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The U.S. Science and Technology Workforce

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Summary

In the 21st century, global competition and rapid advances in science and technology will challenge the scientific and technical proficiency of the U.S. workforce. Policymakers often discuss policy actions that could enhance the nation's science and technology (S&T) workforce—deemed by some as essential to both meet U.S. workforce demands as well as to generate the new ideas that lead to improved and new industries that create jobs.

The America COMPETES Act (P.L. 110-69) addresses concerns regarding the S&T workforce and STEM education, and the 111th Congress is debating funding for the programs authorized within it. Policymaker discussions tend to focus on three issues: demographic trends and the future S&T talent pool, the current S&T workforce and changing workforce needs, and the influence of foreign S&T students and workers on the U.S. S&T workforce. Many perspectives exist, however, on the supply and demand of scientists and engineers. Some question the fundamental premise that any action is necessary at all regarding U.S. competitiveness. They question whether or not the S&T workforce and STEM education are problems at all.

The first issue of demographic trends and the future S&T talent pool revolves around whether the quality of science, technology, engineering and mathematics (STEM) education received by all Americans at the pre-college level is of sufficient quality that workers are available to satisfy current and future workforce needs. In response, some policymakers propose taking actions to increase the number of Americans interested in the S&T workforce. These policies are motivated by demographic trends that indicate the pool of future workers will be far more diverse than the current STEM workforce. Proposed policies would take actions to enhance the quality of STEM education these Americans receive so they are able to consider S&T careers, and to recruit them into the S&T workforce.

The second issue regarding the current S&T workforce and changing workforce needs tend to focus on whether or not the number of Americans pursuing post-secondary STEM degrees is sufficient to meet future workforce needs compared to students in countries considered to be U.S. competitors. The goal of proposed policies responding to this concern to reinvigorate and retrain Americans currently trained in science and engineering who voluntarily or involuntarily are no longer part of the current STEM workforce.

The third issue focuses on whether or not the presence of foreign S&T students and workers is necessary to meet the nation's workforce needs and attract the best and brightest to bring their ideas to the United States, or if the presence of such individuals adversely affects the U.S. S&T students and workers. Policy discussions focus on immigration policy, primarily increasing the ability of foreign STEM students currently in U.S. universities to more easily obtain permanent admission, and increasing the number of temporary worker visas available so more talent from abroad can be recruited to the United States.

The challenge facing policymakers when making decisions regarding the S&T workforce is that science, engineering, and economic conditions are constantly changing, both in terms of workforce needs as well as the skills the STEM workforce needs to be marketable relative to demand.

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In the 21st century, global competition and rapid advances in science and technology will challenge the scientific and technical proficiency of the U.S. workforce. This report provides an overview of the status of the U.S. science and technology (S&T) workforce, and identifies some of the issues and options that are currently being discussed in Congress.

Background

The ability of the United States to be competitive in the global economy is viewed by many experts as a major factor influencing the ability of the United States to maintain its economic growth and standard of living. Scientific and technological advances can further economic growth because they contribute to the creation of new goods, services, jobs, and capital, or increase productivity.[1] From a company, employee, and possibly community perspective, competitiveness may be defined as the ability of a firm to compete for market share against imports from abroad or to compete with foreign firms in overseas export markets.[2] The America COMPETES Act (P.L. 110-69) responds to some of these concerns.[3] Congress is discussing additional actions that it may take in response to concerns about the S&T workforce.

Interest in the competitiveness issue began following World War II and perhaps reached its peak in the 1970s, when some experts became concerned that Japan, Europe, and newly industrialized countries were becoming major competitors with the United States. The United States had lost market share in autos, cameras, stereos, television sets, steel, machine tools, and microelectronics.[4] Now that the nation has entered the 21st century, today's competitiveness concerns tend to be focused on issues related to increased economic globalization—that is, increasing integration of national economies into a worldwide trading system.[5] This globalization has a growing impact, both positive and negative, on the economic futures of American companies, workers, and families. Increasing integration with the world economy can make the United States more productive, leading to increases in living standards and real disposable incomes. However, rising trade with low-wage developing countries increases workers' concerns about job loss, lower wages, and benefits as American companies take actions to compete in a global economy. The information technology revolution has expanded these competitiveness concerns to U.S. white collar jobs.[6]

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[1] Excerpted from CRS Report RL33528, *Industrial Competitiveness and Technological Advancement: Debate Over Government Policy*, by (name redacted).

[2] CRS Report RS22445, *Taxes and International Competitiveness*, by (name redacted).

[3] For more information, see CRS Report RL34396, *The America COMPETES Act and the FY2009 Budget*, and CRS Report RL34328, *America COMPETES Act: Programs, Funding, and Selected Issues*, both by (name redacted).

[4] Bruce L. R. Smith, *American Science Policy Since World War II* (Washington, DC: Brookings Press, 2000), p. 101-105. Kent H. Hughes, *Building the Next American Century: The Past and Present of American Economic Competitiveness* (Baltimore: The Johns Hopkins Press, 2005). James Turner, "The Next Innovation Revolution: Laying the Groundwork for the United States," *innovations*, spring 2006, p. 123-144, at http://publicaa.ansi.org/sites/apdl/Documents/News%20and%20Publications/Other%20Documents/Turner-Innovations.pdf.

[5] CRS Report RL33944, *Trade Primer: Qs and As on Trade Concepts, Performance, and Policy*, coordinated by (name redacted).

