Chapter 3
Science and Engineering Labor Force

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Highlights

The science and engineering workforce in the United Sates has grown rapidly, both over the last half century and the last decade.

- From 1950 to 2000, employment in S&E occupations grew from fewer than 200,000 to more than 4 million workers, an average annual growth rate of 6.4%.
- Between the 1990 and 2000 censuses, S&E occupations continued to grow at an average annual rate of 3.6%, more than triple the rate of growth of other occupations.
- 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. S&E bachelor's degrees grew at a 1.4% average annual rate, and S&E doctorates at 1.9%.

The S&E labor force does not include just those in S&E occupations. S&E skills are needed and used in a wide variety of jobs.

- Approximately 12.9 million workers say they need at least a bachelor's degree level of knowledge in S&E fields in their jobs. However, only 4.9 million were in occupations formally defined as S&E.
- Twelve million workers have an S&E degree as their highest degree and 15.7 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.

S&E occupations have generally had low unemployment, but were unusually affected by the most recent recession.

- Unemployment in S&E occupations reached 4.6% in 2003, the highest level in the 22 years for which it has been calculated.
- The difference between the S&E unemployment rate and the unemployment rate for all workers fell to just 1.4 percentage points in 2003, compared with 6.9 percentage points in 1983.

Increases in median real salary for recent S&E graduates between 1993 and 2003 indicate relatively high demand for S&E skills during the past decade.

- The median real salary for recent S&E bachelor's degree recipients increased more than that of recipients of non-S&E bachelor's degrees, in all broad S&E fields.
- The largest increases for recent bachelor's degree recipients were in engineering (34.1%), computer and mathematical sciences (28.0%), and life sciences (24.5%). Smaller increases were found for recent bachelor's degree recipients in social sciences (15.8%), physical sciences (9.5%), and non-S&E fields (7.7%).
- For all broad S&E fields, median real salaries grew faster over the decade for master's degree recipients than for bachelor's in the same field. This ranged from a 31.8% increase in median real earnings for recipients of physical science master's degrees to a 54.8% increase for recipients of master's degrees in computer and mathematical sciences. At the master's level, however, non-S&E degrees also enjoy large increases in real median salary, growing by 52.7%.
- Median salary increased by only 0.3% for recent doctoral degree recipients in life sciences over the past 10 years. This reflects in part the increased participation in postdoc positions, which provide further training but traditionally pay low salaries.

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

- Twenty-nine 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, 44% are age 50 or over.
- By age 62, half of S&E bachelor's degree holders had left full-time employment. Doctorate 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.
- Forty percent of doctorate degree holders in S&E occupations in 2003 were foreign born.
- Among all doctorate holders resident in the United States in 2003, a majority in computer science (57%), electrical engineering (57%), civil engineering (54%), and mechanical engineering (52%) were foreign born.

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 S&E occupations in 1980 and 25% in 2000. However, the growth in representation between 1990 and 2000 was only 3 percentage points.
- The representation of blacks in S&E occupations increased from 2.6% in 1980 to 6.9% in 2000. The representation of Hispanics increased from 2.0% to 3.2%. However, for Hispanics, this is proportionally less than their increase in the population.

Introduction

Chapter Overview

Although workers with science and engineering skills still make up only a 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 century, the size of the S&E labor force has grown dramatically—with employment in S&E occupations growing 2,510% 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 growth 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 each 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. First is a general profile of the U.S. S&E labor force. This includes demographic characteristics (population size, sex, 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 National Survey of College Graduates (NSCG) and the 2003 Survey of Doctorate Recipients.

Second is a look at the labor market conditions for recent S&E graduates—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.

Third is the age and retirement profile 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 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 proportion of women and ethnic minorities in the S&E labor force continues to grow, but with the exception of Asians/Pacific Islanders, remains smaller than their 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 scientist or 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?")

The size of the S&E workforce in 2003 varies between approximately 4 million and 15 million individuals, depending on the definition and perspective used (see table 3-1).

In 2003, 15.7 million individuals had at least one degree in an S&E field. 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. A slightly smaller number, 11.9 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 2003 NSF Scientists and Engineers Statistical Data System (SESTAT) data estimated 4.9 million workers, whereas the U.S. Census Bureau's 2003 American Community Survey estimated 4.0 million. Occupation-based estimates not limited to college graduates include 5.0 million in November 2003 from the Bureau of Labor Statistics (BLS) Occupational Employment Statistics Survey and 5.6 million from the 2003 American Community Survey.

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 and 5.3 million a need for knowledge of the social sciences. That the need for S&E knowledge is more than double the number in

Who Is a Scientist or an Engineer?

The terms scientist and engineer have many definitions, none of them perfect. (For a more thorough discussion, see *SESTAT and NIOEM: Two Federal Databases Provide Complementary Information on the Science and Technology Labor Force* [NSF/SRS 1999b] and "Counting the S&E Workforce—It's Not That Easy" [NSF/SRS 1999a]). 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 regarding 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 an individual who has both a bachelor's degree in engineering and a master's degree in business administration from an S&E workforce analysis.
- **Need for S&E knowledge.** Many individuals identify their jobs as requiring at least a bachelor's degree level of knowledge in S&E—not all of whom 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 mostly avoids 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

Concept	Education coverage	Source	Number
Occupation			
Employment in S&E occupations	All	2003 BLS Occupations and Employment Survey	4,962,000
Employment in S&E occupations	Bachelor's and above	2003 NSF SESTAT data	4,928,000
Employment in S&E occupations	Bachelor's and above	2003 American Community Survey	4,014,000
Employment in S&E occupations	All	2003 American Community Survey	5,604,000
Education			
Highest degree in S&E field	Bachelor's and above	2003 NSF SESTAT data	11,891,000
Any degree in S&E field	Bachelor's and above	2003 NSF SESTAT data	15,689,000
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

SOURCES: NSF, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT), preliminary estimates (2003), http://sestat.nsf.gov; U.S. Department of Labor, BLS, Occupations and Employment Survey (2003); and U.S. Census Bureau, American Community Survey (2003).

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formal S&E occupations suggests the pervasiveness of technical knowledge in the modern workplace.

S&E Workforce Growth

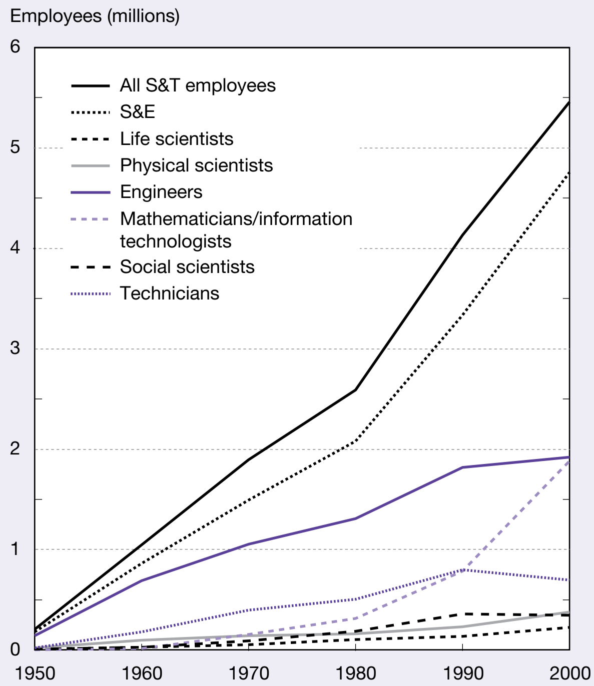
Despite some limitations in measuring the S&E labor force, occupation classifications allow examination of growth in at least one measure of scientists and engineers over extended periods. According to data from the decennial censuses, the number of workers in S&E occupations grew to 4.0 million, at 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 science and technology (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 (see figure 3-2, done with a log scale to better compare growth rates). S&E employment grew between 1990 and 2000 at a 3.6% average annual rate (and S&T employment at a 2.8% average annual rate) compared with 1.1% for the whole workforce. Social scientist and technician occupations experienced declines in employment in the 1990s.

In all broad categories of S&E fields, employment in the occupations directly associated with the field 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 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 Current Population Survey (CPS) from 1993 to 2004 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 3.9% in 2004. Also noteworthy are the decreases in employment in

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



S&T = science and technology

NOTE: Data include those with 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: B.L. Lowell, Estimates of the Growth of the Science and Technology Workforce, Commission on Professionals in Science and Technology (forthcoming). See appendix table 3-1.

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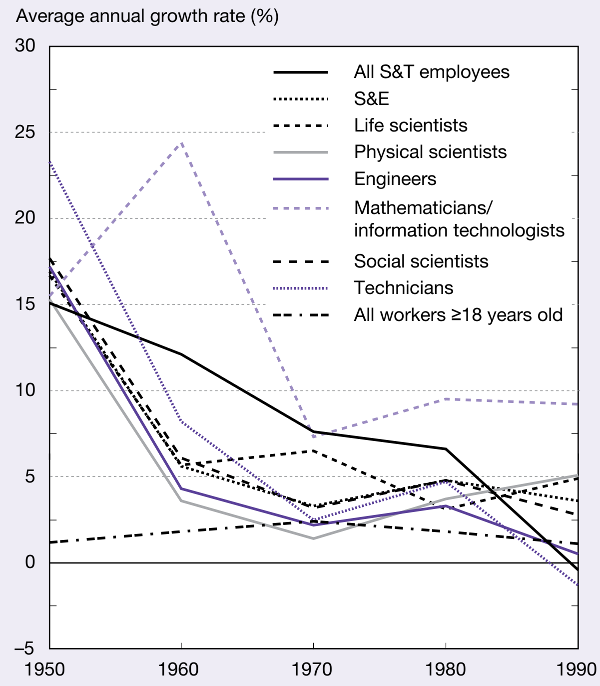
Figure 3-2
Annual growth rate in science and technology employment, by decade: 1950–90



S&T = science and technology

NOTE: Data include those with 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: B.L. Lowell, Estimates of the Growth of the Science and Technology Workforce, Commission on Professionals in Science and Technology (forthcoming). See appendix table 3-1.

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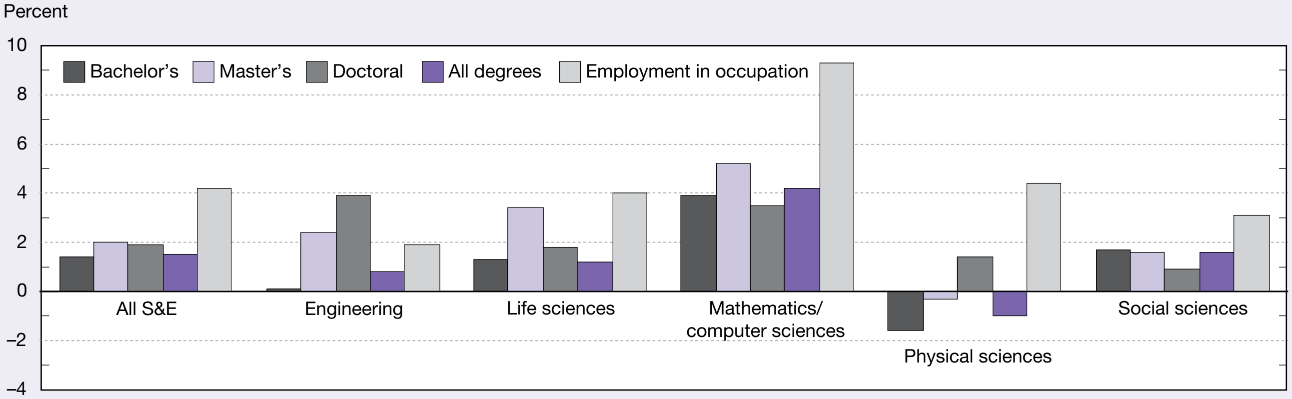
Figure 3-3
Annual average growth rate of degree production and occupational employment, by S&E field: 1980–2000



SOURCES: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), special tabulations from U.S. Census Bureau, Public-Use Microdata Sample (PUMS) (1980–2000); and NSF/SRS data on degree production. See appendix table 3-2.

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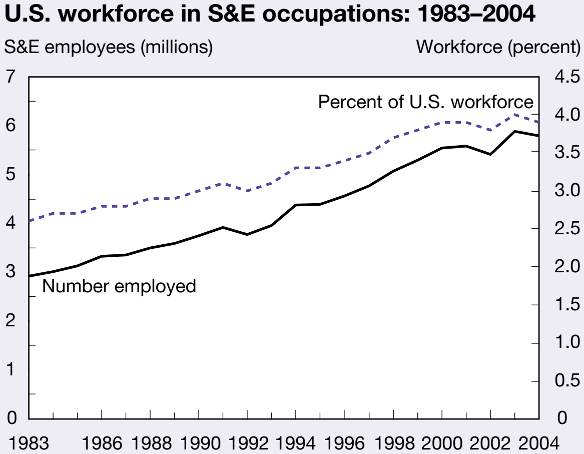
S&E occupations between 1991 and 1992 and between 2001 and 2002—evidence that S&E employment is not exempt from economic downturns (see figure 3-4).

Projected Demand for S&E Workers

The most recent occupational projections from BLS, for 2002–12, forecast that employment in S&E occupations will increase about 70% faster than the overall growth rate for all occupations (figure 3-5). It is worth noting that these projections involve only the demand for strictly defined S&E occupations, and do not include the wider range of jobs in which S&E degree holders often use their training.

