Chapter 3
Science and Engineering Labor Force

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Highlights

The S&E workforce in the United States has grown rapidly for decades.

- From 1950 to 2000, employment in S&E occupations grew from fewer than 200,000 to approximately 4.8 million workers. The average annual growth rate of 6.7% contrasts with a 1.6% annual average growth rate for total employment.
- Between 1990 and 2000, S&E occupations grew at a lower average annual rate of 3.6%, but this was more than triple the rate of growth of other occupations. Different data sources suggest the same rate of employment growth in 2005.
- Between 1980 and 2000, the total number of S&E degrees earned grew at an average annual rate of 1.5%, which was faster than labor force growth, but less than the 4.2% growth of S&E occupations. The loose fit between degrees and occupations and the immigration of S&E workers helped to account for the different rates of degree and occupation growth.

The S&E labor force does not include just those in S&E occupations.

- Approximately 12.9 million workers said in 2003 that they needed at least a bachelor's degree level of knowledge in S&E fields in their jobs. However, in that year only 4.9 million were in occupations formally defined as S&E.
- Fifteen million workers in 2006 had an S&E degree as their highest degree and 17 million have at least one degree in an S&E field.
- Sixty-six percent of S&E degree holders in non-S&E occupations say their job is related to their degree, including many in management and marketing occupations.
- Fifty-five percent of S&E degree holders who spent at least 10% of their work hours on R&D were in non-S&E occupations.

S&E occupations have generally recovered from unusually high unemployment in the most recent recession.

- Unemployment in S&E occupations declined to 1.6% in 2006, down from the 20-year high of 4.0% in 2003.
- Unemployment rates also declined in the S&E-related occupational categories of technicians and computer programmers to 3.1% and 2.8%, respectively, in 2006.

Changes between 1993 and 2003 in median real salary for recent S&E graduates indicate increasing relative demand for S&E skills during the past decade.

- The mean real salary for recent S&E bachelor's degree recipients increased in all fields, averaging 15% across all fields of degree.
- The largest increases for recent bachelor's degree recipients were in computer and mathematical sciences (23.3%) and engineering (20.4%),

Retirements from the S&E labor force are likely to become more significant over the next decade.

- Twenty-six percent of all S&E degree holders in the labor force are age 50 or over. Among S&E doctorate holders in the labor force, 40% are age 50 or over.
- By age 62, half of S&E bachelor's degree holders had left full-time employment. Doctoral degree holders work slightly longer, with half leaving full-time employment by age 66.

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.
- At least 41% of the foreign-born university educated in the United States in 2003 had their highest degree from a foreign educational institution.
- About half of S&E doctorate holders in U.S. postdoc positions may have earned their doctorates outside of the United States.

The capability for doing science and technology work has increased throughout the world.

- From 1994 to 2004, R&D employment outside the United States by U.S. firms increased by 76%, compared with a 31% increase in R&D employment by the same firms in the United States, and an 18% increase in U.S. R&D employment at the U.S. subsidiaries of foreign firms.

The proportions of women, blacks, and Hispanics in S&E occupations have continued to grow over time, but are still less than their proportions of the population.

- Women were 12% of those in nonacademic S&E occupations in 1980 and 26% in 2005. Women are a higher proportion of nonacademic S&E occupations at the doctoral level, increasing from about 23% in 1990 to 31% in 2005.
- The proportion of blacks in nonacademic S&E occupations increased from less than 3% in 1980 to 5% in 2005. The proportion of Hispanics increased from 2% to 5% in 2005. 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, rising to 6% in 2005.

Postdoc positions have become an increasingly important stage in the career paths of S&E doctorate recipients.

- Across all S&E fields, the proportion of U.S. S&E doctorate holders reporting ever holding a postdoc position reached 46% for the 2002–05 graduation cohort. Proportions are highest in the life sciences and the physical sciences.
- There has been a steady growth in the availability of employment benefits for postdocs, with 90% now reporting having medical benefits and 49% reporting retirement benefits.
- Former postdocs are moderately more likely than those with no postdoc experience to be in tenured or tenure-track positions, to have R&D as a major work activity, and to report that their job is closely related to their field of degree. However, these relationships are not necessarily causal.

Introduction

Chapter Overview

Although workers with S&E skills make up only a small fraction of the total U.S. civilian labor force, their effect on society belies their numbers. These workers contribute enormously to technological innovation and economic growth, research, and increased knowledge. Workers with S&E skills include technicians and technologists, researchers, educators, and managers. In addition, many others with S&E training use their skills in a variety of nominally non-S&E occupations (such as writers, salesmen, financial managers, and legal consultants), and many niches in the labor market require them to interpret and use S&E knowledge.

In the last half of the last century, the size of the S&E labor force grew dramatically—with employment in S&E occupations expanding 25-fold between 1950 and 2000 (albeit from a small base of 182,000 jobs). Although the highest growth rates occurred in the 1950s, employment in S&E occupations in the 1990s continued to grow by 3 to 4 times the rate of other jobs.

This growth in the S&E labor force was largely made possible by three factors: (1) increases in S&E degrees earned by both native and foreign-born students, (2) both temporary and permanent migration to the United States of those with foreign S&E education, and (3) the relatively small numbers of scientists and engineers old enough to retire. Many have expressed concerns (see National Science Board 2003) that changes in any or all of these factors may limit the future growth of the S&E labor force in the United States.

Chapter Organization

This chapter has four major sections. The first provides a general profile of the U.S. S&E labor force. This includes demographic characteristics (population size, sex, nativity, and race/ethnicity). It also covers educational backgrounds, earnings, places of employment, occupations, and whether the S&E labor force makes use of S&E training. Much of the data in this section comes from the National Science Foundation's (NSF) 2003 surveys of S&E degree holders[1]—the National Survey of College Graduates (NSCG), the National Survey of Recent College Graduates (NSRCG), and the Survey of Doctorate Recipients (SDR). When combined in a way to form a single profile of the S&E-educated population in the United States, these three surveys are known as the Scientists and Engineers Statistical Data System (SESTAT).

The second section looks at the labor market conditions for recent S&E graduates, whose labor market outcomes are most sensitive to labor market conditions. For recent S&E doctoral degree recipients, the special topics of academic employment and postdoc appointments are also examined.

The third section examines the age and retirement profiles of the S&E labor force. This is key to gaining insights into the possible future structure and size of the S&E-educated population.

The last section focuses on the global S&E labor force, both its growth abroad and the importance of the international migration of scientists and engineers to the United States and to both sending and destination countries elsewhere in the world.

U.S. S&E Labor Force Profile

This section profiles the U.S. S&E labor force, providing specific information about its size, recent growth patterns, projected labor demand, and trends in sector of employment. It also looks at workers' use of their S&E training, educational background, and salaries.

Section Overview

The S&E labor force includes both individuals in S&E occupations and many others with S&E training who may use their knowledge in a variety of different jobs. Employment in S&E occupations has grown rapidly over the past two decades and is currently projected to continue to grow faster than general employment through the next decade. Although most individuals with S&E degrees do not work in occupations with formal S&E titles, most of them, even at the bachelor's degree level, report doing work related to their degree even in mid- and late-career. The proportions of women and ethnic minorities in the S&E labor force continue to grow, but with the exception of Asians/Pacific Islanders, they remain smaller than their respective proportion of the overall population.

How Large Is the U.S. S&E Workforce?

Estimates of the size of the U.S. S&E workforce vary based on the criteria used to define who is a scientist or an engineer. Education, occupation, field of degree, and field of employment are all factors that may be considered. (See sidebar "Who Is a Scientist or an Engineer?")

Estimates of the size of the S&E workforce in 2006 ranged from approximately 5 million to more than 21 million individuals, depending on the definition and perspective used (table 3-1). In that year, 17.0 million individuals had at least one degree in an S&E field and 21.4 million had either an S&E degree or a degree in an S&E-related field such as health or technology. This broader definition of the S&E workforce may be most relevant to many of the ways science and technical knowledge is used in the United States, as S&E skills are used in a wide variety of occupations. A smaller number, 14.5 million, has an S&E degree as its highest degree.

If the labor force definition is limited to those in S&E occupations with at least a bachelor's degree, the 2006 NSF SESTAT data estimated 5.0 million workers, whereas the

Who Is a Scientist or an Engineer?

The terms scientist and engineer have many definitions, none of them perfect. This chapter uses multiple definitions for different analytic purposes; other reports use even more definitions. The three main definitions used in this chapter are:

- **Occupation.** The most common way to count scientists and engineers in the workforce is to include individuals having an occupational classification that matches some list of S&E occupations. Although considerable questions can arise about how well individual write-ins or employer classifications are coded, the occupation classification comes closest to defining the work a person performs. (For example, an engineer by occupation may or may not have an engineering degree.) One limitation of classifying by occupation is that it will not capture individuals using S&E knowledge, sometimes extensively, under occupational titles such as manager, salesman, or writer.* It is common for individuals with an S&E degree in such occupations to report that their work is closely related to their degree and, in many cases, to also report R&D as a major work activity.
- **Highest degree.** Another way to classify scientists and engineers is to focus on the field of their highest (or most recent) degree. For example, classifying as "chemist" a person who has a bachelor's degree in chemistry but who works as a technical writer for a professional chemists' society magazine may be appropriate. Using this "highest degree earned" classification does not solve all problems, however. For example, should a person with a bachelor's degree in biology and a master's degree in engineering be included among biologists or engineers? Should a person with a bachelor's degree in political science be counted among social scientists if he also has a law degree? Classifying by highest degree earned in situations similar to the above examples may be appropriate, but one may be uncomfortable excluding from an analysis of the S&E labor force an individual who has both a bachelor's degree in engineering and a master's degree in business administration.
- **Need for S&E knowledge.** Many individuals identify their jobs as requiring at least a bachelor's degree level of knowledge in S&E, although not all of them have such a degree.

*For example, in most collections of occupation data a generic classification of postsecondary teacher fails to properly classify many university professors who would otherwise be included by most definitions of the S&E workforce. The Scientists and Engineers Statistical Data System (SESTAT) data partially avoid this problem through use of a different survey question, coding rules, and respondent followups.

Table 3-1
Concepts and counts of S&E labor force: 2003 and 2006

Concept	Education coverage	Source	Number
Occupation			
Employment in S&E occupations	All	2006 BLS Occupational and Employment Statistics Survey	5,408,000
Employment in S&T or "STEM" occupations	All	2006 BLS Occupational and Employment Statistics Survey	7,442,000
Employment in S&E occupations	Bachelor's and above	2006 NSF SESTAT data	5,024,000
Employment in S&E occupations	Bachelor's and above	2005 American Community Survey	3,858,000
Employment in S&E occupations	All	2005 American Community Survey	5,301,000
Education			
Highest degree in S&E field	Bachelor's and above	2006 NSF SESTAT data	14,531,000
Any degree in S&E field	Bachelor's and above	2006 NSF SESTAT data	17,034,000
Any degree in S&E or S&E related fields	Bachelor's and above	2006 NSF SESTAT data	21,378,000
Need for S&E knowledge			
At least bachelor's degree-level knowledge in S&E........................	Bachelor's and above	2003 NSF SESTAT data	12,851,000
At least bachelor's degree-level knowledge in natural sciences and engineering...........................	Bachelor's and above	2003 NSF SESTAT data	9,211,000
At least bachelor's degree-level knowledge in social sciences.......	Bachelor's and above	2003 NSF SESTAT data	5,333,000

BLS = Bureau of Labor Statistics; NSF = National Science Foundation; SESTAT = Scientists and Engineers Statistical Data System

SOURCES: NSF, Division of Science Resources Statistics, SESTAT database, 2003 and 2006 (preliminary data for 2006), http://sestat.nsf.gov; BLS, Occupational and Employment Statistics Survey, May 2006; and Census Bureau, American Community Survey (2005).

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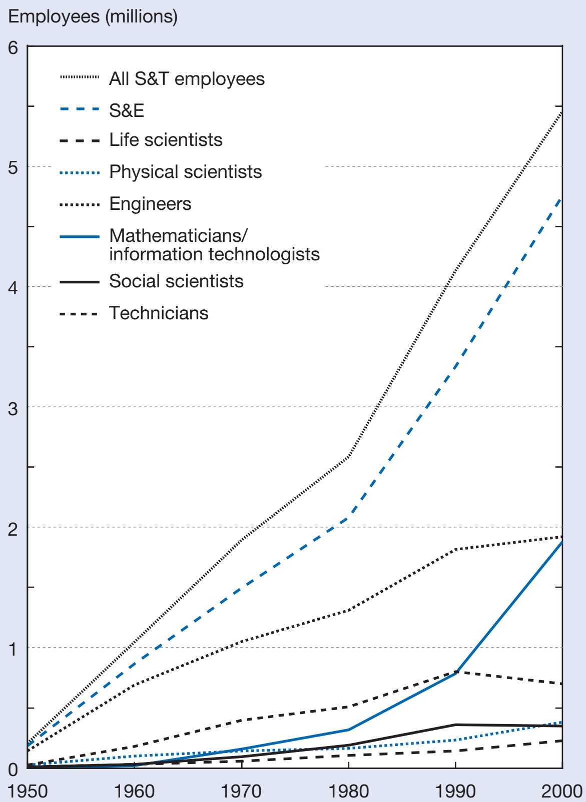
Census Bureau's 2005 American Community Survey estimated 3.9 million. Occupation-based estimates not limited to college graduates include 5.4 million in May 2006 from the Bureau of Labor Statistics (BLS) Occupational Employment Statistics Survey (OES) and 5.3 million from the 2005 American Community Survey. OES and NSF SESTAT occupational estimates include postsecondary teachers in S&E fields, but estimates from the American Community Survey, the Current Population Survey (CPS), and the decennial census have to exclude postsecondary teachers, as no information on field is collected.

Terminology referring to the technical labor force can be confusing. Sometimes a study will refer to the science and technology (S&T) or to the STEM (science, technology, engineering, and math) labor force. These terms are approximately equivalent, and as used in this chapter include all S&E occupations with the addition of technicians, programmers, technical managers, and a small number of nonhealth S&E-related occupations such as actuary and architect. In addition, some recent reports from private organizations have used the label "S&E labor force" to discuss what is labeled here as "S&T occupations." The estimate from the May 2006 OES of individuals employed in S&T occupations is 7.4 million.

A third measure, based on self-reported need for S&E knowledge, is available from the 2003 SESTAT for workers with degrees from all fields of study. An estimated 12.9 million workers reported needing at least a bachelor's degree level of S&E knowledge, with 9.2 million reporting a need for knowledge of the natural sciences and engineering (NS&E) and 5.3 million a need for knowledge of the social sciences (1.6 million reported a need for both social science and NS&E knowledge). That the need for S&E knowledge is more than double the number in formal S&E occupations suggests the pervasiveness of the need for technical knowledge in the modern workplace.

Figure 3-1
Science and technology employment: 1950–2000



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.

SOURCE: Adapted from Lowell BL, Regets MC, A Half-Century Snapshot of the STEM Workforce, 1950 to 2000, Commission on Professionals in Science and Technology (2006).

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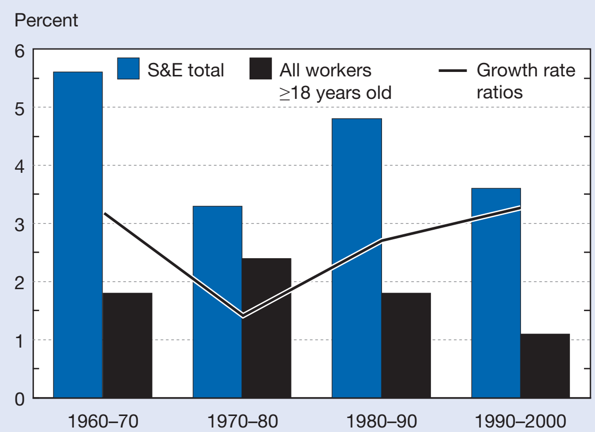
S&E Workforce Growth

Occupation classifications allow examination of growth in at least one measure of scientists and engineers over extended periods (for a discussion of even longer time periods, see the sidebar "Scientists Since Babylon"). According to data from the decennial censuses, the number of workers in S&E occupations grew to 4.8 million, at an average annual rate between 1950 and 2000 of 6.4%, compared with a 1.6% average annual rate for the whole workforce older than age 18. By a broader definition of the S&T occupations including technicians and programmers, S&T occupations grew to 5.5 million at a 6.8% average annual rate (figures 3-1 and 3-2).

The growth rate of S&E employment continued to be greater than for the full workforce in the 1990s (figure 3-2). S&E employment grew between 1990 and 2000 at a 3.6%

Figure 3-2
Average annual growth rates of S&E occupations versus all workers: 1960–2000



SOURCE: National Science Foundation, Division of Science of Science Resources Statistics, decennial census data, special tabulations.

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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, titling one book *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 faster (every 10 years).

One implication of this long-term exponential growth often cited in popular science writing is that “80 to 90 percent of all the scientists that ever lived are alive today” (Price 1961). This insight follows from the likelihood that most of the last 45 years’ (a period of three doublings) production of new scientists would still be alive. Price was interested in many implications of these growth patterns, but in particular the idea that this growth could not continue indefinitely and that the number of scientists would reach “saturation.” Not everyone is either capable of becoming, or wants to become, a scientist, and society will always need people to perform other jobs. Even if no other limits applied, the number of scientists could not exceed the size of the population. Although not predicting exactly when growth in the number of scientists would slow, 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? A doubling every 10 years would imply an annual average growth rate of 7.1%; every 15 years an average annual rate of 4.7%; and every 20 years an annual average growth rate of 3.5%. Table 3-2 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 3.0% (doubling in 24 years if this growth rate were to continue). The number of doctorate holders employed in S&E occupations in the United States showed faster average annual growth of 4.6% (doubling in 16 years if continued). There are no global counts of individuals in S&E, but the Organisation for Economic Co-operation and Development (OECD) does count “researchers” in the developed countries that are OECD members. In the OECD countries, the number of researchers grew at an average annual rate of 3.4% (21 years to double). Very limited data exists on the population of scientists and engineers in most developing countries, but OECD data for researchers in China show a 7.4% average annual grow rate (10 years to double).

All of these numbers are broadly consistent with a continuation of growth in S&E labor exceeding the rate of growth in the general labor force, both in the United States and in the world as a whole. Because none of the measures are the same as those used by Price, it is impossible to say that there has been a slowing in growth. What about the ultimate limit to growth for scientists and engineers in the United States? If the 1990s growth rates shown in figure 3-2 for the number employed in S&E occupations and for the total labor force were to continue indefinitely, all U.S. workers in 2135 would be in S&E occupations.

Table 3-2
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	1995–2002	2,815,000	3,559,000	3.4
Doctorate holders in U.S. nonacademic S&E occupations	U.S. Census	1990–2005	200,000	390,000	4.6
College graduates in U.S. nonacademic S&E occupations	U.S. Census	1990–2005	2,362,000	4,111,000	3.8
S&E doctorate holders in U.S.	NSF/SRS SESTAT	1993–2003	590,000	796,000	3.0
S&E bachelor’s degree and above holders in U.S.	NSF/SRS SESTAT	1993–2003	11,022,000	15,684,000	3.6
Researchers in China	OECD	2000–03	695,000	862,000	7.4

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 (2006).

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average annual rate (and S&T employment at a 2.8% average annual rate) compared with 1.1% for the whole workforce. Although the growth rate for S&E occupations was somewhat less in the 1990s than in the 1980s, it actually increased relative to the growth of all workers.

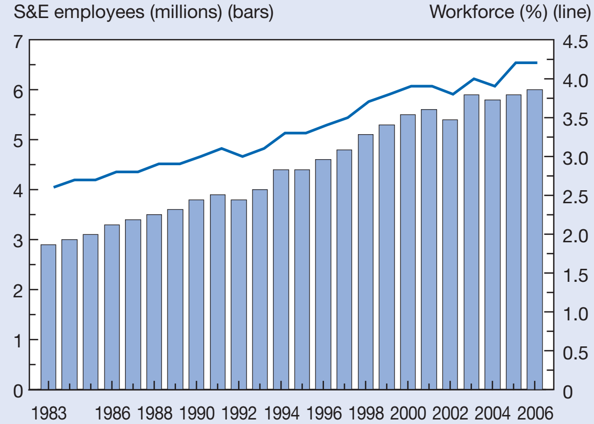
In all broad categories of S&E fields, employment in the occupations directly associated with the category has grown faster than new degree production (see chapter 2 for a fuller discussion of S&E degrees). Average annual growth rates of employment and degree production are shown in figure 3-3 for 1980–2000. Although S&E employment grew at an average annual rate of 4.2%, total S&E degree production grew by a smaller 1.5%. With the exception of the social sciences, there was greater growth in the number of graduate degrees in each field, with total S&E master's degrees granted growing at an average annual rate of 2.0% and doctoral degrees at 1.9%.

Using data from the monthly CPS from 1983 to 2006 to look at employment in S&E occupations across all sectors and education levels creates a very similar view, albeit with some significant differences. The 3.1% average annual growth rate in all S&E employment is almost triple the rate for the general workforce. This is reflected in the growing proportion of total jobs in S&E occupations, which increased from 2.6% in 1983 to 4.2% in 2006. Also noteworthy are the decreases in employment in S&E occupations in 1992 and again in 2002, evidence that S&E employment is not exempt from economic downturns (figure 3-4).

Projected Demand for S&E Workers

The most recent occupational projections from BLS, for 2004–14, forecast that total employment in occupations that NSF classifies as S&E will increase at nearly double the overall growth rate for all occupations (figure 3-5). 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.

Figure 3-4
U.S. workforce in S&E occupations: 1983–2006



SOURCE: National Science Foundation, Division of Science Resources Statistics, special tabulations from Bureau of Labor Statistics, Current Population Survey Monthly Outgoing Rotation files (1983–2006).

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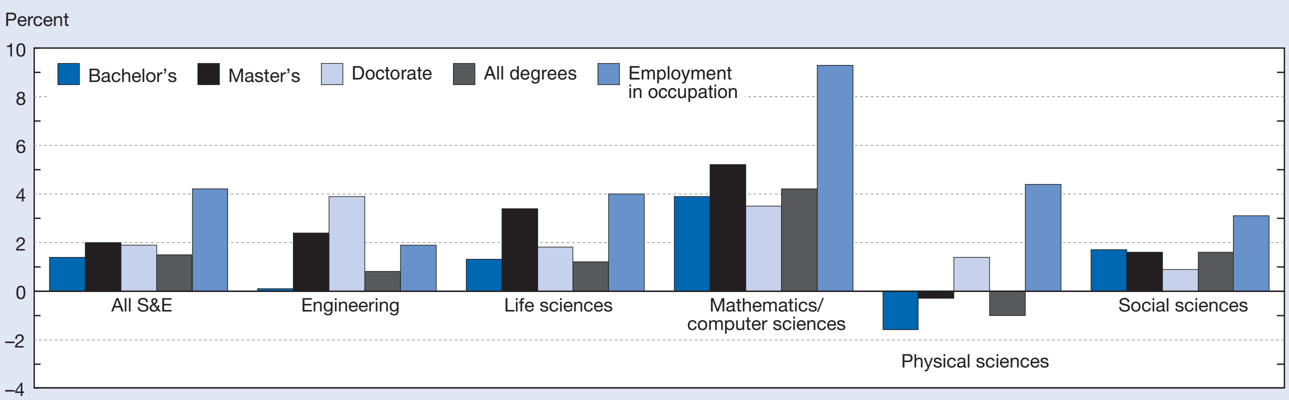
S&E occupations are projected to grow by 26% from 2004 to 2014, while employment in all occupations is projected to grow 13% over the same period (BLS 2006).[2] However, S&E occupations may be particularly difficult to forecast. Many spending decisions on R&D by corporations and governments are difficult 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 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.

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



SOURCES: Census Bureau, Public Use Microdata Sample (PUMS), 1980–2000; and National Science Foundation, Division of Science Resources Statistics, data on degree production and special tabulations.

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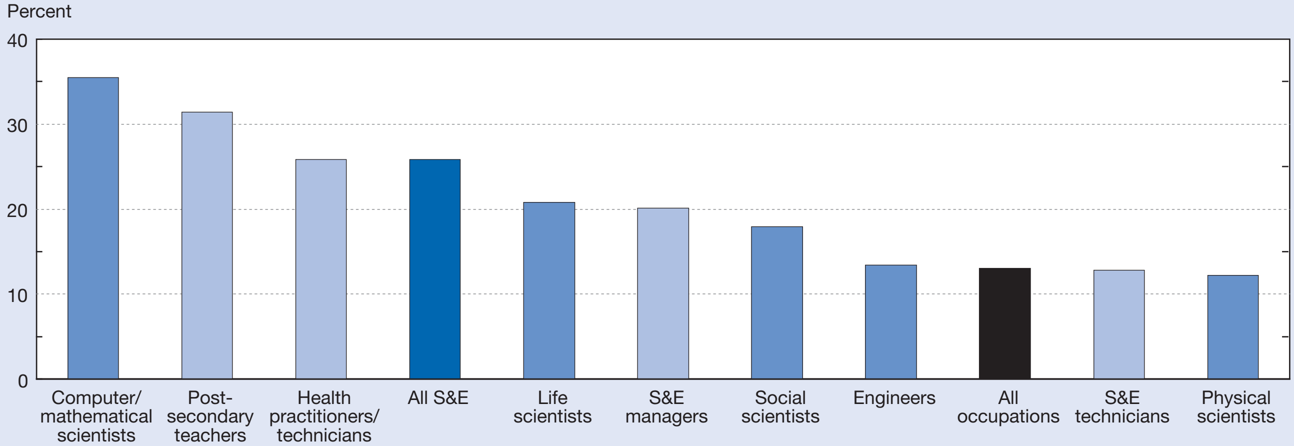
Figure 3-5
Projected increase in employment, for S&E and selected other occupations: 2004–14



SOURCE: Bureau of Labor Statistics, Office of Occupational Statistics and Employment Projections. See appendix table 3-7.

