Remarks before the

National Academies' Commission on the Health of the US IT R&D Ecosystem

Trends in U.S. IT Workforce and Education

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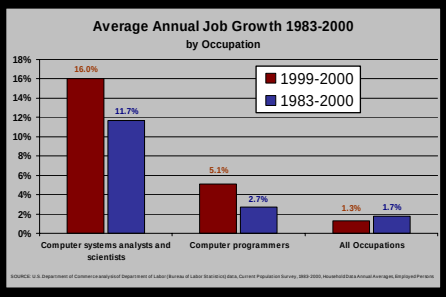
Overview

- Employment
  - 1990s: Rapid growth
  - Early 2000s: Small reduction
  - Recent: Small growth
  - Today: There are more professional IT workers in the United States than ever
  - Future: Strong growth projected
- Wages
  - Growing, but growth rates vary substantially by occupation
- Education
  - Rapid degree growth through 1986
  - Rapid degree decline from 1986 to 1994
  - Rapid new enrollment growth from 1995 to 2001
  - Rapid new enrollment decline from 2001 to 2005

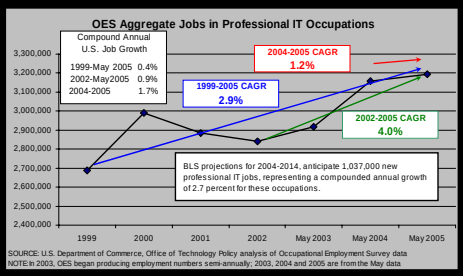
Employment

A Glass Half-Empty or Half-Full?

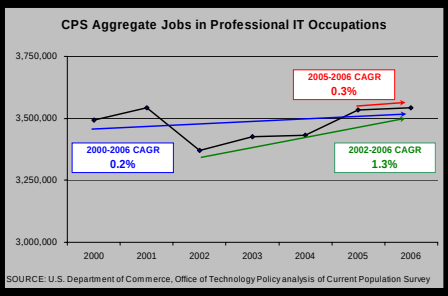
Historical Perspective: Stellar Job Growth



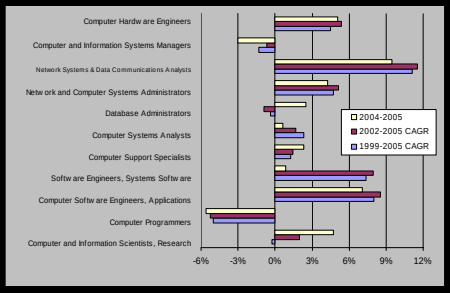
Strong, Not Stellar…
Much Better Than Overall U.S. Job Growth



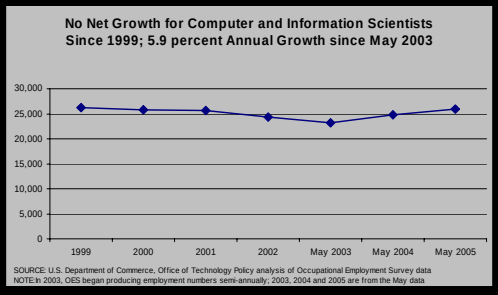
CPS Data Shows Weaker Job Growth Than OES Data



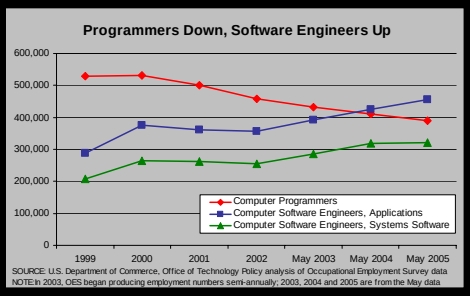
Growth Rates Vary Substantially Among IT Professions



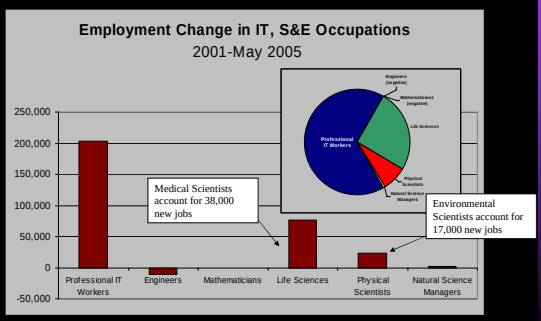
Computer and Information Scientists: Return to Growth in 2003



Computer Software Engineers Offsetting Computer Programmers' Losses



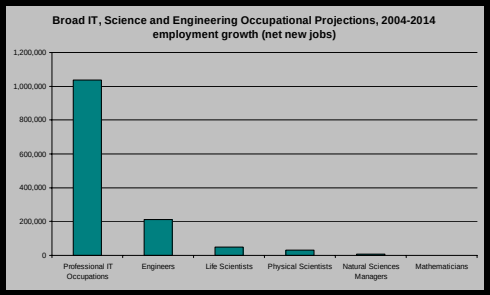
Professional IT Occupations Continue to Dominate Technical Job Growth



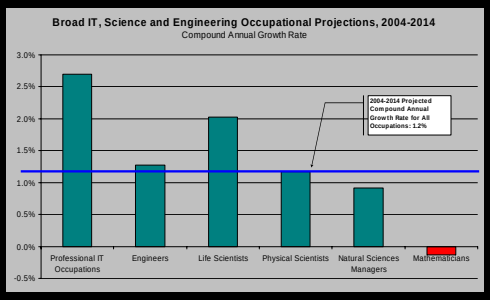
Occupational Projections

IT Job Growth Dominates S&E Occupational Growth,
Outstrips Overall U.S. Job Growth

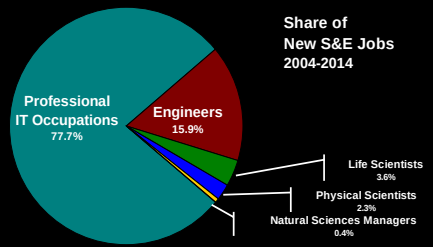
Professional IT Occupations Account for Lion's Share of Projected S&E Job Growth



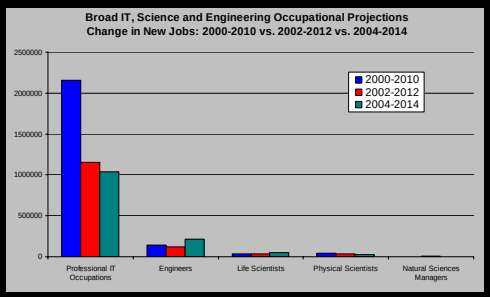
Only IT and Life Sciences Occupations Have Growth Rates Significantly Higher Than for Overall Jobs