S&E occupations are projected to grow by 26% from 2002 to 2012, while employment in all occupations is projected to grow 15% over the same period (BLS 2004). This is a revision of BLS projections for 2000 to 2010 that projected a 47% increase in S&E employment (BLS 2001).

Figure 3-4
U.S. workforce in S&E occupations: 1983–2004



SOURCE: National Science Foundation, Division of Science Resources Statistics, special tabulations from U.S. Census Bureau, Current Population Survey Monthly Outgoing Rotation files (1983–2004). See appendix table 3-3.

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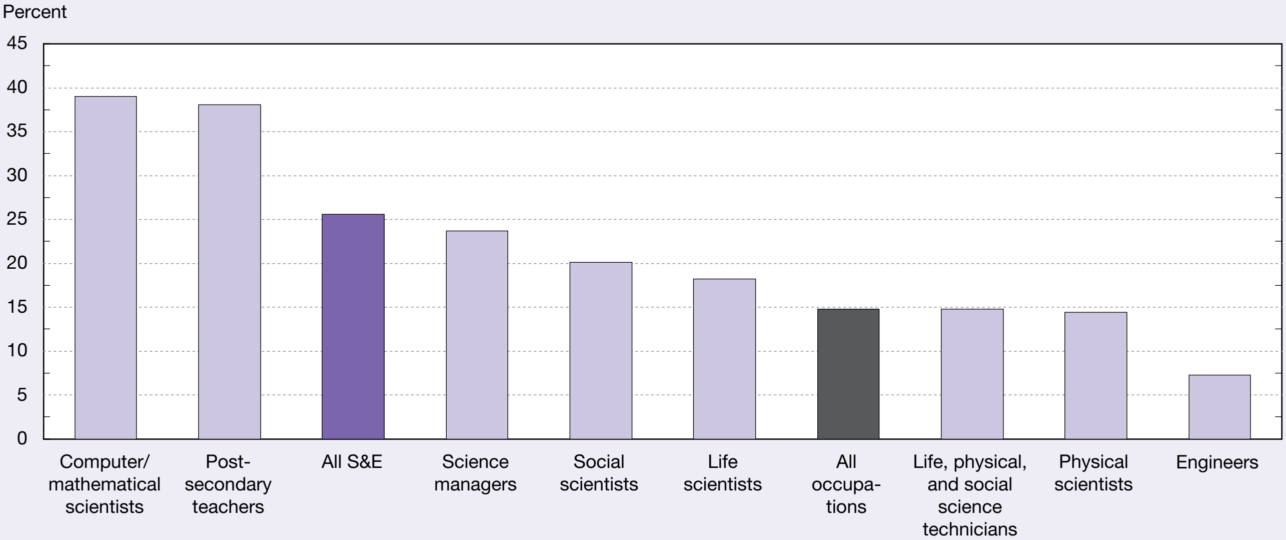
Although BLS labor force projections often do a reasonable job of forecasting employment in many occupations (see Fullerton, 2003), S&E occupations may be particularly difficult to forecast. Many spending decisions on research and development by corporations and governments are difficult or impossible 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.

Approximately 78% of BLS's projected increase in S&E jobs is in computer-related occupations (see table 3-2). Aside from computer-related occupations, faster than average growth is projected for life scientists, social scientists, and for the S&E-related occupation of science manager. An occupation of interest, "postsecondary teacher" (which includes all fields of instruction), is projected to grow almost as fast as computer occupations, rising from 1.6 to 2.2 million over the decade between 2002 and 2012.

Overall engineering employment is forecasted by BLS to grow only about 7% over the decade. Within engineering occupations, industrial engineering is projected to have the biggest relative employment gains, increasing by 20%, followed by civil engineering and environmental engineering, each projected to increase by about 18%.

BLS also forecasts that job openings in S&E occupations over the 2002–12 period will be a slightly greater proportion of current employment than for all occupations: 43% versus 39% (see 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

Figure 3-5
Projected increase in S&E employment, by occupation: 2002–12



SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Office of Occupational Statistics and Employment Projections. See appendix table 3-4.

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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 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 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 of supply and demand estimates impossible.

One indicator of the level of labor market demand for a set of skills is the changes observed over time in the pay received by individuals with those skills, regardless of what occupations they may be in.[1] The changes between 1993 and 2003 in real (inflation-adjusted) median salary for recent graduates in S&E and non-S&E fields are shown in figure 3-7. Among bachelor's degree recipients in non-S&E fields 1–5 years after degree, median real salaries grew by only 7.7% over 10 years. In contrast, recent bachelor's degree recipients in all S&E fields enjoyed greater increases in median real salary: 24.5% in the life sciences, 28.0% in

Table 3-2
S&E jobs: 2002 and projected 2012
(Thousands)

Occupation	2002	2012	Change
All occupations	144,014	165,319	21,305
S&E	4,873	6,119	1,246
Computer/mathematical scientists	2,504	3,480	976
Engineers	1,478	1,587	109
Life scientists	214	253	39
Physical scientists	251	287	36
Social scientists/related occupations	426	512	86

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Office of Occupational Statistics and Employment Projections, *National Industry-Occupation Employment Projections 2002–2012* (2004).

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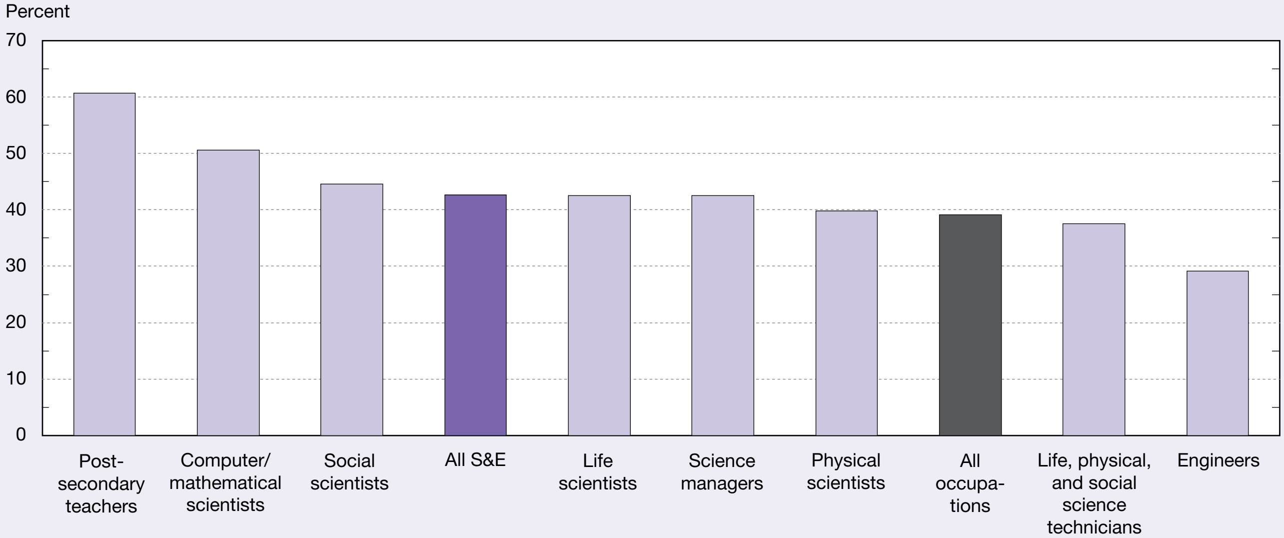
Figure 3-6
Projected job openings as percentage of 2002 employment, by occupation: 2002–12



SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Office of Occupational Statistics and Employment Projections. See appendix table 3-4.

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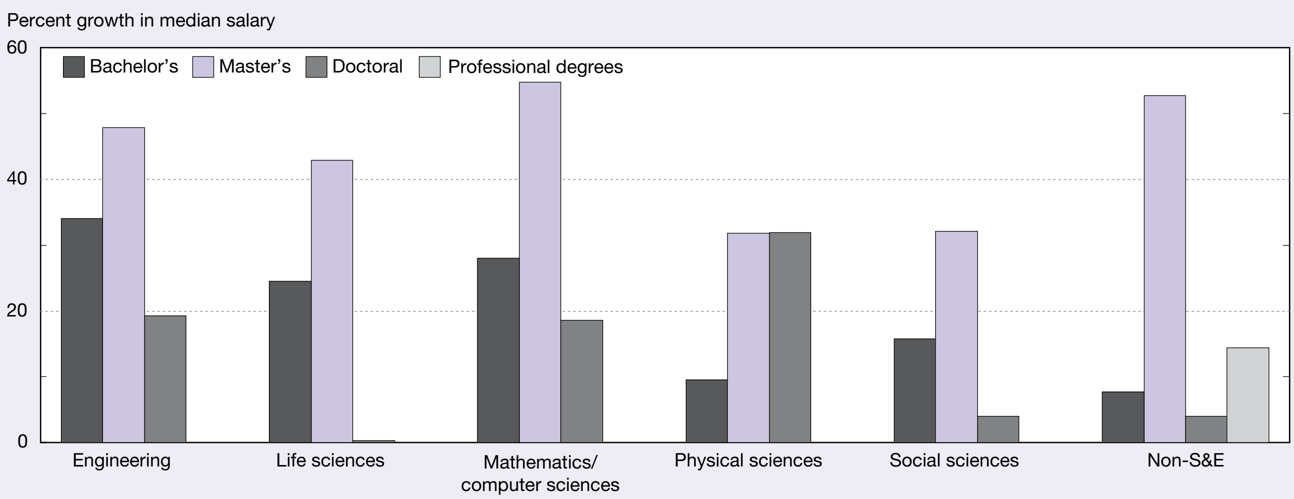
computer and mathematical sciences, and 34.1% in engineering. The smallest increase at the S&E bachelor's degree recipient level was in the physical sciences at 9.5%.

Among recent master's degree recipients, all fields, including non-S&E, showed increases in median real salaries between 1993 and 2003. Non-S&E master's degree recipients experienced a 52.7% increase in median real salary, surpassed only by master's degrees in computer and mathematical science (54.8% increase). Real median earnings for other recent S&E master's degree recipients grew by 47.9% in engineering, 42.9% in the life sciences, 32.1% in the social sciences, and 31.8% in the physical sciences. These high growth rates in earnings for recent master's degree recipients in all fields are indicative of the increasing returns to high skills throughout the U.S. economy during this period.

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



NOTE: Non-S&E fields include the SESTAT categories "non-S&E" and "S&E related."

SOURCE: National Science Foundation, Division of Science Resources Statistics, National Survey of College Graduates (1993) and preliminary estimates (2003).

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Among recent doctoral degree recipients, the increase in median real salary was greatest for those in the physical sciences (31.9%) and smallest was in the life sciences (0.3%). Recent non-S&E doctorate recipients increased real earnings by only 4.0%, the same rate as recent doctorates in social sciences. Real earnings for recent doctoral degree recipients increased by 19.3% in engineering and 18.6% in mathematical and computer sciences. In all fields except the physical sciences, earnings increased less in percentage terms than at the master's level. This may reflect the greater proportion of doctorate holders in academia and, particularly in the case of life sciences, in postdoc positions.

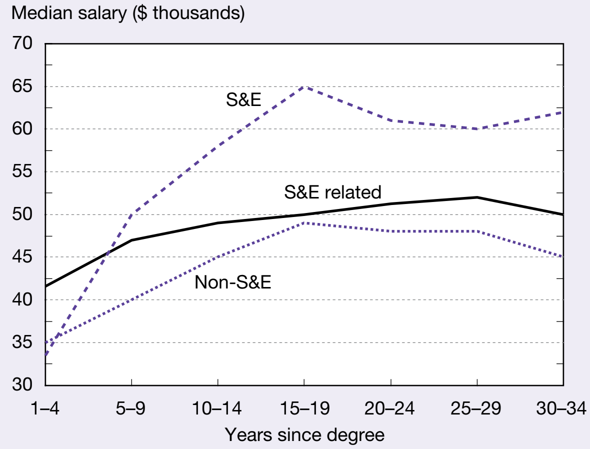
Evaluation of recent doctoral degree recipient salaries is made more difficult by the earnings differentials between academic and nonacademic employment, as well as the increasing prevalence of postdocs. As shown in figure 3-8, recent doctoral degree recipients in engineering, life sciences, and mathematical and computer sciences actually had lower median salaries than recent master's degree recipients in the same fields.

The median salary for recent non-S&E master's degree recipients was higher than for either those with non-S&E doctorates or non-S&E professional degrees (law, medicine, and other professional degrees).

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. At all years since degree, holders of S&E bachelor's degrees earn more than those with non-S&E degrees. Median salaries for S&E bachelor's degree holders in 2003 peaked at $65,000 at 15–19 years after degree, compared to $49,000 for those with non-S&E bachelor's degrees. Those with bachelor's degrees in S&E-related fields (such as technology, architecture, or health) also earned more than non-S&E bachelor's holders at most years since degree, peaking at $52,000 25–29 years after degree—much less than for S&E graduates.

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



SOURCE: National Science Foundation, Division of Science Resources Statistics, National Survey of College Graduates, preliminary estimates (2003).

