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Science and Engineering Labor Force

National Science Foundation

Abstract

[Excerpt] Like most developed economies, the United States increasingly depends on a technically skilled workforce, including scientists and engineers. Workers for whom knowledge and skill in S&E are central to their jobs have an effect on the economy and the wider society that is disproportionate to their numbers: they contribute to research and development, increased knowledge, technological innovation, and economic growth. Moreover, the knowledge and skills associated with science and engineering have diffused across occupations and become more important in jobs that are not traditionally associated with S&E.

Keywords

labor market, workforce, science, engineering, United States

Chapter 3
Science and Engineering Labor Force

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Highlights

The S&E workforce has shown sustained growth for over half a century, and growth is projected to continue into the future.

- The number of workers in S&E occupations grew from about 182,000 in 1950 to 5.5 million in 2007. This represents an average annual growth rate of 6.2%, nearly 4 times the 1.6% growth rate for the total workforce older than age 18 during this period.
- More recently, from 2004 to 2007, S&E workforce growth averaged 3.2% but was still twice as high as that of the total U.S. workforce.
- The sustained U.S. S&E workforce growth rests largely on three factors: increased S&E degree production, immigration of scientists and engineers, and few retirements because of the relative youth of the S&E workforce compared to the total U.S. workforce.

Scientists and engineers can be categorized in many ways, including by occupation and by degree field.

- Defined by occupation, the U.S. S&E workforce totaled between 4.3 million and 5.8 million people in 2006.
- Individuals with an S&E bachelor's degree or higher (16.6 million) or whose highest degree was in S&E (12.4 million) substantially outnumbered those working in S&E occupations.
- The majority of those with an S&E degree but working in non-S&E occupations report that their jobs are related to their degree.

R&D is an important activity for the S&E workforce.

- The majority of S&E degree holders who report R&D as a major work activity have bachelor's degrees as their highest degree (53%); only 12% have doctorates.
- Engineering degree holders comprise more than one-third (36%) of the total R&D workforce; those with degrees in computer sciences and mathematics constitute another 17%.
- Well above half of doctorate holders in most S&E fields report participating in R&D; the exception is those with social science doctorates.
- Among all scientists and engineers named on patent applications from fall 1998 to fall 2003, 41% held a bachelor's degree, 31% a master's degree, and 24% a doctorate.

Scientists and engineers work for all types of employers.

- For-profit firms employed 47% of all individuals whose highest degree is in S&E but only 28% of S&E doctorate holders.
- Academic institutions employed about 42% of individuals with S&E doctorates, including those in postdocs or other temporary positions.
- About 17% of employed workers whose highest degree was in S&E (1.7 million workers) reported they were self-employed in 2006, with two-thirds in incorporated businesses.

S&E occupations are found throughout industry.

- Industries with above-average proportions of S&E jobs tend to pay higher average salaries to both their S&E and non-S&E workers.
- Small firms are important employers of those with science or engineering degrees. Firms with fewer than 100 persons employ 36% of them.

Aging and retirement patterns are likely to alter the composition of the S&E labor force.

- Absent changes in degree production, immigration, and retirement patterns, the number of S&E-trained persons in the workforce will continue to grow, but at a slowing rate, as more S&E workers reach traditional retirement age (26% were older than age 50 in 2006).
- Across all S&E degree levels, by age 61 about half of S&E workers are no longer working full time; for doctorate holders, half no longer work full time by age 66.
- A much larger proportion of doctorate holders than those with bachelor's and master's degrees are near retirement age.

Women remain underrepresented in the S&E workforce, although to a lesser degree than in the past.

- Women constituted two-fifths (40%) of those with S&E degrees in 2006, but their proportion is smaller in most S&E occupations.
- As more women than men have entered the S&E workforce over the decades, their proportion in S&E occupations rose from 12% in 1980 to 27% in 2007.
- Women in the S&E workforce are on average younger than men, suggesting that larger proportions of men than of women may retire in the near future, thus changing these sex ratios.

The proportion of blacks and Hispanics in the S&E labor force is lower than their proportion in the general population; the reverse is true for Asians/Pacific Islanders.

- The proportions of blacks and Hispanics in S&E occupations have continued to grow over time. However, these groups remain underrepresented relative to their proportions in the total population.
- Blacks, Hispanics, and other underrepresented minorities together constitute 24% of the U.S. population, 13% of college graduates, and 10% of the college-degreed in S&E occupations.
- The proportion of blacks in nonacademic S&E occupations was 3% in 1980 and 5% in 2007; that of Hispanics was 2% and 4%, respectively.

- At the doctoral level, blacks, Hispanics, and American Indians/Alaska Natives combined represented just over 4% of employment in nonacademic S&E occupations in 1990 and 6% in 2007.
- Asian/Pacific Islanders constitute 5% of the U.S. population, 7% of college graduates, and 14% of those in S&E occupations; most of them (82%) are foreign born.

Workers with S&E degrees or occupations tend to earn more than other comparable workers.

- Half of the workers in S&E occupations earned $70,600 or more in 2007, more than double the median earnings ($31,400) of the total U.S. workforce.
- Workers with S&E degrees, regardless of their occupations, earn more than workers with comparable-level degrees in other fields.

Especially at lower education levels, people whose work is associated with S&E are less often exposed to unemployment.

- Unemployment rates for those in S&E occupations tend to be lower than those for all college-degreed individuals and much lower than those of persons with less than a bachelor's degree.
- Unemployment data through September 2009 illustrate the advantages occurring to those whose jobs involve S&E: 9.7% unemployment for all workers, 7.6% for S&E technicians and computer programmers, 5.4% for all bachelor's degree holders, and 5.5% for those in S&E occupations.
- For the 12 months beginning in September 2008, unemployment rates rose sharply for all workers, moving from 6.1% to 9.7%. Substantial increases occurred for technicians and programmers (4.9 percentage points) and workers in S&E occupations (3.3 percentage points), which exceeded those for all bachelor degree holders (2.3 percentage points).
- The unemployment rates for S&E doctorate holders are generally much lower than for those at other degree levels.

Postdoc positions are increasingly common, but their frequency is different in different disciplines.

- The total number of postdocs in the United States is unknown. About half of the known postdocs in 2005 are in the biological and other life sciences.
- The incidence of individuals taking S&E postdoc positions during their careers has risen, from about 31% of those with a pre-1972 doctorate to 46% of those receiving their doctorate in 2002–05.
- A majority of doctorate holders in the life or physical sciences now have a postdoc position as part of their career path; so do 30% or more of doctorate holders in mathematics and computer sciences, social sciences, and engineering.

The importance of foreign-born scientists and engineers to the S&E enterprise in the United States continues to grow.

- Twenty-five percent of all college-educated workers in S&E occupations in 2003 were foreign born, as were 40% of doctorate holders in S&E occupations.
- More than 40% of all university-educated foreign-born workers had their highest degree from a foreign institution, up from about half that percentage before the 1980s.
- From 2003 to 2007, the shares of the foreign born among master's degree and doctorate holders rose 2 percentage points each.
- About half of all foreign-born scientists and engineers are from Asia, including: 16% from India; 11% from China; 4% to 6% each from the Philippines, South Korea, and Taiwan.
- More than a third of U.S.-resident doctorate holders come from China (22%) and India (14%).

The number of most types of temporary work visas issued to high-skilled workers has continued to increase from their post-9/11 lows.

- More temporary visas are issued than are used.
- H-1B temporary work visas are restricted to 65,000 annually, with 20,000 exemptions for students earning U.S. master's degrees or doctorates and further exemptions for U.S. academic and research institutions in their own hiring.
- Over two-thirds of H-1B visas were issued for S&E occupations, with a large portion of the remainder for closely related work.
- More than half of all H-1B visa recipients were from India; Asian citizens made up three-quarters of all H-1B visa recipients.

Most foreign doctoral students choose to remain in the United States after earning their degree.

- The 5-year stay rate for foreign doctoral students showed a small decline: 62% of 2002 doctorate recipients were in the country in 2007, down from 65% for the class of 2000 but remaining near its record high.
- Overall declines in stay rates reflect lower rates for doctorate recipients from some countries (e.g., Taiwan, Japan, and India), whereas stay rates for students from other countries (e.g., the United Kingdom and Germany) increased.
- Tentative evidence suggests that foreign students who receive their doctorates from highly rated departments may have long-term (5-year) stay rates that are below the rates for those who receive their doctorates from less highly reputed departments.

The capability to work in science and technology has increased throughout the world.

- ♦ There are no comprehensive measures of the global S&E labor force, but fragmentary data suggest that the U.S. world share is continuing to decline.
- ♦ Data on the number of researchers compiled by the Organisation for Economic Cooperation and Development (OECD) show moderate average growth from 1995 to 2007 for established scientific nations and regions, in contrast to rapid growth in selected developing regions.
- ♦ Over about a decade, the estimated number of U.S. researchers rose by 40% to about 1.4 million in 2007, that of the European Union to 1.4 million, and Japan's to about 710,000.
- ♦ The number of researchers in China rose to an estimated 1.4 million, comparable to the estimates for the EU-27 and the United States.

R&D employment of multinational companies (MNCs) has been increasing.

- ♦ In 2004 U.S.-based MNCs employed about 854,000 research and development (R&D) workers globally, 16% of them overseas in majority-owned subsidiaries, compared with about 727,000 researchers in 1994 (14% of them overseas).
- ♦ From 1994 to 2004, R&D employment of foreign-based MNCs in the United States rose from about 90,000 to 129,000.

Introduction

Chapter Overview

Like most developed economies, the United States increasingly depends on a technically skilled workforce, including scientists and engineers. Workers for whom knowledge and skill in S&E are central to their jobs have an effect on the economy and the wider society that is disproportionate to their numbers: they contribute to research and development, increased knowledge, technological innovation, and economic growth. Moreover, the knowledge and skills associated with science and engineering have diffused across occupations and become more important in jobs that are not traditionally associated with S&E.

Chapter Organization

This chapter has five major sections. The first describes different measures of the U.S. S&E workforce by occupation, education, and technical expertise needed on the job. It also presents a discussion of the size and growth of the S&E workforce.

The second section examines employment patterns. This includes discussion of the types of jobs that S&E degree holders have, where they work, and what they do on the job.

S&E labor force demographics are the subject of the third section. Topics include the age distribution and retirement patterns of the S&E labor force, trends in the participation of women and underrepresented racial/ethnic minorities, and the continuing importance of foreign-born, and often foreign-educated, scientists and engineers.

The fourth section presents measures of recent S&E labor market conditions. It includes measures of earnings and unemployment, indicators which are applicable to all segments of the labor market. In addition, it reports data on the proportion of S&E-trained workers who are involuntarily working outside of their field. Because highly educated S&E workers often prefer, but cannot always find, work that uses knowledge and skills related to their education, variations in this measure can be a valuable indicator of labor market conditions for these workers. For recent S&E doctoral recipients, data on academic employment and postdoc appointments are also presented.

High-quality data on the global S&E labor force are quite sparse. The available data are presented in the final section. It includes data on the growth in S&E human capital across most of the globe and on the increasing importance of international movements of highly skilled workers to developed nations and elsewhere. This section also includes a more detailed discussion of the globalization of the U.S. S&E workforce, about which there are relatively more complete data.

Scope of the S&E Workforce

Measures of the S&E Workforce

The terms *scientist* and *engineer* can include very different sets of workers. This section presents three types of measures that can be used to estimate the size and describe the characteristics of the U.S. S&E labor force.[1] Different categories of measures are better adapted for addressing some questions than others, and not all general population and workforce surveys include questions in each category.

Occupation

U.S. federal occupation data classify workers by the activities or tasks they primarily perform in their jobs. The Bureau of Labor Statistics' (BLS's) Occupational Employment Statistics (OES) survey collects data that rely on employers to classify their workers using standard occupational definitions. Census Bureau and National Science Foundation (NSF) occupational data in this chapter come from surveys in which individuals supplied information about job titles and/or work activities. This information enables jobs to be coded into standard occupational categories.

Although there is no standard definition of an S&E occupation, NSF has developed a widely used set of occupational categories that it calls *S&E occupations.* These occupations are generally associated with a bachelor's level of knowledge and education in S&E fields. A second set of occupations, *S&E-related occupations,* also require some S&E knowledge or training, but not necessarily as a required credential or at the bachelor's degree level. Examples of such occupations are S&E technicians or managers of the S&E enterprise who may supervise people working in S&E occupations. Other occupations, although classified as *non-S&E,* may include individuals who use their S&E technical expertise in their work. Examples include salespeople who sell specialized research equipment to chemists and biologists and technical writers who edit scientific publications. The NSF occupational classification of S&E, S&E-related, and non-S&E occupations appears in table 3-1.

Other general terms, including science, technology, engineering, or mathematics (STEM), science and technology (S&T), and science, engineering, and technology (SET), are often used to designate the part of the labor force that works with S&E. These terms are broadly equivalent and have no standard meaning.

In this chapter, the narrow classification of S&E occupations is sometimes expanded to include S&E technicians, computer programmers, S&E managers, and a small number of non-health S&E-related occupations such as actuary and architect. This broader grouping is referred to here as STEM occupations.

Education

The pool of S&E workers could also be identified in terms of educational credentials. Individuals who possess an S&E degree, whose highest degree is in S&E, or whose most recent degree is in S&E may be qualified to hold jobs that require S&E knowledge and skills and may choose to seek such jobs if they do not currently hold them. However, a focus on people with relevant educational credentials includes individuals who do not hold jobs that are generally identified with S&E and are not likely to seek them in the future.

Table 3-1
Classification of degree field and occupation

Classification	Degree field	Occupation	Classification of occupation: STEM (X)	Classification of occupation: S&T (X)
S&E	Computer and mathematical sciences	Computer and mathematical scientists	X	X
	Biological, agricultural, and environmental life sciences	Biological, agricultural and environmental life scientists	X	X
	Physical sciences	Physical scientists	X	X
	Social sciences	Social scientists	X	X
	Engineering	Engineers	X	X
		S&E postsecondary teachers	X	X
S&E-related	Health fields	Health-related occupations		
	Science and math teacher education	S&E managers	X	
	Technology and technical fields	S&E precollege teachers		
	Architecture	S&E technicians and technologists	X	X
	Actuarial science	Architects		
		Actuaries		
		S&E-related postsecondary teachers		
Non-S&E	Management and administration	Non-S&E managers		
	Education (except science and math teacher education)	Management-related occupations		
		Non-S&E precollege teachers		
	Social services and related fields	Non-S&E postsecondary teachers		
	Sales and marketing	Social services occupations		
	Arts and humanities	Sales and marketing occupations		
	Other fields	Arts and humanities occupations		
		Other occupations		

S&T = science and technology; STEM = science, technology, engineering, and mathematics

NOTES: Designations STEM and S&T refer to occupation only. For a more detailed classification of occupations and degrees by S&E, S&E-related, and non-S&E, see National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), http://sestat.nsf.gov/docs/occ03maj.html and http://sestat.nsf.gov/docs/ed03maj.html.

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Workers with degrees in S&E may not have maintained current knowledge of the fields in which they were trained, may lack interest in working in jobs that require skills associated with S&E education, or may have advanced in their careers to a point where other skills have become more important.

S&E Technical Expertise

The S&E workforce may also be defined by the expertise required to perform a job or the extent to which job requirements are related to formal training in S&E. Many people, including some outside S&E occupations or without S&E degrees, report that their jobs require at least a bachelor's degree level of technical expertise in engineering, computer sciences, mathematics, the natural sciences, or social sciences (S&E technical expertise). Unlike defining the S&E workforce by occupational groupings or educational credentials, defining it by the use of technical knowledge, skills, or expertise involves assessing the content and characteristics of individual jobs. However, it also involves asking survey respondents to make a complex judgment about their jobs and apply a criterion that they are likely to interpret differently.[2]

Size of the S&E Workforce

Defined by occupation, the U.S. S&E workforce totaled between 4.3 million and 5.8 million people in 2006 (table 3-2). Those in S&E occupations who also had bachelor's degrees were estimated at between 4.3 million (Census Bureau 2007) and 5.0 million (NSF, Division of Science Resources Statistics [SRS], Scientists and Engineers Statistical Data System [SESTAT]).[3] SESTAT's 2006 estimates for individuals with an S&E degree at the bachelor's level or higher (16.6 million) or whose highest degree was in S&E (12.4 million) were substantially higher than the number of current workers in S&E occupations. Many of those whose highest degree is in S&E reported that their job, although not in an occupation classified as S&E, was closely or somewhat related to their highest degree (1.95 million closely related and 2.02 million somewhat related). Counting these people, along with those in S&E occupations, as part of the S&E workforce increases by 80% the size of the estimate by occupation alone.

The 2003 SESTAT surveys provide the most recent estimate for a different subjective assessment of S&E

Table 3-2
Measures and counts of S&E workforce: 2003 and 2006

Measure	Education coverage	Data source	Number
Occupation			
Employment in S&E occupations	All	2006 BLS OES	4,962,000
Employment in S&E occupations	Bachelor's and above	2006 NSF/SRS SESTAT	5,024,000
Employment in S&E occupations	Bachelor's and above	2006 Census Bureau ACS	4,262,000
Employment in S&E occupations	All	2006 Census Bureau ACS	5,771,000
Education			
At least one degree in S&E field	Bachelor's and above	2006 NSF/SRS SESTAT	16,602,000
Highest degree in S&E field	Bachelor's and above	2006 NSF/SRS SESTAT	12,436,000
Employed and job closely related to highest degree	Bachelor's and above	2006 NSF/SRS SESTAT	4,540,000
Job is in S&E	Bachelor's and above	2006 NSF/SRS SESTAT	2,590,000
Job is something other than S&E	Bachelor's and above	2006 NSF/SRS SESTAT	1,950,000
Employed and job somewhat related to highest degree	Bachelor's and above	2006 NSF/SRS SESTAT	3,045,000
Job is in S&E	Bachelor's and above	2006 NSF/SRS SESTAT	1,026,000
Job is something other than S&E	Bachelor's and above	2006 NSF/SRS SESTAT	2,019,000
Employment requires bachelor's level S&E technical expertise in —			
One or more S&E fields	Bachelor's and above	2003 NSF/SRS SESTAT and NSCG	12,855,000
Engineering, computer science, math, or natural sciences	Bachelor's and above	2003 NSF/SRS SESTAT and NSCG	9,215,000
Social sciences	Bachelor's and above	2003 NSF/SRS SESTAT and NSCG	5,335,000

ACS = American Community Survey; BLS = Bureau of Labor Statistics; OES = Occupational and Employment Statistics; NSF/SRS = National Science Foundation, Division of Science Resources Statistics; SESTAT = Scientists and Engineers Statistical Data System; NSCG = National Survey of College Graduates

SOURCES: BLS, 2006 OES Survey; Census Bureau, 2006 ACS; and NSF/SRS, 2006 SESTAT integrated file and special analytic file comprising 2003 SESTAT integrated file and 2003 NSCG.

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work—whether jobs require technical expertise at the bachelor's degree level or higher in S&E fields. According to these surveys, 12.9 million bachelor's degree holders reported that their jobs required at least this level of expertise in one or more S&E fields. This contrasts with 2003 SESTAT estimates of 4.8 million in S&E occupations and 11.9 million whose highest degree is in an S&E field.

Growth of the S&E Workforce

However defined, the S&E workforce has for decades grown faster than the total workforce. Defined by occupation, growth in the S&E workforce can be examined over nearly 6 decades using Census Bureau data. (For a discussion of longer periods, see the sidebar "Scientists Since Babylon.") The number of workers in S&E occupations grew from about 182,000 in 1950 to 5.5 million in 2007. This represents an average annual growth rate of 6.2%, nearly 4 times the 1.6% growth rate for the total workforce older than age 18 during this period. The somewhat broader category of S&T occupations grew from 205,000 to 6.5 million (figure 3-1).

In each decade, the growth rate of S&E occupations exceeded that of the total workforce (figure 3-2). During the 1960s, 1980s, and 1990s, the difference in growth rates was very large (about 3 times the rate for the total labor force). It was smallest during the slower growth period of the 1970s and between 2000 and 2007. S&E occupational employment has grown from 2.6% of the workforce in 1983 to 4.3% of all employment in 2007 (figure 3-3).

Recent OES employment estimates for workers in S&E occupations indicate that the S&E workforce is continuing to grow faster than the total workforce (see table 3A in sidebar "Scientists Since Babylon"). The OES estimate was 5.6 million in May 2007, up 9.9% from the May 2004 total of 5.1 million. This implies an average annual growth rate of 3.2%, about double the 1.6% average annual increase in employment in all occupations. During the same period, the broader STEM aggregate (including technicians, S&E managers, etc.) reached 7.6 million in May 2007 but grew at an average annual rate of 2.2%—slower than S&E occupations because of employment declines for both technicians/programmers and S&E managers. OES projections are that S&E occupations will continue to grow at a faster rate than the total workforce. (See sidebar, "Projected Growth of Employment in S&E Occupations.")

Between 1980 and 2000, although the number of S&E degree holders in the workforce grew more than the number of people working in S&E occupations, degree production in all broad categories of S&E fields rose at a slower pace than employment in S&E jobs (figure 3-4; see chapter 2 for a

Scientists Since Babylon

In the early 1960s, a prominent historian of science, Derek J. de Solla Price, examined the growth of science and the number of scientists over very long periods in history and summarized his findings in a book entitled *Science Since Babylon* (1961). Using a number of empirical measures (most over at least 300 years), Price found that science, and the number of scientists, tended to double about every 15 years, with measures of higher quality science and scientists tending to grow slower (doubling every 20 years) and measures of lower quality science and scientists tending to grow faster (every 10 years).

According to Price (1961), one implication of this long-term exponential growth is that "80 to 90% of all the scientists that ever lived are alive today." This insight follows from the likelihood that most of the scientists from the past 45 years (a period of three doublings) would still be alive. Price was interested in many implications of these growth patterns, but in particular, he was interested in the idea that this growth could not continue indefinitely and the number of scientists would reach "saturation." Price was concerned in 1961 that saturation had already begun.

How different are the growth rates in the number of scientists and engineers in recent periods from what Price estimated for past centuries? Table 3-A shows growth rates for some measurements of the S&E labor force in the United States and elsewhere in the world for a period of available data. Of these measures, the number of S&E doctorate holders in the United States labor force showed the lowest average annual growth of 2.4% (doubling in 31 years if this growth rate were to continue). The number of doctorate holders employed in S&E occupations in the United States showed a faster average annual growth of 3.8% (doubling in 20 years if continued). There are no global counts of individuals in S&E, but counts of "researchers" in member countries of the Organisation for Economic Co-operation and Development (OECD) grew at an average annual rate of 3.3% (doubling in 23 years if continued). Data on the population of scientists and engineers in most developing countries are very limited, but OECD data for researchers in China show a 10.8% average annual growth rate (doubling in 8 years if continued). All these numbers are broadly consistent with a continuation of growth in S&E labor exceeding the rate of growth in the general labor force.

Table 3-A
Growth rates for selected S&E labor force measurements

Measurement	Source	Years	First year	Last year	Average annual growth rate (%)
Researchers in OECD countries	OECD	1995–2005	2,815,000	3,880,000	3.3
College graduates in the U.S. in S&E occupations (except postsecondary teachers)	U.S. Census	1990–2005	200,000	390,000	4.6
Doctorate holders in the U.S. in S&E occupations (except postsecondary teachers)	U.S. Census	1990–2005	2,362,000	4,111,000	3.8
Workers with highest degree in S&E who report job related to degree	NSF/SRS SESTAT	1993–2006	5,342,000	7,585,000	2.7
S&E doctorate holders in U.S.	NSF/SRS SESTAT	1993–2006	590,000	803,000	2.4
S&E bachelor's degree and above holders in U.S.	NSF/SRS SESTAT	1993–2006	11,022,000	16,602,000	3.2
Engineers in Japan	Statistical Yearbook Japan	1980-2000	686,662	1,687,795	4.6
Researchers in China	OECD	2000–07	695,000	1,423,400	10.8

NSF/SRS = National Science Foundation, Division of Science Resources Statistics; OECD = Organisation for Economic Co-operation and Development; SESTAT = Scientists and Engineers Statistical Data System

SOURCES: NSF/SRS, SESTAT database, 1993 and 2003, http://sestat.nsf.gov; Census Bureau, Public Use Microdata Sample, 1990; American Community Survey, 2005; and OECD, Main Science and Technology Indicators (2009/1).

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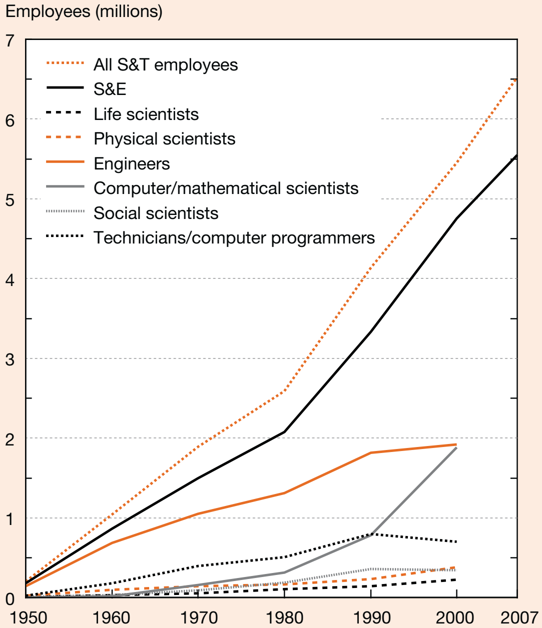
Figure 3-1
Employment in S&T occupations: 1950–2007



S&T = science and technology

NOTE: 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. No estimates available below level of S&E and S&T from the 2007 American Community Survey.

SOURCE: Lowell BL, Regets M, A half-century snapshot of the STEM workforce, 1950 to 2000, Commission on Professionals in Science and Technology, STEM Workforce Data Project: White Paper No. 1 (2006); and Census Bureau, American Community Survey (2007).

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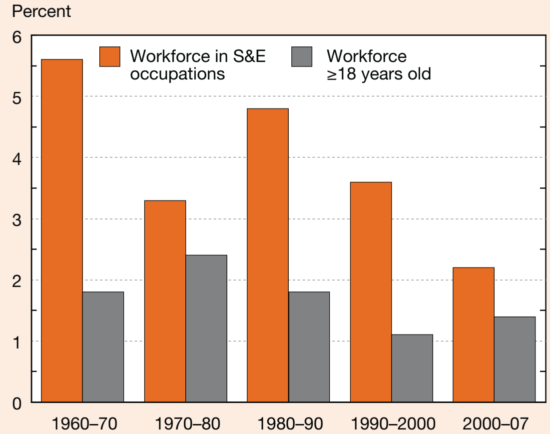
fuller discussion of S&E degrees). During this period, S&E employment grew from 2.1 million to 4.8 million (4.2% average annual growth), while total S&E degree production increased from 526,000 to 676,000 (1.5% average annual growth). Except for mathematics, computer sciences, and the social sciences, the growth rate for advanced degrees was higher than for bachelor's degrees.

This growth in the S&E labor force was largely made possible by the following three factors: (1) increases in U.S. S&E degrees earned by both native and foreign-born students who entered the labor force, (2) temporary and permanent migration to the United States of those with foreign S&E education, and (3) the relatively small proportion of scientists and engineers leaving the S&E labor force because they had reached retirement age. Many have expressed concerns about the effects of changes in any or all of these factors on the future of the U.S. S&E labor force (see NSB 2003).

Figure 3-2
Average annual growth rates of total workforce and workforce in S&E occupations: 1960–2007



SOURCE: University of Michigan, Integrated Public Use Microdata Series, 1960–2000 Decennial Census files and 2007 American Community Survey, http://usa.ipums.org/usa/, special tabulations.