IT Occupations Account for More Than 3 of 4 Projected New Jobs in S&E



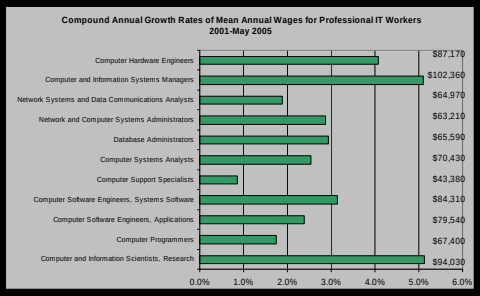
Job Growth Projections for Professional IT Occupations: Still Down, But Dominant



IT Wage Growth

Everybody's Getting More;
The Highest Paid Are Growing Fastest

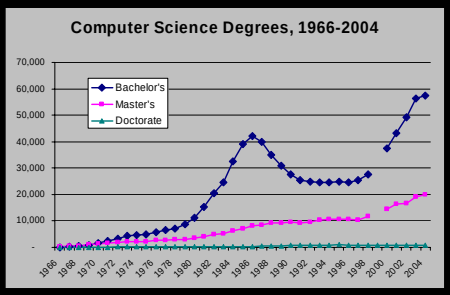
Strong Wage Growth in High Wage IT Occupations



Computer Science Degrees, Enrollment

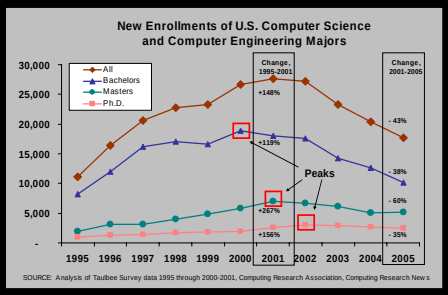
A Market-responsive Rollercoaster Ride

Degree Production Follows Market Demand with Lag



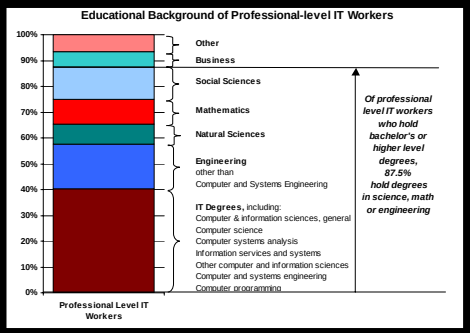
Source: National Science Foundation

Enrollments in CS Up, Then Down, in Response to Market Signals

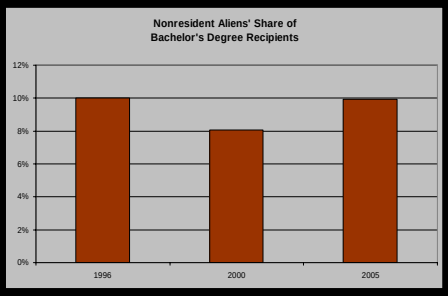


Source: Computing Research Association Taulbee Survey, 1995-2005

Professional Level IT Workers Hold a Wide Array of Science, Engineering and Other Degrees

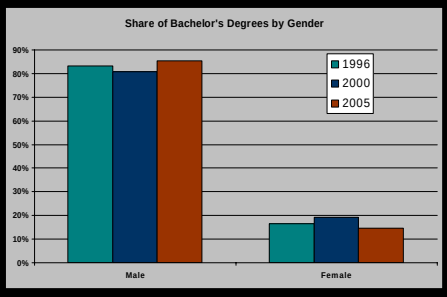


Share of Foreign Students Earning B.S. Degrees in CS Remains Steady at ~10%



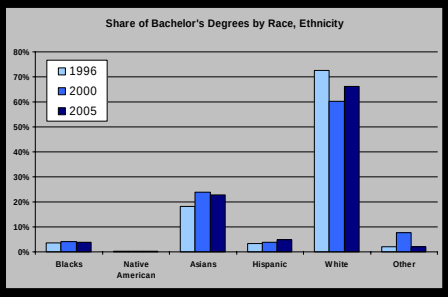
Source: Computing Research Association Taulbee Survey, 1995-2005

Women Remain Underrepresented in CS

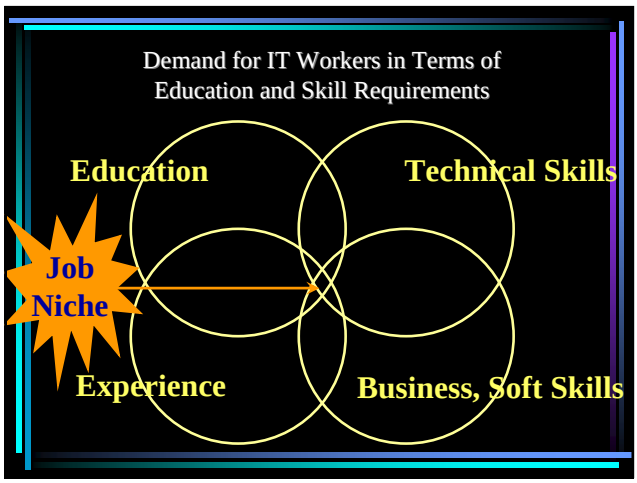


Source: Computing Research Association Taulbee Survey, 1995-2005

Blacks, Hispanics, Native Americans Remain Underrepresented in CS, as in Colleges Generally



Source: Computing Research Association Taulbee Survey, 1995-2005



Some Implications

- Rapid diffusion, improved education and training delivery systems, improved knowledge capture and sharing systems mean:
  - Hot technical skills become a commodity—and ripe for off-shoring– faster
  - Reduction in the number of jobs U.S. can capture from its technical innovations as they mature and diffuse

Characteristics of IT Work Favorable for Performance in the United States

- Work in which there is uncertainty about what the customer wants or what the specifications should be.
- Projects that require highly iterative development processes.
- Work that crosses many disciplines.
- Work that requires a high degree of personal interaction with end-users/clients.
- Applications with complex procedures, including ones that involve substantial manual intervention and data fixes.
- Applications that involve a high degree of integration with other systems developed and maintained on-shore.
- Work involving nuances or deep cultural understanding.