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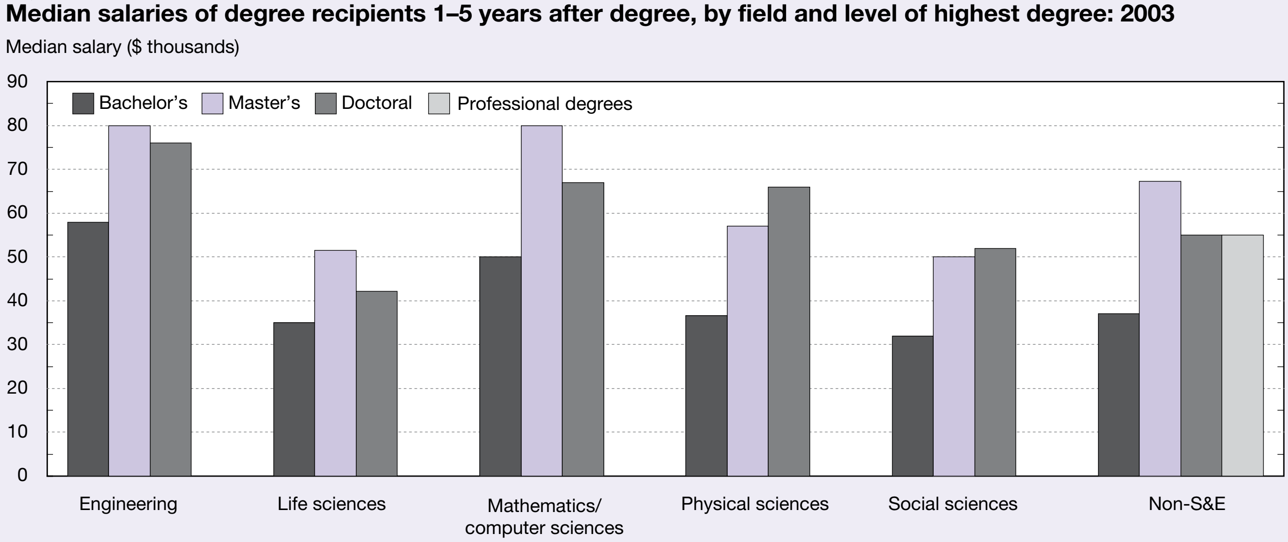
Figure 3-8
Median salaries of degree recipients 1–5 years after degree, by field and level of highest degree: 2003



NOTE: Non-S&E fields include the SESTAT categories of "non-S&E" and "S&E-related."

SOURCE: National Science Foundation. Division of Science Resources Statistics, National Survey of College Graduates, preliminary estimates (2003)

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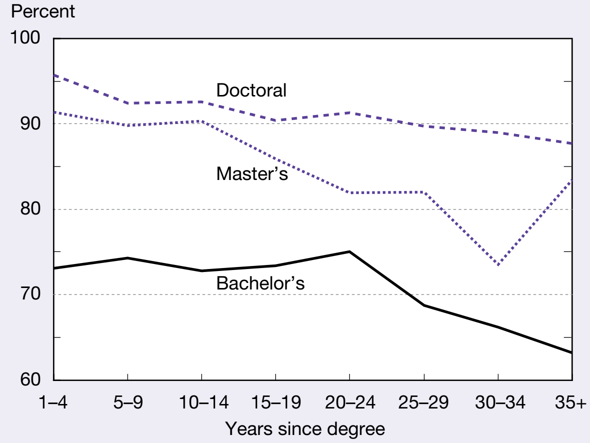
How Are People With an S&E Education Employed?

Although the majority of 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 3-3).

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 degrees tends to fall with time since 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. When a somewhat weaker criterion is used such as are jobs "closely" or "somewhat" related to an individual's field of highest degree, even higher proportions of S&E graduates report their jobs being related to their degrees. More than 70% of S&E bachelor's degree holders report their jobs are at least somewhat related to their field of degree until 25–29 years after their degrees. Even 30–34 years after their degree, only 11% of S&E doctoral degree holders report their jobs are not related to their field of degree, and only one-third of S&E bachelor's degree holders (figure 3-10).

Figure 3-10
Employed individuals with S&E highest degrees in jobs closely or somewhat related to highest degree: 2003



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

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Figure 3-11 shows differences in a stricter criterion for relatedness: the percentages of individuals who reported their job as closely related to their field of degree, by major S&E disciplines for bachelor's degree holders. From 1 to 4 years after receiving their degrees, the percentage of S&E bachelor's degree holders who reported their jobs are closely related to their field of degree ranged from 28% for individuals with degrees in social sciences to 59% for individuals with degrees in engineering. Between these extremes, most other S&E fields showed similar percentages for recent graduates: 57% for computer and mathematical sciences, 54% for physical sciences, and 48% for life sciences. As with relatedness in general, this stricter definition of relatedness of job and degree declines only slowly with years since degree.

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

		Degree related to job		
Highest degree	*n* (thousands)	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
Doctoral	303	42.3	36.6	21.2

[a]Includes professional degrees.

NOTES: Non-S&E occupations include the 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, Scientists and Engineers Statistical Data System (SESTAT), preliminary estimates (2003), http://sestat.nsf.gov.

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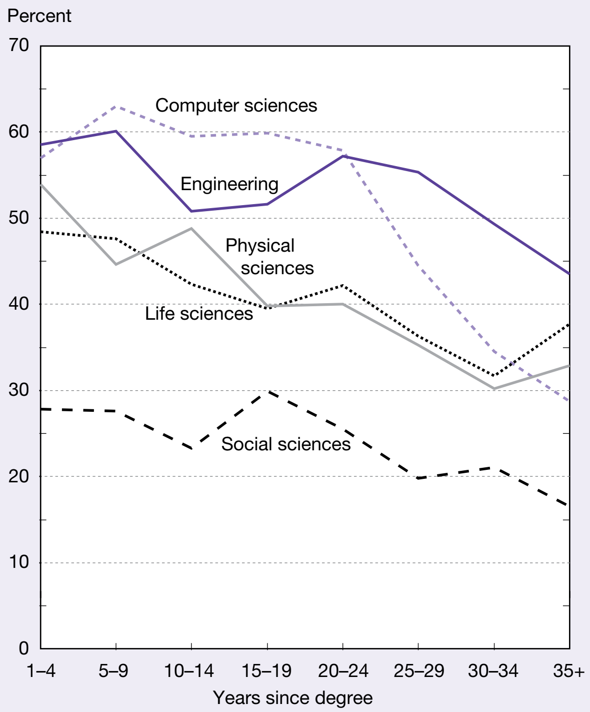
Figure 3-11
S&E bachelor's degree holders employed in jobs closely related to degree, by field and years since degree: 2003



SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT), preliminary estimates (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 3-4). This included 1.6 million in management and management-related occupations, of whom 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 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 two-decades-long view of unemployment trends in S&E occupations, regardless of education level, comes from the CPS data for 1983–2004. During this 22-year period, the unemployment rate for all individuals in S&E occupations ranged from a low of 1.4% in 1999 to a high of 4.6% 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%) or for S&E technicians (ranging from 2.0% to 6.1%). During most of the period, computer programmers had a similar unemployment rate as those in S&E occupations, but greater volatility (ranging from 1.2% to 6.7%). The most recent recession in 2002–03 appears to have had a strong effect on S&E employment, with the differential between S&E and general unemployment falling to only 1.4 percentage points in 2003, compared with 6.9 percentage points in 1983 (figure 3-12). This may

Table 3-4
Individuals with S&E as highest degree 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 non-S&E	1,743	20.7	28.8	50.5

NOTES: Non-S&E occupations include the 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, Scientists and Engineers Statistical Data System (SESTAT), preliminary estimates (2003), http://sestat.nsf.gov.

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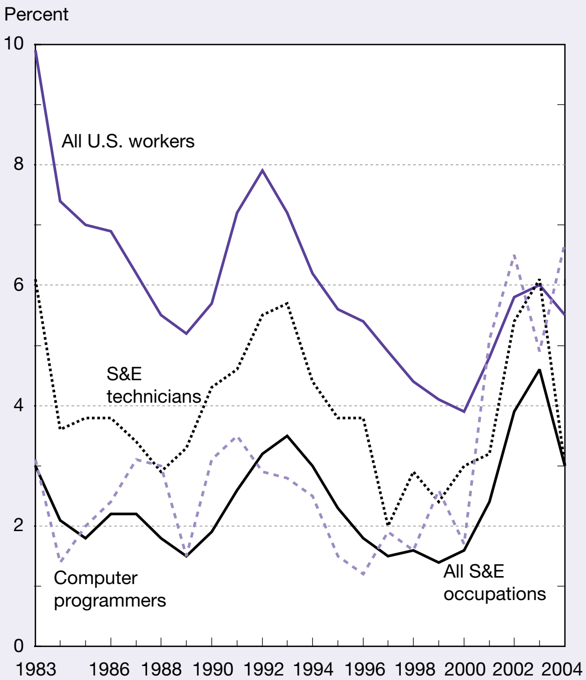
be due to the unusually strong reductions in R&D in the information and related technology sectors (see chapter 4).

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 both individuals who might have left an S&E occupation for negative economic reasons and individuals who moved into other careers due to more positive factors. 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 portion of bachelor's degree holders who said they were working involuntarily out of the field (IOF) of their highest degree than on doctoral degree holders (figure 3-14). For doctoral degree holders, IOF rates changed little between 1999 and 2003. IOF rates actually dropped for recent doctorate 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.

Figure 3-12
Unemployment rate, by occupation: 1983–2004



SOURCE: National Bureau of Economic Research, Merged Outgoing Rotation Group Files, from U.S. Department of Labor, Bureau of Labor Statistics, Current Population Survey. See appendix table 3-8.

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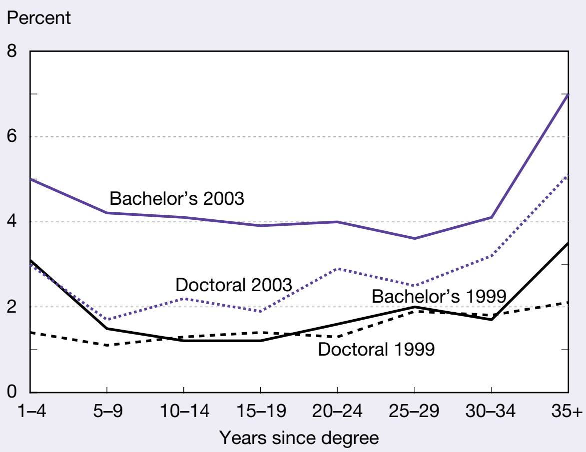
Figure 3-13
Unemployment rates for individuals with S&E highest degrees, by years since highest degree: 1999 and 2003



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

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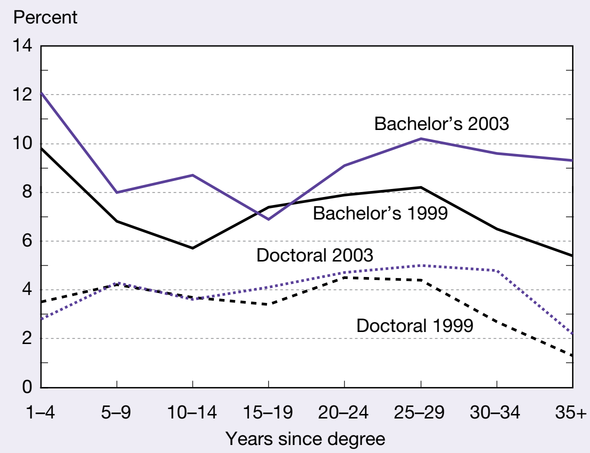
Metropolitan Areas

United States metropolitan areas are ranked in table 3-5 according to the proportion of the entire metropolitan area workforce that is employed in S&E occupations, and in table 3-6 by the total number of workers employed in S&E

Figure 3-14
Involuntarily out-of-field rates of individuals with S&E highest degrees, 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 preliminary estimates (2003), http://sestat.nsf.gov.

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Table 3-5
S&E employment by metropolitan area, by S&E percentage of total employment: 2003

Rank	Metropolitan area	Workforce (%)	S&E employees (*n*)
United States		3.9	4,961,540
1	Boulder-Longmont, CO PMSA	13.1	20,110
2	Corvallis, OR MSA	12.7	4,470
3	San Jose, CA PMSA	12.0	102,700
4	Huntsville, AL MSA	11.6	20,580
5	Washington, DC-MD-VA-WV PMSA	9.4	253,410
6	Raleigh-Durham-Chapel Hill, NC MSA	8.9	59,710
7	Rochester, MN MSA	8.7	8,590
8	Melbourne-Titusville-Palm Bay, FL MSA	8.5	16,080
9	Seattle-Bellevue-Everett, WA PMSA	8.3	106,200
10	Lowell, MA-NH PMSA	7.9	9,680
11	Richland-Kennewick-Pasco, WA MSA	7.8	6,220
12	Austin-San Marcos, TX MSA	7.6	51,760
13	Charlottesville, VA MSA	7.5	6,280
14	Madison, WI MSA	7.5	20,950
15	Boston, MA-NH PMSA	7.2	136,530
16	Colorado Springs, CO MSA	7.1	16,380
17	Fort Collins-Loveland, CO MSA	6.8	8,060
18	Olympia, WA PMSA	6.8	5,840
19	San Francisco, CA PMSA	6.8	65,330
20	Middlesex-Somerset-Hunterdon, NJ PMSA	6.8	42,090

MSA = metropolitan statistical area; PMSA = primary metropolitan statistical area

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Occupational Employment Statistics Survey (2003).