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Approximately 73% of BLS's projected increase in S&E jobs is in computer-related occupations (table 3-3). Aside from computer-related occupations, life scientists, social scientists, and engineers all have projected growth rates above those for all occupations.[3] An occupation of interest to the S&E labor market, "postsecondary teacher" (which includes all fields of instruction), is projected to grow almost as fast as computer occupations, rising from 1.8 to 2.3 million over the decade between 2004 and 2014.

BLS also forecasts that job openings in NSF's list of S&E occupations over the 2004–14 period will be a slightly greater proportion of current employment than for all occupations: 42% versus 38% (figure 3-6). Job openings include both growth in total employment and openings caused by attrition. One big reason that S&E job openings are not much higher than average job growth is retirements (see the discussion later in this chapter). Although retirements in S&E may be expected to increase rapidly in coming years and increase in percentage terms faster than retirements from other

Table 3-3
S&E employment and job openings, by occupation: 2004 and projected 2014
(Thousands)

Occupation	2004	2014	Change	Job openings	10-year total growth (%)	10-year job openings as percent of 2004 employment
All occupations	145,612	164,540	18,928	54,680	13.0	37.5
All S&E	5,120	6,440	1,319	2,186	25.8	42.7
Computer/mathematical scientists	2,698	3,656	958	1,273	35.5	47.2
Engineers	1,449	1,644	195	507	13.4	35.0
Life scientists	232	280	48	103	20.8	44.6
Physical scientists	250	281	30	94	12.2	37.4
Social scientists/related occupations	492	580	88	209	17.9	42.5
Selected other occupations						
S&E managers	513	616	103	200	20.1	39.0
S&E technicians	874	986	112	303	12.8	34.7
Postsecondary teachers/administrators	1,760	2,312	553	953	31.4	54.1
Computer programmers	455	464	9	117	2.0	25.6
Healthcare practitioner/technical occupations	6,805	8,561	1,756	3,047	25.8	44.8

NOTE: Bureau of Labor Statistics (BLS) does not make projection for S&E occupations as a group; numbers in table based on sum of BLS projections in those occupations that National Science Foundation considers S&E.

SOURCE: BLS, Office of Occupational Statistics and Employment Projections, National Industry-Occupation Employment Projections 2004–14 (2005).

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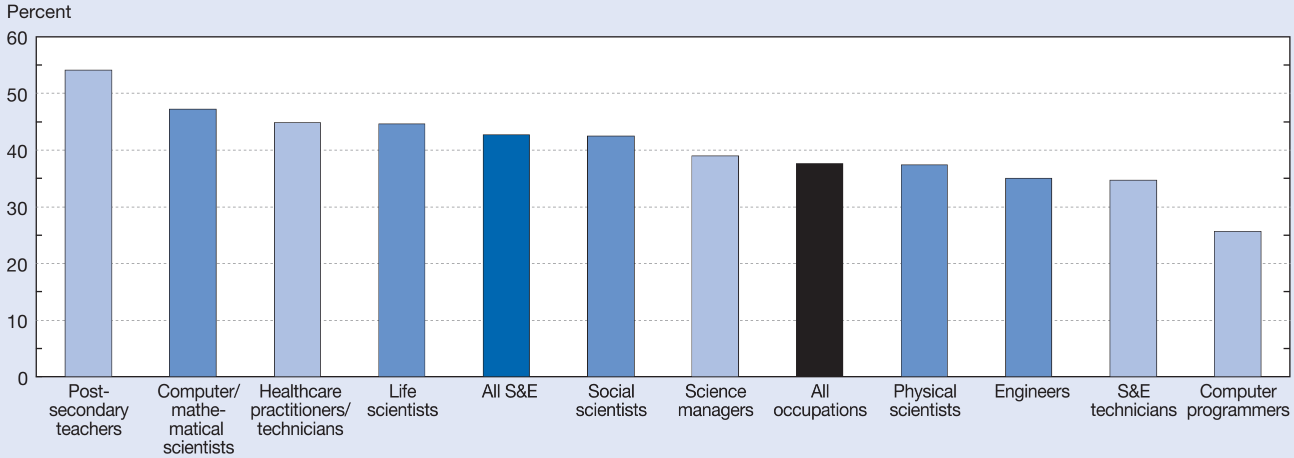
Figure 3-6
Projected job openings as percentage of 2004 employment, for S&E and selected other occupations: 2004–14



SOURCE: Bureau of Labor Statistics, Office of Occupational Statistics and Employment Projections. See appendix table 3-7.

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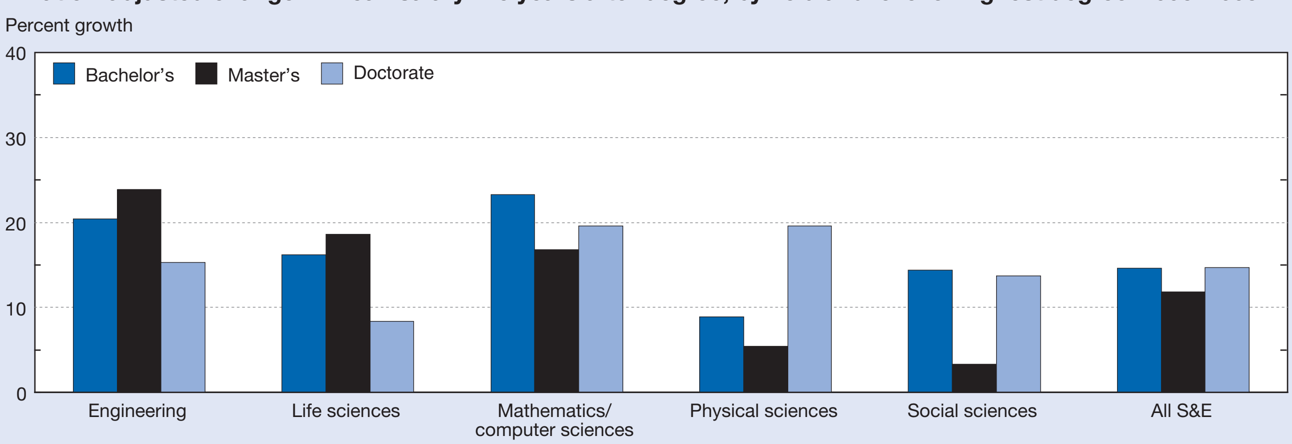
employment, scientists and engineers are still on average younger than the labor force as a whole. Retirement is also the likely reason that S&E job openings are less dominated by computer-related occupations, which have younger age distributions than other S&E areas.

Salary Changes as an Indicator of Labor Market Conditions

Sometimes discussions of S&E labor markets use difficult-to-define words like "surplus" or "shortage" that imply a close matching between particular types of educational credentials or skill sets and particular jobs. As discussed previously in this chapter, individuals with a particular S&E degree may use their training in occupations nominally associated with different S&E fields or in occupations not considered S&E. They may also work in various sectors of employment such as private industry, academia, government, or K–12 education. All of this makes any "simple" comparison between projections of labor supply and market demand impossible.

One indicator of the level of labor market demand, compared with the supply of individuals with those skills, is the changes observed over time in the pay received by individuals with similar sets of skills.[4] The changes between 1993 and 2003 in real (inflation-adjusted) mean salary for recent graduates in S&E fields are shown in figure 3-7 and actual means for 2003 in figure 3-8. On average real mean earnings increased for recent S&E bachelor's degree graduates

Figure 3-7
Inflation-adjusted change in mean salary 1–5 years after degree, by field and level of highest degree: 1993–2003



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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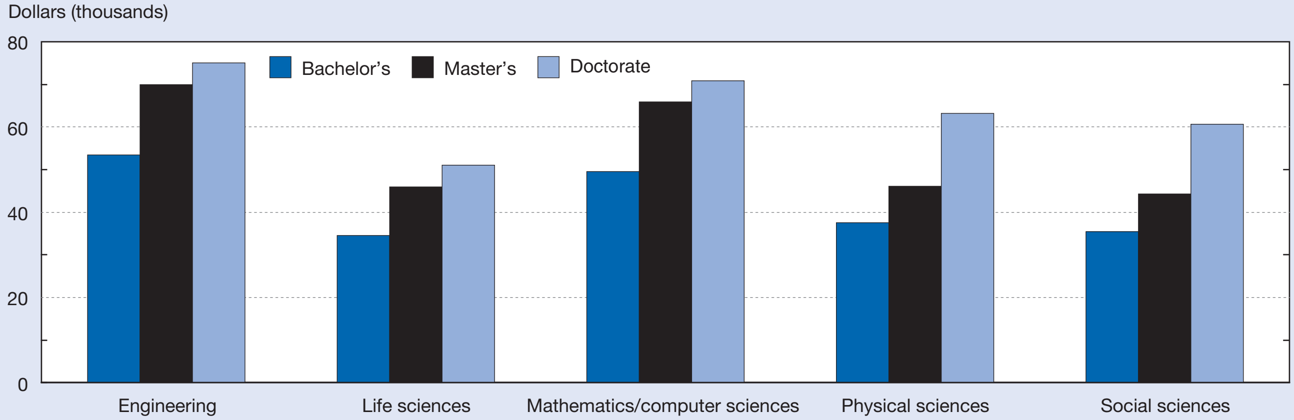
Figure 3-8
Mean salaries of S&E and S&E-related degree recipients 1–5 years after degree, by field and level of highest degree: 2003



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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by 15%, ranging from 9% in the physical science to 23% for those with mathematical and computer science bachelor's degrees. Recent engineering bachelor's recipients showed the second highest real growth in salary of 20%.

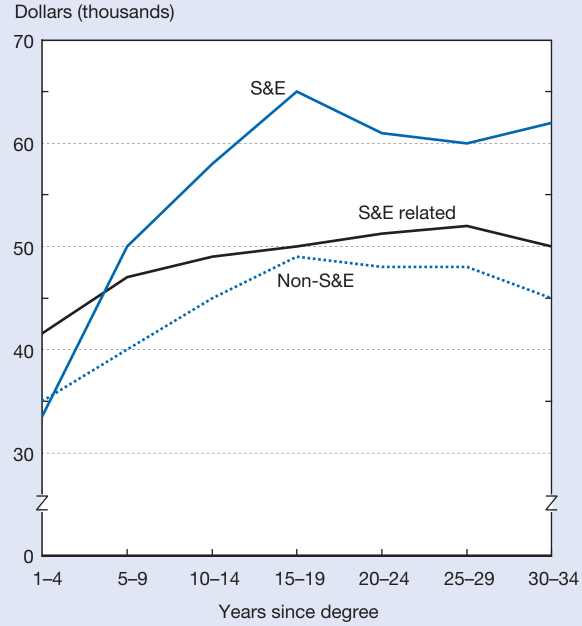
Among recent S&E master's degree recipients, real mean salaries increased 12%, ranging from 3% in the social sciences to 24% in engineering.

Among recent doctoral degree recipients, the increase in median real salary was greatest for those in the physical sciences and mathematical and computer science (each 20%) and smallest was in the life sciences (8%). Evaluation of recent doctoral degree recipient salaries is made more difficult by the earnings differentials between academic and nonacademic employment, as well as the increasing prevalence of lower-paying postdoc positions.

Salaries Over a Person's Working Life

Estimates of median salary at different points in a person's working life are shown in figure 3-9 for individuals with bachelor's degrees in a variety of fields. After the first 4 years, 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 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—much less than for S&E graduates but higher than for non-S&E bachelor's holders at most years since degree.

Figure 3-9
Median salaries for bachelor's degree holders, by years since degree: 2003



NOTE: S&E related defined within National Science Foundation's labor force surveys as including technician and health fields, as well as some smaller fields such as actuarial science.

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

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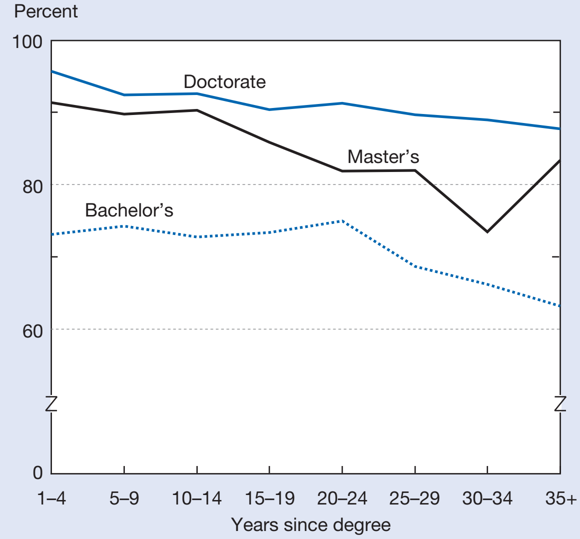
How Are People With an S&E Education Employed?

Although most S&E degree holders do not work in S&E occupations, this does not mean they do not use their S&E training. In 2003, of the 6.0 million individuals whose highest degree was in an S&E field and who did not work in S&E occupations, 66% indicated that they worked in a job either closely or somewhat related to the field of their highest S&E degree (table 3-4).

One to four years after receiving their degrees, 96% of S&E doctoral degree holders say that they have jobs closely or somewhat related to the degrees they received, compared with 91% of master's degree recipients and 73% of bachelor's degree recipients (figure 3-10). This relative ordering of relatedness by level of degree holds across all periods of years since recipients received their degrees. However, at every degree level, the relatedness of job to degree tends to fall with time since receipt of degree, with some exceptions for older workers, who may be more likely to still work when their jobs are related to their education. There are many good reasons for this trend: individuals may change their career interests over time, gain skills in different areas while working, take on general management responsibilities, or forget some of their original college training (or some of their original college training may become obsolete). Given these possibilities, the career-cycle decline in the relevance of an S&E degree is only modest.

Even when a stricter criterion ("closely related") is used for the fit between an individual's job and field of degree, the data indicate that many recent bachelor's degree recipients work in jobs that use skills developed during their college S&E training (figure 3-11). In natural science and engineering fields, about half of individuals from 1 to 4 years after graduation characterized their jobs as closely related to their field of degree. Among the major disciplines in this group, the proportion of bachelor's degree holders reporting a close relationship between their job and their college major was highest in engineering (59%), followed by computer and mathematical sciences (57%), physical sciences (54%), and life sciences (48%). The comparable figure for social science graduates (28%) was substantially lower. According to this stricter definition of relatedness of job and degree, as with relatedness in general, relatedness declines only slowly with years since degree.

Figure 3-10
Individuals with highest degree in S&E employed in jobs closely or somewhat related to highest degree, by years since highest 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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Employment in Non-S&E Occupations

About 6.0 million individuals whose highest degree is in S&E worked in non-S&E occupations in 2003. Of these, two-thirds said that their job was at least somewhat related to their degree (table 3-5). This included 1.6 million in management and management-related occupations, of whom

Table 3-4
Individuals with highest degree in S&E employed in non-S&E occupations, by highest degree and relation of degree to job: 2003
(Percent)

Highest degree	*n* (thousands)	Degree related to job: Closely	Somewhat	Not
All degree levels[a]	6,022	33.3	32.9	33.8
Bachelor's	4,868	29.8	33.6	36.7
Master's	972	48.3	30.0	21.6
Doctorate	165	42.3	36.6	21.2

[a]Includes professional degrees.

NOTES: Non-S&E occupations include Scientists and Engineers Statistical Data System (SESTAT) categories "non-S&E" and "S&E related." Detail may not add to total because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Statistics, SESTAT database, 2003, http://sestat.nsf.gov.

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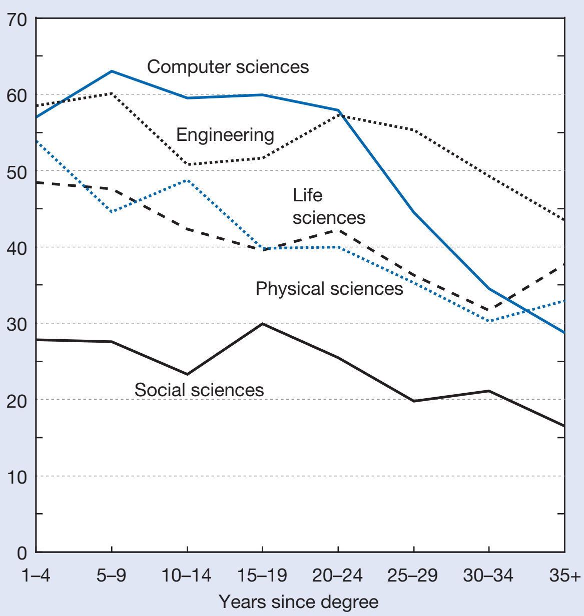
Figure 3-11
S&E bachelor's degree holders employed in jobs closely related to degree, by field and years since degree: 2003



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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33% said their jobs were closely related and 40% said somewhat related to their S&E degrees. In the next largest occupation category for S&E-degreed individuals in non-S&E jobs, sales and marketing, slightly over half (51%) said their S&E degrees were at least somewhat relevant to their jobs. Among K–12 teachers whose highest degree is in S&E, 78% say their job is closely related to their degrees.

Unemployment

A more than two-decades-long view of unemployment trends in S&E occupations, regardless of education level, comes from the CPS data for 1983–2006. Unemployment of college degree holders in S&E occupations fell to 1.6% in 2006, reflecting a recovery from employment difficulties earlier in the decade. This compares to a 4.6% unemployment rate for all workers in 2006 and a 2.2% unemployment rate for other college graduates. Unemployment rates also declined in the S&E-related occupational categories of technicians and computer programmers (not limited by education level) to 3.1% and 2.8%, respectively.

During this 22-year period, the unemployment rate for all individuals in S&E occupations ranged from a low of 1.3% in 1997 and 1998 to a high of 4.0% in 2003. Overall, the S&E occupational unemployment rate was both lower and less volatile than either the rate for all U.S. workers (ranging from 3.9% to 9.9%), for all workers with a bachelor's degree or higher (ranging from 1.8% to 7.8%), or for S&E technicians (ranging from 2.0% to 6.1%). During most of the period, computer programmers had an unemployment rate similar to that of S&E occupations, but greater volatility (ranging from

Table 3-5
Individuals with highest degree in S&E employed in non-S&E occupations, by occupation and relation of degree to job: 2003
(Percent)

		Degree related to job		
Occupation	*n* (thousands)	Closely	Somewhat	Not
All non-S&E	6,022	33.3	32.9	33.8
Sales and marketing	950	16.3	34.9	48.8
Management related	842	26.1	40.1	33.8
Non-S&E managers	545	34.8	43.5	21.7
Health related	402	53.3	30.4	16.3
Social services	340	67.1	24.8	8.1
Technologists and technicians	289	47.4	35.4	17.2
K–12 teachers (other than S&E)	275	54.2	29.3	16.5
S&E K–12 teachers	190	78.4	18.2	3.4
Management of S&E	188	57.1	35.2	7.7
Arts and humanities	163	20.7	36.7	42.6
Non-S&E postsecondary teachers	52	62.9	24.9	12.2
Other S&E related	44	70.0	24.7	5.3
Other non-S&E	1,743	20.7	28.8	50.5

NOTES: Non-S&E occupations includes Scientists and Engineers Statistical Data System (SESTAT) categories "non-S&E" and "S&E related." Detail may not add to total because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Statistics, SESTAT database, 2003, http://sestat.nsf.gov.

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1.2% to 6.7%). The most recent recession (in 2001) appears to have had a strong effect on S&E employment, with the differential between S&E and general unemployment falling to only 1.9 percentage points in 2002, compared with 6.9 percentage points in 1983 (figure 3-12). During 2002 and 2003, unemployment of college graduates in S&E occupations rose above that of other college graduates by 0.8 percentage points in each year. This may have been because of the unusually strong reductions in R&D in the information and related technology sectors (see chapter 4).

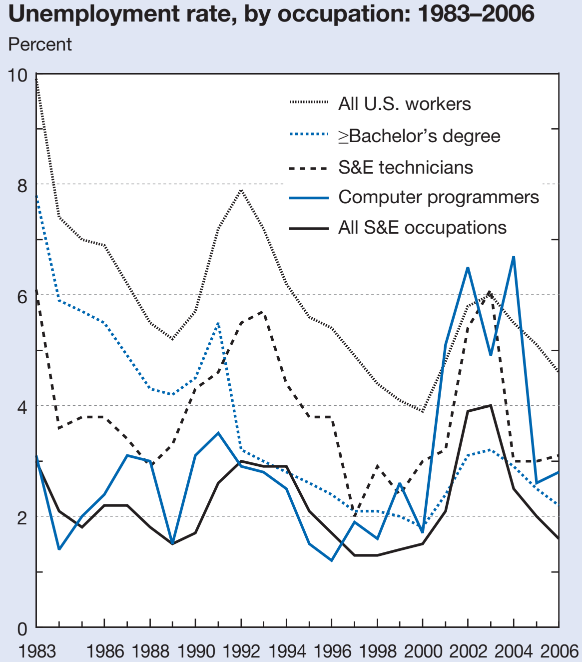
Figure 3-13 compares unemployment rates over career cycles for bachelor's and doctoral degree holders in 1999 and in 2003. Looking at field of degree rather than occupation includes individuals who might have left an S&E occupation for negative economic reasons in addition to the larger portion of the S&E labor force who have other occupational titles. The generally weaker 2003 labor market had its greatest 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. Although labor market conditions had a lesser effect on doctoral degree holders' unemployment rates, some increases in unemployment rates between 1999 and 2003 did occur for those individuals in most years-since-degree groups.

Similarly, labor market conditions from 1999 to 2003 had a greater effect on the proportion of bachelor's degree holders than on doctoral degree holders who said they were working involuntarily out of the field (IOF) of their highest degree (figure 3-14). For doctoral degree holders, IOF rates changed little between 1999 and 2003. IOF rates actually dropped for recent doctoral degree graduates, while increasing slightly for those later in their careers. However, in both 1999 and 2003, the oldest doctoral degree holders actually had the lowest IOF rates, which may partially reflect lower retirement rates for individuals working in their fields. Taken together with the unemployment patterns shown in figure 3-13, this finding implies that more highly educated S&E workers are less vulnerable to changes in economic conditions than individuals who hold only bachelor's degrees.

S&E Employment From Occupational Employment Statistics Survey

Estimates of employment in S&E occupations in the United States from the OES survey of employers reached 5.4 million in May 2006 (table 3-6). This was up 6.3% from May 2004 (a 3.1% average annual rate) and exceeded the 1.7% average annual increase in employment in all occupations.

Figure 3-12
Unemployment rate, by occupation: 1983–2006



SOURCE: National Bureau of Economic Research, Merged Outgoing Rotation Group Files; Bureau of Labor Statistics, Current Population Survey.

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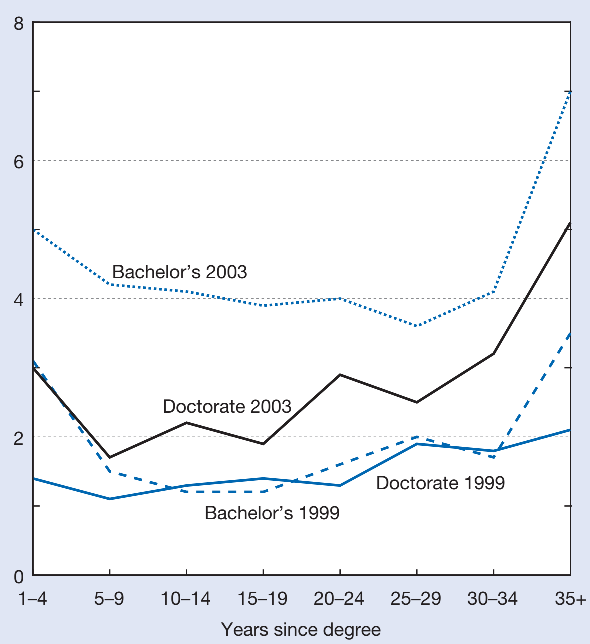
Figure 3-13
Unemployment rates for individuals with highest degree in S&E, by years since highest degree: 1999 and 2003



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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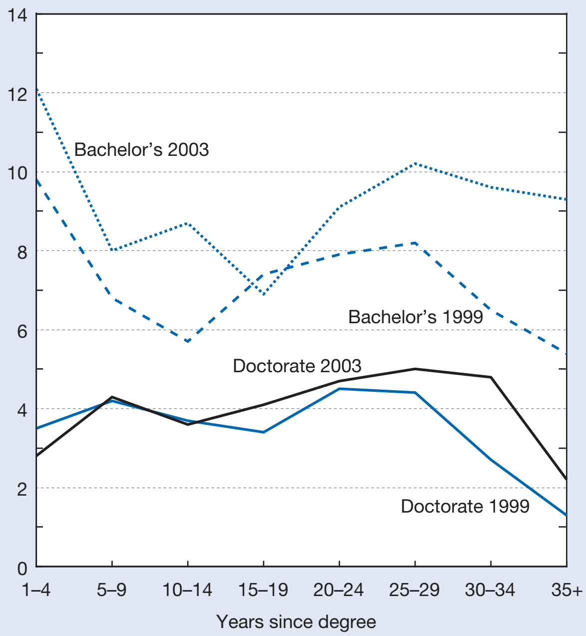
Figure 3-14
Involuntarily out-of-field rates of individuals with highest degree in S&E, by years since highest degree: 1999 and 2003



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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Table 3-6
Employment and employment growth in science and technology and related occupations: May 2004–May 2006

Occupation	2006 occupation total (*n*)	Average annual growth rate (%)
All U.S. employment	132,604,980	1.7
Science and technology occupations	7,441,780	1.9
S&E occupations	5,407,710	3.1
Social scientists	536,880	5.4
Physical scientists	291,380	3.2
Mathematical/computer scientists	2,743,560	3.4
Life scientists	291,980	3.2
Engineers	1,543,900	1.9
Technology occupations	2,034,070	–1.0
Technicians/programmers	1,560,250	–0.7
Technical managers	473,820	–2.1
Other S&E-related occupations (not included above)	7,317,320	2.9
Healthcare practitioner/ technical workers	7,160,310	2.8
Other	157,010	4.4

SOURCE: Bureau of Labor Statistics, Occupational Employment Statistics Survey, May 2004 and May 2006. See appendix tables 3-1 to 3-3.

