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A Global Engineering Education: *Why Make That Investment?*

Tom Peterson, Dean
College of Engineering
University of Arizona

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Drivers for International Partnerships

- Strengthening our Technology Base
- Strengthening Research Programs
- Expanding opportunities for Graduates

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The Business Model

- What's in it for:
  - The Students
  - The Faculty
  - The Institution (University/College/Department)
  - Country/World
- What are the Costs
  - To the student, the college, the university
  - Are the benefits worth the costs?

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Factors Influencing the Engineering Profession and Engineering Education

- **Public Awareness of Engineering** – ***What is Engineering to the 'person on the street'?***
- **The US Economy** – ***How does Engineering impact our Economy?***
- **Comparative Economies Worldwide** – ***How does Engineering impact the Global Economy?***
- **K-12 Education** – **Are we *preparing the pipeline of future Engineers?***
- **Higher Education** – ***What value-added are we providing?***
- **Research** – ***Are we discovering new knowledge?***
- **Quality Perceptions Worldwide** – ***What does 'good' mean?***
- **Engineering 'Grand Challenges'** – ***Engineering problems of worldwide importance***

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Sources of Information

THE TIMES HIGHER EDUCATION SUPPLEMENT QS

ENGINEERING TRENDS

DUKE EDMUND T. PRATT, JR. SCHOOL OF ENGINEERING

Shanghai Jiao Tong University, China

THE NATION'S REPORT CARD
National Assessment of Educational Progress
National Assessment Governing Board
U.S. Department of Education

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Status of Engineering and Technology in the US

- ***Rising Above the Gathering Storm***
- ***American Competitiveness Institute***
- ***The Engineer of 2020***
- ***Engineering Deans Institute***

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Global Business Competitiveness

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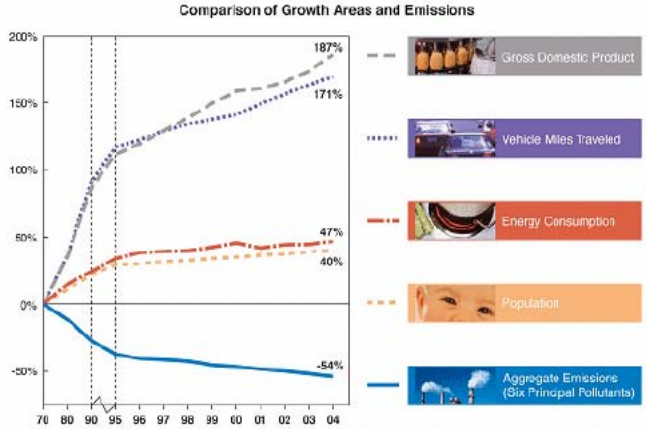

FIGURE 2-10 US air quality has improved despite increases in gross domestic product, vehicle miles traveled, and energy consumption since the 1970s.

SOURCE: US Environmental Protection Agency. *Air Emissions Trends - Continued Progress Through 2004.* Available at http://www.epa.gov/airtrends/2005/econ-emissions.html.

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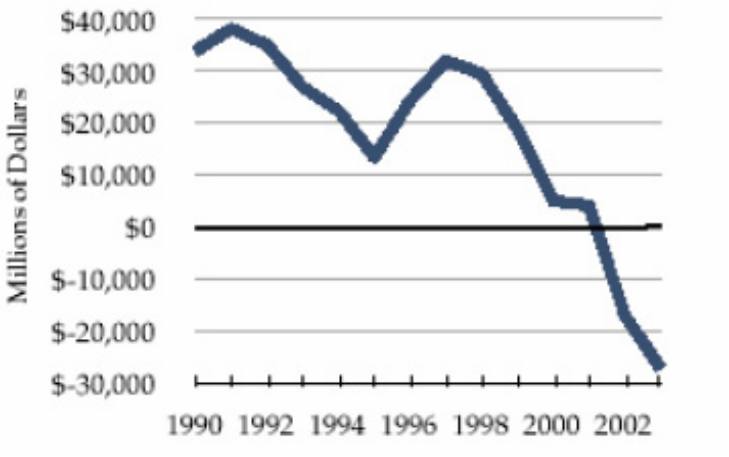

US Trade balance for high-tech products, 1990-2003

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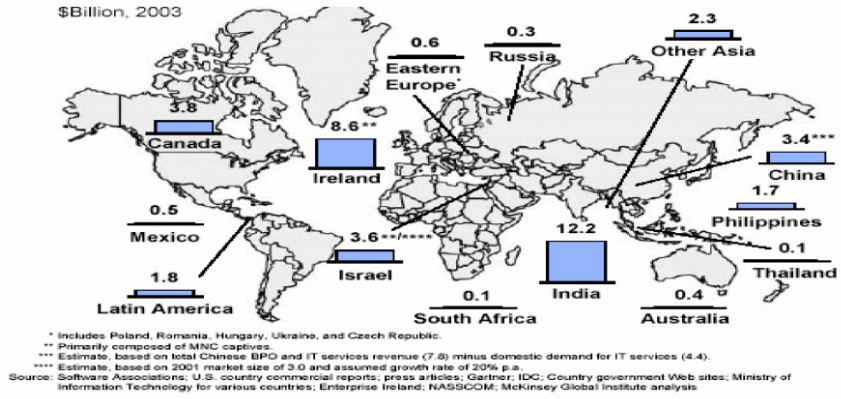

Offshore Services Market, 2003, in $B

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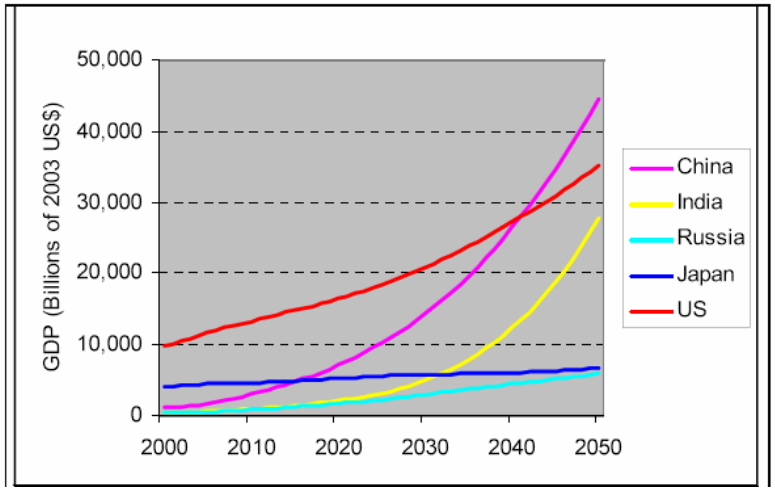

Anticipated Growth in Emerging Markets (Goldman Sachs)

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K-12 Information

- How have we done nationally in Math and Science Achievement?
- How do we compare to the rest of the world in Math Science and Reading Achievement?