Characteristics of IT Work Favorable for Performance in the United States

- Work in which much of the knowledge exists only in the minds of the on-shore IT staff
- Analytical tasks, leading-edge research and non-rule-based decision-making
- High levels of creativity, innovation, insight, “thinking outside the box”
- High management requirements
- Process design and business analysis
- Technology and systems integration (applications, hardware and networks)
- Fusion of industry knowledge, high-level IT skills, and business process expertise
- Requires U.S. security clearance

Contact Information

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Characteristics of Work Favorable to Performance Offshore

- High wage differential with similar occupation/level in destination country
- High labor intensity
- Clearly defined requirements, little nuance
- Repetitive tasks
- Rule-based decision-making and problem solving
- Documented or easily transferred content and process knowledge
- Discreet, separable; low degree of interaction across different services, applications
- Low degree of personal interaction with end-users, clients
- Stable applications with minimum of "firefighting"

Characteristics of Work Favorable to Performance Offshore

- Long projected useful life to amortize offshore set-up costs
- Low-to-medium business criticality
- Less time-sensitive, longer transition periods
- Projects involving simple and standard hardware and software
- Digital, Internet-enabled
- Low setup barriers
- Low-to-medium technical complexity
- Not multi-disciplinary
- Projects in business areas in which offshoring is a broadly accepted concept
- Tightly defined work processes
- Stable process

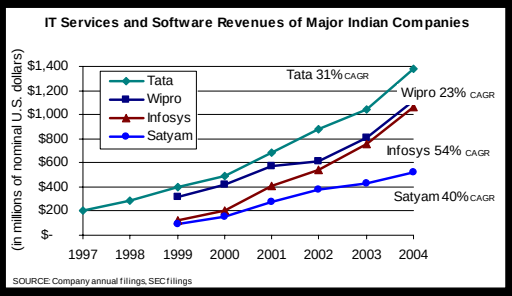
A Difference Mix of Skills

- Project Development Management and Program Management (with technology skills)
- Communications, Liaison, and Relationship-building
- Technology and Systems Integration
- Business Analysis
- Business Process Knowledge
- Domain (industry-specific) Knowledge
- Business Savvy
- Broad Technology Acumen
- Process Design
- Business Planning and Management
- Technology Management
- Business Problem Solving
- Contracting
- Negotiation
- Compliance Monitoring

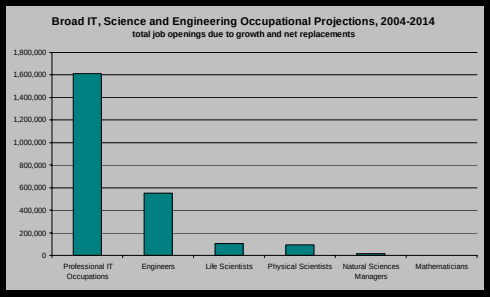
A Difference Mix of Skills

- Financial and Accounting
- Supply Management (such as strategic sourcing and vendor management)
- Human Capital Management
- Business Development
- Security Analysis
- Service Management
- Data Mining
- Business Intelligence
- Network Engineering and Architecture
- Internet/Web Architecture
- Middleware
- Open Standards Software (including legal, intellectual property, and industry practices in the open standards arena)
- Business Transformation
- IT Consulting

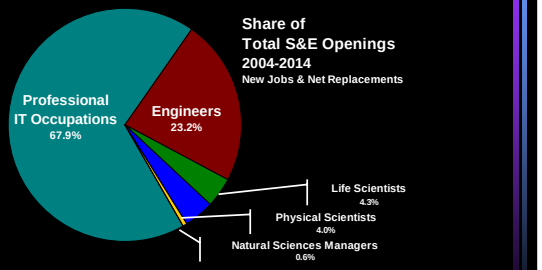
Rapidly Changing Landscape



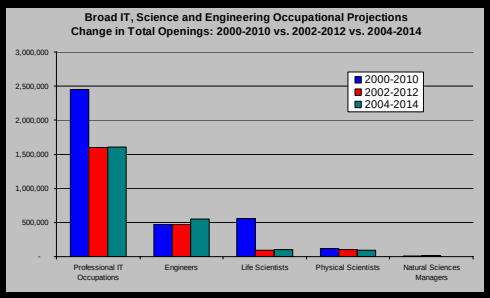
Professional IT Occupations Account for Lion's Share of Total Projected S&E Job Openings



IT Occupations Account for More Than 2 of 3 Projected Openings in S&E



Total Openings in Professional IT Occupations: Still Down, but Dominant



Groupings of Occupations for This Analysis

Professional IT Occupations
- Computer support specialists
- Computer programmers
- Computer systems analysts
- Computer software engineers, applications
- Computer and information systems managers
- Computer software engineers, systems software
- Network and computer systems administrators
- All other computer specialists
- Network systems and data communications analysts
- Database administrators
- Computer hardware engineers
- Computer and information scientists, research

Engineers
- Aerospace engineers
- Agricultural engineers
- Biomedical engineers
- Chemical engineers
- Civil engineers
- Electrical engineers
- Electronics engineers, except computer
- Environmental engineers
- Health and safety engineers, except mining safety engineers and inspectors
- Industrial engineers
- Marine engineers and naval architects
- Materials engineers
- Mechanical engineers
- Mining and geological engineers, including mining safety engineers
- Nuclear engineers
- Petroleum engineers
- All other engineers
- Engineering managers

Life Scientists
- Agricultural and food scientists
- Biochemists and biophysicists
- Microbiologists
- Zoologists and wildlife biologists
- Biological scientists, all other
- Conservation scientists
- Foresters
- Epidemiologists
- Medical scientists, except epidemiologists
- All other life scientists

Physical Scientists
- Astronomers
- Physicists
- Atmospheric and space scientists
- Chemists
- Materials scientists
- Environmental scientists and specialists, including health
- Geoscientists, except hydrologists and geographers
- Hydrologists
- All other physical scientists

Natural sciences managers

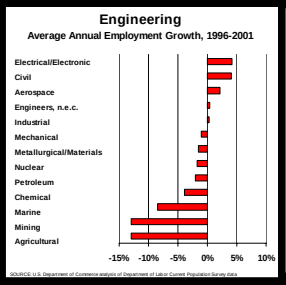
Mathematicians

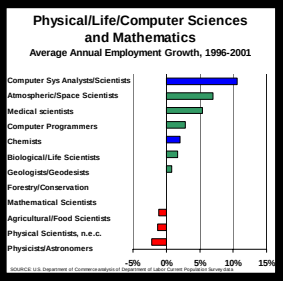
Alarm Bells…

- **"… the nation may likely face severe shortages in SET workers…"**
  - ***Land of Plenty***, Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology Development (CAWMSET)
- **"There is a quiet crisis building in the United States [that] stems from the gap between the nation's growing need for scientists, engineers, and other technically skilled workers, and its production of them."**
  - **The Quiet Crisis: Falling Short in Producing American Scientific and Technical Talent**, Building Engineering and Science Talent (BEST)
- **"… U.S. need for the highest quality human capital in science, mathematics and engineering is not being met."**
  - **Hart-Rudman Commission**
- **"Our 1998 study found a shortage of 346,000 programmers, systems analysts and computer scientists."**
  - ITAA president Harris Miller
- **"We are not training enough American scientists and engineers to retain our prosperity …."**
  - American Scientist magazine, 2001
- **"a serious deficit of scientists and engineers" resulting in "an evaporating dominance."**
  - Dan Goldin, former NASA administrator, 2001