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Science and Technology Occupations

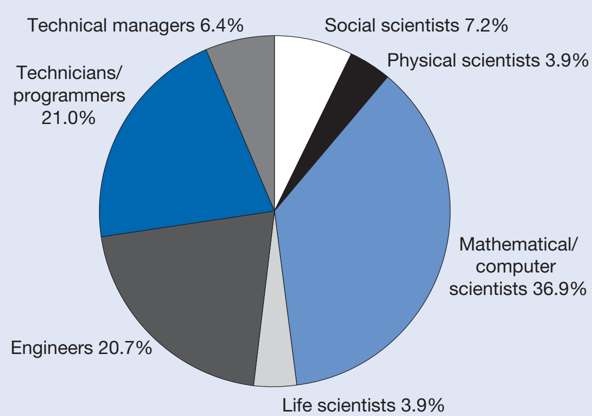
Discussions of the S&E labor force sometimes use broader definitions, referring to the S&T or the STEM labor force. These broader definitions usually include technicians, computer programmers, and technical managers, along with those occupations that NSF considers to be S&E. The broader aggregate may thus be thought of as S&E occupations plus individuals who directly manage S&E activities and the technical workers who support those in S&E occupations. Total employment in this broader set of S&T occupations was 7.4 million in May 2006. The distribution of employment across S&T occupations is shown in figure 3-15. In contrast to S&E occupations, S&T employment grew only slightly faster than the labor market as a whole (1.9% versus 1.7% average annual growth) because of a declining number of technicians and programmers as well as technical managers.

A number of occupations may be considered related to this broader set of S&T occupations. They include health-care occupations and a number of technical occupations such as actuary and architect. Overall, the more than 7 million people in these additional occupations increased by an average annual rate of 2.9%.

Annual Earnings From OES Data

Median annual earnings (regardless of education) in S&E occupations were $67,780, more than double the median ($30,400) for all occupations (table 3-7). The spread in average (mean) earnings was less dramatic but still quite wide, with individuals in S&E occupations earning considerably more on average than workers in all occupations: $71,150 versus $39,190 for all occupations. Average earnings ranged from a mean of $64,570 for social science occupations to $77,910 for engineering occupations. Mean annual earnings for S&E-related

Figure 3-15
Employment distribution across science and technology or STEM occupations: May 2006



STEM = science, technology, engineering, and mathematics

NOTE: As generally used in policy discussions and as used in this chapter, STEM and science and technology have identical meaning.

SOURCE: Bureau of Labor Statistics, Occupational and Employment Statistics Survey, May 2006.

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Table 3-7
Annual earnings and earnings growth in science and technology and related occupations: May 2004–May 2006

Occupation	Mean: 2006 annual earnings ($)	Mean: Average annual growth rate (%)	Median: 2006 annual earnings ($)	Median: Average annual growth rate (%)
All U.S. employment	39,190	2.9	30,400	2.8
Science and technology occupations	68,940	2.9	64,160	2.8
S&E occupations	71,150	3.1	67,780	3.0
Social scientists	64,570	3.2	58,310	3.0
Physical scientists	70,870	3.6	64,520	3.7
Mathematical/computer scientists	68,910	2.9	65,900	3.0
Life scientists	68,760	2.9	60,750	2.6
Engineers	77,910	3.5	74,800	3.3
Technology occupations	64,700	2.9	NA	NA
Technicians/programmers	51,440	2.6	47,350	2.7
Technical managers	108,390	4.3	103,020	4.5
Other S&E-related occupations (not included above)	63,130	3.8	53,050	4.4
Healthcare practitioner/technical workers	62,990	4.1	52,830	4.9
Other	69,450	2.3	62,960	3.0

NA = not available

SOURCE: Bureau of Labor Statistics, Occupational Employment Statistics Survey, May 2004 and May 2006. See appendix tables 3-1 to 3-3.

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technical occupations ranged from $51,440 for technicians and programmers to $108,390 for technical managers.

The growth in mean earnings was slightly greater for all S&E and S&E-related occupation groups than for the total of all occupations included in OES, an average annual rate of 3.1% in S&E occupations, 2.9% in technology occupations, and 3.8% in other S&E-related occupations, compared with 2.9% for all occupations. Technicians and programmers experienced a slower than average 2.6% average annual growth in earnings.

Metropolitan Areas

United States metropolitan areas are ranked in table 3-8 according to the proportion of the entire metropolitan area workforce that is employed in S&E occupations, and in table 3-9 by the total number of workers employed in S&E occupations. The Boulder-Longmont, Colorado, metropolitan area had the highest percentage of its workforce employed in S&E occupations in May 2006, at 14.3%. The New York metropolitan area has the greatest total number of individuals employed in S&E occupations at 309,000, while having a slightly below average 3.8% of workers in S&E occupations. Although the top-20 list for proportion of S&E employment consists mainly of smaller and perhaps less economically diverse metropolitan areas, Washington, DC, Seattle, Boston, San Francisco, and San Jose appear in both top-20 lists.

S&E Occupation Density by Industry

Individuals in S&E occupations are not just employed by “high-technology” employers. S&E knowledge is necessary in a variety of different industries, and as shown in table 3-10, workers with such knowledge are found in industries with very different percentages of S&E occupations as a portion of total employment. More than 1 million in S&E occupations are employed in industries with less than the average 4% of S&E occupations. These industries, with a below average density of S&E occupations, employ 75% of all workers and 19% of all workers in S&E occupations. Industries with a low density of S&E occupations include a wide variety of activities, such as local government (2.9% with 158,000 in S&E occupations), hospitals (1.3% with 63,000 in S&E occupations), and plastic parts manufacturing (2.4% with 15,000 in S&E occupations).

In general, industries with higher proportions of individuals in S&E occupations pay higher average salaries to both S&E and non-S&E workers. The average salary of workers in non-S&E occupations who are in industries with more than 40% S&E occupations is nearly double the average salary of workers in non-S&E occupations in industries with below average density of S&E occupations ($68,600 versus $34,600).

Employment Sectors

Industry is the largest provider of employment for individuals with S&E degrees (figure 3-16), employing 59% of all individuals whose highest degree is in S&E, including 33% of S&E doctoral degree holders. Four-year colleges and universities are an important but not majority employer for S&E doctoral degree holders (44%). This 44% includes a variety of employment types other than the tenured and tenure-track employment that is still sometimes referred to as the “traditional” doctoral career path, including many younger doctorate holders in postdoc positions and other temporary employment situations, as well as individuals with a variety of research and administrative functions.

Table 3-8
Top-ranked metropolitan areas for employment in S&E occupations, by S&E percentage of total employment: 2006

Rank	Metropolitan area	Workforce (%)	S&E employees (*n*)
na	United States	4.1	5,407,710
1	Boulder, CO	14.3	22,520
2	San Jose-Sunnyvale-Santa Clara, CA	14.1	126,090
3	Huntsville, AL	12.2	24,030
4	Durham, NC	10.7	27,770
5	Corvallis, OR	10.7	4,150
6	Washington-Arlington-Alexandria, DC-VA-MD-WV	10.5	297,670
7	Kennewick-Richland-Pasco, WA	9.3	7,880
8	Ames, IA	8.4	3,440
9	Palm Bay-Melbourne-Titusville, FL	7.9	16,490
10	Olympia, WA	7.9	7,440
11	Austin-Round Rock, TX	7.9	56,100
12	Seattle-Tacoma-Bellevue, WA	7.8	127,070
13	Ann Arbor, MI	7.6	14,950
14	Boston-Cambridge-Quincy, MA-NH	7.4	180,110
15	Portsmouth, NH-ME	7.3	4,140
16	Colorado Springs, CO	7.0	17,610
17	Fort Walton Beach-Crestview-Destin, FL	6.9	5,970
18	Madison, WI	6.9	22,640
19	Raleigh-Cary, NC	6.9	32,920
20	San Francisco-Oakland-Fremont, CA	6.9	137,150

na = not applicable

SOURCE: Bureau of Labor Statistics, Occupational Employment Statistics Survey, May 2006. See appendix table 3-6.

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Industry also dominates employment in S&E occupations in the BLS's OES survey (figure 3-17). Government and educational services sectors each had less than 11% of total employment in S&E occupations in 2006. The largest sector of employment for S&E occupations was "professional, scientific, and technical services" with 28%, followed by manufacturing with 17%.

Employer Size

Small firms are important employers of scientists and engineers, particularly at the doctoral degree level. 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 3-18. Across all degree levels, 37% of S&E degree holders are employed in companies with fewer than 100 employees. In general, there is a similar pattern of employment across employer size by degree levels, but

Table 3-9
Top-ranked metropolitan areas for employment in S&E occupations, by total number of individuals employed in S&E occupations: 2006

Rank	Metropolitan area	S&E employees (*n*)	Workforce (%)
na	United States	5,407,710	4.1
1	New York-Northern New Jersey-Long Island, NY-NJ-PA	308,860	3.8
2	Washington-Arlington-Alexandria, DC-VA-MD-WV	297,670	10.5
3	Los Angeles-Long Beach-Santa Ana, CA	231,900	4.1
4	Boston-Cambridge-Quincy, MA-NH	180,110	7.4
5	Chicago-Naperville-Joilet, IL-IN-WI	179,560	4.1
6	Dallas-Fort Worth-Arlington, TX	140,140	5.0
7	San Francisco-Oakland-Fremont, CA	137,150	6.9
8	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	134,980	4.9
9	Detroit-Warren-Livonia, MI	128,430	6.4
10	Seattle-Tacoma-Bellevue, WA	127,070	7.8
11	San Jose-Sunnyvale-Santa Clara, CA	126,090	14.1
12	Houston-Sugar Land-Baytown, TX	117,310	4.9
13	Atlanta-Sandy Springs-Marietta, GA	100,560	4.3
14	Minneapolis-St. Paul-Bloomington, MN-WI	100,540	5.7
15	San Diego-Carlsbad-San Marcos, CA	76,830	5.9
16	Denver-Aurora, CO	75,690	6.3
17	Phoenix-Mesa-Scottsdale, AZ	70,070	3.8
18	Baltimore-Towson, MD	67,930	5.3
19	Miami-Fort Lauderdale-Miami Beach, FL	65,940	2.8
20	St. Louis, MO-IL	56,520	4.3

na = not applicable

NOTE: Values for New York-Northern New Jersey-Long Island, NY-NJ-PA are for 2005.

SOURCE: Bureau of Labor Statistics, Occupational Employment Statistics Survey, May 2006. See appendix table 3-6.

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Table 3-10
Employment distribution and average earnings of 4-digit NAICS industry classifications, by proportion of employment in S&E occupations: 2006

			Average worker salary ($)	
Workers in S&E occupations (%)	All occupations	All S&E occupations	Non-S&E occupations	S&E occupations
>40	2,080,670	973,160	68,600	77,100
20-40	3,483,360	984,060	52,800	78,000
10–20	10,491,600	1,504,350	53,900	72,000
4–10	13,045,120	835,750	46,000	65,900
<4	99,710,090	1,049,190	34,600	61,600

NAICS = North American Industry Classification System

NOTES: NAICS has a 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. For data by individual 4-digit NAICS industries, see appendix tables 3-4 and 3-5.

SOURCE: Bureau of Labor Statistics, Occupational Employment Statistics Survey, May 2006.

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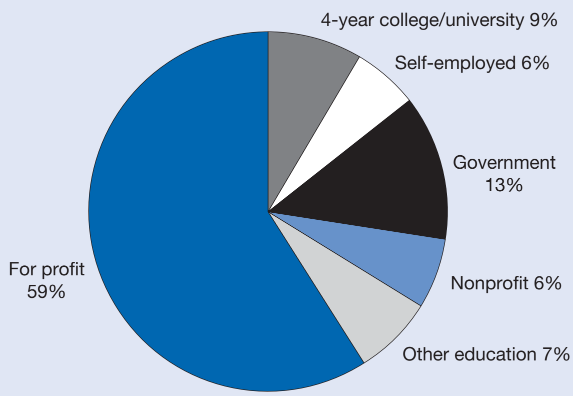
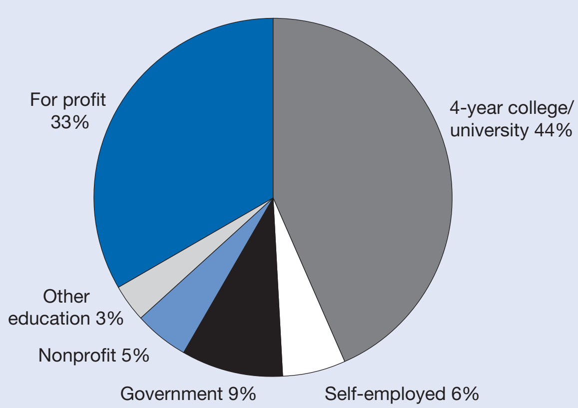
Figure 3-16
Employment sector for individuals with highest degree in S&E: 2003



All S&E



S&E doctorate

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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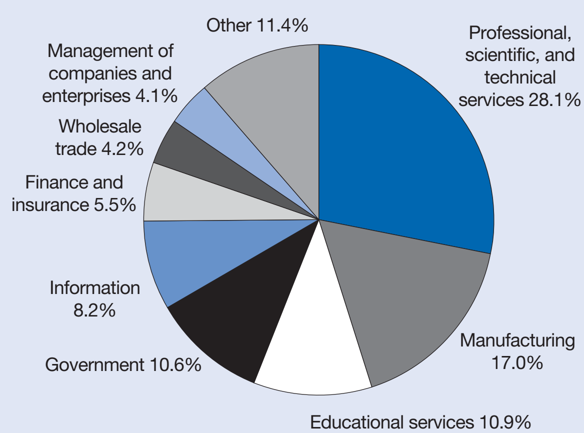
Figure 3-17
Largest sectors of employment for individuals in S&E occupations, by NAICS sectors: May 2006



NAICS = North American Industry Classification System

SOURCE: Bureau of Labor Statistics, Occupational Employment Statistics Survey, May 2006.

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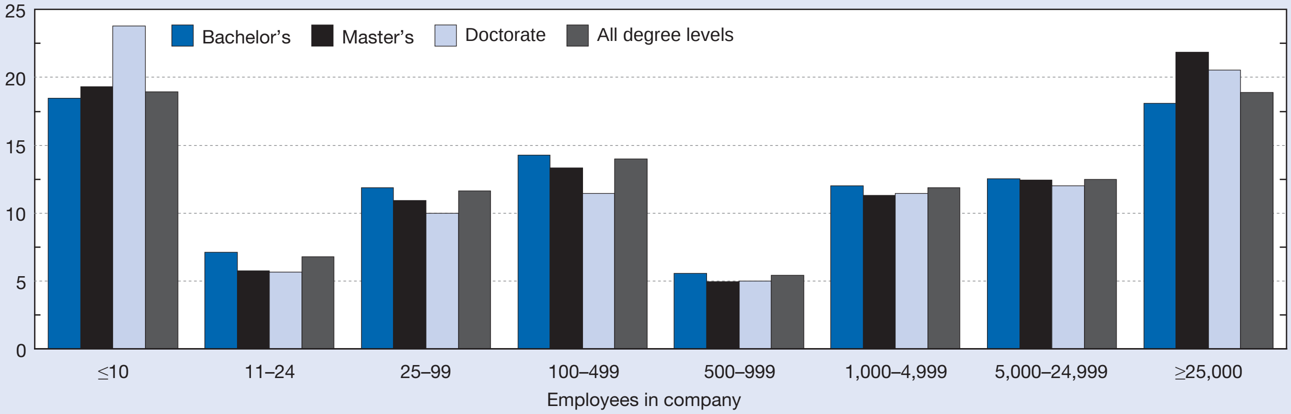
Figure 3-18
Individuals with highest degree in S&E employed in private business, by employer size: 2003



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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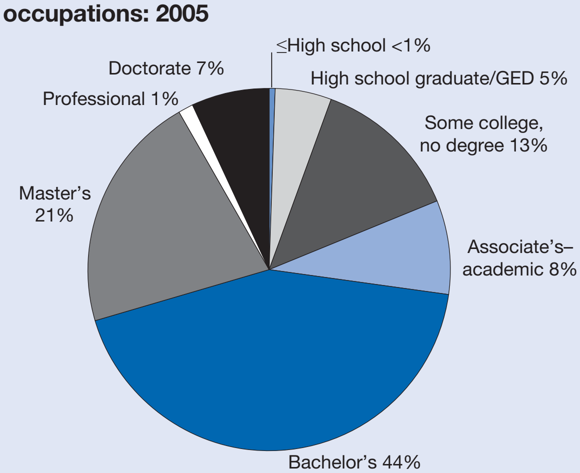
S&E doctorate holders are somewhat more concentrated at very small and very large firms. Conversely, although 18% of S&E bachelor's degree holders in business and industry are employed in firms with fewer than 10 employees, this figure is 19% at the master's degree and 24% at the doctoral degree level.

Educational Distribution of S&E Workers

Discussions of the S&E workforce often focus on individuals who hold doctoral degrees. However, American Community Survey data on the educational achievement of individuals working in S&E occupations outside academia in 2005 indicate that only 7% had doctorates (figure 3-19). In 2005, about two-thirds of individuals working in nonacademic S&E occupations had bachelor's degrees (44%) or master's degrees (21%).[5] Slightly more than one-quarter of individuals working in S&E occupations had not earned a bachelor's degree.

Although technical issues of occupational classification may inflate the estimate of the size of the nonbaccalaureate S&E workforce, it is also true that many individuals who have not earned a bachelor's degree enter the labor force with marketable technical skills from technical or vocational school training (with or without earned associate's degrees), college courses, and on-the-job training. In information technology (IT), and to some extent in other occupations, employers frequently use certification exams, not formal degrees, to judge skills. (See sidebar "Who Performs R&D?" and discussion in chapter 2.)

Figure 3-19
Educational distribution, by nonacademic S&E occupations: 2005



GED = General Equivalency Diploma

SOURCE: Census Bureau, American Community Survey, 2005.

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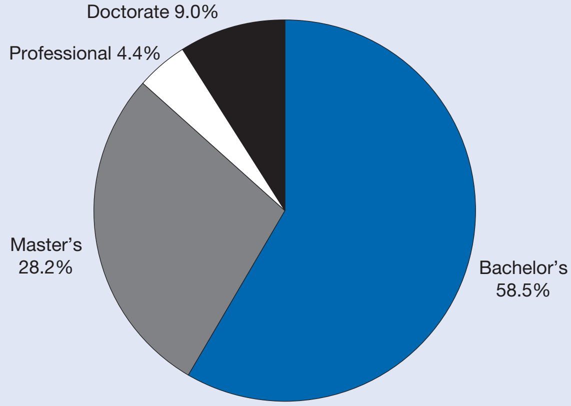
Who Performs R&D?

Although individuals with S&E degrees use their acquired knowledge in various ways (e.g., teaching, writing, evaluating, and testing), R&D is of particular importance to both the economy and the advancement of knowledge. Figure 3-20 shows the distribution of individuals with S&E degrees who report R&D as a major work activity (defined as the activity involving the greatest, or second greatest, number of work hours from a list of 22 possible work activities), by level of degree. Individuals with doctoral degrees constitute only 6% of all individuals with S&E degrees but represent 9% 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 (59%). An additional 28% have master's degrees and 4% have professional degrees, mostly in medicine. Figure 3-21 shows the distribution of individuals with S&E degrees who reported R&D as a major work activity, by field of highest degree. Individuals with engineering degrees constitute more than one-third (36%) of the total.

Individuals who are in non-S&E occupations do much R&D. Table 3-11 shows the occupational distribution of S&E degree holders who report R&D as a major work activity, as well as those reporting that at least 10% of their time involves R&D. Forty percent of those for whom R&D is a major work activity are in non-S&E occupations (and two-thirds of these are also outside of the occupations that NSF classifies as "S&E related"). Among those S&E degree holders whose jobs involve at least 10% R&D, 55% are in non-S&E occupations.

Figure 3-22 shows the percentages of S&E doctoral degree 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, with the lowest R&D rates in social sciences. Although the percentage of doctoral degree holders engaged in R&D activities declines as time since receipt of degree increases, it remains greater than 50% in all fields except social sciences for all years since receipt of degree. The decline may reflect movement into management or other career interests. It may also reflect, even within nonmanagement positions, increased opportunity and the ability of more experienced scientists to perform functions involving the interpretation and use of, as opposed to the creation of, scientific knowledge.

Figure 3-20
Distribution of S&E degree holders with R&D as major work activity, by level of education: 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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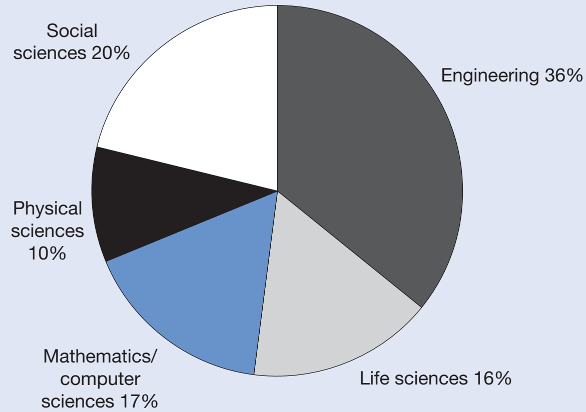
Figure 3-21
Distribution of S&E degree holders with R&D as major work activity, by field of highest degree: 2003



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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Table 3-11
Occupations of S&E degree holders with R&D work activities: 2003
(Percent)

Occupation	R&D as major work activity	R&D at least 10% of work time
S&E occupations	60.5	45.0
Engineering occupations	24.4	17.7
Life sciences	7.9	5.1
Mathematics/computer science occupations	18.1	14.8
Physical science occupations	5.5	3.7
Social science occupations	4.8	3.8
Non-S&E occupations	39.5	55.0
S&E-related occupations	13.2	15.1
Other non-S&E occupations	26.3	39.9

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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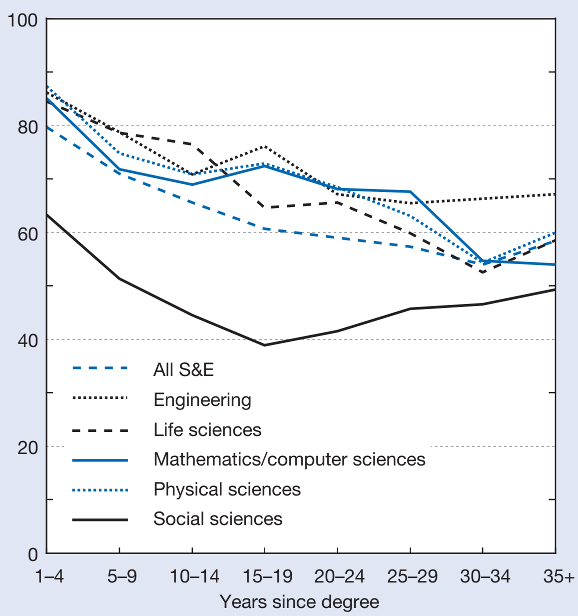
Figure 3-22
S&E doctorate holders with R&D as major work activity, by field and years since degree: 2003



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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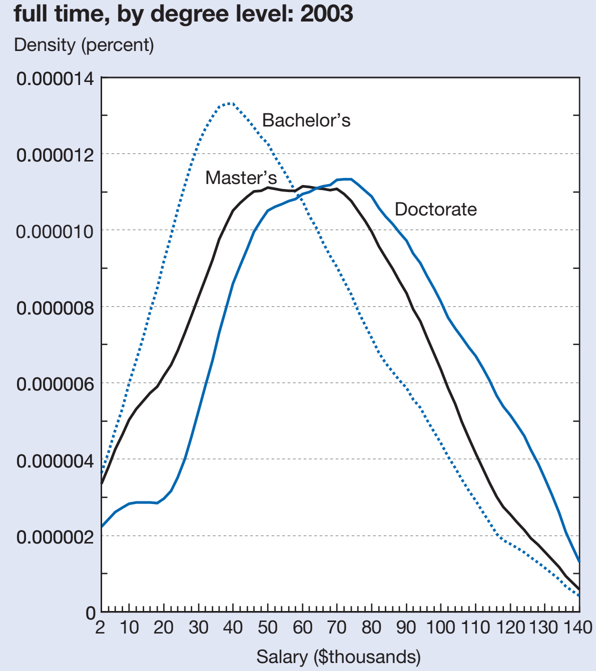
Salaries

Figure 3-23 illustrates the distribution of salaries earned by individuals with S&E degrees. Education produces far more dramatic effects on the "tails" of the distribution (the proportion with either very high or very low earnings) than on median earnings. In 2003, 11% of S&E bachelor's degree holders had salaries higher than $100,000, compared with 28% of doctoral degree holders. Similarly, 22% of bachelor's degree holders earned less than $30,000, compared with 8% of doctoral degree holders. The latter figure reflects the inclusion of postdoc appointees. (The Survey of Doctorate Recipients defines postdoc appointments as a temporary position awarded in academia, industry, or government for the primary purpose of receiving additional research training.)

