Globalization and Engineering

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The Globalization Reality

- U.S. businesses see tremendous opportunities abroad and will increasingly locate their operations closer to growth markets
- They will also outsource engineering jobs to reduce costs and move their research functions closer to their offshore development sites
- The long-term impact of this trend is not clear

What’s at Stake:

*Our standard of living and world economic leadership*
The Debate: Prescriptions for the U.S. to Keep its Global Edge

- **Improve K–12 science and mathematics education** – National Academy of Sciences
- **Graduate 100,000 more engineers and scientists** – Democratic Party Innovation Agenda, Nov 2005
- **Expand numbers of H1-B visas** – Craig Barrett, Scott McNealy, Bill Gates
- **Increase investment in basic research** – National Academies
The Debate: Supporting Arguments

- Last year more than 600,000 engineers graduated from institutions of higher education in China. In India, the figure was 350,000. In America, it was 70,000 – National Academies

- Last year China’s schools graduated more than 600,000 engineers and India’s schools produced 350,000, compared with 70,000 in America - The U.S. Department of Education

- In engineering, China’s graduates will number over 600,000, India’s 350,000, America’s only about 70,000…All those university graduates in China and India threaten U.S. living standards…- Fortune Magazine
Some Problems with the Prescriptions

- **Missing Facts:**
  
  Graduation statistics have no basis – same numbers in use since 2002

- **We don’t have that much time:**
  
  If K-12 was fixed today, it would take 10-15 years and the war would be lost

- **Curing the symptom rather than the disease:**
  
  Haphazard increases in graduation rates will lead to dropping salaries, unemployment and damage the profession

- **Misinformation:**
  
  H1-B’s are temporary worker visas – with the immigration backlog, the majority of these workers will have to return home and become our competitors

- **Money isn’t the only solution:**
  
  Will spending more on research without making commercialization more effective lead to more innovation and growth?
Duke Research Project 1: Graduation Rates

<table>
<thead>
<tr>
<th>Country</th>
<th>Graduates</th>
<th>What’s Included:</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>70,000</td>
<td>Only accredited 4-year engineering bachelors degrees</td>
</tr>
<tr>
<td>China</td>
<td>600,000</td>
<td>“short cycle” engineering degrees, inconsistent definition of &quot;engineer“, CS, IT and technician degrees (motor mechanics, etc)</td>
</tr>
<tr>
<td>India</td>
<td>350,000</td>
<td>2 year “diplomas”, CS and IT degrees</td>
</tr>
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**Problem:** We’re not comparing Apples to Apples
Actual Engineering, CS and IT Degrees Awarded in 2004

*China data are considered suspect – collection methods and definition of engineers are inconsistent*
2004 Engineering, CS and IT Degrees Awarded Per Capita

*China data are considered suspect – collection methods and definition of engineers are inconsistent
New Questions

- Are companies going offshore because of a U.S. skills shortage or a deficiency in U.S. workers?
- What are the relative strengths and weaknesses of U.S. engineering graduates vs. India/China?
- Do companies hire 2 or 3 year degree/diploma holders?
- How do U.S. engineering jobs compare with India/China?
- Where is this headed?

We surveyed 78 division representatives of 58 U.S. based companies involved in engineering outsourcing
Is There a Shortage of Engineers in the U.S.?

- Acceptance Rates:
  - 47% reported acceptance rates greater than 60%
  - 80% said acceptance rates had increased or stayed constant

- Signup Bonuses:
  - 88% offered no bonuses or to less than 20% of hires

- Time to Fill an Open position:
  - 80% said engineering jobs were filled within 4 months

In other words – No indication of a shortage
Duke Research Project 2: Offshoring Trends

Degree Requirements:

- The majority did not mandate that job candidates possess a four-year engineering degree.
- 44% hired engineers with 2 & 3 year degrees. Additional 17% would hire such applicants if they had additional training or experience.

*In other words – It’s not the education in India/China that is causing companies to locate there.*
Duke Research Project 2: Offshoring Trends

How do the Workforces Compare?

- Productivity -- 87% responses - U.S. workers more productive or equal
- Quality -- 98% said U.S. locations produced higher or equal quality
- Adequate to Large Supply of Well-Qualified Entry Level Workers:
  - India – 75%
  - U.S. - 59%
  - China - 54%
- Relative Advantages:
  - U.S. -- communication skills, understanding of U.S. industry, business acumen, education/training, proximity to work centers
  - China -- cost, willingness to work long hours
  - India -- cost, technical knowledge, English, strong work ethic

_in other words – we can’t blame American education, productivity or quality_
Why are companies going offshore?