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Table 3-6
S&E employment by metropolitan area, by total number of workers employed in S&E occupations: 2003

Rank	Metropolitan area	Workforce (%)	S&E employees (n)
United States		3.9	4,961,540
1	Washington, DC-MD-VA-WV PMSA	9.4	253,410
2	Chicago, IL PMSA	4.2	164,650
3	Los Angeles-Long Beach, CA PMSA	3.9	156,340
4	Boston, MA-NH PMSA	7.2	136,530
5	New York, NY PMSA	3.2	126,730
6	Atlanta, GA MSA	5.3	111,610
7	Seattle-Bellevue-Everett, WA PMSA	8.3	106,200
8	San Jose, CA PMSA	12.0	102,700
9	Detroit, MI PMSA	5.2	102,500
10	Houston, TX PMSA	4.9	100,030
11	Dallas, TX PMSA	5.3	99,780
12	Philadelphia, PA-NJ PMSA	4.2	97,410
13	Minneapolis-St. Paul, MN-WI MSA	5.4	90,390
14	Orange County, CA PMSA	5.0	71,640
15	Denver, CO PMSA	6.2	69,370
16	Phoenix-Mesa, AZ MSA	4.2	67,020
17	San Francisco, CA PMSA	6.8	65,330
18	San Diego, CA MSA	5.1	64,220
19	Baltimore, MD PMSA	5.1	63,000
20	Oakland, CA PMSA	6.1	60,750

MSA = metropolitan statistical area; PMSA = primary metropolitan statistical area

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Occupational Employment Statistics Survey (2003).

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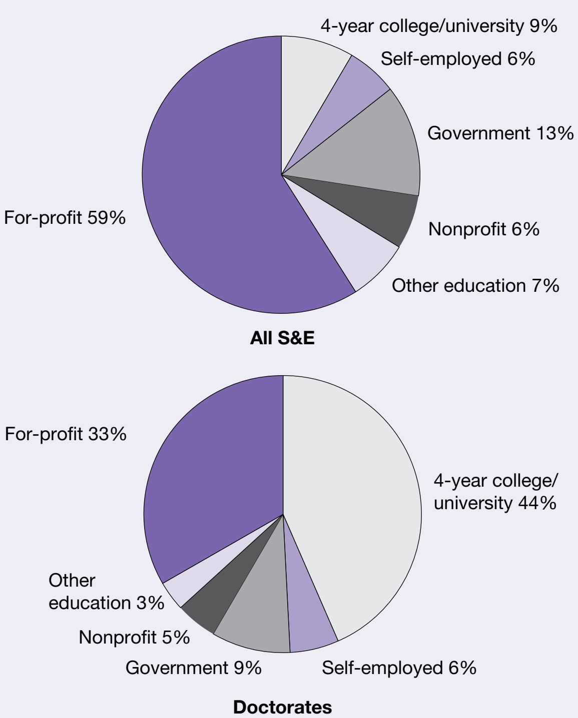
occupations. The Boulder-Longmont, Colorado metropolitan area had the highest percentage of its workforce employed in S&E occupations in November 2003 at 13.1%. The Washington, D.C. metropolitan area has the greatest total number of individuals employed in S&E occupations at over one-quarter million. Although the top-20 list for proportion of S&E employment consists mainly of smaller, and perhaps less economically diverse, metropolitan areas, Washington, D.C.; Seattle; Boston; and San Francisco were able to make both top-20 lists.

Employment Sectors

The private for-profit sector is the largest provider of employment for individuals with S&E degrees (figure 3-15), 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 doctorate degree holders (44%). This 44% includes a variety of employment types other than the tenured and tenure-track employment that is still sometimes inaccurately referred to as the "traditional" doctorate career path—including many younger doctorate holders in postdoc and other temporary employment situations, as well as individuals with a variety of research and administrative functions.

Figure 3-15
Employment sector for all S&E degree holders and S&E doctoral degree holders: 2003



SOURCE: National Science Foundation, Division of Science Resources Statistics, SESTAT, preliminary estimates (2003), http://sestat.nsf.gov. See appendix table 3-9.

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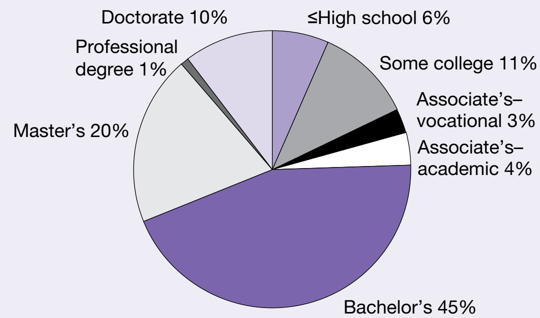
Figure 3-16
Educational distribution, by nonacademic S&E occupations: 2000



SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Current Population Survey (2000).

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Educational Distribution of S&E Workers

Discussions of the S&E workforce often focus on individuals who hold doctorate degrees. However, CPS data on the educational achievement of individuals working in S&E occupations outside academia in 2000 indicate that only 10% had doctorates (figure 3-16). In 2000, more than two-thirds of individuals working in nonacademic S&E occupations had bachelor's degrees (45%) or master's degrees (20%).

Almost one-fourth 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 discussion in chapter 2).

From 1983 to 2004, the proportion of individuals in the S&E workforce without college degrees remained relatively constant, rising only slowly to 73% in 2004. Among individuals working in S&E technician occupations the proportion with college degrees also remained nearly constant, rising to only about 24% in 2004. The occupation of computer programmer, a non-S&E occupation of particular interest in discussions of the S&E labor force, increased its percentage of individuals with college degrees from 50% to 68% (figure 3-20). (See sidebar, "Who Performs Research and Development?")

Salaries

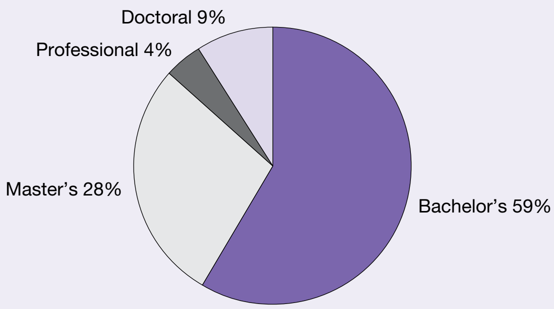
Figure 3-21 illustrates the distribution of salaries earned by individuals with S&E degrees. Education produces far more dramatic effects on the "tails" of the distribution (the

Who Performs Research and Development?

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 3-17 shows the distribution of individuals with S&E degrees by level of degree 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). Individuals with doctorate 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 3-18 shows the distribution of individuals with S&E degrees, by field of highest degree, who reported R&D as a major work activity. Individuals with engineering degrees constitute more than one-third (37%) of the total.

Figure 3-19 shows the percentages of S&E doctorate 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 doctorate 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 a normal career process of 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 3-17
Distribution of S&E-degreed workers 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), preliminary estimates (2003), http://sestat.nsf.gov.

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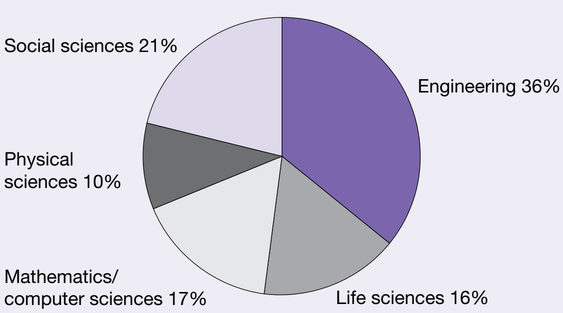
Figure 3-18
Distribution of S&E-degreed workers with R&D as major work activity, by field of highest degree: 2003



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

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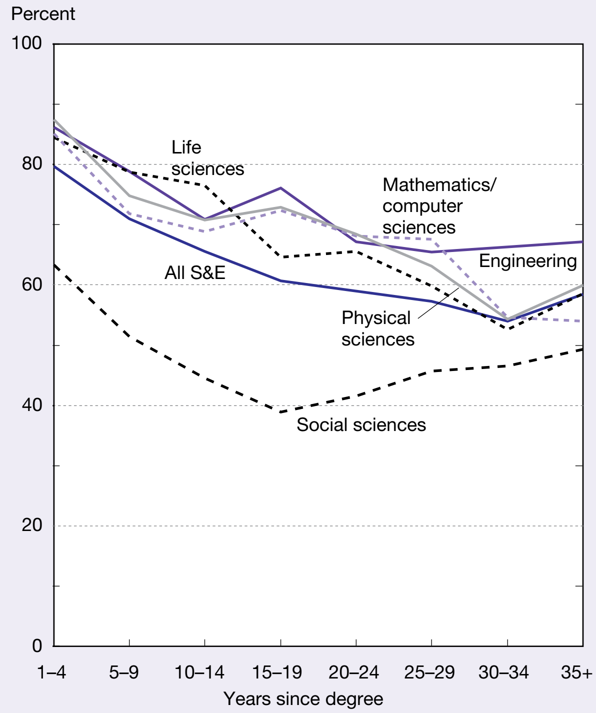
Figure 3-19
S&E doctorate holders engaged in R&D as major work activity: 2003



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

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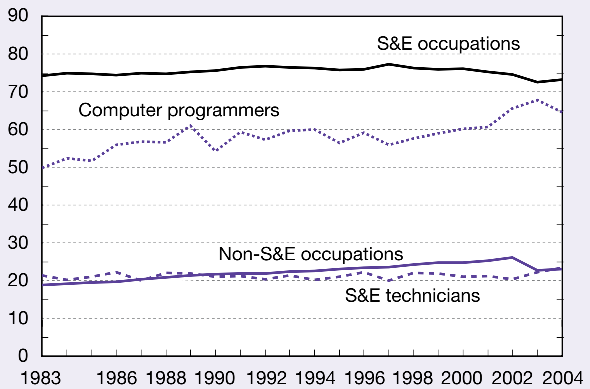
Figure 3-20
Individuals with bachelor's degrees or higher for S&E and selected other occupations: 1983–2004



NOTE: Pre-1992 data based on those who had completed at least 16 years of education.

SOURCES: National Bureau of Economic Research, Monthly Outgoing Rotation files, from the U.S. Department of Labor, Bureau of Labor Statistics, Current Population Survey (1983–2004).

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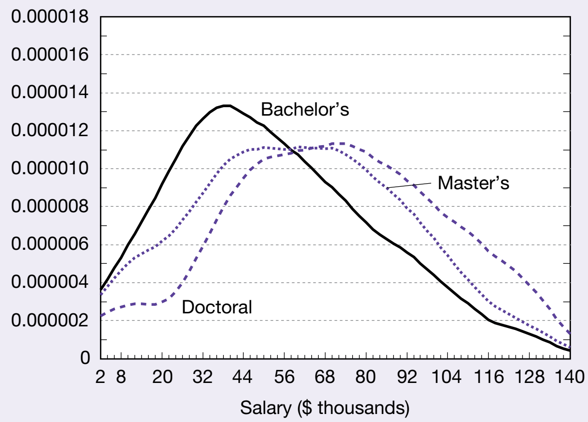
Figure 3-21
Salary distribution of S&E degree holders employed full time, by degree level: 2003



NOTE: Salary distribution smoothed using kernel density techniques.

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

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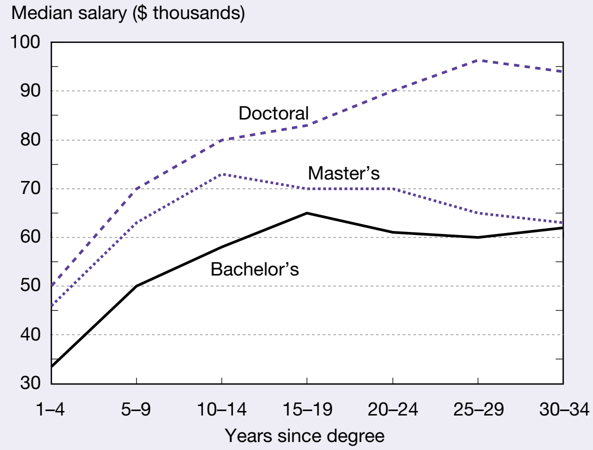
proportion with either very high or very low earnings) than on median earnings. In 2003, 11% of S&E bachelor's degree holders had salaries higher than $100,000, compared with 28% of doctorate degree holders. Similarly, 22% of bachelor's degree holders earned less than $30,000, compared with 8% of doctorate degree holders. The latter figure is inflated because of the inclusion of postdocs. (The Survey of Doctorate Recipients defines postdoc 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 3-22. 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 doctorate degree holder's 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 doctorate degree holders.

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, Minorities, and the Foreign Born 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.

Figure 3-22
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), preliminary estimates (2003), http://sestat.nsf.gov.

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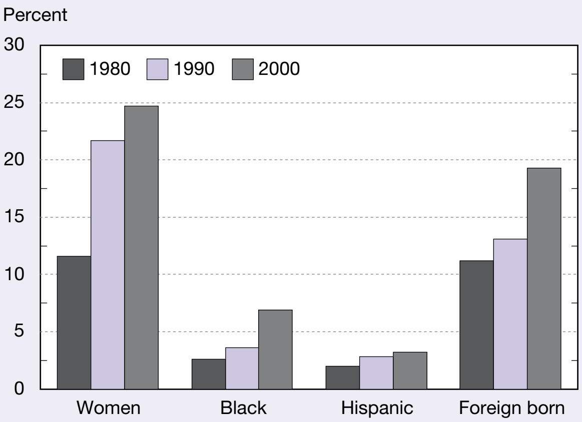
Growth of Representation of Women, Minorities, and the Foreign Born in S&E Occupations

A longer view of changes in the sex 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 Census, the 1990 Census, and the 2000 Census Public-Use Microdata Sample (PUMS) (figure 3-23). In 2000, 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 24.7% of the S&E workforce and 48.6% of the college-degreed workforce.
- Blacks made up 6.9% of the S&E workforce and 7.4% of the college-degreed workforce.
- Hispanics made up 3.2% of the S&E workforce and 4.3% of the college-degreed workforce.