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Exhibit 2. 1996 Science NAEP, Grade 4: Percentage of Students Within Each Achievement Level

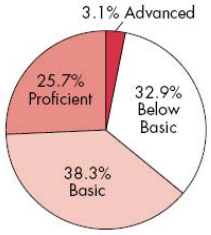


Exhibit 4. 1996 Science NAEP, Grade 8: Percentage of Students Within Each Achievement Level

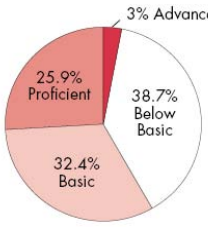
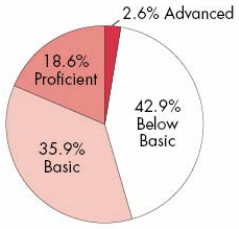


Exhibit 6. 1996 Science NAEP, Grade 12: Percentage of Students Within Each Achievement Level



US Science Achievement; 4th, 8th and 12th Grades
(*National Assessment of Educational Progress, NAEP)*

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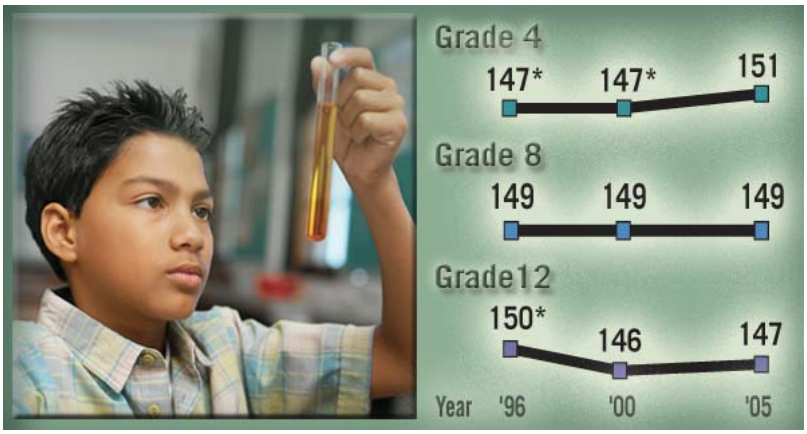

Science Achievement has not Improved in the past 10 years

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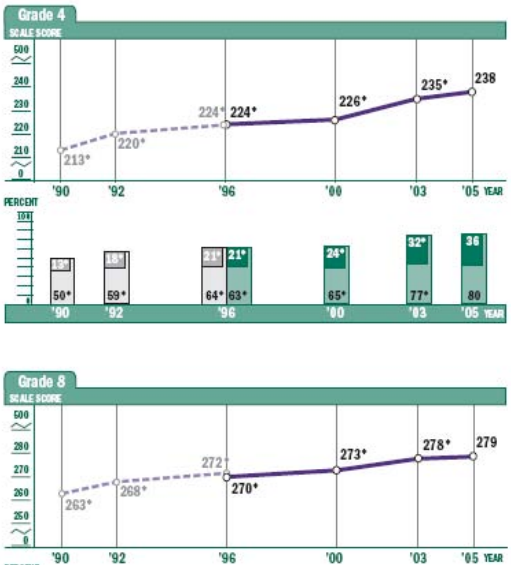
Mathematics Achievement has Improved Modestly



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How do we Stand Worldwide?

- International Comparison of Math, Reading, and Science Skills Among 15-Year-Olds
- More than 250,000 15-year old students from 41 countries participated in the assessment. The countries included all major industrialized nations (results for Britain were not available) and 11 other nations that chose to participate. The test scores are from 2003.

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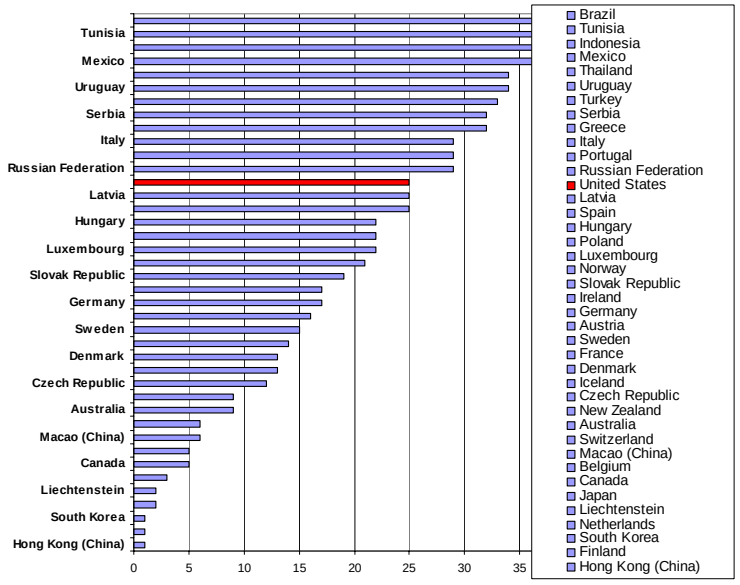

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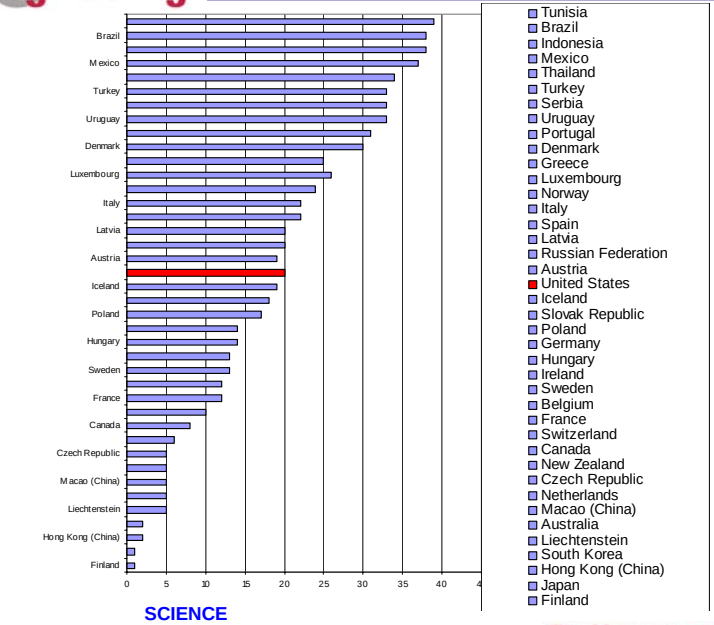

