Educating for a World of Technological Change

Introduction

- Tremendous hype surrounding "high tech"
  - robotics, the chip, computers, genetic engineering
  - Visions of Silicon Valley dance in our head...
- A major resurgence of interesting in science and technology
  - Almost akin to Sputnik era
  - But now focussed on industrial competitiveness and military security (Star Wars)
- Since I have been immersed in this technology for many years, it seemed appropriate to make several comments about its implication for your business: education

Background

- First, a couple of comments to introduce my background
- Engineer -- rather, applied scientist
  - Participating and observing technological change
    - Nuclear rockets, lasers, fusion
    - Computers
    - Robotics, machine intelligence, expert systems
- Dean
  - Demand for scientists and engineers
  - Demand on part of best H.S. students
- National policy -- NSB
  - Concerns about K-12 education
    - Science and Engineering Education Directorate
    - Education and Human Resources Committee

The Glamor of High Tech = New Technology

- Society --> love-hate relationship with technology
  - Early 60s: Sputnik era -- space program
  - 1970s: environmental movement, Vietnam
    - distrust of technology
  - Today: strong signs that technology is in vogue again
    - Economic competitiveness
    - National Security
    - The Information Age
- EXAMPLE 1: Demand for engineers
  - Through good times and bad, mobs of recruiters still crowd our placement center.
  - 80% of all job interviews at UM for engineers
  - Starting salaries: $30 K +
  - Many offers for each graduate
  - All national studies indicate shortage of engineers
- EXAMPLE 2: Demand for admission to engineering programs
  - For past decade, student interest has grown steadily
    - At UM we are forced to limit admissions
    - 4,000 applications for 800 positions

SATs: 1280, GPAs: 3.8
25% are straight 4.0 students

EXAMPLE 3: Reawakening of public interest in science
New magazines and TV programs --
"golly-gee-whiz-bang" style of science
Media attention to areas like robotics, computers
NYT article
John Naisbett
Impact of personal computer -- telecommunications
Even the counterculture types of the 60s have now traded in organic gardening of lettuce for Apples -- rather, Macintoshes!

But, if we look beneath the hype, we see danger signs!!

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, autos, ...
Energy (particularly nuclear)
Electronics
Also serious signs that lead is slipping rapidly in
Computers
Aerospace

WARNING SIGN 2: S&E Manpower Shortage
US faces a S&E manpower crisis of unprecedented proportions
Some examples:
Per capita production of US engineers lowest among industrialized nations:
US: 72,000 (3%)
Japan: 85,000 (21%)
USSR: 300,000 (35%)
President of Sony:
"In US you produce 4 lawyers for every engineer. In Japan, we graduate 4 engineers for every lawyer!"
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!

WARNING SIGN 3: THE IMPACT OF TECHNOLOGY

We really haven't appreciated impact of technology.

Example:

Technology doubles every 5 years in some fields!

Graduates are obsolete by the time they graduate!

Engineers must factor change into their career objectives.

Change is a permanent feature of our environment

Traditionally, engineer stayed in same general area.

However now engineers will have to change areas frequently.

Continuing education will be an absolute necessity.

Example: IMPACT OF THE COMPUTER

Computer is a "lever" for the mind

Now improves both the productivity and intellectual span

CAD, CAM, CIM, CEP --> CAE

Obvious implications

Integrate ("saturate") curriculum

Take advantage of enhanced productivity

Unlease student's creativity

Not so obvious, but more profound implications

Computer has changed engineering practice

No longer: design-analysis-production-manufacturing...

Now one engineer spans all

Hence we demand a generalist -- not a specialist

Computer has provided powerful analysis tools

No longer does engineer pick a design and spend days analyzing it

Instead, can explore many designs -- let computer do dog work

Reemphasizes creativity over analysis -- science back to art

Right to left side of brain

WARNING SIGN 4: Technological Illiteracy

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

Some examples:

How many of you recognize the follow terms

expert systems, polymeric composites,

lattice guage theory, recursive procedures,

CAE, CIP, FMS, CCC,...
Modern tools of professional
CAD, CAM, CAE
Modern workstations
Expert Systems and Knowledge Engineering
Examine education system:
Incredible that students can graduate from high school without a solid education in science & math -- or can complete college without such coursework.
80% of hs graduates --> 1 course in physical science
Another example: K-12 education in physics
In US, one year for a few...
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:
We are condemning an entire generation to a lifelong estrangement from the very technology that will inevitably govern their lives.
Already see danger signs: misunderstanding of science
Pop or psuedo-science:
astrology, health fads, parapsychology
Nonsense surrounding nuclear power, genetic engineering, hazardous waste disposal, smoking
WARNING SIGN 5: Labor force of Michigan is becoming obsolete!
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!
It is bad enough to face the prospet 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?

Possible Responses

- Investments
  - For some reason, education is always at the bottom of the list of social services (usually dominated by health concerns) -- perhaps an aging electorate!
  - There seems little doubt that we are underinvesting in our children...we are simply not willing to provide them with the same opportunities that we ourselves have benefited from.
  - Some signs:
    - Michigan is a state with one of the highest per capita incomes in thenation. Yet it has slipped to the bottom (45th) in its level of state support per student in higher education
    - How many parents are willing to make the sacrifices these days to pay for a first class education for their children? Few families save toward a college education anymore -- whether because of an unrealistic expectation of public support or simply a preference for expensive vacations, cars, or snowmobiles.
    - I am sure that each of you has seen the erosion in public support of millages -- of your schools
- Some Structural Problems with our Education System
  - Structure of science & math instruction
    - The problems with tracking and stereotypes
      - We set up an obstacle course with AC and AP
      - Very few survive
      - We don't seem to recognize different rates of intellectual maturation
    - Should broaden out the paths into S&E education
    - And we should require ALL students to continue with some form of science and mathematics in ALL of their years of education.
  - Content of science & math instruction
    - Broadening the base of S&M instruction
      - Eliminate undergraduate B.S. Education
      - Allow graduates with B.S. in math, science,... engineering...even practicing engineers and scientists...to easily obtain the credentials necessary for instruction!
      - Make more use of visiting instructors from industry!
  - The importance of a liberal education
- Need for a reawakening of interest
  - Background
    - National leadership

For most of this century our nation has maintained world leadership in science and technolology.

In a sense it has been this fact, more than any other, which has led to the standard of living we now enjoy -- which has provided both the means and opportunity to free us from drugery -- which has built the America we know today.

Slipping behind

And yet, today for the first time in many decades, this nation stands on the verge of losing its world leadership in science and technology to other nations. A glance at the rapid growth of science and technology in nations such as Japan, France, and the Soviet Union provides ample testimony to this alarming situation.

Why are we losing leadership

Have our colleges and universities lost the ability to provide the quality of education in science and technology necessary for world leadership? I think not. The enormous number of foreign students attending American universities from those very nations that are passing us in science and technology give evidence to this.

Perhaps it is due to short-sighted government policies. To be sure, the federal government seems to have lost it enthusiasm for the support of science and technology, while this state has certainly lost its capacity to support higher education -- at least at the level that built distiniguished universities such as Michigan. But this still doesn't explain the situation.

Key Factor

Rather I would suggest a more fundamental factor. I believe that for the past decade or more the best of our students have bypassed careers in science (or perhaps have been persuaded to pbypass these careers) in favor of other professions such as business, law, medicine, and so on.

The simple fact of the matter is that unlike the 1950s when the best of our students chose careers in science and engineering, over the past decade few have done so.

But, whatever the reason, it is certainly true that this nation needs a reawakening of interest in science and engineering among our best students.