Education and Research in Engineering
- How are we doing in a rapidly changing world-

Taylan Altan, Professor & Director, altan.1@osu.edu

Engineering Research Center for Net Shape Manufacturing
ERC/NSM
www.ercnsm.org

Taylan Altan - Background

- Born in Turkey / French High School
- Diploma Engineer (MS) – Mechanical Engineering / Manufacturing Technical University Hannover, Germany, 1962
- MS and PhD - Mechanical Engineering – University of California at Berkeley, 1964 and 1966
- 1966-68 – DuPont, Research Scientist
- 1968-86 – Battelle Columbus Labs, Research Scientist/Sr. Research Leader
- 1986 – present – The Ohio State University

Objectives

- Reality Check – Comparison with other countries / Competition
- International alternatives in Engineering Education and Research
- What can we do individually and as an institution (if we select to do so)
- Interactive presentation and discussion
- Are statements made in this presentation correct?
- Questions

Outline

- General Observations
- Engineering Education in U.S. and Germany (Sweden, Switzerland, Austria, Holland)
- What U.S. Engineering Education System Can Learn From Others?
- What Can I Do (undergraduate/MS/PhD student) for my Future?

General Observations

- In engineering (education/production) competition from developed and developing countries is intense and will continue to increase
- Low wage countries (Eastern Europe, South East Asia) represent formidable competition (access to capital and technology, government subsidies, well-trained manpower); examples, METU, Shanghai Jia Tong, Singapore + others
- Global competition for well paid jobs will continue to increase

General Observations

- In U.S. and Japan, most professors who teach engineering do not have industry experience. In Germany nearly all engineering professors have industry experience
- Both in Germany (Sweden, Switzerland, Austria) and Japan, there is excellent infra-structure for cooperation between engineering schools and industry

General Observations

The U.S. has some advantages compared to other nations because:

- English (and to some extent the U.S. culture) is accepted for global communication in business, science & technology
- the U.S. has the largest market for engineered products (cars, aircraft, household goods, etc.)
- the U.S. offers flexibility in business culture and a social infra-structure that (still) encourages immigration of well-trained engineering manpower

Education/Technology/Income (1/3)
N.Y. Times 4/20/08 – Business Section

Shift in Income in the U.S.

0.01% of the Population Received:

- 0.87% of Total National Income in 1980
- 3.89% of Total National Income in 2006

Education/Technology/Income (2/3)

Over the last several decades, technology kept up its pace (continued to grow), while educational advancement has slowed down.

- Workers born in 1950 had (on average) 4.67 years more schooling than those born in 1900 (0.93 year per decade)
- Workers born in 1975 had 0.74 years more schooling than those born in 1950 (0.3 year per decade)

Education/Technology/Income (3/3)

- In 1980 each year of college raised a person's wage by 7.6%
- In 2005, the corresponding wage increase was 1.29%
- The rate of return from each year of graduate school has risen from 7.3% to 14.2%
- The incomes of super rich, however, can not be explained by education alone

General Observations

The Myth of “Best in the World”
Sharon Begby, Newsweek, March 31, 2008, p. 47

- In a Harvard survey, 55% of Americans said U.S. Health Care is the best in the world
- In Infant Mortality, U.S. is 28th in the world (after Portugal, Greece and many others)
- In 1997 in U.S. health care costs were $6,697 per capita (twice the average of 30 wealthy countries in OECD)
- Insurance is tied to employment (switch employers, switch doctors, quality of care suffers)

General Observations

Secondary Education (2003) – Source OECD

Mean 15 year old performance – Math scores

Finland	545
Korea	540
Netherlands	537
Japan	535
Canada	530
Britain	527
New Zealand	523
Sweden	510
U.S.	485

General Observations

Exports in the World (2006)

- Germany 9.4%, China 8.1%, U.S. 8.6% (today China is the largest exporter)
- Exports are based on innovation in machinery + software + chemicals (1/3 from products less than 3 years old)

Annual Trade Deficits (-) and Surplus (+) – Merchandise trade only (The Economist – Jan. 23, 2010)

- U.S. -$518 billion / Japan +$34 / China + 196 / Britain -$126 / Germany + $182 / Switzerland +$18 / Singapore +$24

General Observations

"The world's best engineering education system is in the U.S."

- True? / False?
- True and False?
- Unfair question: "if we are so smart how come we are not so rich". (is it smart to assume we are the best?)

Engineering Education
U.S. (Germany)

Engineering Faculty Professors

• Assistant/Associate/Full	(Full only)
• Industry Experience – not common	(Usual)
• Promotion/Tenure - needs publications/funding	(automatic)
• Position/Support – no Chair or Institute	(Chair/Institute)

Engineering Education
U.S. (Germany)

Engineering Students (Undergraduate)

• High School Graduates	(?)
(only 10-12% has background for engineering	
• Cost of Education - $25k to $40k/yr	(about $1.5k/yr)
• Practical Training – some co-op	(Praktikum 6-12 months)
• University Engineering Employment - little	(encouraged/50+%) (Univ Aachen)

Engineering Education U.S. (Germany)

Engineering Students – International

- Undergraduate – 10-15% (about 10%)
- Graduate School – about 50%-75% of PhD's (Dr. Ing – 5-10%)
- Foreign nationals graduating from U.S. universities receive 12 months training visa (smart move) (no special arrangement)

Educational Structure

- The University System – BS/MS/PhD degrees / engineering technology programs / community (2 year) colleges (Tech. Univ/ Univ of Applied Science)
- Engineering within University – most engineering schools are part of a large university / exceptions are MIT, Caltech, RPI, IIT, etc. (Tech. Univ)
- Ranking of universities – very important in U.S. private universities (MIT, Stanford, Princeton, Yale, etc.) have more resources (endowments) but some public universities are also good (Berkeley, Michigan, etc.) (?)
- Science vs. engineering – in general U.S. engineering schools emphasize science of engineering (faculty interest, limited laboratory equipment) (?)
- Design and manufacturing – in U.S. often with Industrial Engineering, some project related learning, some faculty with industry experience (emphasis in Germany)

Educational Structure / Graduate School

- Entrance requires examination and good grades (less consideration of other factors, as in undergraduate school) (only Dr. Ing-No exam/ no courses)
- Foreign students have an advantage since they are better prepared for the entrance examination
- MS takes two years, some programs do not require a thesis but only course work (not desirable) (all Dipl. Ing.(MS) require projects and thesis)
- PhD takes two to four years after the MS, requires courses and dissertation, mostly theoretical topics (4 to 6 yrs +other work)
- Graduate schools attract the best students from all over the world (?)

Relevant R&D

- To make an impact engineering research must be relevant to the needs of industry and society
- The R&D expenditures in U.S. are more than those of Germany, Japan, England, France combined (a lot for defense and space)
- U.S. spends more resources on science than engineering (NSF, NIH)
- Universities encourage peer reviewed publications, rarely read and often isolated from the real world (72 percent of engineering papers were never cited – Science, Jan. 4, 1991)

What can be done

- select research topics, relevant to potential industrial applications
- participate in industry/government internships, coop programs and the like
- improve knowledge, not only in conventional engineering topics & research areas but also in ability to work in teams, knowledge of economics and cost related issues, good communication skills

Final Word

- “There is nothing more difficult to carry out nor more doubtful of success, than to initiate a new order of things. For the reformer has enemies in all those who profit from the status quo”. Machiavelli

- “We must continually expect the unexpected. We must strengthen the fundamentals for uncertain future”. Dr. Ng Eng Hen, Education Minister, Singapore, Jan. 2010