However, since 1980, share of S&E occupations has more than doubled for blacks (2.6% to 6.9%) and women (11.6% to 24.7%). Hispanic representation also increased between 1980 and 2000, albeit at a lower rate (2.0% to 3.2%). The percentage of foreign-born college graduates (including both U.S. and foreign degreed) in S&E jobs increased from 11.2% in 1980 to 19.3% in 2000.

Figure 3-23
College graduates in nonacademic S&E occupations, women, minorities, and foreign-born: 1980, 1990, and 2000



SOURCE: National Science Foundation, Division of Science Resources Statistics, special tabulations of U.S. Decennial Census Public-Use Microdata Sample (PUMS) (1980–2000).

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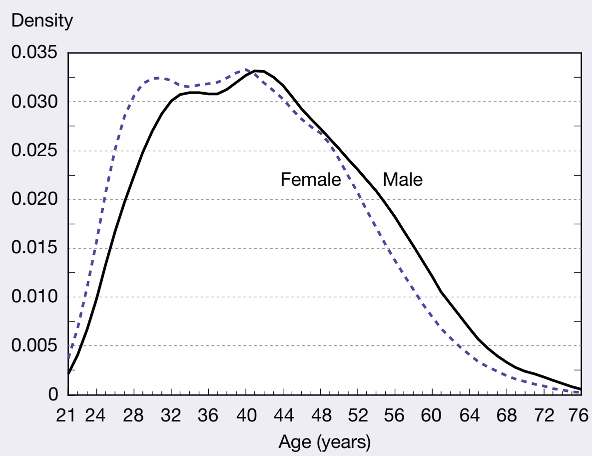
Representation of Women in S&E

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 (46%) of the total U.S. workforce in 2003.

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 3-24 and 3-25): 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 doctorate level, which has a much greater concentration of female doctorate degree holders in their late 30s. One clear consequence of this age distribution is that a much larger proportion of male scientists and engineers at all degree levels, but particularly at the doctorate level, will reach traditional retirement age during the next decade. This alone will have a significant effect upon sex ratios, and also perhaps on the numbers of female scientists in positions of authority as the large proportion of female doctorate degree holders in their late 30s moves 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 3-26). Since 1993, the percentage of women in most S&E occupations has gradually increased from 23% to 27% across all S&E occupations. However, in mathematics and

Figure 3-24
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), preliminary estimates (2003), http://sestat.nsf.gov.

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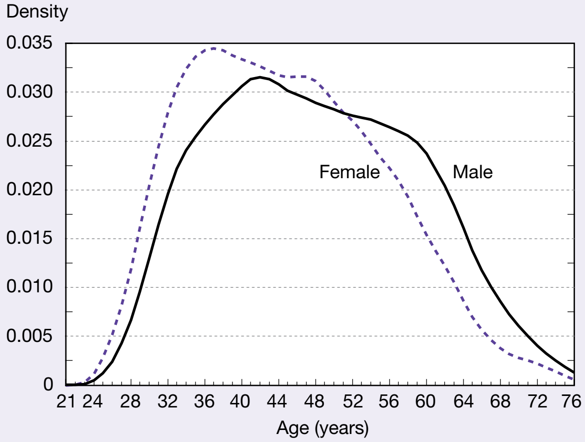
Figure 3-25
Age distribution of doctorate holders in S&E occupations: 2003



NOTE: Age distribution smoothed with kernel density techniques.

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

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Figure 3-26
Women as proportion of employment in S&E occupations, by broad occupation: 1993 and 2003

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

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computer science occupations, 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 3-7).

Table 3-7
Unemployment rate of individuals in S&E occupations, by sex, race/ethnicity, and visa status: 1993 and 2003
(Percent)

Sex/race/ethnicity	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, SESTAT (1993) and preliminary estimates (2003), http://sestat.nsf.gov. See appendix table 3-10.

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Salaries. In 2003, females in S&E occupations earned a median annual salary of $53,000, about 24% less than the median annual salary earned by male scientists and engineers ($70,000). Several factors may contribute to these salary differentials. Women more often work in educational institutions, in social science occupations, and in nonmanagerial positions. In addition, precisely because of growth in the number of women entering S&E fields, they also tend to have fewer years of experience.

Within NSF's data on individuals with college degrees, increases in representation for women are actually associated with lower wage growth. Between 1993 and 2003, median annual salaries for females in S&E occupations increased by 34%, compared with an increase of 40% for male median salaries (table 3-8). This may also be because of changes in relative years of experience, as more women enter these occupations.

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) constituted 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

Table 3-8
Median annual salary of individuals employed in S&E occupations, by sex, race/ethnicity, and visa status: Selected years, 1993–2003
(Dollars)

Sex/race/ethnicity	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) (1993–1999) and preliminary estimates (2003), http://sestat.nsf.gov.

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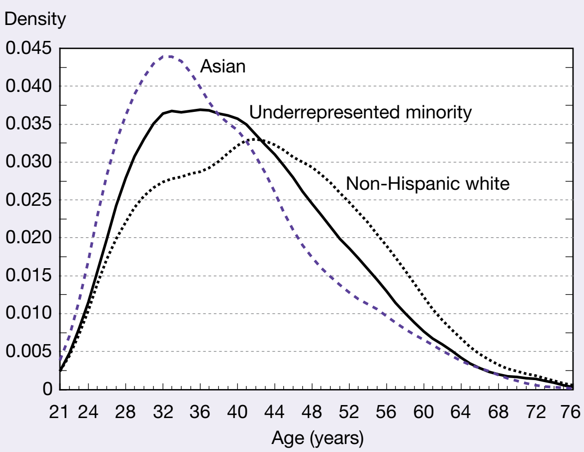
Islanders are also more likely than their numbers to be employed in S&E.

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 (figures 3-27 and 3-28), and this is even truer for doctorate degree holders in S&E occupations. In the near future, a much greater proportion of non-Hispanic white doctorate degree holders in S&E occupations will be reaching traditional retirement ages compared with underrepresented racial and ethnic minority doctorate degree holders. Indeed, unlike the distribution of ages of male and female doctorate 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 doctorate degree holders in S&E occupations (measured by race and not by place of birth) are on average the youngest racial/ethnic group.

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 1999, they constituted 4% of social scientists, but more than 11% of engineers and more than 13% of individuals working in mathematics and computer

Figure 3-27
Age distribution of individuals in S&E occupations, by race/ethnicity: 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), preliminary estimates (2003), http://sestat.nsf.gov.

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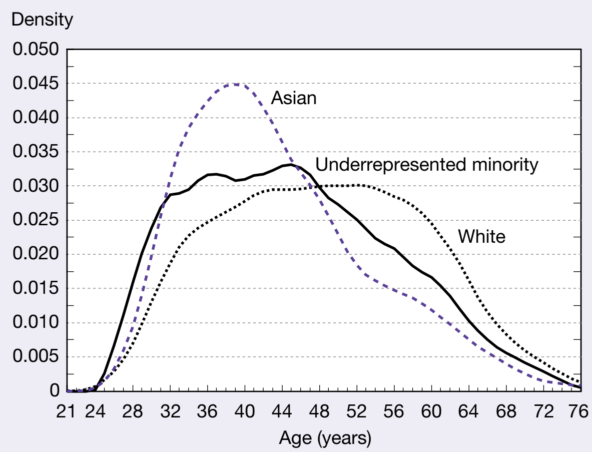
Figure 3-28
Age distribution of S&E doctorate holders in S&E occupations, by race/ethnicity: 2003



NOTE: Age distribution smoothed with kernel density techniques.

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

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sciences. More black scientists and engineers work in social sciences and in computer sciences and mathematics than in other fields. In 1999, 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 includes 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 1999. Hispanics appear to have a more even representation across all fields, constituting approximately 2.5%–4.5% of scientists and engineers in each field.

Salaries. Salaries for individuals in S&E occupations 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 3-8). 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. (See sidebar, "Salary Differentials.")

Labor Market Conditions for Recent S&E Graduates

The labor market activities of recent S&E graduates often serve as the most sensitive indicators of changes in the S&E labor market. This section looks at a number of standard labor market indicators for bachelor's and master's degree recipients, and also 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 reflects 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.

Bachelor's and Master's Degree Recipients

Recent recipients of S&E bachelor's and master's degrees form an important component of the U.S. S&E workforce, accounting for almost half of the annual inflow into S&E occupations. Recent graduates' career choices and entry into the labor market affect the supply and demand for scientists and engineers throughout the United States. This section offers insight into labor market conditions for recent S&E graduates in the United States. Topics examined include graduate school enrollment rates, employment by level and field of degree, employment sectors, and median annual salaries.

Employment Sectors

The private for-profit sector employs the majority of recent S&E bachelor's and master's degree recipients (table 3-9). In 2003, 57% of recent (1–5 years after degree) bachelor's degree recipients and 49% of recent master's degree recipients found employment with private for-profit companies. Government was the second most important employer—employing 12% of both recent S&E bachelor's degree and recent S&E master's degree graduates.

Employment and Career Paths

Although it is 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 bachelor's and master's degree recipients whether they had obtained employment in a career track 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 (see figure 3-29). 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.

Salaries

In 1999, recent (1–3 years since degree) bachelor's degree recipients with degrees in computer and information sciences earned the highest median annual salaries ($44,000) among all recent science graduates. For recent graduates with degrees in engineering, individuals receiving degrees in electrical/electronics, computer, and communications engineering earned the highest median annual salaries ($46,000). The same pattern held true for recent master's degree recipients: individuals receiving degrees in computer and information sciences earned the highest median annual salaries ($58,000) among science graduates. Among engineering graduates, individuals who received master's degrees in electrical/electronics, computer, and communications engineering earned the highest median annual salaries ($60,000).

Table 3-9
1998–2002 S&E bachelor's and master's degree recipients, by employment sector and degree field: 2003
(Percent)

Employment sector	Bachelor's	Master's
For-profit business	57.1	49.1
Nonprofit	8.5	7.7
Government	12.0	12.4
4-year college/university	10.7	17.6
Other education	8.0	10.2
Self-employment	3.7	3.0

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

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Salary Differentials

Differences in salaries of women and ethnic minorities are often used as indicators of progress that individuals in those groups are making in S&E employment. Indeed, these salary differences are substantial when comparing all individuals with S&E degrees by level of degree: in 1999, women with S&E bachelor's degrees had full-time mean salaries that were 35.1% 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 21.9% less than those of non-Hispanic whites and Asians/Pacific Islanders with S&E bachelor's degrees.* These raw differences in salary are lower but still large at the doctorate level (–25.8% for women and –12.7% for underrepresented ethnic groups). In contrast, foreign-born individuals with U.S. S&E degrees have slightly higher salaries than U.S. natives at the bachelor's and master's levels, but their salaries at the doctorate level show no statistically significant differences from those of natives.

However, differences in average age, work experience, fields of degree, and other characteristics make direct comparison of salary and earnings statistics difficult. 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.† Table 3-10 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 all information on individual skill sets, personal background and attributes, or other characteristics that may affect compensation. In addition, even characteristics that are measurable are not distributed randomly among individuals. An individual's choice of degree field and occupation, for example, will reflect in part the real and perceived opportunities for that individual. The associations of salary differences with individual characteristics, not field choice and occupation choice, are examined here.

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 degree reduces salary differentials for women compared with men by about one-fourth at the

Table 3-10
Estimated salary differentials of individuals with S&E degrees, by individual characteristics: 1999
(Percent)

Variable	Degree: Bachelor's	Master's	Doctoral
Female versus male	–35.1	–28.9	–25.8
Controlling for age and years since degree	–27.2	–25.5	–16.7
Plus field of degree	–14.0	–9.6	–10.3
Plus occupation and employer characteristics	–11.0	–8.0	–8.4
Plus family and personal characteristics	–10.2	–7.4	–7.4
Plus sex-specific marriage and child effects	–4.6	NS	–3.1
Black, Hispanic, and other versus white and Asian/Pacific Islander	–21.9	–19.3	–12.7
Controlling for age and years since degree	–13.0	–14.6	–4.7
Plus field of degree	–8.6	–6.7	–2.2
Plus occupation and employer characteristics	–7.3	–4.2	NS
Plus family and personal characteristics	–5.7	–3.3	NS
Foreign born with U.S. degree versus native born	3.7	9.5	NS
Controlling for age and years since degree	6.7	12.4	7.8
Plus field of degree	NS	NS	NS
Plus occupation and employer characteristics	NS	–2.8	–2.8
Plus family and personal characteristics	NS	–3.1	–2.7

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) (1999), http://sestat.nsf.gov.

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bachelor's degree level (to –27.2%) and by about one-third at the doctorate level (to –16.7%).‡

When controlling for differences in age and years since degree, even larger 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 more than two-fifths at the bachelor's degree level (to –13.0%) and by nearly two-thirds at the doctorate level (to –4.7%).

Because foreign-born individuals in the labor force who have S&E degrees are somewhat younger on average than natives, controlling for age and years since degree actually increases the salary differential, making an initial earnings advantage over natives even larger, to 6.7% for foreign-born individuals with S&E bachelor's degrees and to 7.8% for those with S&E doctorates.