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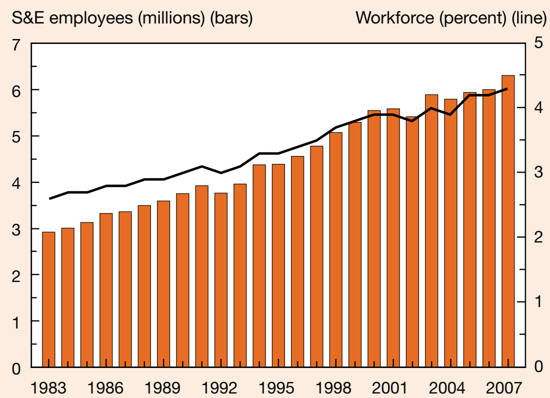
Figure 3-3
U.S. workforce in S&E occupations: 1983–2007



SOURCE: National Science Foundation, Division of Science Resources Statistics, special tabulations from Bureau of Labor Statistics, Current Population Survey Monthly Outgoing Rotation files (1983–2007).

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Employment Patterns

This section describes the distribution of members of the S&E labor force in the economy. In view of the disjunction between S&E occupations and S&E degrees, this discussion begins with an analysis of data on the educational characteristics of those in S&E occupations and the occupations of workers with S&E degrees. It then describes the institutional sectors in which members of the S&E labor force are employed and provides industry breakdowns within the

Projected Growth of Employment in S&E Occupations

Projections of employment growth are notoriously difficult to make, and the present economic environment makes them even more uncertain. Conceivably, the worldwide economic crisis will produce long-term changes in employment patterns and trends. The reader is cautioned that the assumptions underlying projections such as these, which rely on past empirical relationships, may no longer be valid.

The most recent BLS occupational projections, for the period 2006–16, suggest that total employment in occupations that NSF classifies as S&E will increase at more than double the overall growth rate for all occupations (figure 3-A). These projections involve only the demand for strictly defined S&E occupations and do not include the wider range of jobs in which S&E degree holders often use their training.

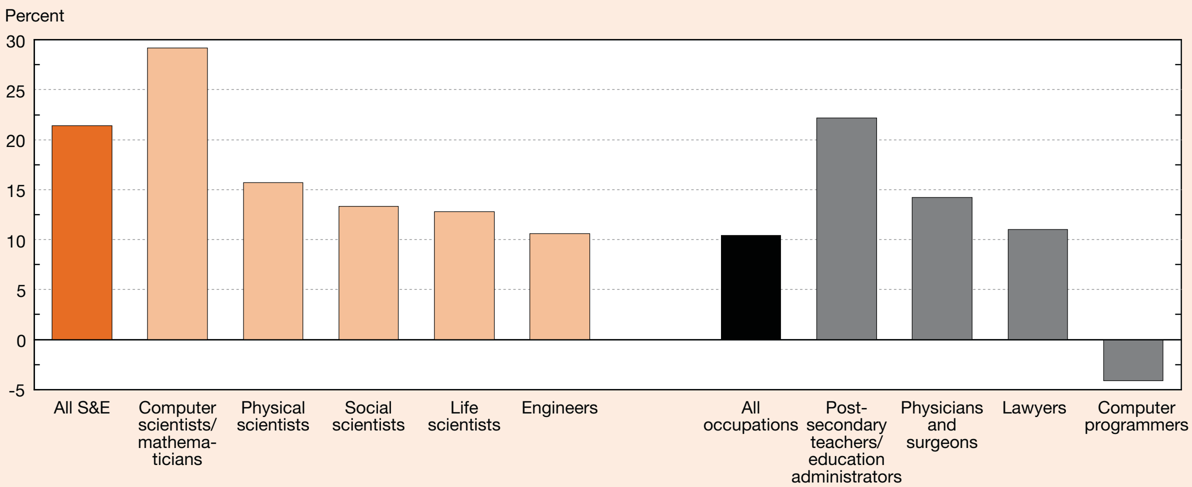
S&E occupations are projected to grow by 21.4% between 2006 and 2016, while employment in all occupations is projected to grow 10.4% over the same period (table 3-B, appendix table 3-2).[4] Yet, there are challenges to making projections about the S&E workforce. Many corporate and government spending decisions on R&D are difficult or impossible to anticipate. In addition, R&D money increasingly crosses borders in search of the best place to have particular research performed. (The United States may be a net recipient of these R&D funds; see the discussion in chapter 4.) Finally, it may be difficult to anticipate new products and industries that may be created via the innovation processes that are most closely associated with scientists and engineers.

Approximately 64% of BLS's projected increase in S&E jobs is in computer and mathematical scientist occupations (table 3-B). Apart from these occupations, the growth rates projected for physical scientists, life scientists, and social scientists are above those for all occupations. Engineering occupations, with projected growth of 10.6%, are growing at about the same rate as all jobs.

Table 3-B also shows occupations that either contain significant numbers of S&E trained people or represent other career paths for those pursuing graduate training. Among these, postsecondary teacher or administrator, which includes all fields of instruction, is projected to grow faster than computer and mathematical occupations, from 1.8 million to 2.3 million workers over the decade between 2006 and 2016—an increase of 31.4%. In contrast, BLS projects computer programmers to increase by only 2.0%.

BLS also projects that job openings in NSF-identified S&E occupations over the 2006–16 period will represent a greater proportion of current employment than all other occupations—43.9% versus 33.7% (figure 3-B). Job openings include both growth in total employment and openings caused by attrition.

Figure 3-A
Bureau of Labor Statistics projections of increase in employment for S&E and selected other occupations: 2006–16



BLS = Bureau of Labor Statistics

SOURCE: BLS, Office of Occupational Statistics and Employment Projections. See appendix table 3-1.

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Table 3-B
Bureau of Labor Statistics projections of employment and job openings in S&E occupations: 2006–16
(Thousands)

Occupation	BLS National Employment Matrix 2006 estimate	BLS projected 2016 employment	Job openings from growth and net replacements, 2006–16	10-year growth in total employment (%)	10-year job openings as percent of 2006 employment
All occupations	150,620	166,220	50,732	10.4	33.7
All S&E	5,187	6,296	2,280	21.4	43.9
Computer/mathematical scientists	2,859	3,694	1,466	29.2	51.3
Life scientists	258	292	103	12.8	40.0
Physical scientists	267	309	109	15.7	41.0
Social scientists/related occupations	291	330	96	13.3	32.9
Engineers	1,512	1,671	505	10.6	33.4
S&E-related occupations					
S&E managers	513	616	200	20.1	39.0
S&E technicians	874	986	303	12.8	34.7
Computer programmers	455	464	117	2.0	25.6
Physicians and surgeons	633	723	204	14.2	32.3
Health technologists and technicians	2,612	3,094	1,074	18.5	41.1
Selected other occupations					
Postsecondary teachers/administrators	1,760	2,312	953	31.4	54.1
Lawyers	761	844	228	11.0	29.9

BLS = Bureau of Labor Statistics

NOTES: Estimates of current and projected employment for 2006–16 period from BLS's National Employment Matrix. Data in matrix from Occupational Employment Statistics (OES) survey and Current Population Survey (CPS). Together, these sources cover paid workers, self-employed workers, and unpaid family workers in all industries, agriculture, and private households. Because derived from multiple sources, data can often differ from employment data provided by OES, CPS, or other employment surveys alone. BLS does not make projections for S&E occupations as a group; numbers in table based on sum of BLS projections in occupations that National Science Foundation considers S&E.

SOURCE: BLS, Office of Occupational Statistics and Employment Projections, National Industry-Occupation Employment Projections, 2006–2016 (2007).

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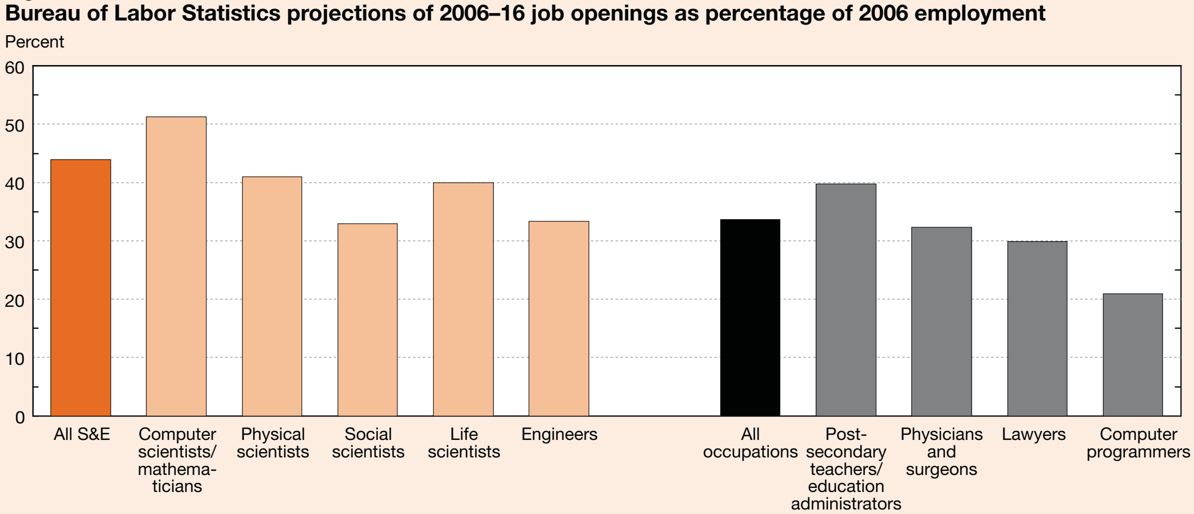
Figure 3-B
Bureau of Labor Statistics projections of 2006–16 job openings as percentage of 2006 employment



BLS = Bureau of Labor Statistics

SOURCE: BLS, Office of Occupational Statistics and Employment Projections. See appendix table 3-1.

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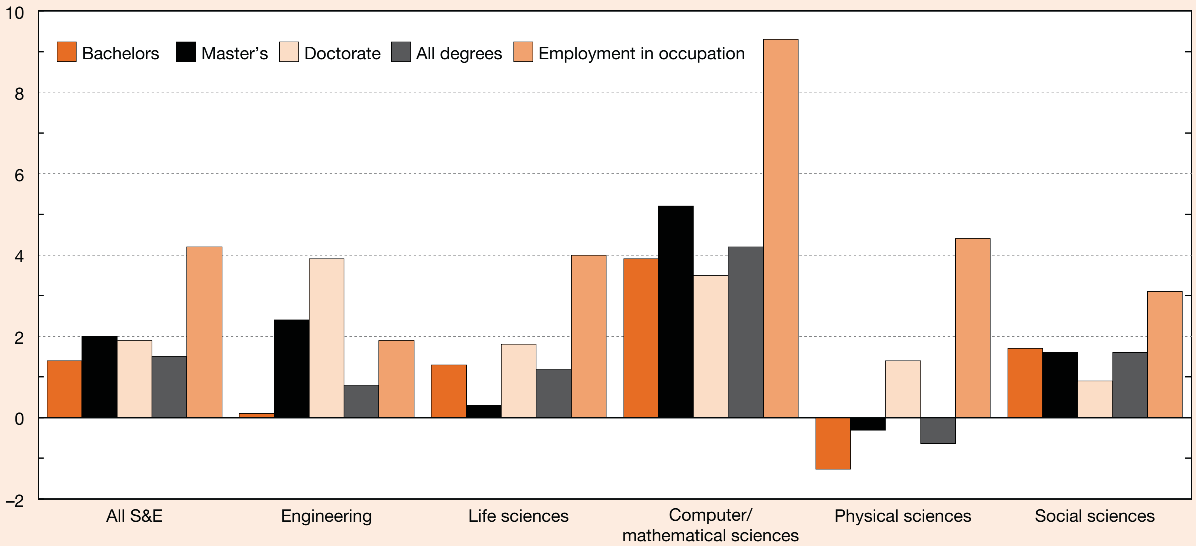
Figure 3-4
Annual average growth rate of degree production and occupational employment, by S&E field: 1980–2000



SOURCES: University of Michigan, Integrated Public Use Microdata Series, 1980–2000 Decennial Census files, http://usa.ipums.org/usa/, and National Science Foundation, Division of Science Resources Statistics, WebCASPAR database, http://webcaspar.nsf.gov, special tabulations.

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private sector, which is the largest employer of individuals in S&E occupations. The section also briefly describes the metropolitan areas and size of firms in which S&E degree holders are found.

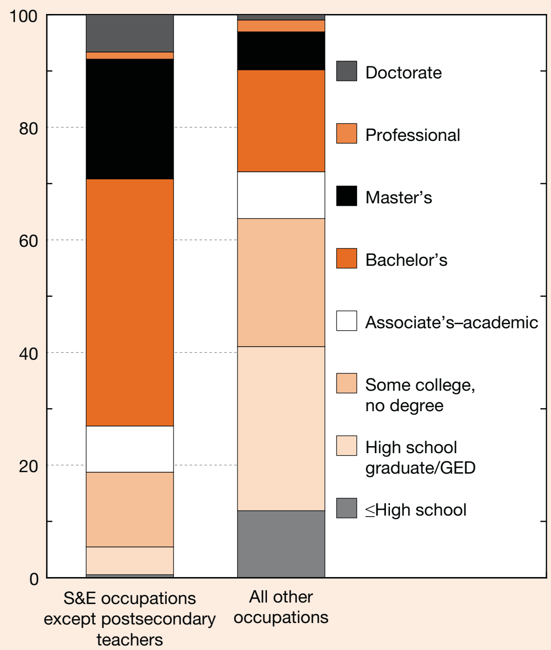
Because the workforce's capacities for R&D, invention, and innovation are a continuing focus of policy concern, this section also features data on R&D and patenting activities in the workforce. Data on work-related training, which can foster innovation through organizational and individual learning, are also presented.

Educational Distribution of Those in S&E Occupations

Workers in S&E occupations have undergone more formal education than the general workforce (figure 3-5). Nonetheless, these occupations include workers with a range of educational qualifications. For all workers in S&E occupations except postsecondary teachers,[5] 2007 ACS data indicate that slightly more than one-quarter had not earned a bachelor's degree. For an additional 44%, a bachelor's was their highest degree. The proportion of workers with advanced degrees was about equal to that of those without a bachelor's degree. Only about 7% of all S&E workers (except postsecondary teachers) had doctorates.

Technical issues of occupational classification may inflate the estimated size of the nonbaccalaureate S&E workforce. Even so, these data indicate that many individuals enter the S&E workforce with marketable technical skills

Figure 3-5
Educational attainment by type of occupation: 2007



GED = General Equivalency Diploma

SOURCE: Census Bureau, American Community Survey (2007).

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Table 3-3
Educational background of workers in S&E occupations: 2006

Educational background	Number	Percent
S&E occupations	5,023,635	100.0
At least one S&E degree	4,294,666	85.5
First bachelor's degree in S&E	4,023,000	80.1
Highest degree in S&E	3,929,860	78.2
All degrees in S&E	3,696,443	73.6
At least one degree in—		
Computer/mathematical sciences	1,052,725	21.0
Life sciences	576,922	11.5
Physical sciences	495,985	9.9
Social sciences	651,519	13.0
Engineering	1,867,172	37.2
No S&E degrees but at least one S&E-related degree	216,509	4.3
No S&E or S&E-related degrees	512,459	10.2

NOTE: Detail may not add to total because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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from technical or vocational school training (with or without earned associate's degrees) or college courses, and many acquire such skills through workforce experience or on-the-job training. In information technology, and to some extent in other occupations, employers frequently use certification exams, not formal degrees, to judge skills. (See "Who Performs R&D?" and the discussion in chapter 2.)

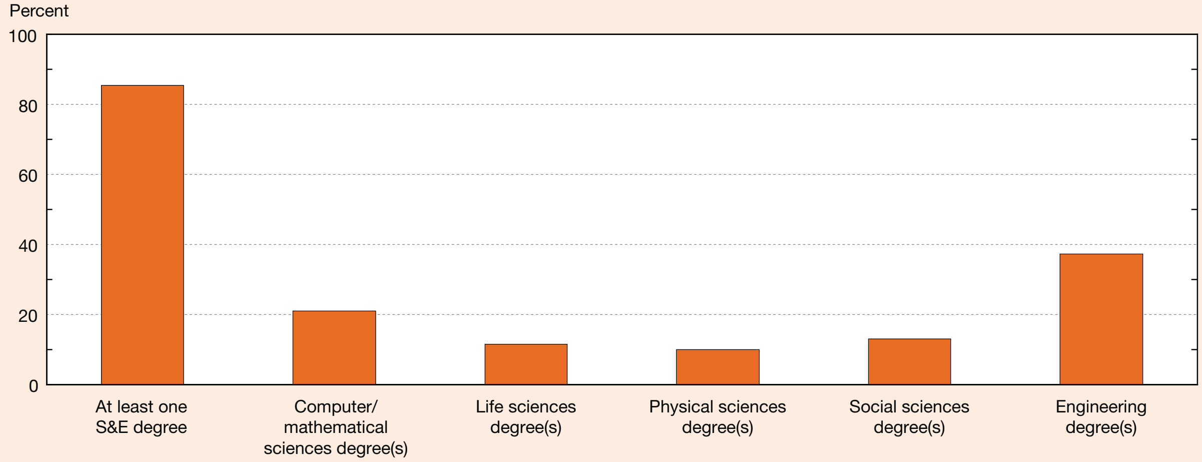
Among individuals with at least a bachelor's degree who work in S&E occupations, a large proportion (86%) have at least one S&E degree, and 74% have S&E degrees only (table 3-3). S&E workers who have both S&E and non-S&E degrees very likely earned their first bachelor's degree in S&E, even if their highest degree was not in an S&E field. Among workers in S&E occupations, the most common degrees are in engineering (37%) and computer and mathematical sciences (21%) (figure 3-6).

Employment in Non-S&E Occupations

S&E degree holders work in all manner of jobs. For example, they work in S&E-related jobs such as health occupations (1.3 million workers) or in S&E managerial positions (267,000 workers), but they also hold non-S&E jobs such as college and precollege teachers in non-S&E areas (622,000 workers) or work in social services occupations (632,000 workers). In 2006, 6.2 million workers whose highest degree was in an S&E field did not work in an S&E occupation. Some 1.1 million worked in S&E-related occupations, while just over 5.0 million worked in non-S&E jobs. The largest category of non-S&E jobs was management and management-related occupations, with 1.4 million workers, followed by sales and marketing occupations, with 990,000 workers (NSF/SRS 2006).

Only about 39% of college graduates whose highest degree is in an S&E field work in S&E occupations (figure 3-7). The proportion is higher for those with more advanced degrees. The overall proportion varies substantially by field, ranging from engineering (66%) at the top, followed closely by computer and mathematical sciences (59%) and physical sciences (55%). Although a smaller percentage (31%) of biological/agricultural sciences degree holders work in S&E

Figure 3-6
S&E degree background of workers in S&E occupations: 2006



SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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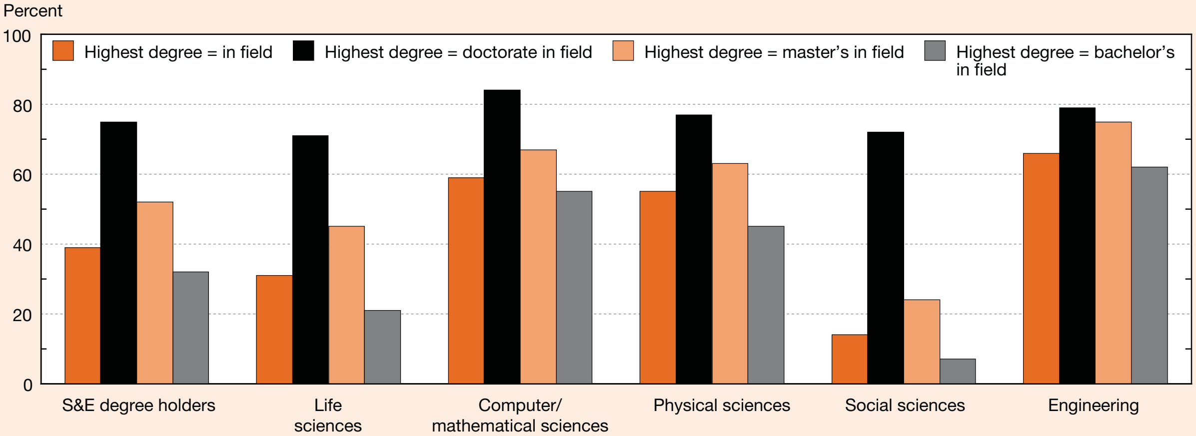
Figure 3-7
S&E degree holders working in S&E occupations, by degree field: 2006



NOTE: Individuals may have degrees in more than one S&E degree field.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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occupations, an additional 25% of persons with degrees in these fields work in S&E-related occupations. Individuals with social science degrees (14%) are least likely to work in S&E occupations. This pattern of field differences generally characterizes individuals whose highest degree is either a bachelor's or a master's. At the doctoral level, these field differences shrink substantially.

By field, holders of degrees in computer and mathematical sciences and engineering most often work in the broad occupation group in which they were trained (51% and 45%, respectively). S&E doctorate holders more often work in the same broad S&E occupation (64%) compared with individuals whose highest degree is an S&E bachelor's (24%) (appendix table 3-1).

Relationships Between Jobs and Degrees

Most individuals with S&E highest degrees who work in S&E-related and non-S&E occupations do not see themselves as working entirely outside their field of degree. Rather, they indicate that their jobs are either closely (31%) or somewhat (32%) related to their degree field (table 3-4). Among those in managerial and management-related occupations, for example, 31% characterize their jobs as closely related and 41% as somewhat related. Almost half (47%) of workers in sales and marketing say their S&E degrees are closely or somewhat related to their jobs. Among S&E precollege teachers whose highest degree is in S&E, 74% say their jobs are closely related to their degrees.

Workers with more advanced S&E education more often do work that is at least somewhat related to their field of degree. One to 4 years after receiving their degrees, 96% of S&E doctorate holders say that they have jobs closely or somewhat related to their degree field, compared with 92% of master's degree holders and 72% of bachelor's degree holders (figure 3-8). Even when the fit between an individual's job and field of degree is assessed using a stricter criterion ("closely related"), the data indicate that many S&E bachelor's degree holders who received their degree 1–4 years earlier are working in jobs that use skills developed during their college training (figure 3-9). In the natural sciences and engineering fields, about half characterized their jobs as closely related to their field of degree: 57% in engineering and physical sciences, 50% in computer sciences, and 48% in biological/agricultural sciences. The comparable figure for social science graduates (30%) was substantially lower.

The stronger relationship between S&E jobs and S&E degrees at higher degree levels holds at all career stages, as evidenced by comparisons among groups of bachelor's, master's, and doctoral degree holders at comparable numbers of years since degree award. However, for each group, the relationship between job and field of degree becomes weaker over time. There are many reasons for this decline: individuals may change their career interests, gain skills in different areas, take on general management responsibilities, forget some of their original college training, or even find that some of their original college training has become obsolete. Against this background, the career-cycle decline in the relevance of an S&E degree appears modest.

Figures 3-10 and 3-11 summarize the loose relationship among jobs, degrees, and individuals' perceptions of the expertise they need to do their work. In figure 3-10, the intersecting area, which shows individuals whose highest degree is in S&E who are working in S&E occupations, is less than

Table 3-4
Individuals with highest degree in S&E employed in S&E-related and non-S&E occupations, by highest degree and relationship of highest degree to job: 2006
(Percent)

Highest degree	Employment (thousands)	Degree related to job		
		Closely	Somewhat	Not
All degree levels[a]	6,226	31.3	32.4	36.3
Bachelor's	5,071	28.3	32.3	39.4
Master's	975	44.9	31.9	23.2
Doctorate	176	41.4	39.0	19.6

[a]Includes professional degrees not broken out separately.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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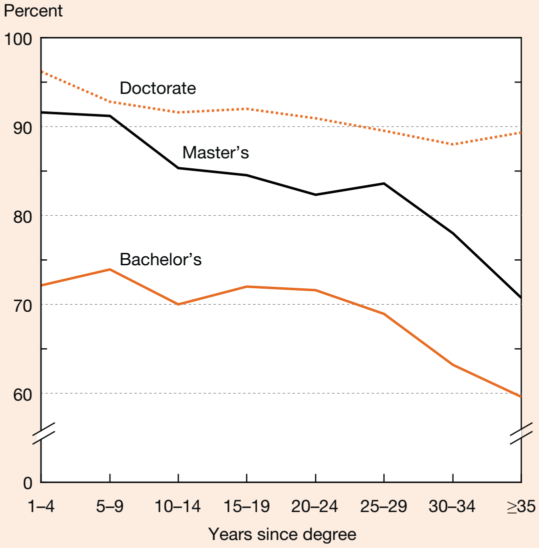
Figure 3-8
Employed S&E degree holders in jobs related to highest degree, by years since degree: 2006



NOTE: Includes those who say their job is either closely related or somewhat related to field of their highest degree.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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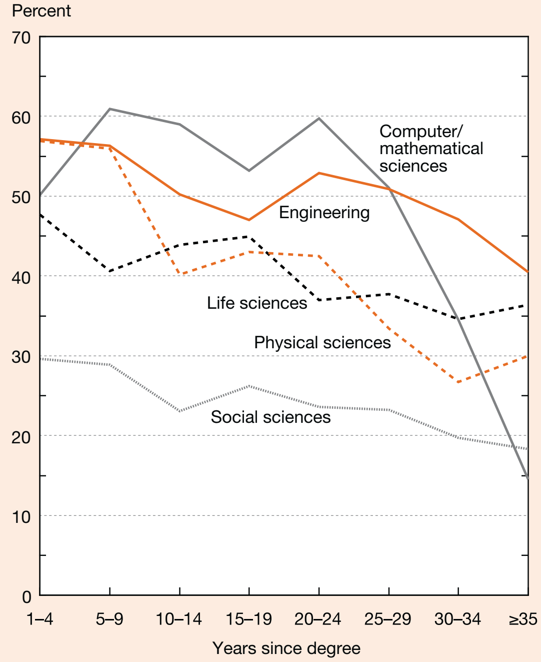
Figure 3-9
S&E bachelor's degree holders employed in jobs closely related to degree, by field and years since degree: 2006



SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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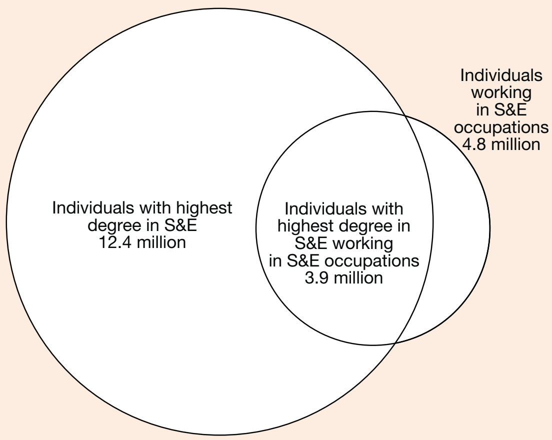
one-third the size of the area comprising individuals with only one or the other attribute. Figure 3-11 compares the following three groups of individuals who hold at least a bachelor's degree: those in S&E occupations, those whose highest degree is in S&E and who say their job is at least somewhat related to their degree, and those who say they need at least a bachelor's degree level of S&E expertise to perform their job. In 2003, the most recent year in which the SESTAT surveys asked about S&E technical expertise, about 15 million Americans fell in one or more of these categories. Only 21% had all three characteristics, and just over half had only one. Even among those in S&E occupations, only about two-thirds also had S&E degrees, had jobs at least somewhat related to S&E, and believed they needed at least a bachelor's degree level of S&E expertise. Among the people who claimed they needed the technical expertise associated with an S&E bachelor's degree for their job, more

Figure 3-10
Intersection of highest degree in S&E and S&E occupation: 2006



SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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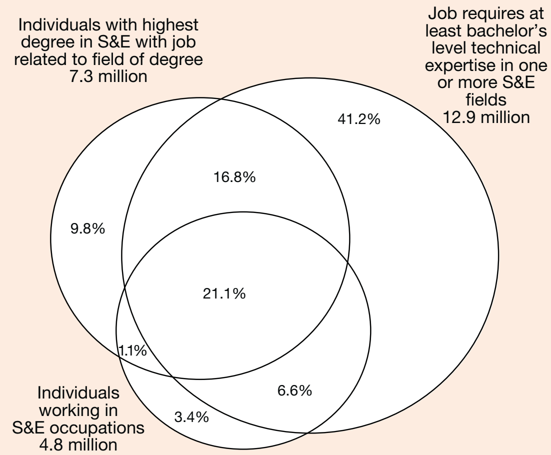
Figure 3-11
Measures of the S&E workforce: 2003



NOTE: Data from special analytic file comprising 2003 Scientists and Engineers Statistical Data System (SESTAT) integrated file and 2003 National Survey of College Graduates (NSCG).