SCIENCE

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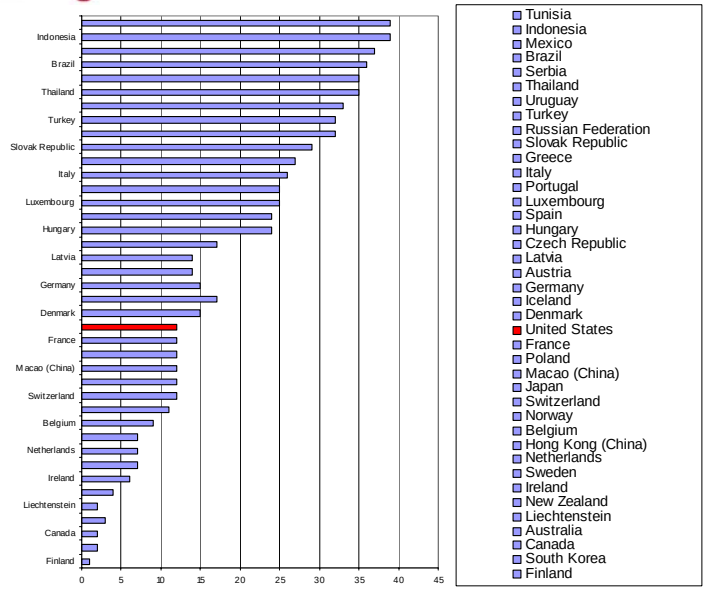

READING

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K-12 Observations

- Modest (if any) improvements in Math and Science at Grades 4, 8 and 12 in the US in the last 10 years
- Our 'peer group' worldwide is:
  - Reading: France and Denmark
  - Math: Latvia, Russia, Spain and Portugal
  - Science: Iceland, Slovakia, Russia

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Enrollments and degrees in University

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Trends in US Engineering Schools

- Degrees in Engineering
- Enrollment in Engineering
- Diversity in Engineering

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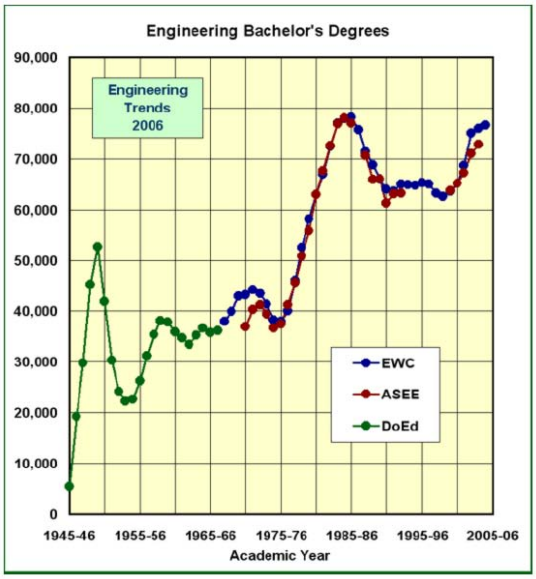

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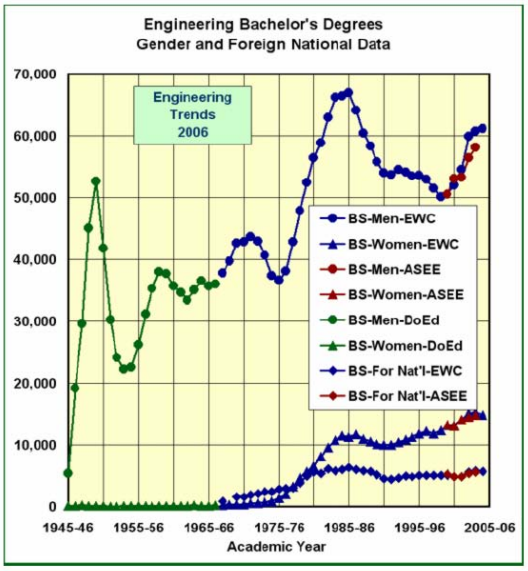

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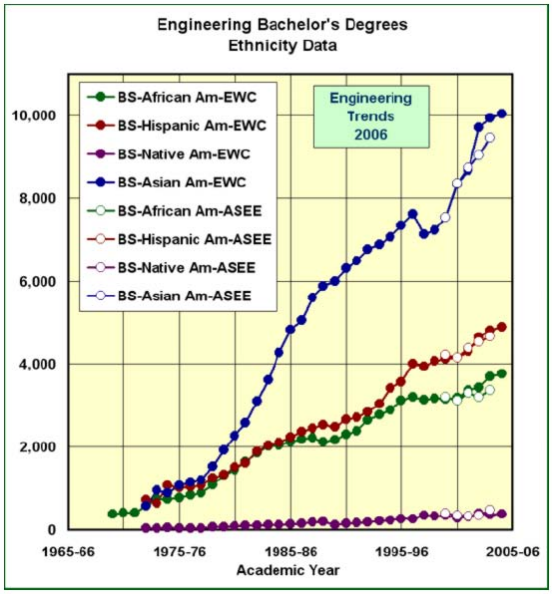

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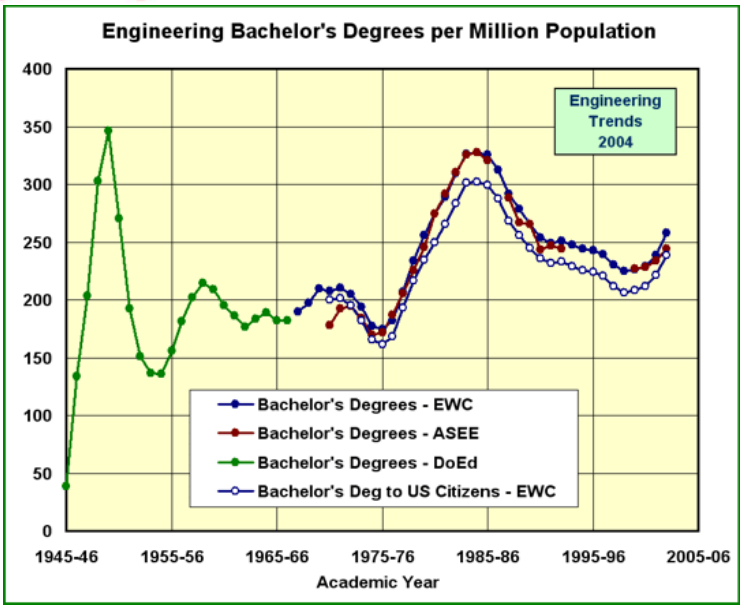

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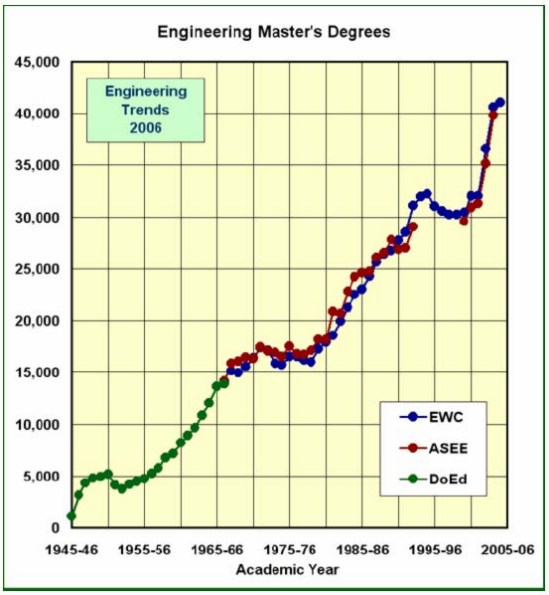