[6] Excerpted from CRS Report RL34091, *Globalization, Worker Insecurity, and Policy Approaches*, by (name redac ted). See also Richard B. Freeman, "Is a Great Labor Shortage Coming?: Replacement Demand in the Global Economy," National Bureau of Economic Research, Working Paper 12541, September 2006 at http://www.nber.org/papers/w12541.pdf.

As in the past, concerns about U.S. competitiveness lead to a focus on the S&T workforce (see **Box 1**). These include questions about whether the quality of science, technology, engineering and mathematics (STEM) education received by all Americans at the pre-college level is of sufficient quality that workers are available to satisfy current and future workforce needs. In addition, the number of Americans pursuing post-secondary STEM degrees is considered to be low relative to students in countries considered to be U.S. competitors.[7] This workforce is deemed by some as essential to both meet U.S. workforce demands as well as to generate the new ideas that lead to improved and new industries, and the jobs that are created as a result.

Box 1. Who Should Be Included in the S&T Workforce?

Determining the S&T workforce is a challenging task. At its core are scientists and engineers, but workforce estimates can vary based on whether or not the estimate includes those in defined S&E occupations, in related S&E occupations (e.g., pre-college teachers, managers, technicians), who use S&E knowledge (e.g., patent lawyers, doctors, health professionals), or who have at least one degree in S&E or an S&E-related fields.[a] Using these varying definitions, S&T workforce estimates are developed by the National Science Foundation (NSF)/National Science Board (NSB), the Bureau of Labor Statistics (BLS), and the U.S. Census Bureau. Each has different definitions of who should be included in the S&T workforce and estimates can also vary depending on the data used.

Most estimates focus only on the S&E workforce as opposed to the entire S&T workforce, but S&E estimates vary as well. NSB indicates that, depending on the definition and perspective used, the size of the S&E workforce varied between approximately 5.0 million and 21.4 million individuals in 2006—approximately 4-15% of all employed civilians in the United States (144.4 million[b]). For example, one NSF analysis finds that, in 2006, 5.0 million of the 18.9 million employed scientists and engineers worked in S&E occupations, 5.2 million worked in S&E-related occupations, and 8.7 million worked in non-S&E-related occupations.[c]

NSB suggests that the most relevant S&E workforce estimate may be 17.0 million, which in 2006 was the number of individuals who had at least one degree in an S&E field, or 21.4 million, which includes both these individuals plus those with a degree in an S&E related field such as health or technology—as it reflects the many ways science and technical knowledge is used in the United States.[a]

Sources:

a. National Science Board, Science and Engineering Indicators 2008, Chapter 3 (Arlington, VA: National Science Foundation, 2008) at http://www.nsf.gov/statistics/seind08/pdf/c03.pdf.

b. U.S. Census Bureau, Statistical Abstract of the United States: 2008, Table 583 (Washington, DC: Government Printing Office, 2008) at http://www.census.gov/compendia/statab/.

c. National Science Foundation, "Unemployment Rate of U.S. Scientists and Engineers Drops to Record Low 2.5% in 2006," NSF 08-235, April 2008 at http://www.nsf.gov/statistics/infbrief/nsf08305/.

Many perspectives exist on the supply and demand of scientists and engineers. While some believe that increasing the number of Americans with STEM degrees is essential to providing an S&T workforce so that the United States is competitive,[8] others question whether or not U.S. competitiveness, the S&T workforce, and STEM education are problems at all.[9] These analysts express doubts as to whether additional scientists and engineers in the United States are needed given current workforce projections, and why if the demand is so high, salaries for those in

[7] CRS Report 98-871, *Science, Engineering, and Mathematics Education: Status and Issues*, by (name redacte d). CRS Report RL33434, *Science, Technology, Engineering, and Mathematics (STEM) Education: Background, Federal Policy, and Legislative Action*, by (name redacted).

[8] See, for example, Tapping America's Potential, "Tapping America's Potential: The Education for Innovation Initiative," July 2005 at http://tap2015.org.

[9] See, for example, testimony at U.S. Congress, House Committee on Science and Technology, *The Globalization of R&D and Innovation, Pt. IV: Implications for the Science and Engineering Workforce*, hearing, 110th Congress, 1st sess., November 6, 2007 at http://science.house.gov/publications/hearings_markups_details.aspx?NewsID=2032.

STEM occupations are not higher.[10] Other analysts suggest that the quality and number of scientists and engineers in China and India, the primary nations that are the focus of today's competitiveness concerns, are exaggerated.[11] Another argument focuses on the possible unintended side-effects of implementation. For example, will the act result in an oversupply of scientists and engineers? These critics propose that policy actions focus on improving the information employers and universities supply to students so they can make better choices, and enhancing the salary and career paths for existing scientific and technical staff.[12]

Status of the U.S. Science and Technology (S&T) Workforce

This section describes the historical, current, and projected future S&T workforce trends in the United States. There are challenges, however, in reviewing these trends (see **Box 2**). This is particularly true in light of current economic conditions. It is important to keep in mind in reviewing the information in this section is that the most recent data available regarding these overall trends is from 2006, and that the information provided here is based on long-term trend analysis and does not take into account the recession that economists indicate began in 2007.[13]

What are the Historical Trends in the U.S. S&T Workforce?

As shown in **Figure 1**, the number of workers in S&T occupations—workers in S&E occupations plus technicians and programmers—grew at a 6.8% average annual rate between 1950-2000, according to NSB.[14] From 1950 to 2000, the number of S&T employees increased from approximately 0.2 million in 1950 to 5.5 million in 2000. NSB's analysis found that workforce demand varied greatly by occupation with major changes, both positive and negative, within occupations. For example, economic downturns in 1992 (as illustrated in **Figure 1**) and 2002 led to decreases in S&E occupation employment in some S&E fields, but not in others.

