

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 for 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...
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 it 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...

Familiar 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 cronicly 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 likelihood 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 force 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 than 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 talent.

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).
 Furthermore, 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 data 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 observations:

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 physical sciences has dropped from 3% to 1.3%; in mathematics, the decline was from 4% to less than 1%.

Recent trends in engineering also show softening.

Applications to most engineering schools are down by 10-20% this year. (USC 30%)

Interest in computer science is always waning. Drop from 4% in 1983 to below 2% in 1987.

Note: dramatic increase in proportion of freshmen interested in business majors--now up to 25% and rising rapidly

Furthermore, the dropout rate is extraordinary...

From 8th grade through PhD, the half-life of students in the mathematics curriculum is one year!

That is, if we begin with 32 million students in junior high school, we lose 50% each year until only a few hundred attain the PhD.

Number of freshman planning to major in computer science has dropped by two-thirds since 1982. Interest 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. Composition of college age population is also changing...
- In 1966 44% of college freshmen were women; today 52%.
 - By 2020 30% will be composed of Blacks and hispanics...
 - students who have not traditionally chosen S&E careers.
 - Indeed, by the turn of the century, over 50% of K-12 students will be Black or Hispanic.
 - Less than 15% of new people entering the labor force of the 1990s will be white males.
 - The fastest growing pool of youths has the lowest participation rate in college and the highest dropout rate in high schools -- not the mention the least likelihood to study science and math.
 - Furthermore, virtually none of the Black college freshmen who score highest on the SAT intend to major in mathematics or the physical sciences
 - Among engineering students, 70% complete school... but completion rate among Blacks is 30%; Hispanics 40%.
 - Indeed, while Blacks and Hispanics account for 20% of total population, they account for less than 2% of scientists and engineers!
 - 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 all 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 because of the rapid growth in foreign citizens receiving US degrees. While we can be proud 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 mankind, 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 your 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 matter 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 surveyed 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 attack 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 competitiveness
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 activities

University of Michigan Actions

The University 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 industry
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, entrepreneurial
environment...a no-holds barred, go-for-it culture...in
which individual initiative, achievement, and the quest
for excellence are dominant elements

Already clear evidence of payoff...

1. Darling of the national press...

Hardly a week goes by without some reference to the phenomena
occurring in "Automation Alley"...from Warren to Ann Arbor...
an area now clearly identified as the hot spot of action in
technology for the next two decades...

California dreamin'

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

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

2. University's federal research increased by 25% each of the
past two years to over \$200 million per year.
Industrially sponsored research has increased by 50%

- Engineering research has more than doubled, to over \$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 increased 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 administration 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 revenues (due to voter resistance) and an out-of-control

correction in the
rate of retention to H.S. graduation.
in the

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

6 - 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

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im†Mich□gan some cypachty

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the d□vastating

impact op!□he past decade...but)t

.heaeÄ6 - is<w-phdly lm□hng!□his capacity...`nd there seems little|doubt

th`t the quality of our system `ill probably □e gone in the

.hec□ 6 - next 10 to 20 years if the present trends of inadequate state support coupled with □uithon constr`ints cnntinue.

.jead 5 +† Whether measured in terms of state appropriation pe` student or.he`d 6 - fraction of our tax dollars directed toward higher|□d,

it is clear that in comparison with other states, our present level of public support is simply inadequate to maintain over the long run c□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 early 1980s, 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 higher ed...that is, we spend more money putting people into jail than we do in keeping u□em 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 a

other program

to build 26 new prisons by 1991. Portion of state General Fund allocated to corrections has risen from 2.8% to 6.9% over the past decade (now approximately \$800 million per year).

financing the education, 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 prisons (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 shortfalls

- Who will pay? The taxpayer or the institutions?

- **Indian Tribal: Reversible SCH**

() Hknh{wAaressive social income transfer program

:.hec 5 + • Takes both tax dollars and fA

ancial axd doolars-Ëec□ 6 - from those who can!

least afford high! red and.hec 6 - transfers them, in effect, to high
income families`hec 6 - (Note Zip Code information)

ik) Convey`fils= perceptiox o` real costs of educ`ion

.hec 5 - <• Not t`ition (\$12 000 per yeap luss than a`r...)

- Rather room, board, books,`supplies`head 5 + • E.G. At UM, bue`et is \$8,500
Duition is`\$3`000 (or 35%)

`head 1 + What!`as happened to our priorities?

What is «rong here???

Who is to blame???

head 3 + Our schools c

d colleges???

g or our local communities...

Would like nothing better than to make education the
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 when 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...)

Head 4 - and our public officials have no choice but to
respond. *Head 2 + 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"...

Head 3 - ...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 learn their studies or participate in their activities.

□ + And you 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--

3 - 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...

Head 3 + Indeed, there is a particularly tragic 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
unpleasant and painful, and the future of our children...
We have chosen instead to mortgage this future to pay for mistakes
made in our past.
The attitude we have taken toward our most precious resource,
our youth, is both callous and alarming.
I simply cannot accept the excuse that "we can no longer
afford this investment in the educational opportunities
we offer our youth".

.head 2 + For any years now we simply have not been

willing to invest in our future...and the future of our children...
We have chosen instead to mortgage this future to pay for mistakes
made in our past.

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

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

< + **To be sure, the immense social needs for welfare assistance,**

medical care, prisons, and all of the other programs that
drain our tax dollars are compelling.

However, by choosing to meet these needs with resources

taken away from our system of public education rather than
through reforms in our tax structure or political system,
we have in reality mortgaged our future by withdrawing
the educational opportunities from our youth.

.head 3 + Michigan has had a long tradition of wealth and a caring

attitude

for its populace. But it seems clear that its priorities are
its "needs" of its

people. It will then have 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 give us

.head 3 - 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 setback

will 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, nurture, 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.

ure
by industry
o support and take advantage o a first class
research/education system has contributed to economic decline
We must guard against the illusion that basic research can

d

advanced education ...s(a luxury on which we can't even dream of).

2) Cooperation

5 + African Americans (tend to compete with each other)

It is (good--*head 6 - (progress, efficiency, high quality goods and services at cError!

this competitive attitude as! serious drawbacks when carried to an
head 6 - extreme .hec 5 + Zealous competition can lead
to a myopic! defense of prerogatives and (turf
at the expense of identifying and achieving common goals.

3a 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 laboratories
Lengthen school 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 teacher 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 strategy that places
existing programs in a larger context that established a clear
sense of direction, develops the leadership for the task, and
insures continuity of effort.

Above all, we must be consistent and persevere.

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 only spending in austerity, but also a long term strategy to generate new wealth."

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 determine 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 in self...□

head 2 + If we are to respond, we 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 both our public and

personal investments in education...

...in our people and their ideas...head 3 - ...in our children...

...and in our future

...and in our future

...and in our future