

Michigan Economy

Titles and Themes

Titles

Michigan at the Crossroads

Themes

Economic transition

Role of Universities in Enabling the Future

Engineering, technology theme

Introduction

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

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

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

Background

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

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

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

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

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

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

My Message

My message today will be suffer from both of my character flaws as a scientist/engineer...
...it will be a vision of the future...
...and it will be unusually candid.

In a nutshell, as I look to the future, I am sensing an ever-accelerating pace of change in our society, in our state, in our nation, in our world.

Yet I also fear that few have realized the enormous changes that our society is undergoing as it

approaches the 21st Century.

We are becoming more diverse, more pluralistic as a people. Indeed, almost 90% of the new entrants into our workforce during the 1990s will be people of color, women, or immigrants.

Our economy and commerce are becoming every more interdependent with other nations as the United States becomes a world nation, a member of the global community.

And we are rapidly evolving into a new post-industrial society, in which the key strategic resource necessary for prosperity and social well-being has become knowledge itself, that is, educated people and their ideas.

The themes of change,

- i) the growing pluralism of our society
- ii) our evolution into a world nation, ever more tightly coupled to the global community
- iii) and our rapid transition to a knowledge-based economy

are not themes of the future...

...they are themes of today...

...and they are already dominating every aspect of American life.

It is clear that the key strategic resource of our society has become knowledge itself... that is, educated people and their ideas.

Knowledge will play the same role that in the past were played by natural resources or geographical location or unskilled labor...

In the pluralistic, knowledge-intensive, global future that is our destiny, it is clear that the quality of and access to

...education in general

...higher education in particular

...and great research universities

such as the U of M most

specifically of all

are rapidly becoming the key determinants of the strength and prosperity of our state.

But here there is some good news...

America is particularly well positioned, since our research universities are clearly the envy of the world, as evidenced by the extraordinary demand by graduates of every country to see advanced education and training in the United States.

Indeed, higher education is not only our nation's highest quality, but also probably also its most competitive industry as measured by the test of the marketplace!

Further, Michigan is particularly well-positioned from this perspective, since our state has built over the years not only one of the strongest systems of public higher education in the nation, but possesses several of the world's leading research universities.

But, now for the bad news...and the candor...

We--that is YOU AND ME--seem hell-bent, both as a nation and as a society, on destroying the extraordinary resources represented by our research

universities, just as we are entering an age of knowledge in which they will become our most valuable resources.

Indeed, a tragic combination of public misunderstanding, short-sightedness, and downright selfishness, is now threatening to constrain and hamper our universities...

Leading to the frightening prospect that we will manage to destroy our international competitiveness of higher education just as we have many other American industries.

In my home state Missouri we have an old saying that the best way to get a mule to move is to first hit it over the head with a 2x4 to get its attention.

Now that I have your attention, let me explain more clearly what is at stake here...

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

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

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

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

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

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

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

The Bad News of the past several years...

Familiar Ills which dominate the headlines

The budget deficit

The trade deficit

Displaced workers

Marginal Industries

More serious

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

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

Even industries like semiconductors and computers are vulnerable to competition from abroad

Facts of life:

7-fold increase in international trade since 1970

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

70% of goods we produce now must compete against merchandise from abroad
The bad news for Michigan is obvious...
Industries of great economic importance to our nation such as steel and automobiles have fallen victim to intense competition from abroad...
Plants have closed...our cities are filled with 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 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. Demographic Change: The New Majority
America is changing rapidly...
When we hear references to the demographic changes occurring in our nation, our first thought probably focuses on the aging of our population.
It is indeed true that the baby boomers are now entering middle age, and their generation has been followed by a baby bust... in which the number of young adults will be declining over the remainder of this century by roughly 20%.
Indeed, today there are more people over 65 than teenagers in this country, and this situation will continue for many decades.
Further, the growth rate in both our population and workforce is declining to the lowest level in our nation's history.
America will simply not be a nation of youth again in your lifetimes.
Yet, there is a far more profound change occurring in the population of our nation.
America is rapidly becoming the most pluralistic, multicultural nation on earth.
Women, minorities, and immigrants now account for about 90% of the growth in the labor force.
By the year 2000, they'll represent 60% of all of our nation's workers!!!
Those groups we refer to today as minorities will become the majority population of our nation in the century ahead...just as they are today throughout the world.
And women have already become not only the predominant gender in our nation and our institutions, but they are rapidly assuming their rightful role as leaders of our society.
What most don't realize is that the social and racial mix of these cohorts will be enormously different from what it was in the 1960s and 1970s.