[10] Titus Galama, James Hosek, *U.S. Competitiveness in Science and Technology*, (Santa Monica, CA: Rand National Defense Research Institute, 2008) at http://www.rand.org. B. Lindsay Lowell and Hal Salzman, "Into the Eye of the Storm: Assessing the Evidence on Science and Engineering Education, Quality, and Workforce Demand" (Washington, DC: The Urban Institute, October 2007).

[11] J. Bhagwati, "The World is Not Flat," *Wall Street Journal*, August 4, 2005. Vivek Wadhwa, Gary Gereffi, Ben Rissing, Ryan Ong, "Seeing through Preconceptions: A Deeper Look at China and India," *Issues in Science and Technology*, Spring 2007 at http://www.issues.org/23.3/wadhwa.html.

[12] Michael Teitelbaum, "Is There Really a Shortage of Technical Professionals?," *Research-Technology Management*, pp. 10-13, March 1, 2008.

[13] For more discussion of this issue, see CRS Report R40080, *Job Loss and Infrastructure Job Creation During the Recession*, by (name redacted).

[14] National Science Board, *Science and Engineering Indicators 2008*, Chapter 3 (Arlington, VA: National Science Foundation, 2008) at http://www.nsf.gov/statistics/seind08/pdf/c03.pdf.

Box 2. Challenges in Developing Conclusions from S&T Workforce Data

Developing conclusions from S&T employment data can be challenging as analysis of data from different sources at different times often presents differing pictures of the workforce. A related factor is that while some data represent the supply of individuals seeking employment, other data provide information on the demand for those individuals.

An example of demand data is a January 2008 analysis of job openings. This analysis found that major U.S. technology companies averaged more than 470 U.S.-based job openings for skilled positions, while defense companies averaged 1,265 each.[a] Supply data just a few months later in May 2008, however, may lead some to a different conclusion. In this case, BLS indicated that overall unemployment is 5.5%, compared with 4.5% in May 2007.[b] The degree to which S&T employment is affected is unknown at this point, and may not be known for 1-2 years, leading to uncertainties in developing a conclusion regarding the status of the S&T workforce. Even with long-term data, such as that in **Figure 1** and **Figure 2**, field-specific and degree-specific differences can offer a very different picture of the status of the U.S. S&T workforce. While demand for those in one field can be high, for others it can be low.

When broad industry or company future projection data are presented, it is important to understand the data. For example, it is important to understand whether projected openings are worldwide or U.S. data, the degree of specialization involved, and whether or not the projection is based on obtaining a particular government or other contract. This last point may be particularly important if multiple companies in a given industry are all hoping to be successful in winning a particular contract as the jobs projected may be duplicative.

BLS conducted an analysis of the accuracy of its occupational projections, and found employment change was projected correctly for approximately 70% of the occupations evaluated. It found that BLS projections tended to be conservative with projected employment for the largest number of occupations estimated at the average growth rate, while in reality most occupations either grew faster or declined. Occupations BLS projected for the most rapid employment growth had greater increases than BLS expected, and those expected to decline had greater decreases than expected. BLS concluded that good occupational projections rely on good industry projections.[c]

Some experts worry that a lack of understanding of the volatility of some S&T occupations, and their dependence on the economy and government policy actions, can lead policymakers to make "false promises"—encouraging students to undertake long-term STEM education for jobs that may not be there when they graduate. NSB acknowledges that predicting the demand for scientists and engineers is difficult. Unanticipated corporate and governments decisions can influence the S&T workforce positively (e.g., new products or industries are created) or negatively (e.g., R&D previously conducted in the United States is moved elsewhere).[d]

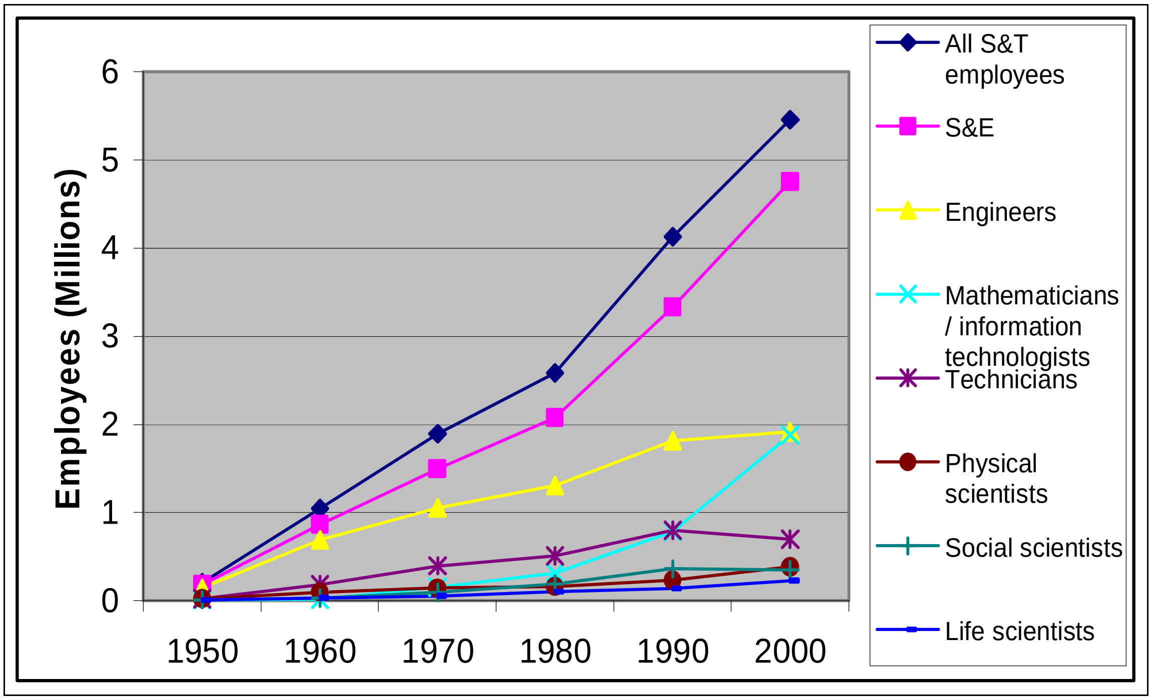
a. National Foundation for American Policy [NFAP], NFAP Policy Brief, March 2008, "Talent Search: Job Openings and the Need for Skilled Labor in the U.S. Economy," at http://www.nfap.com/pdf/080311talentsrc.pdf.