In your offshoring endeavors, how much of an advantage, if any, has your company gained from the following? (1: No Advantage; 2: Slight Advantage; 3: Moderate Advantage; 4: Strong Advantage; 5: Significant Advantage)

- Salary or Personnel savings: 3.83
- Overhead savings: 3.06
- 24/7 continuous development cycle: 2.97
- Access to new markets: 2.89
- Cultural or geographic proximity to customers: 2.86
- Tax incentives & host government assistance: 2.52
- Co-location of design and production facilities: 2.32

In other words – It’s all about cost and markets
Where is this headed?

- 95% said outsourcing will continue and gain momentum
- Most said they would send a greater variety of jobs abroad including research and design
- Senior execs of India/China divisions of IBM, Microsoft, Oracle, GE, etc. expressed strong satisfaction with local operations and expected their units to increasingly provide R&D for worldwide operations

*In other words, we’ve got a lot to worry about*
More Questions

- Will the new R&D jobs being outsourced require more advanced degrees?
- How does the U.S. compare to India/China in the production of Masters and PhD’s?
- What has the trend been in degree production?

*In other words – Where is the U.S. edge?*
Duke Research Project 3: Trends, Masters and PhD degrees

Bachelors Degrees in Engineering, CS and IT

China numbers are suspect – inconsistent data collection, unrelated degrees. India/China numbers were revised slightly based on new data.
Masters Degrees in Engineering, CS and IT

China numbers are suspect – inconsistent data collection, unrelated degrees.
Duke Research Project 3: Trends, Masters and PhD degrees

PhD’s in Engineering, CS and IT

Academic Year

Graduates

US (Engr/Tech)

China (Engr/Tech)

India (Engr/Tech)
Duke Research Project 3: Trends, Masters and PhD degrees

U.S. Engineering Degrees Earned by Foreign Nationals

Houston, we’ve got another problem
Some American Advantages:

- Entrepreneurship
- Innovation
- Education/university research
- Immigrants -- “the melting pot”
- Democracy/freedom/legal system

We decided to study the role of skilled immigrants

- Called 2054 engineering and tech companies founded from 1995-2005
- Was the CEO or CTO a first-generation immigrant? From what country?
Duke Research Project 4: Our Advantages – Skilled Immigrants

- 25.3% had an immigrant as a key founder
- 2005 revenue -- $52 billion. Employed 450,000
- Indians founded 26% of these -- more than the next 4 groups combined
- Indians founded 47% of NJ immigrant startups, Hispanics are the dominant group in FL, Israelis in MA. Chinese tend to concentrate in CA.
- 52.4% of Silicon Valley startups founded by immigrants
- 24.2% of U.S. international patent applications in 2006 had contributions by foreign nationals (up from 7.3% in 1998). Chinese authored the most.
Immigrant Founded Companies by Industry

- **Semiconductors**: 35.2%
- **Computers / Communications**: 31.7%
- **Software**: 27.9%
- **Innovation / Manufacturing-Related Services**: 25.9%
- **Bioscience**: 20.1%
- **Environmental**: 9.2%
- **Defense / Aerospace**: 7.9%
- **All Industry Fields**: 25.3%

Percentage of Immigrant Key Founders
Duke Research Project 4: Our Advantages – Skilled Immigrants

Birthplace of Immigrant Founders

- India: 30%
- UK: 25%
- China: 5%
- Taiwan: 5%
- Japan: 5%
- Germany: 5%
- Korea: 5%
- Israel: 5%
- Canada: 5%
- Iran: 5%
Question: Why Are Immigrants So Successful?

Preliminary results from our next research - Project 5:

- 96% of immigrant company founders have bachelor's degrees or higher
- 70%+ have a Masters or PhD
- 71%+ have degrees in engineering, math or science related fields
- 55% obtained degrees in the U.S. and stayed after graduation

*Plus anecdotal evidence indicates that immigrants who come to the U.S. are risk takers and highly entrepreneurial*
Conclusions/Questions

In other words:

- *Let’s get our facts together and figure out how to keep research in the U.S.*
- *Facilitate higher education in science and engineering*
- *Encourage the best foreign students to stay*
- *Provide incentives for entrepreneurship and*
- *Compete on American strengths*