The 21st Century will be the first post-European century in American history.

An absolute majority of young people born in US in the 21st Century will be born of parents of other than European background... Asian, African, Hispanic

And this will represent a major change in the character of our society.

In this future, the full participation of currently underrepresented minorities and women will be of increasing concern as we strive to realize our commitment to equity and social justice.

But, in addition, this objective will be the key to the future strength and prosperity of America, since our nation cannot afford to waste the human talent represented by those currently underrepresented in our society, this human potential, cultural richness, and social leadership.

If we do not create a nation that mobilizes the talents of all our citizens, we are destined for a diminished role in the global community, increased social turbulence, and most tragically, we will have failed to fulfill the promise of democracy upon which this nation was founded.

But there are other important challenges associated with such demographic change.

In particular, it is important to realize here that 21st Century America will NOT be a melting pot in which all cultures are homogenized into a uniform blend -- at least not during our lifetimes.

Rather, it will be pluralistic...composed of peoples of vastly different backgrounds, cultures, and beliefs...peoples seeking to retain their cultural roots...to maintain their differences and identities.

Our challenge will be to find the common bonds and values that unit us, even as we learn to respect and value our differences.

The growing pluralism of our society is one of our greatest challenge as a nation...yet it is also among our most important opportunities, since it gives us an extraordinary vitality and energy as a people.

2. The Internationalization of America

The second theme is triggered by an event that happened from almost exactly two decades ago...when Apollo 11 set down on the Sea of Tranquility to put man on the moon.

The image I have in mind is that extraordinary photo of the earth taken by Lunar Orbiter as it circled the moon... ..an image that dramatically revealed how nations and peoples are passengers together on spaceship Earth.

It was a portent of today, a time in which all aspects of American life are becoming increasingly "internationalized", in which our nation has become a member of a truly global community.

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

The world and our place in it have changed.

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...

Our economy...our companies...are truly international, spanning

the globe...and intensely interdependent on other nations and other peoples.

We are no longer self-sufficient or self-sustaining. We are not immune to the shocks of the world society.

As the recent events in China and the Soviet Union make all too clear.

But beyond commerce and national security, there is an even more important reason to pay attention to the trends of internationalization...

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.

As we have been throughout our history, we continue to be nourished and revitalized by wave after wave of immigrants, coming to our shores with unbounded energy, hope, and faith in the American dream.

Yet today, in a very real sense,

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

From this perspective, it becomes clear that understanding cultures other than our own has become necessary not only for personal enrichment and good citizenship, but indeed, necessary for our very survival as a nation.

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.

Some examples:

1. Industrial production is steadily switching away from material and labor intensive products and processes to knowledge intensive processes:
2. Our nation's future has probably never been less constrained by the cost of natural resources.
3. Increasing manufacturing production has come to mean decreasing blue collar employment!
4. We are in the midst of an information revolution that is changing the basis of economic competitiveness and world power. Today information and data flow quickly across continents, oceans, and nations. 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)

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.

We're emerging from the economy of the industrial revolution--an economy confined

to and limited by the earth's physical resources--
into an economy of the mind, an era in which
there are no bounds on human imagination and the
freedom to create is the most precious natural
resource"

But the whole thrust of the information revolution
is to decentralize power away from both
government and corporate bureaucracies
back to the individual.

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,
and creative people come together...and, as we have learned,
it spreads very quickly.

The knowledge revolution is happening worldwide
and at a very rapid rate.

It is clear that the key strategic resource of our society
has become knowledge itself...
that is, educated people and their ideas.

Knowledge will play the same role that in the past were played
by natural resources or geographical location or
unskilled location...

In the knowledge-intensive future that is our destiny
it seems clear that education in general...
...higher education in particular...
...and the research university most specifically
are rapidly becoming the key ingredients determining
the strength, prosperity, and social-well being
of our nation.

General

Transition from linear to nonlinear world
...from a world of gradual change to
a world of revolutionary change

Deterministic to stochastic
"Ill-posed"--unstable dependence on initial
conditions or perturbations
("butterfly effect")

Unusual importance of young or newly-initiated
in triggering change.

Concerns...

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tightly coupled to the global community
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economy
are not themes of the future...
...they are themes of today...
...and they are already dominating
every aspect of American life.

