Grand Rapids Economics Club

Introduction

It's always great to visit Grand Rapids...
I must confess that in many ways we
tend to think of your city and ours
as sister cities.

In a very real sense your community is
characterized by an economic vitality
and quality of life which is the envy of
all of Michigan...

But, like the rest of Michigan...and indeed
our nation, you face a serious challenge
these days--the challenge of developing
a strategy to sustain prosperity in the face
of intense international competition and
rapid technological change.

And it is this challenge that I would like to
focus on in my remarks today...the
challenge of dramatic economic change,
being drive in large measure by technology...

Of course, leaders of your community have
recognized this challenge for some time...
And you have embarked on an ambitious
plan to build in research and education
infrastructure in science and engineering
to sustain your prosperity.

In this, I would like to both commend you and
encourage you...as well as offer you
assistance where we can provide it...
and stay out of your hair when you need
to develop local capabilities.

My remarks today therefore will take on thehead 3 - broader perspective. Three years ago,
President
Reagan appointed me to membership on the
National Science Board, our
nation's principal body of science and
education policy.

In recent months the Board's deliberations have
been dominated by two growing concerns with
profound implications for long term
economic prosperity and security
of our nation:
i) Our serious underinvestment in civilian
research and development...
ii) The inability of our present educational
system to produce the human capital
necessary to respond to the challenge
of international competitiveness.

You will find that these themes--an inadequate
investment in people and ideas--run through
most of my remarks today...

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 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.

The Bad News of the past several years...

Familar Ills which dominate the headlines
The budget deficit
The trade deficit
A volatile Stock Market
Displaced workers
Marginal Industries

The bad news for Michigan is obvious...
Industries of great economic importance to our
nation such as steel and automobiles have
fallen victim to intense competition from abroad...
Plants have closed...many of our cities are filled with
cronically unemployed...
In Michigan we no longer worry about nuclear war and
and the bomb because we believe that
"The(odds are greater that America will be bought up by the
Japanese than blown up by the Russians..."

What is happening?
The world economy is now in control
.heyd 3 + However, it is misleading to blame all our ills on
international competitiveness alone!
We tend to blame all of our ills on international competitiveness...
Something else is happening...

The Challenge of Change

The challenge of dramatic economic change...
Traditional industry economy is shifu ng to a new
know edge-based economy, just as o˜r industrial
economy ewèlved from an agrarian society at the
turn of the century.
The days of low interest rates, limiu□d foreign competition,
slow-moving technol;gy, stable markets, and mass production
processes that once allowed our,industries to thrive in a
sheltered environment have long since passed.
This change has gripped the Rust Belt...
A transition is occurring in which..
Intellectual capital has replaced
financial and physical capital as key to economic development
The challenge today is to deve op an agenda to achieve and
sustain prosperity in a new environment of intense
international competition and rapid technological change.

Some examples:
Industrial production is steadily switching away from
material and labor intensive products and processes
to knowledge intensive processes:
In a car, 40% materials, 25% labor...
In a chip, 1% materials, 10% labor, 70% knowledge!!!
Increasing manufacturing production has come to mean
decreasing blue collar employment!
In the 1920s, 1 of 3 was a blue-collar worker
today 1 in 6 and dropping fast
probably to about 1 in 20 within a couple of decades...

In all developed countries, "knowledge" workers have already
become the center of gravity of the labor force.
As Erich Bloch, Director of the National Science Foundation
puts it, we have entered a new age, an "Age of
Knowledge in a Global Economy"

The Age of Knowledge in a Global Economy

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

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

Technological innovation, achieved by applying new knowledge created through basic research, has been responsible for nearly halp of all US productiw ty gains since WWII

At another level, technolm□ies of transportation and communication make possible an integrated economy.

Tremendous new industries have been created by new technical knowledge: electronics is the obvious example of the last three decades; biotechnology may be the example for t»e coming three decades.

These industries depend on knowledge as the most critical resource.

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

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

By contrast, the knowledge revolution is happening worldwide

.heqd 3 - and at a very rapid ryte.

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

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

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

Example:

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

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

Clouds on the Horizon

WARNING SIGN 1: America is slipping

No question that US has lost lead in many areas

Industrial productivity and heavy manufacturing

Steel, durable goods, ...

Energy

Electronics

Also serious signs that lead is slipping rapidly in

Computers

Aerospace

Moreover, key activities such as product design, engineering, and software development increasingly are likely to be done overseas.

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

WARNING SIGN 2: 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. We are now far behind Japan and Germany in the fraction of GNP invested in R&D.

