Remarks before the Computing Research Association

The Adequacy of the U.S. S&E Workforce:

A QUANTITATIVE PERSPECTIVE

Offshore Outsourcing

John Sargent
Senior Policy Analyst
U.S. Department of Commerce
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 (CAWMSSET)

• “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

**Engineering**

Average Annual Employment Growth, 1996-2001

- Electrical/Electronic
- Civil
- Aerospace
- Engineers, n.e.c.
- Industrial
- Mechanical
- Metallurgical/Materials
- Nuclear
- Petroleum
- Chemical
- Marine
- Mining
- Agricultural

**Physical/Life/Computer Sciences and Mathematics**

Average Annual Employment Growth, 1996-2001

- Computer Sys Analysts/Scientists
- Atmospheric/Space Scientists
- Medical scientists
- Computer Programmers
- Chemists
- Biological/Life Scientists
- Geologists/Geodesists
- Forestry/Conservation
- Mathematical Scientists
- Agricultural/Food Scientists
- Physical Scientists, n.e.c.
- Physicists/Astronomers

Recent Occupational Growth
Growth in Numbers

Employment Growth in S&E Occupations
1996-2001, in thousands

Computer Systems Analysts & Scientists
Electrical/Electronic Engineers
Computer Programmers
Civil Engineers
Medical Scientists
Chemists
Biological/Life Scientists
Aerospace Engineers
Engineers, n.e.c.
Atmospheric/Space
Industrial Engineers
Geologists/Geodesists
Forestry/Conservation Scientists
Mathematical Scientists, n.e.c.
Agricultural Engineers
Nuclear Engineers
Agricultural/Food Scientists
Metallurgical/Materials Engineers
Petroleum Engineers
Mining Engineers
Physical Scientists, n.e.c.
Physicists/Astronomers
Marine Engineers
Mechanical Engineer
Chemical Engineers

Aggregate IT Employment
1999-2002

Change, 1999-2000
Number: 295,880
Percent: +12.6%

Change, 2000-2001
Number: -92,870
Percent: -3.5%

Change, 2001-2002
Number: -42,090
Percent: -1.7%

IT Occupational Employment
1999-2002

Change in IT Occupational Employment
Number, 2001-2002

Computer Systems Analysts
Network Systems and Data Communications Analysts
Network and Computer Systems Administrators
Computer Hardware Engineers
Computer and Information Scientists, Research
Database Administrators
Computer and Information Systems Managers
Computer Software Engineers, Applications
Computer Software Engineers, Systems Software
Computer Support Specialists
Computer Programmers

Change in IT Occupational Employment Percentage, 2001-2002

- Network Systems and Data Communications Analysts
- Computer Systems Analysts
- Network and Computer Systems Administrators
- Computer Hardware Engineers
- Computer and Information Systems Managers
- Computer Software Engineers, Applications
- Database Administrators
- Computer Software Engineers, Systems Software
- Computer Support Specialists
- Computer and Information Scientists, Research
- Computer Programmers

Salary Growth

Annual Average Salary Increases, 1995-2000

All Workers
Aerospace
Mechanical
Civil
Electrical/Electronic
Engineers, n.e.c.
Chemical
Industrial
Chemists
Biological/Life Scientists
Medical Scientists
Computer Systems Analysts and Scientists
Computer Programmers

Salary Growth in IT Occupations 1999-2002

Percent Salary Growth in IT Occupations

Unemployment Rates

Average Annual Unemployment
Engineers, IT Workers, Professional Specialties
1983-2002

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, software specialist, and other occupations. Computer system analysts and scientists are classified within professional specialty occupations and computer programmers in technicians and related support occupations. Data for 2000-2002 have been revised to incorporate population controls from Census 2000.
IT, Science and Engineering Occupational Projections, 2002-2012

Employment, Numbers

- Professional IT Occupations
- Engineers
- Life Scientists
- Physical Scientists
- Natural Sciences Managers
IT, Science and Engineering Occupational Projections, 2002-2012

Employment Growth: Rate

- Professional IT Occupations: 35%
- Engineers: 5%
- Life Scientists: 15%
- Physical Scientists: 10%
- Natural Sciences Managers: 5%
IT, Science and Engineering Occupational Projections, 2002-2012

Employment Growth: Numbers

- Professional IT Occupations
- Engineers
- Life Scientists
- Physical Scientists
- Natural Sciences Managers

Bar chart showing employment growth numbers for different occupational categories.
IT, Science and Engineering Occupational Projections, 2002-2012

Total Job Openings

- Professional IT Occupations: 1,800,000
- Engineers: 400,000
- Life Scientists: 200,000
- Physical Scientists: 100,000
- Natural Sciences Managers: 0

Total Job Openings from 200,000 to 1,800,000.
Occupational Distribution of Projected S&E Job Openings (new jobs plus net replacements) 2002-2012

- Information Technology: 70%
- Engineers
- Life Scientists
- Physical Scientists
- Natural Science Managers
IT, Science and Engineering Occupational Projections, 2002-2012


![Graph showing job growth for Professional IT occupations, Engineers, Life Scientists, Physical Scientists, and Natural Sciences Managers between 2000-2010 and 2002-2012.]
Change in Growth: 2000-2010 vs. 2002-2012

- Professional IT Occupations: -1,200,000
- Engineers: -1,000,000
- Life Scientists: -800,000
- Physical Scientists: -600,000
- Natural Sciences Managers: -400,000
Projected IT Job Growth 2010 vs. 2012 Projections

- A reduction of more than 1 million jobs
- A reduction of 1.6 million jobs

2010: 5,000,000
2012: 4,000,000
2012 if previous trend of 5.2% annual growth had continued: 5,400,000

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

- Professional IT Occupations
- Engineers
- Life Scientists
- Physical Scientists
- Natural Sciences Managers

- 2000-2010
- 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?