Needless to say, the same challenges of pluralism,
of internationalization, and of this age of knowledge
that is our future will also pose great challenges to
our state.

Indeed, 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...

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

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

Previous economic transformations were closely 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.

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...

Clouds on the Horizon

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

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

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Signs in Michigan

Look at the prosperous areas in Michigan

Grand Rapids
Oakland County
Grand Rapids

and contrast these with impoverished areas

Detroit
Battle Creek
Benton Harbor
Saginaw
Muskegon

Real difference stands out: education!!!

"Most economically successful areas are those with educated and highly skilled labor force.

In Ann Arbor, 90% of people 25 or older have completed at least 12 years of school:

Saginaw: 57%
Flint: 60%
Jackson: 63%
Lansing: 72%
Kalamazoo: 73%
Grand Rapids: 67%

WARNING SIGN 1: America is slipping

No question that we have lost lead in many areas
Industrial productivity and heavy manufacturing
Steel, durable goods, ...

Moreover, key activities such as product design, engineering, and software development increasingly

are likely to be done overseas.

Whether automobiles or refrigerators, computers or microchips, nuclear power or energy transmission systems, the likelihood is increasing that the systems are assembled from components designed, engineered, manufactured, and shipped from all parts of the world.

US trade deficit is only a symptom of America's lagging competitiveness. It means that the US economy has been living beyond its means.

The most serious long term problem is low productivity growth, however. With productivity growing at less than 1% per year, the American standard of living is falling relative to those in most industrialized nations.

Our wages are already below those in Europe and Japan.

Over the long haul productivity growth is the main determinant of trends in living standards, and no amount of fiscal ledgerdemain can obscure a basic weakness.

The necessity for lower wage growth in US is result of lagging US productivity--that is, a lower rate of growth in physical output per worker and a declining advantage in technology and quality.

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

Key input, however, is quality of the workforce.

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

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

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

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

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

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

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

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

WARNING SIGN 3: The "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. Interesting 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 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 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 4: 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?

WARNING SIGN 5: Michigan's Work Force is Becoming Obsolete

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

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

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

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

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

Michigan is undergoing dramatic change in industry...

Away from low-skill, blue-collar workers

The factory of the future will have NO low skill workers

Statistical quality control and just-in-time inventory
systems require production workers with mathematical
abilities that are far beyond the present level.

Unskilled labor will lose relevance in a world dominated
by microelectronics, computers, and automation.

An example: Expert systems

The "expert system" craftsman...

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

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

Serious concern:

1. The present generation of blue-collar workers does not
have the formal education to be retrained!!!

2. Little sign that education system is adapting to this future.

Key input, however, is quality of the workforce.

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

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

It is bad enough to face the prospect of a significant fraction of our labor force becoming permanently unemployable because of an inadequate education. Do we want to condemn their children...OUR children...to a similar fate? Can we afford it?

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

Some observations:

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

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

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

WARNING SIGN 6: 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 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 grasp than between now and the end of the century. The alternative is a growing mismatch 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
Michigan Rankings:
Total state appropriation per student (CC + U): 46th
Total state appropriation per student (4 Y): 32nd
State appropriation per capita: 24th
Increase over past 10 years: 45th
Increase over past 2 years: 42nd
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
them 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 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!

Eroding state support...

Over the past two decades, the State of Michigan
has dropped from the position of a national
leader (ranked 6th in 1965) in its public support
of higher education to among the lowest in the
nation (ranked 37th in 1989)

- | | |
|-----------------------|------|
| i) Appro per student | 43rd |
| ii) Appro as % of tax | 37th |
| iii) Two year % inc | 42nd |
| iv) Ten year % inc | 45th |

As a highly industrialized state undergoing a
dramatic change to a knowledge-intensive
economy, Michigan is critically dependent upon
quality higher education. Yet Michigan has
now fallen into the bottom ranks of industrialized
states in its support of these critical resources.

Tuition wars...

This situation has been compounded by political efforts to force tuition levels to artificially low levels, even as our universities have become ever more dependent on tuition revenues in the face of eroding state appropriations.

This latter effort is ironic, since in reality, tuition levels in Michigan's public institutions (\$2,000 to \$3,000 per year) are quite comparable to those at most other public institutions and quite low compared to private institutions (\$10,000 to \$15,000 per year). Further, these tuitions cover only a small fraction (typically 20% to 30%) of the cost of an education at a public institution.