SOURCE: National Science Foundation, Division of Science Resources Statistics, SESTAT (2003) and NSCG (2003).

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than half said either that their job was unrelated to their actual degree or that their highest degree was not in S&E.

Work-Related Training

Education for most scientists and engineers does not end when they receive their college degree. About two-thirds of SESTAT survey respondents (persons who received a bachelor's degree or higher in S&E, or S&E-related fields, plus persons holding a non-S&E bachelor's or higher degree who were employed in an S&E or S&E-related occupation) participated in work-related training in 2006. Those in S&E-related occupations (health-related occupations, S&E managers, S&E precollege teachers, and S&E technicians and technologists) had the highest participation rate (79%) (table 3-5).

Most who took training did so to improve skills or knowledge in their current occupational field (56%) (appendix table 3-3). Others did so for licensure/certification in their current occupational field (21%) or because it was required or expected by their employer (14%).

Table 3-5
Scientists and engineers participating in work-related training, by occupation: 2006

		Participated in training	
Occupation	All employed	Number	Percent
All occupations	18,927,000	12,696,000	67.1
S&E occupations	5,024,000	3,037,000	60.4
Computer and mathematical scientists	2,112,000	1,202,000	56.9
Life scientists	487,000	296,000	60.8
Physical and related scientists	334,000	183,000	54.8
Social and related scientists	470,000	301,000	64.0
Engineers	1,621,000	1,056,000	65.1
S&E-related occupations	5,246,000	4,167,000	79.4
Non-S&E occupations	8,657,000	5,492,000	63.4

NOTES: Scientists and engineers include those with one or more S&E or S&E-related degrees at bachelor's level or higher or who have a non-S&E degree at bachelor's level or higher and were employed in an S&E or S&E-related occupation in 2006. Detail may not add to total because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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Women participated in work-related training at a higher rate than men: 72% compared with 64% of men (appendix table 3-4). Smaller percentages of the oldest (aged 65 and older) and youngest (24 and under) age groups of workers attended training. SESTAT survey respondents at companies of all sizes took work-related training, but more of those who worked for larger organizations did so: 58% of respondents working in organizations with 10 or fewer people compared with 72% in organizations that employ 500 to 24,999 people (appendix table 3-5).

Who Performs R&D?

Although individuals with S&E degrees use their knowledge in many ways, there is a special interest in work in research and development. R&D creates new knowledge and new types of goods and services that fuel economic growth. (See sidebar, "Patenting Activity of Scientists and Engineers.") Figure 3-12 shows the distribution of individuals with S&E degrees, by degree level, who report R&D as a major work activity—the activity involving the greatest or second greatest number of work hours from a list of 14 choices.

Individuals with doctorates constitute only 6% of all individuals with S&E degrees but represent 12% of individuals who report R&D as a major work activity. However, the majority of S&E degree holders who report R&D as a major work activity have only bachelor's degrees (53%). An additional 31% have master's degrees and 4% have professional degrees, mostly in medicine.

Figure 3-13 shows the distribution by field of highest degree of individuals whose highest degree is in S&E and who reported R&D as a major work activity. Individuals with engineering degrees constitute more than one-third (36%) of the total R&D workforce, followed by those with social science degrees (22%).

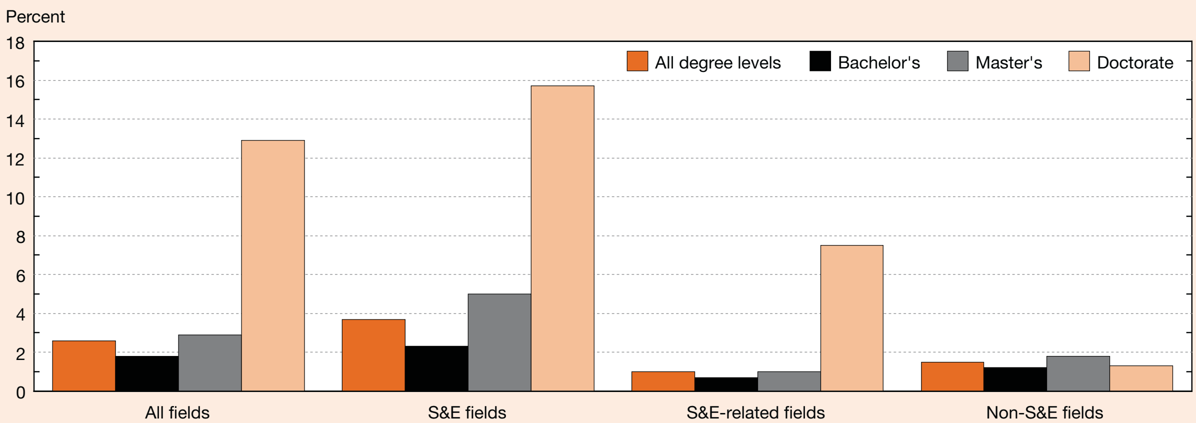
Patenting Activity of Scientists and Engineers

The U.S. Patent and Trademark Office (USPTO) grants patents to inventions that are new, useful, and nonobvious. Thus, patenting is a limited but useful indicator of the inventive activity of scientists and engineers.

In its 2003 SESTAT surveys of the S&E workforce, NSF asked scientists and engineers to report on their recent patenting activities. Among those who had ever worked, 2.6% reported that from fall 1998 to fall 2003, they had been named as an inventor on a U.S. patent application (appendix table 3-6). This patent activity rate was 3.5% for those working in the business/industry sector, 1.7% in the education sector, and 0.9% in the government sector (appendix table 3-7).

By degree level, S&E doctorate holders have the highest patent activity rate (15.7%), while bachelor's degree holders in S&E-related fields have the lowest (0.7%) (figure 3-C). However, there are far fewer doctoral-level scientists and engineers, so they account for only about

Figure 3-C
Patenting activity rate of scientists and engineers, by broad field and level of highest degree: 2003



NOTES: "All degree levels" includes professional degrees not broken out separately; it does not include individuals who have never worked. Scientists and engineers include those with one or more S&E or S&E-related degrees at bachelor's level or higher or who have a non-S&E degree at bachelor's level or higher and were employed in an S&E or S&E-related occupation in 2003. For classification of degrees by S&E, S&E-related, and non-S&E, see Scientists and Engineers Statistical Data System (SESTAT), http://sestat.nsf.gov/docs/ed03maj.html. Patent activity rate is proportion of each group indicating they had been named as inventor on U.S. patent application during period from October 1998 to fall 2003.

SOURCE: National Science Foundation, Division of Science Resources Statistics, SESTAT (2003). See appendix table 3-6.

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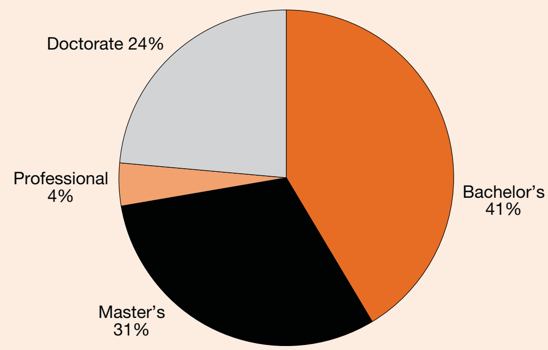
Patenting Activity of Scientists and Engineers *continued*

a quarter of all survey respondents named on a U.S. patent application. Bachelor's and master's degree holders account for 41% and 31%, respectively, of all patenting activity reported in the survey (figure 3-D).

USPTO does not grant all patent applications, and not all granted patents produce useful commercial products or processes. NSF estimates that in the 5-year period for which data were collected, U.S. scientists and engineers filed 1.8 million patent applications. USPTO granted some 1.0 million (although applicants may have applied for some of these at an earlier period). (See appendix tables 3-6 through 3-8.)

Of those patents granted between 1998 and 2003, about 54% resulted in a commercialized product, process, or license during the same period. Scientists and engineers employed in the business/industry sector reported the highest commercialization success rate (58%), much higher than the education (43%) and government (13%) sectors. The overall commercialization rate varies by degree level, at 60%–65% for bachelor's and master's degree holders but 38% for doctorate holders (many of whom work in education, which has a low commercialization rate relative to other sectors).

Figure 3-D
Distribution of patenting activity of scientists and engineers, by level of highest degree: 2003



NOTES: Total does not include individuals who have never worked. Scientists and engineers include those with one or more S&E or S&E-related degrees at bachelor's level or higher or who have a non-S&E degree at bachelor's level or higher and were employed in an S&E or S&E-related occupation in 2003. For classification of degrees by S&E, S&E-related, and non-S&E, see Scientists and Engineers Statistical Data System (SESTAT), http://sestat.nsf.gov/docs/ed03maj.html.

SOURCE: National Science Foundation, Division of Science Resources Statistics, SESTAT (2003). See appendix table 3-6.

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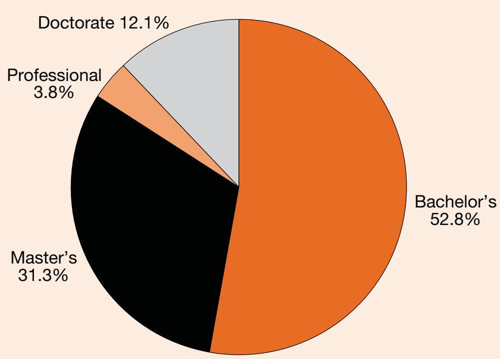
Individuals who are in non-S&E occupations do much R&D. Table 3-6 shows the occupational distribution of S&E degree holders who report R&D as a major work activity. Twenty-six percent of those for whom R&D is a major work activity are in non-S&E occupations. Among those S&E degree holders whose jobs have them spend at least 10% of their time on R&D, 39% are in non-S&E occupations (lawyers or S&E managers, for example).

Figure 3-12
Distribution of S&E degree holders with R&D as major work activity, by level of education: 2006



SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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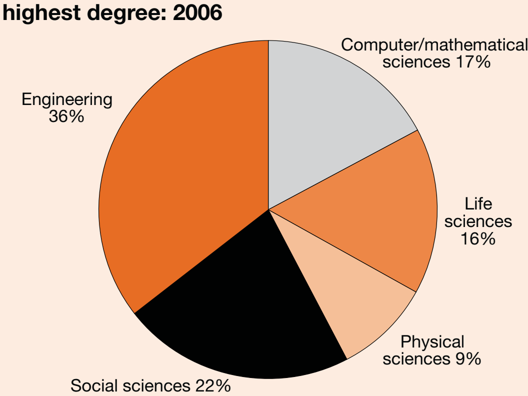
Figure 3-13
Distribution of individuals with highest degree in S&E with R&D as major work activity, by field of highest degree: 2006



SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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Table 3-6
S&E degree holders with R&D work activities, by occupation: 2006

Occupation	Employed S&E degree holders		R&D as major work activity			R&D at least 10% of work time		
	Number	Percent	Number	Percent	R&D activity rate (%)	Number	Percent	R&D activity rate (%)
All occupations	13,752,000	100.0	4,155,000	100.0	30.2	7,369,000	100.0	53.6
S&E occupations	4,295,000	31.2	2,541,000	61.2	59.2	3,371,000	45.7	78.5
Computer/mathematical scientists	1,626,000	11.8	802,000	19.3	49.3	1,171,000	15.9	72.0
Life scientists	435,000	3.2	330,000	7.9	75.7	383,000	5.2	88.0
Physical scientists	319,000	2.3	220,000	5.3	68.9	264,000	3.6	82.8
Social scientists	412,000	3.0	197,000	4.7	47.7	271,000	3.7	65.6
Engineers	1,502,000	10.9	993,000	23.9	66.1	1,282,000	17.4	85.4
S&E-related occupations	2,236,000	16.3	524,000	12.6	23.4	1,110,000	15.1	49.6
Non-S&E occupations	7,221,000	52.5	1,090,000	26.2	15.1	2,888,000	39.2	40.0

NOTE: Detail may not add to total because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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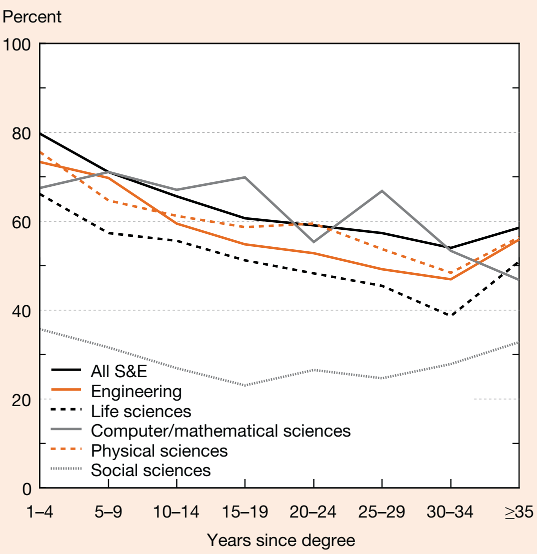
Figure 3-14 shows the percentages of S&E doctorate holders reporting R&D as a major work activity by field of degree and by years since receipt of doctorate. Individuals working in physical sciences and engineering report the highest R&D rates over their career cycles, and those in the social sciences report the lowest R&D rates. The percentage of doctorate holders engaged in R&D activities declines with increasing time since award of the degree. The decline may reflect movement into management or other career interests. It may also reflect increased opportunity for more experienced scientists to perform functions involving the interpretation and use of, as opposed to the creation of, scientific knowledge.

Figure 3-14
S&E doctorate holders engaged in R&D as major work activity, by years since degree: 2006



SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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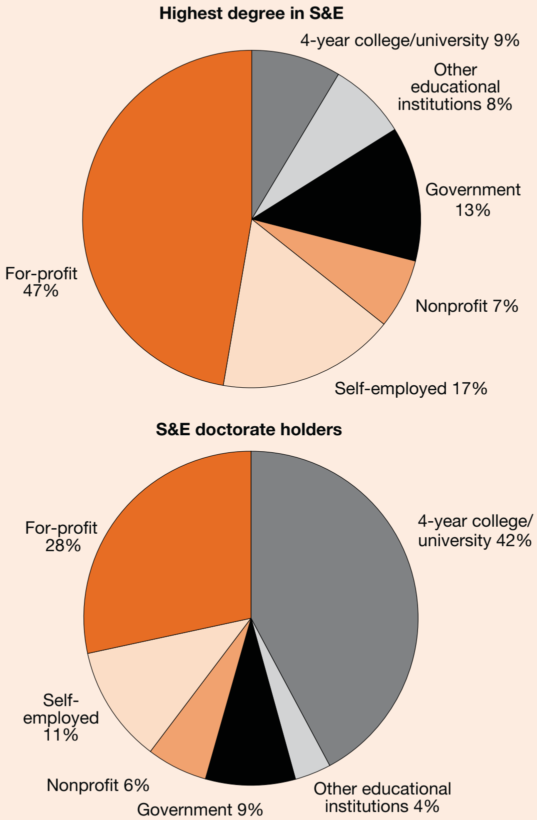
Employment Sectors

Individuals with S&E degrees are employed in all sectors of the U.S. economy. For-profit firms are their largest employer, but substantial numbers work in academia, nonprofit organizations, and government, or are self-employed.

For-profit firms employ the greatest number of individuals with S&E degrees (figure 3-15). They employed 47% of all individuals whose highest degree is in S&E and 28% of S&E doctorate holders. For those with an S&E doctorate, 4-year colleges and universities are an important but not a majority employer (42%). This 42% includes tenured and tenure-track faculty, individuals in postdoc and other temporary positions, and individuals with teaching, research, and administrative functions.

The OES survey provides more detailed estimates for sectors of employment, although it excludes the self-employed and those employed in recent startups (figure 3-16). The largest such employment segment for S&E occupations was "professional, scientific, and technical services" with 29%, followed by manufacturing with 17%. Government and educational services sectors each had less than 11% of total employment in S&E occupations in 2007.

Figure 3-15
Employment sector for individuals whose highest degree is in S&E and for S&E doctorate holders: 2006



NOTE: Self-employment includes employment at both incorporated and unincorporated businesses.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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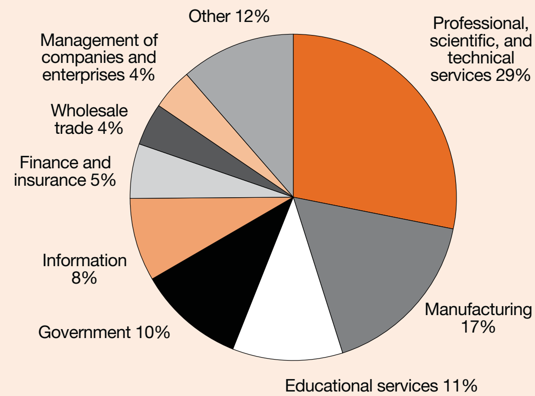
Figure 3-16
Largest sectors of employment for individuals in S&E occupations: May 2007



NOTE: Sector defined by North American Industry Classification System.

SOURCE: Bureau of Labor Statistics, Occupational Employment Statistics Survey (2007).

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Figure 3-17
Self-employment rates of workers whose highest degree is in S&E, by degree level and type of self-employment: 2006

NOTE: "All degree levels" includes professional degrees not broken out separately.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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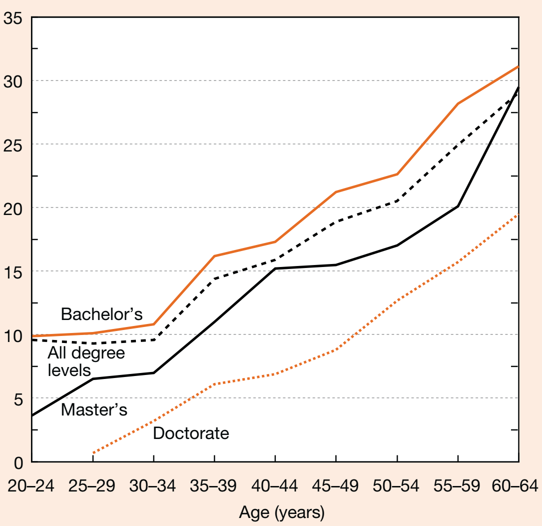
Self-Employment

More than 1.7 million workers whose highest degree is in S&E were self-employed in 2006, 17% of the total (NSF/SRS 2006). This SESTAT estimate of S&E self-employment is much higher than others that have been published elsewhere because it uses a different definition. Most reports of federal data on self-employment include only individuals whose businesses are unincorporated. While only a minority (33%) of all self-employed workers in the United States work in incorporated businesses (Census Bureau 2007), the reverse is true for those whose highest degree is in S&E. As shown in figure 3-17, adding "incorporated self-employed" greatly increases the proportion of workers whose highest degree is in S&E who are also self-employed. The rate of incorporated self-employment is much higher for individuals with S&E degrees than for the U.S. workforce as a whole, where only 11% are self-employed, and only one-third of those are incorporated (Census Bureau 2007). Among those whose highest degree is in S&E who are also self-employed, 64% work in incorporated businesses. Similar to other types of employment for S&E degree holders, 64% of self-employed workers whose highest degree is in S&E report

Figure 3-18
Self-employment rates of workers whose highest degree is in S&E, by degree level and age: 2006



NOTE: "All degree levels" includes professional degrees not broken out separately.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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that their job is related to the field of their highest degree (NSF/SRS 2006).

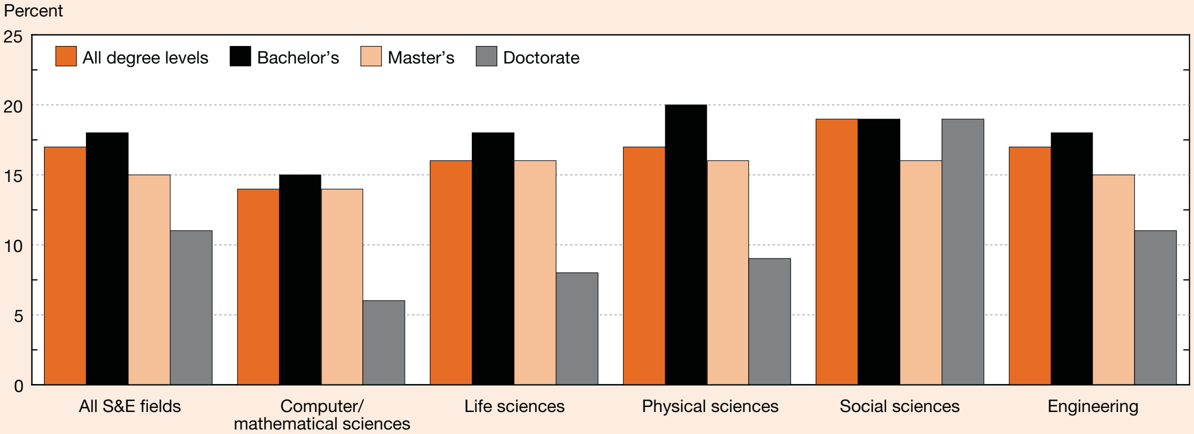
The proportion of self-employed workers generally decreases by level of degree and increases with age (see figures 3-17 and 3-18). While 18% of S&E bachelor's degree holders are self-employed, the proportion falls to 11% for S&E doctorate holders. However, self-employment increases with age at all degree levels. By age 60–64 self-employment reached about 30% for bachelor's and master's degree holders and 20% for S&E doctorate holders.

The rates of self-employment are similar across broad S&E fields, at the bachelor's degree level ranging from 14.8% in computer and mathematical sciences to 20.4% in the physical sciences (see figure 3-19). The highest self-employment rate among doctorate holders occurs in the social sciences (19%) and the lowest (6%) in computer and mathematical sciences.

Federal S&E Employment

The United States federal government is a major employer of scientists and engineers, largely limited to those with U.S. citizenship.[6] According to data from the U.S. Office of Personnel Management, the federal government employed approximately 210,000 persons in S&E occupations in 2005. Many of these workers were in occupations that, nationwide, include relatively large concentrations of foreign-born persons, some of whom are non-citizens, rendering them ineligible for many federal jobs. Among federal employees, 59% were in science occupations and 41% were

Figure 3-19
Self-employment rates of workers whose highest degree is in S&E, by degree level and field: 2006



NOTE: "All degree levels" includes professional degrees not broken out separately.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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in engineering occupations. The Department of Defense was the largest employer, with nearly 45% of the federal S&E workforce (NSF/SRS 2008a).

With regard to gender, the federal S&E workforce (defined by occupation) generally reflects the total S&E workforce. Women make up 26% of all U.S. employees in S&E occupations; for federal employees, the comparable proportion is 25%. The number of women in federal S&E positions shows a consistent decrease as age increases beyond the ages of 40–49; this is also true of the whole S&E workforce.

The S&E workforce at large is younger than the federal S&E workforce. Twenty-eight percent of the general S&E workforce is under 35 years of age, with only 15% of those in federal S&E occupations in that age group (appendix table 3-9).

S&E Occupation Density by Industry

High-technology employers are not the only companies who hire individuals in S&E occupations. As shown in table 3-7, workers with high-technology knowledge are found in industries with very different percentages of S&E occupations as a portion of total employment. Almost 1 million workers in S&E jobs are employed in industries whose S&E employment component is less than the national average of 4.2%. These industries employ 79% of all workers and 18% of all workers in S&E occupations. Illustrative examples include local government (at 3.0%, with 163,000 S&E jobs), hospitals (at 1.4%, with 68,000 S&E jobs), and plastic parts manufacturers (at 2.6%, with 16,000 S&E jobs).

Industries with higher proportions of individuals in S&E occupations tend to pay higher average salaries to both their S&E and non-S&E workers. The average salary of workers in non-S&E occupations employed in industries where more than 40% of workers are in S&E occupations is nearly double the average salary of workers in non-S&E occupations in industries with below-average proportions of workers in S&E occupations ($71,550 versus $36,146).

Metropolitan Areas

The availability of highly skilled workers can be relevant to an area's economic competitiveness. Two measures of availability with regard to S&E occupations are (1) the number of workers in S&E occupations and (2) the proportion of the entire metropolitan workforce that S&E occupations represent. These estimates should be used with care in comparing areas because the geographic scope of a metropolitan area varies significantly from city to city.

The Census Bureau divides some larger metropolitan areas into metropolitan divisions, and these divisions are used in comparisons with smaller metropolitan areas. Accordingly, table 3-8 lists metropolitan divisions with the largest estimated proportion of the workforce employed in S&E occupations. Table 3-9 lists areas and divisions with the largest estimated total number of workers employed in S&E occupations. Table 3-10 presents these data for larger metropolitan areas with multiple metropolitan divisions. These data are for May 2007.

The San Jose-Sunnyvale-Santa Clara and Boulder metropolitan areas had 14.3% and 14.2% of their workforces employed in S&E occupations, respectively. San Jose-Sunnyvale-Santa Clara had 18.2% of their workers in STEM occupations. No metropolitan areas had higher estimates for S&E or STEM occupations. Although the metropolitan areas with the highest estimated proportion of S&E employment are mainly smaller and perhaps less economically diverse, Washington, DC, Seattle, Boston, San Francisco, and San Jose also appear on the list of metropolitan areas with the greatest intensity of S&E occupational employment.

The largest numbers of workers in S&E occupations are in the Washington-Arlington-Alexandria, New York-White Plains-Wayne, Los Angeles-Long Beach-Glendale, and Chicago-Naperville-Joliet metropolitan divisions. These divisions have very large and diverse workforces even after being broken off from their larger metropolitan areas. With the exception of Washington-Arlington-Alexandria, each of

Table 3-7
Employment distribution and average earnings of workers in NAICS 4-digit industries, by proportion of employment in S&E occupations: 2007

Workers in S&E occupations (%)	All occupations	S&E occupations	Average annual worker salary ($): Non-S&E occupations	Average annual worker salary ($): S&E occupations
>40	2,456,900	1,150,410	71,550	81,093
20-40	3,533,150	952,320	54,039	80,230
10–20	10,558,950	1,444,490	56,319	74,833
4.2–10	12,158,410	880,540	47,237	68,179
<4.2 (below national average)	105,112,220	988,950	36,146	64,961

NAICS = North American Industry Classification System

NOTE: NAICS has hierarchal structure that uses 2 to 4 digits; 4-digit NAICS industries are subsets of 3-digit industries, which are subsets of 2-digit sectors.

SOURCE: Bureau of Labor Statistics, Occupational Employment Statistics Survey (May 2007).

