



Engineering and Science Myths

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How our half-baked national policies could be a “competitive blunder”

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The Globalization Reality

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- Globalization is the new reality:
 - U.S. businesses see tremendous opportunities abroad and will increasingly locate their operations closer to growth markets
 - They will also outsource research and development 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



Common Prescriptions for the U.S. to Keep its Edge

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- 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

***We blame the education system and prescribe nice remedies
.....but what's the disease?***



Most Common Arguments

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- *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
- *U.S. children rank below international averages on a test in general knowledge in mathematics and science* --National Academies
- *Tech companies going abroad because they can't find enough computer science applicants in the U.S....*-- Bill Gates and others

Do we have our facts straight?



Duke Research: Graduation Rates

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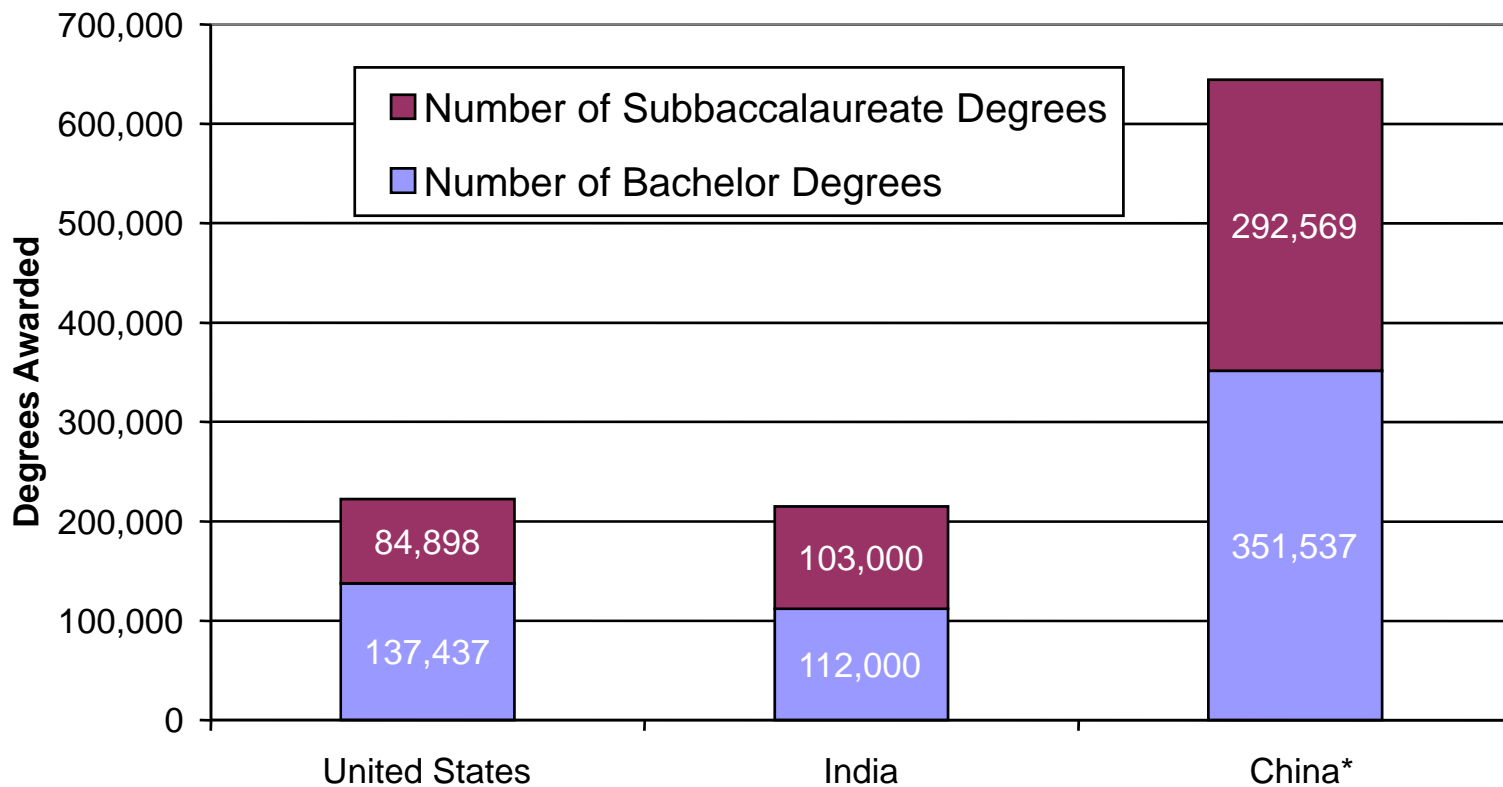
Country	Graduates	What's Included:
U.S.	70,000	Only accredited 4-year engineering bachelors degrees
China	600,000	“short cycle” engineering degrees, inconsistent definition of “engineer”, CS, IT and technician degrees (motor mechanics, etc)
India	350,000	2 year “diplomas”, CS and IT degrees