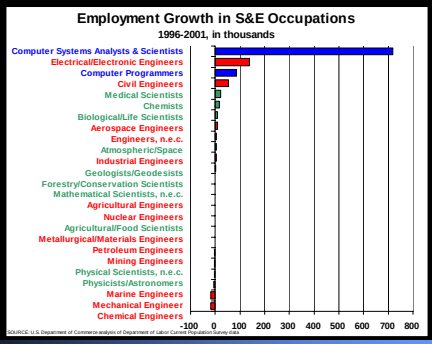
Demand for S&E Workers

Recent Occupational Growth
Growth Rates

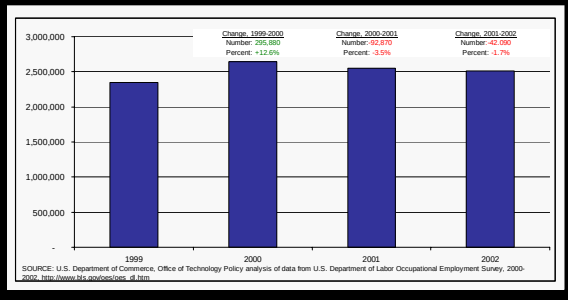




Recent Occupational Growth
Growth in Numbers

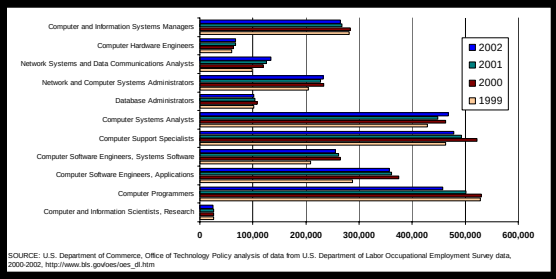


Aggregate IT Employment
1999-2002



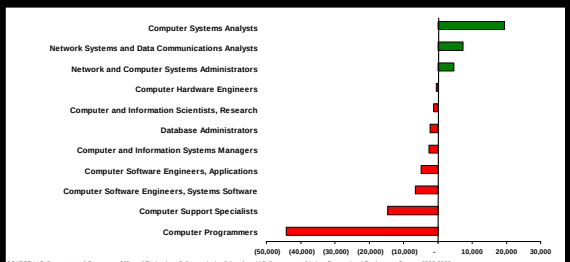
SOURCE: U.S. Department of Commerce, Office of Technology Policy analysis of data from U.S. Department of Labor Occupational Employment Survey, 2000-2002, http://www.bls.gov/oes/oes_dl.htm

IT Occupational Employment
1999-2002



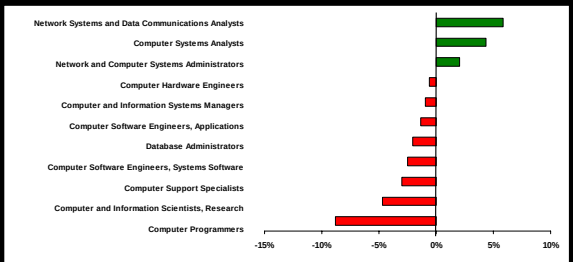
SOURCE: U.S. Department of Commerce, Office of Technology Policy analysis of data from U.S. Department of Labor Occupational Employment Survey data, 2000-2002, http://www.bls.gov/oes/oes_dl.htm

Change in IT Occupational Employment
Number, 2001-2002



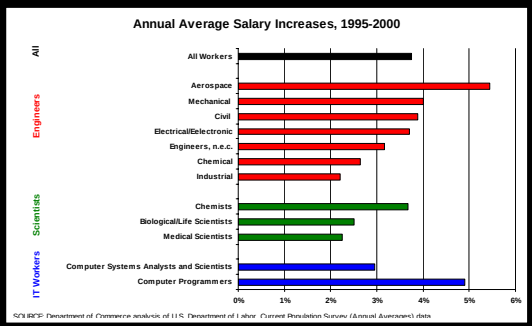
SOURCE U.S. Department of Commerce, Office of Technology Policy analysis of data from U.S. Department of Labor Occupational Employment Survey, 2000-2002, http://www.bls.gov/oes/oes_dl.htm

Change in IT Occupational Employment
Percentage, 2001-2002



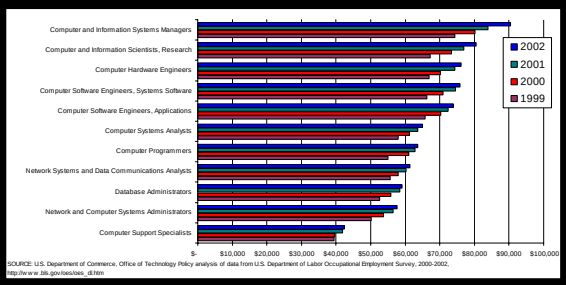
SOURCE: U.S. Department of Commerce, Office of Technology Policy analysis of data from U.S. Department of Labor Occupational Employment Survey, 2000-2002, http://www.bls.gov/oes/oes_dl.htm

Salary Growth



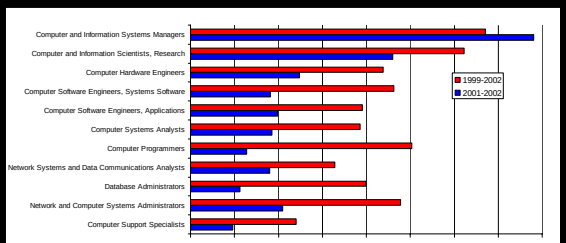
SOURCE Department of Commerce analysis of U.S. Department of Labor, Current Population Survey (Annual Averages) data