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Table 3-8
Metropolitan areas with highest percentage of workers in S&E occupations: 2007

Metropolitan area	Percentage of workforce: S&E occupations	Percentage of workforce: STEM occupations	Workers employed: S&E occupations	Workers employed: STEM occupations
San Jose-Sunnyvale-Santa Clara, CA	14.3	18.2	130,180	165,400
Boulder, CO	14.2	17.4	22,830	28,010
Huntsville, AL	12.8	16.2	25,680	32,630
Framingham, MA NECTA Division	12.7	16.6	19,900	25,940
Durham, NC	11.1	15.5	29,880	41,560
Lowell-Billerica-Chelmsford, MA-NH NECTA Division	11.1	14.1	13,100	16,580
Washington-Arlington-Alexandria, DC-VA-MD-WV Metropolitan Division	10.6	12.7	242,350	290,700
Bethesda-Gaithersburg-Frederick, MD Metropolitan Division	9.6	12.0	54,370	68,340
Seattle-Bellevue-Everett, WA Metropolitan Division	9.3	11.8	131,620	167,060
Olympia, WA	8.7	10.1	8,300	9,700
Kennewick-Richland-Pasco, WA	8.4	11.2	7,300	9,700
Austin-Round Rock, TX	8.4	11.0	62,270	82,100
Ithaca, NY	8.0	12.5	4,020	6,270
Bloomington-Normal, IL	8.0	10.1	6,880	8,680
Ann Arbor, MI	8.0	10.3	15,620	20,250
Boston-Cambridge-Quincy, MA-NH NECTA Division	7.9	10.3	134,190	174,180
Palm Bay-Melbourne-Titusville, FL	7.9	10.7	16,210	21,800
Ames, IA	7.8	10.7	3,270	4,480
San Francisco-San Mateo-Redwood City, CA Metropolitan Division	7.6	9.7	75,700	96,170
Fort Walton Beach-Crestview-Destin, FL	7.2	8.8	5,860	7,200

NECTA = New England City and Town Area; STEM = science, technology, engineering, and mathematics

NOTES: Larger metropolitan areas broken into component metropolitan divisions. Differences among employment estimates may not be statistically significant.

SOURCE: Bureau of Labor Statistics, Occupational Employment Statistics Survey (2007).

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these areas has about the same proportion of workers in S&E occupations as the national workforce.

Looking just at the larger metropolitan areas, without breaking them into divisions, New York-Northern New Jersey-Long Island has the largest number (350,670) of individuals employed in S&E occupations but the same proportion (4.2%) as the workforce nationwide (see table 3-10 and figure 3-3).

Employer Size

For individuals whose highest degree is in S&E and who are employed in business/industry, the distribution of employer size is shown in figure 3-20. Across all degree levels, companies with fewer than 100 employees employ 36% of S&E degree holders. About 33% work at large firms with more than 5,000 employees. In general, there is a similar pattern of employment across employer size by degree levels, except that S&E doctorate holders are more concentrated at very small firms.

Demographics

Age and Retirement

The age distribution and retirement patterns of the S&E labor force affect its size, productivity, and the opportunities it offers for new S&E workers. For many decades, rapid increases in new entries into the workforce created a relatively young pool of workers, with only a small percentage near traditional retirement age. Now, individuals who earned S&E degrees in the late 1960s and early 1970s are moving into the later part of their careers.

The increasing average age of S&E workers may mean increased experience and greater productivity among them. However, it could also reduce opportunities for younger researchers to make productive contributions by working independently. In many scientific fields, folklore and empirical evidence indicate that the most creative research comes from younger people (Stephan and Levin 1992).

Table 3-9
Metropolitan areas with largest number of workers in S&E occupations: 2007

Metropolitan area	Workers employed: S&E occupations	Workers employed: STEM occupations	Percentage of workforce: S&E occupations	Percentage of workforce: STEM occupations
Washington-Arlington-Alexandria, DC-VA-MD-WV Metropolitan Division	242,350	290,700	10.6	12.7
New York-White Plains-Wayne, NY-NJ Metropolitan Division	209,670	279,960	4.1	5.5
Los Angeles-Long Beach-Glendale, CA Metropolitan Division	160,480	215,970	3.9	5.2
Chicago-Naperville-Joliet, IL Metropolitan Division	156,390	209,890	4.1	5.5
Boston-Cambridge-Quincy, MA-NH NECTA Division	134,190	174,180	7.9	10.3
Seattle-Bellevue-Everett, WA Metropolitan Division	131,620	167,060	9.3	11.8
San Jose-Sunnyvale-Santa Clara, CA	130,180	165,400	14.3	18.2
Houston-Sugar Land-Baytown, TX	128,020	182,920	5.2	7.4
Dallas-Plano-Irving, TX Metropolitan Division	119,910	161,610	5.8	7.9
Minneapolis-St. Paul-Bloomington, MN-WI	103,280	137,400	5.8	7.7
Atlanta-Sandy Springs-Marietta, GA	102,540	139,350	4.3	5.8
Philadelphia, PA Metropolitan Division	94,350	128,750	5.1	6.9
Santa Ana-Anaheim-Irvine, CA Metropolitan Division	80,170	107,300	5.2	7.0
Denver-Aurora, CO	79,030	99,430	6.4	8.1
San Diego-Carlsbad-San Marcos, CA	78,860	105,470	6.0	8.0
Warren-Troy-Farmington Hills, MI Metropolitan Division	76,870	103,390	6.6	8.9
San Francisco-San Mateo-Redwood City, CA Metropolitan Division	75,700	96,170	7.6	9.7
Phoenix-Mesa-Scottsdale, AZ	73,920	107,260	3.9	5.7
Baltimore-Towson, MD	71,660	93,720	5.6	7.3
Oakland-Fremont-Hayward, CA Metropolitan Division	63,540	85,240	6.2	8.3

NECTA = New England City and Town Area; STEM = science, technology, engineering, and mathematics

NOTES: Larger metropolitan areas broken into component metropolitan divisions. Differences among employment estimates may not be statistically significant.

SOURCE: Bureau of Labor Statistics, Occupational Employment Statistics Survey (2007).

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Table 3-10
Workers in S&E and STEM occupations in larger metropolitan areas: 2007

Metropolitan area	Workers employed: S&E occupations	Workers employed: STEM occupations	Percentage of workforce: S&E occupations	Percentage of workforce: STEM occupations
New York-Northern New Jersey-Long Island, NY-NJ-PA	350,670	474,540	4.2	5.7
Washington-Arlington-Alexandria, DC-VA-MD-WV	296,720	359,040	10.4	12.6
Los Angeles-Long Beach-Santa Ana, CA	240,650	323,270	4.2	5.7
Boston-Cambridge-Quincy, MA-NH	187,950	244,130	7.6	9.9
Chicago-Naperville-Joliet, IL-IN-WI	179,070	241,800	4.0	5.4
Dallas-Fort Worth-Arlington, TX	149,470	206,810	5.2	7.1
San Francisco-Oakland-Fremont, CA	139,240	181,410	6.9	9.0
Seattle-Tacoma-Bellevue, WA	138,710	177,150	8.2	10.5
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	133,990	183,810	4.9	6.7
Detroit-Warren-Livonia, MI	129,550	172,140	6.6	8.8
Miami-Fort Lauderdale-Miami Beach, FL	68,500	94,400	2.9	4.0

STEM = science, technology, engineering, and mathematics

NOTE: Includes only metropolitan statistical areas with multiple metropolitan divisions. Differences among employment estimates may not be statistically significant.

SOURCE: Bureau of Labor Statistics, Occupational Employment Statistics Survey (2007).

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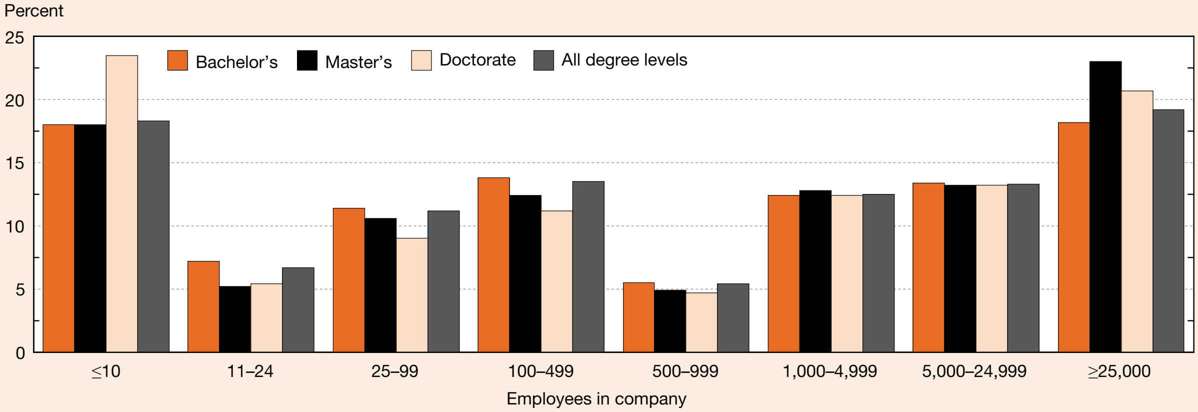
Figure 3-20
Individuals with highest degree in S&E employed in private business, by employer size: 2006



NOTE: Includes self-employment, employment by noneducation for-profit firms, and by noneducation nonprofit firms.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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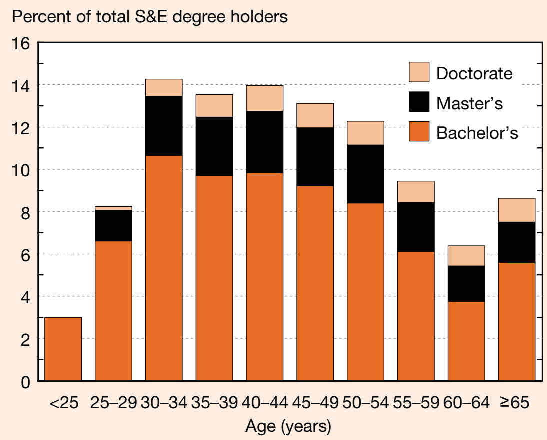
Aside from the possible effects on productivity, early career opportunities, and, perhaps, the culture within some scientific fields, the age structure of the S&E labor force has important implications for its growth rate. This section does not attempt to project future S&E labor market trends; however, it posits some general conclusions. Absent changes in degree production, retirement patterns, or immigration, the number of S&E-trained workers in the labor force will continue to grow for some time, but the growth rate may slow considerably as an increasing proportion of the S&E labor force reaches traditional retirement age. With slowing growth, the average age of the S&E labor force will increase.

Age Distribution of the S&E Workforce

Net immigration, morbidity, mortality, and, most of all, historical S&E degree production patterns affect the age distribution of scientists and engineers in the workforce. With the exception of new fields such as computer sciences (in which 56% of degree holders are younger than age 40), the greatest population density of individuals with S&E degrees occurs between the ages of 40 and 49. Figure 3-21 shows the age distribution of the labor force with S&E degrees broken out by level of degree. In general, the majority of individuals in the labor force with S&E degrees are in their late thirties through their early fifties, with the largest group at ages 40–44. More than half of workers with S&E degrees are age 40 or older, and the 40–44 age group is more than twice as large as the 60–64 age group.

This general pattern also holds for individuals with S&E doctorates. Because of the length of time needed to obtain a doctorate, those who hold these degrees are somewhat older than individuals who have less advanced S&E degrees. The greatest population density of S&E doctorate holders occurs between the ages of 40 and 54. This can be seen most easily in figure 3-22, which compares the age distribution of S&E degree holders in the labor force at each level of degree, and in figure 3-23, which shows the cumulative age distribution for individuals at each degree level. Even if one takes into account the somewhat older retirement ages of doctorate holders, a much larger proportion of S&E doctorate holders are near traditional retirement ages than are individuals with either S&E bachelor's or master's degrees.

Figure 3-21
Age distribution of individuals in labor force with highest degree in S&E: 2003



SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2003), http://sestat.nsf.gov.

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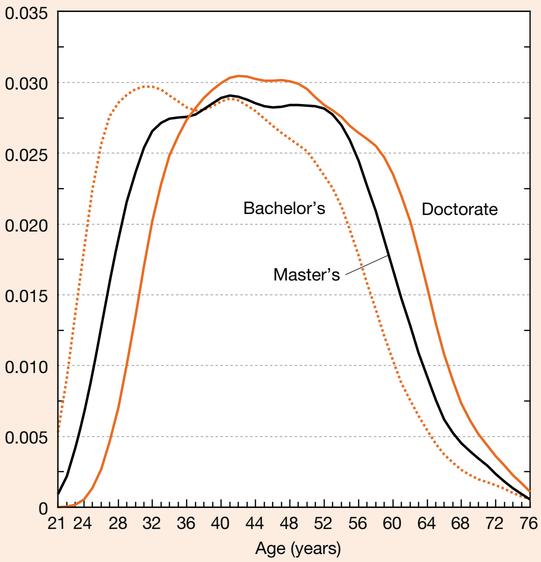
Figure 3-22
Age distribution of individuals in labor force with highest degree in S&E, by degree level: 2003



NOTE: Age distribution smoothed using kernel density techniques.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2003), http://sestat.nsf.gov.

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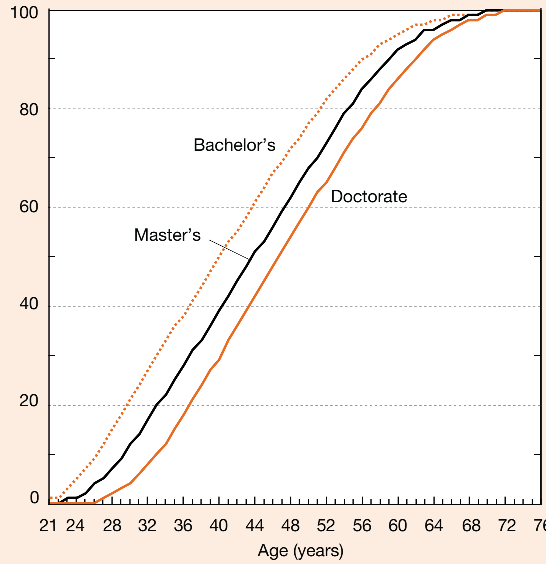
Figure 3-23
Cumulative age distribution of individuals in labor force whose highest degree is in S&E, by degree level: 2003



NOTE: Age distribution smoothed using kernel density techniques.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2003), http://sestat.nsf.gov.

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Figure 3-24, which compares the age distributions of S&E doctorate holders in 1993 and 2003, highlights the extent of the shift in the age structure of the S&E labor force. S&E doctorate holders under age 35 are about the same proportion of the S&E doctorate holders in the total labor force in both years. However, over the decade, the 35–54 age group became a much smaller proportion of the doctoral-level S&E labor force. What grew was the proportion of S&E doctorate holders age 55 and older.

Across all degree levels and fields, 26.4% of the labor force with S&E degrees is older than age 50. The proportion ranges from 15% of individuals with their highest degree in computer sciences to 41% of individuals with their highest degree in geosciences (figure 3-25).

Altogether, the age distribution of S&E-educated individuals suggests the following likely effects on the future of the S&E labor force:

- ♦ Barring large changes in degree production, retirement rates, or immigration, the number of trained scientists and engineers in the labor force will continue to increase, because the number of individuals currently receiving S&E degrees exceeds the number of workers with S&E degrees nearing traditional retirement age.
- ♦ However, unless large increases in degree production occur, the average age of workers with S&E degrees will rise.
- ♦ Barring large reductions in retirement rates, the total number of retirements among workers with S&E degrees will increase over the next 20 years.

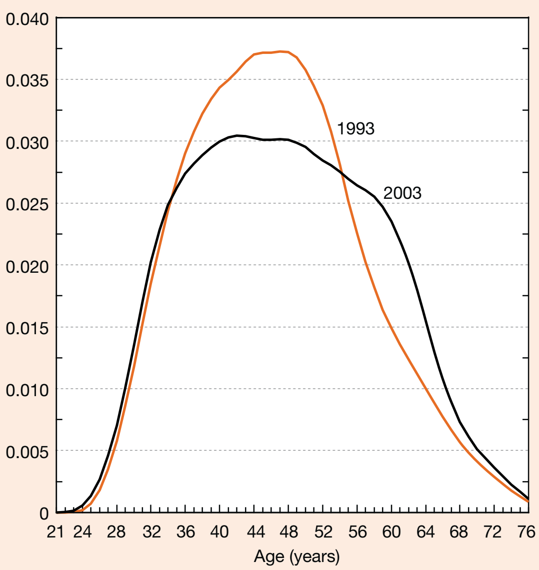
Taken together, these factors suggest a slower growing and older S&E labor force. Both trends would be accentuated if either new degree production were to drop or immigration were to slow, both concerns raised by a 2003 report of the Committee on Education and Human Resources Task Force on National Workforce Policies for Science and Engineering of the National Science Board (NSB 2003).

S&E Workforce Retirement Patterns

The retirement behavior of individuals can differ in complex ways. Some individuals retire from one job and continue to work part time or even full time at another position, sometimes even for the same employer. Others leave the workforce without a retired designation from a formal pension plan. Table 3-11 summarizes three ways of looking at changes in workforce involvement for S&E degree holders: leaving full-time employment, leaving the workforce, and retiring from a particular job.

By age 61, slightly more than 50% of those with an S&E bachelor's degree as their highest degree are no longer working full time. The age at which at least half of S&E

Figure 3-24
Age distribution of S&E doctorate holders in labor force: 1993 and 2003



NOTE: Age distribution smoothed using kernel density techniques.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (1993 and 2003), http://sestat.nsf.gov.

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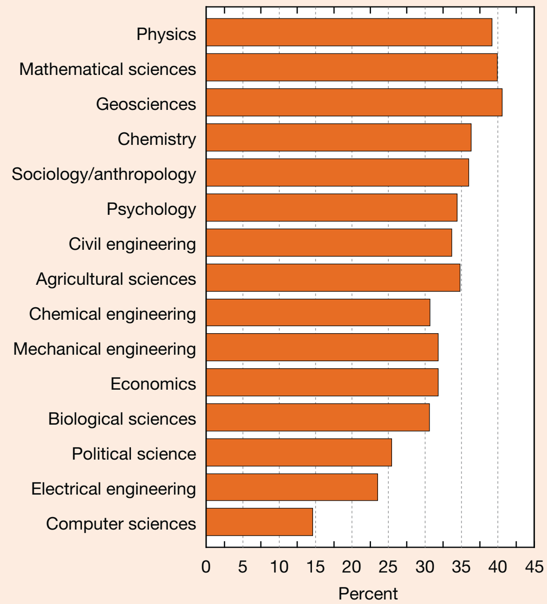
Figure 3-25
Employed S&E degree holders older than 50, by selected field of highest degree: 2006



SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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degree holders no longer work full time increases by degree level—to age 62 at the master's level and age 66 at the doctoral level. Longevity also differs by degree level when measuring the number of individuals who leave the workforce entirely: half of all S&E bachelor's degree holders left the workforce entirely by age 65, compared with S&E master's degree and doctorate holders who left the workforce at ages 66 and 69, respectively. Although many S&E degree holders who formally retire from one job continue to work full time or part time, formal retirement occurs at similar ages for all levels of degree holders: more than 50% of bachelor's, master's, and doctoral degree holders have formally retired from jobs by age 65, 66, and 67, respectively.

Figure 3-26 shows data on S&E degree holders working full time at ages 55–69. For all degree levels, the proportion of S&E degree holders who work full time declines fairly steadily by age, but after age 55, full-time employment for doctorate holders becomes significantly greater than for bachelor's and master's degree holders. At age 69, 27% of doctorate holders work full time, compared with 16% of bachelor's degree recipients.

Table 3-12 shows the rates at which holders of U.S. S&E doctorates left full-time employment, by sector of employment, between October 2003 and April 2006. For every age group, the retirement rates for S&E doctorate holders were slightly higher for those working in the private sector than those employed in education or government. Although many S&E degree holders who formally retire from one job continue to work full time or part time, this occurs most often among individuals younger than age 63 (table 3-13). However, of retired S&E degree holders age 71 to 75, only 12% of bachelor's degree holders keep working either full time or part time, 17% of master's degree holders, and 19% of doctorate holders.

Table 3-11
Labor force participation for individuals with highest degree in S&E, by education level and age: 2003

	Age at which more than half were—		
Highest degree	No longer employed full-time	Not in labor force	Ever retired
Bachelor's................	61	65	65
Master's...................	62	66	66
Doctorate.................	66	69	67

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2003), http://sestat.nsf.gov.

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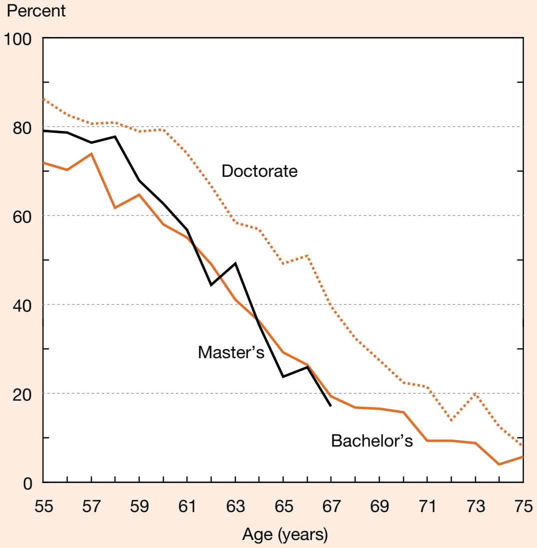
Figure 3-26
Full-time labor force participation by older individuals with highest degree in S&E, by age and degree level: 2006



NOTES: Calculated from 2-month pooled samples. Data for master's degree holders shown only through age 67 due to small sample sizes.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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Table 3-12
Proportion of employed S&E doctorate holders who had left full-time employment since October 2003, by employment sector and age: April 2006
(Percent)

	October 2003 employment sector			
Age (years)	All sectors	Education	Private	Government
50–55	6.7	4.5	9.7	4.4
56–62	15.0	11.8	18.6	14.9
63–70	28.0	26.2	31.5	25.2

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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Women and Minorities in S&E

An important part of the growth of the S&E labor force comes from the increased presence of women and ethnic minorities. In 2006, white males constituted 58% of those in the labor force over age 50 whose highest degree was in S&E. Among those under age 30, only 35% were white

Table 3-13
Employment status of retired individuals with highest degree in S&E, by education level and age: 2003
(Percent)

Degree level and employment status	Age (years)			
	50–55	56–62	63–70	71–75
Bachelor's	100.0	100.0	100.0	100.0
Part time	8.2	13.8	10.7	9.0
Full time	51.1	28.9	9.0	2.6
Not working	40.7	57.3	80.3	88.4
Master's	100.0	100.0	100.0	100.0
Part time	14.0	15.8	18.3	9.3
Full time	62.3	35.3	11.8	8.0
Not working	23.7	48.9	69.9	82.7
Doctorate	100.0	100.0	100.0	100.0
Part time	22.6	24.1	21.2	14.7
Full time	50.6	33.1	12.9	4.7
Not working	26.8	42.8	65.9	80.6

NOTES: Retired individuals are those who said they had ever retired from any job. Percents may not add to 100% because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2003), http://sestat.nsf.gov.

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males (NSF/SRS 2006). This represents both a change in the composition of the total U.S. labor force and a growth in the participation of women and minorities in S&E.

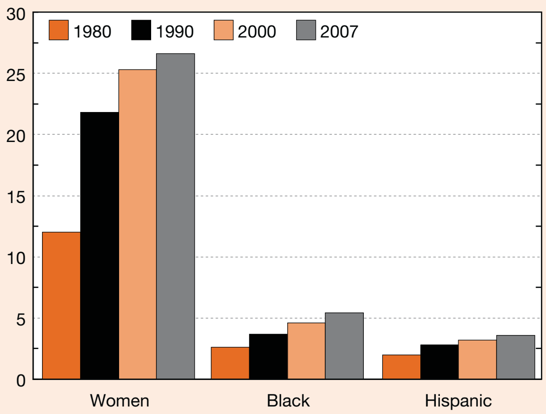
Both women and underrepresented ethnic minorities have shown steady growth in their proportion of the S&E labor force (see figures 3-27 and 3-28, which look at sex and ethnic representation within S&E occupations).

Representation of Women in S&E

Women constituted more than one-fourth (26%) of the college-educated workforce in S&E occupations and two-fifths (40%) of those with S&E degrees in 2006, according to NSF's SESTAT data.

Census data on S&E occupations from 1980 to 2007 show the number of women in S&E occupations rising from 12% to 27% over those 27 years (figure 3-27). Figures 3-29 and 3-30 show the growth in the number of women with education in S&E for different graduation cohorts and broad fields of degree. The notable exception is in computer and mathematical sciences at the bachelor's degree level, where the proportion of women in the workforce is lower for 2002–05 graduates (27%) than it is for 1972–76 graduates (35%). In contrast, the proportion of women in the most recent bachelor's degree cohorts in both the social sciences and the life sciences has risen to above 60%. Among S&E doctorate holders in the workforce, the proportion of women is generally higher in more recent cohorts, including the computer and mathematical sciences.

Figure 3-27
College-educated women and racial/ethnic minorities in S&E occupations: 1980, 1990, 2000, and 2007



NOTE: Postsecondary S&E teachers not included because they cannot be identified in data source.

SOURCE: University of Michigan, Integrated Public Use Microdata Series, 1980–2000 Decennial Census files and 2007 American Community Survey, http://usa.ipums.org/usa/, special tabulations.

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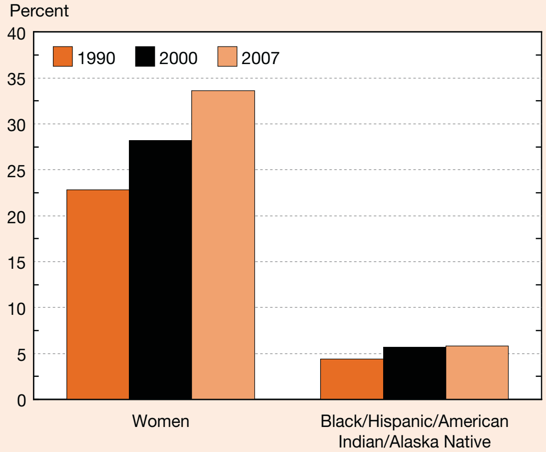
Figure 3-28
Women and racial/ethnic minority doctorate holders in S&E occupations: 1990, 2000, and 2007



NOTE: Postsecondary S&E teachers not included because they cannot be identified in data source.

SOURCE: University of Michigan, Integrated Public Use Microdata Series, 1990–2000 Decennial Census files and 2007 American Community Survey, http://usa.ipums.org/usa/, special tabulations.

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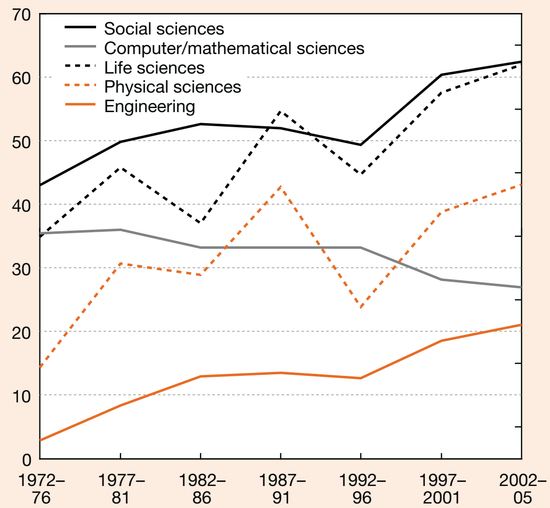
Figure 3-29
Representation of women among workers whose highest degree is S&E bachelor's, by year of degree: 2006



SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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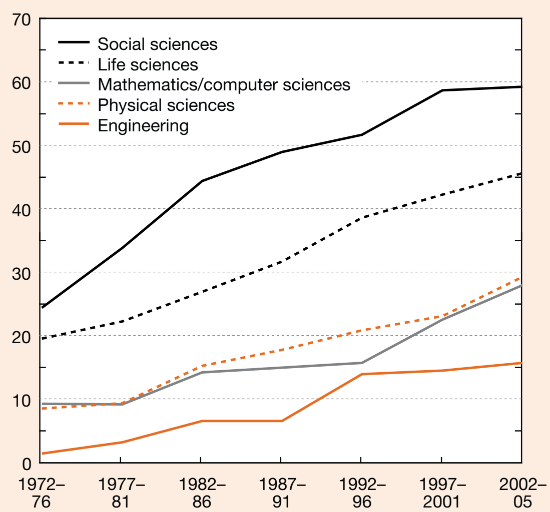
Figure 3-30
Representation of women among workers whose highest degree is S&E doctorate, by year of doctorate: 2006



SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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Age Distribution and Experience. On average, women in the S&E workforce are younger than men (figures 3-31 and 3-32). Forty-six percent of women and 31% of men employed in science and engineering in 2003 received their degrees within the previous 10 years. The difference is even more profound at the doctoral level, which has a much greater concentration of women in their late thirties. Consequently, a much larger proportion of male scientists and engineers at all degree levels, but particularly at the doctorate level, will reach traditional retirement age during the next decade. This will affect sex ratios and potentially the number of female scientists in senior-level positions.