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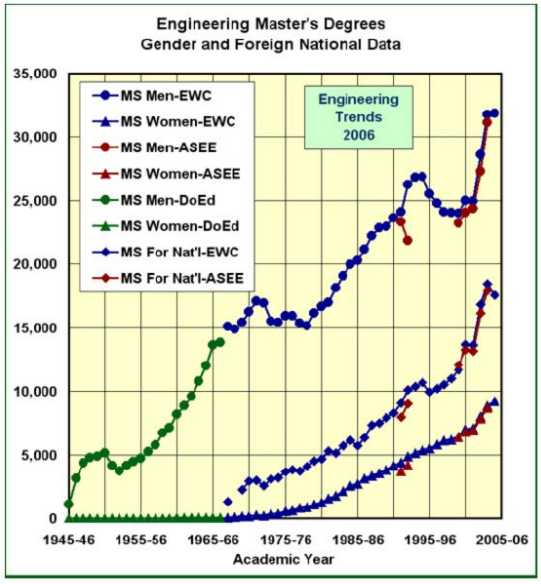

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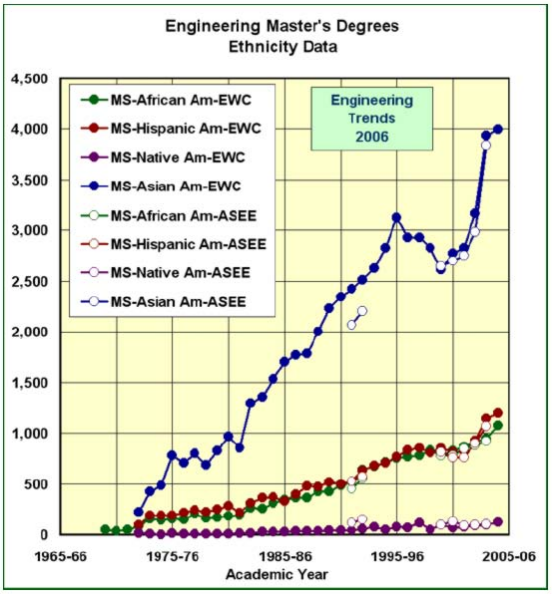

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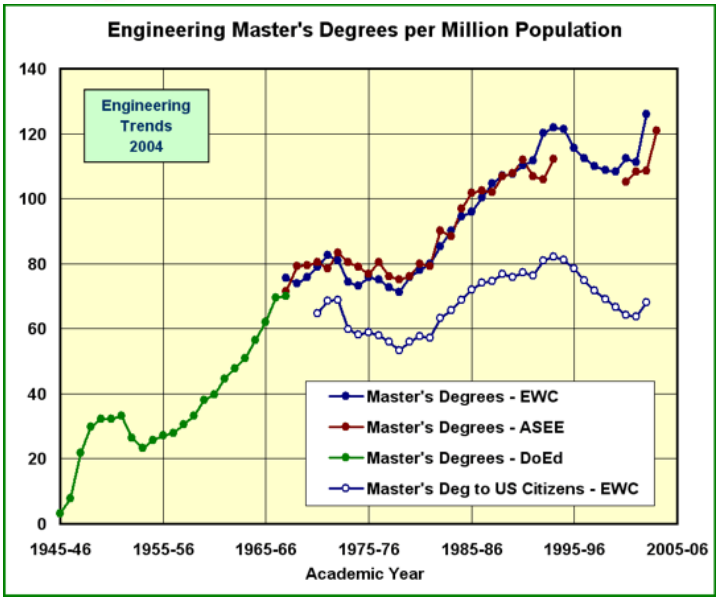

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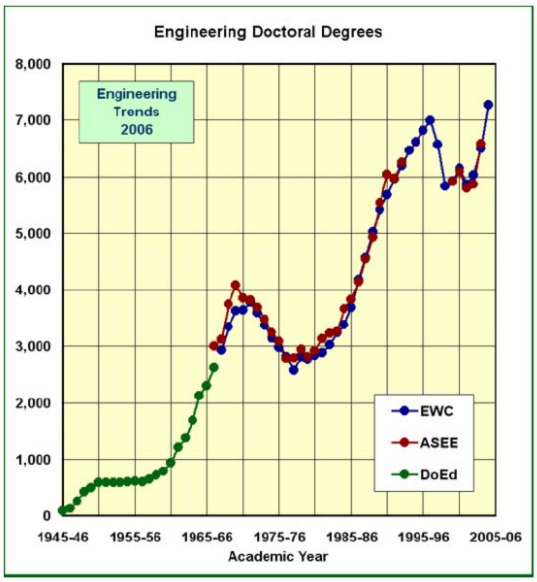

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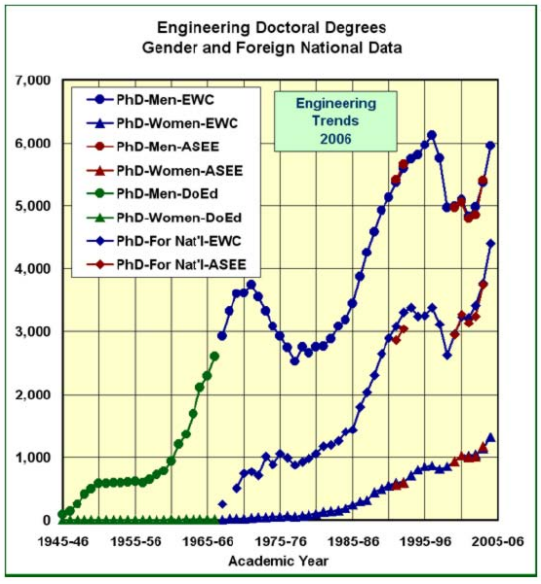

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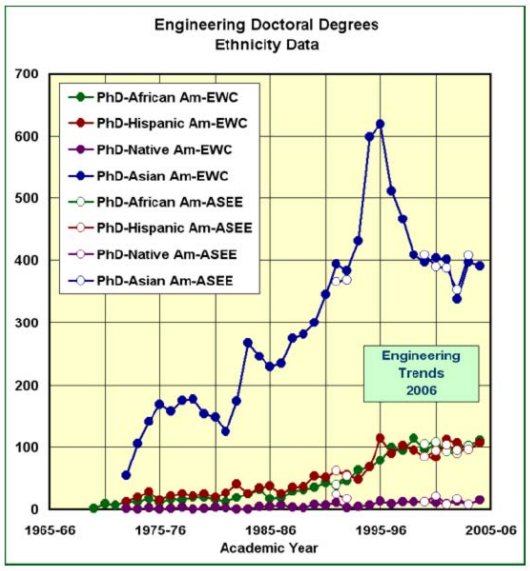