Salary Growth in IT Occupations
1999-2002



SOURCE: U.S. Department of Commerce, Office of Technology Policy analysis of data from U.S. Department of Labor Occupational Employment Survey, 2000-2002, http://www.bls.gov/oes/oes_dl.htm

Percent Salary Growth in IT Occupations
1999-2002, 2001-2002



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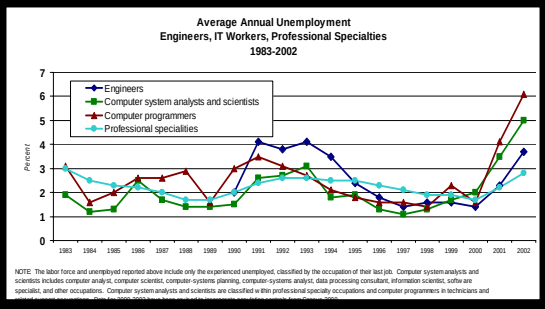
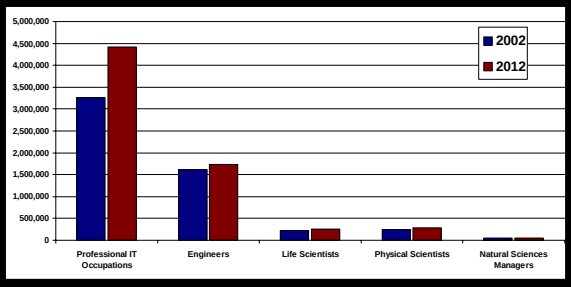
Unemployment Rates



NOTE: The labor force and unemployed reported above include only the experienced unemployed, classified by the occupation of their last job. Computer system analysts and scientists includes computer analyst, computer scientist, computer systems planning, computer-systems analyst, data processing consultant, information scientist, softw are specialist, and other occupations. Computer system analysts and scientists are classified w ithin profes sional specialty occupations and computer programmers in technicians and

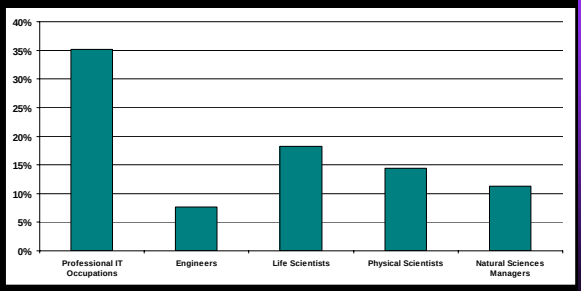
IT, Science and Engineering Occupational Projections, 2002-2012

Employment, Numbers



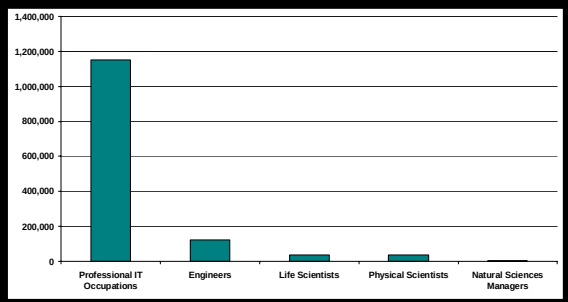
IT, Science and Engineering Occupational Projections, 2002-2012

Employment Growth: Rate



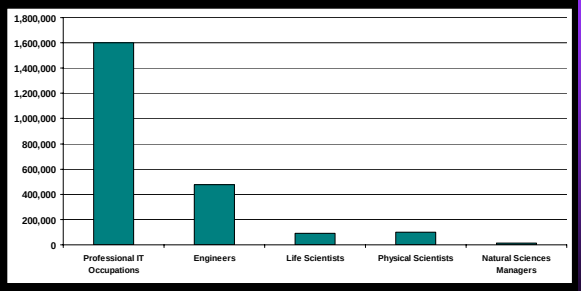
IT, Science and Engineering Occupational Projections, 2002-2012

Employment Growth: Numbers

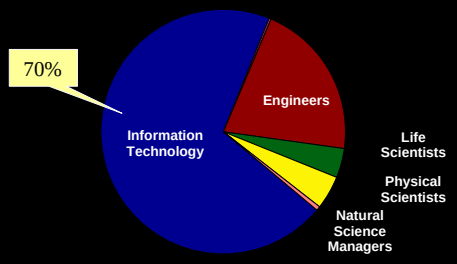


IT, Science and Engineering Occupational Projections, 2002-2012

Total Job Openings

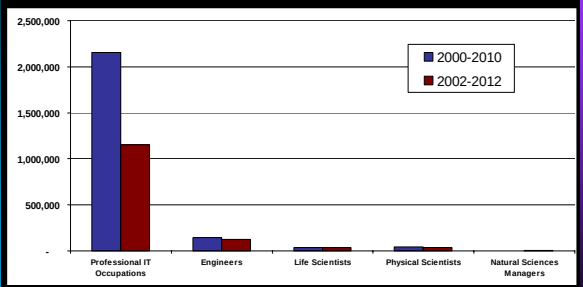


Occupational Distribution of Projected S&E Job Openings (new jobs plus net replacements) 2002-2012



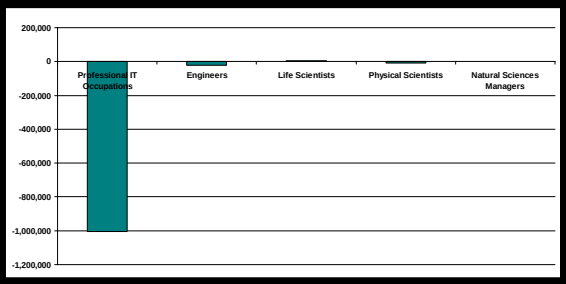
IT, Science and Engineering Occupational Projections, 2002-2012

Job Growth: 2000-2010 vs. 2002-2012



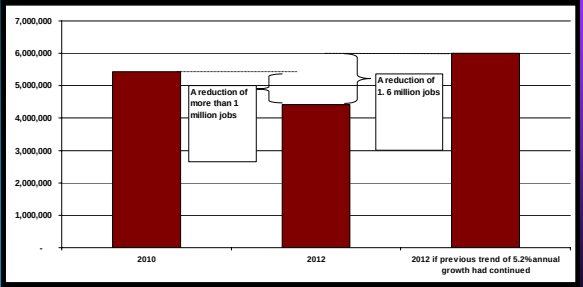
IT, Science and Engineering Occupational Projections, 2002-2012