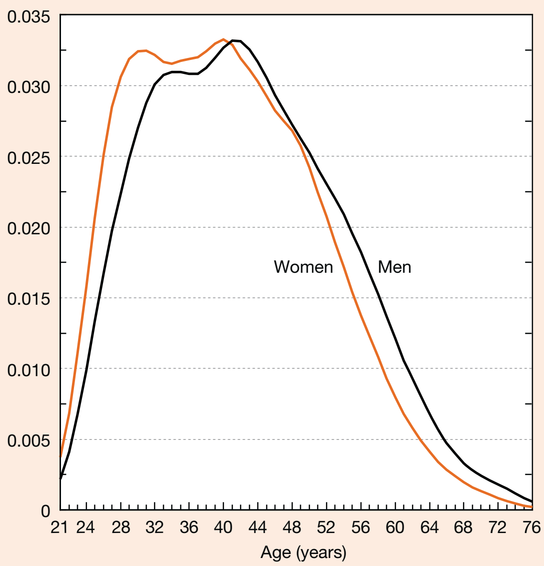
Unemployment. Unemployment rates in 2006 were somewhat higher for women in S&E occupations than for men: 2.2% of men and 2.9% of women were unemployed. In contrast, the unemployment rate in 1993 was 2.7% for men and 2.1% for women (table 3-14).

Representation of Racial and Ethnic Minorities in S&E

With the exception of Asians/Pacific Islanders, racial and ethnic minorities represent only a small proportion of those employed in S&E occupations in the United States.

Figure 3-31
Age distribution of individuals in S&E occupations, by sex: 2003

Density (percent)



NOTE: Age distribution smoothed with kernel density techniques.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2003), http://sestat.nsf.gov.

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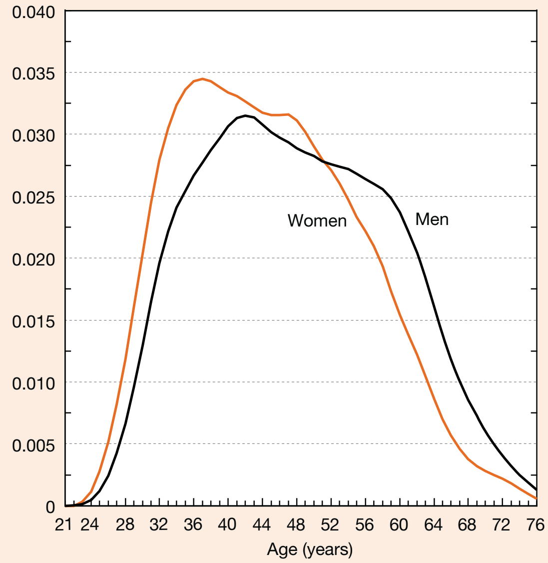
Figure 3-32
Age distribution of doctorate holders in S&E occupations, by sex: 2003

Density (percent)



NOTE: Age distribution smoothed with kernel density techniques.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2003), http://sestat.nsf.gov.

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Table 3-14
Unemployment rate for individuals in S&E occupations, by sex, race/ethnicity, and visa status: 1993, 2003, and 2006
(Percent)

Characteristic	1993	2003	2006
All individuals in S&E occupations	2.6	3.3	2.4
Sex			
Male	2.7	3.3	2.2
Female	2.1	3.5	2.9
Race/ethnicity			
White	2.4	2.9	2.2
Asian/Pacific Islander	4.0	5.7	2.8
Black	2.8	4.2	4.4
Hispanic	3.5	2.5	2.5
Temporary residents	3.4	2.7	2.8

NOTE: 2003 and 2006 data include some individuals with multiple races in each category.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (1993, 2003, and 2006), http://sestat.nsf.gov.

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Collectively, blacks, Hispanics, and other ethnic groups (the latter category includes American Indians/Alaska Natives) constitute 24% of the total U.S. population, 13% of college graduates, and 10% of college-educated individuals employed in S&E occupations.

Conversely, Asians/Pacific Islanders, despite constituting only 5% of the U.S. population, accounted for 7% of college graduates and 14% of those employed in S&E occupations in 2003. Although most (82%) Asians/Pacific Islanders in S&E occupations were foreign born, those born in the United States were also more highly represented in S&E than in the total workforce.

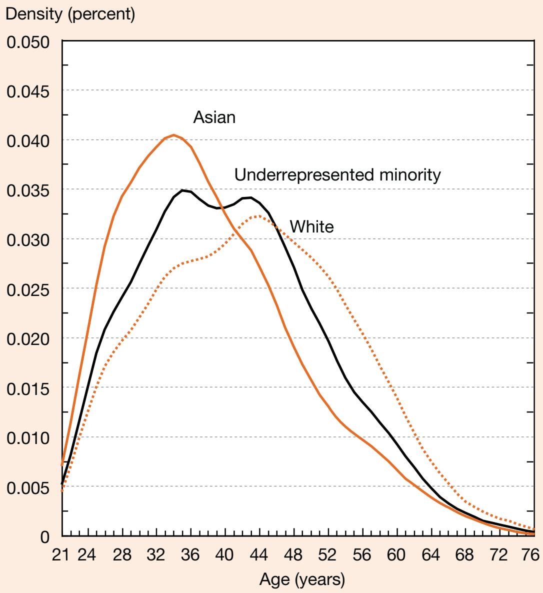
Age Distribution. As is the case for women, underrepresented racial and ethnic minorities in the S&E workforce are much younger than non-Hispanic whites in the same S&E jobs (figure 3-33), and this difference is even more pronounced for doctorate holders in S&E occupations (figure 3-34). This finding could point to an upcoming shift in the overall composition of the S&E workforce. In the near future, a much greater proportion of non-Hispanic white doctorate holders in S&E occupations will be reaching traditional retirement ages. This circumstance could signal a more rapid increase in the number of non-Hispanic white doctorate holders who will retire or otherwise leave S&E employment. On the other hand, Asian/Pacific Islander doctorate holders in S&E occupations (measured by race and not by place of birth) are on average the youngest racial/ethnic group, and thus the least likely to have large numbers of retirees.

Salary Differentials for Women and Minorities

Trends in Median Salaries. Women and members of underrepresented minority groups have generally lower earnings than their male and nonminority counterparts. However, differences in average age, work experience, fields of degree, sector of employment, and other characteristics can make direct comparison of salary and earnings statistics misleading. This section discusses these income gaps and explores some of the underlying factors that may affect them.

Factors Influencing Salary Differentials. Regression analysis is a statistical method that can be used to examine salary and other differences simultaneously.[7] Although this type of analysis can provide insight, it cannot give definitive answers to questions about the openness of S&E to women

Figure 3-33
Age distribution of individuals in S&E occupations, by race/ethnicity: 2003



NOTES: Age distribution smoothed with kernel density techniques. Underrepresented minority includes Hispanic, Black, Native Hawaiian/Pacific Islander, American Indian/Alaska Native, and multiple race.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2003), http://sestat.nsf.gov.

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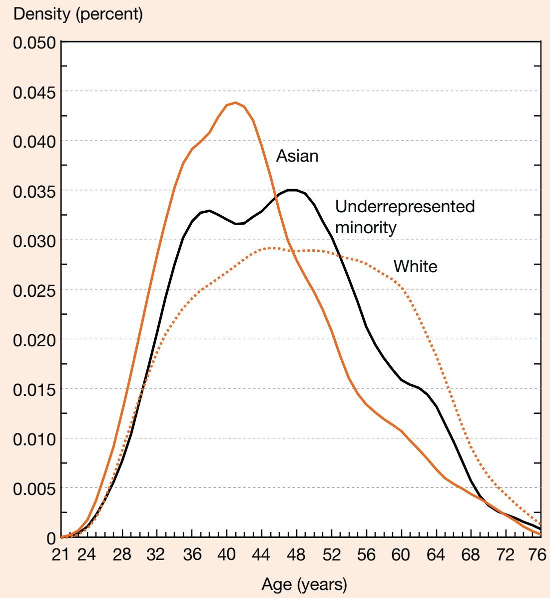
Figure 3-34
Age distribution of S&E doctorate holders in S&E occupations, by race/ethnicity: 2003



NOTES: Age distribution smoothed with kernel density techniques. Underrepresented minority includes Hispanic, Black, Native Hawaiian/Pacific Islander, American Indian/Alaska Native, and multiple race.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2003), http://sestat.nsf.gov.

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and minorities. The most basic reason is that no labor force survey ever captures information on all characteristics that may affect compensation.

Figures 3-35 and 3-36 show estimates of salary differences for different groups after controlling for several individual characteristics. Differences in mean annual salary are substantial when comparing all individuals with S&E degrees by level of degree only.

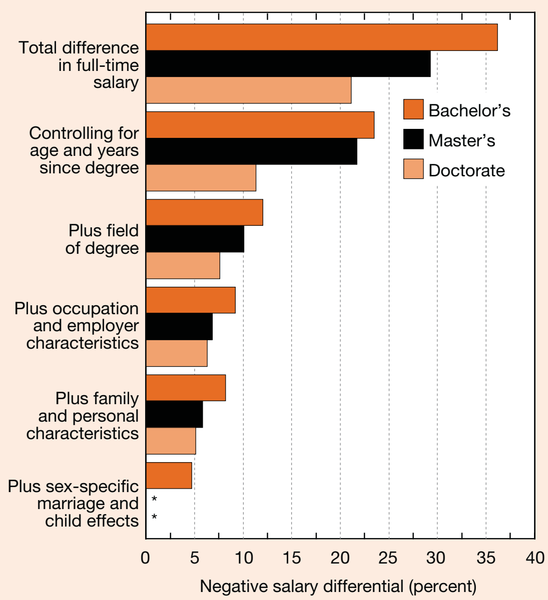
In 2006, women with S&E bachelor's degrees working full time had mean salaries that were 36.2% less than those of their male counterparts. Likewise, full-time salaries of blacks, Hispanics, and individuals in other underrepresented ethnic groups with S&E bachelor's degrees were 25.8% less than those of non-Hispanic whites and Asians/Pacific Islanders with S&E bachelor's degrees.[8] While still substantial, these salary differentials decrease as level of degree increases for both women and ethnic minorities, reaching 21.1% and 15.0% respectively.

Effects of Age and Years Since Degree. On average, women and members of underrepresented minority groups are younger than their counterparts in most S&E fields. Controlling for differences in both age and years since receipt of degree reduces the estimated salary differential for both women and minorities at every degree level.

For women, it reduces salary differentials by about one-third at the bachelor's and master's degree levels, and by about half at the doctorate level.[9] Statistical controls may make less difference at lower degree levels because similar proportions of men and women with S&E degrees are in mid-career, but a larger proportion of men are at older ages, where salaries begin to decline.

For underrepresented ethnic minorities, controlling for age and years since degree produces proportionally larger reductions in salary differentials than is the case for women. Introducing these controls reduces salary differentials between underrepresented minorities and both non-Hispanic whites and Asians/Pacific Islanders by more than half at all degree levels.

Figure 3-35
Estimated differences in full-time salary between women and men with highest degree in S&E, controlling for level of degree and other characteristics: 2006



* = not significantly different from zero at p = .05

NOTES: Salary differentials represent estimated differences in full-time salary for women compared to men in regression analyses including different characteristics. Regression coefficients are estimated using the natural log of full-time annual salary as the dependent variable.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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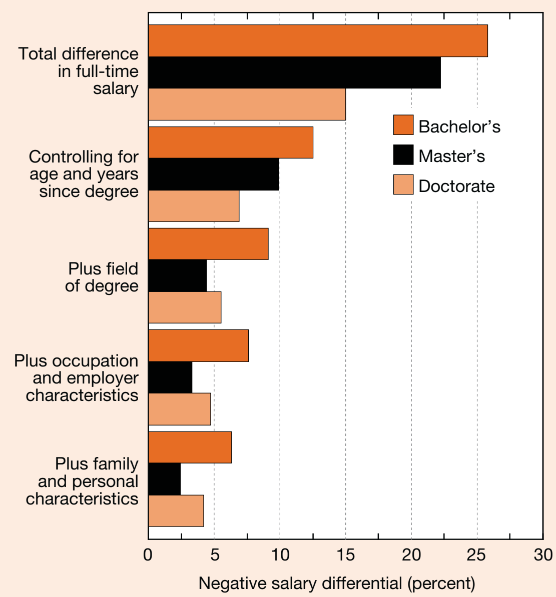
Figure 3-36
Estimated differences in full-time salary of underrepresented minorities versus non-Hispanic whites and Asians with highest degree in S&E, controlling for level of degree and other characteristics: 2006



NOTES: Salary differentials represent estimated differences in full-time salary for underrepresented ethnic minorities compared to non-Hispanic whites and Asians in regression analyses including different characteristics. Regression coefficients are estimated using the natural log of full-time annual salary as the dependent variable.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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Effects of Field of Degree on Salary Differentials. Controlling for field of degree in addition to age and years since degree reduces the estimated salary differentials for women with S&E degrees to –12.0% at the bachelor's degree level and to –7.6% at the doctorate level.[10] These reductions generally reflect the greater concentration of women in the lower-paying social and life sciences as opposed to engineering and computer sciences.

Field of degree is also associated with reduction of estimated salary differentials for underrepresented ethnic groups. Controlling for field of degree further reduces salary differentials to –9.1% for individuals with S&E bachelor's degrees and to –5.5% for individuals with S&E doctorates. At the doctoral level, field of degree, age, and years since degree together account for two-thirds of salary differentials for underrepresented ethnic groups.

Effects of Occupation and Employer Characteristics on Salary Differentials. Occupation and employer characteristics affect compensation.[11] Academic and nonprofit employers typically pay less for the same skills than employers pay in the private sector, and government compensation falls somewhere between the two groups. Other factors affecting salary are the sector of the economy, the U.S. region where a person works, and whether the person is working in S&E or in R&D. However, occupation and employer characteristics may not be determined solely by individual choice; they may also in part reflect an individual's career success.

When comparing women with men and underrepresented ethnic groups with non-Hispanic whites and Asians/Pacific Islanders, controlling for occupation and employer further reduces salary differentials. At the doctoral level, controlling for occupation leaves no statistically significant difference between the salaries of underrepresented ethnic groups compared with non-Hispanic whites and Asians/Pacific Islanders.

Effects of Family and Personal Characteristics on Salary Differentials. Marital status, the presence of children, parental education, and other personal characteristics are often associated with differences in compensation. Although these differences may involve discrimination, they may also reflect many subtle individual differences that can affect work productivity.[12] For example, having highly educated parents is associated with higher salaries for individuals of all ethnicities and both sexes. It may well be associated with greater academic achievement not directly measured in these data; alternatively, it may be associated with family and personal networks that are conducive to career success. In any event, for many individuals in many ethnic groups, historical discrimination probably affected parents' educational opportunities and achievement.

Controlling for these additional characteristics changes salary differentials only slightly for each group and degree level.[13] An additional issue for the wage differentials of women, however, is that family and child variables often have different effects for men and women. In these estimates, both marriage and children are associated with higher salaries for men with S&E degrees at all levels, but have a negligible association with women's earnings. Allowing for these differences in sex effects reduces the salary differential at the bachelor's degree level to 4.7% and leaves no statistically significant difference in salary at the master's degree and doctorate levels.

S&E Labor Market Conditions

Labor market conditions for scientists and engineers affect the attractiveness of S&E fields to both students and those already in the labor force. In general, holders of S&E degrees have higher rates of pay and lower rates of unemployment than other college graduates. However, this does not exempt them from unemployment due to overall business cycles or specific events affecting individuals with training in their fields. This section looks at both long-term and recent trends using NSF, Census Bureau, and BLS data.

Earnings

The estimated annual wages of individuals in S&E occupations, based on BLS's OES survey, are considerably higher than the average of the total workforce. Median annual wages in 2007 (regardless of education level or field) in S&E occupations were $70,600, more than double the median ($31,410) for total U.S. employment (table 3-15). The spread in average (mean) wage was less dramatic but still quite wide, with individuals in S&E occupations again earning considerably more on average ($74,070) than workers in all occupations ($40,690). Mean S&E wages ranged from $66,370 for social science occupations to $81,050 for engineering occupations. Mean annual wages for technology occupations ranged from $53,165 for technicians and programmers to $114,470 for S&E managers.

The 2004–07 growth in mean wages for both the S&E and STEM occupation groups (3.4%) was slightly greater than that for all workers included in the OES survey (3.2%). Among S&E occupations, those in physical S&E occupations experienced the highest wage growth (3.7% average annual rate) and those in social science occupations experienced the lowest (3.1% average annual rate).

Workers with S&E degrees also have higher earnings than those with degrees in other fields. Figure 3-37 shows estimates of median salary at different points in life for individuals with a bachelor's degree as their highest degree in a variety of fields. Except in the first 4 years after earning their degrees, holders of S&E bachelor's degrees earn more than those with non-S&E degrees at every year since degree. Median salaries for S&E bachelor's degree holders in 2003 peaked at $65,000 at 15–19 years after receiving their degree, compared with $49,000 for those with non-S&E bachelor's degrees. Median salaries of individuals with bachelor's degrees in S&E-related fields (such as technology, architecture, or health) peaked at $52,000 at 25–29 years after degree, but were higher than those for non-S&E bachelor's degree holders at most years since receiving their degree.

Table 3-15
Annual earnings and earnings growth in science and technology and related occupations: May 2004–May 2007

Occupation	Mean: 2007 annual earnings ($)	Mean: Average annual growth rate since 2004 (%)	Median: 2007 annual earnings ($)	Median: Average annual growth rate since 2004 (%)
All U.S. employment	40,690	3.2	31,410	3.0
STEM occupations	72,000	3.4	66,950	3.3
S&E occupations	74,070	3.4	70,600	3.4
Computer/mathematical scientists	71,940	3.4	68,910	3.5
Life scientists	71,700	3.3	63,170	3.1
Physical scientists	73,720	3.7	67,190	3.9
Social scientists	66,370	3.1	60,380	3.2
Engineers	81,050	3.7	77,750	3.5
Technology occupations	67,870	0.3	NA	NA
S&E managers	114,470	4.7	NA	NA
S&E technicians/computer programmers	53,165	2.8	NA	NA
S&E-related occupations (not included above)	66,150	4.1	50,540	4.5
Health-related occupations	66,000	4.4	55,310	4.8
Other S&E-related occupations	73,110	3.3	50,250	3.8

NA = not available

STEM = science, technology, engineering, and mathematics

NOTE: Occupational Employment Statistics (OES) employment data do not cover employment in agriculture, private household, or among self-employed, and therefore do not represent total U.S. employment.

SOURCE: Bureau of Labor Statistics, OES Survey (May 2004 and May 2007).

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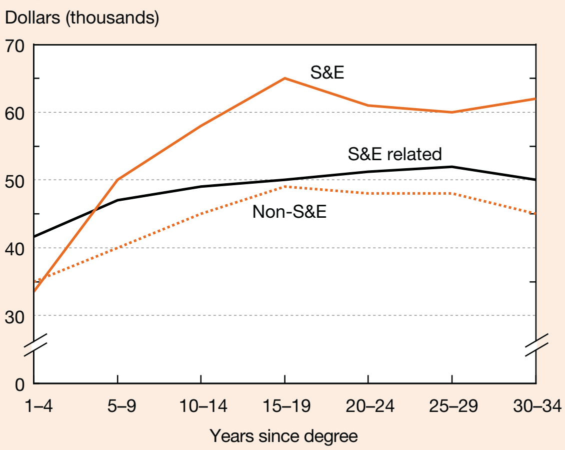
Figure 3-37
Median salaries for bachelor's degree holders, by broad field classification and years since degree: 2003



NOTE: See table 3-1 for definitions of S&E, S&E-related, and non-S&E degrees.

SOURCE: National Science Foundation, Division of Science Resources Statistics, National Survey of College Graduates, 2003.

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Earnings at Different Degree Levels

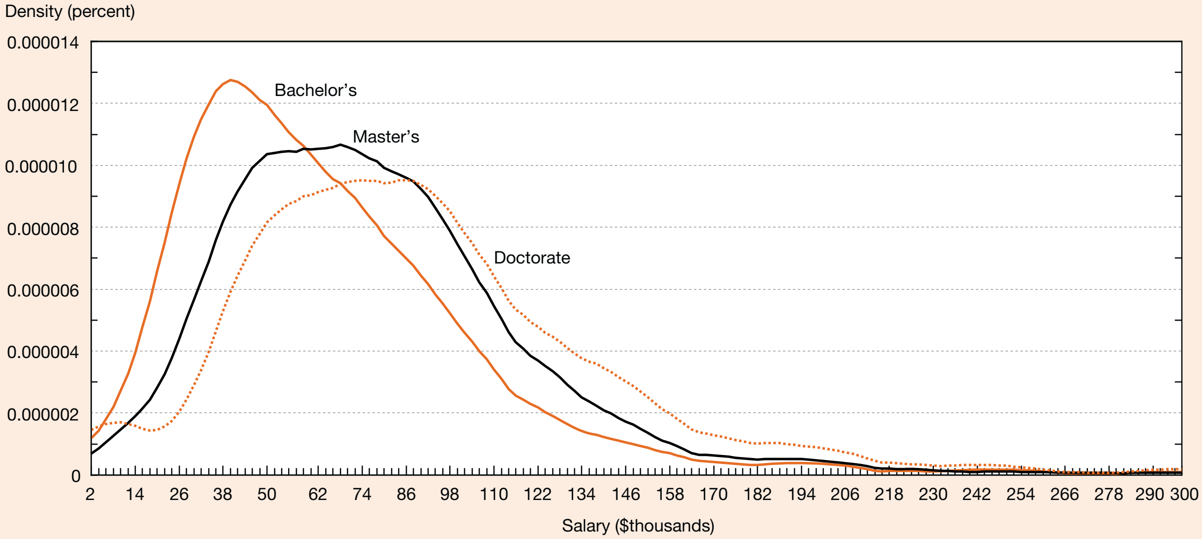
Figure 3-38 illustrates the distribution of median salaries earned by individuals with S&E degrees at various levels. (The distributions are heavily skewed, making the median a preferred summary statistic.) Not surprisingly, salaries are higher for those with more advanced degrees. In 2003, 11% of S&E bachelor's degree holders had salaries higher than $100,000, compared with 28% of doctorate holders. Similarly, 22% of bachelor's degree holders earned less than $30,000, compared with 8% of doctorate holders.[14]

Figure 3-39 shows a cross-sectional profile of median 2003 salaries for S&E degree holders over the course of their career. Median earnings generally increase with time since degree, as workers add on-the-job knowledge to the formal training they received in school. For holders of bachelor's and master's degrees in S&E, average earnings adjusted for inflation begin to decline in mid to late career, a common pattern that is often attributed to "skill depreciation." In contrast, earnings for S&E doctorate holders continue to rise even late in their careers. Median salaries in 2003 peaked at $65,000 for bachelor's degree holders, $73,000 for master's degree holders, and $96,000 for doctorate holders.

Unemployment in S&E Occupations

Along with higher salaries, relatively low unemployment rates are among the labor market rewards of the S&E labor force. Historically, unemployment rates in S&E occupations have tended to be lower than those for college-educated

Figure 3-38
Salary distribution of S&E degree holders employed full time, by degree level: 2003



NOTE: Salary distribution smoothed using kernel density techniques.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2003), http://sestat.nsf.gov.

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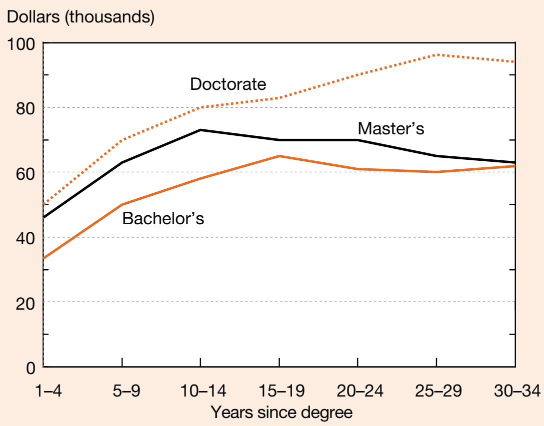
Figure 3-39
Median salaries of S&E graduates, by degree level and years since degree: 2003



SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2003), http://sestat.nsf.gov.

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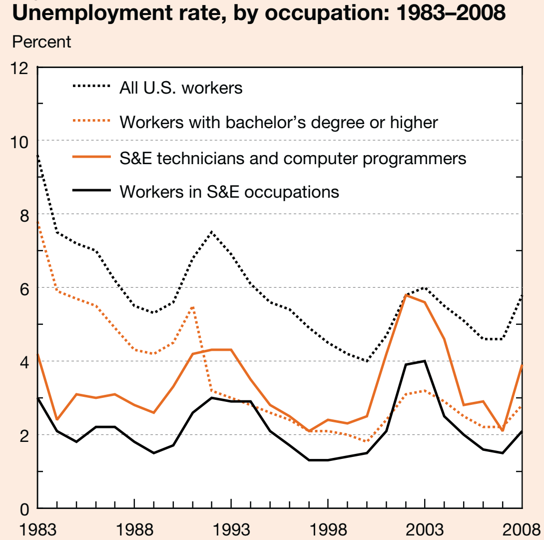
Figure 3-40
Unemployment rate, by occupation: 1983–2008



SOURCES: National Bureau of Economic Research, Merged Outgoing Rotation Group Files; and Bureau of Labor Statistics, Current Population Survey (various years).

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workers generally and much lower than those for workers with less than a bachelor's degree, although the present recession, like that of the early 2000s, is a partial exception to these patterns. Unemployment rates in S&E occupations are also generally less volatile than unemployment rates for these other groups (figure 3-40). The Census Bureau's Current Population Survey data for 1983–2008 indicate that the unemployment rate for all individuals in S&E occupations ranged from 1.3% to 4.0%, which contrasted favorably with rates for all U.S. workers (ranging from 4.0% to 9.6%)

and all workers with a bachelor's degree or higher (from 1.8% to 7.8%). The rate for S&E technicians and computer programmers ranged from 2.1% to 5.8%. During most of the period, computer programmers had an unemployment rate similar to that of S&E occupations, but greater volatility (from 1.2% to 6.7%).

Data on the economic downturn that began in late 2007 initially fit with long-term trends. In 2008, workers in S&E occupations or S&E technician and computer programmer occupations had lower unemployment rates (2.1% or 3.9%, respectively) than all workers (5.8%). College-educated S&E workers had lower unemployment rates (2.1%) than all college graduates (2.8%). However, in the 3-month period ending in September 2009, the unemployment rate of college educated S&E workers rose to 5.5%, approximately the same rate as for all college graduates (5.4%). S&E technicians and computer programmers continued to experience a considerably lower unemployment rate (7.6%) than that of the general labor force (9.7%) (figure 3-41).