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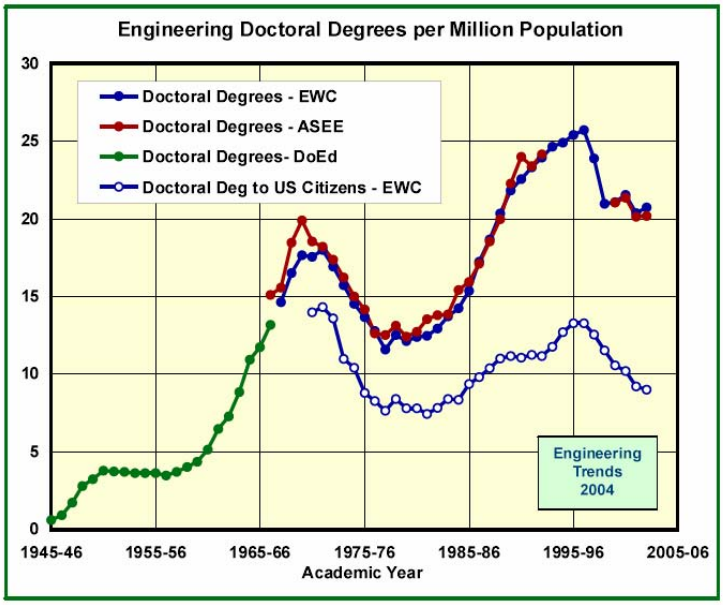

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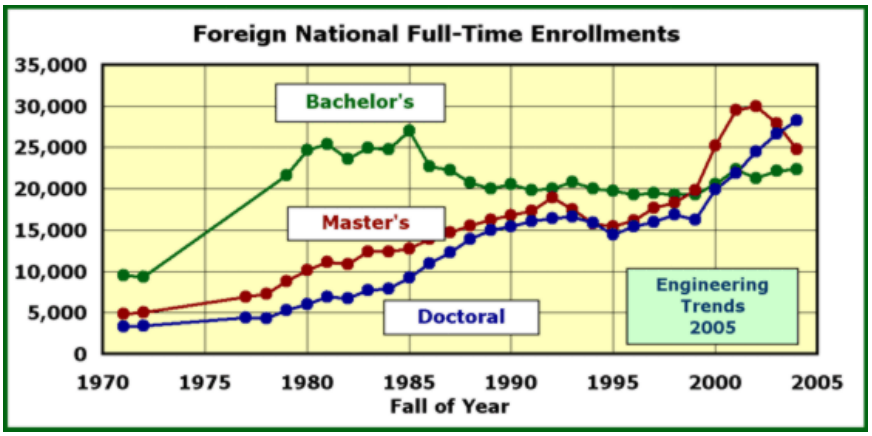

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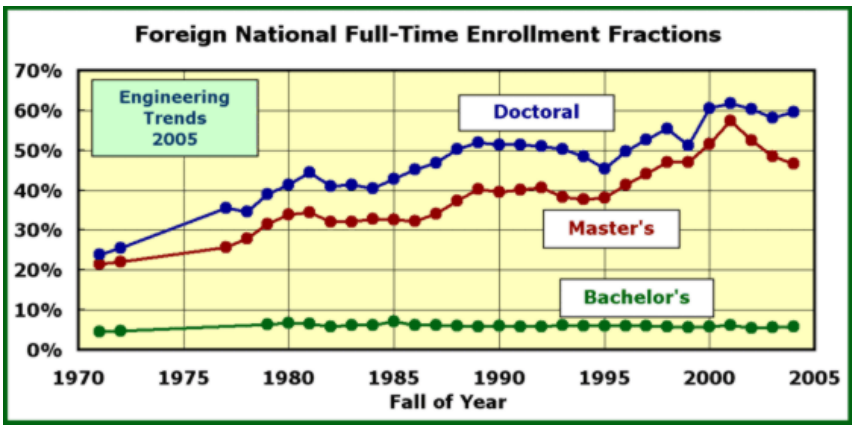

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TABLE 3-2 Change in Applications, Admissions, and Enrollment of International Graduate Students, 2003-2005

	Total	Engineering	Life Sciences	Physical Sciences
Applications	−28% (−5%)	−36% (−7%)	−24% (−1%)	−26% (−3%)
Admissions	−18%	−24%	−19%	−17%
Enrollment	−6%	−8%	−10%	+6%

NOTE: There have been large declines in applications and admissions and a more moderate decrease in enrollment. The admissions data for the 2005 academic year are shown in parentheses.
SOURCES: H. Brown and M. Doulis. *Findings from the 2005 CGS International Graduate Survey I.* Washington, DC: Council of Graduate Schools, 2005. H. Brown. *Council of Graduate Schools Finds Decline in New International Graduate Student Enrollment for the Third Consecutive Year.* Washington, DC: Council of Graduate Schools, Nov. 4, 2004.

Decline in US Enrollment of International Graduate Students

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Engineering Study Trends in Other Countries

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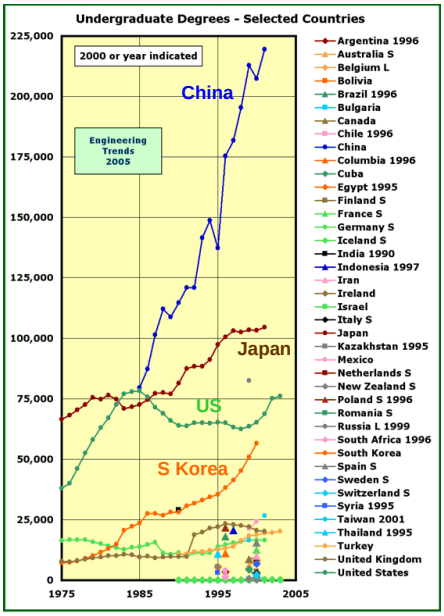

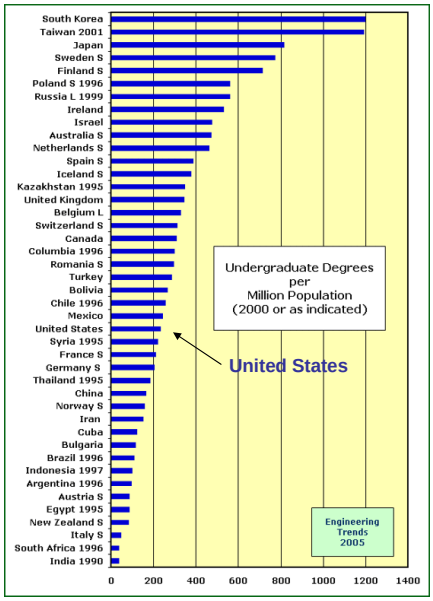

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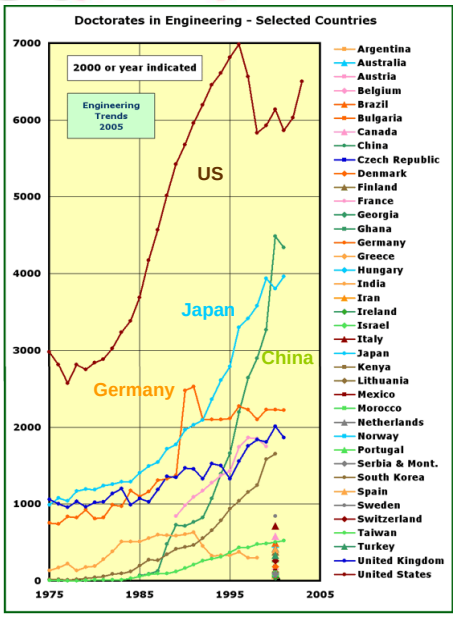