Problem: We're not comparing Apples with Apples



Actual Engineering, CS and IT Degrees Awarded in 2004

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



New Questions

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- 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



Offshoring Trends

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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 in U.S.



Where are the shortages?

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- Adequate to Large Supply of Well-Qualified Entry Level Workers:
 - India -- 75%
 - U.S. -- 59%
 - China -- 54%

No shortages in India, and greater supply in the U.S. than China??



Skills of Indians/Chinese vs. Americans

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- Productivity -- 87% said U.S. workers more productive or equal
- Quality -- 98% said U.S. locations produced higher or equal quality
- 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

***Americans are ahead in productivity, quality & market knowledge,
but Indian and Chinese workers cost less and work harder***



Do bachelor degrees even matter?

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Degree Requirements:

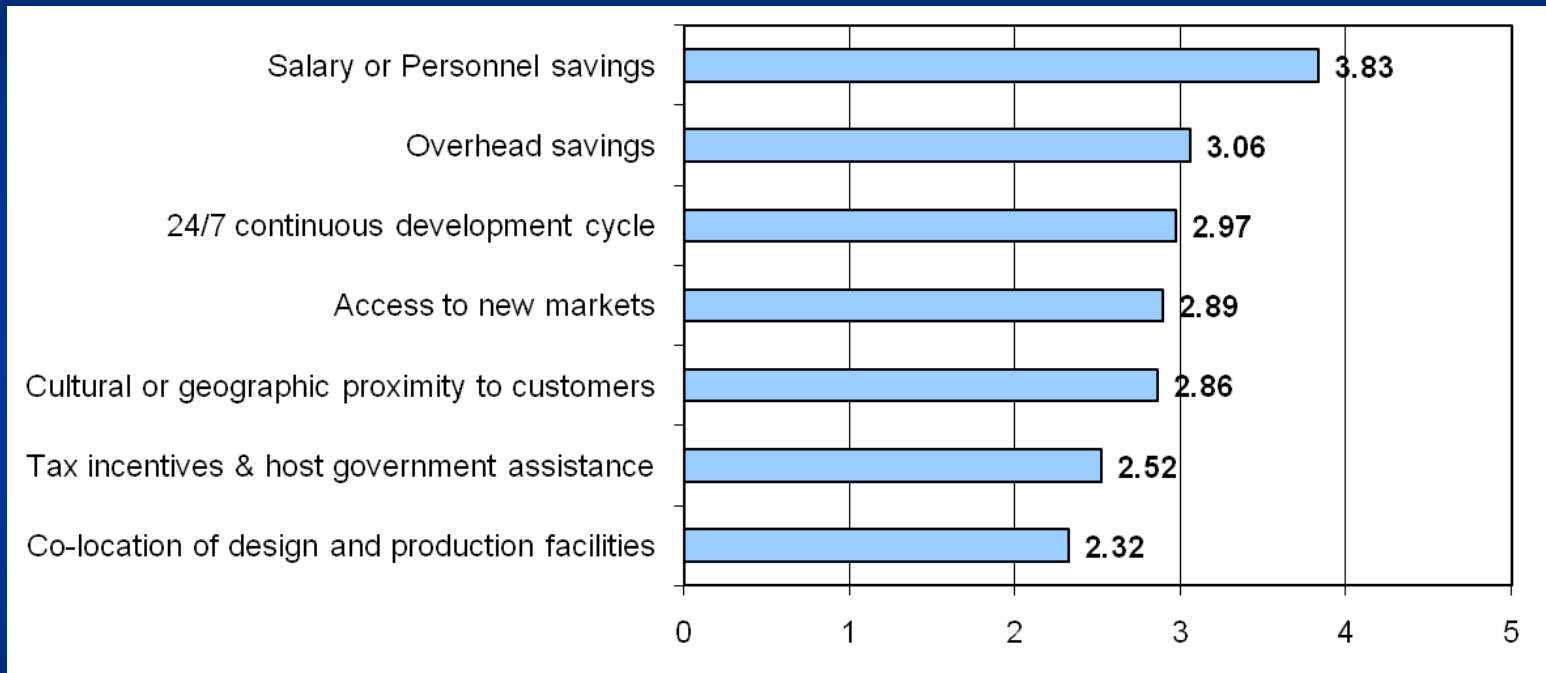
- 44% hired engineers with 2- & 3-year degrees. Additional 17% would hire such applicants if they had additional training or experience

