs in a larger context that established a clear sense of direction, develops the leadership for the tast, and insures continuity of effort.
- Above all, we must be consistent and perservere.

Coordinated campaign to improve the image of science as a career for young people. Must attack the simplistic and often antagonistic stereotypes of scientists in media

Massive federal fellowship program (3,000 new starts), since otherwise shortfalls in PhDs will have devastating consequences for colleges and universities and for business and industry

Better support for GSAs, since while they are doctoral candidates, they are also doing research and teaching

Fight cultural and social barriers that can make research careers an extraordinary hurdle for women and minorities

Knowledge Infrastructure

Level of Funding

How much money is enough? Better to point out the loss to the nation that will occur if we can only support at a certain level.

In FY89, $64 B in R&D. But $37 B of this is DOD.

Only $10 B into basic science. Should double this! Annual growth rate of 14% for each of next 5 years

Note that doubling basic science research over 5 years is a mere drop in the bucket.

(In fact, during Reagan presidency, defense budget doubled from $150 B to $300 B...there would hardly be a ripple if science budget doubled to $20 B)

What about federal deficit: "This requires not onlyspending austerity, but also a long term strategy to generate new wealth."

Concluding Remarks

To Us...

In a very real sense, our state has entrusted to us its most valuable resources...its youth...and its future.

To be responsible stewards of the public trust, it is clear that we must strive to achieve greater cost-effectiveness in our use of public funds...and I can assure you that we intend to do just that.

But even beyond this, we must become staunch guardians for the quality of our institutions...

For in education, as in every other aspect of American life, quality will be the key to our future.

Hence, to us falls the responsibility of taking the forceful and courageous actions necessary to sustain and enhance this quality...in the long run the people of this state both demand and deserve nothing less!

To You...

Higher education represents one of the most important investments a society can make in its future...since it is an investment in its people...

It is indeed the case that our state and our nation have developed the finest systems of higher education in the world...

But we must also remember 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 those of us in this auditorium today with unsurpassed educational opportunities.

We have inherited these marvelous institutions because of the commitments and the sacrifices of previous generations...and it is our obligation as responsible stewards--not to mention as responsible parents--to sustain them to serve our own children and grandchildren.

It seems clear that if we are to honor this responsibility to future generations, we must re-establish the priority of both our **personal** and our **public** investments in education, in the future of our children...and hence in the future of our state and our nation.

The Need for a New Coalition

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!

Today Michigan faces serious challenges that will clearly determinine its future prosperity and well being...
the challenge of pluralism...
the challenge of participation in a global community...
the challenge of the Age of Knowledge
the challenge of change itself...

If we are to respond, we simply must reorder the priorities of this state...

We must shift away from the temptation to address only the needs and desires of the moment

And, instead, we must begin to make some of the key investments necessary for the long term...

The key investments in our people...
in our children...

This is not just the worry of local communities or state government or public institutions

It is everybody's concern!

Each of us must step forward and unite to face the challenge of the future.

We must work together to build new coalitions including the public and private sectors...state government, education, business, industry, and labor...to develop an agenda appropriate to secure the future of our children, our state, and our nation.

Michigan continues to be blessed with abundant natural resources, a people of great strength, and a system of higher education of a quality envied by the rest of the nation...indeed the world!

But, the writing is on the wall...

If Michigan is to prosper in the age of knowledge that is almost certainly our future, we must join together now to restore both our public and personal investments in education...
...in our people and their ideas...
...in our children...
...and in our future

Themes of the Future

There is another image in my mind this evening however...
...and it comes from two decades ago...
...in fact, exactly 20 years ago this June 20.

When Apollo 11 set down on the Sea of Tranquility to put man on the moon.

The image is that extraordinary photo of our earth, taken by Apollo as it orbited the moon...
...and image that dramatically revealed how nations and peoples are passengers together

on spaceship Earth.

The program today has focussed on a subject of great importance to Michigan, to our nation and to the University--the internationalization of nearly every aspect of our lives. And it appears that this process of globalization has only begun.

The Globalization of America

Whether through travel and communication, the arts and culture, the internationalization of commerce, capital, and labor, we will become increasingly dependent on other nations and other peoples.

Some UM signs:

Professors Ken Lieberthall and Mike Oskenberg's briefing of the nation on the extraordinary events in China. In fact, Ken was over in China with the UMAA tour group

Dean Lee Bollinger, Dean of our Law School is currently hosting an Alumni Reunion ...in Florence, Italy, for his European alumni... ...at the UM Campus in Florence...

University of 21st Century

Spacetime physics course...electronic networks

MIT, Oberlin, Vienna, Towson State, Boise State, New Mexico...

Some facts of life:

The world and our place in it have changed.