A cross-sectional profile of median 2003 salaries for S&E degree holders over the course of their career is shown in figure 3-24. As is usual in such profiles, median earnings generally increase with time since degree, as workers add on-the-job knowledge to the formal training they received in school. Also usual is to find averages of earnings begin to decline in mid-to-late career, as is shown here for holders of bachelor's and master's degrees in S&E, which is a common pattern often attributed to "skill depreciation." In contrast, the profile of S&E doctoral degree holders' earnings continues to rise even late in their careers. Median salaries peak at $65,000 for bachelor's holders, $73,000 for master's degree holders, and at $96,000 for doctoral degree holders.

Figure 3-23
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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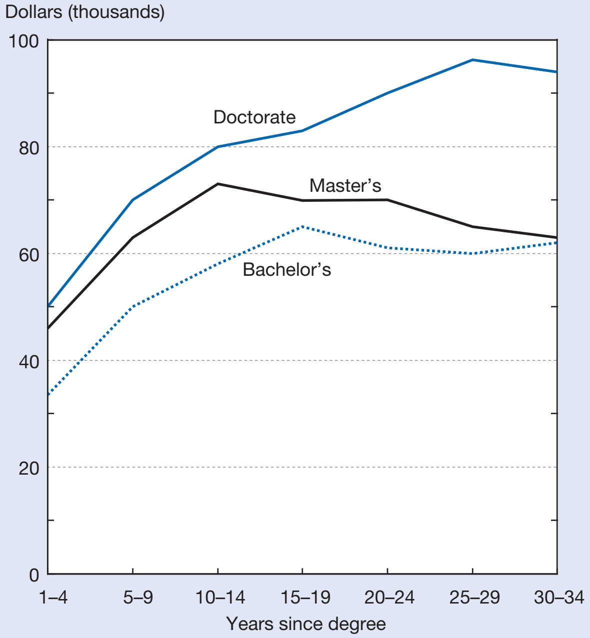
Figure 3-24
Median salaries of S&E graduates, by degree level and years since degree: 2003



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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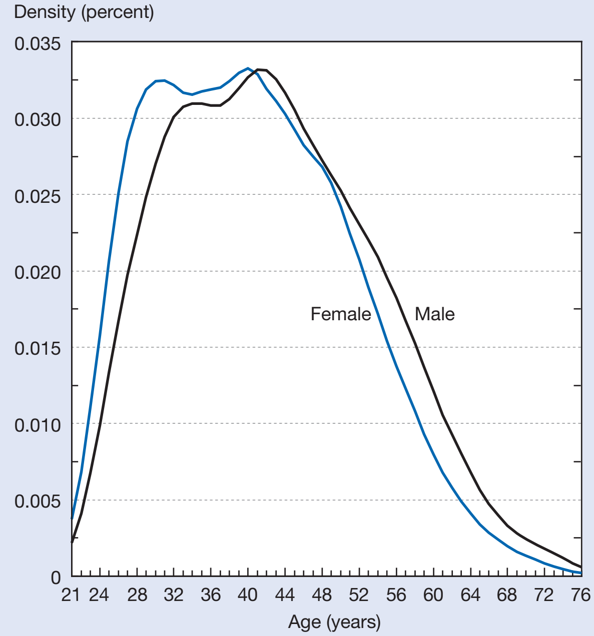
Figure 3-25
Age distribution of individuals in S&E occupations, by sex: 2003



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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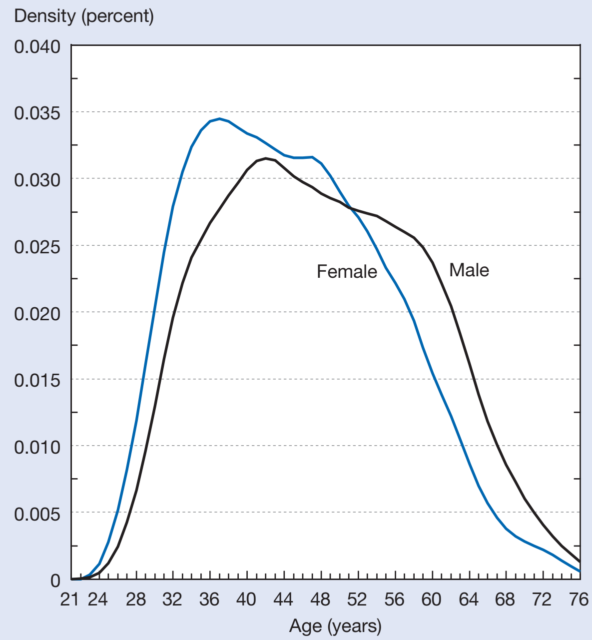
Figure 3-26
Age distribution of doctorate holders in S&E occupations, by sex: 2003



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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Women and Minorities in S&E

Demographic factors for women and minorities (such as age and years in the workforce, field of S&E employment, and highest degree level achieved) influence employment patterns. Demographically, men differ from women, and minorities differ from nonminorities; thus, their employment patterns also are likely to differ. For example, because larger numbers of women and minorities entered S&E fields only recently, women and minority men generally are younger than non-Hispanic white males and have fewer years of experience. Age and stage in career in turn influence such employment-related factors as salary, position, tenure, and work activity. In addition, employment patterns vary by field (see sidebar "Growth of Representation of Women and Ethnic Minorities in S&E Occupations"), and these differences influence S&E employment, unemployment, salaries, and work activities. Highest degree earned, yet another important influence, particularly affects primary work activity and salary.

Representation of Women in S&E

Women constituted more than one-fourth (26%) of the college-educated workforce in S&E occupations (and more than one-third, 37%, of those with S&E degrees) but close to half (47%) of the total U.S. college-educated labor force in 2005.

Age Distribution and Experience. Differences in age and related time spent in the workforce account for many of the differences in employment characteristics between men and women. On average, women in the S&E workforce are younger than men (figures 3-25 and 3-26): 46% of women and 31% of men employed as scientists and engineers in 2003 received their degrees within the past 10 years. The difference is even more profound at the doctoral level, which has a much greater concentration of female doctoral degree holders in their late 30s. One consequence of this age distribution is that a much larger proportion of male scientists and engineers at all degree levels, but particularly at the doctoral level, will reach traditional retirement age during the next decade. This alone will have a significant effect on sex

Growth of Representation of Women and Ethnic Minorities in S&E Occupations

A view of changes in the gender and ethnic composition of the S&E workforce can be achieved by examining data on college-educated individuals in nonacademic S&E occupations from the 1980–2000 censuses and the 2005 American Community Survey* (figures 3-27 and 3-28).

In 2005, the percentage of historically underrepresented groups in S&E occupations remained lower than the percentage of those groups in the total college-educated workforce:

- Women made up 25.8% of college-degreed individuals in S&E occupations and 47.2% of the college-degreed workforce. Among doctorate holders working in S&E occupations in 2005, women were 30.6% of the total, while representing 34.1% of doctorate holders in the labor force.
- Blacks made up 5.1% of the S&E workforce and 7.5% of the college-degreed workforce.
- Hispanics made up 5.2% of the S&E workforce and 5.8% of the college-degreed workforce.
- Among doctorate holders working in S&E occupations in 2005, all underrepresented ethnic groups combined† (blacks, Hispanics, and American Indians/Alaska Natives) were 6.1%, while representing 9.1% of doctorate holders in the labor force.

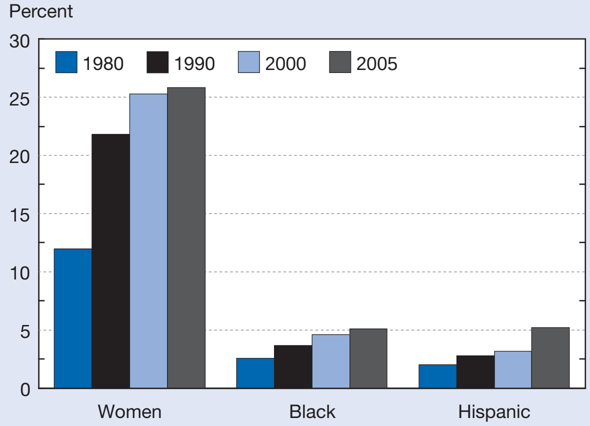
However, since 1980, the share of S&E occupations has almost doubled for blacks (2.6% to 5.1%) and more than doubled for women (12.0% to 25.8%) and Hispanics (2.0% to 5.2%). Among doctorate holders (measured only since 1990), women increased in representation from 22.8% to 30.6%; and blacks, Hispanics, and American Indians/Alaska Natives increased from 4.4% to 6.1%.

---

*The Census Bureau no longer reports postsecondary teaching occupations by field of instruction, so it is not possible to identify S&E professors from the decennial Public Use Microdata Sample, the American Community Survey, or the Current Population Survey. Postsecondary teachers of S&E subjects are identified in NSF's own labor force surveys.

†Different ethnic groups were combined to maintain sufficient sample size for this estimate.

Figure 3-27
College-educated women and ethnic minorities in nonacademic S&E occupations: 1980, 1990, 2000, and 2005



SOURCE: National Science Foundation, Division of Science Resources Statistics, Decennial Census Public Use Microdata Sample (PUMS), 1980–2000; and Census Bureau, American Community Survey, 2005.

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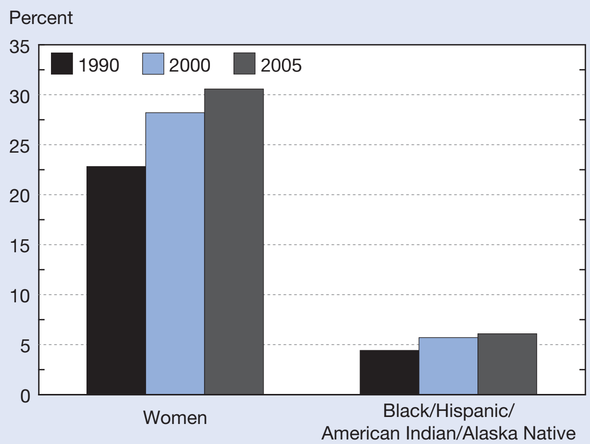
Figure 3-28
Women and ethnic minority doctorate holders in nonacademic S&E occupations: 1990, 2000, and 2005



SOURCE: National Science Foundation, Division of Science Resources Statistics, Decennial Census Public Use Microdata Sample (PUMS), 1990–2000; and Census Bureau, American Community Survey, 2005.

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ratios, and also perhaps on the numbers of female scientists in senior-level positions as the many female doctoral degree holders in their late 30s move into their 40s.

S&E Occupation. Representation of men and women also differs according to field of occupation. For example, in 2003, women constituted 52% of social scientists, compared with 29% of physical scientists and 11% of engineers (figure 3-29). Since 1993, the percentage of women in most S&E occupations in NSF's labor force surveys has gradually increased from 23% to 27% across all S&E occupations. However, in mathematics and computer sciences, the percentage of women declined about 2 percentage points between 1993 and 2003.

Labor Force Participation, Employment, and Unemployment. Unemployment rates were somewhat higher for women in S&E occupations than for men in 2003: 3.7% of men and 4.2% of women were unemployed. By comparison, the unemployment rate in 1993 was 2.7% for men and 2.1% for women (table 3-12).

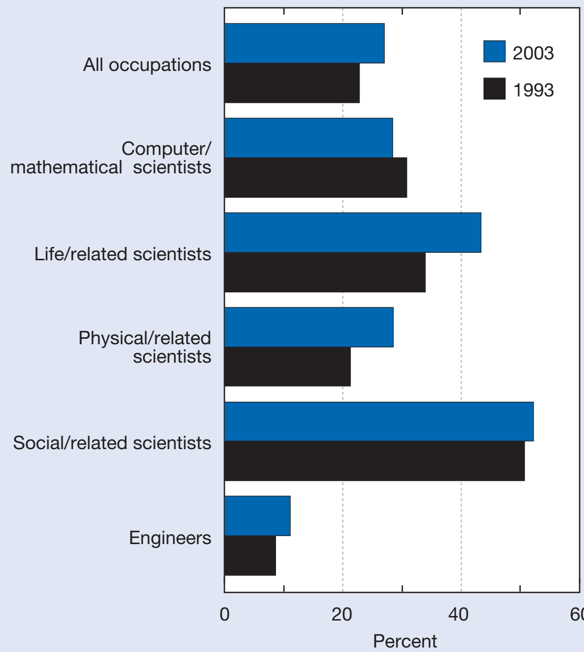
Representation of Racial and Ethnic Minorities in S&E

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

Although Asians/Pacific Islanders constitute only 5% of the U.S. population, they accounted for 7% of college graduates and 14% of those employed in S&E occupations in 2003. Although 82% of Asians/Pacific Islanders in S&E occupations were foreign born, native-born Asians/Pacific Islanders are more highly represented in S&E than in the workforce as a whole.

Age Distribution. As in the case of women, underrepresented racial and ethnic minorities are much younger than non-Hispanic whites in the same S&E occupations (figure 3-30), and this is even truer for doctoral degree holders in S&E occupations (figure 3-31). In the near future, a much greater proportion of non-Hispanic white doctoral degree holders in S&E occupations will be reaching traditional retirement ages compared with underrepresented racial and ethnic minority doctoral degree holders. Indeed, unlike the distribution of ages of male and female doctoral degree holders, the slope of the right-hand side of the age distribution is far steeper for non-Hispanic whites. This implies a more rapid increase in the numbers retiring or otherwise leaving S&E employment. It should also be noted that Asian/Pacific Islander doctoral degree holders in S&E occupations (measured by race and not by place of birth) are on average the youngest racial/ethnic group.

Figure 3-29
Women as proportion of S&E workforce, by broad field of occupation: 1993 and 2003



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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Table 3-12
Unemployment rate for individuals in S&E occupations, by sex, race/ethnicity, and visa status: 1993 and 2003
(Percent)

Characteristic	1993	2003
All with S&E occupations	2.6	3.9
Male	2.7	3.7
Female	2.1	4.2
White	2.4	3.4
Asian/Pacific Islander	4.0	6.0
Black	2.8	5.3
Hispanic	3.5	2.7
Temporary residents	4.8	2.1

NOTE: 2003 data includes 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 and 2003, http://sestat.nsf.gov.

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S&E Occupation. Asian/Pacific Islander, black, and American Indian/Alaska Native scientists and engineers tend to work in different fields than their white and Hispanic counterparts. Fewer Asians/Pacific Islanders work in social sciences than in other fields. In 2003, they constituted 4% of social scientists but more than 11% of engineers and more than 13% of individuals working in mathematics and computer sciences. More black scientists and engineers work in social sciences and in computer sciences and mathematics than in other fields. In 2003, blacks constituted approximately 5% of social scientists, 4% of computer scientists and mathematicians, 3% of physical scientists and engineers, and 2% of life scientists. Other ethnic groups (which include American Indians/Alaska Natives) work predominantly in social and life sciences, accounting for 0.4% of social and life scientists and 0.3% or less of scientists in other fields in 2003. Hispanics appear to have a more even representation across all fields, constituting approximately 2.5%–4.5% of scientists and engineers in each field.

Salary Differentials

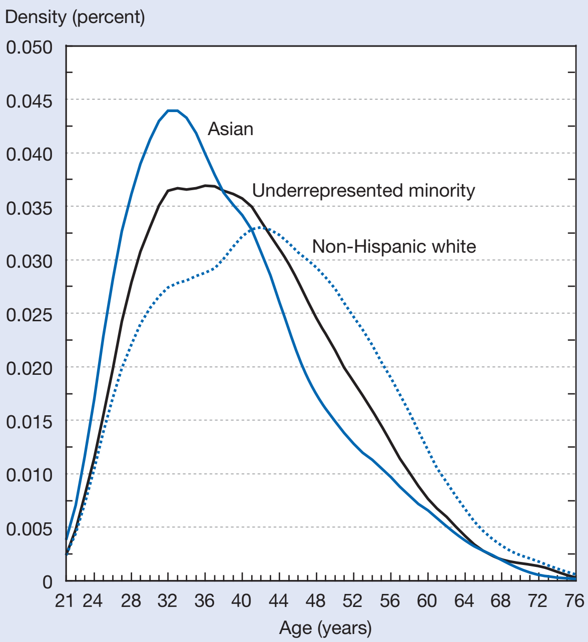
Trends in Median Salaries. In 2003, female scientists and engineers earned a median annual salary of $53,000, about 25% less than the median annual salary of $70,000 earned by male scientists and engineers (table 3-13). Several factors may contribute to these salary differentials. Women more often work in educational institutions, in social science occupations, and in nonmanagerial positions; they also tend to have fewer years of experience.

Between 1993 and 2003, median annual salaries for women in S&E occupations increased by 33%, compared with an increase of 40% for male median salaries (table 3-13). This may be because relatively more women than men have recently entered these occupations.

Salaries for individuals in S&E occupations also vary among the different racial and ethnic groups. In 2003 whites and Asians/Pacific Islanders in S&E occupations earned similar median annual salaries of $67,000 and $70,000, respectively, compared with $60,000 for Hispanics and $58,000 for blacks (table 3-13). Some limited sign of convergence appears in data from 1993 to 2003, with the median salary for blacks in S&E occupations rising 45% versus 40% for whites, but the absolute salary differential actually rose.

Analysis of Salary Differentials. It is often difficult to use gross differences in the salaries of women and ethnic minorities in S&E as indicators of the progress of individuals in those groups in S&E employment. Differences in average age, work experience, fields of degree, and other characteristics can make direct comparison of salary and earnings statistics

Figure 3-30
Age distribution of individuals in S&E occupations, by race/ethnicity: 2003



NOTES: Age distribution smoothed with kernel density techniques. Underrepresented minority includes blacks, Hispanics, and American Indians/Alaska Natives.

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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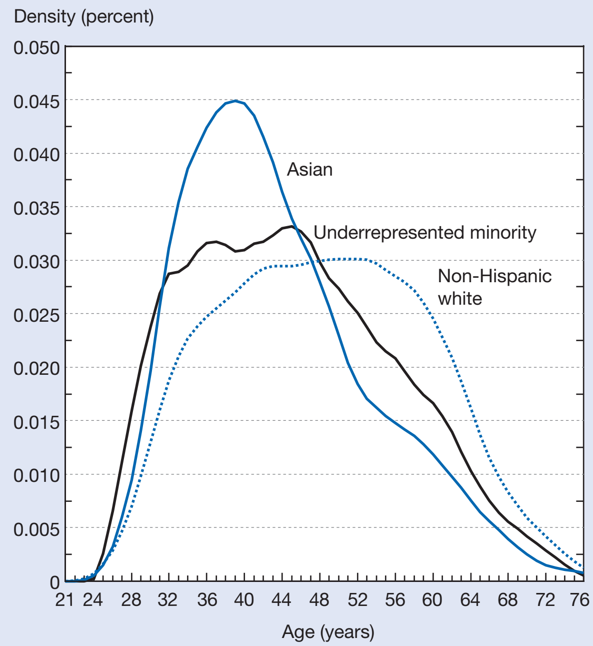
Figure 3-31
Age distribution of S&E doctorate holders in S&E occupations, by race/ethnicity: 2003



NOTES: Age distribution smoothed with kernel density techniques. Underrepresented minority includes blacks, Hispanics, and American Indians/Alaska Natives.

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 3-13
Median annual salary of individuals in S&E occupations, by sex, race/ethnicity, and visa status: Selected years, 1993–2003
(Dollars)

Characteristic	1993	1995	1997	1999	2003
S&E employed	48,000	50,000	55,000	60,000	66,000
Male	50,000	52,000	58,000	64,000	70,000
Female	40,000	42,000	47,000	50,000	53,000
White	48,000	50,500	55,000	61,000	67,000
Asian/Pacific Islander	48,000	50,000	55,000	62,000	70,000
Black	40,000	45,000	48,000	53,000	58,000
Hispanic	43,000	47,000	50,000	55,000	60,000
Temporary residents	43,300	49,700	49,000	52,000	60,000

NOTE: 2003 data includes 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, http://sestat.nsf.gov.

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misleading. Generally, engineers earn a higher salary than social scientists, and newer employees earn less than those with more experience. One common statistical method that can be used to look simultaneously at salary and other differences is regression analysis.[6] Table 3-14 shows estimates of salary differences for different groups after controlling for several individual characteristics. Although this type of analysis can provide insight, it cannot give definitive answers to questions about the openness of S&E to women and minorities for many reasons. The most basic reason is that no labor force survey ever captures information on all individual skill sets, personal background and attributes, or other characteristics that may affect compensation.

Differences in mean annual salary are substantial when comparing all individuals with S&E degrees only by level of degree, with no other statistical controls: in 2003, women with S&E bachelor's degrees had full-time mean salaries that were 34.2% less than those of men with S&E bachelor's degrees. Blacks, Hispanics, and individuals in other underrepresented ethnic groups with S&E bachelor's degrees had full-time salaries that were 18.8% less than those of non-Hispanic whites and Asians/Pacific Islanders with S&E bachelor's degrees.[7]

Table 3-14
Estimated salary differentials of individuals with S&E degrees, by individual characteristics: 2003
(Percent)

Variable	Bachelor's	Master's	Doctorate
Female vs. male	–34.2	–31.7	–18.5
Controlling for age and years since degree	–33.2	–30.6	–11.1
Plus field of degree	–25.4	–24.9	–7.9
Plus occupation and employer characteristics	–20.1	–17.3	–6.1
Plus family and personal characteristics	–18.2	–15.2	–5.0
Plus sex–specific marriage and child effects	–7.8	–5.8	NS
Black, Hispanic, and other vs. white and Asian/Pacific Islander	–18.8	–14.2	–13.2
Controlling for age and years since degree	–17.9	–12.1	–6.6
Plus field of degree	–13.6	–8.9	–5.2
Plus occupation and employer characteristics	–10.7	–5.9	–1.9
Plus family and personal characteristics	–7.6	–3.4	–1.4
Foreign born with U.S. degree vs. native born	–2.7	10.0	–1.8
Controlling for age and years since degree	NS	9.6	2.7
Plus field of degree	–6.3	NS	NS
Plus occupation and employer characteristics	–9.7	–5.8	–3.8
Plus family and personal characteristics	–6.8	NS	NS

NS = not significantly different from zero at $p = .05$

NOTE: Linear regressions on ln (full–time annual salary).

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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These differentials are somewhat lower than those shown in a similar analysis using 1999 data (see *Science and Engineering Indicators 2006* [NSB 2006]). These raw differences in salary are lower but still large at the doctoral level (–18.5% for women and –13.2% for underrepresented ethnic groups). Foreign-born individuals with U.S. S&E degrees have slightly lower salaries than U.S. natives (–2.7% at the bachelor's and –1.8% at the doctoral levels), but at the master's degree level earn 10.0% more than U.S. natives.

Effects of Age and Years Since Degree on Salary Differentials. Salary differences between men and women reflect to some extent the lower average ages of women with degrees in most S&E fields. Controlling for differences in age and years since receipt of degree reduces salary differentials for women compared with men by only about 1 percentage point at the bachelor's (to –33.2%) and master's (to –30.6), but by two-fifths at the doctoral level (to –11.1%).[8] Two factors may explain why statistical controls make less difference at lower degree levels: a similar proportion of men and women with S&E degrees are in midcareer, but a larger proportion of men are at older ages where salaries begin to decline.

Similar small drops in salary differentials are found for underrepresented ethnic minorities. Such controls reduce salary differentials of underrepresented minorities compared with non-Hispanic whites and Asians/Pacific Islanders by only 1 or 2 percentage points at the bachelor's and master's degree levels, but by half at the doctoral level (to –6.6%).

Effects of Field of Degree on Salary Differentials. Controlling for field of degree and for age and years since degree reduces the estimated salary differentials for women with S&E degrees to –25.4% at the bachelor's level and to –7.9% at the doctoral level.[9] These reductions generally reflect the greater concentration of women in the lower-paying social and life sciences as opposed to engineering and computer sciences. As noted above, this identifies only one factor associated with salary differences and does not speak to why differences exist between men and women in field of degree or whether salaries are affected by the percentage of women with degrees in each field.

Field of degree is associated with significant estimated salary differentials for underrepresented ethnic groups relative to all other ethnic groups. Controlling for field of degree further reduces salary differentials to –13.6% for those individuals with S&E bachelor's degrees and to –5.2% for those individuals with S&E doctorates. Thus, age, years since degree, and field of degree are associated with two-thirds of doctoral-level salary differentials for underrepresented ethnic groups.

Compared with natives, foreign-born individuals with advanced S&E degrees show no statistically significant salary differences when controlling for age, years since degree, and field of degree. At the bachelor's degree level, foreign-born S&E degree holders still had a –6.3% salary differential.

Effects of Occupation and Employer Characteristics on Salary Differentials. Occupation and employer characteristics affect compensation.[10] 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 relation of work performed to degree earned: whether the person is working in S&E or in R&D, employer size, and U.S. region. However, occupation and employer characteristics may not be determined solely by individual choice, for they may also reflect in part 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 reduces salary differentials somewhat beyond what is found when controlling for age, years since degree, and field of degree. At the doctoral level, the addition of occupation leaves no statistically significant difference between the salaries of underrepresented ethnic groups, compared with whites and Asians. For the foreign born, controlling for occupational characteristics actually moves differentials in a negative direction, suggesting that the foreign born generally have better-paying occupations than natives.

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 might affect work productivity.[11] For example, having highly educated parents is associated with higher salaries for individuals of all ethnicities and genders, and may well be associated with greater academic achievement not directly measured in these data. However, for many individuals in many ethnic groups, historical discrimination probably affected parents' educational opportunities and achievement.