Further, Michigan public universities have significantly increased their financial aid programs to protect access. Indeed, at the U of M, we have a policy that all Michigan resident undergraduates are provided with adequate financial aid to meet their needs until graduation.

Since federal funding for financial aid has declined 50% in recent years, tuition revenue has become a primary source of funds for financial aid programs. Hence, political efforts to drive tuitions down also drive down financial aid pools as well. The result is that those least able to afford a quality education are in danger of becoming deprived of this opportunity.

6. Threats to autonomy...

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 them 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.

But political efforts to set tuition levels in Lansing rather than on our campuses raise another even more serious threat.

The traditional autonomy of governance of Michigan's public universities has been the critical factor in sustaining program quality while continuing to serve the state in spite of sharp erosion in public support.

This autonomy allowed Michigan's universities to take strong internal actions, reallocating resources, redefining priorities, and increasing tuition levels to partly compensate for reduce public support.

In recent years, however, even as state appropriations have been declining, the political pressure to restrict tuition levels to artificially low levels has increasingly threatened this autonomy.

While such political efforts have been portrayed as an effort to protect access (affordability) to public education in Michigan, they have had just the opposite effect by slashing financial aid programs. It is clear that these forces from Lansing are being driven by not by concerns about access, but rather by fears that the Michigan Education Trust program, a prepaid college tuition program developed and financial on the assumption of low tuition levels, will become financial insolvent.

7. 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 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 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 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%)

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!!

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 have become consumers of education,
not investors in the future.

What's Going On Here?

Something has changed in America...

You know, I was brought up in a long tradition in
which one's first responsibility was to one's children
My parents scrimped and saved for my college education...
...and my wife and I have done the same for our
daughters (who, since they attended eastern
private universities, have taken essentially all of the
savings we have been able to muster over
the past 20 years)

Saving for a college education came first...

...before a house, before a fancy car, before an exotic vacation

But today's generation is different...

...the "me generation" of the 1960s has grown up into
comfortable Yuppiehood...

...it is bad enough that they have not saved
for their children's college education

...and not supported adequate tax programs
to support higher education

...but they have actively encouraged government
at both the state and federal level to intervene
in an effort to hold tuition levels to unrealistic
low levels...

(either not realizing or perhaps not caring that
they were undermining the quality of the
education their children would receive at these
bargain-basement prices--and depriving many
others from less fortunate backgrounds of the
opportunity for a college education because of
the erosion of financial aid programs in the
face of inadequate tuition revenue).j

Our approach to education...like to so much else in life
these days...can be summarized by that T-shirt slogan:

"Eat dessert first, life is uncertain"

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

"American's look ahead 10 minutes while Japanese look ahead 10 years..." (Morita, Sony)

"The last ten years have witnessed the substantial abdication by our governments of their responsibility in critical society areas, including education". When matched against the Japanese commentary, it is virtually cause and effect.

Without the opportunity for all Americans of limited or virtually no real income to obtain the benefits of an outstanding education, the class gap will continue to grow. And we will develop an educational elite in the 19th Century European tradition, to be sure, with all of its unfortunate results.

Japanese trade negotiations:

US should upgrade schools, invest in scientific research, close the Federal deficit, and take other drastic steps to improve American industrial competitiveness.

"If the US wants Japan to change its system, the US must be more ready to correct its own shortcoming. We can't solve our trade imbalances looking at Japan alone."

American high schools and colleges must upgrade the teaching of mathematics, science, and foreign languages.

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.

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

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

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

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

The Dangers...

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

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

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

Is this because of an aging electorate?

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

No. Rather it is the fact that for many years now we simply have not been willing to invest in our future...and the future of our children... We have chosen instead to mortgage this future to pay for mistakes made in our past.

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

The old T-shirt expression: "Eat dessert first, life is uncertain" reflects our present tax policy.

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

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

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

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

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

All human societies endeavor to endow their children with an enlarged and enriched culture, for transmission to their successors.

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

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

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

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

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

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

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 \$30,000/y to put someone in jail...

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.

Knowledge, in the modern competitive world, is the new critical commodity just as natural resources and access to low skilled labor were until just a few decades ago.

The second thing 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 identifying 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 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 teaching 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 austerity, but also a long term strategy to generate new wealth."

A National Response

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

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

People must be the major focus...