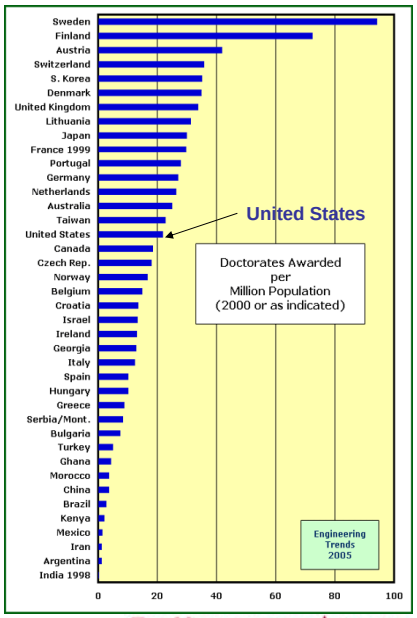

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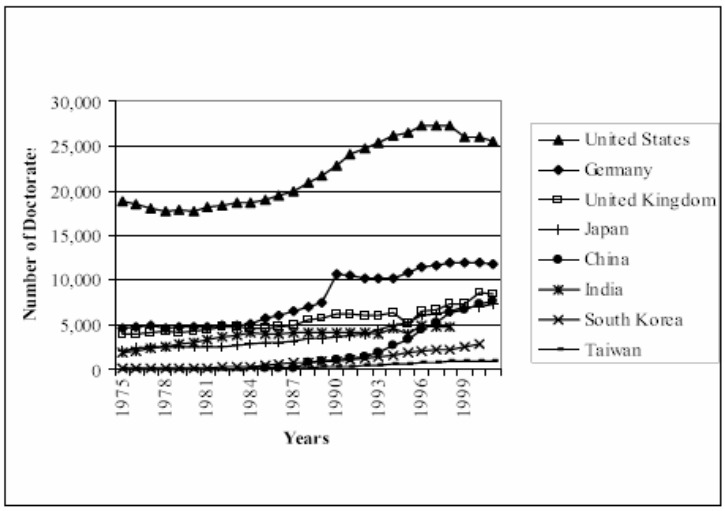

Science and Engineering Doctorate Production 1975-2001

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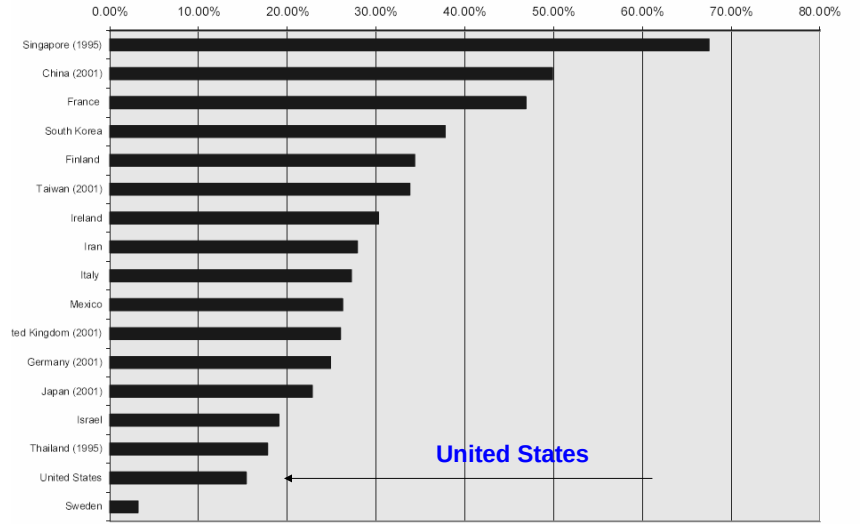

Percentage of 24 yr olds with first degrees in science or engineering relative to all university degree recipients.

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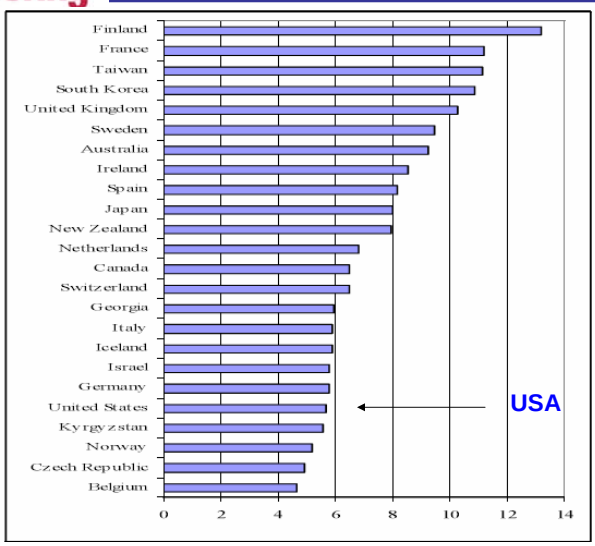

Percentage of 24-yr olds with first degrees in science or engineering relative to all 24-yr olds, 2000

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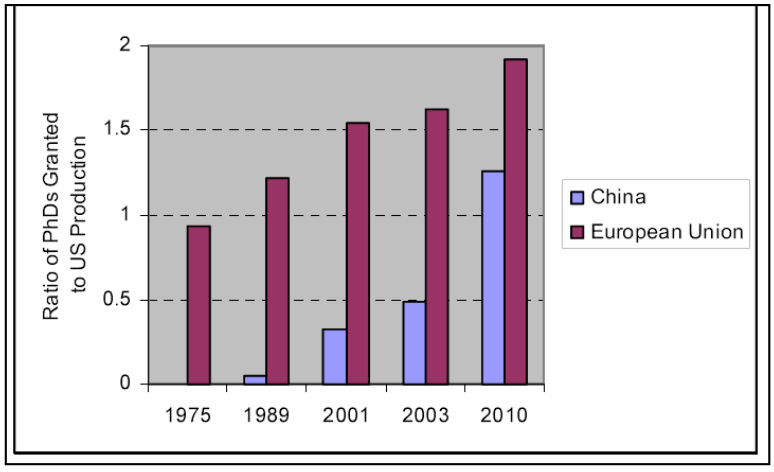

International Production of Science and Engineering Doctorates Compared to US Production