FOr most of our history our political and geographic isolation, abundance of resources, and technological leadership insured control over our own destinies and steady improvements in the quality of life.

Today's reality is different. The world has been transformed.

No longer isolated, we are a player, still powerful, but no longer controlling, in a competitive, global market.

The fact is that a truly domestic US economy has ceased to exist. ...It is no longer relevant to speak of the Michigan economy or the American economy...or the competitiveness of Michigan industry or American industry.

Our economy...our companies...are truly international, spanning the globe...and intensely interdependent on other nations and other peoples.

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

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 signfiicant 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.

In fact, as Robert Reich has noted in his recent article in The New Republic, a company with headquarters in the US, production facilties in Taiwan, and a

marketing force spread across many nations
competes with another, similarly ecumenical company.
This has extraordinary implications, since it means that
we all are really part of an international labor market
encompassing Asian, African, Western Europe, etc.
Hence, our competitiveness as workers depends not on
the fortunes of any American corporation, or any
American industry, but on what function each of us
serve within the global economy.
This has created dramatic discrepancies in America...
...those professions involved with the manipulation
of information, so-called "symbolic-analytic services",
are highly competitive in the world marketplace
and seeing incomes rising rapidly.
...in sharp contrast, those involved in routine production
services or routine personal services are simply
no longer competitive, and will continue to suffer
from decline real income levels for the foreseeable
future since they are competing directly with
other low-skilled workers throughout the world.

The Role of Knowledge

Key element in transformation, is the emergence of knowledge
as the new critical commodity, as important as mineral ores,
timber, and access to low skilled labor were at an earlier time.
This new critical commodity knows no boundaries.
It is generated and shared wherever educated, dedicated,
and creative people come together...and, as we have learned,
it spreads very quickly.
We are in the midst of an information revolution that is changing
the basis of economiccompetitiveness and world power.
Today information and data flow quickly across continents,
oceans, and nation.s
We learn about events almost as they occur. The world is
linked electronically.
As a result, the relationships between nations and the pace
of change are increasing.
A global economy is not only possible, it exists.
Markets are changing and realigning. We have seen it in
the far east and now we are seeing it in Europe as the
continent races toward 1992, an event whose potential
consequences we grossly underestimate in the US.
What's more, these new technologies magnify the effects
of change. "Today the velocity of change is so great...
that the tectonic plates of national sovereignty and power
have begun to shirt" (Walter Wriston)
What's more, these new technologies magnify the effects
of change. "Today the velocity of change is so great...
that the tectonic plates of national sovereignty and power
have begun to shift" (Walter Wriston)
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!!!

A World Nation

But there is another important reason for our renewed attention to the international agenda of the University.

The US has become the destination of about half the world's immigrants

Probably 10 million this decade alone...

With falling fertility rates, immigration will soon become the main determinant of the variability in our population.

Our nation continues to be nourished and revitalized by the extraordinary diversity of our population--particularly those formerly excluded such as minorities and women and by our immigrants.

Indeed, it is the continuing fluidity of society that is our greatest asset and our primary defense against the doom and gloom prophecies of America's decline.

America is evolving into the first true "world nation", with not simply just economic and political, but indeed ethnic ties to all parts of the globe!

A Future of Hope

It is astonishing to me that these global interconnections have proceeded so swiftly. It is only twenty years ago that we caught our first glimpse of the planet earth from the surface of the moon. Perhaps in some ways that sight has helped us see ourselves for the first time as one human family.

We are no longer self-sufficient or self-sustaining. We are not immune to the shocks of the world society. We have never been more dependent on other nations and peoples.

Unfortunately, many see internationalization as a threat promising doom on gloom for our future. And indeed the cost has been great for many segments of our society from farmers and laborers to the highest reaches of corporate America. But I believe these can be seen as only temporary dislocations.

Certainly, there are threats to our prosperity and security inherent in the destabilization that comes from so rapid and profound a change in the relations among people. But think of the long term opportunity and challenge this offers! For the first time in history, we are linked together integrally, more self-conscious of our common fate than ever before. Clearly the key thing now is to learn to learn to appreciate our differences while at the same time forging some basis of common values.

We must take care not to lose perspective--

On the whole, the world is becoming more connected and more democratic.

From the moment when we first saw ourselves reflected as one world from the moon's surface back in 1969, we have been increasingly bound together through commerce, culture, arts, literature, travel, and communications.

Despite the pessimists, we have no full scale wars and we have made at least some progress in limiting the arms race.

Chances of superpower warfare are less and prospects for prosperity are good.

Michigan's Heritage

Understanding cultures other than our own will become

necessary not only for personal enrichment and good citizenship, but indeed, necessary for our very survival as a nation.

If our institutions are to serve America in its role as a member of the global community, we must think and act more imaginatively, more aggressively, and more strategically to strengthen our role as truly international centers of learning.