Companies will make do with the best talent they can find and train employees as needed



Why are companies going offshore?

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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)

In other words, its all about cost and markets -- not the education level of Americans



Offshoring Trends

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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

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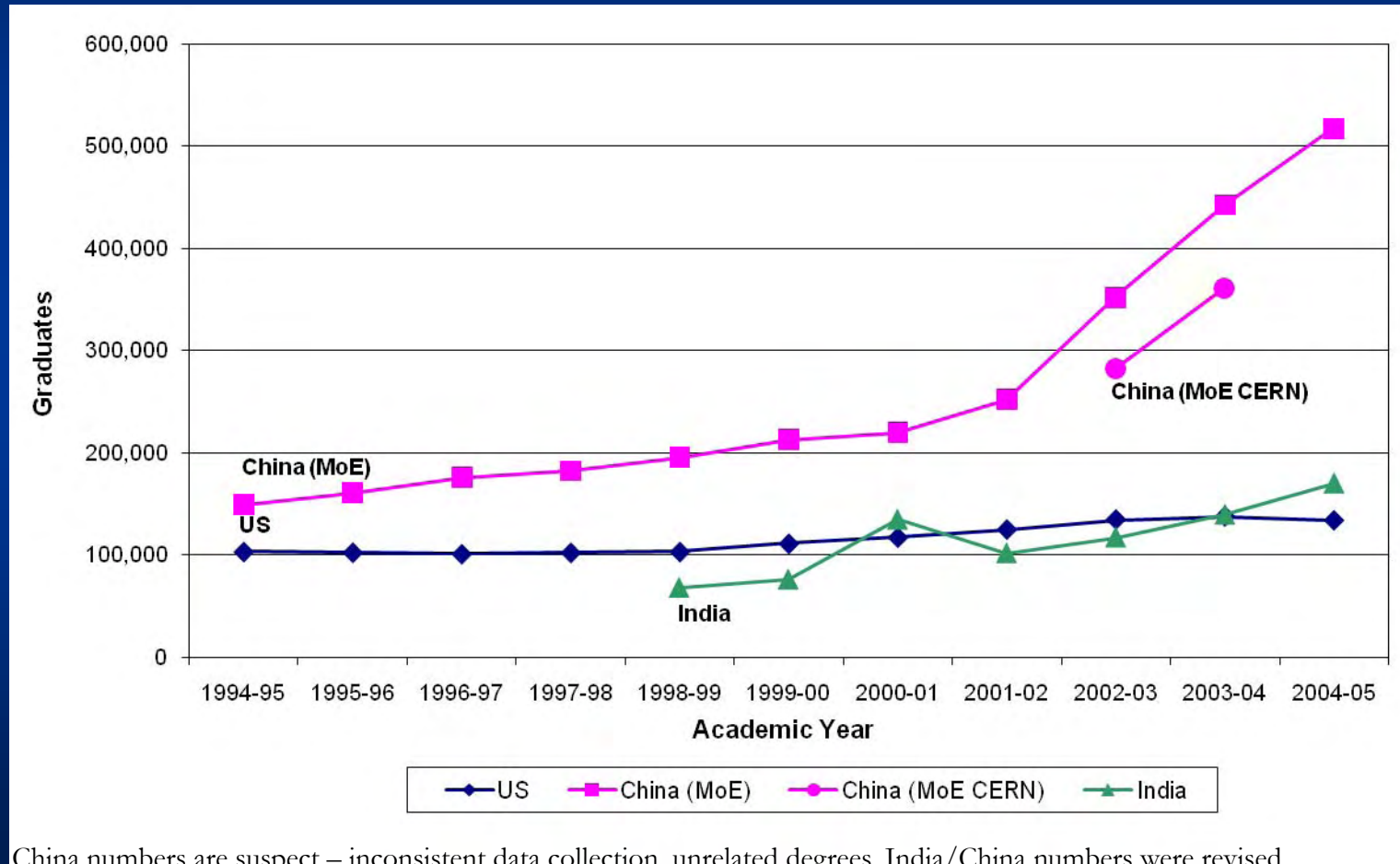
- Will the new R&D jobs being outsourced require more advanced degrees?
- How does the U.S. compare to India/China in the production of Masters and PhD's?
- What has the trend been in degree production?