A 23 percent decline since 1985…

…or a 53 percent increase since 1976?
Both, depending on your perspective...
The Market Perspective
Degree Production vs. Projected Job Openings

Annual Degrees and Job Openings in Broad S&E Fields

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
Engineering
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/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

- Occupations include Electrical, Electronics, Computer Hardware Engineers
- There are an additional 400 jobs per year for Material Scientists (not shown here; included in the "Other Physical Sciences" category)
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/NSF: 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

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/IES: 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.
Biological and Agricultural 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/IRI: 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.
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
Professional Level IT Workers Hold a Wide Array of Science, Engineering and Other Degrees

Of professional level IT workers who hold bachelor's or higher level degrees, 87.5% hold degrees in science, math or engineering.
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

[Bar chart: Registered Time from Baccalaureate to Doctorate for Physical Sciences, Engineering, and Life Sciences, 2001]

- Median Age for Physical Sciences: 30.6 years
- Median Age for Engineering: 31.2 years
- Median Age for Life Sciences: 31.8 years
- Median Age for Law School: Not applicable
- Median Age for MBA: Not applicable
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!
Contact Information

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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

Bachelor's Degrees in Various S&E Disciplines As a Percent of All Bachelor's Degrees Earned By That Gender
By Gender 2000

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Men/Women Ratio</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering</td>
<td>5.2:1</td>
<td>11%</td>
</tr>
<tr>
<td>Computer Sciences</td>
<td>3.4:1</td>
<td>7%</td>
</tr>
<tr>
<td>Earth, Atmos. &amp; Ocean Sciences</td>
<td>2.0:1</td>
<td>4%</td>
</tr>
<tr>
<td>Physical Sciences</td>
<td>1.9:1</td>
<td>3%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>1.5:1</td>
<td>2%</td>
</tr>
<tr>
<td>Social Sciences</td>
<td>1.1:1</td>
<td>1%</td>
</tr>
<tr>
<td>Biological Sciences</td>
<td>1.1:1</td>
<td>1%</td>
</tr>
<tr>
<td>Psychology</td>
<td>1:2.4</td>
<td>0.5%</td>
</tr>
</tbody>
</table>
Women’s Share of MEPS Bachelor’s Degrees Growing, Still Comparatively Low

Share of Bachelor’s Degrees in Physical Sciences, Engineering, Computer Science, Mathematics by Gender, 1966-2000
Share of Bachelor’s Degrees in Each Field Earned by Women, 2000

Percentage of All Degrees Awarded in Each Field Earned by Women

- All Fields
- Non-S&E Fields
- Total S&E
- Engineering
- Physical Sciences
- Computer Science
- Math
- Earth, Atmos. & Ocean Sciences
- Biological/Agricultural Sciences
- Psychology
- Social Sciences

2000

0% 10% 20% 30% 40% 50% 60% 70% 80% 90%
Share of Total U.S. S&E Bachelor’s Degrees

Underrepresented Minorities' Share of
Total U.S. Science and Engineering Bachelor's Degrees
Citizens and Permanent Residents, 1991-2000
Bachelor's Degrees in Various S&E Disciplines
As a Percent of All Bachelor's Degrees Earned By That Group
By Race, 2000

- White, non-Hispanics
- Asians/Pacific Islanders
- Black, non-Hispanics
- Hispanics
- American Indians or Alaskan Natives

Disciplines:
- Engineering
- Physical Science
- Mathematics
- Computer Science
- Biological Science
IT Occupational Growth Rate 5 Times Greater Than Natural Scientists, Engineers

IT, Natural Scientists and Engineers
Average Annual Employment Growth, 1996-2001

Occupational Growth Rates
IT vs. All Occupations

Growth Rate of Professional-level IT Occupations
Outstrips Growth Rate for All Occupations
Growth Rate of IT Occupations, All Occupations Since 1991

S&E Occupational Growth Dominated by Information Technology Occupations

Occupational Growth, 1996-2001

IT Occupations
S&E 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

[Graph showing the percentage of Science and Engineering degrees from 1966 to 2000.]
Strong correlation between Federal R&D investments in MEPS and bachelor’s degree production in MEPS fields

\[ y = 21064 + 1.029x \quad R^2 = 0.953 \]

1953-1968

\[ y = -13561 + 2.4612x \quad R^2 = 0.83663 \]

1970-1998

Federal R&D, Non-Biomedical constant (1996) B$
Share of Total S&E Degrees Earned by Non-Resident Aliens, by Degree Level

Share of U.S. Degrees Earned By Non-Resident Aliens in 2000, by Degree Level

- Engineering
- Physical Science
- Mathematics
- Computer Science
- Biological Science

Degree Levels:
- BS
- PhD
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.