As with occupation and employer characteristics, controlling for these characteristics changes salary differentials only slightly for each group and degree level. However, it does have enough of an effect to eliminate the rest of the estimated salary differentials for both underrepresented ethnic groups with advanced S&E degrees vis-à-vis all others, and for foreign-born individuals vis-à-vis native-born individuals.

An additional issue for the wage differentials of women, however, is that family and child variables often have different effects for men and women. Marriage is associated with higher salaries for both men and women with S&E degrees, but has a larger positive association for men. Children have a positive association with salary for men but a negative association with salary for women, except at the doctoral level, where children have no statistically significant effect. Allowing for these differences in gender effects in the model reduces the salary differential at the bachelor's degree level by 10.4 percentage points (to –7.8%) and at the master's level by 9.4 percentage points (to 5.8%), and leaves no statistical significant difference in earnings at the doctoral level.

Labor Market Conditions for 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 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. In general, NSF's data on recent graduates in 2003 reflect the economic downturn that started in 2001 and its unusually large effect on R&D expenditure, state government budgets, and universities, all areas of importance for scientists and engineers.

General Labor Market Indicators for Recent Graduates

Some basic labor market statistics are summarized for recent (defined here as those between 1 and 5 years since degree) recipients of S&E degrees in table 3-15. Across all fields of S&E degrees in 2003, there was a 4.7% unemployment rate for bachelor's degree holders who received their degrees in the previous 1–5 years. This ranged from 4.0% for physical sciences degree recipients to 5.1% for social science degree recipients. Although individuals often change jobs more often and have higher unemployment early in their careers, all of these values are less than the unemployment rate for the full labor force in 2003 of 6.0%. For doctorate recipients across all fields of degree, the unemployment rate was 2.8%.

A more subjective indicator of labor market conditions is the percentage of recent graduates who report that they sought, but could not find, full-time employment related to their field of degree. The IOF employment rate is a measure unique to NSF's labor force surveys. Because highly educated people are usually able to find employment of some kind, the IOF rate is sometimes a more sensitive indicator of changing conditions in the S&E labor market than the unemployment rate. At the bachelor's degree level, across all S&E fields, the IOF rate was 11.5%, but ranged from 3.6% for recent engineering bachelor's graduates to 15.7% in the social sciences. In all fields of degree, the IOF rate decreases with level of education, reaching 2.9% for recent doctorate recipients.

Average salary for recent S&E bachelor's degree recipients in 2003 was $40,900, ranging from $34,300 in the life sciences to $53,500 in engineering. Recent master's recipients had average salaries of $55,200 and recent doctorate recipients only about $5,000 more at $60,300. 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.

Employment and Career Paths for Recent Bachelor's and Master's Recipients

Although a very subjective measure, one indicator of labor market conditions is whether recent graduates feel that they are in "career-path" jobs. Most recently in 1999, the National Survey of Recent College Graduates asked new S&E

Table 3-15
Labor market indicators for recent S&E degree recipients 1–5 years after receiving degree, by field: 2003
(Percent)

Indicator	All S&E fields	Computer/ mathematical sciences	Life sciences	Physical sciences	Social sciences	Engineering
Unemployment rate						
Bachelor's	4.7	4.5	4.1	4.0	5.1	4.4
Master's	4.4	5.4	2.9	2.6	4.6	4.5
Doctorate	2.8	2.1	4.6	1.1	1.9	3.3
Involuntary out-of-field rate						
Bachelor's	11.5	9.2	10.9	9.4	15.7	3.6
Master's	5.5	3.4	3.0	6.4	9.5	2.9
Doctorate	2.9	3.0	1.4	4.1	4.0	2.5
Average salary ($)						
Bachelor's	40,900	49,600	34,300	37,500	35,400	53,500
Master's	55,200	65,100	45,000	45,900	43,600	67,600
Doctorate	60,300	65,200	48,500	61,800	59,600	74,100

NOTE: Average salary rounded to nearest $100.

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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bachelor's and master's degree recipients whether they had obtained employment in a career path job within 3 months of graduation.

As one might expect, more S&E master's degree holders reported having a career-path job compared with S&E bachelor's degree holders. Approximately two-thirds of all S&E master's degree recipients and one-half of all S&E bachelor's degree recipients held a career-path job in 1999 (figure 3-32). Graduates with degrees in computer and information sciences or in engineering were more likely to hold career-path jobs compared with graduates with degrees in other fields: about three-quarters of recent bachelor's and master's degree graduates in engineering or computer and mathematical sciences reported that they held career-path jobs.

Recent Doctoral Degree Recipients

Analyses of labor market conditions for scientists and engineers holding doctorate degrees often focus on the ease or difficulty of beginning careers for recent doctoral degree recipients. Although a doctorate degree 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 doctoral degree holders also face an additional period of low earnings while in a postdoc position. In addition, some doctoral degree holders do not obtain the jobs they desire after completing their education.

Since the 1950s, the federal government has actively encouraged graduate training in S&E through numerous mechanisms. Doctorate programs have served multiple facets of the national interest by providing a supply of highly trained and motivated graduate students to aid university-based research. These programs have not only provided individuals with detailed, highly specialized training in particular areas of research, they have also cultivated a general ability to perform self-initiated research in more diverse areas.

The career rewards of highly skilled individuals in general, and doctoral degree holders in particular, often cannot be measured by just salary and employment. Their technical and problem-solving skills make them highly employable, but they often attach great importance to the opportunity to do a type of work they care about and for which they have been trained. For that reason, no single measure can satisfactorily reflect the state of the doctoral S&E labor market. Some of the available labor market indicators, such as unemployment rates, IOF employment, satisfaction with field of study, employment in academia versus other sectors, postdoc positions, and salaries, are discussed below.

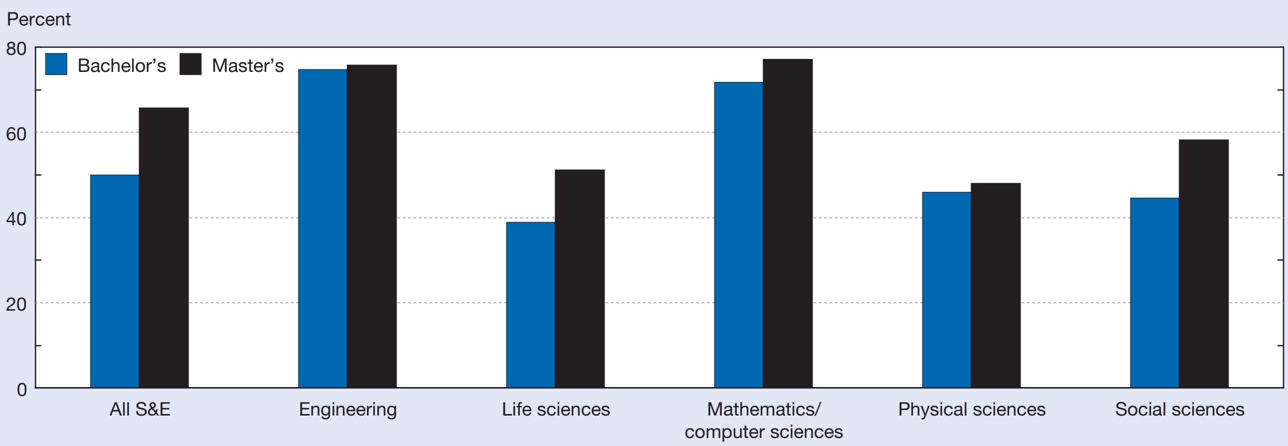
Aggregate measures of labor market conditions for recent (1–3 years after receipt of degree) U.S. S&E doctoral degree recipients in 2006 show improvement from the already generally good rates found when last measured in 2003: unemployment fell from 2.3% to 1.3% and IOF rates fell from 3.3% to 1.3% (table 3-16). There was also an increase in the percentage of the most recent graduates entering tenure-track programs at 4-year institutions—from 17.8% in 2003 to 19.2% in 2006.

Unemployment

The 1.3% unemployment rate for recent S&E doctoral degree 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.

The highest unemployment rates were for recent doctoral degree recipients 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.

Figure 3-32
Recent S&E recipients in career-path jobs within 3 months of degree, by field: 1999



SOURCE: National Science Foundation, Division of Science Resources Statistics, National Survey of Recent College Graduates,1999.

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Table 3-16
Labor market rates for recent doctorate recipients 1–3 years after receiving doctorate, by field: 2001, 2003, and 2006
(Percent)

	Unemployment rate			Involuntary 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
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
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
Mathematics/computer 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
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

NOTES: Two-year institutions not included. Doctorate recipients in health fields included in life sciences for consistency with prior years. Rates of 0.0, like other rates in this table, are rounded estimates and do not preclude possibility that some individuals in that field may be unemployed or working involuntarily out of field.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients, 2001, 2003, and 2006 (preliminary data for 2006).

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The unemployment rate for recent S&E doctoral degree recipients in computer sciences, the field with the third highest unemployment rate in 2003, fell from 4.4% to 1.7% in 2006.

Involuntarily Working Outside Field

In addition to unemployment, another 1.3% of recent S&E doctoral degree recipients in the labor force reported in 2006 that they could not find (if they were seeking) full-time employment that was “closely related” or “somewhat related” to their degrees, which was a decline from 3.4% in 2001 and 3.3% in 2003. Although this measure is more subjective than the unemployment rate, the IOF rate often proves to be a more sensitive indicator of labor market difficulties for a highly educated and employable population. However, it is best to use both the IOF rate along with unemployment rates and other measures as different indicators of labor market success or distress.

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

Tenure-Track Positions

Most S&E doctoral degree holders ultimately do not work in academia, and there has been a long-term decline in this proportion, as academic opportunities grew slower than those in other sectors of the economy. In recent years, however, the proportion of all recent doctorate recipients in the labor force who are in tenure-track academic jobs (the tenure-track rate) has increased. Increases in the rate of new doctorate holders entering tenure-track positions at 4-year academic institutions were observed in NSF surveys between 2001 and 2003, and again between 2003 and 2006. As a result, in 2006, tenure-track rates for both those 1–3 years after degree and 4–6 years after degree returned roughly to the same rates found in 1993 (figure 3-33 and table 3-17). The rate for those 1–3 years since degree rose from 17.8% to 19.2% and the rate for those 4–6 years since degree increased from 23.5% to 25.8%. (See chapter 5 for a discussion of trends in tenure-track positions as a proportion of all academic positions.)

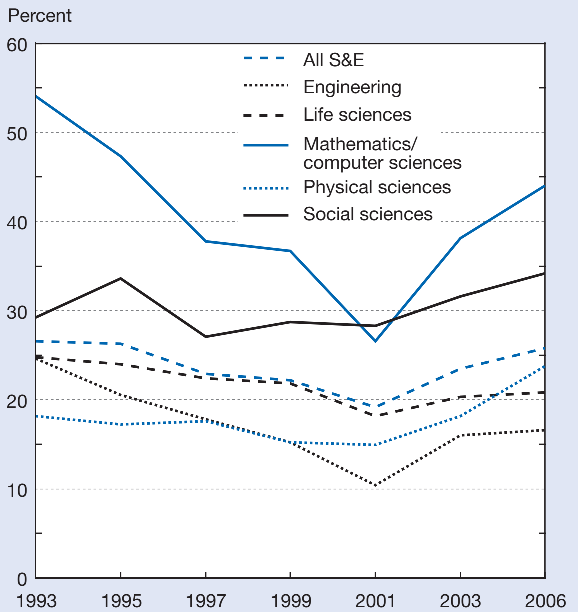
Academia is just one possible sector of employment for S&E doctorate holders, but the availability of tenure-track positions is an important aspect of the job market for individuals who seek academic careers. Changes over time in tenure-track employment reflect availability of tenure-track job opportunities in academia and the availability of nonacademic employment opportunities. For example, one of the quickest declines in tenure-track employment occurred in computer sciences, from 51.5% in 1993 to 23.6% in 2001, despite many discussions about difficulties that computer science departments were having finding faculty (figure 3-33).

Salaries for Recent S&E Doctoral Degree Recipients

In 2006 for all fields of degree the median annual salary for recent S&E doctoral degree recipients 1–5 years after 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 3-18).

By type of employment, salaries for recent doctoral degree recipients range from $40,000 for postdoc positions to $80,000 for those employed by private for-profit business (table 3-19).

Figure 3-33
Doctorate recipients holding tenure and tenure-track appointments at academic institutions 4–6 years after degree, by field: 1993–2006



NOTE: Two-year institutions not included. Doctorate recipients in health fields included in life sciences for consistency with prior years.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients, 1993, 2003, and 2006 (preliminary data for 2006).

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Postdoc Positions

The growing number of recent doctoral graduates in postdoctoral appointments, generally known as postdocs,[12] has become a major issue and concern in science policy. Neither the reasons for its growth, nor the effect of the growth on the health of science, are well understood. Are new doctoral degree recipients more likely to enter postdoc positions because of increased competition for tenure-track academic research jobs? Are postdoc positions needed more than in the past because of the increasing team nature of research and the increased need for training?

Although individuals in postdoc positions perform much 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 their career advancement. Because postdoc positions usually pay much less than these highly educated individuals could make in other employment, forgone earnings add significantly to the costs of a doctoral education and may discourage doctoral-level careers in S&E.

Postdocs by Academic Discipline

Around half (49%) of U.S.-educated S&E doctorate recipients in postdoc positions in April 2006 had doctorates in the biological sciences, well above the 23% they represented of all S&E doctorates awarded in 2005 (figure 3-34). The high representation among postdocs of biological sciences doctorates reflects both the field's high rate of entering postdocs (about three-fifths of the 2002–05 graduation cohort) and the relatively long periods these individuals spent in postdoc positions. Other fields with high rates of entering postdocs (psychology, chemistry, and physics) make up another one-quarter of postdocs. The remaining quarter come from all other fields of S&E, most of which do not have strong traditions of a postdoc position being a normal part of a doctoral career path.

How Many Postdocs Are There?

No single data source measures the entire population of postdocs, and some parts of the population are not systematically measured at all. Two NSF surveys, the Survey of Doctorate Recipients and the Survey of Graduate Students and Postdoctorates in Science and Engineering (GSS), include data bearing on the number of postdocs in the United States.

SDR covers U.S. residents who have earned S&E and health doctorates from U.S. schools (MDs and other types of degrees with "doctor" in the name are not included). Thus, postdocs who received doctorate degrees from foreign institutions are not included in SDR. In 2006, SDR collected data on the dates of current and past postdoc positions, allowing an estimate to be made of the number of postdocs in fall 2005, the same period as the most recent GSS data. Unlike SDR, which collects data from individuals, GSS surveys academic departments. GSS asks departments that offer graduate programs in S&E and specific health-related

Table 3-17
Doctorate recipients holding tenure and tenure-track appointments at academic institutions, by years since receipt of doctorate: 1993, 2003, and 2006
(Percent)

	1993		2003		2006	
Field	1–3	4–6	1–3	4–6	1–3	4–6
All S&E	18.4	26.6	17.8	23.5	19.2	25.8
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
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
Mathematics/computer 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
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

NOTE: Two-year institutions not included. Doctorate recipients in health fields included in life sciences for consistency with prior years.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients, 1993, 2003, and 2006 (preliminary data for 2006).

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Table 3-18
Salary of recent doctorate recipients 1–5 years after receiving degree, by percentile: 2006
(Dollars)

Field	25th	50th	75th
All fields	40,000	52,000	74,000
Engineering	41,000	70,000	87,500
Life sciences	38,000	46,000	65,000
Mathematics/ computer sciences	43,500	64,000	84,000
Physical sciences	40,000	53,000	75,600
Social sciences	40,000	51,300	65,000

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

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fields for counts of all of their postdocs, regardless of whether their degrees were earned in the United States or abroad. However, unlike SDR, it does not gather data on people in nonacademic positions or academic units that lack graduate programs, including many academic research organizations and affiliated nonprofit research centers.

Table 3-20 shows the estimates that SDR and GSS provide for those parts of the U.S. postdoc population that they measure. Estimates for many, but not all, parts of the postdoc population can be derived from these data sources and used to piece together an overall national estimate for fall 2005. However, any overall estimate involves numerous uncertainties and assumptions.

Academic Postdocs. SDR estimates that 22,900 U.S. citizens and permanent residents were in academic postdoc positions in the fall of 2005.[13] The 2005 GSS estimate (16,200) is substantially lower, in part because postdocs affiliated with some non-degree-granting academic departments and research centers are not captured on GSS. In addition, the individuals surveyed by SDR and the departments surveyed by GSS may have somewhat different views on whether an individual should be classified as a postdoc.

Not surprisingly, GSS reports a much larger number of academic postdocs with temporary visas (26,600) than SDR (7,700). The most likely explanation for this gap is that GSS, unlike SDR, includes people with doctorates from non-U.S. universities in its counts.[14]

Other Postdocs. Neither survey includes data on the number of foreign-educated postdocs. SDR estimates that 29% of U.S.-educated postdocs, 13,000 total, are in industry, nonprofits, government, and other types of educational institutions. There is no reason to believe that the proportions of U.S. and foreign-educated postdocs in nonacademic positions are similar.

Table 3-19
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
Engineering	70,000	80,000	71,000	40,000	56,000	80,000
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

S = data suppressed for reasons of reliability

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

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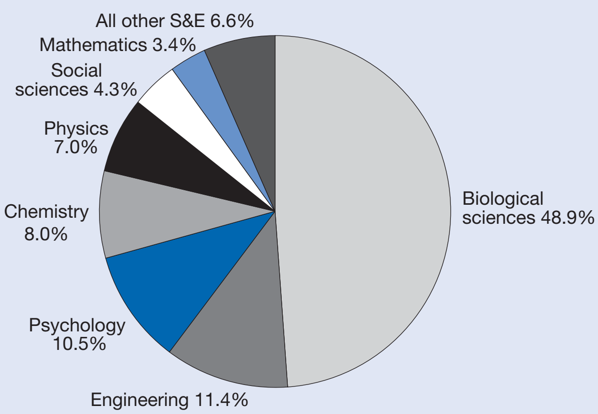
Figure 3-34
Field of doctorate of U.S.-educated S&E doctorate recipients in postdoc positions: 2006



NOTES: Social sciences exclude psychology. Detail does not add to 100% because of rounding.

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

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Using these data, one might, for example, estimate as follows:

- 22,900 U.S. citizens and permanent residents in academic postdoc positions (SDR estimate).
- 26,600 persons on temporary visas in academic postdoc positions (GSS estimate).
- 13,000 U.S.-educated persons in postdoc positions not covered by GSS (SDR estimate).
- 26,500 postdocs on temporary visas and in positions not covered by GSS (estimate derived by assuming that the proportion of temporary visa postdocs in other sectors and other parts of academia is the same as in the portion covered by GSS).

This estimate yields a total of 89,000 postdocs but other, comparably plausible assumptions lead to a substantially different total.

Increase in the Likelihood and Length of Postdoc Positions

Among holders of U.S. S&E doctorates received before 1972, 31% reported having had a postdoc position earlier in their careers (figure 3-35).[15] This proportion has risen over time to 46% among 2002–05 graduates. This increase over time occurred both in fields in which postdocs have been traditionally important and in those in which only a small number of doctoral degree recipients went on to postdoc positions. In the high postdoc fields such as the life sciences (from 46%–60%) and the physical sciences (from 41%–61%), a majority of doctoral degree recipients now have a postdoc position as part of their career path. Similar increases were found in mathematical and computer sciences (19%–31%), social sciences (18%–30%), and engineering (14%–38%). The increasing use of postdoc positions in engineering is particularly noteworthy, with recent engineering doctoral degree recipients now being almost as likely to take a postdoc position as physical sciences doctoral degree recipients were 35 years ago.

There have also been increases in the average length of time spent in a postdoc position, most notably in the life sciences (figure 3-36). The median length of time spent in postdoc positions for life science doctoral degree recipients grew from 24 months for pre-1972 graduates to 46 months for 1992–96 graduates. Although the median length of time in a postdoc position for those who completed postdoc positions falls for later graduation cohorts, this in part reflects some individuals who did not enter a postdoc position immediately after graduation and were still in the position in April 2006. The increase in the time spent in postdoc positions in the physical sciences was more modest, rising from a median of 21 months to 30 months for 1992–96 graduates. In contrast, in psychology, which is a high-postdoc rate discipline, median months in postdoc positions has remained

Table 3-20
Postdoc estimates from two NSF surveys, by place of employment and citizen/visa status: Fall 2005

Place of employment and citizen/visa status	SDR Estimate	SDR Percent	GSS Estimate	GSS 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 = National Science Foundation; SDR = Survey of Doctorate Recipients

[a]For SDR, individuals reporting postdoc in 4-year U.S. educational institutions/medical schools/affiliated research institutes (includes those whose institution type in fall 2005 unknown); 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 doctorate in S&E/health field from U.S. educational institution. GSS gathers information from institutional coordinators at U.S. educational institutions with programs leading to graduate degrees in S&E/health fields, i.e., GSS 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: National Science Foundation, Division of Science Resources Statistics, SDR, 2006 (preliminary data); and GSS, 2005.

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essentially the same for the 20 years from the 1972–76 graduation cohort (23 months) to the 1992–96 graduation cohort (22 months). In all other areas of S&E taken together, the estimated median months in postdoc positions has also shown little growth, and is never higher than the 23 months estimated for the 1972–76 cohort. In these nontraditional postdoc fields, the growing importance of postdoc positions is driven by the increased rate of entering postdocs, and not by the length of the postdoc appointment.

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 use of postdocs 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, as shown in table 3-21. By broad field, this ranges from a 44% pay gap with recent engineering doctoral degree recipients to a 25% gap for doctorate holders in the social sciences. Nonacademic postdocs have better pay than academic postdocs, but the medium salary is still 20% less than for nonpostdocs.

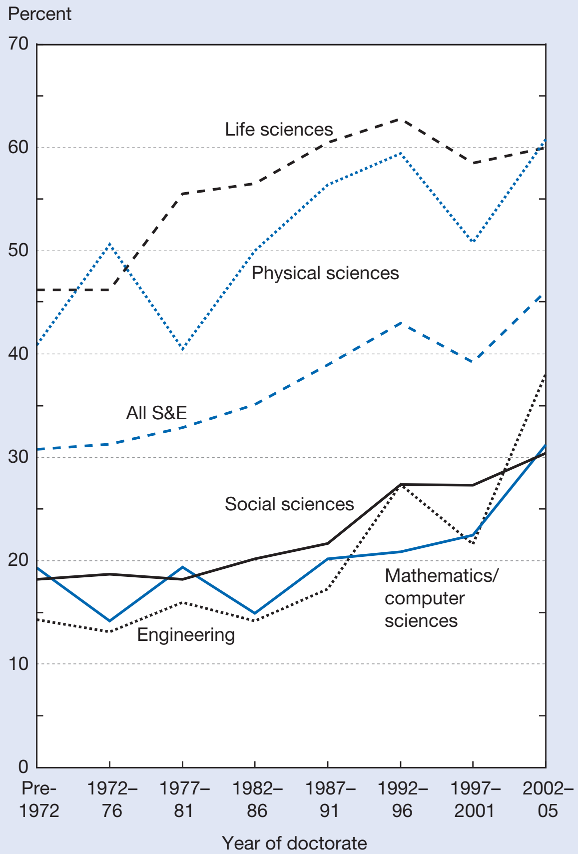
Most individuals in postdoc positions in 2006 did have employment benefits. Indeed, across all S&E fields, 90% of postdocs reported having medical benefits and 49% reported having retirement benefits. It is not possible to know from the survey how extensive medical benefits may be, or how transferable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

The perception that postdocs do not receive employee benefits does have a historical basis. As shown in figure 3-37, among former postdocs who received their S&E doctorates before 1972, only 59% of biological science postdocs and 60% of postdocs in all other fields reported having medical benefits, and only 16% and 18%, respectively, reported having retirement benefits. The prevalence of both types of employment benefits for postdocs has risen fairly steadily over time.

Postdocs as a Sign of Labor Market Distress for Recent Doctoral Degree Recipients

Former postdoc position holders were asked about the reason they accepted a postdoc appointment. Most respondents reported reasons consistent with the traditional view

Figure 3-35
Proportion ever holding a postdoc among S&E doctorate holders, by field and year of doctorate: 2006



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

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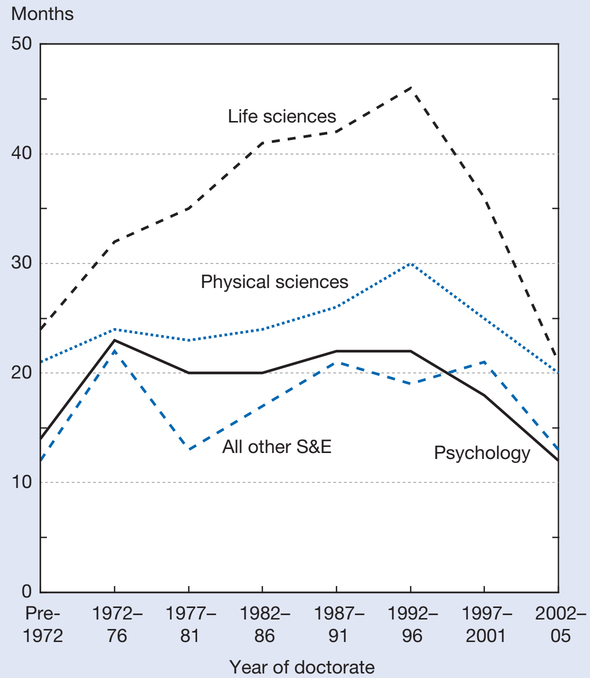
Figure 3-36
Median time spent in postdoc postions for S&E doctorate recipients completing postdocs, by field and year of doctorate: 2006



NOTE: Excludes those currently in postdoc position.