- 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)

WARNING SIGN 3: S&E Manpower Shortage

- US faces a S&E manpower crisis of unprecedented proportions
  0. Indeed, today the United States awards the smallest proportion of university degrees in science and engineering of any industrialized nation!
  1. Proportion of graduating seniors who major in science and engineering is smaller today that it was in 1970s (5%). Particularly severe drops in physical sciences and mathematics. (Fallen by 40% over past decade)
  2. Per capita production of US engineers lowest among industrialized nations:
     - US: 72,000 (3%)
     - Japan: 85,000 (21%)
     - USSR: 300,000 (35%)
       - Japan has doubled its technical workforce in past decade...
         - 7 of 1,000 American students receive engineering degrees
         - 40 of 1,000 Japanese -- indeed, Japan with less than half the population is producing far more scientists and engineers!
     - President of Sony:
       - "In US you produce 4 lawyers for every engineer. In Japan, we graduate 4 engineers for every lawyer!"
  3. More than 60% of engineering PhDs are now foreign
     - Indeed, foreign students account for nearly 85% of growth.
     - It is bad policy to be dependent on an unpredectable resource and not to be able to meet more of our needs with American tealent.
- But things are going to get MUCH rougher: NSF Study
  - 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
  - Supply will probably fall off dramatically
    - 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),
        - there will be a cumulative shortfall of 700,000 by 2010!
  - Note: Compositionof college age population is also changing...
    - By 2020 30% will be composed of Blacks and hispanics...
      - students who have not traditionally chosen S&E careers.
    - 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.
    - Indeed, while Blacks and Hispanics account for 20% of total population, they account for less than 2% of scientists and engineers!
    - NOTE: We must make special efforts to expand participation by these groups...not just because that is good social policy, but because we cannot afford to waste their talents!

WARNING SIGN 4: Technological Illiteracy

- We really haven't appreciated impact of technology.
  - Today we are witnessing an unprecedented explosion of

knowledge.
Technology doubles every 5 years in some fields!
Graduates are obsolete by the time they graduate!
Technological change is a permanent feature of our environment
Examples of just the past few months:
i) hole in the ozone layer over Antarctica
ii) new supernova in the heavens
iii) new high temperature superconductor
iv) a new theory suggesting that all mater is composed of infinitesimal "superstrings" rather than point particles

Yet, at the same time public ignorance is extraordinary!
A recent NSF survey indicated that only 18% of those asked said they knew how a telephone works -- and only half of these gave the right answer.
Yet more than half of those survyed indicated they believed we were being visited by aliens from outer space!

And yet, our education system has not responded...
Note: it is bad enough that...
10% of Americans are illiterate
25% now fail to complete high school
Incredible that students can graduate from high school without a solid education in science & math -- or can complete college without such coursework.
More than half of all our high school graduates have not had even one year of science.
Math: Only 1 out of 100,000 high school students study calculus...and then for only part of a year
Five million Soviet high schools students receive a full two years!
Physics: Few US students will ever take a physics course. In fact, only one out of four American high schools even offer a course in physics!
In Europe, teaching of physics as a separate subject begins as early as 6th grade (also in USSR)
Student planning on majoring in physics will have had 6 years -- more than 500 class hours
Non-science major will have had 3 years
Face it, gang:
The tragedy is not simply our poor showing relative to other nations.
We are condemning an entire generation to a lifelong estrangement from the very technology that will inevitably govern their lives.

SOME FINAL 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
But, we have already noted that in the age of knowledge that is our future, knowledge workers will rapidly replace low-skilled or semi-skilled labor as the cornerstone of our workforce...
Yet, there is little sign that our education system is preparing to respond to this future.
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!

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

A National Response

What is to be done?

Tax, 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 ideas -- 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 Reagan 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...

Blessed with leaders in both the public and private sector--that have recognized the challenge, had the vision to develop a forward-looking strategy, 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"

The Role of Higher Education

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

Why?:

Through research produce the new knowledge necessary for economic development

Produce the trained professionals capable of applying

- this knowledge
- Attract "risk capital" through massive federal R&D support
- Key to knowledge transfer
  - Traditional: graduates, publications
  - Entrepreneurs
  - Startups
- Development of Unique State-University Partnership
  - State government committed itself to:
    - Establishing higher education as a high priority
    - Providing seed resources to sustain key thrust areas
    - Developing novel institutions to act as catalysts in these activites
  - Michigan's colleges and 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...
    - Developing new mechanisms for cooperation and collaboration among institutions

University of Michigan Actions:

- Key:
  - Began to think and act strategically...how to better position ourselves
- Recognition:
  - Michigan is where our nation makes things...
  - Cars, refrigerators, furrniture...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 taht 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 galium arsenide.
  - Information Technology
    - CITI -- The Center for Information Technology Integration, essentially

a skunkworks operation exploring the forefront of modern computer telecommuncations with several fo the leading companies in the nation. The U of M itself has become the laboratory, the "test bed", for this exciting venture.