Change in Growth: 2000-2010 vs. 2002-2012



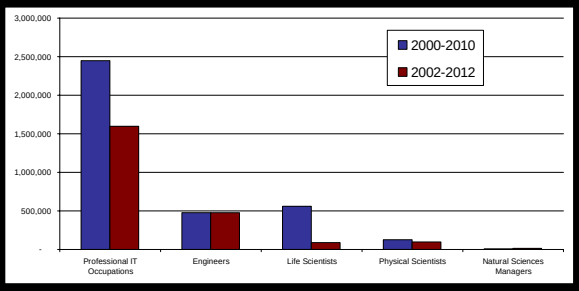
IT, Science and Engineering Occupational Projections, 2002-2012

Projected IT Job Growth 2010 vs. 2012 Projections



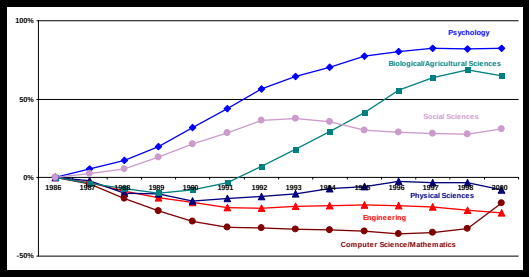
IT, Science and Engineering Occupational Projections, 2002-2012

Change in Total Openings: 2000-2010 vs. 2002-2012



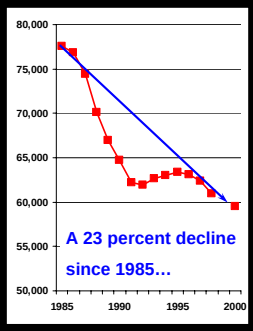
S&E Bachelor's Degrees

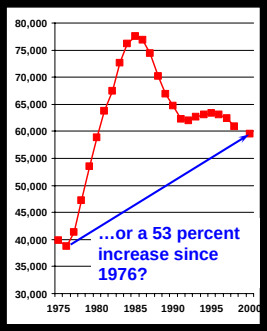
Life Sciences Up...



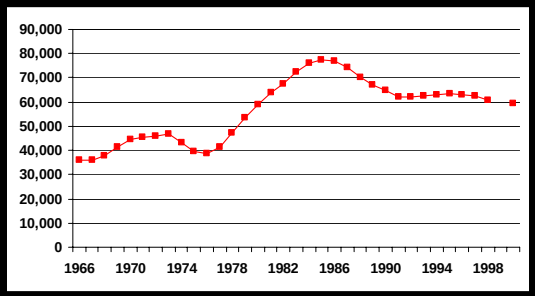
...Engineering, Physical Sciences, and Math Down

Engineering Bachelor's Degrees... Half Empty or Half Full?



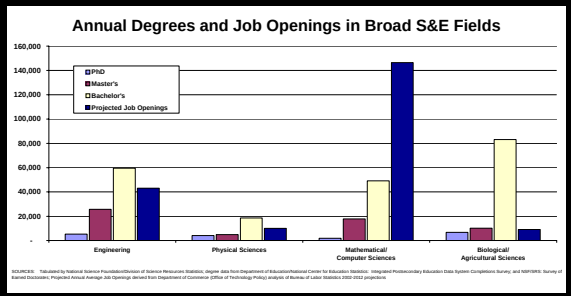


Both, depending on your perspective...

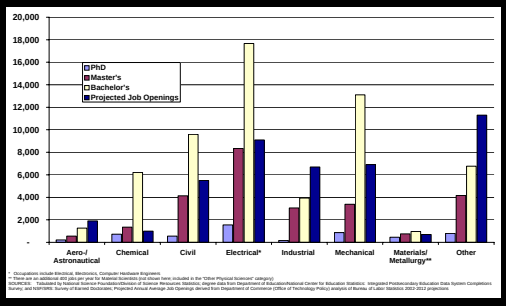


The Market Perspective

Degree Production vs. Projected Job Openings

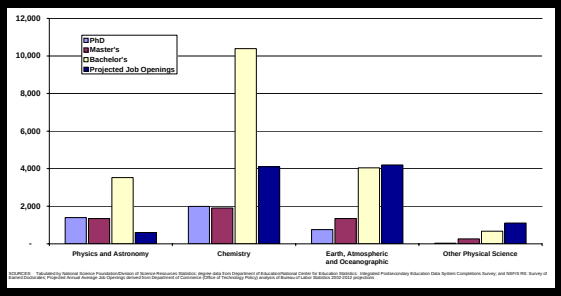


Engineering
Degrees & Projected Job Openings



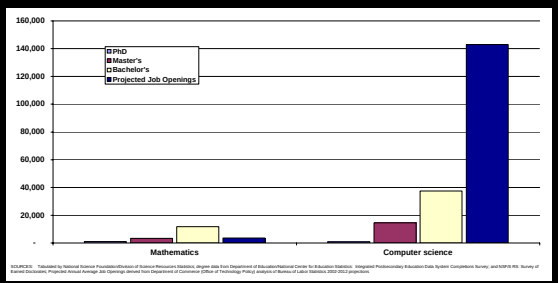
* Occupations include Electrical, Electronics, Computer Hardware Engineers
** There are an additional 800 jobs per year for Material Scientists (not shown here; included in the "Other Physical Sciences" category)
SOURCES: Tabulated by National Science Foundation/Division of Science Resources Statistics, degree data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey, and NSF/SRS: Survey of Earned Doctorates, Projected Annual Average Job Openings derived from Department of Commerce (Office of Technology Policy) analysis of Bureau of Labor Statistics 2002-2012 projections

Physical Sciences
Degrees & Projected Job Openings



SOURCES: Tabulated by National Science Foundation/Division of Science Resources Statistics, degree data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey, and NSF/S RS: Survey of Earned Doctorates, Projected Annual Average Job Openings derived from Department of Commerce (Office of Technology Policy) analysis of Bureau of Labor Statistics 2002-2012 projections

Mathematics and Computer Science
Degrees & Projected Job Openings



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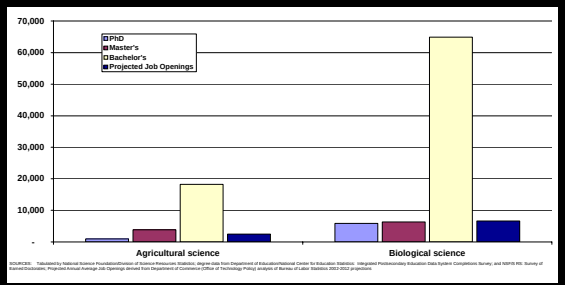
Biological and Agricultural Sciences
Degrees & Projected Job Openings