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

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of postdoc appointments 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 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 science; 8% in computer and mathematical sciences; 10% in the physical sciences; 14% in the social sciences; and 16% in engineering.

A cohort trend for former and current postdocs who reported taking their first postdoc position because no other employment was available is shown in figure 3-38. Across all S&E fields, this proportion has a peak at 12% for both the 1972–76 and the 1992–96 graduation cohorts (5% in 1992–96 if looked at as a proportion of all doctorate holders). Both peaks roughly coincide with periods of relative difficulty for S&E doctorate holders, in the first case following an oil crisis and recession, and in the second following the end of the Cold War.

Postdoc Outcomes

There are several differences in the career patterns of former postdocs and nonpostdocs. However, available data do not permit definitive judgments about whether the experience gained in a postdoc position produced these differences. For example, those who entered postdoc positions may have already been more interested in research careers, and may have already given employers a reason to believe they have the ability and aptitude for such a career.

Most former postdocs report that the postdoc experience was helpful to their career, and the proportion of former postdocs saying this is remarkably constant over different doctorate graduation cohorts (figure 3-39). Across all S&E fields and cohorts, 53%–56% of former postdocs said that their postdoc experience “greatly helped” their careers. Across all cohorts, an additional 33%–38% said that their postdoc experience “somewhat helped” their careers. The proportion of those completing postdoc positions who said that it was no help to their careers ranged from only 8% for the 2002–05 graduation cohort to 12% for the 1987–2001 cohort.

Nonetheless, there are only modest differences in many measures of the career status of former postdocs and nonpostdocs in 2006. For example, among 1997–2001 recipients of U.S. S&E doctorates, 31% of those who had a postdoc

Table 3-21
Salary and benefits of U.S. S&E doctorate holders in postdoc positions: 2006

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

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

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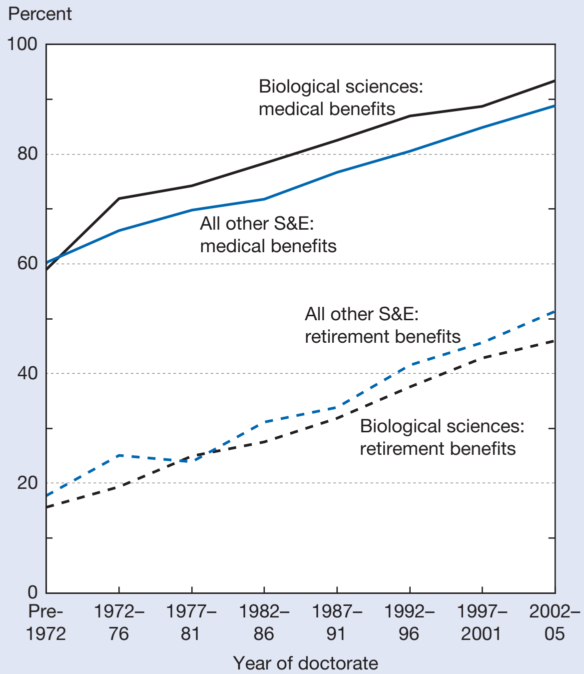
Figure 3-37
Growth of job benefits for S&E doctorate holders in postdoc positions, by field and year of doctorate: 2006



NOTE: Percentage currently or formerly in postdoc position who reported receiving medical or retirement benefits.

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

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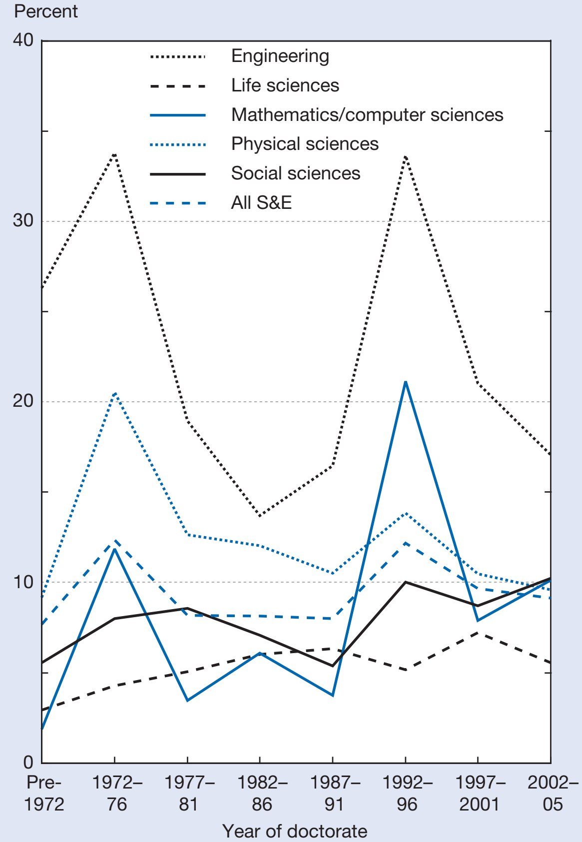
Figure 3-38
Former or current postdocs who took first postdoc position because other employment not available, by field and year of doctorate: 2006



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

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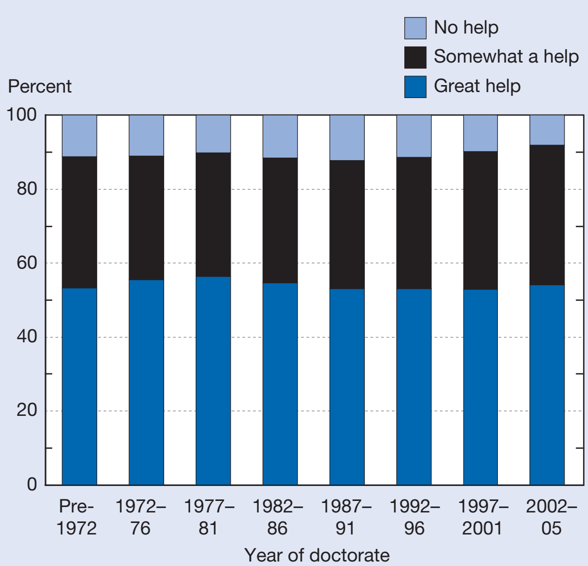
position were in tenured or tenure-track positions at a 4-year postsecondary institution, compared with 25% of those not in postdoc positions. The differences between the tenure-track rates were larger for computer and mathematical sciences (a 21 percentage point difference), and for engineering and the physical sciences (each with a 14 percentage point difference between former postdocs and nonpostdocs in the proportion in tenure track). However, in the life sciences, where it is often said that a postdoc position is a requirement for an academic career, there is only a 5 percentage point difference between former postdocs and nonpostdocs in tenure-track employment. In the social sciences, nonpostdocs are actually slightly more likely to be in a tenure-track position, but this may be because many postdoc positions in psychology provide primarily clinical training.

Changes in the proportion in 2006 tenured or tenure-track positions can be seen in figure 3-40. In the life sciences, the tenure-track rate has generally declined for more recent graduation cohorts for both former postdocs and nonpostdocs, with the largest gap of 12 percentage points occurring in the oldest graduation cohort, those receiving their doctorate prior to 1972. In contrast, in the physical sciences, the tenure-track rate is relatively constant across graduation cohorts for former postdocs, with former postdocs being 18 percentage points more likely than nonpostdocs to be in a tenure-track position among the newest, not the oldest, cohort. In psychology, there is a similar proportion going into tenure-track positions among most graduation cohorts. In all other S&E fields, there is a higher tenure-track rate for former postdocs that varies greatly by graduation cohort and ranges from 3 to 18 percentage points above the rate for nonpostdocs.

The 1997–2001 graduation cohort is the most recent to be almost entirely finished with postdoc experiences. In this cohort, the additional proportion in tenure-track positions for former postdocs ranged from 21 percentage points in the mathematical and computer sciences to minus 5 percentage points in the social sciences, where nonpostdocs have higher tenure-track rates (figure 3-41).

Former postdocs are also more likely than nonpostdocs to have R&D as a major work activity, defined here as reporting that basic research, applied research, design, or development is the work activity on which they spend the greatest, or second greatest amount of time. In the 1997–2001 graduation cohort, 73% of former postdocs had R&D as a major work activity in 2006, compared with 59% among those who

Figure 3-39
Former postdocs' evaluation of degree to which postdoc position helped career, by year of doctorate: 2006



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

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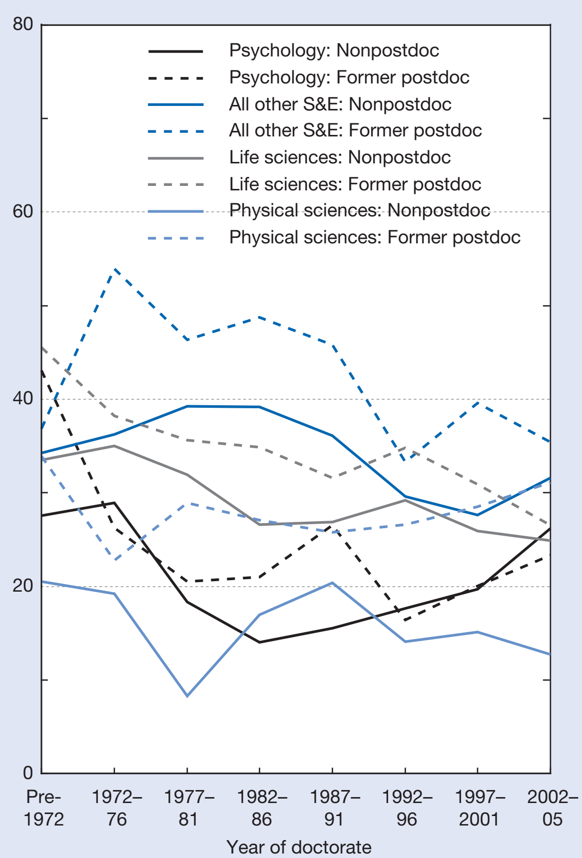
Figure 3-40
S&E doctorate holders in tenured or tenure-track positions in 2006, by field, postdoc status, and year of doctorate: 2006



NOTES: Excludes those still in postdoc position in April 2006. All other S&E fields include engineering, mathematics/computer sciences, and all other social sciences.

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

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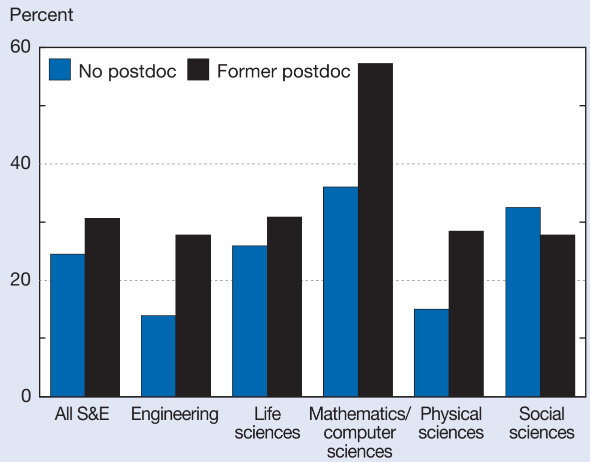
Figure 3-41
S&E doctorate holders in 1997–2001 graduation cohort in tenured or tenure-track positions, by degree field and postdoc status: 2006



NOTE: Excludes those currently in postdoc position.

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

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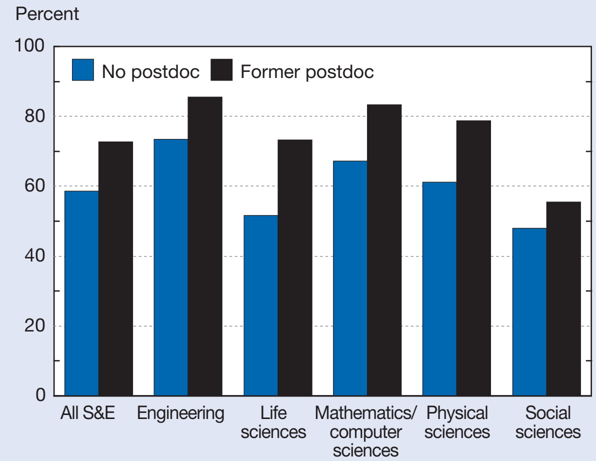
Figure 3-42
S&E doctorate holders in 1997–2001 graduation cohort with R&D as primary or secondary work activity, by degree field and postdoc status: 2006



NOTE: Excludes those currently in postdoc position.

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

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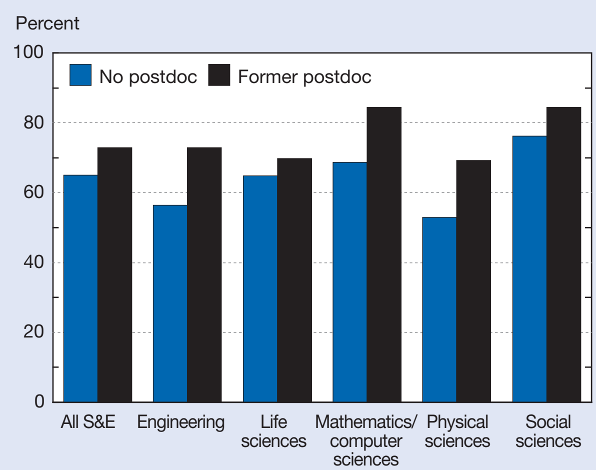
never has a postdoc position (figure 3-42). This increased likelihood to do R&D exists for all broad S&E fields of degree, and ranges from 7 percentage points in the social sciences to 21 percentage points in the life sciences.

Former postdocs are also somewhat more likely to report that their job is closely related to their degree. Although over 90% of S&E doctorate holders report that their job is at least somewhat related to their degree, smaller proportions report that it is closely related. In the 1997–2001 graduation cohort, 73% of former postdocs reported that their job was closely related to their degree in 2006, compared with 65% among those who never had a postdoc position (figure 3-43). The difference in reporting of a job closely related to degree ranged from 5 percentage points in the life sciences to 17 percentage points in engineering and the physical sciences.

Taking a postdoc position delays an individual's entry into a career path with a more permanent employer, but also may provide the individual with valuable experience and skills. Figure 3-44 shows the difference in the 2006 salary of former postdocs and nonpostdocs by field of degree and sector of employment. For this purpose, an older cohort, 1992–96 doctoral degree graduates, is used for comparison to allow somewhat more time for former postdocs to demonstrate their performance with an employer. In all fields of degree, former postdocs working for a private noneducational employer earned less than nonpostdocs in the same sector. In mathematical and computer sciences, former postdocs earned 8% less, and in all other fields former postdocs earned 10% less in the private sector. In the three fields in which enough postdocs enter government service to allow measurement—the physical sciences, life sciences, and engineering—a positive salary differential is associated with having been a postdoc, ranging from 3% in engineering to 9% in the life sciences. A more ambiguous salary differential appears among former postdocs in the educational sector, who earn more than nonpostdocs in the physical sciences, computer and mathematical sciences, and engineering, but earn less in the social sciences and life sciences.

Figure 3-43
S&E doctorate holders in 1997–2001 graduation cohort with job closely related to degree field, by degree field and postdoc status: 2006



NOTE: Excludes those currently in postdoc position.

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

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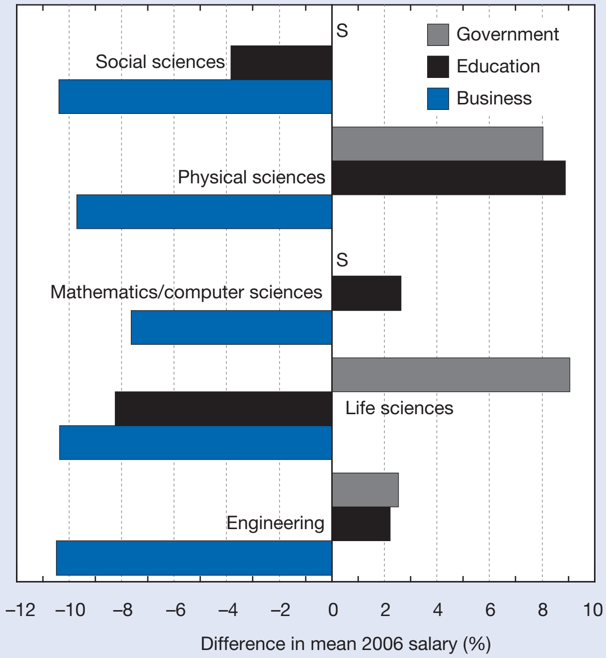
Figure 3-44
Salary of former postdocs relative to nonpostdocs for S&E doctorate holders in 1992–96 graduation cohort, by degree field and sector of employment: 2006



S = suppressed for reliability

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

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In summary, postdocs in S&E fields are associated with a greater likelihood to be engaged in research, hold a tenure-track position, and report that their job is closely related to their degree. Having had a postdoc position is associated with a moderate disadvantage in salary within private non-educational employment, and a moderate advantage in government employment. A majority of former postdocs from all graduation cohorts said that their postdoc positions were a great help to their career, and only about one-tenth said that a postdoc position was of no help to their careers.

Age and Retirement

The age distribution and retirement patterns of the S&E labor force affect its size, productivity, and opportunities for new S&E workers. For many decades, rapid increases in new entries into the workforce led to a relatively young pool of workers, with only a small percentage near traditional retirement age. Now, the picture is changing as individuals who earned S&E degrees in the late 1960s and early 1970s move into the latter part of their careers.

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

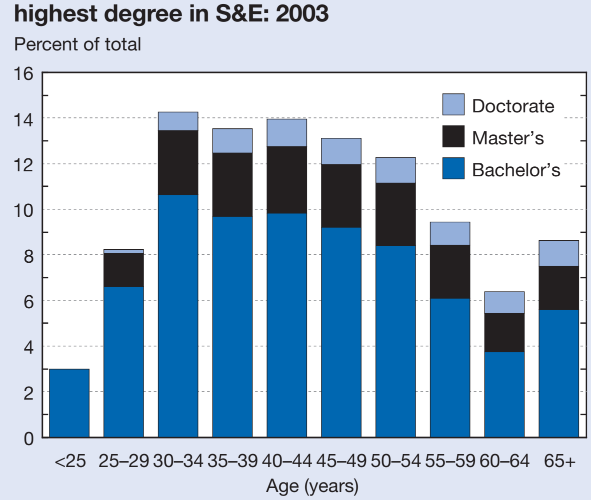
This section does not attempt to project future S&E labor market trends; however, some general conclusions can be made. Absent changes in degree production, retirement patterns, or immigration, the number of S&E-trained workers in the labor force will continue to grow for some time, but the growth rate may slow significantly as a dramatically greater proportion of the S&E labor force reaches traditional retirement age. As the growth rate slows, the average age of the S&E labor force will increase.

Implications for S&E Workforce

Net immigration, morbidity, mortality, and, most of all, historical S&E degree production patterns affect age distribution among 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 30 and 49. (Figure 3-45 shows the age distribution of the labor force with S&E degrees broken down by level of degree.) In general, the majority of individuals in the labor force with S&E degrees are in their most productive years (from their late 30s through their early 50s), with the largest group ages 30–34. More than half of workers with S&E degrees are age 40 or older, and the 40–44 age group is more than two times as large as the 60–64 age group.

This general pattern also holds true for those individuals with S&E doctoral degrees. Because of the long time needed

Figure 3-45
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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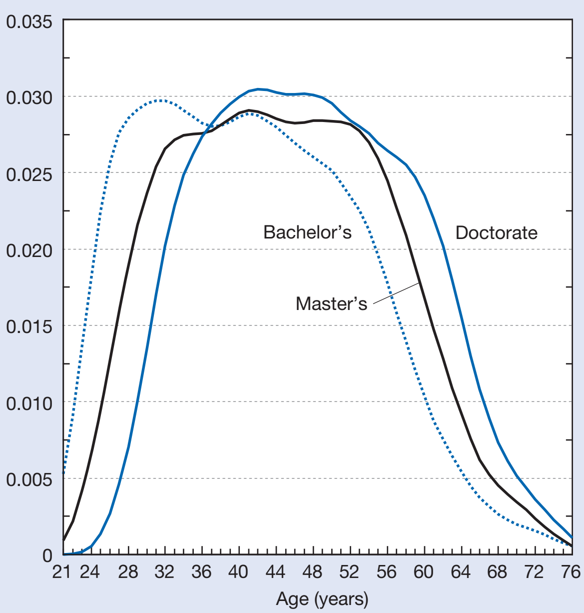
to obtain a doctorate, doctoral degree holders are somewhat older than individuals who have less-advanced S&E degrees. The greatest population density of S&E doctoral degree holders occurs between the ages of 40 and 54. This can be most easily seen in figure 3-46, which compares the age distribution of S&E degree holders in the labor force at each level of degree, and in figure 3-47, which shows the cumulative age distribution for individuals at each degree level. Even if one takes into account the somewhat older retirement ages of doctoral degree holders, a much larger proportion of them are near traditional retirement ages than are individuals with either S&E bachelor's or master's degrees.

The extent of the recent aging of the S&E labor force is highlighted in figure 3-48, which shows the age distribution of S&E doctorate holders in 1993 and 2003. S&E doctorate holders under age 35 are about the same proportion of the S&E doctoral-level labor force in both years. However, over the decade, the 35–54 age group became a much smaller part of the full S&E doctoral-level 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 10.8% of individuals with their highest degree in computer sciences to 38.0% of individuals with their highest degree in physics (figure 3-49).

Figure 3-46
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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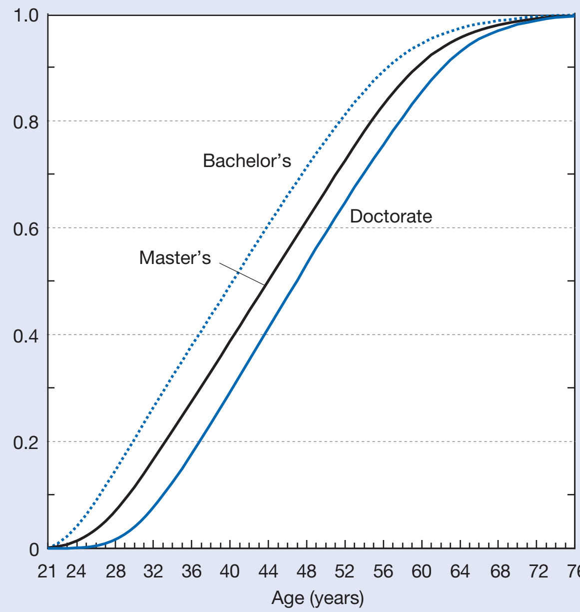
Figure 3-47
Cumulative age distribution of individuals in labor force with highest degree in S&E, by degree level: 2003



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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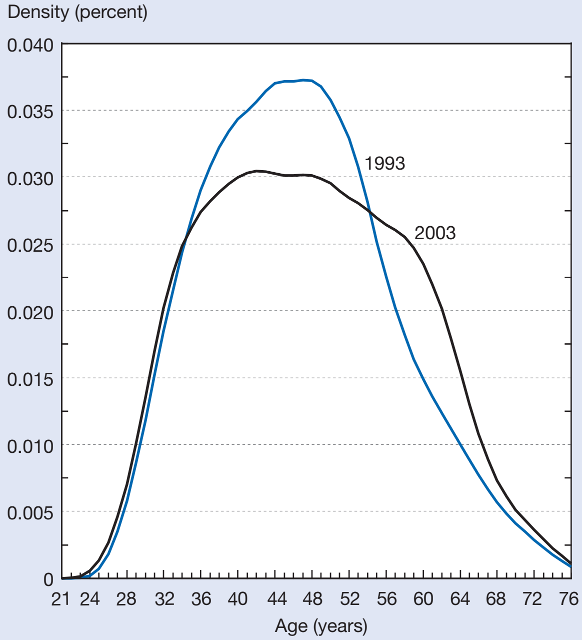
Taken as a whole, the age distribution of S&E-educated individuals suggests several likely important effects on the future S&E labor force:

- ♦ 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 greatly 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 dramatically increase over the next 20 years. This may prove particularly true for doctoral degree holders because of the steepness of their age profile. As retirements increase, the difference between the number of new degrees earned and the number of retirements will narrow (and ultimately disappear).

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 to slow, both concerns raised by a 2003 report of the

Figure 3-48
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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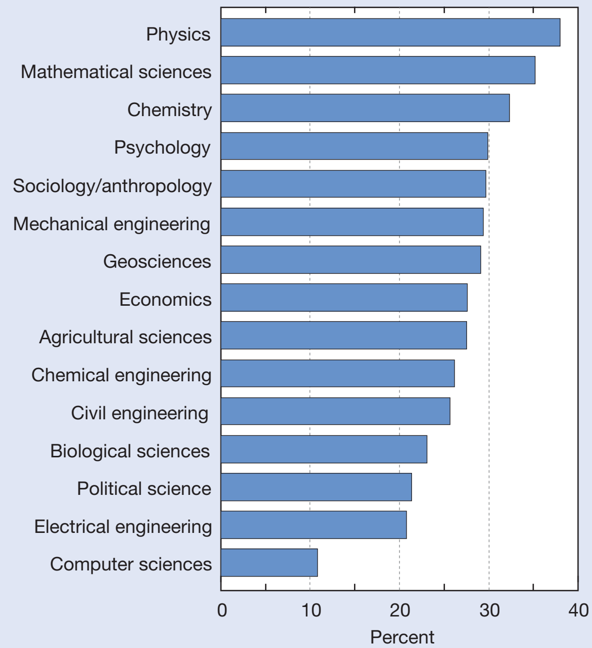
Figure 3-49
Employed S&E degree holders older than 50, by selected field: 2003



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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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 3-22 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 62, 50% of S&E bachelor's degree recipients no longer work full-time. Similarly, by age 62, 50% of master's degree recipients do not work full-time either. However, only at age 66 do S&E doctoral degree holders reach the 50% not working full-time. Longevity also differs by degree level when measuring the number of individuals who leave the workforce entirely: half of S&E bachelor's degree recipients had left the workforce entirely by age 65, but the same proportion of master's degree and doctoral degree holders did not do so until ages 66 and 70, respectively. Formal retirement also occurs at somewhat higher ages for doctoral degree holders: more than 50% of bachelor's and master's degree recipients have "retired" from jobs by age 62, compared with age 65 for doctoral degree holders.