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 –14.0% at the bachelor's level and to –10.3% at the doctorate level.§ 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 there are differences between males and females in field of degree or whether salaries are affected by the percentage of women studying in each field.

Field of degree is also associated with significant estimated salary differentials for underrepresented ethnic groups. Controlling for field of degree further reduces salary differentials to –8.6% for those individuals with S&E bachelor's degrees and to –2.2% for those individuals with S&E doctorates. Thus, age, years since degree, and field of degree are associated with almost all doctorate-level salary differentials for underrepresented ethnic groups.

Compared with natives at any level of degree, foreign-born individuals with S&E degrees show no statistically significant salary differences when controlling for age, years since degree, and field of degree.

Effects of Occupation and Employer on Salary Differentials

Obviously, occupation and employer characteristics affect compensation.‖ 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, whether the person is working 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 only slightly beyond what is found when controlling for age, years since degree, and field of degree. For foreign-born individuals compared with natives, controls for occupation and employer characteristics also produce only small changes in estimated salary differentials, but in this case, the controls result in small negative salary differentials at the master's (–2.8%) and doctorate (–2.8%) levels.

Effects of Family and Personal Characteristics on Salary Differentials

Marital status, children, parental education, and other personal characteristics are often associated with differences in compensation. Although these differences may indeed involve discrimination, they may also reflect many subtle individual differences that might affect work productivity.# As with occupation and employer characteristics, controlling for these characteristics changes salary differentials only slightly at any degree level. However, most of the remaining salary differentials for women disappear when the regression equations allow for the separate effects of marriage and children for each sex. Marriage is associated with higher salaries for both men and women, 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.

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

†Specifically presented here are coefficients from linear regressions using the 1999 Scientists and Engineers Statistical Data System (SESTAT) data file of individual characteristics upon the natural log of reported full-time annual salary as of April 1999.

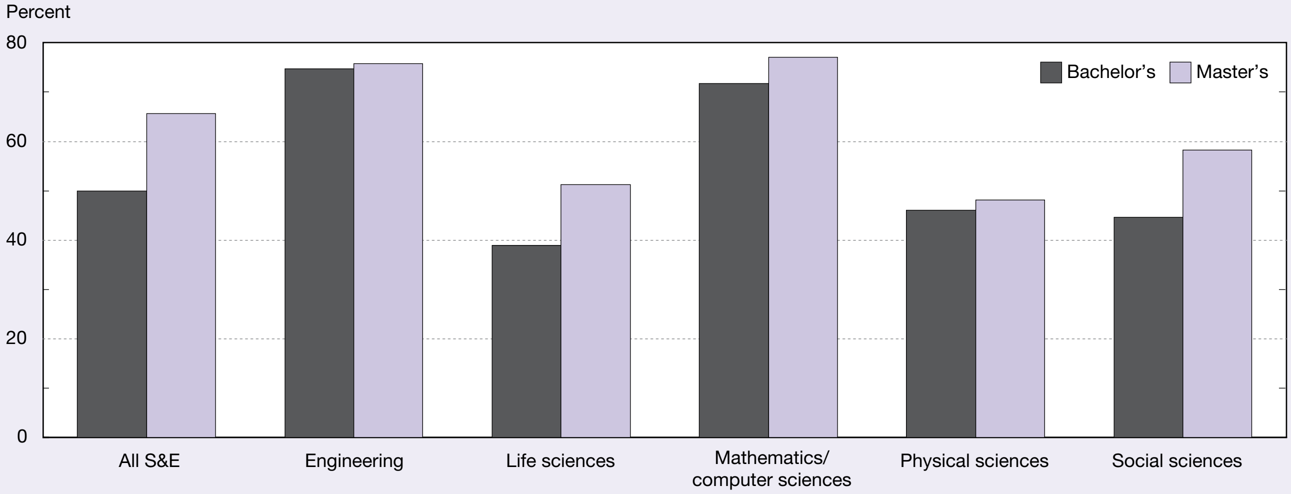
‡In the regression equation, this is the form: age, age^2, age^3, age^4; years since highest degree (YSD), YSD^2, YSD^3, YSD^4.

§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").

‖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.

#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.

Figure 3-29
Recent S&E recipients in career-path jobs within 3 months of degree: 1999



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

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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 creates more 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. Many doctorate degree holders also face an additional period of low earnings while completing a postdoc. In addition, some doctorate degree holders may not find themselves in the type of employment they desired while in graduate school.

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 more highly trained and motivated graduate students to aid university-based research. These programs have provided individuals with detailed, highly specialized training in particular areas of research, and paradoxically, through that same specialized training, generated a general ability to perform self-initiated research in more diverse areas.

The career aspirations of highly skilled individuals in general, and doctorate 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 describe the doctoral S&E labor market. Some of the available labor market indicators, such as unemployment rates, working involuntarily out of the field (IOF) outside of their field, satisfaction with field of study, employment in academia versus other sectors, postdocs, and salaries, are discussed below.

As between 1999 and 2001 (see NSB 2004), aggregate measures of labor market conditions changed only moderately between 2001 and 2003 for recent (1–3 years after receipt of degree) S&E doctoral degree recipients. The most notable increase in a measure of labor market distress was unemployment rates: across all fields unemployment for recent S&E doctoral degree holders increased from 1.3% to 2.1% (table 3-11). However, a smaller proportion of recent doctoral degree recipients reported working IOF because jobs were not available, decreasing from 3.4% to 1.9%. However, these aggregate numbers mask numerous changes, both positive and negative, in many individual disciplines.

Unemployment

The 2.1% unemployment rate for recent S&E doctoral degree recipients as of October 2003 was low, compared with the April 2003 unemployment rate for all civilian workers of 6.0%. The highest unemployment rates were for recent doctoral degree recipients in sociology and anthropology (7.7%), mechanical engineering (6.7%), and mathematics (4.0%).

Involuntarily Working Outside Field

Another 1.9% of recent S&E doctoral degree recipients in the labor force reported in 2003 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. 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 political science (8.7%) and in physics

Table 3-11
Labor market rates for recent S&E doctorate recipients 1–3 years after receiving doctorate, by field: 2001 and 2003
(Percent)

Doctorate field	Unemployment rate		Involuntary out-of-field rate	
	2001	2003	2001	2003
All S&E	1.3	2.1	3.4	1.9
Engineering	1.8	3.0	1.7	2.1
Chemical	1.6	2.0	2.0	5.8
Civil	3.5	S	3.6	4.5
Electrical	0.9	2.4	1.5	0.0
Mechanical	3.2	6.7	1.7	3.7
Life sciences	1.1	2.5	2.5	1.1
Agriculture	0.3	1.5	4.1	3.0
Biological sciences	1.0	2.7	2.4	0.7
Mathematics/computer sciences	0.3	3.1	2.4	3.1
Computer sciences	0.4	2.1	2.3	2.0
Mathematics	0.3	4.0	2.4	4.2
Physical sciences	1.3	1.3	5.0	4.9
Chemistry	0.8	2.0	3.2	5.6
Geosciences	1.9	2.2	3.0	0.0
Physics/astronomy	1.9	0.0	8.2	6.8
Social sciences	1.3	2.5	5.1	5.7
Economics	2.2	0.5	2.1	2.7
Political science	0.8	0.0	8.7	8.7
Psychology	1.4	2.0	3.8	5.6
Sociology/anthropology	1.2	7.7	6.3	4.7

S = insufficient sample size for estimate

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

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and astronomy (6.8%). The lowest IOF rates were found in electrical engineering (0.0%), geosciences (0.0%), and the biological sciences (0.7%).

Tenure-Track Positions

Most S&E doctorate degree holders ultimately do not work in academia and this has been true in most S&E fields for several decades (see chapter 5). In 2003, among S&E doctorate degree holders who received their degree 4–6 years previously, 19.8% were in tenure-track or tenured positions at 4-year institutions of higher education, essentially the same as the 19.2% in 2001 (table 3-12). Across fields, rates of tenure program academic employment for individuals who had received their degree 4–6 years previously ranged from 8.4% in chemical engineering to 50.4% in political science. In contrast, among doctorate degree holders who received their degree 1–3 years previously, only 9% were in tenure programs, a drop from 16.2% in 2001. In part this may reflect diminished employment opportunities at the time of graduation for recent doctorate degree recipients. This rate also reflects the continuing employment as postdocs of recent doctoral degree recipients in many fields.

The longer-term trend (1993–2003) for obtaining tenure-track positions is down for both cohorts of recent doctorate degree recipients. For those 1–3 years since degree, tenure-track positions declined from 18.4% to 9.0%. For those 4–6 years after degree, the decline was more modest from 26.6% to 19.8%.

Although S&E doctorate degree holders must consider academia as just one possible sector of employment, the availability of tenure-track positions is an important aspect of the job market for individuals who seek academic careers. Decreases over time in tenure-track employment reflect the availability both of tenure-track job opportunities in academia and of alternative employment opportunities. For example, one of the largest declines in tenure-track employment occurred in computer sciences, from 51.5% in 1993 to 29.4% in 2003, despite many discussions about difficulties that computer science departments were having finding faculty. It is worth noting that computer science also has one of the largest rates of increase in the percentage of recent doctorate degree recipients entering tenure-track positions between 2001 and 2003, which was a period of particular stress for others in computer-related employment.

However, the attractiveness of other alternatives is less likely to explain smaller but steady drops in tenure program employment rates in fields that show other measures of distress, such as physics (with an IOF rate of 6.8%) and biological sciences (which has low unemployment and IOF rates, but shows other indications of labor market distress such as low salaries). Between 1993 and 2003 several fields registered an increase in tenure program rates for individuals who received their doctorate 4–6 years previously, including geosciences (increasing from 26.2% to 34.2%) and agriculture (increasing from 27.0% to 33.0%).

Table 3-12
S&E doctorate recipients holding tenure and tenure-track appointments at academic institutions, by years since receipt of doctorate: 1993, 2001, and 2003
(Percent)

	1993		2001		2003	
Doctorate field	1–3	4–6	1–3	4–6	1–3	4–6
All S&E	18.4	26.6	16.2	19.2	9.0	19.8
Engineering	16.0	24.6	11.4	10.4	10.8	16.3
Chemical	8.1	14.0	5.8	4.3	4.6	8.4
Civil	24.7	27.1	18.8	21.7	29.8	26.0
Electrical	17.6	26.9	9.5	8.2	13.3	14.5
Mechanical	13.5	29.5	9.9	9.3	8.8	27.0
Life sciences	12.6	24.8	12.6	18.2	7.3	18.0
Agriculture	15.6	27.0	23.7	12.8	10.2	33.0
Biological sciences	12.1	24.8	11.3	18.3	5.0	15.1
Mathematics/computer sciences	39.7	54.1	22.5	26.6	32.2	38.5
Computer sciences	37.1	51.5	19.2	23.6	32.0	29.4
Mathematics	41.8	56.0	25.0	29.3	32.4	46.7
Physical sciences	9.7	18.2	10.2	14.9	11.9	16.7
Chemistry	7.7	16.3	10.2	11.5	13.7	14.4
Geosciences	12.7	26.2	17.7	25.4	20.2	34.2
Physics/astronomy	12.0	17.7	7.8	11.4	6.3	12.8
Social sciences	26.4	29.2	25.9	28.3	26.6	30.8
Economics	46.6	48.6	37.1	28.6	45.3	38.0
Political science	53.9	47.1	45.0	40.0	43.8	50.4
Psychology	12.7	15.5	14.8	19.3	11.7	18.8
Sociology/anthropology	37.9	46.9	41.3	44.1	42.7	50.3

NOTE: Two-year institutions not included.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients (1993, 2001, and 2003).

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Postdocs

The definition of postdocs differs among the academic disciplines, universities, and sectors that employ them, and these differences probably affect self-reporting of postdoc status in the Survey of Doctorate Recipients. Researchers often analyze data on postdoc appointments for recent doctoral degree recipients in relation to recent labor market issues. Although some of these individuals want to receive more training in research, others may accept temporary (and usually lower-paying) postdoc positions because of a lack of permanent jobs in their field.

Science and Engineering Indicators – 1998 (NSB 1998) included an analysis of a one-time postdoc module from the 1995 Survey of Doctorate Recipients. This analysis showed a slow increase in the use of postdocs in many disciplines over time. (This rate was measured cross-sectionally by looking at the percentage of individuals in each graduation cohort who reported ever holding a postdoc position.) In addition, in physics and biological sciences (the fields with the most use of postdocs), median time spent in postdocs extended well beyond the 1–2 years found in most other fields.

Reasons for Taking a Postdoc

In 2003 for all fields of degree 11.6% of postdocs gave “other employment not available” as their primary reason for accepting a postdoc, essentially the same as the 11.5% that gave this reason in 2001. However, in 1999, 32.1% of postdocs said that the primary reason was “other employment not available (NSB 2002, 2004) (table 3-13). Most respondents gave reasons consistent with the defined training and apprenticeship functions of postdocs (e.g., 31% said that postdocs were generally expected for careers in their fields, 18% said they wanted to work with a particular person, 22% said they sought additional training in their fields, and 14% said they sought additional training outside their specialty). In 1999, a high proportion of postdocs in the biological sciences (38%) and physics (38%) had reported “other employment not available” as the primary reason for being in a postdoc, but in 2003, both fields had below-average rates for this particular indicator of labor market distress. In contrast, nearly a third of engineering postdocs in 2003 reported “other employment not available” as the primary reason for their postdoc.