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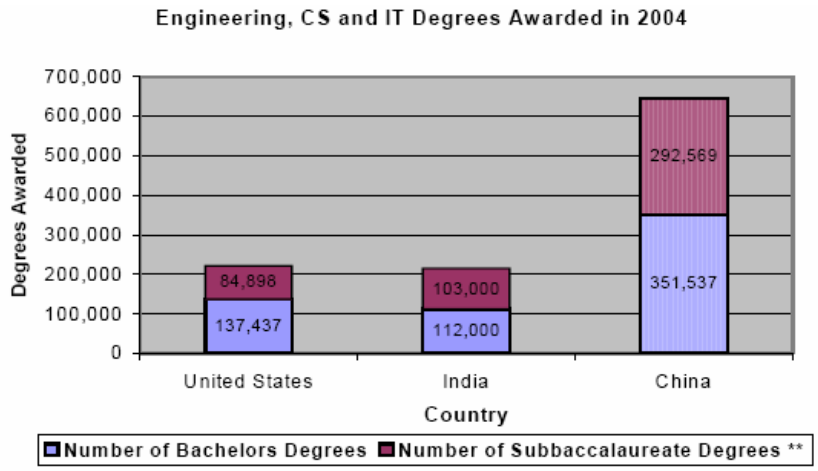

Engg, CS and IT Degrees Awarded, 2004

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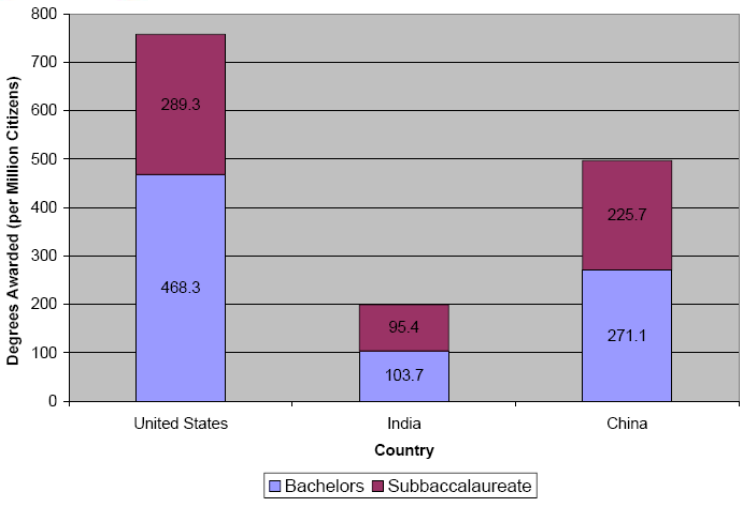

Bachelors and Subbaccalaureate degrees in Eng, CS and IT per million citizens, 2004

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Research Support Information

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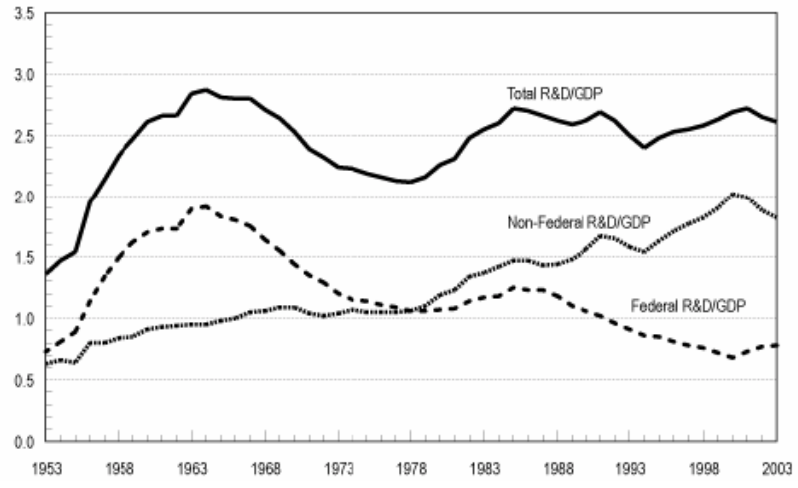

Total US R&D Expenditures as % of GDP, 1953-2003

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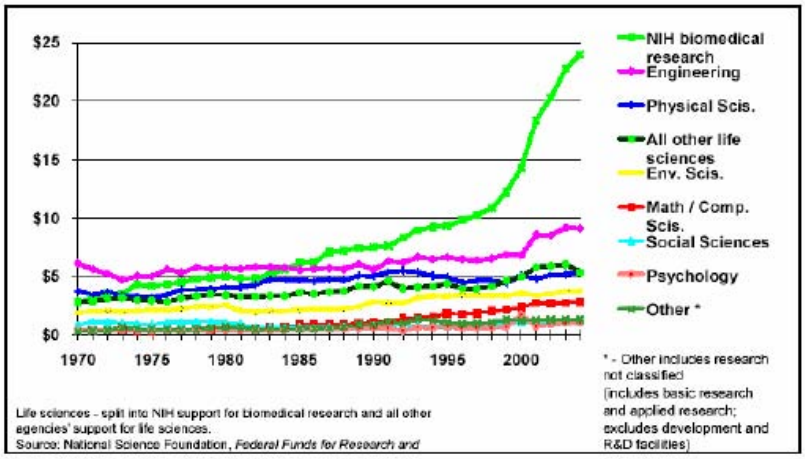

Trends in Federal Research by discipline, 1970-2004

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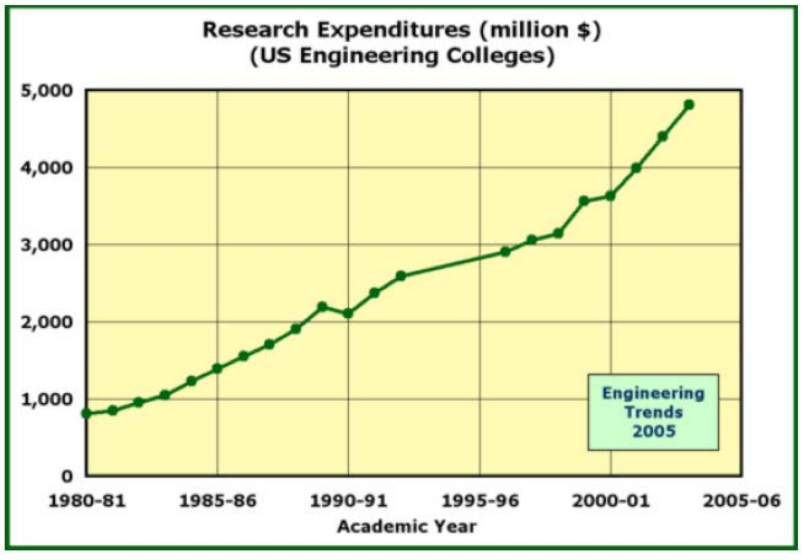