As you have gathered today, the University has strong international programs and some of the leading specialists to be found anywhere on foreign people and places and cultures and on international issues.

Indeed, from our founding this University has been linked to the international world of scholarship. The initial vision of the University, set out by French priests in 1817, was based on law governing the Imperial University of France. Our early presidents traveled regularly to Europe gathering books and ideas and borrowing heavily from educational traditions and practices in England, Germany, and other Euopean countries.

And from these international roots grew the dinstinctively American model of a public research university that has shaped our nation's system of higher education. As partners with our State and larger society, public universities such as Michigan helped to transform the Frontier and havest its agricultural riches, and then help forge our industrial strength. Today we are an integral part of the knowledge revolution that is once again transforming our society. And we will develop our international programs in this same spirit--to provide intellectual and practical leadership to help our state and nation grasp the opportunities and challenges of internationalization rather than allowing ourselves to be passively shaped and undermined by them.

The Challenges to Michigan

Certainly we have a long ways to go in this country to know what we need to know to participate fully as members of our human family. American knowledge of other languages and cultures is abysmally inadequate. By every measure we fall short educationally of the knowledge and skills it will take to do business, work cooperatively on common problems or advance our common ideals for humanity.

Too many of our graduates have never been exposed to a foreign language or visited a foreign country. Many have not had a chance to feel the texture of life in another era or another culture through literature and poetry or film. Some cannot locate Mexico or Egypt on a map.

Despite the intellectual richness of our campus, we suffer still from the insularity

and ethnocentrism that is the heritage of a country that for much of its history has been insulated from the rest of the world and self sufficient in its economy .....perhaps even self absorbed

Consequently, we must reexamine the way in which we foster, manage and promote the international dimension of our educational mission.

•We must strengthen the international component of our teaching and scholarship so that it pervades the liberal arts curriculum and that of the professional schools.

• We must be mindful that knowledge is not tied to geographic regions; rather the knowledge revolution is a world wide phenomenon and science speaks a universal language

-- We must be open to the challenge and excitement for our intellectual work in the disciplines that results from the infusion of other experiences and perspectives of other regions, cultures and traditions.

We must ensure that our students are prepared with an understanding of how the rapidity of modern communications and ease of travel will change the texture of their lives.

Above all, we must enable our students to appreciate the unique contributions to human culture which come to us from other traditions.....to communicate.. to work.. to live.. to thrive..in multicultural settings whether in this country or anywhere on the face of globe.

U of M: The University of the World

Therefore a key priority for the University of Michigan for the future is to build on the foundation of strength in international studies we have in place ....and to remain in the forefront of international educational programs in languages, study abroad, faculty and student exchanges, international research collaboration. Indeed, increasingly, I believe it is the infusion of international perspectives into our disciplines and professions that will be critical.

Education, however strongly rooted in a state or nation, is a universal institution just as the language of science and scholarship is a univeral language.

We occasionally attempt to develop slogans to represent key strategic thrusts...
...the University of America...or America's University

But perhaps a better slogan is
The University of Michigan:
A University **of** the World...and **for** the World...

After all, as President Marion Burton stated over a half-century ago...

"The function of the State University--of Michigan---is to serve the state and through the state to serve the nation and the world."

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 ...

Over the years, I have become increasingly convinced that education -- or more generally, the development of human capital -- will become the dominant issue for our state, just as it will be for our nation, in the 1990s and beyond.

In a very real sense, we are entering a new age... what has been termed, an "age of knowledge", in which knowledge...that is, educated people and their ideas...will become the keys to our future...

And in this knowledge-intensive future, research universities such as the University of Michigan will become the cornerstone of our prosperity and well-being...

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....

And in economic development activities first as Dean of Engineering at Michigan and then as its Provost.

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.

Note: Close working relationships with Bush Administration

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...

Familar Ills which dominate the headlines
The budget deficit
The trade deficit
Displaced workers
Marginal Industries
More serious
Trade deficits show little improvement despite a shart
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 cronically
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, it has become clear to most states, indeed, to most nations, that research universities are the key element in the infrastructure to provide for prospersity and social well-being.
change is technology, itself.

Without these key producers of advanced knowledge and the graduates who know how to apply it, a region will quickly slide into the backwater of the age of knowledge that we are now entering.

2) THE INTERNATIONALIZATION OF AMERICA

It will be a future in which America will become "internationalized"... in which every aspect of American life must be viewed from the broader context of participation in the global community...

Whether through travel and communication, the arts and culture, the internationalization of commerce, capital, and labor, we will become increasingly dependent on other nations and other peoples.

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 importanct alliances will be forced in every signfiicant 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."

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 tomorrows economy.

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!

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