b. Bureau of Labor Statistics, "The Employment Situation: May 2008," USDL 08-0757, June 6, 2008 at http://www.bls.gov/news.release/pdf/empsit.pdf.

c. Bureau of Labor Statistics, "The 1988-2000 Employment Projections: How Accurate Were They?," Andrew Alpert and Jill Auyer (authors), Occupational Outlook Quarterly, Spring 2003 at http://www.bls.gov/opub/ooq/2003/spring/art01.pdf.

d. National Science Board, Science and Engineering Indicators 2008, Chapter 3 (Arlington, VA: National Science Foundation, 2008) at http://www.nsf.gov/statistics/seind08/pdf/c03.pdf.

Figure 1. Science and Technology Employment: 1950-2000



Source: National Science Board, *Science and Engineering Indicators 2008*, Figure 3-1, (Arlington, VA: National Science Foundation, 2008) at http://www.nsf.gov/statistics/seind08/pdf/c03.pdf.

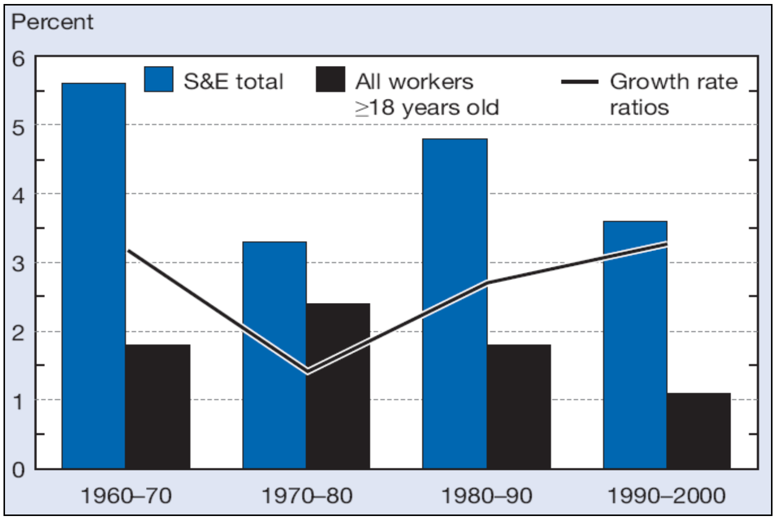
Note: S&T = science and technology. S&E = scientists and engineers. Data include bachelor's degrees or higher in science occupations, some college and above in engineering occupations, and any education level for technicians and computer programmers.

Figure 2 takes the major influence on the number of workers in S&T occupations, those in S&E occupations, and compares the average annual growth rate of these workers to that of all workers.[15] As shown here, the average annual growth rate for S&E occupations was consistently higher than that for all workers from 1960-2000. For all S&E fields, employment has grown faster than degree production. As shown in **Figure 3**, while the number of workers in S&E occupations grew at an average annual rate of 4.2% from 1980-2000, the S&E degree production grew at a lower rate of 1.5% [16] According to the NSB, the marketplace responded to that difference between degree and occupation growth by employing individuals in S&E occupations who did not have S&E degrees and foreign S&E workers.

[15] Ibid.

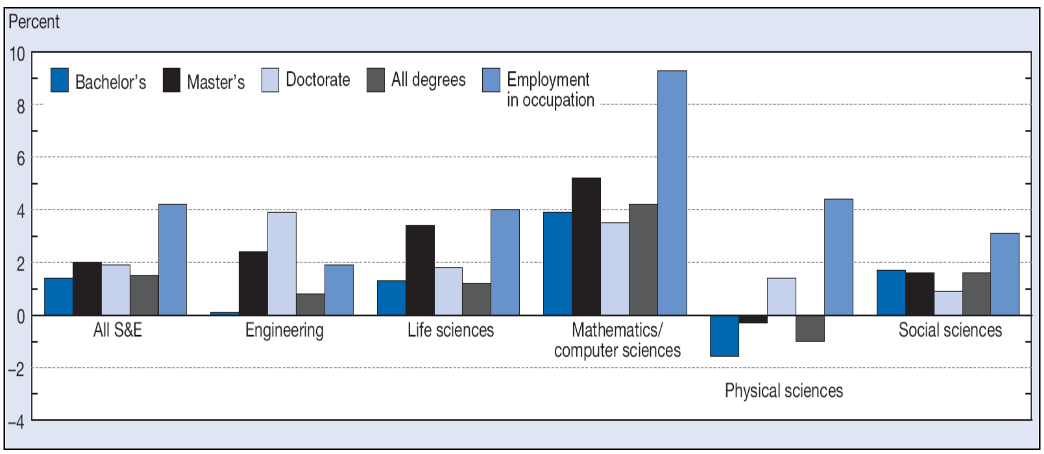
[16] Ibid.