In other words – Where is the U.S. edge?



Bachelor in Engineering, CS and IT

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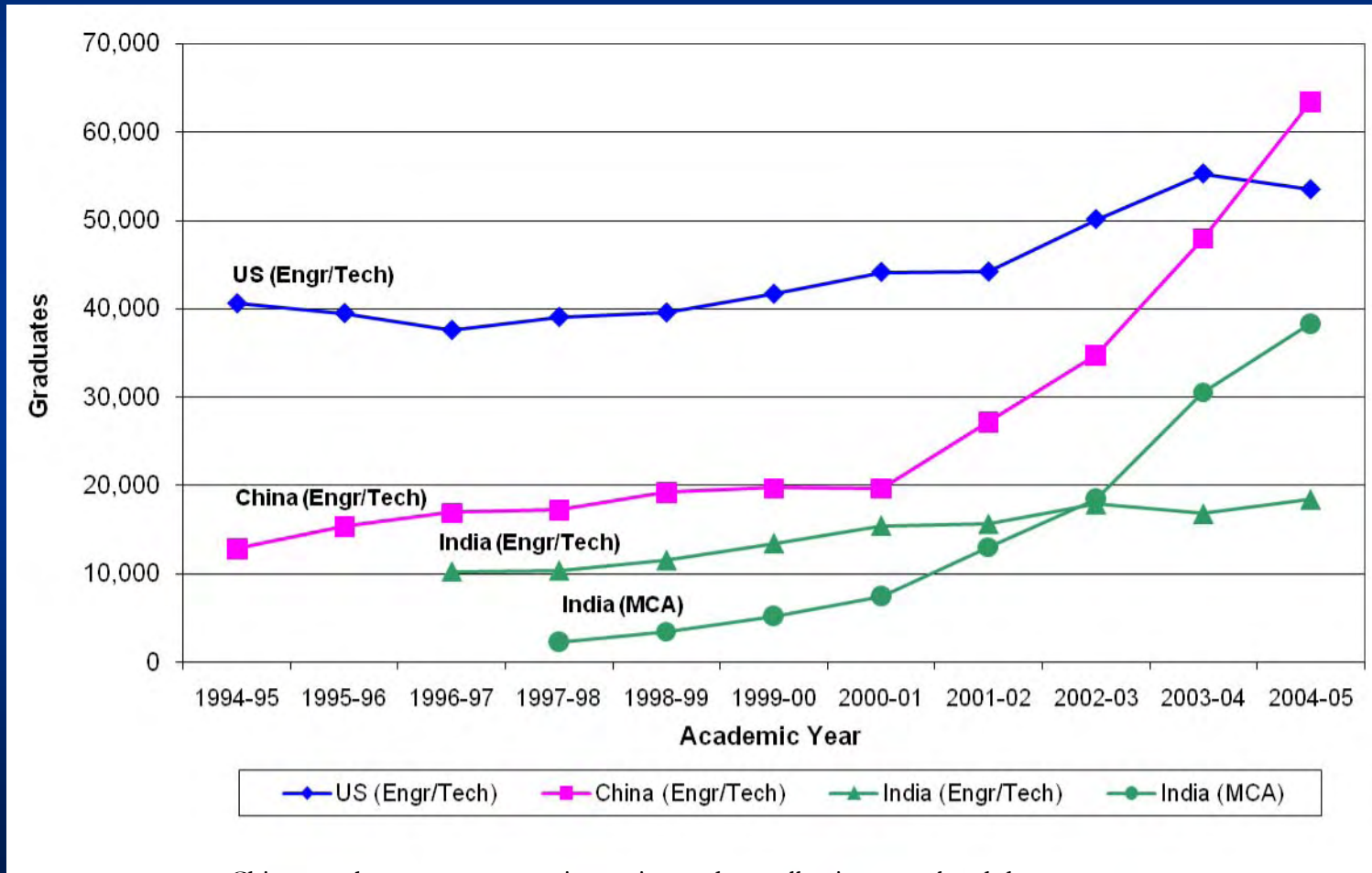