Figure 3-50 shows data on S&E degree holders working full-time at ages 55 through 69. For all degree levels, the portion of S&E degree holders who work full-time declines fairly steadily by age, but after age 55 full-time employment for doctoral degree holders becomes significantly greater than for bachelor's and master's degree holders. At age 69, 21% of doctoral degree holders work full-time, compared with 16% of bachelor's or master's degree recipients.

Table 3-22
Retirement age for individuals with highest degree in S&E, by education level and age: 2003

	First age at which >50% were—		
Highest degree	Not working full time	Not in labor force	Retired from any job
Bachelor's	61	65	62
Master's	62	66	62
Doctorate	66	70	65

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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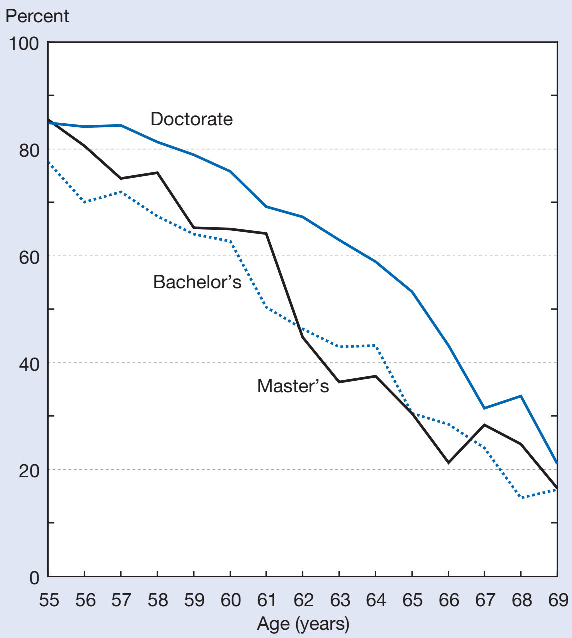
Table 3-23 shows rates at which doctoral degree holders left full-time employment, by sector of employment, between 1999 and 2001 and 2001 and 2003. At nearly every age and sector of employment, a smaller proportion of doctoral degree holders left full-time employment in the more recent period than between 1999 and 2001. More examination is needed to understand why this change might have occurred.

Although many S&E degree holders who formally retire from one job continue to work full- or part-time, this occurs most often among individuals younger than age 63 (table 3-24). However, among "retired" individuals ages 71–75, 12% keep working either full-time or part-time among bachelor's degree holders, 17% among master's degree holders, and 19% among doctoral degree holders.

Figure 3-50
Older S&E degree holders working full time, by degree level: 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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Global S&E Labor Force and the United States

"There is no national science just as there is no national multiplication table" (*Anton Chekhov 1860–1904*).

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 among the world's economies. The rapid development of the capacity to make scientific and 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, from

Table 3-24
Retired individuals with highest degree in S&E who continue to work, by education level and age: 2003
(Percent)

Age (years)	Bachelor's Part time	Bachelor's Full time	Master's Part time	Master's Full time	Doctorate Part time	Doctorate Full time
50–55	8.2	51.1	14.0	62.3	22.6	50.6
56–62	13.8	28.9	15.8	35.3	24.1	33.1
63–70	10.7	9.0	18.3	11.8	21.2	12.9
71–75	9.0	2.6	9.3	8.0	14.7	4.7

NOTE: Retired are those who said they had ever retired from any job.

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 3-23
Employed S&E doctorate holders leaving full-time employment, by employment sector and age 2 years previous: 2001 and 2003
(Percent)

Age (years)	2001 (1999 employment sector) All sectors	Education	Private	Government	2003 (2001 employment sector) All sectors	Education	Private	Government
51–55	9.7	8.0	14.6	6.5	6.3	3.1	10.2	5.1
56–60	16.7	13.2	23.2	17.4	10.3	7.4	14.2	9.7
61–65	34.8	36.8	37.9	22.9	25.6	22.7	32.3	19.9
66–70	54.4	59.3	47.7	52.5	33.6	37.9	29.7	15.0
71–73	51.6	50.7	S	S	36.9	34.9	38.6	41.1

S = data suppressed for reasons of reliability

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients, 1999, 2001, and 2003.

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increases in foreign economic development, and from expanding international migration of highly trained scientists and engineers.

Other chapters in *Science and Engineering Indicators 2008* provide indirect indicators on the global S&E labor force. Production of new scientists and engineers through university degree programs is reported in chapter 2 (Higher Education in Science and Engineering). Indicators of R&D performed by the global S&E labor force are provided in chapter 4 (in sections on R&D expenditures and alliances), chapter 5 (in sections on publications output and international collaborations), and chapter 6 (in section on patenting activity).

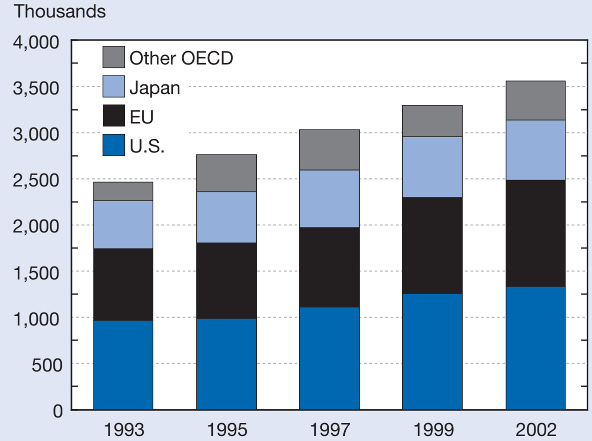
Section Overview

Although the number of researchers employed in the United States has continued to grow faster than the growth of the general workforce, this is still a third less than the growth rate for researchers across all Organisation for Economic Co-operation and Development (OECD) countries. Foreign-born scientists in the United States are more than a quarter, and possibly more than a third, of the S&E doctoral degree labor force, and are even more prevalent in many physical science, engineering, and computer fields. Along with the increases in graduate education for domestic and foreign students elsewhere in the world (as discussed in chapter 2), national governments and private industry have increased their efforts to recruit the best talent from wherever it comes. As a result, the United States is becoming less dominant as a destination for migrating scientists and engineers.

Counts of Global S&E Labor Force

Few direct measures of the global S&E labor force exist; however, reports on the number of researchers in OECD member countries constitute one source of data. From 1993 to 2002, the number of researchers reported in OECD countries increased by 33.3% (a 4.2% average annual rate of increase) from approximately 2.5 million to 3.6 million (figure 3-51). During this same period, approximately comparable U.S. estimates increased 38.3% (a 3.7% average annual rate of increase) from about 1.0 million to 1.3 million. Of course, many scientists and engineers are in non-OECD countries, and counts of these individuals are harder to obtain. Figure 3-52, based on estimates by Robert Barro and Jong-Wha Lee (Barro and Lee 2000), shows the global distribution of tertiary education graduates (roughly equivalent in U.S. terms to individuals who have earned at least technical school or associate's degrees and also including all degrees up to doctorate) in 2000, or the most recently available data. About one-fourth of the tertiary graduates in the labor force were in the United States. However, the next three largest countries in terms of tertiary education are China, India, and Russia, which are all non-OECD members.

Figure 3-51
Researchers in OECD countries: Selected years, 1993–2002



EU = European Union; OECD = Organisation for Economic Co-operation and Development

NOTE: 1999 and 2002 numbers reflect EU-25 membership.

SOURCE: OECD, Main Science and Engineering Indicators (2006).

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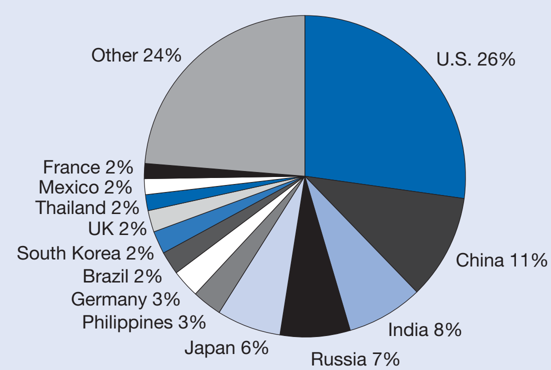
Figure 3-52
Tertiary-educated population more than 15 years old: 2000 or most recent year



UK = United Kingdom

SOURCE: Adapted from Barro RJ, Lee J, International Data on Educational Attainment: Updates and Implication, Center for International Development (2000).

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R&D Employment by Multinational Corporations

R&D is often done for companies that are based outside the country in which the researcher resides. Comparable data is available every 5 years on two aspects of this common phenomenon: the employment of R&D workers by U.S. firms at their foreign subsidiaries and by foreign firms at their subsidiaries in the United States.[16] This information is derived from the Bureau of Economic Analysis surveys that are discussed in more detail in chapter 4.

It is worthwhile noting that these measures capture only some parts of industrial R&D employment for global economic purposes. R&D is often done by a company in one country under contract to a company in another country, in arrangements that range from simple consulting work to strategic collaborations. R&D is also done to develop products and services for specific foreign markets. Neither work is captured by measures that only look at a company's own subsidiaries. Nevertheless, R&D work by subsidiaries is important in itself, and may be an indicator of other international R&D activity.

R&D employment in the United States by U.S. subsidiaries of foreign firms rose from 105,100 in 1994 to a peak of 135,300 in 1999, then declined to 123,900 in 2004, for an 18% net increase over the decade (figure 3-53). Over the same 10 years, R&D employment by U.S. firms at their foreign subsidiaries grew 75.8%, from 102,000 to 179,300. Most of the R&D employment at foreign subsidiaries of U.S. firms is in Europe (63.5%), followed by Asia (17.8%) and Canada (10.3%).

Although the growth in R&D employment abroad by U.S. firms from 1994 to 2004 was fairly rapid (a 5.8% average annual growth rate), it does not represent a very large shift in the location of R&D employment by U.S. multinational corporations (MNCs). Over the same 10 years, domestic R&D employment of the same corporations increased by 31.0% (a 2.7% average annual rate) to 818,700 in 2004 (figure 3-54). The proportion of the total R&D employment of U.S. MNCs that is abroad increased from 14.0% in 1994 to 18.0% in 2004.

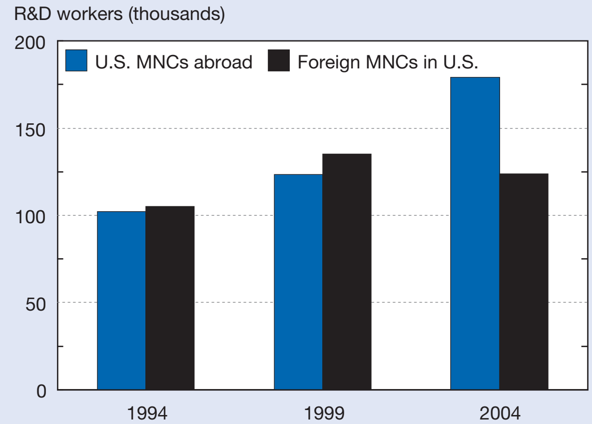
The data in both figures 3-53 and 3-54 are consistent with two trends discussed in this chapter: rapid growth in S&T employment in the United States occurring at the same time as a general expansion of the ability to do S&T work throughout the world.

Migration to the United States

Migration of skilled S&E workers across borders is increasingly seen as a major determinant of the quality and flexibility of the labor force in most industrial countries. The knowledge of scientists and engineers can be transferred across national borders more easily than many other skills. Additionally, cutting-edge research and technology inevitably create unique sets of skills and knowledge that can be transferred through the physical movement of people. 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. Many countries have both increased their research investments and also made high-skilled migration an important part of national economic strategies. An NSB taskforce noted that "[g]lobal 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 Canada and Japan.")

The nature of high-skilled migration makes it difficult to count foreign-born scientists and engineers working in the United States. According to an estimate based on data from the Census Bureau's American Community Survey, slightly over one million individuals in S&E occupations (26% of all college-educated workers in these occupations)

Figure 3-53
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

SOURCE: Bureau of Economic Analysis, Survey of Foreign Direct Investment in the United States, and Survey of U.S. Direct Investment Abroad, 2004 (preliminary data).

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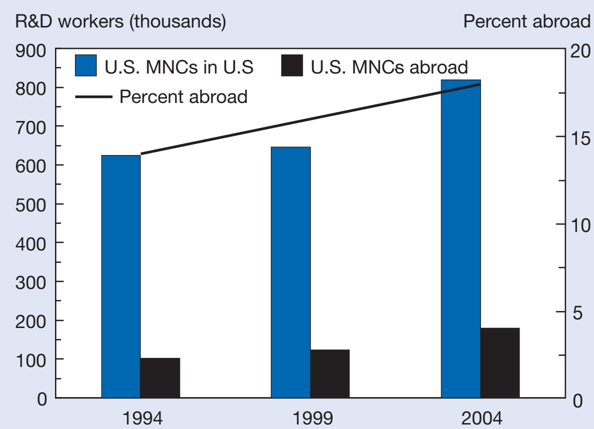
Figure 3-54
R&D employment of U.S. MNCs in United States and at their foreign affiliates: 1994, 1999, and 2004



MNC = multinational corporation

SOURCE: Bureau of Economic Analysis, Survey of Foreign Direct Investment in the United States, and Survey of U.S. Direct Investment Abroad, 2004 (preliminary data).

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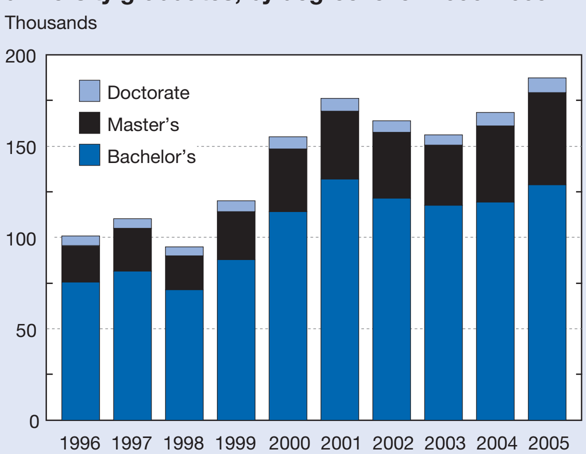
High-Skill Migration to Canada and Japan

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

In 2005, Canada issued permanent visas to 189,000 immigrants with university degrees (figure 3-55). The ratio of such visas to the total Canadian population far exceeded the comparable ratio in the United States. For the U.S. ratio to reach the Canadian level, the United States would have had to grant 1.7 million permanent visas to college graduates in 2005; in fact, it issued only 891,000 permanent visas to adults at all education levels. The Canadian government estimated the number of workers in Canada with high-skilled temporary visas (44,000) had increased by 63% during the 1995–2005 decade (figure 3-56). This number of temporary workers is particularly notable since Canada also has relatively quick and easy pathways for those on temporary visas to obtain permanent visas. In addition, many types of workers who would need temporary work visas in the United States, such as advanced degree recipients from U.S. graduate schools, would usually be able to bypass temporary visas and qualify for a "skilled worker" permanent visa based upon Canada's point system.*

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 2003, 268,045 workers entered Japan in high-skilled temporary visa categories, a 93% increase compared with 1992 (figure 3-57). For comparison purposes, this equals half of 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) (Fuess 2001).

Figure 3-55
Canadian awards of permanent residency to university graduates, by degree level: 1996–2005



SOURCE: Citizenship and Immigration Canada, Facts and Figures 2005 (2006).

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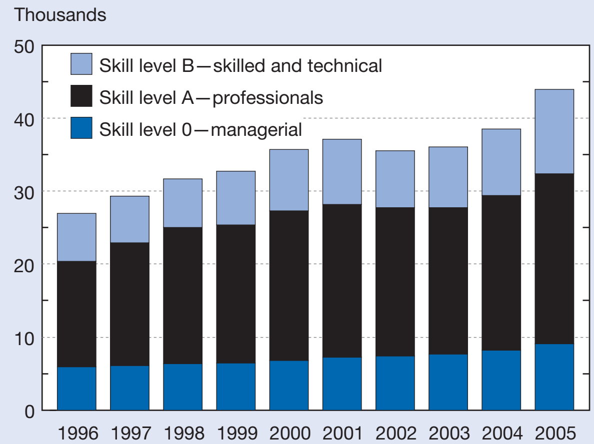
Figure 3-56
Stock of workers in Canada on high-skilled temporary work visas, by skill level: 1996–2005



SOURCE: Citizenship and Immigration Canada, Facts and Figures 2005 (2006).

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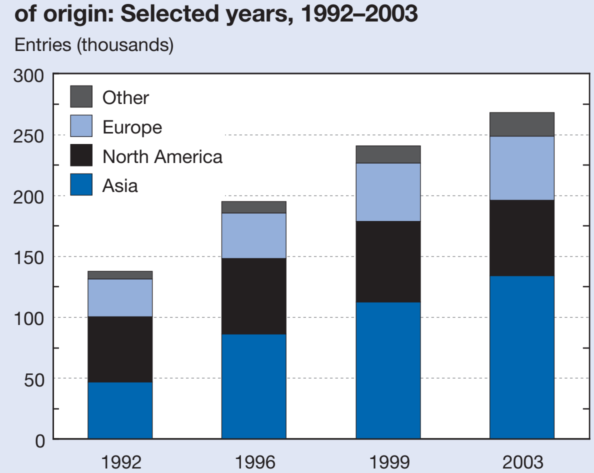
Figure 3-57
High-skilled workers with visas in Japan, by region of origin: Selected years, 1992–2003



SOURCES: Fuess SM Jr, Highly Skilled Workers and Japan: Is There International Mobility? University of Nebraska and Institute for the Study of Labor (2001); and *Japan Statistical Yearbook*, Ministry of Internal Affairs and Communications, Japan (2004).

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* See http://www.cic.gc.ca/english/immigrate/skilled/assess/index.asp, accessed 11 June 2007.

were foreign born (table 3-25). The proportions ranged from 19% among bachelor's degree holders to 41% at the doctorate level. However, these estimates are likely to be on the low side, because census occupational classifications miss many individuals who use S&E knowledge extensively in their jobs. For example, most university professors teaching in S&E fields are excluded from census S&E occupational counts, because they are classified as "postsecondary teacher." NSF 2003 SESTAT data, on the other hand, show 4.9 million college graduates in S&E occupations but 12.9 million who said they needed at least a bachelor's level of S&E knowledge in their jobs.

NSF's labor force surveys (SESTAT) gather information on education and workplace activities that can be used to identify the broader S&E labor force and that goes beyond the data in the decennial census or the American Community Survey. However, SESTAT data also have important limitations. SESTAT excludes individuals with foreign degrees who were not in the United States for the previous decennial census. As a result, SESTAT surveys miss foreign-educated S&E workers who have entered the country since the most recent census. Because high-skilled migrants often come to the United States for just a few years to pursue training or work, this can be a serious limitation. For example, the 1999 SESTAT survey provided an estimate of 15% foreign-born among college-educated individuals in S&E occupations; the corresponding census estimate is about 22% (table 3-25). In the 2000 census, about 43% of all college-educated, foreign-born individuals in S&E occupations (62% of doctorate holders) reported arriving in the United States after 1990. The 1999 NSF/SRS SESTAT estimates in table 3-25 include these post-1990 arrivals only if their degrees are from a U.S. institution.

In contrast, 2003 SESTAT estimates of the foreign born in S&E occupations are quite close to estimates from the 2000 census (table 3-25). By level of degree, SESTAT estimates are only 1 to 2 percentage points different from comparable census estimates.

The 2003 SESTAT survey also provides an estimate of foreign-born S&E degree holders by field of degree (table 3-26). The foreign born are over half of all holders of doctorates in engineering (including 57% of doctorate holders in electrical engineering) and in computer science. 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% of those in physics/astronomy and 28% in electrical engineering.

Origins of S&E Immigrants

Immigrant scientists and engineers come from a broad range of countries. Figure 3-58 shows country-of-birth for the 2.2 million foreign-born S&E degree holders in the United States, 276,000 of whom have doctorates. Although no one source country dominates, 16% came from India and 11% came from China. Source countries for foreign-born holders of S&E doctorates are somewhat more concentrated, with China providing 22% and India 14%.

Although many foreign-born scientists and engineers in the United States first came to the United States to study, many other individuals came to the United States after receiving their university training abroad (table 3-27). This fact is important both to understanding the various ways that the United States recruits highly skilled workers from around the world, but also to understanding how these workers help to connect the United States to universities and research institutions around the world. (See sidebar "Foreign Scientists at the Max Planck Society" for a discussion of the importance of foreign scientists in Germany's research system).

Table 3-25
NSF and Census Bureau estimates of foreign-born individuals in S&E occupations, by education level: Selected years, 1999–2005
(Percent)

			2003		2005
Education	1999 NSF/SRS SESTAT	2000 Census 5% PUMS	NSF/SRS SESTAT	Census American Community Survey	Census American Community Survey
All college educated	15.0	22.4	22.5	25.0	25.5
Bachelor's	11.3	16.5	16.3	18.8	19.1
Master's	19.4	29.0	29.0	32.0	32.7
Doctorate	28.7	37.6	35.6	39.5	41.1

NSF/SRS = National Science Foundation, Division of Science Resources Statistics; PUMS = Public Use Microdata Sample; SESTAT = Scientists and Engineers Statistical Data System

NOTES: Includes all S&E occupations other than postsecondary teachers because field of instruction not included in occupation coding for 2000 Census or American Community Survey. NSF/SRS SESTAT S&E occupations adjusted to be compatible with Census and American Community Survey occupations. All college educated includes those with professional degrees.

SOURCES: NSF/SRS, SESTAT database, 1999 and 2003, http://sestat.nsf.gov; Census Bureau, PUMS, 2000; and American Community Survey, 2003, 2005.

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Table 3-26
Foreign-born proportion of total with highest degree in S&E, by field and education level: 2003
(Percent)

Field	All degree levels	Highest degree: Bachelor's	Master's	Doctorate
All S&E	18.9	15.2	27.2	34.6
Engineering	26.7	21.5	38.3	50.6
Chemical	25.7	17.5	49.2	47.0
Civil	24.9	19.7	39.5	54.2
Electrical	34.0	28.1	45.9	57.0
Mechanical	22.9	19.5	34.2	52.2
Life sciences	16.7	12.6	21.2	36.2
Agriculture	11.7	8.8	15.6	32.7
Biological sciences	19.1	14.7	23.9	37.4
Mathematics/computer sciences	25.8	19.3	40.4	47.5
Computer sciences	29.9	22.3	46.5	57.4
Mathematics	18.5	14.4	25.2	43.1
Physical sciences	23.0	16.9	28.9	36.9
Chemistry	25.5	18.2	42.0	37.0
Geosciences	11.4	8.3	13.0	26.2
Physics/astronomy	32.2	26.6	34.4	40.1
Social sciences	11.5	10.8	13.3	16.9
Economics	21.6	19.7	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

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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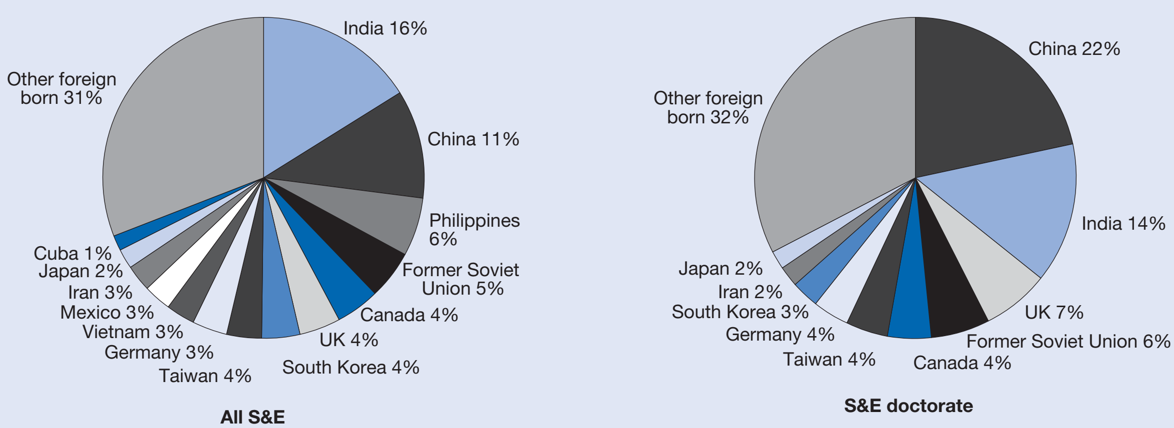
Across all levels of degree, 41% of the university-educated foreign born in the United States had their highest degree from a foreign educational institution and 55% had at least one foreign degree. At the highest level of education, 36% of foreign-born doctorate holders earned their doctorates from a foreign school.

The prevalence of foreign degrees among foreign-born S&E degree holders has been increasing over time (figure

Figure 3-58
Foreign-born individuals with highest degree in S&E living in United States, by place of birth: 2003



UK = United Kingdom

SOURCE: National Science Foundation, Division of Science Resources Statistics, SESTAT database, 2003, http://sestat.nsf.gov. See appendix table 3-8.

