

Educating for a World of Change

Why Graduate Education?

After all...

Starting salaries for BS Engineers are so tempting...

Furthermore, if I'm going to invest the time and effort in continuing my studies, why not go into another profession:

- i) law
- ii) medicine
- iii) MBA
- iv) investment banking..

Beside, don't graduate degrees just narrow your options...

e.g., confine you to R&D activities?

And how could I ever afford it...even if I wanted to continue my studies.

already

And how could I stand it...just as the end of the tunnel of an engineering education is in sight, I need to get out into the real world...

The Other Side of the Coin...

Premise: Students of your ability have a serious obligation to at least consider further graduate study.

Why?

1. You are not going to be challenged by the types of jobs available to BS graduates. You should seek further education.
2. The M.S. is the entry degree into the profession (not the B.S.)
3. Graduate education opens up doors and opportunities...
 - i) Pecking order phenomenon...
PhDs > MSs > BSs
 - ii) PhDs do everything...not just research
4. Totally different style of education...
Achieve the critical mass of knowledge necessary to learn on your own...
No longer parent-child...but peer-to-peer
5. Ample sources of financial aid, so you generally can obtain full support...you won't live like royalty, but you won't starve either
6. You owe it to your country to consider the possibility of further graduate studies.

The Bad News of the past several years...

Familiar Ills which dominate the headlines

The budget deficit

The trade deficit

Displaced workers

Marginal Industries

The bad news for Michigan is obvious...

Industries of great economic importance to our nation such as steel and automobiles have fallen victim to intense competition from abroad...

Plants have closed...our cities are filled with cronicly unemployed...

In Michigan we no longer worry about nuclear war and the bomb because we believe that

"The odds are greater that America will be bought up by the Japanese than blown up by the Russians..."

What is happening?

The world economy is now in control

However, it is misleading to blame all our ills on international competitiveness alone!

Something else is happening...

The Challenge of Change

The challenge of dramatic economic change...

Traditional industry economy is shifting to a new knowledge-based economy, just as our industrial economy evolved from an agrarian society at the turn of the century.

A transition is occurring in which..

Intellectual capital has replaced financial and physical capital as key to economic development

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 10 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 half of all US productivity gains since WWII

At another level, technologies 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 the coming three decades.

These industries depend on knowledge as the most critical resource.

But knowledge 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 and at a very rapid rate.

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

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

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

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.

The handwriting is on the wall...

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

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 likelihood 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 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%)

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 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

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: Composition of 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 matter 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 surveyed indicated they
believed we were being visited by aliens from outer
space!

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

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!

So what can you do about this?

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obligation to at least consider further graduate study.

Why?

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2. The M.S. is the entry degree into the profession (not the B.S.)
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Summary:

You owe it to your country...

You owe it to yourself...