China numbers are suspect – inconsistent data collection, unrelated degrees. India/China numbers were revised slightly based on new data



Masters in Engineering, CS and IT

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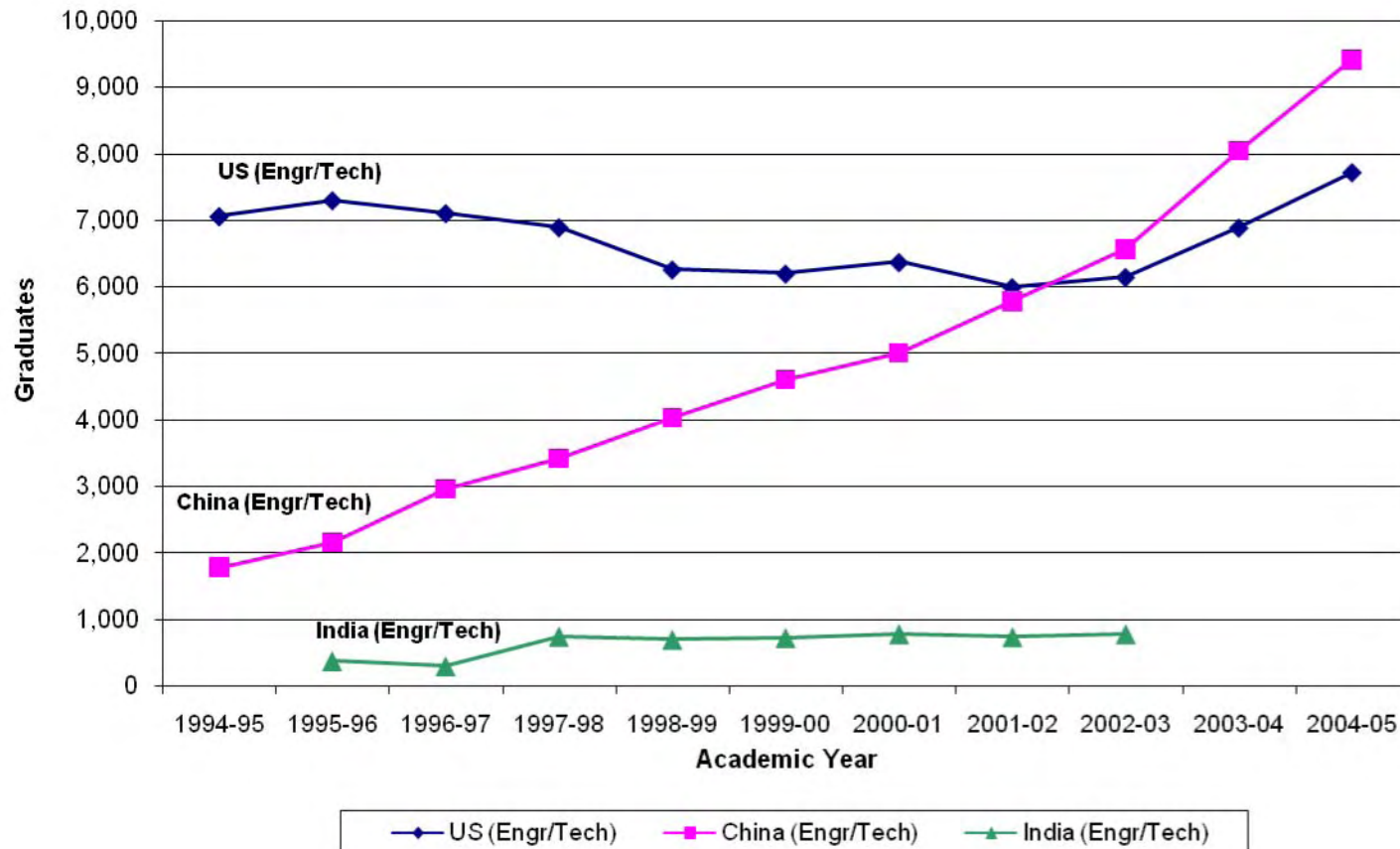