Figure 2. Average Annual Growth Rate of S&E Occupations Versus All Workers: 1960-2000



Source: National Science Board, *Science and Engineering Indicators 2008*, Figure 3-2 (Arlington, VA: National Science Foundation, 2008) at http://www.nsf.gov/statistics/seind08/pdf/c03.pdf.

Figure 3. Annual Average Growth Rate of Degree Production and Occupational Employment, by Science & Engineering (S&E) Field: 1980-2000



Source: National Science Board, *Science and Engineering Indicators 2008*, Figure 3-3 (Arlington, VA: National Science Foundation, 2008) at http://www.nsf.gov/statistics/seind08/pdf/c03.pdf.

What is the Status of the Current S&T Workforce?

NSF's most current workforce data analysis focuses on the 18.9 million employed scientists and engineers (out of a population of 22.6 million scientists and engineers) in the United States in 2006.[17] The NSF data indicate that the overall unemployment rate for scientists and engineers at

[17] National Science Foundation, "Unemployment Rate of U.S. Scientists and Engineers Drops to Record Low 2.5% in 2006," NSF 08-235, April 2008 at http://www.nsf.gov/statistics/infbrief/nsf08305/. Note that this analysis uses the (continued...)

all degree levels in the United States dropped from 3.2% in 2003 to 2.5% in 2006, with those holding doctorate and professional degree at the lowest unemployment rate of 1.6%. The majority of scientists and engineers, according to these NSF data, work in the business/industry sector (69.4%), followed by educational institutions (18.8%) and government (11.8%). According to the National Science Board, "S&E occupations have generally recovered from unusually high unemployment in the most recent recession."[18]

BLS provides more recent as to the number of individuals in science and engineering occupations employed and unemployed.

Table 1. Employment and Unemployment Data, Select Occupations, 2007-2009

	Employed Persons, by Occupation (in thousands)			Unemployed Rate, by Occupation (%)	
	Annual Average	Annual Average	May	Annual Average	Annual Average
Occupation	**2007**	**2008**	**2009**	**2007**	**2008**
Computer and mathematical occupations	3,441	3,676	3,498	2.1%	2.6%
Architecture and engineering occupations	2,932	2,931	2,809	1.6%	3.1%
Life, physical, and social science occupations	1,382	1,307	1,298	2.0%	2.4%

Source: Congressional Research Service based on BLS data from Current Population Survey, Table 9, "Employed persons by occupation, sex, and age," at http://www.bls.gov/cps/cpsaat9.pdf; Table A-19, " Employed persons by occupation, sex, and age," at http://www.bls.gov/web/cpseea19.pdf; and Table 25, "Unemployed persons by occupation and sex," at http://www.bls.gov/cps/cpsaat25.pdf.

Notes: Household data. Employed persons data for May 2009 has not been seasonally adjusted. Updated population controls are introduced annually with the release of January data.

In terms of demographics, the U.S. 2006 S&E workforce included 54.8% men and 45.2% women.[19] Looking at this same population, an analysis of race/ethnicity finds that 77.0% of this workforce was white, 10.0% Asian, 5.6% black, 5.3% Hispanic (any race), with American Indian/Alaska Native, Native Hawaiian, and multiple race each at 1% or less. These NSF data indicate that 84.5% of the U.S. 2006 S&E workforce were native U.S. citizens, 10.5% naturalized U.S. citizens, 3.7% non-U.S. citizen permanent residents, and 1.3% non-U.S. citizen temporary residents.

(...continued)

2003 and 2006 Scientists and Engineers Statistical Data System (SESTAT) so it will differ slightly from some of the data presented in the previous section. Scientists and engineers refers to all persons who have ever received a bachelor's degree or higher in an S&E or S&E-related field, plus persons holding a non-S&E bachelor's or higher degree who were employed in an S&E or S&E-related occupation in 2003.

[18] National Science Board, *Science and Engineering Indicators 2008* (Arlington, VA: National Science Foundation, 2008) at http://www.nsf.gov/statistics/seind08/pdf/c03.pdf.

[19] Ibid.

What Is the Projected Future S&T Workforce?

In terms of future demand, BLS projects professional and related occupations employment will provide more jobs (5.0 million) than any other group between 2006 and 2016, an increase of nearly 17%.[20] Of the eight subgroups within this occupation category, BLS projects that health care practitioners and technicians will add the most new jobs (1.4 million; 19.8% growth rate) and computer and mathematical occupations will grow the most quickly (0.8 million jobs; 24.8% growth rate). BLS expects other occupational groups related to science and engineering to grow as well, including architecture and engineering (0.3 million jobs; 10.4% growth rate), and life, physical, and social sciences (0.2 million jobs; 14.4% growth rate). Of the 30 fastest growing occupations, with a growth rate of 27% compared to the 10% average for all the occupations, many are science and technology-related.[21]