In most economic downturns, workers with advanced S&E degrees have been less vulnerable to changes in economic conditions than individuals who hold only S&E bachelor's degrees. Figure 3-42 compares unemployment rates over career cycles for persons with S&E bachelor's degrees and doctorates, regardless of their occupation, for 1999 and 2003—periods of relatively good and relatively difficult labor market conditions, respectively. The relatively difficult 2003 labor market had a greater effect on bachelor's degree holders: for individuals at various points in their careers, the unemployment rate increased by between 1.6 and 3.5 percentage points between 1999 and 2003. Labor market conditions had a smaller effect on doctorate holders, but some increases in unemployment rates affected individuals in most years-since-degree cohorts.

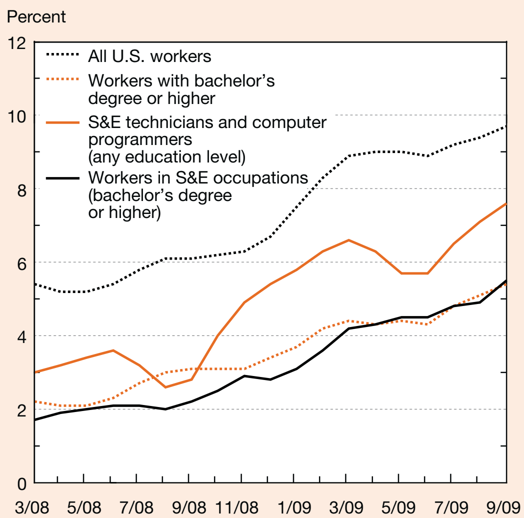
Similarly among those who said they were working involuntarily out of the field (IOF) of their highest degree, labor market conditions from 1999 to 2003 had a greater effect on the proportion of bachelor's degree holders than on doctorate holders (figure 3-43). These rates ranged from 7% to 12% for bachelor's degree holders in 2003 versus 2% to 5% for those with doctorates. IOF rates for doctorate holders changed little between 1999 and 2003.

Although S&E qualifications may help workers weather recessions, they do not make them immune from adverse labor market conditions. The estimated 4.3% unemployment rate for S&E occupations in April 2009, although low relative to other occupations, was the highest in 25 years.

Recent S&E Graduates

Compared with experienced S&E workers, recent S&E graduates more often bring newly acquired skills to the labor market and have relatively few work or family commitments that limit their job mobility. As a result, measures of

Figure 3-41
Estimated unemployment rates over previous 3 months for workers in S&E occupations and selected other categories: March 2008 to September 2009



NOTES: Estimates not seasonally adjusted. Estimates made from pooled microrecords of Current Population Survey and, while similar, are not same as 3-month moving average.

SOURCE: Current Population Survey, Public Use Microdata Sample (PUMS), January 2008–September 2009.

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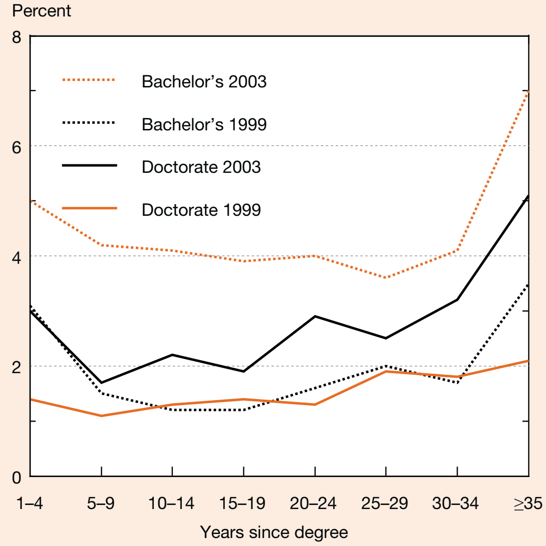
Figure 3-42
Unemployment rates for individuals whose highest degree is in S&E, by years since degree: 1999 and 2003



SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (1999 and 2003), http://sestat.nsf.gov.

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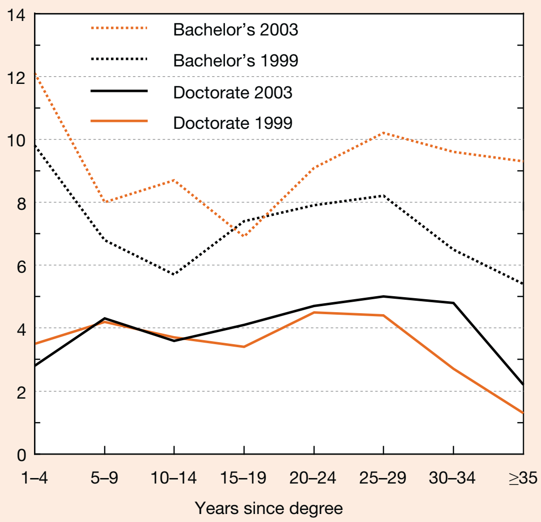
Figure 3-43
Involuntarily out-of-field rate of individuals whose highest degree is in S&E, by years since degree: 1993 and 2003



NOTE: Individuals involuntarily employed out of field include those in jobs not related to field of highest degree because job in that field not available and those employed part-time because full-time work not available.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (1999 and 2003), http://sestat.nsf.gov.

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the success of recent graduates in securing good jobs can be sensitive indicators of changes in the S&E labor market.

This section looks at a number of standard labor market indicators for recent S&E degree recipients at all degree levels and examines a number of other indicators that may apply only to recent S&E doctorate recipients.

General Labor Market Indicators for Recent Graduates

Table 3-16 summarizes some basic labor market statistics for recent (1–5 years after receipt of degree) recipients of S&E degrees. Across all fields of S&E degrees in 2006, there was a 3.8% unemployment rate for bachelor's degree holders who received their degrees in the previous 1–5 years. This ranged from 1.9% for those with engineering degrees to 5.1% for social science degree recipients. Individuals early in their career tend to change jobs more often and have higher unemployment, yet most of these values are less than the unemployment rate of 4.7% for the full labor force in 2006. For doctorate recipients across all fields of degree, the unemployment rate was 1.1%.

A useful but more subjective indicator of labor market conditions for recent graduates is the proportion reporting that they sought, but could not find, full-time employment related to their field of degree. The involuntarily out of field (IOF) rate is a measure unique to NSF's labor force surveys. At the bachelor's degree level, across all S&E fields, the IOF rate was 11.0%, but it ranged from 3.6% for recent engineering graduates to 15.7% for recent graduates in the social sciences. In all fields of degree, the IOF rate decreases with

Table 3-16
Labor market indicators for recent S&E degree recipients 1–5 years after receiving degree, by field: 2006

Indicator and degree	All S&E fields	Highest degree field: Computer/ mathematical sciences	Life sciences	Physical sciences	Social sciences	Engineering
	Percent					
Unemployment rate						
Bachelor's	3.8	4.6	4.6	4.0	5.1	1.9
Master's	2.5	3.1	2.9	2.6	4.6	2.5
Doctorate	1.1	0.6	1.1	1.1	1.9	1.4
Involuntary out-of-field rate						
Bachelor's	11.0	8.5	9.9	9.4	15.7	3.6
Master's	4.2	3.5	4.1	6.4	9.5	2.9
Doctorate	1.8	1.6	0.6	4.1	4.0	2.5
	Dollars					
Average salary						
Bachelor's	39,500	48,600	31,700	35,900	34,400	54,000
Master's	55,000	65,000	45,500	44,700	42,100	67,300
Doctorate	56,000	72,700	54,700	63,300	57,800	75,000

NOTES: Average salary rounded to nearest $100. Unemployment rate for recent S&E degree recipients differs from rate for entire S&E labor force.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

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level of education, reaching a low of 1.8% for recent doctorate recipients.

The average salary for recent S&E bachelor's degree recipients in 2006 was $39,500, ranging from $31,700 in the life sciences to $54,000 in engineering. Recent master's degree recipients had average salaries of $55,000 and recent doctorate recipients had salaries yielding only slightly more at $56,000. This reflects in part the relatively low postdoc salaries of some recent doctorate recipients (see discussion in next section) and the greater employment of doctorate holders in academia.

Recent Doctorate Recipients

The career rewards of highly skilled individuals in general, and doctorate holders in particular, often extend beyond salary and employment to more personal rewards that come from doing the kind of work for which they have trained. No single standard measure satisfactorily reflects the state of the doctoral S&E labor market; a range of available labor market indicators are discussed below, including unemployment rates, IOF employment, satisfaction with field of study, employment in academia versus other sectors, employment in postdoc positions, and salaries. Although a doctorate opens career opportunities both in terms of salary and type of employment, these opportunities come at the price of many years of foregone labor market earnings. Some doctorate holders also face an additional period of low earnings while in a postdoc position. In addition, some doctorate holders do not obtain the jobs they desire after completing their education.

In 2006, aggregate measures of labor market conditions for recent (1–3 years after receipt of degree) recipients of U.S. S&E doctorates showed improvement from the already generally good conditions found when last measured in 2003. Unemployment fell from 2.3% to 1.3% and IOF rates fell from 3.3% to 1.3% (table 3-17). In addition, the percentage of recent graduates entering tenure-track programs at 4-year institutions—a goal of many young doctorate holders—increased, rising from 17.8% in 2003 to 19.2% in 2006 (table 3-18).

Unemployment

The 1.3% unemployment rate for recent S&E doctorate recipients as of April 2006 was even lower than other generally low 2006 unemployment rates. The 2006 unemployment rate for all civilian workers was 4.6%, with lower rates of 2.2% for those with a bachelor's degree or above and 1.6% for those in S&E occupations (figure 3-40).

Table 3-17
Labor market rates for recent doctorate recipients 1–3 years after receiving doctorate, by selected field: 2001, 2003, and 2006
(Percent)

	Unemployment rate			Involuntarily out-of-field rate		
Field	2001	2003	2006	2001	2003	2006
All S&E	1.3	2.3	1.3	3.4	3.3	1.3
Computer/mathematical sciences	0.3	4.2	0.7	2.4	3.6	2.2
Computer sciences	0.4	4.4	1.7	2.3	1.4	2.3
Mathematics	0.3	4.0	0.0	2.4	5.6	2.1
Life sciences	1.1	2.5	0.9	2.5	1.5	0.3
Agriculture	0.3	3.1	0.0	4.1	2.9	1.7
Biological sciences	1.0	2.6	1.0	2.4	1.3	0.2
Physical sciences	1.3	0.9	1.6	5.0	3.6	2.3
Chemistry	0.8	1.2	1.9	3.2	4.3	0.9
Geosciences	1.9	1.5	1.9	3.0	0.0	0.0
Physics/astronomy	1.9	0.0	1.0	8.2	4.3	5.9
Social sciences	1.3	2.5	1.2	5.1	5.0	1.5
Economics	2.2	0.3	0.0	2.1	1.9	0.0
Political science	0.8	0.0	0.0	8.7	9.0	0.6
Psychology	1.4	2.8	1.2	3.8	5.2	1.3
Sociology/anthropology	1.2	5.0	2.4	6.3	4.5	4.8
Engineering	1.8	2.3	1.9	1.7	3.0	1.5
Chemical	1.6	2.1	0.7	2.0	8.9	9.8
Electrical	0.9	2.3	0.3	1.5	0.8	1.0
Mechanical	3.2	5.8	3.0	1.7	2.6	0.0

NOTES: Doctorate recipients in health fields included in life sciences. Rates of 0.0, like other rates in this table, are rounded estimates based on sample survey data and do not preclude possibility that some individuals in that field may be unemployed or working involuntarily out of field. Unemployment rates for recent doctoral recipients differ from those for the entire S&E labor force.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients (2001, 2003, and 2006), Scientists and Engineers Statistical Data System (SESTAT), http://sestat.nsf.gov.

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Table 3-18
Doctorate recipients holding tenure and tenure-track appointments at academic institutions, by years since receipt of doctorate and selected field: 1993, 2003, and 2006
(Percent)

	1993		2003		2006	
S&E field	1–3 years	4–6 years	1–3 years	4–6 years	1–3 years	4–6 years
All fields	18.4	26.6	17.8	23.5	19.2	25.8
Computer/mathematical sciences	39.7	54.1	34.5	38.1	36.1	44.0
Computer sciences	37.1	51.5	30.9	30.3	37.8	36.4
Mathematics	41.8	56.0	37.7	43.8	34.7	50.6
Life sciences	12.6	24.8	8.0	20.3	13.4	20.8
Agriculture	15.6	27.0	23.7	35.1	18.9	30.0
Biological sciences	12.1	24.8	6.5	18.6	13.2	20.6
Physical sciences	9.7	18.2	13.7	18.2	10.7	23.8
Chemistry	7.7	16.3	14.5	16.0	11.0	22.2
Geosciences	12.7	26.2	21.6	35.1	13.9	30.5
Physics/astronomy	12.0	17.7	9.4	14.5	8.7	22.5
Social sciences	26.4	29.2	28.3	31.6	29.6	34.2
Economics	46.6	48.6	43.7	32.2	37.4	39.4
Political science	53.9	47.1	45.0	50.6	45.0	51.3
Psychology	12.7	15.5	14.5	21.1	18.7	21.9
Sociology/anthropology	37.9	46.9	43.3	48.0	62.1	65.0
Engineering	16.0	24.6	12.2	16.0	14.7	16.6
Chemical	8.1	14.0	4.9	6.0	8.2	9.4
Electrical	17.6	26.9	11.6	15.3	18.6	15.4
Mechanical	13.5	29.5	11.1	16.0	16.5	14.6

NOTES: Two-year institutions not included. Doctorate recipients in health fields included in life sciences.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients (1993, 2003, and 2006), Scientists and Engineers Statistical Data System (SESTAT), http://sestat.nsf.gov.

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The highest unemployment rates for recent doctorate recipients were in mechanical engineering (3.0%) and sociology/anthropology (2.4%). Unemployment in both fields (which also had the highest unemployment rates in 2003) fell from 5.8% and 5.0%, respectively, in 2003. The unemployment rate for recent S&E doctorate recipients in computer sciences, the field with the third highest unemployment rate in 2003, fell from 4.4% to 1.7% in 2006.

Working Involuntarily Outside the Field

In addition to the 1.3% who were unemployed in 2006, another 1.3% of recent S&E doctorate recipients in the labor force reported that they took a job that was not related to the field of their doctorate because a job in their field was not available. Comparable figures were 3.4% in 2001 and 3.3% in 2003.

The highest IOF rates were found for recent doctorate recipients in chemical engineering (9.8%), physics/astronomy (5.9%), and sociology/anthropology (4.8%).

Tenure-Track Positions

Many S&E doctorate recipients may aspire to tenure-track academic appointments, but most will end up working in other positions and sectors. Recently, the proportion of all recent doctorate recipients entering tenure-track academic jobs has increased, breaking a long-term decline. Such increases can be seen between 2001 and 2003, and again between 2003 and 2006. As a result, 2006 tenure-track rates for those 1–3 years after receiving their degree and those 4–6 years after receiving their degree were broadly the same as in 1993 (figure 3-44; table 3-18). From 2003 to 2006, the rate for those 1–3 years since receiving their degree rose from 18% to 19%, and the rate for those 4–6 years since receiving their degree increased from 24% to 26%. (See chapter 5 for a discussion of trends in tenure-track positions as a proportion of all academic positions.)

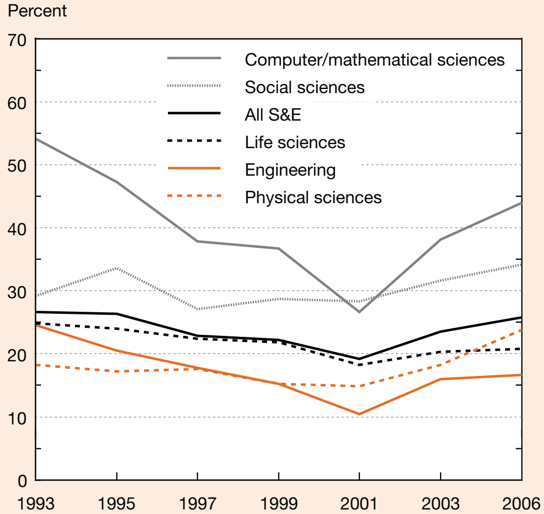
The availability of tenure-track positions may be counterbalanced by the availability of desirable nonacademic employment opportunities. One of the quickest declines in tenure-track employment occurred in computer sciences, from 52% in 1993 to 24% in 2001 despite the difficulties computer sciences departments had in finding faculty.

Salaries for Recent S&E Doctorate Recipients

In 2006 for all S&E degree fields, the median annual salary for recent doctorate recipients 1–5 years after they received their degrees was $52,000. Across various S&E fields of degree, median annual salaries ranged from a low of $46,000 in the life sciences to a high of $70,000 in engineering (table 3-19).

By type of employment, salaries for recent doctorate recipients ranged from $40,000 for postdoc positions to

Figure 3-44
Doctorate recipients holding tenure and tenure-track appointments at academic institutions 4–6 years after degree, by field: 1993–2006



NOTES: Two-year institutions not included. Life sciences includes doctorate recipients in health fields.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients (1993–2006).

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Table 3-19
Salary of recent doctorate recipients 1–5 years after receiving degree, by degree field and percentile: 2006
(Dollars)

Degree field	25th percentile	50th percentile	75th percentile
All S&E fields	40,000	52,000	74,000
Computer/mathematical sciences	43,500	64,000	84,000
Life sciences	38,000	46,000	65,000
Physical sciences	40,000	53,000	75,600
Social sciences	40,000	51,300	65,000
Engineering	41,000	70,000	87,500

NOTE: Doctorate recipients in health fields included in life sciences.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients (2006), Scientists and Engineers Statistical Data System (SESTAT), http://sestat.nsf.gov.

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$80,000 for those employed by private for-profit businesses (table 3-20).

Postdoc Positions

The growing number of recent doctorate recipients in postdoctoral appointments, generally known as postdocs,[15] has become a major issue and concern in science policy. Neither the reasons for this growth nor its effect on the health of science are well understood. Increases in competition for tenure-track academic research jobs, collaborative research in large teams, and needs for specialized training are possible factors explaining this growth. Although individuals in postdoc positions often perform cutting-edge research, there is a concern that time spent in a postdoc position is time added onto the already long time spent earning a doctorate, thereby delaying the start and advancement of independent careers. Because postdoc positions usually offer low pay, forgone earnings add significantly to the costs of a doctoral education and may discourage doctoral-level careers in S&E.

How Many Postdocs Are There?

The total number of postdocs in the United States is unknown; broad estimates depend upon a number of assumptions. NSF's Survey of Doctorate Recipients (SDR) covers U.S. residents with research doctorates in S&E and health fields from U.S. universities, but not those with non-U.S. doctorates. The NSF Survey of Graduate Students and Postdoctorates in Science and Engineering gathers information on postdocs from U.S. academic graduate departments, regardless of where their doctorate was earned. It does not cover people in nonacademic employment, at some university research centers, or at academic departments that lack graduate programs. Table 3-21 shows the SDR and GSS estimates of the U.S. postdoc population that these surveys cover.

Academic Postdocs. SDR estimates that 22,900 U.S. citizens and permanent residents were in academic postdoc positions in fall 2005, along with 7,700 temporary visa holders.[16] The corresponding 2005 GSS estimate is 16,200 U.S. citizens and permanent residents but 26,600 temporary visa holders.

Postdocs in FFRDCs. Many federally funded research and development centers (FFRDCs) employ postdocs as part of their efforts to assist government agencies with scientific research and analysis and to train the country's researchers and scientists. According to NSF's 2007 Survey of Postdocs at FFRDCs, 22 of the 38 FFRDCs on the master government FFRDC list maintained by the NSF reported employing 2,235 postdocs. Of those 2,235 postdocs, 1,336 (about 60%) were temporary visa holders and 2,030 (about 91%) received federal support.

Table 3-20
Median annual salary of recent doctorate recipients 1–5 years after receiving degree, by type of employment: 2006
(Dollars)

Field	All sectors	Private	Tenure track	Postdoc	Other education	Nonprofit/ government
All S&E fields	52,000	80,000	53,000	40,000	48,500	68,000
Computer/mathematical sciences	64,000	90,000	62,000	48,500	48,000	S
Life sciences	42,600	74,000	57,000	40,000	48,000	60,000
Physical sciences	53,000	78,000	50,500	42,000	48,000	76,000
Social sciences	51,300	65,000	52,000	39,600	50,000	62,000
Engineering	70,000	80,000	71,000	40,000	56,000	80,000

S = data suppressed for reasons of reliability

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients (2006), Scientists and Engineers Statistical Data System (SESTAT), http://sestat.nsf.gov.

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Table 3-21
Postdoc estimates from two NSF/SRS surveys, by place of employment and citizen/visa status: Fall 2005

	SDR		GSS	
Place of employment and citizen/visa status	Estimate	Percent	Estimate	Percent
All places of employment				
All postdocs	43,400	100.0	43,100	100.0
U.S. citizens/permanent residents	33,400	77.0	16,200	37.5
Temporary visa	10,000	23.0	27,000	62.5
Higher education institutions[a]				
All postdocs	30,500	100.0	26,900	100.0
U.S. citizens/permanent residents	22,900	74.8	16,200	37.6
Temporary visa	7,700	25.2	26,900	62.4
All other educational institutions				
All postdocs	1,900	100.0	NA	NA
U.S. citizens/permanent residents	1,600	85.5	NA	NA
Temporary visa	300	14.5	NA	NA
Nonprofits/government/industry/all other institutions				
All postdocs	11,100	100.0	NA	NA
U.S. citizens/permanent residents	9,000	81.2	NA	NA
Temporary visa	2,100	18.8	NA	NA

NA = not available

GSS = Survey of Graduate Students and Postdoctorates in Science and Engineering; NSF/SRS = National Science Foundation, Division of Science Resources Statistics; SDR = Survey of Doctorate Recipients

[a]For SDR, individuals reporting postdoc in 4-year U.S. colleges and universities/medical schools/university-affiliated research institutes/unknown institution type in fall 2005; for GSS, postdocs in graduate S&E/health departments in U.S. graduate schools (excludes holders of medical and other professional degrees, some of whom may also hold doctorates).

NOTES: SDR gathers information from individuals with research doctorates in S&E and health fields earned at U.S. educational institutions. GSS gathers information from U.S. educational institutions with programs leading to graduate degrees in S&E/health fields and includes postdocs with doctorates/equivalent degrees from foreign institutions. Estimates of postdoc status from 2006 SDR constructed from postdoc history module; fall 2005 used rather than April 2006 for comparability with GSS data and to capture those who may have left a postdoc position early. Detail may not add to total because of rounding.

SOURCES: NSF/SRS, 2006 SDR, Scientists and Engineers Statistical Data System (SESTAT), http://sestat.nsf.gov, and 2005 GSS, Integrated Science and Engineering Resources Data System (WebCASPAR), http://webcaspar.nsf.gov.

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Other Postdocs. Neither the GSS nor the SDR survey includes data on the number of foreign-educated postdocs in all sectors. SDR estimates that 29% of U.S.-educated postdocs, 13,000 in all, are in industry, nonprofits, government, and other types of educational institutions. Using these data, one might estimate as follows:

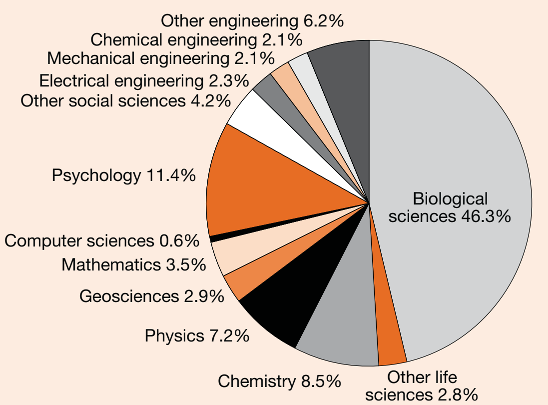
- 22,900 U.S. citizens and permanent residents in academic postdoc positions (SDR)
- 26,900 persons on temporary visas in academic postdoc positions (GSS)
- 13,000 U.S.-educated persons in postdoc positions not covered by GSS (SDR)
- 26,500 postdocs on temporary visas in positions not covered by GSS, based on the assumption that proportions of temporary visa postdocs in sectors and parts of academia not covered by GSS are the same as in the GSS estimates.

These assumptions yield approximately 89,300 postdocs, but other comparably plausible assumptions lead to substantially different totals.

Postdocs by Academic Discipline

About half of all U.S.-educated postdocs in 2005 (49%) had doctorates in the biological and other life sciences (figure 3-45). In this field, postdoc training has been common for a long time and individuals remain in postdoc positions longer than in other fields. Psychology, chemistry, and physics also have high rates of graduates entering postdoc positions and together make up another one-quarter of postdoc positions. The remaining quarter come from all other fields of S&E, most of which do not have a strong postdoc tradition as part of their career paths.

Figure 3-45
Field of doctorate of U.S.-educated S&E doctorate recipients in postdoc positions: Fall 2005



NOTE: Percentages do not add to 100% because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients (2006).

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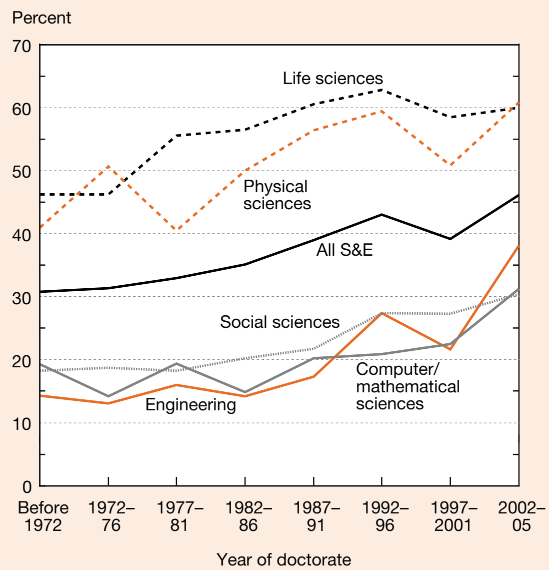
Increase in the Likelihood and Length of Postdoc Positions

Among holders of U.S. S&E doctorates received before 1972,[17] 31% reported having had a postdoc position earlier in their careers (figure 3-46). This proportion has risen over time to 46% among 2002–05 graduates and has increasingly involved fields in which formerly only a small number of doctorate recipients went on to postdoc positions. In traditionally high-postdoc fields such as the life sciences (from 46% to 60%) and the physical sciences (from 41% to 61%), a majority of doctorate recipients now have a postdoc position as part of their career path. Similar increases were found in mathematical and computer sciences (19% to 31%), social sciences (18% to 30%) and engineering (14% to 38%). Recent engineering doctorate recipients are now almost as likely to take a postdoc position as physical sciences doctorate holders were 35 years ago.

Postdoc Pay and Benefits

Low pay and fewer benefits for postdocs are frequently raised as concerns by those worried about the effect of the increasing number of postdoc positions on the attractiveness of science careers. The median academic postdoc salary is one-third less than the median salary for nonpostdocs 1–3 years after receiving their doctorates (table 3-22). By broad field, this ranges from a 44% pay gap for recent recipients of engineering doctorates to a 25% gap for doctorate holders in the social sciences. Nonacademic postdocs are better paid

Figure 3-46
U.S. S&E doctorate holders ever holding postdoc, by field and year of doctorate: 2006



SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients (2006).

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Table 3-22
Salary and benefits of U.S. S&E doctorate holders in postdoc positions: 2006

	Median salary ($)			Benefits (%)	
Field of doctorate	Academic postdoc	Nonacademic postdoc	Nonpostdocs 1–3 years after degree	Medical	Retirement
All S&E	40,000	48,000	60,000	90.1	48.9
Computer/mathematical sciences	47,000	55,000	72,000	93.0	69.1
Life sciences	40,000	44,000	55,000	92.9	47.7
Physical sciences	40,000	55,000	63,000	92.7	54.7
Social sciences	40,000	50,000	53,000	75.0	44.8
Engineering	40,000	60,000	71,400	92.4	56.2

NOTE: Doctorate recipients in health fields included in life sciences.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients (2006), Scientists and Engineers Statistical Data System (SESTAT), http://sestat.nsf.gov.