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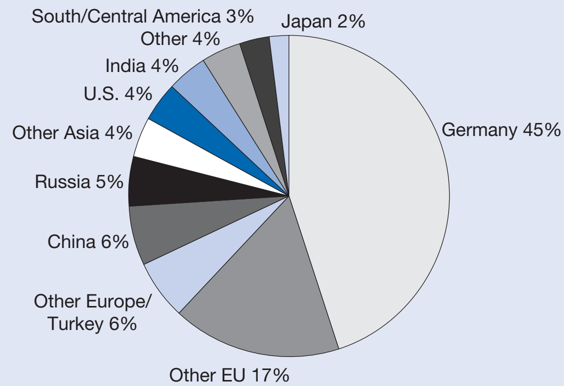
Foreign Scientists at the Max Planck Society

In many European countries, research institutes that are outside of formal universities play a very large role in basic research and graduate training. Research institutes often also have a major role in recruiting international scientists and engineers, very often to work in laboratories and classrooms where English is the working language. Germany's Max Planck Society is an example of this phenomenon.

The Max Planck Society is a nonprofit research organization mostly funded by the German government. It is a notable part of both German and global science, with a budget of just under $2 billion in 2006, and with research performed at 78 separate Max Planck Institutes. The 78 institutes are run by 260 Scientific Directors, 28% of whom (in October 2006) are foreign citizens. Hierarchically just below the Scientific Directors are approximately 4,300 staff scientists, 27% of whom are foreign citizens. However, at the junior and guest scientist level, over half of the 10,900 are foreign citizens (54%, see figure 3-59). Less than one-third of these foreign citizens are from other European Union countries, with China, Russia, the United States, and India the largest non-EU countries of citizenship.

Figure 3-59
Citizenship of junior and guest scientists at Max Planck Institutes: 2005



EU = European Union

SOURCE: Max Planck Society, Division of International Relations.

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3-60). 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 3-27
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 degree levels ...	41.4	54.8	69.2
Bachelor's	47.9	49.7	65.8
Master's	26.8	58.6	74.2
Professional	49.5	58.5	63.3
Doctorate	36.3	78.6	93.0

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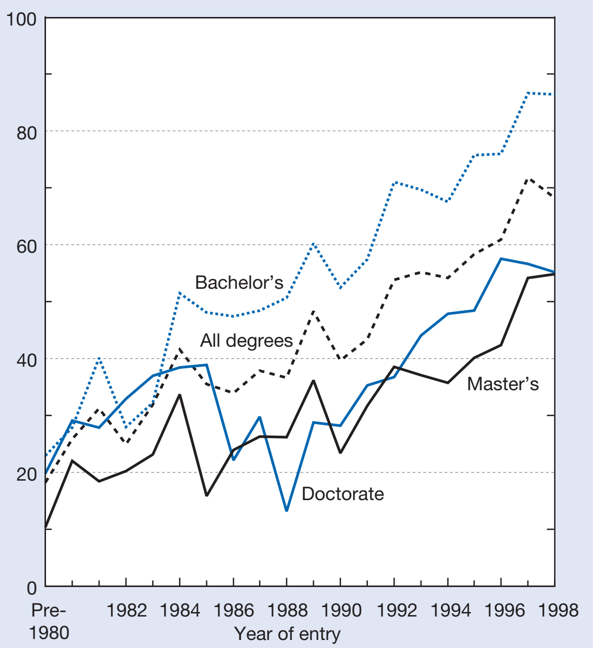
Citizenship and Visa Status of Foreign-Born Scientists and Engineers in the United States

The length of time 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 shown in figure 3-61, 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 hire only citizens: the federal government and private companies engaged in defense and other classified research.

The length of time before acquiring citizenship is not necessarily because of a lack of interest on the part of the foreign-born scientists and engineers. Consider a hypothetical case of a bachelor's-level engineer who enters the United States with a student F visa to pursue a doctorate, who spends 6 years completing the doctorate, followed by 2 years in a postdoc position, and then is hired by an employer for a permanent job on a temporary work visa. The employer applies for a permanent work visa for their new worker, who receives it 2 years after starting work. Now, 10 years after entering the United States, a 5-year waiting period begins after receiving a permanent visa, before the engineer can apply for citizenship. The engineer applies soon after becoming eligible, and after 1 year, becomes a U.S. citizen, 16 years after entry to the United States.

Figure 3-60
Foreign-born S&E degree holders with highest degree from foreign institution, by year of entry to United States: 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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The importance of temporary visas is also shown in figure 3-60. Five years after entry to the United States, half of the foreign born with S&E degrees are still on temporary visas. Among those who have been in the United States for 10 years, 12% are on some form of temporary visa.

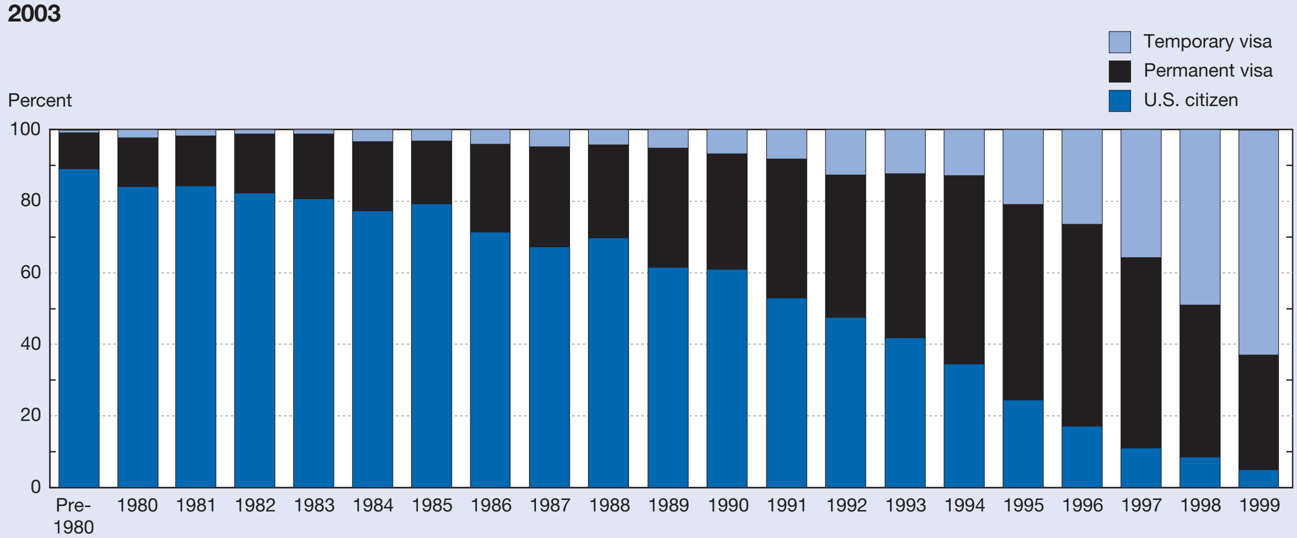
Temporary Work Visas

In recent years, policy discussion has focused on the use of various forms of temporary work visas by foreign-born scientists. Many newspaper and magazine stories have been written about the H-1B visa program, which provides visas for up to 6 years for individuals to work in occupations mostly requiring at least a bachelor's degree. A wide variety of skilled workers use H-1B visas; those in computer occupations have represented at peak levels a little over half, and at lowest level a little less than one-quarter, of new H-1B visas issued.

Over two-thirds of the slightly more than 110,000 recipients of H-1B visas in 2006 are in S&T occupations (figure 3-62). A large portion of the remainder are either in closely related fields such as medicine and health (5%) or have occupational titles that often mask the S&T expertise required, such as college and university education (8%) and various managerial, administrative, and professional and technical occupations (13%).

In 2006, 51% of new H-1B recipients were in computer-related occupations, including 48% in the United States Citizenship and Immigration Services occupational category of "occupations in systems analysis and programming," which includes many S&E occupations, such as computer scientist,

Figure 3-61
Distribution of foreign-born S&E degree holders, by citizenship/visa status and year of entry to United States: 2003



NOTE: Although some data on foreign-born S&E degree holders available through 2003, 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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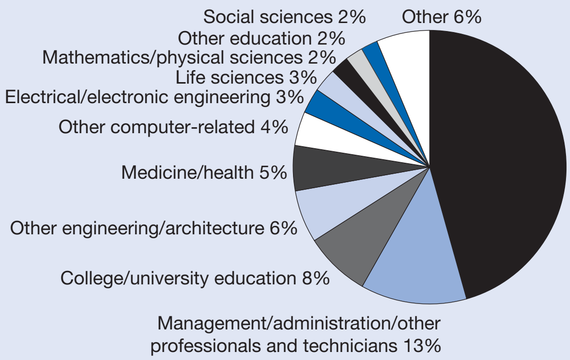
Figure 3-62
Distribution of occupations of new recipients of U.S. H-1B temporary work visas: FY 2006



NOTE: Total 2006 new H-1B visas approved: 113,593.

SOURCE: Citizenship and Immigration Services, special tabulations.

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Table 3-28
Temporary visas issued in categories likely to include scientists and engineers, by visa type: FY 2006

Visa type	Category	Visas
Work		
H-1B	Specialty occupations requiring bachelor's equivalent	135,421
L-1	Intracompany transfers	72,613
O-1	People of extraordinary ability	6,961
O-2	Workers assisting O-1	3,726
TN	NAFTA high-skilled visa (most from Canada)	2,972
Student/exchange		
F-1	Students	273,870
J-1	Exchange visitors	309,951

NAFTA = North American Free Trade Agreement

NOTES: Actual numbers of individuals entering United States likely to be lower, and H-1B numbers in particular include some visa reissuances. U.S. Citizenship and Immigration Services numbers show 109,614 new H-1B issuances in FY 2006.

SOURCE: Department of State, Immigrant Visa Control and Reporting Division, administrative data (2007).

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and technician occupations, such as programmer. This actually represents an increase in recent years (from a low of 25% in 2002) in the proportion of new H-1B visas going to computer-related occupations. In 2006, 44% of those receiving new H-1B visas in computer-related occupations had master's degrees, and a little more than 1% had doctoral degrees.

An important change to the H-1B visa program took effect on October 1, 2003: the annual ceiling on admissions fell from 195,000 to 65,000 because of the expiration of legislation that had allowed the additional visas. Universities and academic research institutions are exempt from this ceiling in their own hiring, and in 2005 an additional 20,000 exemptions from the H-1B quotas were added for students receiving master's degrees or doctorates from U.S. schools. However, even with these extra allowances, the H-1B visa ceiling constrains the use of foreign scientists and engineers by private industry for R&D located in the United States. It also makes it more difficult for foreign students to stay in the United States after their studies, because long delays in the visa process usually makes it impractical to be directly hired with a permanent work visa without first being a temporary worker. For FY 2008, the ceiling on H-1B visas was reached in the first day that applications were accepted.

Scientists and engineers may also receive temporary work visas through intracompany transfer visas (L-1 visas), high-skilled worker visas under the North American Free Trade Agreement (TN-1 visas, a program previously primarily for Canadians, which granted full access for Mexican professionals in 2004), work visas for individuals with outstanding abilities (O-1 visas), and several smaller programs. In addition, temporary visas are used by researchers who may also be students (F-1 and J-1 visas) or postdocs, and by visiting scientists (mostly J-1 visas but often H-1B visas or other categories). State Department counts of visas issued for each of these categories are shown in table 3-28. For all types of visas, the actual number of individuals using them is less than the number issued for any number of reasons. For example, some individuals may have job offers from employers in more than one country, and choose not to foreclose any options until a visa is certain.

Characteristics of Workers Issued New H-1B Visas

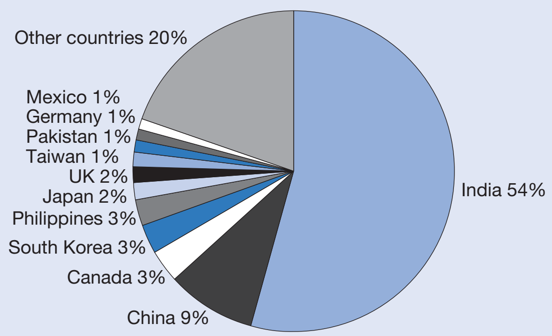
Education Levels. In FY 2006, 57% of new H-1B visa recipients had advanced degrees, including 41% with master's degrees, 5% with professional degree, and 11% with doctorates. This degree distribution differs by occupation, with 87% holding advanced degrees in math and physical sciences occupations (47%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

For those with advanced degrees, it may be possible to infer the proportion without prior U.S. education by examining the number seeking to be counted against the larger quota for those with advanced degrees from U.S. schools. In FY 2006, 59% of doctorate holders, 21% of professional degree holders, and 52% of master's degree holders indicated on their H-1B applications that their degree was from a U.S. school. This both documents 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 in bringing the foreign educated to the United States.

H-1B Country of Citizenship. H1-B visa recipients have a diverse set of citizenships, with a large representation of Indian citizens overall and Chinese citizens among those holding doctorates (figures 3-63 and 3-64). Across all recipients of new H-1B visas in FY 2006, 54% were Indian citizens, followed by 9% for China, and 3% each for Canada,[17] South Korea, and the Philippines. Among the 12,500 doctorate holders receiving new H-1B visas, 32% were Chinese citizens, followed by 13% for India, 7% for South Korea, 5% for Canada, and 3% each for Germany, the United Kingdom, and Japan. Most doctorate holders coming from countries with large university systems had low rates of claiming a U.S. degree, 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 U.S. degrees on their visa applications.

H-1B Salaries. Salaries paid to new recipients of H-1B temporary work visas are shown in table 3-29 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 have been previously reported based on applications from firms to the Department of Labor,

Figure 3-63
Country of citizenship for new recipients of U.S. H-1B temporary work visas: 2006

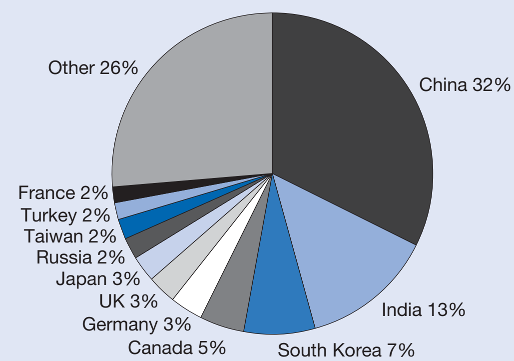


UK = United Kingdom

SOURCE: Citizenship and Immigration Services, special tabulations.

Science and Engineering Indicators 2008

Figure 3-64
Country of citizenship for new recipients of U.S. H-1B temporary work visas holding doctorates: FY 2006



UK = United Kingdom

SOURCE: Citizenship and Immigration Services, special tabulations.

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Table 3-29
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
Computer-related occupations	56,200	56,000	55,600	71,200	80,400
Managers/officials nec	78,000	70,800	81,500	107,500	105,300
Miscellaneous professional/technical/managerial	64,400	54,800	68,800	na	84,500
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
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
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
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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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 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 decline experienced after FY 2001 (which ended on 30 September 2001). In FY 2006, student visa applications for the first time exceeded the previous 2001 high, and visa-rejection rates were below those experienced by applicants in FY 2001 (20.1% versus 22.9% rejections in 2001) (table 3-30). Relatively few potential students are formally rejected because of security issues, but U.S. law also requires student visa applicants to prove that they are unlikely to want to stay in the United States after the completion of their studies. In addition to reductions in the rejection rate, applications for student visas are likely to have been favorably affected by the rapid growth of demand for university education elsewhere in the world, by rising incomes in East and South Asia, and by the declines in the value of the U.S. dollar (which reduces the cost of a U.S. education for foreign students).

Stay Rates for U.S. Doctoral Degree Recipients With Temporary Visas

How many foreign students who receive S&E doctorates from U.S. schools remain in the United States? According to a report by Michael Finn (2007) of the Oak Ridge Institute for Science and Education, 65% of 2000 U.S. S&E doctoral degree recipients with temporary visas remained in the United States in 2005. This is up from a 61% 5-year stay rate found in 2003 (figure 3-65). The 5-year stay rate has been increasing for S&E doctorate recipients from a wide number of countries.

Table 3-30
Initial applications for student/exchange visitor visas: FY 2001–06

	Student (F-1)		Exchange visitor (J-1)	
Year	Applications	Refused (%)	Applications	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
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

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.

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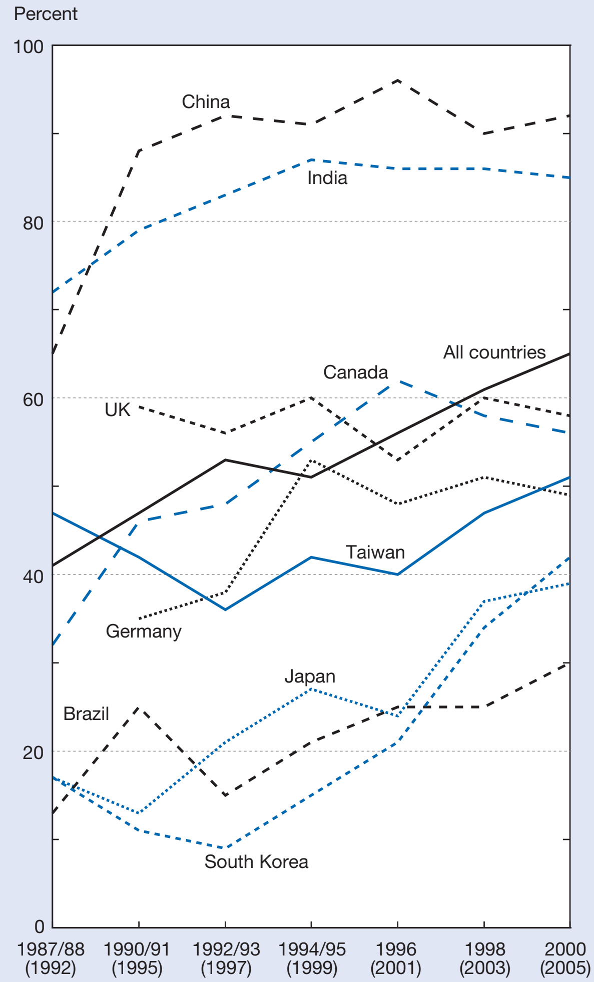
Figure 3-65
Five-year stay rates for U.S. S&E doctorate recipients with temporary visas, by place of origin: 1992–2005



UK = United Kingdom

NOTE: Year of observation in parentheses.

SOURCE: Finn M, Stay Rates of Foreign Doctorate Recipients from U.S. Universities: 2005, Oak Ridge Institute for Science and Education (2007).

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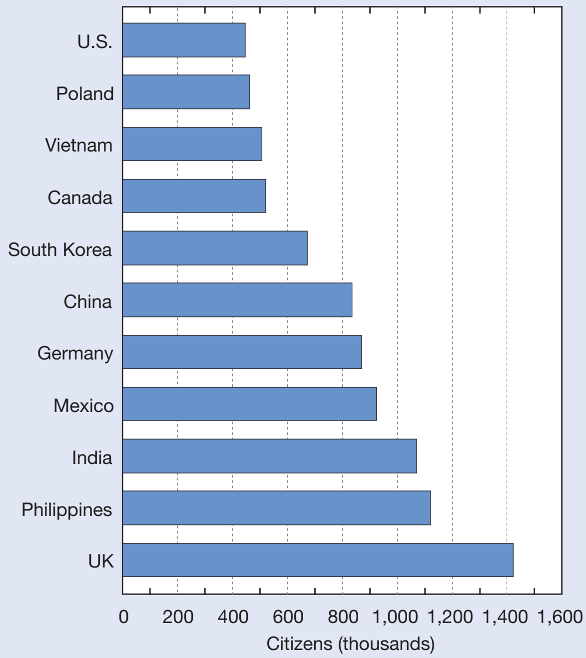
Highly Skilled Migrants in OECD Countries

Estimates of international migrants residing in OECD countries were made by Docquier and Marfouk (2004) using data from the various national censuses. Based on their data, figure 3-66 shows the 11 countries with the largest number of citizens found residing abroad in OECD countries in 2000. With 1.4 million tertiary-educated citizens in other OECD countries, the United Kingdom has the largest high-skilled diaspora. Although originally used to describe much less voluntary dispersals of population in history, high-skilled diaspora is increasingly used to describe networks of contact and information flow that form among the internationally mobile portion of a country's nationals. These networks can

Figure 3-66
Top countries of origin of persons with tertiary-level education or better who reside abroad in OECD countries: 2000



OECD = Organisation for Economic Co-operation and Development; UK = United Kingdom

SOURCE: Docquier F, Marfouk A, International Migration by Educational Attainment (1990–2000), Institute for the Study of Labor (2004).

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provide advantages for a country that help to mitigate the loss of human capital through migration.

The United States, ranking number 11 with 448,000 tertiary-educated citizens in other OECD countries, has a fairly small high-skilled diaspora compared with its population, and particularly compared with its number of educated workers.

Conclusion

The U.S. S&E labor market continues to grow, both in absolute numbers and as a percentage of the total labor market. Although the most dramatic growth has occurred in the IT sector, other areas of S&E employment also have recorded strong growth over the past two decades.

In general, labor market conditions for individuals with S&E degrees improved during the 1990s. (These conditions have always been better than the conditions for college graduates as a whole.) However, engineering and computer science occupations have been unusually affected by the recent recession, causing the unemployment rate for individuals in all S&E occupations to reach a 20-year high of 4.6% in 2003 before dropping to 3.0% in 2004. Labor market conditions for new doctoral degree recipients have been good according to most conventional measures; for example, the vast majority of S&E doctoral degree holders are employed and doing work relevant to their training. However, these gains have come in the nonacademic sectors. In nearly all fields, the proportion of doctoral recipients that obtain tenure-track academic positions, long a minority, has continued to decline. The globalization of the S&E labor force continues to increase as the location of S&E employment becomes more internationally diverse and S&E workers become more internationally mobile. These trends reinforce each other as R&D spending and business investment cross national borders in search of available talent, as talented people cross borders in search of interesting and lucrative work, and as employers recruit and move employees internationally. Although these trends appear most strong in the high-profile international competition for IT workers, they affect every S&T area.

The rate of growth of the S&E labor force may decline rapidly over the next decade because of the aging of individuals with S&E educations, as the number of individuals with S&E degrees reaching traditional retirement ages is expected to triple. If this slowdown occurs, the rapid growth in R&D employment and spending that the United States has experienced since World War II may not be sustainable.

The growth rate of the S&E labor force would also be significantly reduced if the United States becomes less successful in the increasing international competition for immigrant and temporary nonimmigrant scientists and engineers. Many countries are actively reducing barriers to high-skilled immigrants entering their labor markets at the same time that entry into the United States is becoming somewhat more difficult. Despite this, many recent statistics suggest that the United States is still an attractive destination for many foreign scientists and engineers.

Slowing of the S&E labor force growth would be a fundamental change for the U.S. economy, possibly affecting both technological change and economic growth. Some researchers have raised concerns that other factors may even accentuate the trend (NSB 2003). Any sustained drop in S&E degree production would produce not only a slowing of labor-force growth, but also a long-term decline in the S&E labor force.

Notes

1. Once a decade, NSF's surveys include non-S&E degree holders, and this was true in 2003.

2. 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%.

3. Since their growth rate projection is near the overall average, engineers and physical scientists are classified as having average growth by BLS.

4. Not all analyses of changes in earnings are able to control for level of skill. For example, data on average earnings within occupation over time may not be a good indicator of labor market conditions if the average experience level was to fall for workers in a rapidly growing occupation.

5. Many comparisons using Census Bureau data on occupations are limited to looking at "nonacademic S&E occupations" because the occupation of "postsecondary teacher" has not been broken out into subjects in most recent census surveys.

6. Specifically presented here are coefficients from linear regressions using the 2003 Scientists and Engineers Statistical Data System (SESTAT) data file of individual characteristics on the natural log of reported full-time annual salary as of October 2003.

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

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

9. Included were 20 dummy variables for NSF/SRS SESTAT field-of-degree categories (out of 21 S&E fields; the excluded category in the regressions was "other social science").

10. Variables added here include 34 SESTAT occupational groups (excluding "other non-S&E"), whether individuals said their jobs were closely related to their degrees, whether individuals worked in R&D, whether their employers had fewer than 100 employees, and their employers' U.S. census region.

11. 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, and citizenship. Also, sex, nativity, and ethnic minority variables are included in all regression equations.

12. Although the formal job title is often postdoctoral fellowship or research associate, many different titles are used. This chapter will generally use the shorter, more commonly used, and best understood name, "postdoc." A postdoc has traditionally been defined as a temporary position, after completion of a doctorate, taken primarily for additional training—a period of advanced professional apprenticeship.

13. Some part of the citizen and permanent resident postdoc population in the fall of 2005 will not be counted even in 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.

14. A 2003 survey conducted by the Sigma Xi honor society, which was nonrepresentative and likely to undercount foreign postdocs, found that 46% of responding postdocs had received their doctorate from a non-U.S. institution.

15. 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 postdocs.

16. Bureau of Economic Analysis R&D employment data are counts of full-time and part-time employees that devote the majority of their time to R&D activities.

17. Although Canadians with university degrees can use the easier-to-obtain TN visa to work in the United States, many prefer to seek H-1Bs, perhaps in part because TN visa holders are not permitted to apply for permanent resident ("green card") status. There is no preferential path to a permanent work visa for H-1B holders; they are not forbidden to seek a green card.

Glossary

EU-25: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and the UK.

High-skilled diaspora: Increasingly used to describe networks of contact and information flow that form among the internationally mobile portion of a country's nationals. These networks can provide advantages for a country that help to mitigate any loss of human capital through migration.

Involuntary employment outside of field: Those either employed outside their field because a job in that field was not available or employed part time in their field because full-time work was not available.

Stay rate: The proportion of students on temporary visas who have stayed in the United States 1–5 years after doctoral degree conferral.

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

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