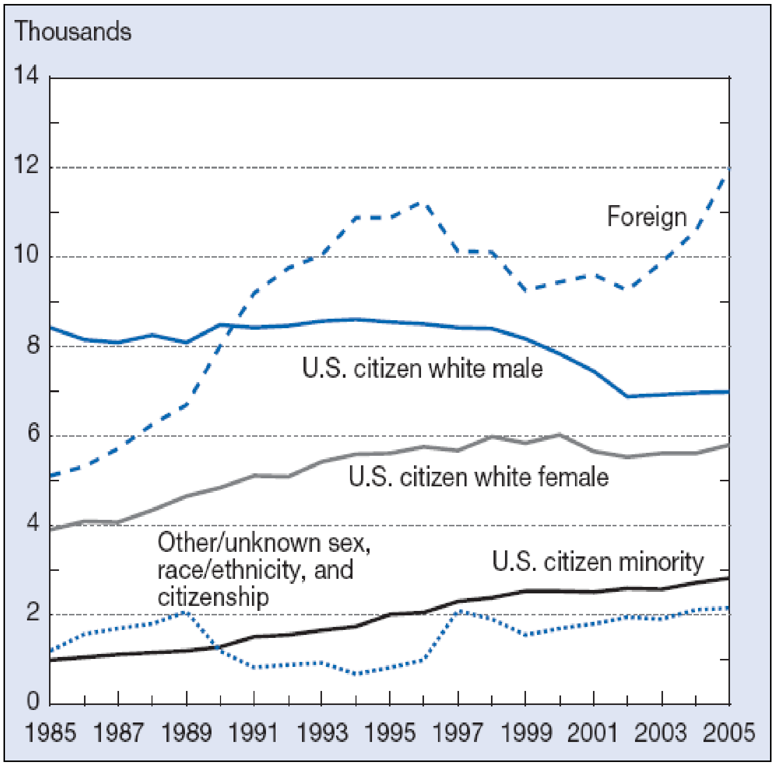
One question is whether or not the United States is educating enough Americans with sufficient STEM education today to meet this projected future demand. Science and engineering occupations have been primarily the domain of white males. As discussed earlier, 77% of the 2006 S&E workforce is white. Within this population, 56% are male.[22] As illustrated in **Figure 4**, however, these demographics are changing. The number of U.S. citizen white males receiving doctoral degrees declined from 1985-2005, while the number of U.S. citizen white females and minorities increased. These demographic groups are looked upon by some as a possible source of increasing the U.S. S&T talent pool.

[20] Bureau of Labor Statistics, Office of Occupational Statistics and Employment Projections, *Employment Outlook: 2006—16: Occupational Employment Projections to 2016*, November 2007, at http://www.bls.gov/opub/mlr/2007/11/art5full.pdf.

[21] Ibid.

[22] National Science Foundation, "Unemployment Rate of U.S. Scientists and Engineers Drops to Record Low 2.5% in 2006," NSF 08-235, April 2008.

Figure 4. S&E Doctoral Degrees, by Sex, Race/Ethnicity, and Citizenship: 1985-2005



Source: National Science Board, *Science and Engineering Indicators 2008*, Figure 2-23 (Arlington, VA: National Science Foundation, 2008) at http://www.nsf.gov/statistics/seind08/pdf/c03.pdf.

NSB found that blacks, Hispanics, and Native Americans/Alaskan Natives as a whole comprise more than 25% of the population and earn, as a whole, 16.2% of the bachelor degrees, 10.7% of the masters degrees, and 5.4% of the doctorate degrees in science and engineering.[23] In 2005, women were awarded approximately 50.5% of the S&E undergraduate degrees, an increase from 46.5% in 1995,[24] and 39.5% of the S&E doctorate degrees, an increase from 32.8% in 1995.[25] Disaggregated data reveal that these awards were concentrated in selected disciplines. In 2005, while women earned 55.0% of the social and behavioral sciences doctorates, women were awarded a lower percentage of the doctorates in other fields—22.5% in engineering, 26.7% in the physical sciences, and 19.8% in computer sciences.[26]

[23] National Science Board, *Science and Engineering Indicators 2008*, Volume 2, Appendix Tables 2-27, 2-29, and 2-31 (Arlington, VA: National Science Foundation, 2008) at http://www.nsf.gov/statistics/seind08/pdf/volume2.pdf.

[24] National Science Board, *Science and Engineering Indicators 2008*, Volume 2, Appendix Table 2-27.

[25] Ibid., Appendix Table 2-31.

[26] Ibid.

Issues and Options for Congress

Discussions among policymakers tend to focus on three issues: demographic trends and the future S&T talent pool, the current S&T workforce and changing workforce needs, and the influence of foreign S&T students and workers on the U.S. S&T workforce.[27] Each of these issues is discussed in more depth below.

Demographic Trends and the Future S&T Talent Pool

Few in the science and engineering community argue about the effect of national demographics on the future science and engineering workforce. With the beginning of the 21st century, a larger proportion of the U.S. population will be composed of minorities—blacks, Hispanics, and Native Americans, with the fastest growing minority group being Hispanics. For example, the population of Hispanic or Latino origin is projected to steadily increase as a percentage of the total U.S. population through 2050, rising from 12.6% in 2000 to 24.4% in 2050.[28] As a result, many are looking toward these groups, currently underrepresented in the S&T workforce, as a source of future U.S. S&T talent.

As a group, minorities traditionally have been underrepresented in the science and engineering disciplines compared to their fraction of the total population.[29] Generally, minorities take fewer high-level science and mathematics courses in high school; earn fewer undergraduate and graduate degrees in science and engineering; and are less likely to be employed in science and engineering positions than white males.[30] While minorities have increased their share of degrees awarded in the sciences, poor preparation in science and mathematics is said to be a major factor limiting the appeal of science and engineering to even larger numbers of these groups. A large number of blacks, Hispanics, and Native Americans lack access to many of the more rigorous college preparatory courses.[31] In addition to recruitment, retention of minorities in the science and engineering educational pipeline, once recruited, also is of concern. The attrition rates for blacks, Hispanics, and Native Americans are higher than for whites or Asians.