What Were 2001 Postdocs Doing in 2003?

Of individuals in postdocs in April 2001, 32.9% remained in a postdoc in October 2003. This is a small reduction from the 36.5% of 1999 postdocs still in such positions in 2001 (NSB 2004). In addition, 23.2% had moved from a postdoc in 2001 to a tenure-track position at a 4-year educational institution in 2003, up from 12.3% for the previous period; 23.7% had found other employment at an educational institu-

Table 3-13
Primary reason for taking current postdoc, by field: 2003
(Percent)

Doctorate field	Additional training in doctorate field	Training outside doctorate field	Postdoc generally expected in field	Association with particular person or place	Other employment not available	Other
All S&E fields	21.8	14.2	30.7	18.1	11.6	3.5
Biological sciences	19.1	15.1	37.2	17.4	8.2	3.0
Chemistry	21.9	26.9	21.8	16.7	10.9	1.9
Engineering	26.3	12.9	18.4	8.2	31.2	3.0
Geoscience	12.9	15.5	12.5	25.3	29.1	4.7
Physics	22.1	12.1	36.0	21.5	2.0	6.3
Psychology	29.1	8.9	24.0	23.1	10.7	4.2

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients (2003).

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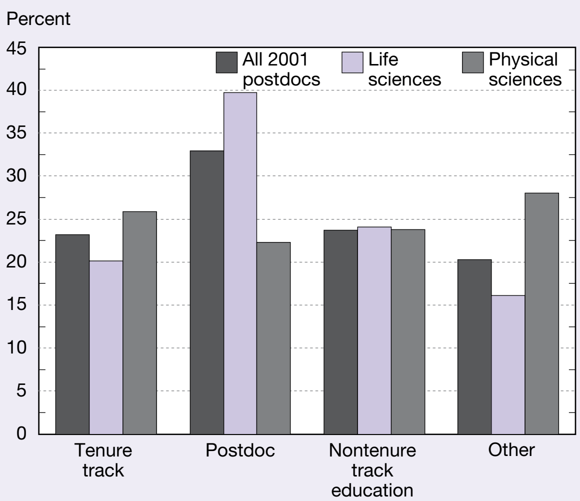
tion; and 20.3% had found some other form of employment (figure 3-30).

No information is available on the career goals of individuals in postdoc positions. It is often assumed that a postdoc is valued most by academic departments at research universities. However, only about one-quarter of postdocs transitioned to a tenure-track position over the 2-year period.

Salaries for Recent S&E Doctoral Degree Recipients

In 2003 for all fields of degree the median annual salary for recent S&E doctoral degree recipients 1–4 years after their degrees was $52,000. Across various S&E fields of degree, median annual salaries ranged from a low of $39,400 in the life sciences to a high of $75,000 in engineering (table 3-14).

Figure 3-30
Status of 2001 S&E postdocs, by field: 2003



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

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Among all doctoral degree recipients, individuals in the top 10% of salary distribution (90th percentile) earned a median annual salary of $100,000. At the 10th percentile, representing the lowest pay for each field, salaries ranged from $20,000 for recent doctoral degree recipients in social sciences to $44,000 for individuals receiving degrees in engineering.

By type of employment, salaries for recent doctoral degree recipients range from $40,000 for postdocs to $80,000 for those employed by private for-profit business (table 3-15).

Age and Retirement

The age distribution and retirement patterns of the S&E labor force greatly affect its size, its 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 general picture is rapidly changing as individuals who earned S&E degrees in the late 1960s and early 1970s move into the latter part of their careers.

Some controversy exists about the possible effects of age distribution on scientific productivity. Increasing average age may mean increased experience and greater productivity among scientific workers. However, others argue that it could reduce opportunities for younger scientists to work independently. In many fields, scientific folklore as well as actual evidence indicate that the most creative research comes from younger people (Stephan and Levin 1992).

This section does not attempt to model and 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.

Table 3-14
Salary of recent S&E doctorate recipients 1–4 years after receiving degree: 2003
(Dollars)

Doctorate field	Percentile 10th	25th	50th	75th	90th
All fields	30,000	40,000	52,000	75,000	100,000
Engineering	44,000	63,000	75,000	88,000	102,000
Life sciences	26,000	32,000	39,400	50,000	72,500
Mathematics/computer sciences	40,000	42,500	60,000	92,500	115,000
Physical sciences	34,000	42,000	62,000	92,000	175,000
Social sciences	20,000	41,000	50,000	67,000	82,000

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients (2003).

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Table 3-15
Median annual salary of recent S&E doctorate recipients 1–5 years after receiving degree, by type of employment: 2003
(Dollars)

Doctorate field	All sectors	Private	Tenure track	Postdoc	Other education	Nonprofit/ government
All S&E fields	57,000	80,000	53,000	40,000	48,500	68,000
Computer/mathematical sciences	67,000	89,000	59,000	45,000	60,000	S
Engineering	74,000	83,000	68,000	39,000	51,500	78,700
Life sciences	42,600	70,000	50,000	39,000	44,000	65,000
Physical sciences	60,000	78,800	51,000	40,000	50,000	60,000
Social sciences	52,000	70,000	50,000	37,000	48,000	63,000

S = insufficient sample size for estimate

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients (2003).

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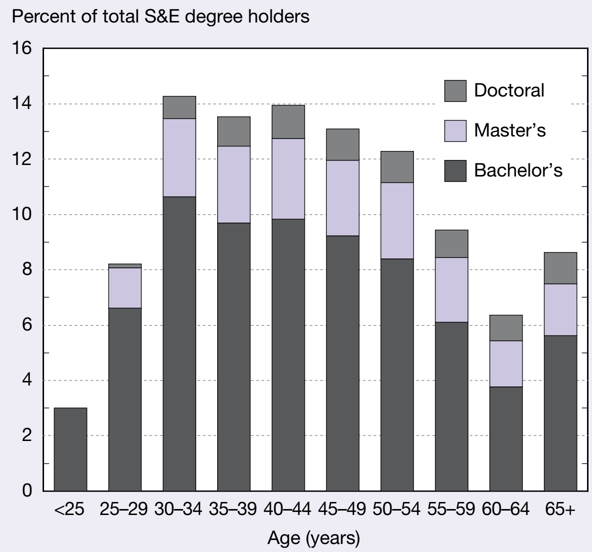
Implications for S&E Workforce

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 40 and 49. (Figure 3-31 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 doctorate degrees. Doctorate degree holders are somewhat older than individuals who have less advanced S&E degrees; this circumstance occurs because fewer doctorate degree holders are in younger age categories, reflecting that time is needed to obtain this degree. The greatest population density of S&E doctorate degree holders occurs between the ages of 40 and 54. This can be most directly seen

Figure 3-31
Age distribution of labor force with S&E highest degrees: 2003



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

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in figure 3-32, which compares the age distribution of S&E degree holders in the labor force at each level of degree. Even if one takes into account the somewhat older retirement ages of doctorate 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.

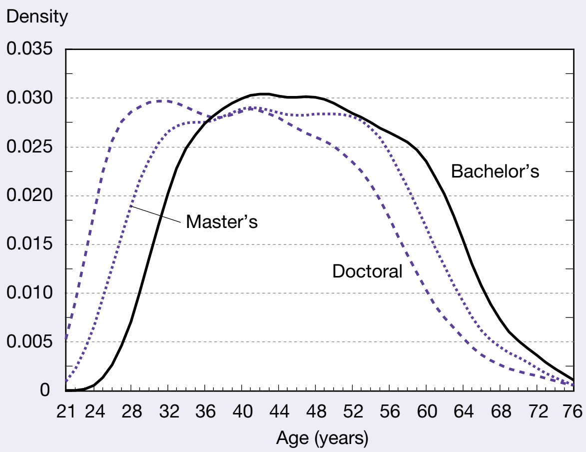
The extent of the recent aging of the S&E labor force is highlighted in figure 3-33, which shows the age distribution of S&E doctorate holders in 1993 and 2003. S&E doctorate holders under age 35 are about the same proportion of the S&E doctorate level labor force in both years. However, over the decade, the 35–54 age group became a much smaller part of the full S&E doctorate-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 11.1% of individuals with their highest degree in computer sciences to 37.7% of individuals with their highest degree in physics (figure 3-34).

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.

Figure 3-32
Age distribution of individuals in the labor force whose highest degree is 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), preliminary estimates (2003), http://sestat.nsf.gov.

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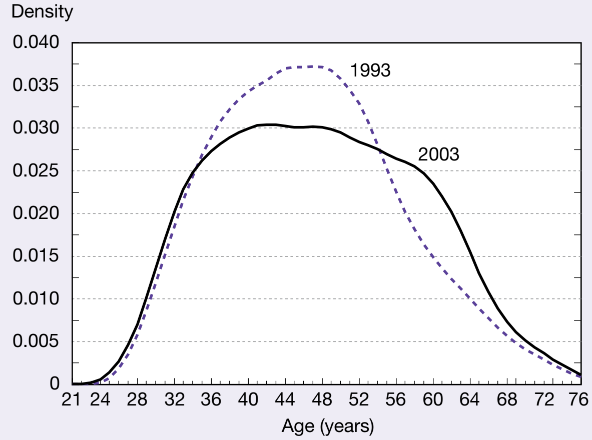
Figure 3-33
Age distribution of S&E doctorate holders in the labor force: 1993 and 2003



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 preliminary estimates (2003), http://sestat.nsf.gov.

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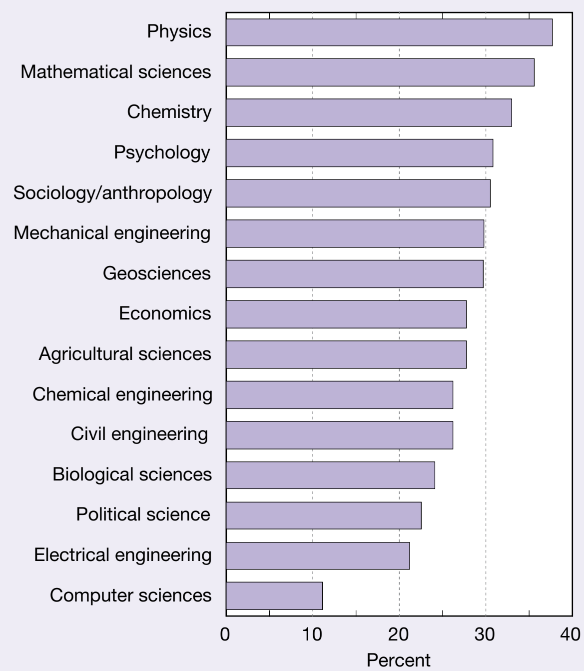
Figure 3-34
Employed S&E degree holders older than 50, by selected field: 2003



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

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- 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 doctorate 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 recent report of the Committee on Education and Human Resources Task Force on National Workforce Policies for Science and Engineering of the National Science Board (NSB 2003).

S&E Workforce Retirement Patterns

The retirement behavior of individuals can differ in complex ways. Some individuals retire from one job and continue to work part time or even full time at another position, sometimes even for the same employer. Others leave the workforce without a retired designation from a formal pension plan. Table 3-16 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, S&E doctorate degree holders do not reach the 50% not working full time until age 66. 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 doctorate degree holders did not do so until ages 66 and 70, respectively. Formal retirement also occurs at somewhat higher ages for doctorate 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 doctorate degree holders.

Figure 3-35 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 doctorate degree holders becomes significantly greater than for bachelor's and master's degree holders. At age 69, 21% of doctorate degree holders work full time, compared with 16% of bachelor's or master's degree recipients.

Table 3-17 shows rates at which doctorate degree holders left full-time employment, by sector of employment, between 1999 and 2001 and between 2001 and 2003. At nearly every age and sector of employment, a greater 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 3-18). However, among "retired" individuals ages 71 to 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.

Table 3-16
Retirement age for holders of S&E highest degree: 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
Doctoral............	66	70	65

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

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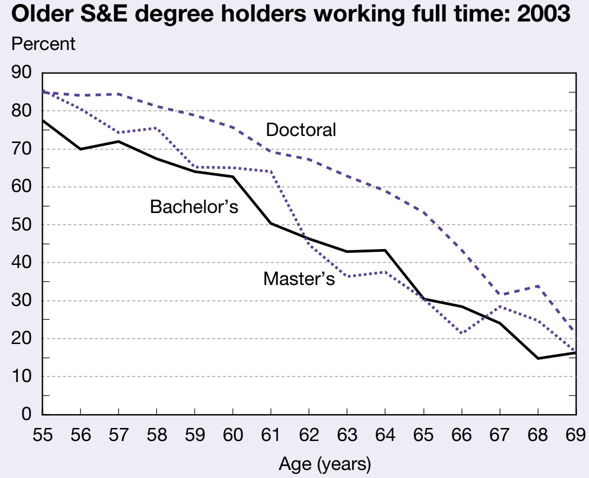
Figure 3-35
Older S&E degree holders working full time: 2003



SOURCE: National Science Foundation, Division of Science Resources Statistics, SESTAT, preliminary estimates (2003), http://sestat.nsf.gov. See appendix table 3-14.