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IT Education & Training Landscape

How IT Workers Get and Maintain their Skills

- IT Bachelor's Degrees
- IT-Related Minors
- Combined IT Bachelors/Masters Degree Programs
- IT-Related Masters of Science Programs
- Techno MBAs
- Two-Year IT Degrees at Community Colleges
- IT Certificate Programs
- Private, For-Profit Education and Training Institutions
- Vendor and Vendor-neutral IT Certification
- Federal, State and Regional IT Training Initiatives
- Boot Camps and Seminars
- Employer Programs
- On-Line, CD-ROM, Books
- The Churn

Possible Niche Areas of Need

- Emerging Disciplines
- Converging Disciplines
- Industries Affected by Past/Current Federal Demand
- University Professors in High Demand Disciplines
- Federal S&E Employees: Unique Challenges
- Industries with Past Workforce Shocks

Challenge to the Community: Action

- Amplify Market Signals
  - Industry Feedback to Post-Secondary Institutions
  - Post-Secondary Institutions' Responsiveness to Market Demands
    - Preparation for industry careers
    - Technical skills in demand
    - Soft and business skills
  - Career Awareness in Middle, High School
  - Dissemination of Occupational Data
    - Demand, job characteristics, unemployment, etc.
- Improve Math and Science Education in K-12

Challenge to the Community: Action

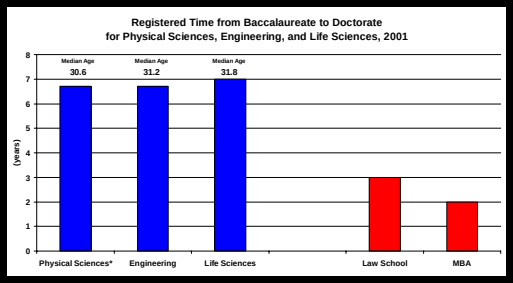
- Math and Science Education in K-12
- Image of Scientists and Engineers
- S&E Career Awareness in Middle, High School
- Industry Feedback to Post-Secondary Institutions
- Post-Secondary Institutions' Responsiveness to Market Demands
- Industry Must Help Itself

Challenges to Growing Domestic S&E Workforce

- Cost-Benefit of Grad Education in S&E vs. Law, Business

Challenges to Growing Domestic S&E Workforce

- Cost-Benefit of Grad Education in S&E vs. Law, Business



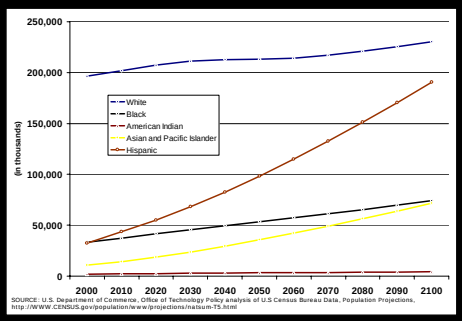
Challenges to Growing Domestic S&E Workforce

- Cost-Benefit of Grad Education in S&E vs. Law, Business
- Attractiveness of Careers in S&E vs. Law, Business
- Strong Emphasis by Other Nations, Cultures on S&E Education
- Access to Foreign Labor in the U.S. (H-1B, L1)
- Access to Foreign Labor Abroad (Offshoring—direct and through contract)
  - Significantly lower salary costs
  - Pools of well-educated S&E talent
  - Improved national infrastructure, political stability
- Large Government, Industry Focus on Health R&D

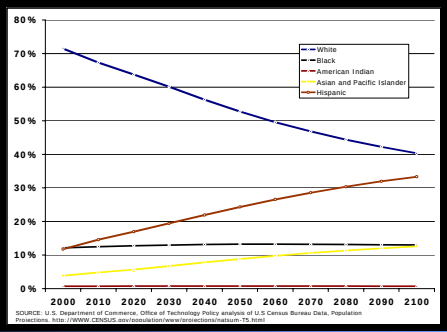
Factors Supporting U.S. Ability to Grow Domestic S&E Workforce

- Premier Academic Research Institutions
- Elite Students Among Best in World
- Powerful Industrial Base, Potential Partners in S&E Education and Training
- Money Talks!

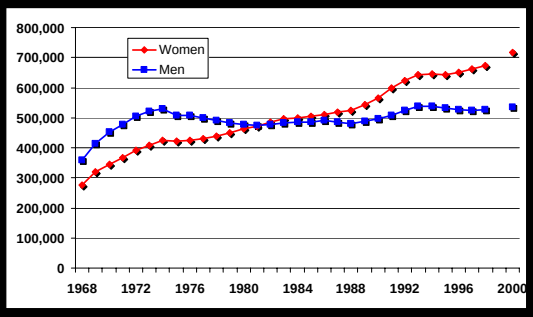
Census Bureau Projections Thru 2100
U.S. Race/Ethnic Composition, numbers



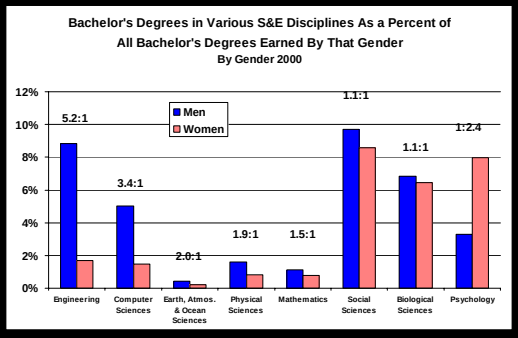
Census Bureau Projections Thru 2100
U.S. Race/Ethnic Composition, percent



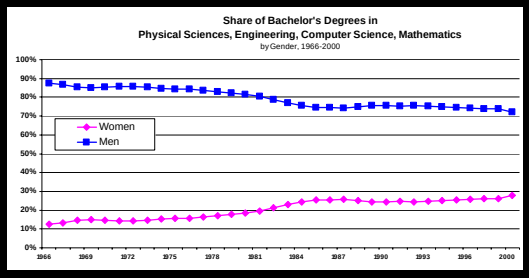
Bachelor's Degrees Awarded, by Gender



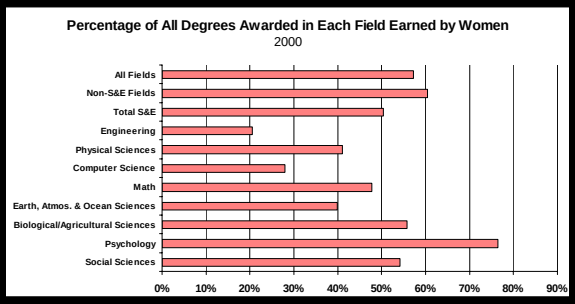
S&E Bachelor's Degrees, by Gender



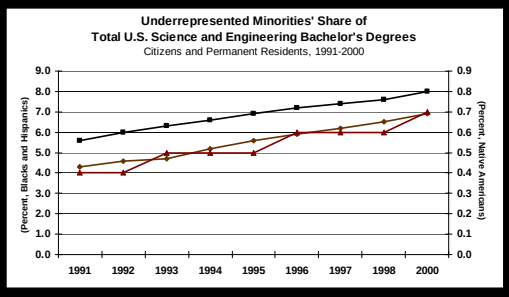
Women's Share of MEPS Bachelor's Degrees Growing, Still Comparatively Low