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than academic postdocs, but their median salary is still 20% less than that of nonpostdocs.

Most individuals in postdoc positions in 2006 had employment benefits. Indeed, across all S&E fields, 90% of postdocs reported having medical benefits and 49% reported having retirement benefits. It is not possible to know from the survey how extensive medical benefits may be or how transferable retirement benefits are. In the social sciences, medical benefits are less available, with only 75% of postdocs reporting that they had medical benefits.

Postdoc Positions as a Sign of Labor Market Distress for Recent Doctorate Recipients

Former postdoc position holders reported reasons for accepting their appointment that are consistent with the traditional intent of a postdoc as a type of apprenticeship, such as seeking "additional training in doctorate field" or "training in an area outside of doctorate field." However, 9% of Survey of Doctorate Recipients respondents in a postdoc position in April 2006 reported that they took their current postdoc position because "other employment not available." This reason was given by 5% of postdocs in the life sciences, 8% in computer and mathematical sciences, 10% in the physical sciences, 14% in the social sciences, and 16% in engineering.

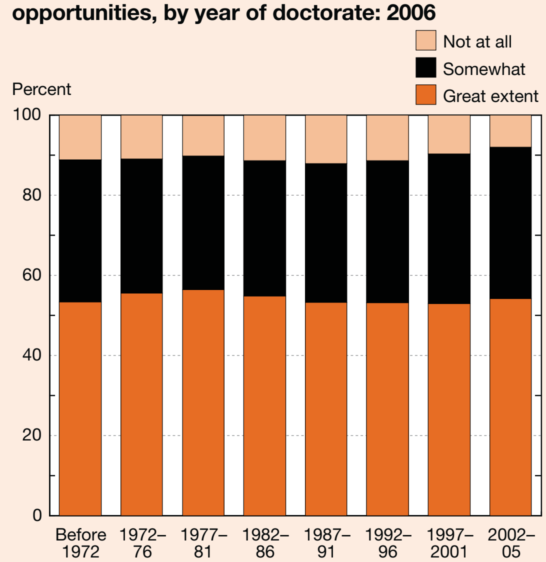
Postdoc Outcomes

Most former postdocs report that their most recent postdoctoral appointment enhanced their career opportunities, and the proportions who say this are similar for different cohorts (figure 3-47). Across all S&E fields and cohorts, 53%–56% of former postdocs said that their postdoc appointment enhanced their career opportunities to a "great extent"; an additional 33%–38% said that their postdoc appointment "somewhat" enhanced their career opportunities. The proportion of those completing postdoc positions who said that it was no help to their career opportunities ranged from only 8% for the 2002–05 graduation cohort to 12% for the 1987–91 cohort. For a more detailed look at perceived and actual outcomes from a postdoc experience, see chapter 3 of *Science and Engineering Indicators 2008* (NSB 2008) and NSF/SRS (2008b).

Global S&E Labor Force

Science is a global enterprise. The common laws of nature cross political boundaries, and the international movement of people and knowledge made science global long before "globalization" became a label for the increasing interconnections now forming among the world's economies. The rapid development of the capacity to make scientific and

Figure 3-47
Former postdocs' evaluation of how much most recent postdoc position enhanced career opportunities, by year of doctorate: 2006



SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients (2006).

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technical innovations is creating a new competitive environment. New ways of doing business and performing R&D take advantage of gains from new knowledge discovered anywhere in the world, from increases in foreign economic development, and from the expanding international migration of highly trained scientists and engineers.

This section begins with an overview of what is known about S&E labor forces in advanced countries, which mostly concerns researchers and people performing R&D for multinational firms. The remainder of the section deals with foreign-born scientists and engineers in the United States.

Other chapters provide indirect indicators on the global S&E labor force. Chapter 2 reports on the production of new scientists and engineers through university degree programs. Chapter 4 provides indicators of R&D performed globally, chapter 5 discusses publications output and international collaboration, and chapter 6 has information on high-technology activities and global patenting activity.

Counts of Global S&E Labor Force

There are no comprehensive measures of the global S&E labor force, but fragmentary data on the global S&E labor force suggest that the U.S. world share is continuing to decline, even as U.S. reliance on foreign-born scientists and engineers may be near or at a historic high. Data exist within some national data systems, and some countries report data in standardized form to international agencies such as the Organisation for Economic Co-operation and Development (OECD). Existing data provide a strong indication of rapid growth in the number of individuals who pursue advanced education and find employment in technical fields, particularly in developing nations.

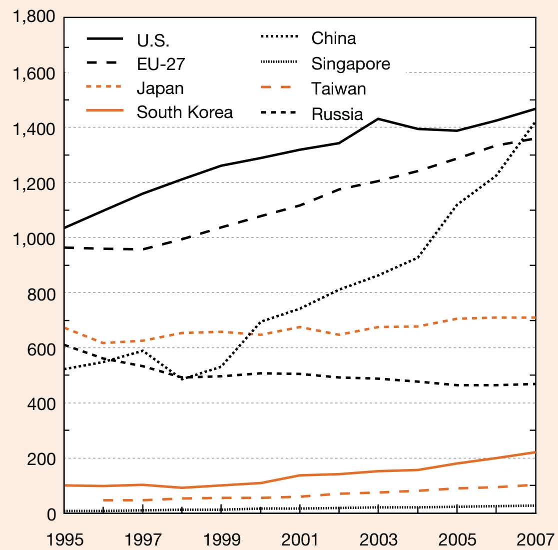
OECD collects data on researchers from its member countries and selected other countries. Unfortunately, this source misses many countries that appear to have high levels of S&T activity, including India, Brazil, and Israel.

Figure 3-48 shows the growth between 1995 and 2007 in the reported number of researchers in selected countries/economies. The United States had about the same growth of researchers as the EU-27, about 40% each over the time period. The number of researchers in Japan rose by just over 5%. Over the same 12-year period, the reported number of researchers in China rose by 173% to more than 1.4 million in 2007—close to the estimated U.S. figure and the number of the combined EU-27. An important caution in interpreting these data is that although countries used a common definition of "researcher" when reporting their data to OECD, there are many judgments necessary to translate from a wide variety of national data systems to the OECD definition.

Tertiary Education

One widely available measure of the education level of a country's population is the number of its residents with a tertiary level of education. This is roughly equivalent in U.S. terms to individuals who have earned at least a technical associate's degree, but also includes all higher degrees

Figure 3-48
Estimated number of researchers in selected regions/countries/economies: 1995–2007



EU = European Union

NOTES: Researchers are full-time equivalents. 2007 data for United States are estimated based on annual growth rate between 1995 and 2006.

SOURCE: Organisation for Economic Co-operation and Development, Main Science and Technology Indicators (2009/1 and earlier years).

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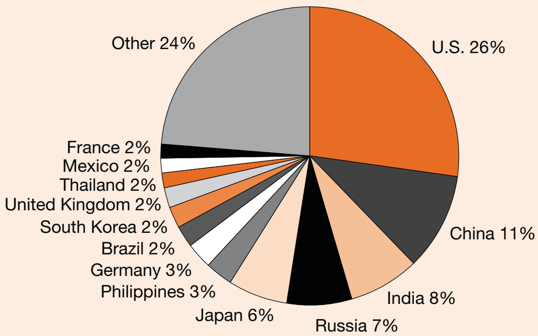
up to the doctorate. Figure 3-49, based on estimates by Barro and Lee (2000), shows the global distribution of tertiary education graduates in 2000 or the most recent available year. About one-fourth of the world's tertiary graduates were in the United States; the next three largest countries in terms of tertiary education are China, India, and Russia, which are all non-OECD members.

Highly Skilled Migrants in OECD Countries

Docquier and Marfouk (2004) made estimates of the highly educated international migrants residing in OECD countries by using data from various national censuses. Based on their data, figure 3-50 shows the leading countries of origin of non-natives with tertiary-level education who lived in OECD countries in 2000. With 1.4 million, the United Kingdom has the largest high-skilled diaspora. (Although originally used to describe much less voluntary dispersals of population in history, the term *diaspora* is increasingly used to describe the internationally mobile portion of a country's nationals, which forms a network for contact and information flow. These networks can provide advantages for a country that help mitigate the loss of human capital through migration.)

The United States, ranking 11th with 448,000 tertiary-educated citizens who live in other OECD countries, has a fairly small high-skilled diaspora compared with its

Figure 3-49
Tertiary-educated population more than 15 years old, by country: 2000 or most recent year



SOURCE: Adapted from Barro RJ, Lee J, International data on educational attainment: Updates and implications, Center for International Development Working Paper No. 042 (2000), http://www.cid.harvard.edu/cidwp/042.htm, accessed 9 September 2009.

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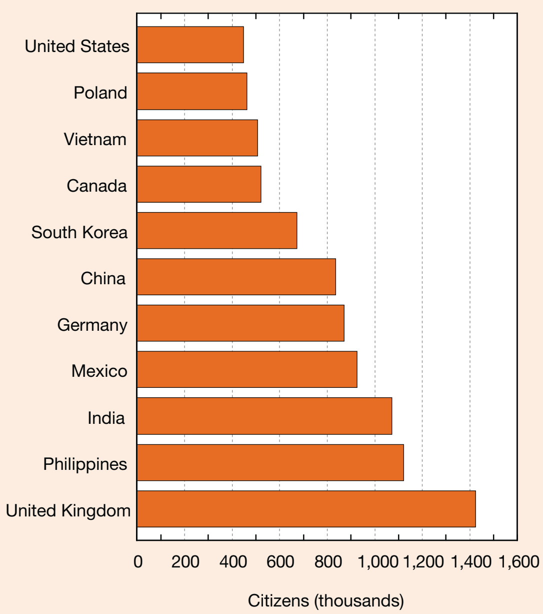
Figure 3-50
Top 11 countries of origin of persons having at least tertiary-level education and residing in OECD countries: 2000



OECD = Organisation for Economic Co-operation and Development

SOURCE: Docquier F, Marfouk A, International Migration by Educational Attainment (1990–2000), Release 1.1, http://team.univ-paris1.fr/teamperso/DEA/Cursus/M1/DM_ozdenschiff.pdf.

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population, and particularly compared with its number of educated workers.

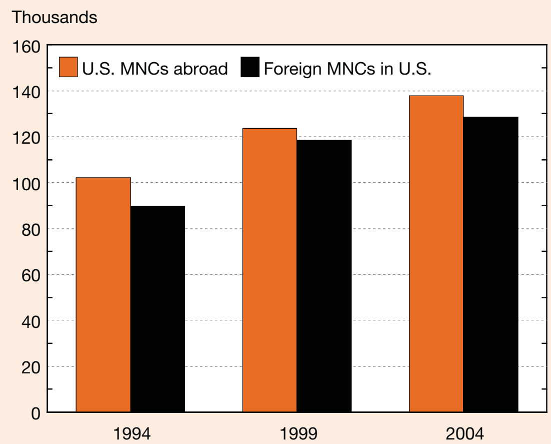
R&D Employment by Multinational Companies

MNCs perform a substantial proportion of R&D through foreign direct investment (FDI) (see chapter 4). Data on MNC R&D employment include all employees engaged in research and development, including managers, scientists, engineers, and other professional and technical employees. Data on R&D employment of parent companies of U.S. MNCs and their overseas affiliates are available every 5 years from the Survey of U.S. Direct Investment Abroad conducted by the Bureau of Economic Analysis (BEA). Separately, data on R&D employment by foreign-based MNCs in the United States are available from BEA's Survey of Foreign Direct Investment in the United States.

By definition, FDI does not include external arrangements ranging from R&D contracting to consulting work and strategic collaborations.[18] Nevertheless, R&D employment by subsidiaries is an important indicator of international R&D activity.

R&D employment in the United States by foreign firms grew slightly faster than R&D employment abroad by U.S. firms. R&D employment in the United States by majority-owned affiliates[19] of foreign firms rose from 89,800 in 1994 to 128,500 in 2004, for a 43% increase over the decade (figure 3-51). Over the same 10 years, R&D employment by U.S. firms at their majority-owned foreign affiliates grew 35%, from 102,000 in 1994 to 137,800 in 2004. Adding

Figure 3-51
R&D employment of U.S. MNCs at their foreign affiliates and foreign MNCs at their U.S. affiliates: 1994, 1999, and 2004



MNC = multinational corporation

NOTE: Includes only employment at majority-owned affiliates.

SOURCE: Bureau of Economic Analysis, Survey of Foreign Direct Investment in the United States and Survey of U.S. Direct Investment Abroad (various years).

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U.S. parent company R&D employment of 716,400 workers, U.S. MNCs employed 854,200 R&D workers globally (figure 3-52) in 2004.

The average annual growth in R&D employment abroad by U.S. firms from 1994 to 2004 was only 3% and did not produce a large shift in their overseas employment, which rose from 14% to 16% of their total.

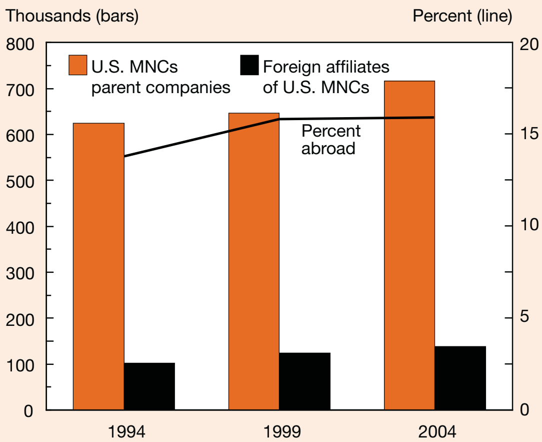
The data in both figure 3-51 and figure 3-52 are consistent with two trends discussed in this chapter: rapid growth in S&T employment in the United States coinciding with a general expansion of the ability to do S&T work throughout the world.

Migration to the United States

The knowledge and specialized skills of scientists and engineers can be transferred across national borders through the physical movement of people. Governments in many industrialized countries increasingly view the immigration of skilled S&E workers as an important contributor to the quality and flexibility of their S&E labor force. Many countries have not only increased their research investments, but have also made encouraging high-skilled immigration an important part of their national economic strategies.

The United States has benefited, and continues to benefit, from this international flow of knowledge and personnel (see Regets 2001 for a general discussion of high-skilled migration). However, competition for skilled labor continues to increase. A National Science Board taskforce noted that "global competition for S&E talent is intensifying, such that the United States may not be able to rely on the international S&E labor market to fill unmet skill needs" (NSB 2003). (See sidebar "High-Skill Migration to Japan and the UK.")

Figure 3-52
R&D employment of U.S. MNC parent companies in the United States and their foreign affiliates: 1994, 1999, and 2004



MNC = multinational corporation

NOTE: Includes only employment at majority-owned affiliates.

SOURCE: Bureau of Economic Analysis, Survey of U.S. Direct Investment Abroad (various years).

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Broadly consistent estimates of U.S. reliance on foreign-born scientists and engineers are available from several sources. Table 3-23 shows upward trends in the percentage of foreign-born individuals in U.S. S&E occupations over time. The percentage changes since 2000 may appear small but are quite substantial, given the short time span and the overall growth of the number of persons in S&E occupations from 2000 to 2007: of an estimated 341,000 total increase, 100,000 were foreign born.

SESTAT surveys include only individuals who were counted in the most recent Decennial Censuses or who received a U.S. S&E degree, thereby missing recently arrived foreign-born and foreign-educated scientists and engineers. Yet, a large proportion of the foreign-born and foreign-educated members of the S&E labor force are recent arrivals. For example, in 2000, about 43% of all college-educated foreign-born workers in U.S. S&E occupations reported arriving in the United States after 1990; among doctorate holders 62% reported arriving after this date.

The 2000 census data provide a good estimate of the foreign born who were actually in the United States in April 2000 but give no information about those performing S&E tasks in a wide variety of non-S&E occupations (as discussed earlier in this chapter), nor about which postsecondary teachers are in S&E fields. Within these limitations, the Census Bureau's 2007 American Community Survey permits an analysis of trends in the proportion of the foreign born in S&E occupations at each degree level during the current decade. It shows growth of 3 percentage points overall, with an extra 4 percentage points each at the master's degree and doctorate levels.

Between 2003 and 2007, employment of college graduates in nonacademic S&E occupations, as measured by the ACS, increased by 345,000: 235,000 U.S. natives and 110,000 foreign born (figure 3-53). The estimated overall proportion of the foreign born rose only slightly over these 4 years (from 24.6% to 25.2%) but increased by 2 percentage points each for those with master's degrees and doctorates in this short span.

Details on the proportion of foreign-born S&E degree holders by field of degree are shown in table 3-24, based on 2003 SESTAT estimates. At the doctoral level, foreign-born individuals constitute about half the total number of workers in both engineering (51%) and mathematics/computer sciences (48%), up from 41% and 33% a decade earlier. Only in the geosciences and the social sciences are the foreign born significantly less than a third of doctorate holders in S&E fields. At the bachelor's degree level, 15% of S&E degree holders were foreign born, ranging from 7% of individuals in sociology/anthropology to 27% in physics/astronomy and 28% in electrical engineering. Given the continuing increase in foreign participation, it is likely that these 2003-based percentages are conservative estimates.

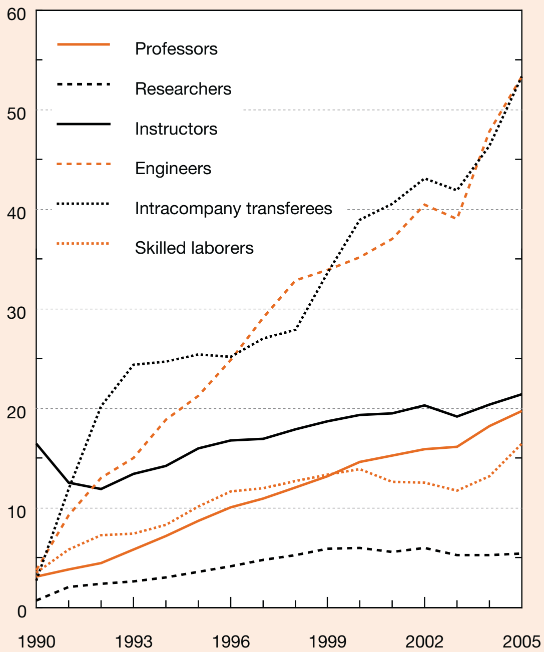
High-Skill Migration to Japan and the UK

Recent debates and legislative changes in many developed (and sometimes less developed) countries have focused on visa programs for temporary high-skilled workers. The United Kingdom and Japan are just two examples of countries that have made temporary high-skilled migration important parts of national economic policies.

A 1989 revision of Japanese immigration laws made it easier for high-skilled workers to enter Japan with temporary visas, which allow employment and residence for an indefinite period (even though the same visa classes also apply to work visits that may last for only a few months). In 2005, 169,800 workers entered Japan in selected high-skilled temporary visa categories, compared with just over 30,000 in 1990 (figure 3-E). For comparison purposes, this equals half the number of Japanese university graduates entering the labor force each year and is more than the number entering the United States in roughly similar categories (H-1B, L-1, TN, O-1, O-2).

The United Kingdom's programs for the entry of high-skilled workers continue to evolve in ways to encourage migration and are currently part of an overall point system. Under the United Kingdom's recent Highly Skilled Migrant Program, admissions grew from 1,197 in 2002 to 21,939 in 2006. An important note for these numbers is that high-skilled EU citizens enter the UK without needing this visa, so actual high-skilled migration to the UK is likely to be much larger. During these years, the number of U.S. citizens entering the UK as high-skilled migrants grew from 273 to a still modest 629 (Salt 2007).

Figure 3-E
Entry to Japan of workers with selected classes of high-skilled temporary visas: 1990–2005



SOURCE: Statistics Bureau, Japanese Ministry for Internal Affairs and Communications (various years).

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Table 3-23
Estimates of foreign-born individuals in S&E occupations from NSF/SRS and Census Bureau, by educational attainment: 1999, 2000, and 2003
(Percent)

Education	1999 NSF/SRS SESTAT	2000 Census 5% PUMS	2003 NSF/SRS SESTAT	2003 Census Bureau ACS
All college educated[a]	15.0	22.4	22.5	25.0
Bachelor's	11.3	16.5	16.3	18.8
Master's	19.4	29.0	29.0	32.0
Doctorate	28.7	37.6	35.6	39.5

ACS = American Community Survey; NSF/SRS = National Science Foundation, Division of Science Resources Statistics; SESTAT = Scientists and Engineers Statistical Data System; 5% PUMS = Public Use Microdata Sample with 5% of sample cases

[a]Includes professional degrees not broken out separately.

NOTES: Includes all S&E occupations except postsecondary teachers because these occupations not separately reported in 2000 Census or 2003 American Community Survey data files.

SOURCES: NSF/SRS, SESTAT (1999 and 2003), Scientists and Engineers Statistical Data System (SESTAT), http://sestat.nsf.gov; and Census Bureau, PUMS (2000) and ACS (2003).

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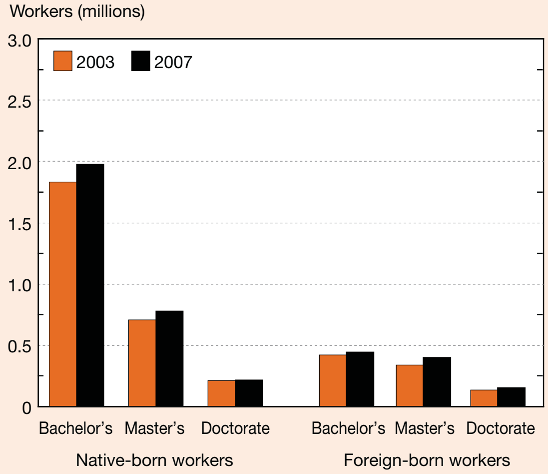
Figure 3-53
Native-born and foreign-born workers in S&E occupations, by degree level: 2003 and 2007



SOURCE: Census Bureau, American Community Survey, Public Use Microdata Files (PUMS) (2003 and 2007).

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Origins of S&E Immigrants

Immigrant scientists and engineers come from a broad range of countries. Figure 3-54 shows country of birth for the 2.2 million foreign-born persons with highest degree in S&E in the United States (country details are in appendix table 3-10). Although no one source country dominates, 16% came from India and 11% came from China. Source countries for the 276,000 foreign-born holders of S&E doctorates are somewhat more concentrated, with China providing 22% and India 14%.

Source of Education for S&E Immigrants

The majority of foreign-born scientists and engineers in the United States first came to the United States to study, but a substantial number came to the United States after receiving their university training abroad. Table 3-25 illustrates the various educational routes that highly skilled workers from around the world take into the United States workforce and indicates how these workers help connect the United States to universities and research institutions worldwide.

Across all levels of degree, 42% of the university-educated foreign born in the United States had their highest degree from a foreign educational institution and 56% had at least

Table 3-24
Foreign-born proportion of individuals with highest degree in S&E, by field and education level: 2003
(Percent)

Field	All degree levels[a]	Highest degree		
		Bachelor's	Master's	Doctorate
All S&E	18.8	15.2	27.2	34.6
Computer/mathematical sciences	25.8	19.3	40.5	47.5
Computer sciences	29.9	22.3	46.5	57.4
Mathematics	18.5	14.4	25.5	43.1
Biological/agricultural/environmental life sciences	16.6	12.6	21.2	36.2
Agricultural and food sciences	11.6	8.8	15.9	32.7
Biological sciences	19.0	14.6	23.9	37.4
Environmental life sciences	6.6	4.3	13.5	13.3
Physical sciences	22.9	16.9	28.9	36.9
Chemistry	25.3	18.1	42.1	37.0
Geosciences	11.3	8.3	13.0	26.2
Physics/astronomy	32.6	27.4	34.4	40.1
Other physical sciences	16.3	14.1	11.1	48.7
Social sciences	11.5	10.8	13.3	16.9
Economics	21.7	19.8	30.5	31.5
Political science	11.0	9.5	17.1	24.2
Psychology	9.7	10.1	8.5	9.8
Sociology/anthropology	7.2	6.7	10.2	13.6
Other social sciences	13.0	10.6	18.2	31.3
Engineering	26.8	21.5	38.3	50.6
Aerospace/aeronautical/astronautical	16.4	9.7	29.6	52.6
Chemical	26.0	17.7	49.4	47.0
Civil	24.9	19.7	39.3	54.2
Electrical	34.1	28.1	45.9	57.5
Industrial	21.5	17.5	33.1	42.0
Mechanical	23.0	19.6	34.3	52.2
Other engineering	23.4	18.8	25.8	44.6

[a]Includes professional degrees not broken out separately.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2003), http://sestat.nsf.gov.

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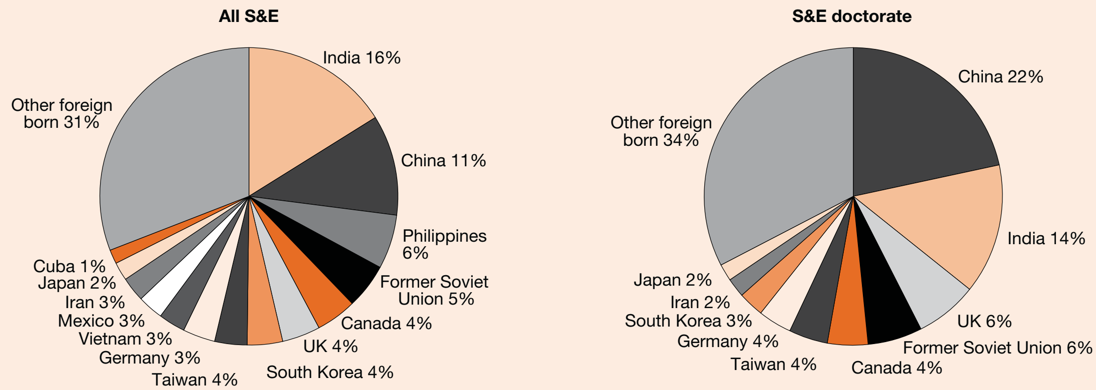
Figure 3-54
Foreign-born individuals with highest degree in S&E living in United States, by place of birth: 2003



UK = United Kingdom

NOTE: Percents may not add to 100% because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Statistics, SESTAT database, 2003, http://sestat.nsf.gov. See appendix table 3-10.

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one foreign degree. At the highest level of education, 33% of foreign-born doctorate holders earned their doctorates from a foreign school.

The prevalence of foreign degrees among foreign-born S&E degree holders has been increasing over time (figure 3-55). Among foreign-born S&E degree holders who entered the United States before 1980, only 20% of doctorate holders and 23% of bachelor's degree holders had their highest degree from a foreign school. These percentages increase for more recent entry cohorts of immigrants. It should be noted that some portion of the increase in the most recent entry years reflects immigrants who entered during those years but have not yet had sufficient time to complete an American degree.

Table 3-25
Share of college-educated, foreign-born individuals in United States holding foreign degrees, by education level: 2003
(Percent)

Highest degree	Highest degree from foreign school	Any foreign university degree	Foreign secondary school
All college graduates	42.4	56.2	70.0
Bachelor's	50.1	52.1	66.4
Master's	27.4	58.7	74.3
Professional	49.4	58.4	63.3
Doctorate	33.1	76.1	87.3
All S&E degree holders	37.3	55.9	NA
Bachelor's	45.6	48.0	63.8
Master's	27.2	63.0	76.9
Professional	28.7	34.6	42.2
Doctorate	34.9	79.7	NA

NA = not available (Data not collected from U.S.-trained S&E doctorates.)

SOURCE: National Science Foundation, Division of Science Resources Statistics, National Survey of College Graduates (2003), Scientists and Engineers Statistical Data System (SESTAT), http://sestat.nsf.gov.