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[27] For more information, see CRS Report 97-746, *Foreign Science and Engineering Presence in U.S. Institutions and the Labor Force*, by (name redacted), and CRS Report RL30498, *Immigration: Legislative Issues on Nonimmigrant Professional Specialty (H-1B) Workers*, by (name redacted).

[28] Excerpt from CRS Report RL32701, *The Changing Demographic Profile of the United States*, by (name redacted).

[29] National Science Board, *Science and Engineering Indicators 2008*, Volume 1, pp. 2-20 - 2-21 (Arlington, VA: National Science Foundation, 2008); National Center for Education Statistics, *Status and Trends in the Education of Racial and Ethnic Minorities*, September 2007, at http://nces.ed.gov/pubs2007/minoritytrends/.

[30] Jeffrey L. White, James W. Altschuld, and Yi-Fang Lee, "Persistence of Interest in Science, Technology, Engineering, and Mathematics: A Minority Retention Study," *Journal of Women and Minorities in Science and Engineering*, v. 12, 2006, pp. 47-64; Raymond B. Landis, California State University, Los Angeles, "Retention by Design - Achieving Excellence in Minority Engineering Education," October 2005, at http://www.nacme.org/pdf/RetentionByDesign.pdf; National Science Foundation, *Women, Minorities, and Persons with Disabilities in Science and Engineering*, Arlington, VA, May 2008 Update, http://www.nsf.gov/statistics/wmpd/pdf/may2008updates.pdf.

[31] See for example, Brian K. Bridges, "Bottlenecks and Bulges: The Minority Academic Pipeline," Presentation at the 2nd Annual Conference on Understanding Interventions that Encourage Minorities to Pursue Research Careers, American Council on Education, May 2008; and The College Board, *4th Annual Advanced Placement Report to the Nation*, February 13, 2008 at http://professionals.collegeboard.com/profdownload/ap-report-to-the-nation-2008.pdf.

In the case of women, while enrollment in rigorous course work and advanced placement classes in high school has increased for women, there is substantial attrition along the S&E educational pathway. According to a National Academy of Sciences study, "fewer high school girls intend to major in science and engineering fields, more alter their intentions to major in science and engineering between high school and college, [and] fewer women science and engineering graduates continue on to graduate school."[32] As a result, some believe that programs are needed to strengthen the course taking and persistence of women all along the educational pipeline, as there is substantial attrition of both men and women at all stages of science and engineering education.[33] And although women receive about half of S&E bachelor's and Ph.D. degrees in 2005, they are underrepresented in engineering, computer science, and physics with 25% or less graduate school enrollments in 2005.[34] Another goal of some, therefore, is to increase the representation of women in these fields.

Current S&T Workforce and Changing Workforce Needs

Three issues discussed in relation to the current S&T workforce are the implications of a constantly changing employment market, an aging workforce, and multinational and U.S. firm employment outside the United States. As science and engineering fields evolve, so do the skills needed by the S&T workforce. Some policies are in place and others are recommended to encourage support of workers to pursue and employers to provide continuing education to help the S&T workforce to maintain its employment, and for employers to have a technically-able workforce available in high need areas. Some U.S. workers believe that if corporations were willing to train the S&T workforce whose skills are out-of-date with the new skills these corporations need, the corporations would not need to seek foreign workers—either by bringing them into the United States or employing them abroad.

Another issue is the aging workforce—a key issue for government, university, and industry. Many employers worry that an insufficient number of American S&T students are in the pipeline to replace those who retire. This issue is often cited when U.S. citizenship is required for employment, particularly in the defense, national security, and similar fields.[35] On the other hand, the overall S&T workforce may be sufficient if degree production, retirement patterns, or immigration do not change—though the workforce will be older and the growth rate in such positions may slow significantly. Some worry, however, that this older workforce may not be as creative, and may reduce the opportunities for junior researchers to become independent.[36] Some policies being discussed in this area include recruiting and supporting more Americans to pursue

[32] The National Academies, *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*, Washington, 2007, pp. 51 at http://books.nap.edu/catalog.php?record_id=11741.

[33] Mary E. Virnoche, "Expanding Girls' Horizons: Strengthening Persistence in the Early Math and Science Education Pipeline," *Journal of Women and Minorities in Science and Engineering*, v. 14, 2008, pp 29-44; The National Academies, *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*, Washington, DC, 2007, pp. 59-60 at http://books.nap.edu/catalog.php?record_id=11741; Cornelia Dean, "Women in Science: The Battle Moves to the Trenches," *The New York Times*, December 19, 2006; Amanda Ripley, "Who Says A Woman Can't be Einstein?" *Time*, March 7, 2005, pp. 51-59.

[34] National Science Board, *Science and Engineering Indicators 2008*, Volume 1, Chapter 2 (Arlington, VA: National Science Foundation, 2008)

[35] See, for example, *Congress Daily*, "DHS Official Warns U.S. Workforce Faces Skills 'Crisis'," June 16, 2008.

[36] National Science Board, *Science and Engineering Indicators 2008*, Chapter 3 (Arlington, VA: National Science Foundation, 2008).