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

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

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

Two-fold challenge

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

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

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

The State of Michigan Response

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

The Michigan Strategy

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

Economic prosperity lies not in tearing down our old industrial base for a different kind of economy, but in helping that base make the changes necessary to compete in a new economic environment.

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

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

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

1. To enhance the growth of R&D in Michigan
2. To accelerate the transfer of technology into Michigan industry
3. To develop a strong coalition within Michigan among government, industry, labor, and universities to create a "venture culture"

As we look to the knowledge-intensive future of Michigan, we recognize as have so many other states that it will be our great research universities that will hold the key to our collective prosperity.

Why?:

Key factors in technology-based economic development

Technological innovation

Technical manpower

Entrepreneurs

Produce talented engineers to implement new technology

Through research produce creativity necessary for innovation

Attract "risk capital" through massive federal R&D support

Key to technology transfer

Traditional: graduates, publications

Entrepreneurs

Startups

Importance of world-class research universities

Look around:

New England: --> MIT

Bay area-Silicon Valley --> Stanford & UCB

Southern California --> Caltech

Astin --> U. Texas

A fact of life:

Only world-class research universities are capable of major impact

Must play in the big leagues...with MIT, Stanford, Berkeley...

To attract the outstanding faculty and students

and massive resources necessary for technological leadership

Development of Unique State-University Partnership

Universities committed themselves to:

Strategically realigning activities into key thrust areas
of major importance to State...

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

Developing new mechanisms for technology transfer...

State government committed itself to:

Establishing higher education in general and the state's
research universities as a high priority

Providing seed resources to sustain key thrust areas

Developing novel institutions to act as catalysts in these activities

State Actions:

Vision and courage of leaders in public and private sector

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

Also were willing to make the investments today necessary
for Michigan's prosperity tomorrow...

1. Research Excellence Fund

\$25 into building key research areas within research universities

2. Centers of Excellence

Industrial Technology Institute

Michigan Biotechnology Institute

Michigan Materials Processing Institute

3. Michigan Strategic Fund

4. New coalitions and partnerships

Fraser-Iacocca Commission on Jobs and Economic Development

University of Michigan Actions:

Background

Since the birth of our state 150 years ago,
there has been a strong bond between the
people of Michigan and their university,
the University of Michigan.

Generation after generation of Michigan citizens

have reaffirmed their commitment to provide in

Ann Arbor an institution capable of:

providing to their sons and daughters an
education equal to the best

attracting to Michigan the most outstanding

scholars, scientists and engineers,

doctors, lawyers, and teachers, and

other professions so essential to our

prosperity and well-being

creating through its research and scholarship

the new knowledge so necessary to

economic growth and development

addressing through a myriad of public

service activities the many challenges

facing our state.

This sustained public investment and confidence

in the University over the years has enable it to serve the state in all of these ways and more. Through this unique partnership, the University and its activities in education, research, and public service have served our state and its citizens well. Today our state faces new challenges that will call once again on the vast resources of its University.

1. Michigan faces a period of dramatic economic change, during which it must evolve from a resource-intensive to a knowledge-intensive economy, in which intellectual capital will replace financial and physical capital as the key to economic development and prosperity.

Our state will become ever more dependent on key knowledge resources such as the UM as it faces the challenge of intense competition and rapid technological change, as it enters the age of knowledge in a global economy that will be its future.

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

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

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

The University must serve as a model in its effort to build a multicultural, pluralistic community on its campus which achieves new levels of understanding, tolerance, and mutual fulfillment for peoples of diverse backgrounds.

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

It intends to focus its considerable resources in the social sciences and professions on the problems faced by Michigan's cities.

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

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

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

Recognition:

Michigan is where our nation makes things...

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

Surrounded by excitement of industry in transition

"factory of the future"

robotics, machine intelligence, animate systems

EDS, Hughes, Saturn

But these are just tip of the iceberg!!!

A fascinating and unique convergence of technology...

The chip, computers, AI, new materials, mech systems

Driven by money (investment) and need (competitiveness)

Michigan-->nation's source of emerging industrial technology

A transition is occurring in which..

Intellectual capital ("brainpower") is replacing

financial or physical capital as key to economic development

Hence, we chose as our thrust areas...

Complex manufacturing systems

CRIM - ITI -- The Center for Research on Integrated Manufacturing, responsible for the basic research and instruction necessary to sustain the Industrial Technology Institute...and to maintain the momentum of Automation Alley now developing in Michigan.