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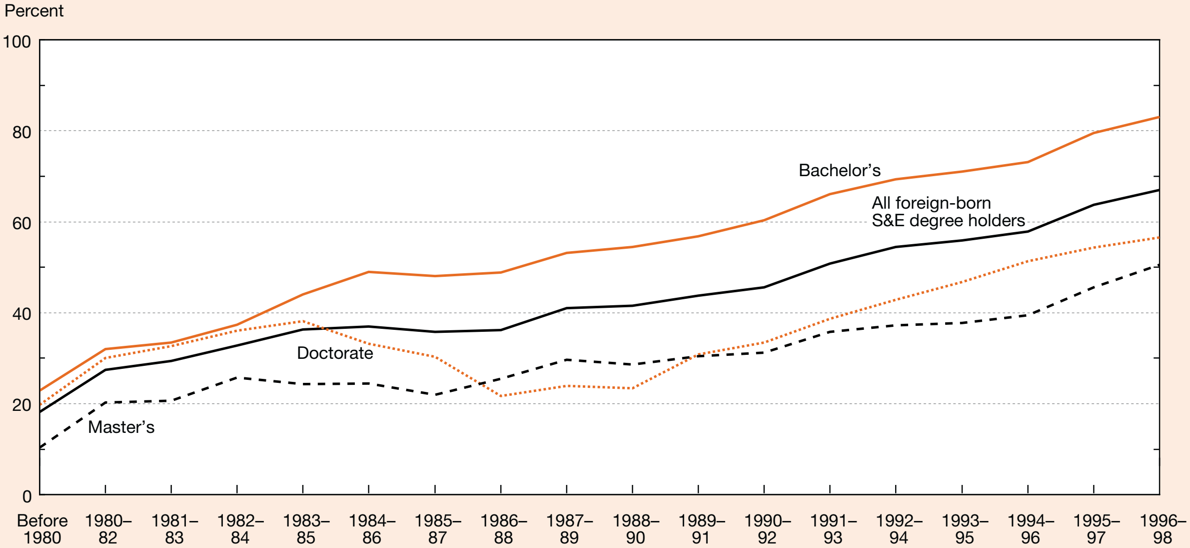
Citizenship and Visa Status of Foreign-Born Scientists and Engineers in the United States

The length of time it takes for foreign scientists and engineers to earn U.S. citizenship affects both their decision to come to the United States and their subsequent decision to stay. As figure 3-56 shows, only about half of foreign S&E degree holders who entered the United States in 1991 and remained in 2003 had obtained citizenship. Citizenship status may particularly affect the supply of S&T talent available to segments of the U.S. economy that can typically hire only citizens: the federal government and private companies engaged in defense and other classified research.[20] While a significant portion of any group of immigrants never seeks citizenship, the type of visas that scientists, engineers, and other high-skilled workers use for initial entry into the United States affects their path to citizenship. Time spent in the United States on a student or temporary work visa does not count toward the 5-year waiting period before immigrants can apply for citizenship.

Temporary Work Visas

In recent years, policy discussion has focused on the use of various forms of temporary work visas by foreign-born scientists and other high-skilled workers. The use of these temporary visas for high-skilled workers has increased over time (as seen in figure 3-57). For all types of temporary work visas, the actual number of individuals using them is

Figure 3-55
Foreign-born S&E degree holders whose highest degree is from a foreign institution, by year of entry to United States: 2003



NOTE: Data are 3-year moving average.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2003), http://sestat.nsf.gov.

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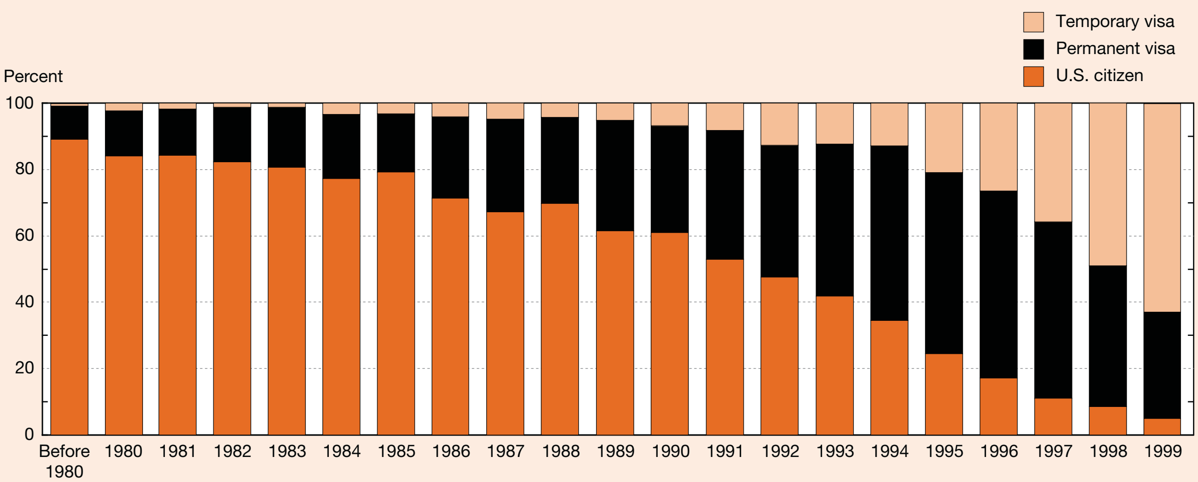
Figure 3-56
Foreign-born S&E degree holders, by citizenship/visa status and year of entry to United States: 1980–99



NOTE: Some data on foreign-born S&E degree holders are available through 2003; however, data after 1999 exclude many individuals with foreign degrees.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2003), http://sestat.nsf.gov.

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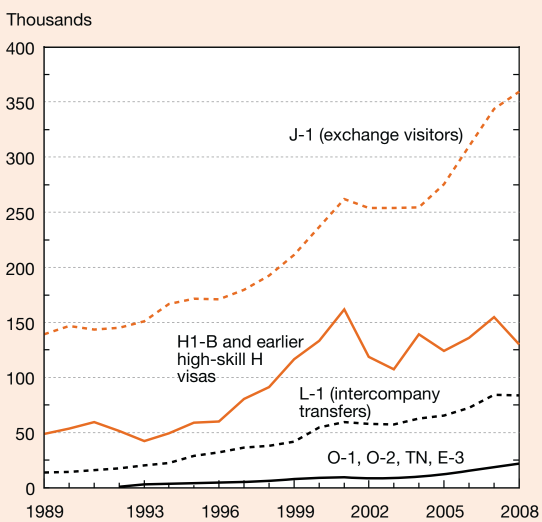
less than the number issued. For example, some individuals may have job offers from employers in more than one country and may choose not to foreclose any options until a visa is certain.

J-1 Exchange Visas. Of the visa types shown, the J-1 exchange visitor visa is the most issued—more than 350,000 in FY 2008. However, many of these visas are given to lower skilled workers, and many J-1s are issued for semester or summer stays. U.S. Immigration and Customs Enforcement (ICE) showed approximately 165,000 J-1 visa holders in the United States, of whom 50% were in categories that were clearly highly skilled, including nearly 50,000 professors and research scholars.

Other Visa Types. There has also been growth in visas issued in other high-skilled categories. Between 2003 and 2008, issuances of L-1 (intracompany transfer) visas grew by 47% to 84,000. The smallest series shown in Figure 3-57 groups together four much smaller high-skilled visa programs: O-1 (a person of outstanding ability), O-2 (an assistant to an O-1, sometimes a postdoc), TN (college-degreed citizens of Canada and Mexico), and E-3 (college-degreed citizen of Australia). Taken together, these four visa types grew by 142% between 2003 and 2008, reaching nearly 22,000 in the number of visas issued.

Figure 3-57
Temporary work visas issued in categories that include many high-skilled workers: FY 1989–2008



NOTE: J-1 exchange visitor visa used for many different skill levels.

SOURCE: U.S. Department of State, Report of the Visa Office, various years. http://travel.state.gov/visa/frvi/statistics/statistics_1476.html.

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H-1B Visas

H-1B temporary work visas are likely to account for a larger number of high-skilled workers than other visa classes. The United States typically issues H-1B visas for 3 years with the possibility of a 3-year renewal. In October 2003, the United States lowered its annual ceiling on admissions from 195,000 to 65,000, but granted universities and academic research institutions exemptions in their own hiring. In 2005, the United States granted an additional 20,000 exemptions for students receiving master's degrees or doctorates from U.S. schools.

Although the occupational categories used in H-1B visa records do not precisely correspond to the classifications used elsewhere in this chapter, it is safe to say that the bulk of H-1B visa recipients work in S&E or S&E-related occupations (figure 3-58; table 3-1).

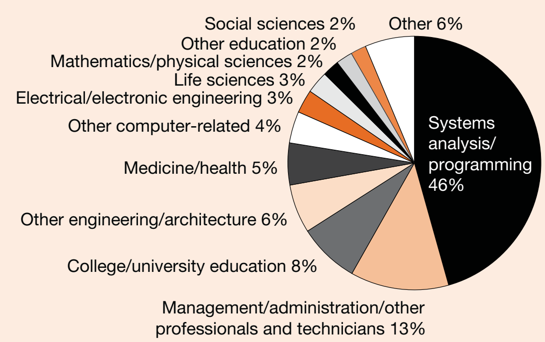
In 2006, half of new H-1B visa recipients were employed in computer-related occupations. This represents a recent increase from a low of 25% in 2002. Of those receiving new H-1B visas in 2006 who were in computer-related occupations, 44% had master's degrees and just over 1% had doctorates.

Characteristics of Workers Issued New H-1B Visas

Education Levels. In FY 2006, 57% of new H-1B visa recipients had advanced degrees, including 41% with master's degrees, 5% with professional degrees, and 11% with doctorates. This degree distribution differs by occupation, with 87% of those holding advanced degrees in math and physical sciences occupations (47% with doctorates) and 89% in life science occupations (61% with doctorates).

Many H-1B visa recipients earned their degrees abroad. In FY 2006, 41% of doctorate holders, 79% of professional degree holders, and 48% of master's degree holders who received H-1B visas indicated on their applications that they did

Figure 3-58
Occupations of new recipients of U.S. H-1B temporary work visas: FY 2006



SOURCE: Department of Homeland Security, U.S. Citizenship and Immigration Services; and National Science Foundation, Division of Science Resources Statistics, special tabulations.

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not have a graduate degree from a U.S. institution.[21] This indicates both the use of the H-1B visa as a way for graduates of U.S. schools to continue their careers in the United States and the importance of the H-1B visa in bringing foreign-educated individuals into the United States (DHS/ICE 2006).

H-1B Country of Citizenship. More than half of recent H-1B visa recipients were from India and an additional 9% from China. Among doctorate holders, one-third were from China and another 13% from India (figures 3-59 and 3-60). Altogether, Asian citizens made up three-quarters of all H-1B visa recipients; among doctorate holders, they were well above half.

Relatively few doctorate holders from countries with better university systems had U.S. degrees. For example, the United Kingdom (21%), Germany (28%), Canada (29%), France (30%), and Japan (31%). In contrast, 71% of doctorate holders from China and 59% of doctorate holders from India claimed advanced degrees from U.S. institutions on their visa applications.

H-1B Salaries. Table 3-26 shows salaries paid to new recipients of H-1B temporary work visas by occupation group and level of degree. These starting salary figures, taken from final visa application forms sent to U.S. Citizenship and Immigration Services, are different from, and generally higher than, H-1B salaries that firms report on their applications to the Department of Labor, which are filed much earlier in the H-1B process. The relatively low average salaries for doctorate holders in the life sciences may reflect the common use of H-1B visas to hire individuals for relatively low-paid postdoc fellowships.

Visa Applications and Rejections for Students and Exchange Visitors

The F-1 and J-1 visas used by students and exchange visitors have recovered from the declines experienced after September 11, 2001 (see table 3-27). F-1 visa applications declined from 380,385 in FY 2001 to a low of 282,662 in FY 2004. After 2004, the number of applications increased each year; the number of F-1 applications was 21% higher in FY 2008 than in FY 2001. J-1 visa applications experienced smaller declines after September 11, 2001, and were 35% higher in FY 2008 than in FY 2001.

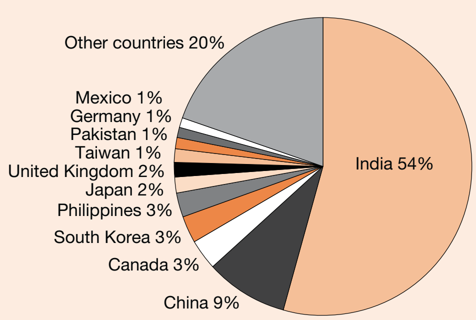
Stay Rates for U.S. Doctorate Recipients with Temporary Visas

Many foreign students opt to stay in the United States after earning their degree. As reported in the Survey of Earned Doctorates, between 2004 and 2007, 76% to 82% of non-U.S. citizen S&E doctorates had firm commitments for work or study in the United States at the time of graduation. The rates were slightly lower for temporary visa holders over the same time period (75% to 81%) (see chapter 2 for further discussion).

Longer-term stay rates are also high. According to a report by Michael Finn (2009) of the Oak Ridge Institute for Science and Education, 62% of 2002 U.S. S&E doctorate recipients with temporary visas were in the United States in 2007. This is down slightly from a 65% 5-year stay rate found in 2005 (figure 3-61), but due to a long upward trend in stay rates, this was still higher than any other 5-year stay rate estimated between 1992 and 2003. As shown in figure 3-61, stay rates differ significantly by country of origin, but have generally been increasing for most major source countries.

New doctorate recipients in 2002 faced relatively poor labor market conditions (see discussions earlier in this chapter), and foreign students earning degrees may have also been worried about greater difficulties with securing visas for themselves and their families.

Figure 3-59
Country of citizenship for new recipients of U.S. H-1B temporary work visas: FY 2006



SOURCE: Department of Homeland Security, U.S. Citizenship and Immigration Services; and National Science Foundation, Division of Science Resources Statistics, special tabulations.

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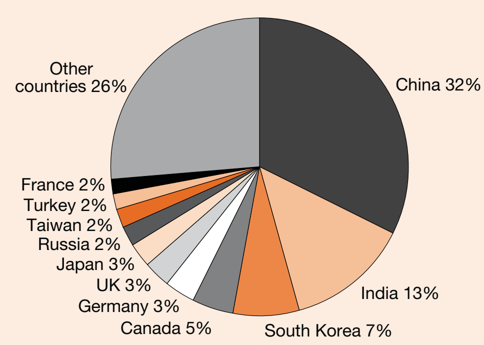
Figure 3-60
Country of citizenship of doctorate holders who are new recipients of U.S. H-1B temporary work visas: FY 2006



UK = United Kingdom

SOURCE: Department of Homeland Security, U.S. Citizenship and Immigration Services; and National Science Foundation, Division of Science Resources Statistics, special tabulations.

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Table 3-26
Average annual salary of new recipients of H-1B temporary work visas, by occupation and degree: FY 2006
(Dollars)

Occupation	All degree levels	Bachelor's	Master's	Professional	Doctorate
Administrative specializations	53,500	49,600	56,200	70,100	85,100
Architecture/engineering/surveying	61,600	58,400	60,000	73,700	73,000
Art	44,800	44,500	44,400	na	na
Computer-related occupations	56,200	56,000	55,600	71,200	80,400
Education	48,500	36,700	43,800	67,000	51,900
Entertainment/recreation	38,900	38,000	40,700	na	na
Law/jurisprudence	100,100	63,200	83,200	114,600	na
Life sciences	45,600	40,400	43,900	47,700	46,700
Managers/officials nec	78,000	70,800	81,500	107,500	105,300
Mathematics/physical sciences	60,400	58,500	59,800	60,900	61,400
Medicine/health	72,300	48,100	51,700	86,800	62,700
Miscellaneous professional/technical/managerial	64,400	54,800	68,800	na	84,500
Museum/library/archival sciences	41,800	39,500	41,300	na	na
Religion/theology	37,400	NA	38,500	na	na
Social sciences	60,900	54,100	64,000	na	77,600
Writing	38,200	37,900	37,500	na	na

na = not applicable; NA = not available; nec = not elsewhere classified

SOURCE: Department of Homeland Security, U.S. Citizenship and Immigration Services, special tabulations.

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There was also a geographic pattern to the changes in 5-year stay rates for foreign S&E doctorate recipients. Stay rates actually showed large percentage point increases for students from the largest European source countries: the UK (+6 percentage points) and Germany (+3 percentage points). The overall decline in stay rate between 2005 and 2007 was driven largely by decreases in stay rates for several Asian source countries: Taiwan (–8 percentage points), Japan (–6 percentage points), and India (–4 percentage points).

Finn also estimates stay rates for doctorate recipients from graduate programs of different quality based on ratings

Table 3-27
Initial applications for student/exchange visitor visas: FY 2001–08

Year	Student (F-1) Applications	Student (F-1) Refused (%)	Exchange visitor (J-1) Applications	Exchange visitor (J-1) Refused (%)
2001	380,385	22.9	275,959	5.1
2002	322,644	27.4	270,702	6.2
2003	288,731	25.3	275,335	7.8
2004	282,662	22.6	274,789	7.4
2005	333,161	19.8	311,728	5.8
2006	385,596	20.1	349,598	5.9
2007	386,144	24.0	346,946	6.2
2008	458,406	25.7	371,527	6.6

NOTE: Application counts and refusal rates adjusted for reapplications and appeals by same individual.

SOURCE: Department of State, Immigrant Visa Control and Reporting Division, administrative data (2001–08).

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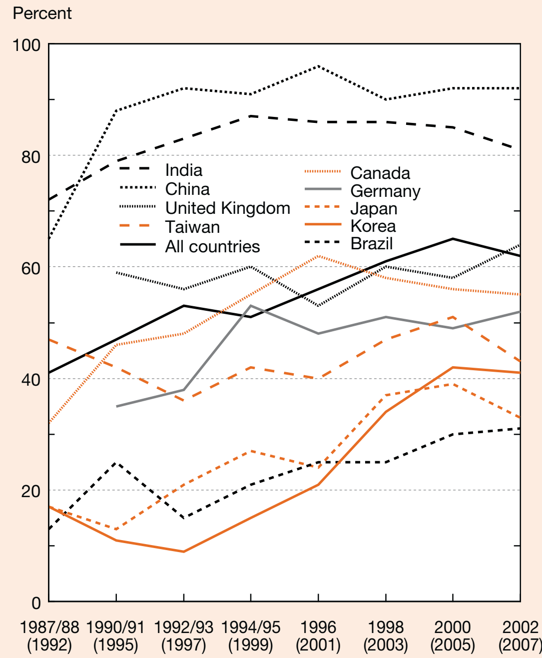
Figure 3-61
Five-year stay rates for recipients of U.S. S&E doctorates who have temporary U.S. visas, by place of origin and year of doctorate: 1992–2007



NOTE: Year of observation in parentheses.

SOURCE: Finn M, Stay rates of foreign doctorate recipients from U.S. universities: 2009, Oak Ridge Institute for Science and Education (forthcoming).

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Table 3-28
Temporary residents who received S&E doctorates in 2002 who were in the United States, by program rating: 2003–07
(Percent)

Program rating	Foreign doctorate recipients (n)	2003	2004	2005	2006	2007
All programs	7,850	69	66	64	62	62
Top-rated programs	2,611	67	63	61	59	58
All other programs	5,239	70	68	65	64	63

NOTE: Characterization of programs as “top-rated” by Finn (forthcoming) using ratings of faculty reputation in research from *U.S. News and World Report* and National Research Council.

SOURCE: Finn M, Stay rates of foreign doctorate recipients from U.S. universities. Oak Ridge, TN: Oak Ridge Institute for Science and Education (forthcoming).

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of faculty by the publication *U.S. News and World Report* and on separate ratings by the National Research Council. Finn used these ratings to select 20 to 25 “top-rated” departments in major S&E fields. Doctorate recipients from the graduate programs that Finn designated as top rated were somewhat less likely to remain in the United States than were graduates of other programs (see table 3-28). For doctorate recipients, the difference in 1-year stay rates was 3 percentage points: 67% of those from the top-rated programs and 70% of other doctorate recipients remained in the United States 1 year after receiving their degrees. By 5 years after receiving their degree, the two groups showed differences that rose to 5 percentage points, with stay rates of 58% and 63%, respectively.

Conclusion

Growth of the U.S. S&E workforce continues to exceed that of the overall workforce. However, the 2000–07 period showed the smallest growth rate (2.2%) in S&E occupations since NSF began tracking these data in the 1950s. Although the U.S. recession that began in 2007 affected workers across all occupations, S&E occupations appear to be less severely affected. The unemployment rate in April 2009 was 9.0% for all workers, but 4.3% for those working in S&E occupations. The influence of the recession on longer-term S&E labor force behavior (e.g. retirement rates, part- and full-time employment) remains to be seen.

A large and growing number of Americans hold degrees in S&E fields; in 2006, 16.6 million individuals in the U.S. workforce held at least one S&E degree. Individuals in S&E occupations are highly educated, with more than 70% holding at least a bachelor’s degree in any field; in contrast, less than 30% of persons working in all other occupations hold a bachelor’s or higher degree. Workers in S&E occupations also received higher wages than those in other occupations.

The globalization of the S&E labor force continues to increase. The number of people with S&E is skills rising, especially in developing nations, and the location of S&E employment is becoming more internationally diverse. S&E workers are becoming more internationally mobile. These trends reinforce each other: as R&D spending and business investment cross national borders in search of available talent, talented people cross borders in search of interesting and lucrative work, and employers recruit and move employees internationally.

The growth rate of the S&E labor force would be significantly reduced if the United States became less successful in the increasing international competition for scientists and engineers. Compared with the United States, many other countries are more actively reducing barriers to highly skilled immigrants entering their labor markets. Nonetheless, the United States is still an attractive destination for many foreign scientists and engineers.

Notes

1. The standard definition of the term *labor force* includes the population that is employed or not working but seeking work (unemployed); other individuals are not considered in the labor force. When data refer only to employed persons, the term *workforce* is used. For data on unemployment rates by occupation, calculations assume that unemployed individuals are seeking further employment in their most recent occupation.

2. Despite the limitations of this subjective measure, variations among occupations in the proportions of workers who say they need this level of S&E technical expertise accord with common sense. For example, among doctoral level postsecondary teachers of physics, 99.7% said they needed at least a bachelor’s level of knowledge in engineering, computer sciences, mathematics or the natural sciences, compared with 5% among doctoral level postsecondary teachers of English. Likewise, among the small numbers of S&E bachelor’s degree holders whose occupation is “secretary/receptionist/typist,” fewer than one in six reported that their job needed bachelor’s level S&E expertise of any kind.

3. Estimates of the size of the S&E workforce vary across the example surveys because of differences in the scope of the data collection (SESTAT surveys collect data

from individuals with bachelor's degrees and above only); because of the survey respondent (SESTAT surveys collect data from individuals, OES collects data from establishments, and ACS collects data from households); or because of the level of detail collected on an occupation, which aids in coding. All of these differences can affect the estimates.

4. Although BLS labor force projections do a reasonable job of forecasting employment in many occupations (see Alpert and Auyer 2003), the mean absolute percentage error in the 1988 forecast of employment in detailed occupations in 2000 was 23.2%.

5. Many comparisons using Census Bureau data on occupations are limited to looking at all S&E occupations except postsecondary teachers because the current U.S. occupation taxonomy does not break out these teachers by field. Only NSF surveys of scientists and engineers collect data on postsecondary teachers by field.

6. Only U.S. citizens and nationals may be appointed in the competitive civil service; however, federal agencies may employ certain noncitizens who meet specific employability requirements in the excepted service or the Senior Executive Service.

7. Specifically presented here are coefficients from linear regressions using the 2003 SESTAT database of individual characteristics on the natural log of reported full-time annual salary as of October 2003.

8. *Underrepresented ethnic group,* as used here, includes individuals who reported their race as black, American Indian/Alaska Native, of Hispanic origin, or other ethnicity.

9. In the regression equation, this is the form: age^1, age^2, age^3, age^4; years since highest degree $(YSD)^1$, YSD^2, YSD^3, YSD^4.

10. The regressions included 20 dummy variables for SESTAT field-of-degree categories (out of 21 S&E fields; the excluded category was "other social science").

11. Variables added here include 34 SESTAT occupational groups (excluding "other non-S&E"), whether individuals worked in R&D, the employer's U.S. census region, and the sector of the economy.

12. Variables added here include dummy variables for marriage, number of children in the household younger than 18, whether the father had a bachelor's degree, whether either parent had a graduate degree, citizenship, nativity, and age at receipt of first bachelor's degree minus 20. Sex and ethnic minority variables are included in all regression equations.

13. This may be because differences between groups in many of these family and personal characteristics are not large. It is also possible that variations in these characteristics correlate with those in other controls already in the statistical model and in that sense have already been taken into account.

14. Many doctorate holders with salaries at this level are postdocs in temporary training positions.

15. Although the formal job title is often postdoctoral fellowship or research associate, titles vary among organizations. This chapter generally uses the shorter, more commonly used, and best understood name, postdoc. A postdoc is traditionally defined as a temporary position that graduate students take primarily for additional training—a period of advanced professional apprenticeship—after completion of a doctorate.

16. Some part of the citizen and permanent resident postdoc population in the fall of 2005 will not be counted even in the SDR. Excluded are summer 2005 graduates who may be in postdoc positions in the fall of 2005, doctorate holders who may have left the country before April 2006, and those who have foreign doctorates.

17. Respondents also had to be under age 76 and resident in the United States in April 2006. In a similar retrospective question on the 1995 SDR, 25% of those earning their doctorates before 1964 reported having had postdoc positions.

18. See section 'Business-to-business linkages' in chapter 4 for information on international transactions in R&D services and technology alliances.

19. An affiliate is a company or business enterprise located in one country but owned or controlled by a parent company in another country. Majority-owned affiliates are those in which the ownership stake of parent companies is more than 50%.

20. Outside of government, it is illegal to discriminate in employment on the basis of citizenship status. However, if the work requires a security clearance, this usually also requires citizenship.

21. These figures are likely to somewhat underestimate the proportion of H-1B recipients without U.S. graduate degrees. Because a portion of H-1B visas were restricted to applicants with advanced degrees from U.S. institutions, these applicants had an incentive to answer the optional question about where their degrees were earned; applicants whose degrees came exclusively from foreign institutions had no reason to answer this question.

Glossary

Career path job: A job that helps graduates fulfill their future career plans.

EU-27: The 27 member states of the European Union since 2007, including Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.

Federally funded research and development center (FFRDC): An organization that performs research and development and is exclusively or substantially financed by the federal government either to meet a particular research and development objective or, in some instances, to provide major facilities at universities for research and associated training purposes.

High-skilled diaspora: Networks of contact and information flow that form among the internationally mobile portion of a country's nationals.

Involuntarily out of the field (IOF) employment: Employment in a job not related to the field of one's highest degree because a job in that field was not available, or employment part time because full-time work was not available.

Labor force: A subset of the population that includes both those who are employed and those who are not working but seeking work (unemployed); other individuals are not considered to be in the labor force.

Postdoc: A temporary position awarded in academia, industry, government, or a nonprofit organization, primarily for gaining additional education and training in research after completion of a doctorate.

SESTAT: Scientists and Engineers Statistical Data System, a system of three surveys conducted by the National Science Foundation that measure the educational, occupational, and demographic characteristics of the science and engineering workforce. The three surveys are the National Survey of College Graduates (NSCG), the Survey of Doctorate Recipients (SDR), and the National Survey of Recent College Graduates (NSRCG).

Stay rate: The proportion of students on temporary visas who stay in the United States 1–5 years after receiving a doctorate.

Tertiary educated: Roughly equivalent in U.S. terms to individuals who have earned at least technical school or associate's degrees and includes all degrees up to doctorate.

Workforce: A subset of the labor force that includes only employed individuals.

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