China numbers are suspect – inconsistent data collection, unrelated degrees.



PhD's in Engineering, CS and IT

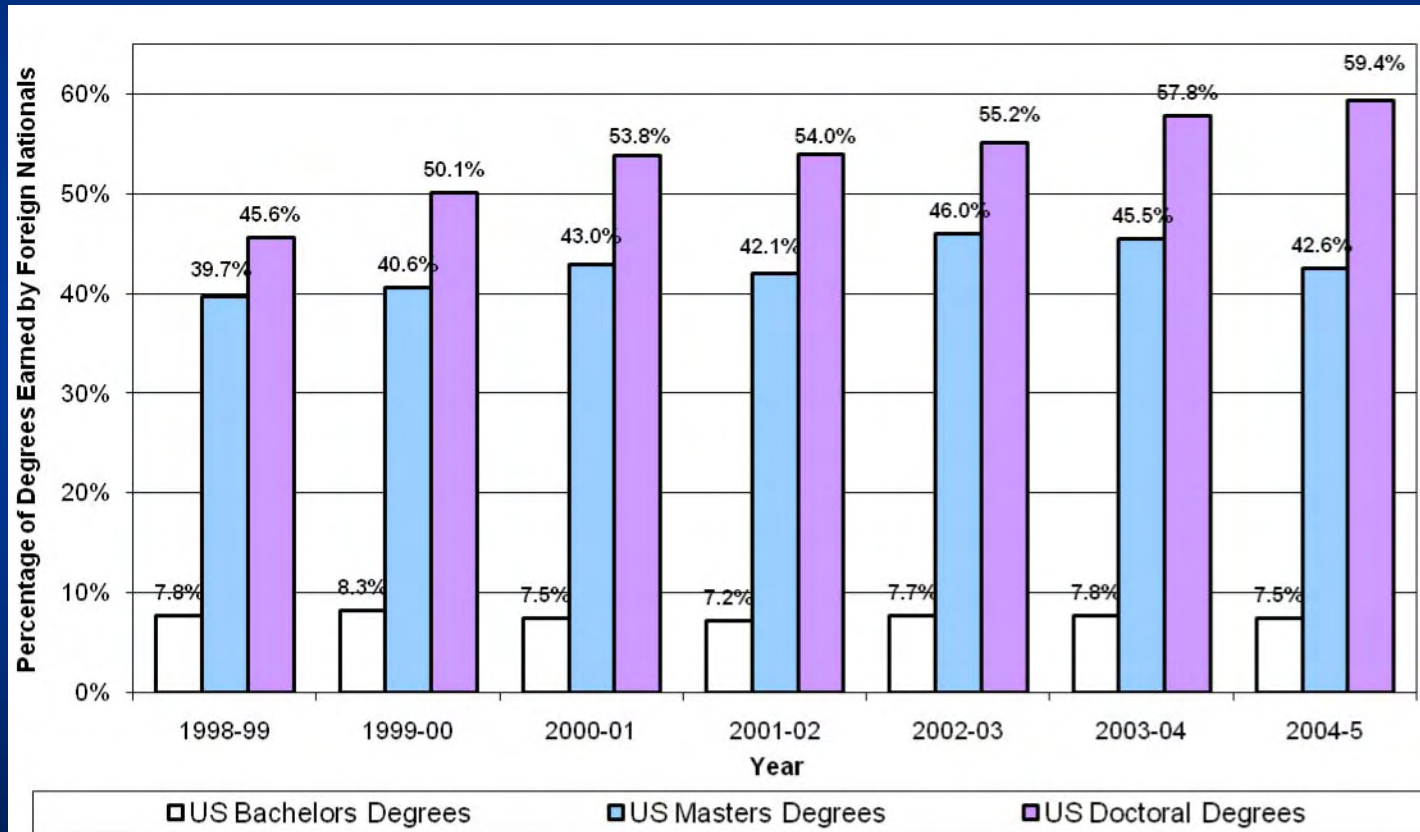
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U.S. Engineering Degrees Earned by Foreign Nationals