S&T workforce careers, and increasing the number of federally sponsored early-career grants focused on younger researchers.[37]

Influence of Foreign S&T Students and Workers

The increased presence of foreign students[38] in graduate science and engineering programs has been and continues to be of concern to some in the scientific community.[39] Enrollment of U.S. citizens in graduate science and engineering programs has not kept pace with that of foreign students in those programs. According to NSF, while the first-time, full-time science and engineering graduate enrollment of foreign students in science and engineering fields increased by 16% from 2005 to 2006, U.S. citizen and permanent resident enrollment increased by slightly more than1%.[40] In addition to the number of foreign students in graduate science and engineering programs, a significant number of non-U.S. citizens with S&E Ph.D. degrees are employed by universities and industry.

There are divergent views in the U.S. scientific and academic community about the effects of a significant foreign presence in graduate science and engineering programs.[41] Some argue that U.S. universities benefit from a large foreign citizen enrollment by helping to meet the needs of the university and, for those students who remain in the United States, the nation's economy.[42] Others argue that the influx of foreign national scientists and engineers has resulted in depressed job opportunities, lowered wages, and declining working conditions for American scientists and engineers.

There are also divergent views regarding immigration and the S&T workforce.[43] While many businesses, especially high-tech companies, have downsized, the federal government annually issued thousands of H-1B[44] visas to foreign workers. There are those in the S&T community who

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[37] See, for example, testimony at U.S. Congress, Senate Committee on Health, Education, Labor, and Pensions, *The Broken Pipeline: Losing Opportunities in the Life Sciences*, hearing, 110th Cong., 2nd sess., March 11, 2008 at http://help.senate.gov/Hearings/2008_03_11/2008_03_11.html. Also, American Academy of Arts and Sciences, "Advancing Research in Science and Engineering: Investing in Early-Career Scientists and High-Risk, High-Reward Research," 2008 at http://www.amacad.org/ariseFolder/.

[38] For more information, see CRS Report RL31146, *Foreign Students in the United States: Policies and Legislation*, by (name redacted).

[39] Cynthia Scanlon, "The H-1B Visa Debate," *Area Development Site and Facility Planning Online*, Oct/Nov 2006 at http://www.areadevelopment.com/laborEducation/oct06/h1bvisa.shtml.

[40] National Science Foundation, First-Time, Full-Time Graduate Student Enrollment in Science and Engineering Increases in 2006, Especially Among Foreign Students, NSF08-302, InfoBrief, December 2007, at http://www.nsf.gov/statistics/infbrief/nsf08302/; and Eugene McCormack, "Number of Foreign Students Bounces Back to Near-Record High," The Chronicle of Higher Education, v. 54, November 16, 2007, p. A1.

[41] See for example, The National Academies, *Policy Implications of International Graduate Students and Postdoctoral Scholars in the United States*, Washington, DC, 2005, pp. 17-65 at http://books.nap.edu/catalog.php?record_id=11289; Norman Matloff, Center for Immigration Studies, "Crying Educational Doom-and-Gloom," May 2, 2008, at http://frontpagemag.com/.

[42] See, for example, Vivek Wadha, AnnaLee Saxenien, Ben Rissing, Gary Gereffi, "Skilled Immigration and Economic Growth," *Applied Research in Economic Development*, 5:1(6-14), May 2008 at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1141190.

[43] For a fuller discussion of the academic literature on these issues, see CRS Report 95-408, *Immigration: The Effects on Low-Skilled and High-Skilled Native-Born Workers*, by (name redacted).

[44] The H-1B temporary visa allows nonimmigrants to work legally in a specialty occupation, such as scientists, engineers, computer programmers, and medical doctors, in the United States for a period up to six years (generally in (continued...)

contend that an over-reliance on H-1B visa workers to fill high-tech positions has weakened opportunities for the U.S. workforce.[45] There are those U.S. workers who also argue that a number of the available positions are being filled by "less-expensive foreign labor."[46] Those critical of the influx of immigrant scientists have advocated placing restrictions on the hiring of foreign skilled employees in addition to enforcing the existing laws designed to protect workers. Those in support of the H-1B program maintain that there is no "clear evidence" that foreign workers displace U.S. workers in comparable positions and that it is necessary to hire foreign workers to fill needed positions, even during periods of slow economic growth.[47]

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three-year increments). For expanded discussion of the H-1B visa see CRS Report RL30498, *Immigration: Legislative Issues on Nonimmigrant Professional Specialty (H-1B) Workers*, by (name redacted); CRS Report 97-746, *Foreign Science and Engineering Presence in U.S. Institutions and the Labor Force*, by (name redacted), and CRS Report RL31973, *Programs Funded by the H-1B Visa Education and Training Fee, and Labor Market Conditions for Information Technology (IT) Workers*, by (name redacted) and (name redacted).

[45] See for example, Ephraim Schwartz, "H-1B: Patriotic or Treasonous?," *InfoWorld*, v. 27, May 6, 2005, at http://www.infoworld.com/article/05/05/06/19NNh1b_1.html.

[46] Carrie Johnson, "Hiring of Foreign Workers Frustrates Native Job-Seekers," *Washington Post*, February 27, 2002, p. E01.

[47] See for example, John Clark, Nadine Jeserich, and Graham Toft, Hudson Institute, *Can Foreign Talent Fill Gaps in the U.S. Labor Force? The Contributions of Recent Literature*, September 2004; Chris Baker, "Visa Restrictions Will Harm U.S. Technology, Gates Says; Microsoft Chief Calls For End to Caps On Workers," *The Washington Times*, April 29, 2005, p. C13; and Ed Frauenheim, "Brain Drain in Tech's Future?," CNET Nets.com, August 6, 2004.