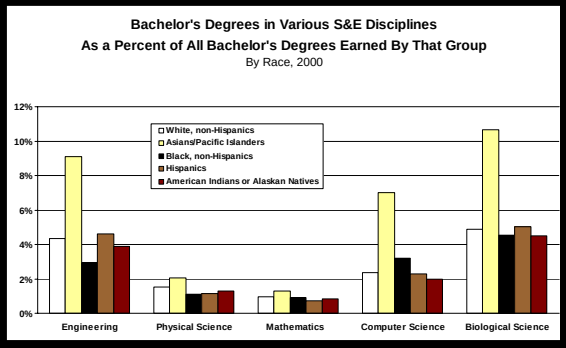
Share of Bachelor's Degrees in Each Field Earned by Women, 2000



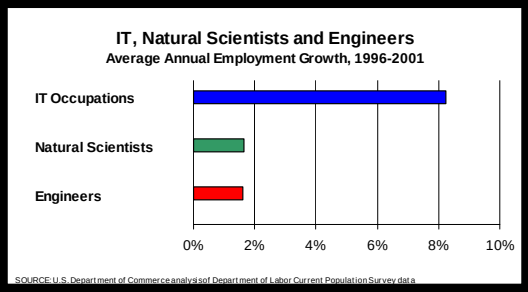
Share of Total U.S. S&E Bachelor's Degrees



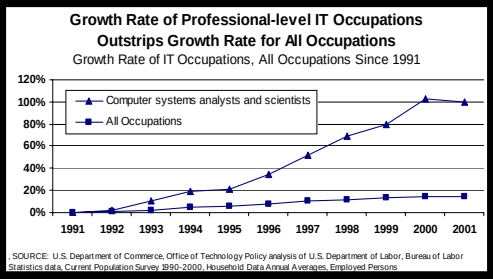
S&E Bachelor's Degrees, by Race



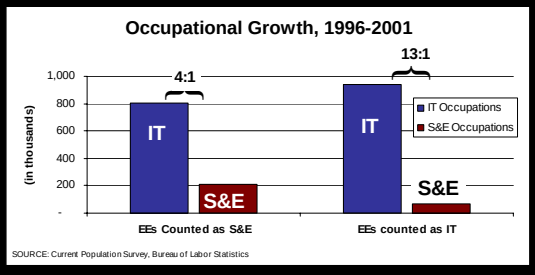
IT Occupational Growth Rate 5 Times Greater Than Natural Scientists, Engineers



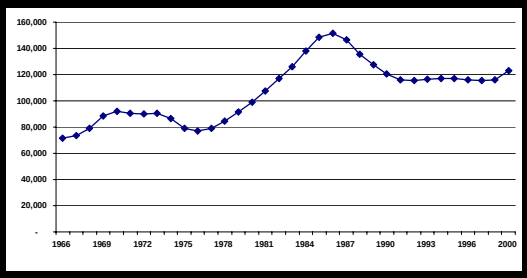
Occupational Growth Rates IT vs. All Occupations



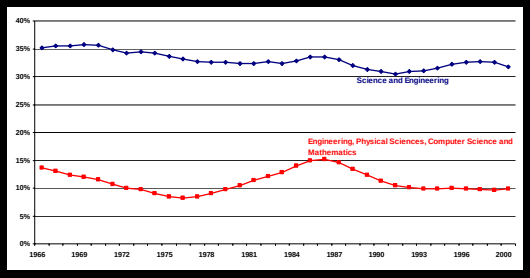
S&E Occupational Growth Dominated by Information Technology Occupations



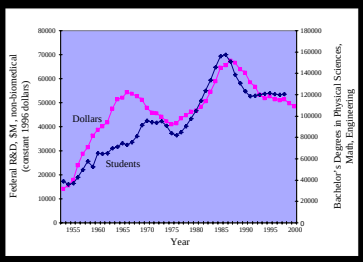
Total Bachelor's Degrees in Engineering, Physical Sciences, Computer Science and Mathematics Stable

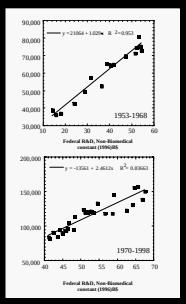


Science and Engineering, MEPS as a Share of All Bachelor's Degrees

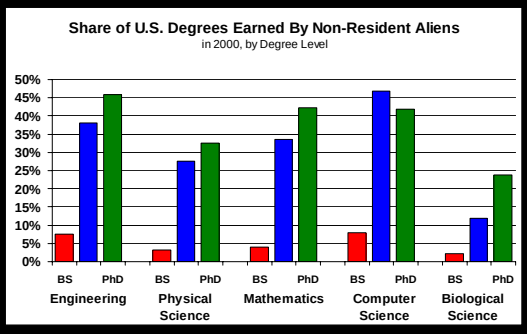


Strong correlation between Federal R&D investments in MEPS and bachelor's degree production in MEPS fields

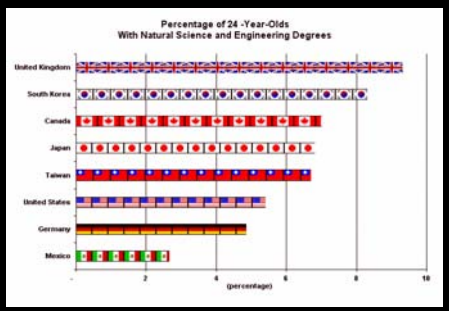




Share of Total S&E Degrees Earned by Non-Resident Aliens, by Degree Level



U.S. Lags Other Nations in Share of 24-Year-Olds With Natural Science, Engineering Degrees



Also: The United States ranks 61st out of 63 nations in the share of S&E degrees as a total of all bachelor's degrees.