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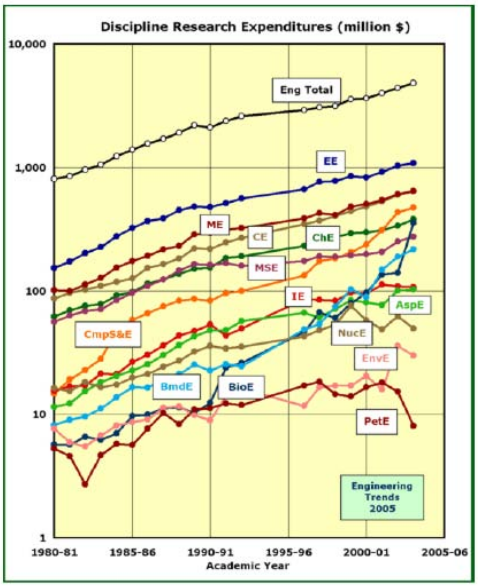

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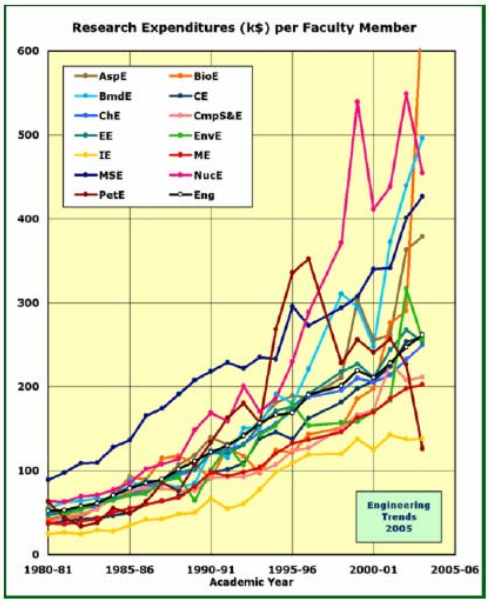

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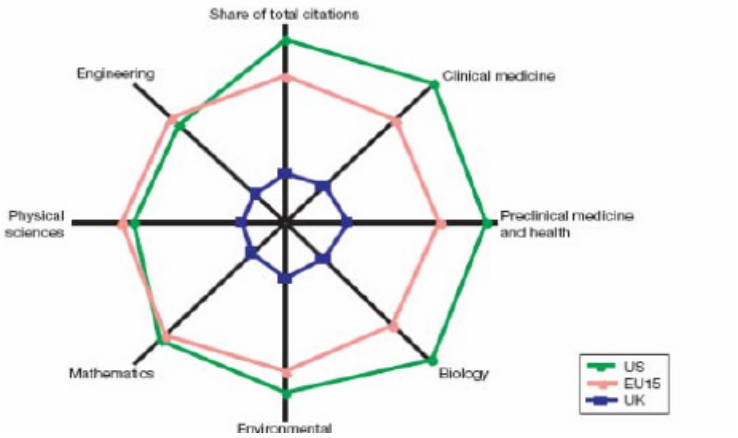

Relative Disciplinary Strengths in the US, EU and UK as judged by ISI Citations. *(Distance from origin proportional to citation share.)*

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"Quality" Assessments

- In the US
  - National Research Council
  - NSF Science and Engineering Expenditures
  - US News and World Report
- Other Countries
  - DAAD/CHE/DIE ZEIT (Germany)
  - Macleans (Canada)
  - The Guardian (UK)
- Worldwide
  - Shanghai JiaoTong University
  - The Times (London) Higher Education Supplement

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SJTU Top 20, 100, 500

	Country	Top 20
1	USA	17
2	UK	2
3	Japan	1

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	Country	Top 20	Top 100
1	USA	17	51
2	UK	2	11
4	Germany		7
3	Japan	1	5
5	Canada		4
6	France		4
7	Sweden		4
8	Switzerland		3
9	Netherlands		2
10	Australia		2
11	Italy		1
12	Israel		1
13	Denmark		1
14	Austria		1
15	Finland		1
16	Norway		1
17	Russia		1

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	Country	Top 20	Top 100	Top 500*
1	USA	17	51	170
4	Germany		7	43
2	UK	2	11	42
3	Japan	1	5	36
5	Canada		4	23
11	Italy		1	23
6	France		4	22
19	China			16
10	Australia		2	14
9	Netherlands		2	12
7	Sweden		4	10
21	Spain			9
8	Switzerland		3	8
20	South Korea			8
12	Israel		1	7
18	Belgium			7
13	Denmark		1	5
14	Austria		1	5
15	Finland		1	5

*5 or more in Top 500

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SJTU Rankings

Region	Top 20	Top100	Top 200	Top 300	Top 400	Top 500
North and Latin America	*17*	*55*	*101*	*138*	*164*	*200*
Europe	*2*	*37*	*79*	*125*	*171*	*209*
Asia/Pacific	*1*	*8*	*21*	*37*	*66*	*89*
Africa				*1*	*2*	*4*
TOTAL	20	100	201	301	403	502

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The Top 20

	THES RANKING			SJTU RANKING	
1	Harvard University	US	1	Harvard University	US
2	Mass. Inst of Technology	US	2	Stanford University	US
3	Cambridge University	UK	3	Cambridge	UK
4	Oxford University	UK	4	Univ California, Berkeley	US
5	Stanford University	US	5	Mass. Inst of Technology	US
6	Univ of Cal, Berkeley	US	6	Calif Inst. of Technology	US
7	Yale University	US	7	Princeton University	US
8	Calif Inst of Technology	US	8	Oxford University	UK
9	Princeton University	US	9	Columbia University	US
10	Ecole Polytechnique	France	10	University of Chicago	US
11	Duke University	US	11	Yale University	US
11	London School of Econ	UK	12	Cornell University	US
13	Imperial College London	UK	13	Univ Cal, San Diego	US
14	Cornell University	US	14	Tokyo University	Japan
15	Beijing University	China	15	Univ of Pennsylvania	US
16	Tokyo University	Japan	16	Univ of Cal,, LA	US
17	Univ of Cal, San Fran	US	17	Univ of Cal, San Fran	US
17	University of Chicago	US	18	Univ of Wisc, Madison	US
19	Melbourne University	Australia	19	Univ of Mich, Ann Arbor	US
20	Columbia University	US	20	Univ of Wash, Seattle	US

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The ‘World 200’

	THES	SJTU		THES	SJTU
US	54	90	Finland	2	1
UK	24	18	Russia	2	1
Germany	9	17	Singapore	2	1
Japan	10	9	Brazil	1	1
Canada	8	9	Mexico	1	1
France	9	8	Norway	1	1
Netherland	10	7	Spain	1	1
Australia	17	6	Switzerland	7	
Sweden	5	6	Hong Kong	4	
Italy	3	5	India	3	
Belgium	3	4	New Zealand	3	
Denmark	3	3	Ireland	1	
Israel	3	3	Malaysia	1	
China	6	1	Taiwan	1	
Austria	3	1	Thailand	1	
South Korea	3	1			

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Factors Influencing the C/B Ratio for International Collaborations

- "Easy" Business case for EU/American partnerships
  - "Blue Chip" Investment
  - Steady (modest?) payoff
- Business models for partnerships with China/India more tenuous
  - Higher Risk
  - Higher Reward
- FOCUS. Do not try to partner with everyone.

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