First Steps

1. Recruiting key engineers and scientists
   E.g., over 150 new engineering faculty in past five years...NSF believes we have now assembled the strongest manufacturing group in the nation
2. Modifying ways we interact with outside world...
   Strengthened interactions with industy
   Forming new alliances with other academic institutions, both in Michigan and throughout the nation and the world...
3. Intellectual property policies

Cultural Changes

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

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

Already clear evidence of payoff...

Already clear evidence of payoff...

1. Semiconductor Research Corporation
   Center of Excellence in Electronics Manufacturing
2. DOD URI Center of Excellence
   UM captured the lions share: $20 M
   Governor's dedication of the most sophisticated solid state electronics laboratory in the nation... focused on optoelectronics -- the fusion of electronics and optics...
3. National Center for Manufacturing Sciences
   $50 million per year
4. NASA Center for Space Commercialization
5. EXPRES
   UM is lead contractor, with Carnegie Mellon, Stanford, MIT, and Berkeley
6. National perspective:
   Last week, 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
   This week US N&WR will rank professional schools.
   UM Engineering has risen to 6th in the nation, behind only MIT, Stanford, Berkeley, Illinois, and Caltech...
   Hence, the investment is apparently paying off...

These are now rolling into our state on a regular bases every few months...

Indeed, within the next several weeks we hope to be able to announce yet another victory for

Michigan by winning a new contract which will have a profound impact on the entire state--Grand Rapids included!

Implications for Grand Rapids

Leaders of your business community have recognized the importance of knowledge-based resources such as education and R&D activities to the future prosperity of Grand Rapids and western Michigan.

Indeed, in 1985 your Batelle Study noted that if Grand Rapids expects to reach a position of economic strength in the 1990s and beyond, it must begin to develop a program of university-linked research and engineering/science education in the 1980s.

Your plans in this regard are ambitious:

i) to build local capabilities in offering advanced instruction in science and engineering through collaborations such as that between Grand Valley and Michigan State

ii) To develop a Grand Rapids Center for Research and Technology, drawing together local industry and educational institutions

iii) To work with other local and nearby institutions to develop capabilities in applied technology

We at UM would not only like to commend you for your vision in this effort, but encourage you to move ahead aggressively.

Yet there may be something else that we at the University can do to help you in your quest.

It is the case that Grand Rapids, just as the State of Michigan--and indeed, our nation--cannot develop such capacity in isolation...

In the intensely competitive world in which excellence has become the key to economic success, just being good is not longer adequate. One just strive to be the best.

And, in that regard, it is appropriate to whether Grand Rapids can draw on the resources of other knowledge resources -- not simply from programs such as those at the University of Michigan, other world-class institutions throughout our nation and the world.

Outreach...

Fortunately, technology may be able to come to the rescue.

For years, we have attempted to work with your community to provide instruction and assistance in engineering and technology.

But, in the end, it just becomes too difficult to put our faculty on the road...

As the Batelle study pointed out, Grand Rapids needs local resources to meet your needs...

Yet, building the world-class resources necessary to attract the outstanding talent and massive federal resources necessary to really be competitive takes both time and effort...

I think of the comment of President Lowell of Harvard, when asked one time what it takes to build a great university, and who responded: "300 years"

So we at Michigan have turned our attention to other mechanisms to assist your community and your local institutions in achieving your goals.

How can we deliver to you the incredible resources
that have been developed at our state's
premier research institutions over many decades?

1. Michigan Information Technology Network
   - A number of Michigan's universities are building
     a state-wide satellite-based television
     network for transmission of instruction,
     technical seminars, etc. to any point in
     the state
   - Model: National Technological University
   - Key component: MERIT
2. MERIT
   - MERIT is computer network that links our
     institutions together...
3. EXPRES Project
4. Merit--NSFnet...
   - Interstate Highway System of information
     exchange
5. Collaboration Technology

Theme: Cooperation and Coordination...

- We are the University want to help...encourage...
  and assist in ways that are appropriate to
  our capabilities and your needs...

UM's Commitment

As you may be aware, this year the State
of Michigan is celebrating its 150th birthday,
its Sesquicentennial...

The University of Michigan is also celebrating
its 150th year in Ann Arbor.

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

Generation after generation of Michigan citizens
have reaffirmed their commitment to provide in
the University 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 enabled 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.

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.

It is rapidly becoming apparent that America's great research universities, as the primary sources of new knowledge and those who can apply it, will hold the key to our collective prosperity and well-being in the age of knowledge that is our future.

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

And, I can assure you that the University is committed to working with your community--in whatever way is appropriate, to assist you in providing locally the knowledge-based resources so essential for your future prosperity.

Concluding Remarks

Grand Rapids faces the challenge of the age of knowledge...just as our state, our nation, and the world.

But, unlike many regions, you are moving aggressively ahead to respond to this challenge.

I commend you for your vision...

I **encourage** you in your actions...

and, speaking for the University...

I **assure** you that we are ready, willing, and able to help in any way that we can...