Machine Intelligence

CMI - EDS -- The Center for Machine Intelligence, an exciting new venture formed with the participation of industry and federal government to explore the whole new technology of thinking machines -- machines that can perceive their environment, think, and act. First applications will be in manufacturing. However next generation of thinking machines will be designed and built by intelligent machine!!! (Note address is 2001 Commonwealth)

Advanced electronics and optics technology

CAEOT -- The Center for Advanced Electronics and Optics Technology, aimed at research into the marriage of electronics and optics -- laser on a chip. It is now the largest university laboratory in the nation specializing in ultra high speed, high frequency electronic devices and advanced electronic materials such as gallium arsenide.

Information Technology

Goal: To use the University as a gigantic laboratory to design the knowledge-based organization of the 21st C

CITI -- The Center for Information Technology Integration, essentially a skunkworks operation exploring the forefront of modern computer telecommunications with several of the leading companies in the nation. The U of M itself has become the laboratory, the "test bed", for this exciting venture.

Center for Collaboration Science and Technology

Cognitive Science and Machine Intelligence Laboratory

Merit and NSFnet

MITN

Health Sciences

\$500 M capital investment in Medical Center

(R&D growing at 20-25% per year)

Drug industry in Michigan (UpJohn, Warner-Lambert)

Particular thrusts

Molecular Medicine

Cancer Center

Geriatrics Center

Substance Abuse Center

Hughes Medical Research Institute

Social Sciences

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

Institute of Social Research...

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

Social Work and Education

Focusing on problems of urban environment...

Problems of underclass

Other steps

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

Cultural Changes

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

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

Already clear evidence of payoff...

1. Darling of the national press...
 - Hardly a week goes by without some reference to the phenomena occurring in "Automation Alley"...from Warren to Ann Arbor... an area now clearly identified as the hot spot of action in technology for the next two decades...
 - California dreamin'
 - Places like Silicon Valley and Route 128 are buzzing about Michigan...we are now raiding their best talent...
 - We've become a showplace: Bobby Inman, Governors,...
2. University's federal research increased by 25% each of the past two years to over \$200 million per year.
 - Industrially sponsored research has increased by 50%
 - Engineering research has more than doubled, to over \$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.

The Local Response

The real power to influence the education at the level

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

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

While it is true that our school districts have suffered serious damage from an erosion in public support, the responsibility for education does not rest with the schools alone.

How many parents commit themselves to working with their children?

How many support the millages necessary to build strong schools?

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

Perhaps it is the lack of commitment of the American public, in general, and American family in particular which so contrasts us with other nations such as Japan.

Few parents take an active interest in their children's education.

Few save toward a college education...

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

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

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

We complain about taxes necessary to support education...

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

Why?

Is it simply an aging electorate?

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

No...root causes lie much deeper.

We have ceased investing in our future!

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

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

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

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

Indeed, Michigan, a state with one of the highest per capita incomes in the nation, continues to slip further and further behind in its investment in education -- just as our nation continues to fall further and further behind those very nations now challenging our economic strength and prosperity. The attitude we have taken toward our most precious resource, our youth, is both callous and alarming. I simply cannot accept the excuse that "we can no longer afford this investment in the educational opportunities we offer our youth. To be sure, the immense social needs for welfare assistance, medical care, prisons, and all of the other programs that drain our tax dollars are compelling. However, by choosing to meet these needs with resources taken away from our system of public education rather than through reforms in our tax structure or political system, we have in reality mortgaged our future by withdrawing the educational opportunities from our youth. We seem to have forgotten the commitments that past generations of citizens have made to build educational institutions of exceptional quality -- institutions that have provided many of us for years with unsurpassed educational opportunities. We simply must re-establish the importance of both our personal and public investments in education, in the future of our children, in our own future, at the local level if Michigan -- indeed, if our nation -- is to face the challenge of the age of knowledge.

Transition

Undergraduate Education
Michigan is making a transition from
an industrial to a knowledge-based economy
What can we do in the near term to sustain our
investments in key resources until
the new economy builds strength
We need to form a partnership...
universities
states
parents
all making sacrifices and commitments
UM is willing to take responsibility for our role
...producing better graduates
...better linkages to the private sector
But we ask that the state and parents do the same.

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 gathering 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 Challenge to Us All...

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 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...
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