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Houston, we've got another problem



Meanwhile....Next Wave of Globalization

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India as a center of research, design and innovation:

- Pharmaceutical
 - Drug discovery, specialty pharmaceuticals, biologics, high value, bulk manufacturing, advanced intermediate manufacturing
- Aerospace
 - In-flight entertainment, airline seat design, collision control/navigation control systems, fuel inverting controls, first-class cabin design
- Consumer Appliances/Semiconductors, etc.
 - Design of next-generation washing machines, dryers, refrigerators, digital TV, cell phones, automobiles, tractors, locomotive motors

India is racing ahead in R&D despite its weak education system and graduation rates

China is using its manf. might to build R&D capability



Our Advantages

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- 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?



Americas New Immigrant Entrepreneurs

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Tech and Engineering companies founded from 1995-2005:

- 25.3% nationwide had an immigrant as a key founder
- 52.4% of Silicon Valley startups founded by immigrants
- 2005 revenue -- \$52 billion. Employed 450,000
- Indians founded 26% of these -- more than the next 4 groups (from U.K, China, Taiwan and Japan) combined

WIPO Patents:

- 25.6% had foreign national authors in 2006. This increased from 7.6% in 1998
- 16.8% had a Chinese-name and 13.7% had an Indian-name authors in 2006. This increased from 11.2% and 9.5% in 1998



Background of Americas New Immigrant Entrepreneurs

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- 96% of immigrant company founders have bachelors degrees
- 74%+ have a Masters or PhD
- 75%+ have degrees in engineering, math or science related fields
- 52% 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

Higher Education in STEM does provide advantage



U.S. Immigration Backlog

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Legal, Educated, skilled workers currently waiting for green cards:

- 500,040 in main employment-based visa categories plus 555,044 family members
- 259,717 intl. grad students plus 38,096 in practical training (includes postdocs)

Permanent resident visas available yearly:

- 120,120 in the three main employment visa categories (EB-1, EB-2, and EB-3)
- Largest numbers in queue from India and China
- Max. number of visas per country – 8,400 (7% of pool)

Over 1 million skilled immigrants waiting for yearly quota of 120,000 visas – with 8,400 max/country

We're headed for a massive reverse brain-drain – Returnees will accelerate the offshoring of R&D



University Research

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\$40 billion invested every year in university research with very few spinoffs and only \$1 billion in license revenue

Problems:

- Incomplete system -- legal and finance in place, but corporate development, marketing, and sales are missing
- Cultural issues -- Academics want to disseminate knowledge and publish papers rather than inhibit it's use. What comes first -- students or commercialization? What about the conflicts of interest?
- University technology is half-baked -- proof of concept not funded

***Untapped goldmine of knowledge and innovation --
effectively mining this is critical for U.S. competitiveness***



Conclusions

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Let's get our facts straight and fix the right problems:

- *Focus higher education in S&E on moving workforce up the ladder rather than graduating more*
- *Bring and keep the worlds best and brightest*
- *Make our investments in research more effective*
- *Understand globalization and create new business models which leverage innovation abroad*
- *Compete on American strengths -- In other words, let's do what we do better*



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