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Table 3-17
Employed S&E doctorate holders leaving full-time employment, by employment sector and age 2 years previous: 2001 and 2003
(Percent)

	2001 (1999 employment sector)				2003 (2001 employment sector)			
Age (years)	All sectors	Education	Private	Government	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 = insufficient sample size for estimate

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

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Table 3-18
S&E highest-degree individuals who have retired but continue to work: 2003
(Percent)

	Bachelor's		Master's		Doctoral	
Age (years)	Part time	Full time	Part time	Full time	Part time	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 individuals 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), preliminary estimates (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 United States (and other countries as well) gains from new knowledge discovered abroad and from increases in foreign economic development. U.S. industry also increasingly relies on R&D performed abroad. The nation's international economic competitiveness, however, depends on the U.S. labor force's innovation and productivity.

Other chapters in *Science and Engineering Indicators 2006* provide indirect indicators on the global labor force. Production of new scientists and engineers through university degree programs is reported in chapter 2. Indicators of R&D performed by the global S&E labor force are provided in chapter 4 (R&D expenditures and alliances), chapter 5 (publications output and international collaborations), and chapter 6 (patenting activity).

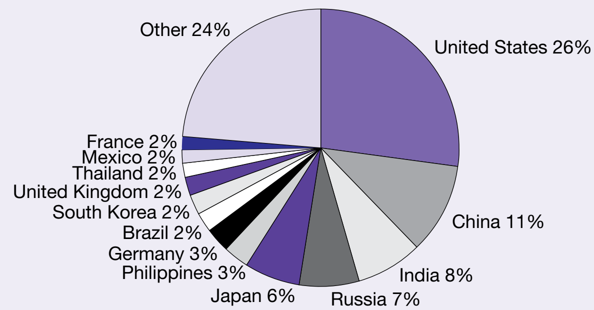
Section Overview

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 doctorate degree labor force, and are even more important 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 the Global S&E Labor Force

Few direct measures of the global S&E labor force exist. Reports on the number of researchers in OECD member countries constitute one source of data. From 1993 to 1999, the number of researchers reported in OECD countries increased by 33.9% (a 5.0% average annual rate of increase) from approximately 2.46 million to 3.30 million (figure 3-36). During this same period, comparable U.S. estimates increased 30.7% (a 4.6% average annual rate of increase) from approximately 965,000 to 1.26 million. Of course, non-OECD countries also have scientists and engineers. Figure 3-37, based on estimates by Robert Barro and Jong-Wha Lee, 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 3-37
Tertiary-educated population more than 15 years old: 2000



SOURCE: Adapted from R.J. Barro and J. Lee, *International Data on Educational Attainment: Updates and Implication,* Center for International Development (2000). See appendix table 3-15.

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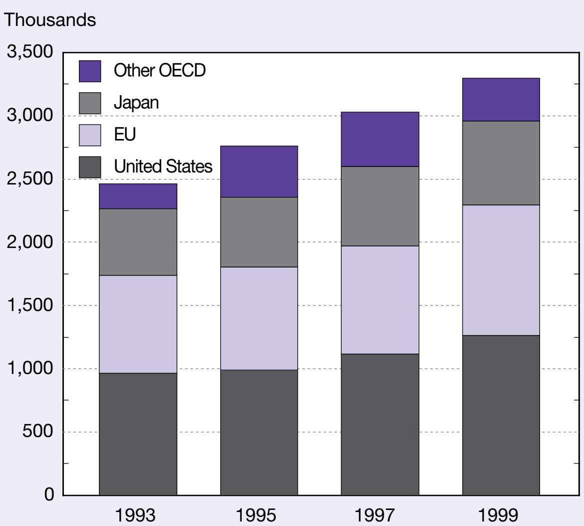
Migration to the United States

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 "[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 Japan.")

Figure 3-36
Researchers in OECD countries: 1993, 1995, 1997, and 1999



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

NOTE: 1999 numbers reflect EU-25 membership.

SOURCE: OECD, *Main Science and Engineering Indicators* (2004).

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The nature of high-skilled migration makes it difficult to count foreign-born scientists and engineers working in the United States. Individuals may come for just a few years to pursue training or to work in a particular job. In addition to making their measure dependent on the timing of surveys, many of these short- to medium-term migrants will have all foreign degrees and not be included at all in some surveys.

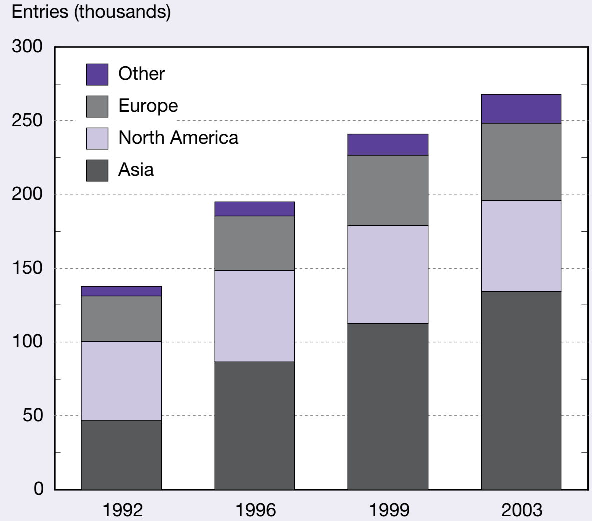
An indication of the scope of the problems with undercounting of foreign-born scientists and engineers comes from a comparison of SESTAT occupational data with approximately comparable data from the 2000 Census. Using the 5% Public-Use Microdata Sample (PUMS), it is possible to compare the proportion of foreign-born individuals among those with S&E occupations other than postsecondary teacher (table 3-19). According to the 1999 SESTAT, 15.0% of college graduates in S&E occupations are foreign born, compared with the 22.4% recorded by the 2000 Census. A particularly noteworthy difference appears in the proportion of foreign-born individuals among those with doctorate degrees; this proportion increases from 28.7% in the 1999 SESTAT to 37.6% in the 2000 Census. The large increases shown by 2000 Census data may in part reflect recent arrivals to the United States, because 42.5% of all college-educated foreign born in these S&E occupations reported arriving in the United States after 1990. Among foreign-born doctorate

High-Skill Migration to Japan

Recent political debate and legislative change in the United States, Germany, Canada, and many other developed countries have focused on visa programs for temporary high-skilled workers. 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).

Scott Fuess of the University of Nebraska (Lincoln) and the Institute for the Study of Labor (Bonn) analyzed 12 Japanese temporary visa occupation categories associated with high-skilled workers. Updating Fuess' data, in 2003, 268,045 workers entered Japan in high-skilled visa categories, a 93% increase compared with 1992 (figure 3-38). 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 3-38
High-skilled worker visas in Japan: Selected years, 1992–2003



SOURCES: S. Fuess, 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). See appendix table 3-17.

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degree holders in S&E occupations, 62.4% reported arriving in the United States after 1990. The 1999 NSF/SRS estimates in table 3-19 include these post-1990 arrivals only if their degrees are from a U.S. institution.

New NSF estimates of the foreign born in S&E occupations are also shown in table 3-19 (table 3-20 shows NSF estimates of foreign born by field of degree, regardless of occupation). The 2003 SESTAT estimates provide an important update over 1999 SESTAT estimates because it includes those with degrees from foreign educational institutions if they were present in the United States in April 2000, at the time of the Decennial Census (new migrants with only foreign degrees who have entered the United States since April 2000 are not included). The estimate of 35.6% of doctorate holders in S&E occupations being foreign born is consistent with an increased coverage of foreign degrees. An unresolved mystery is why the SESTAT proportion of foreign-born doctorate degree holders in S&E occupations is less than either the 2000 Census or the 39.5% found on the 2003 American Community Survey. One possibility is that NSF's data, through a series of detailed questions, may more accurately screen out foreign degrees that are not really doctorate equivalents. However, it is also possible that the 2003 SESTAT, which is based in part on a sample of individuals on the 2000 Census, does not detect foreign doctorate degree holders staying in the United States for just a few years to pursue postdocs and other research opportunities while on temporary visas.

By field of degree, in the 2003 SESTAT data, 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 bachelor's degree holders in sociology/anthropology to 27% of bachelor's degree holders 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 3-39 shows country of birth for the 3.1 million foreign-born S&E degree holders in the United States, 300,000 of whom have doctorates. Although no one source country dominates, 14% came from India and 9% came from China. Source countries for foreign-born holders of S&E doctorates are somewhat more concentrated, with China providing 21% and India 14%.

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 requiring at least a bachelor's degree (or to work as fashion models). Although a common misperception exists that only

Table 3-19
NSF versus Census Bureau estimates of foreign-born individuals in S&E occupations, by education level: 1999, 2000, and 2003
(Percent)

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

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

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. All college educated includes those with professional degrees.

SOURCES: NSF/SRS, SESTAT (1999) and preliminary estimates (2003), http://sestat.nsf.gov; U.S. Census Bureau, PUMS (2000); and American Community Survey (2003).

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Table 3-20
Foreign-born proportion of total with S&E highest degrees, by field and level of highest degree: 2003
(Percent)

Field	All degree levels	Highest degree: Bachelor's	Highest degree: Master's	Highest degree: Doctoral
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), preliminary estimates (2003), http://sestat.nsf.gov.

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IT workers may use these visas, a wide variety of skilled workers actually use H-1B visas.

Exact occupational information on H-1B visas issued is not available. Some occupational data on H-1B admissions in 2001, which count individuals who reenter the United States multiple times, does exist. This information can provide an approximate guide to the occupational distribution of individuals on H-1B visas. Individuals working in computer-related positions accounted for more than half (57.8%) of H-1B admissions, and those working in architecture and engineering constituted another 12.2%. Another 4.6% indicated other scientific and technical occupations, and the 8.7% of those in categories such as education and medicine also may include many with S&E backgrounds (table 3-21). It is possible that the occupational distribution of H-1B visas may now be less computer related—both because of the downturn in the computer industry and changes made in the visa program since 2001.

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. In FY 2005, this ceiling was reached in the first day of the fiscal year. Although universities and academic research institutions are exempt from this ceiling, this change is likely to constrain the use of foreign scientists and engineers by private industry for any R&D located in the United States. 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.

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, 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). Counts of visas issued for each of these categories are shown in table 3-22. The annual quota of H-1B visas is controlled through issuance of visas to workers rather than through applications from companies. (See sidebar, "Visas for Scientists and Engineers.")

Table 3-21
H-1B visa admissions, by occupation: FY 2001

Occupation	Admissions: Number	Admissions: Percent
All occupations	331,206	100.0
Computer related	191,397	57.8
Architecture, engineering, surveying	40,388	12.2
Education	17,431	5.3
Medicine	11,334	3.4
Life sciences	6,492	2.0
Social sciences	6,145	1.9
Mathematical/physical sciences	5,772	1.7
Other professional/ technical	5,662	1.7
Other (non-S&E related)	46,585	14.1

NOTE: Total admissions includes each entry to United States and thus is much greater than number of visas issued.

SOURCE: U.S. Department of Homeland Security, Bureau of Citizenship and Immigration Services, administrative data.

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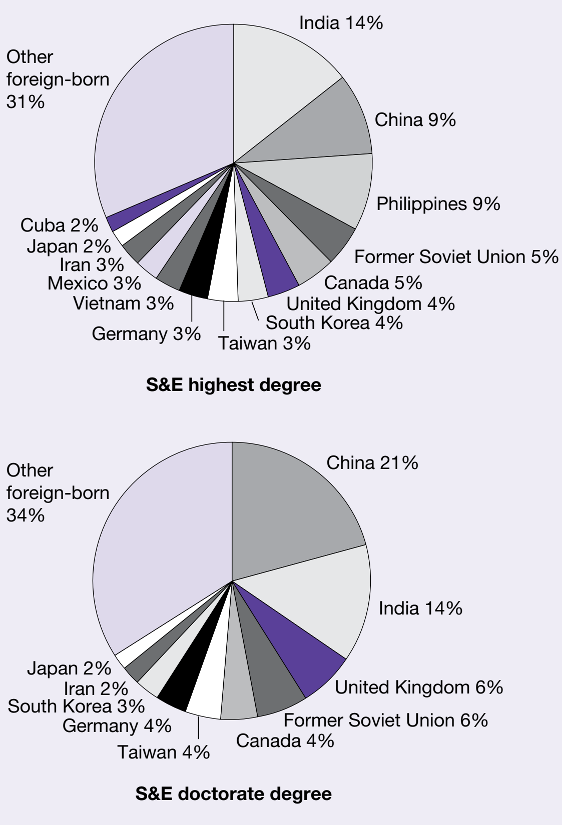
Figure 3-39
Foreign-born individuals with S&E highest degree living in United States, by place of birth: 2003



SOURCE: National Science Foundation, Division of Science Resources Statistics, SESTAT, preliminary estimates (2003), http://sestat.nsf.gov. See appendix table 3-18.

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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 (2003 and unpublished 2005 data) of the Oak Ridge Institute for Science and Education, 61% of 1998 U.S. S&E doctoral degree recipients with temporary visas remained in the United States in 2003. This is up from a 56% 5-year stay rate found in 2001. The number of foreign students staying after obtaining their doctorates implies that between 4,500 and 5,000 foreign students remain from each

Table 3-22
Temporary visas issued in categories likely to include scientists and engineers: FY 2004

Visa type	Category	Number
Work		
H-1B	Specialty occupations requiring bachelor's equivalent	138,958
L-1	Intracompany transfers	62,700
O-1	People of extraordinary ability	6,437
O-2	Workers assisting O-1	2,611
Student/exchange		
F-1	Students	218,898
J-1	Exchange visitors	254,504

SOURCE: U.S. Department of State, Immigrant Visa Control and Reporting Division, administrative data.

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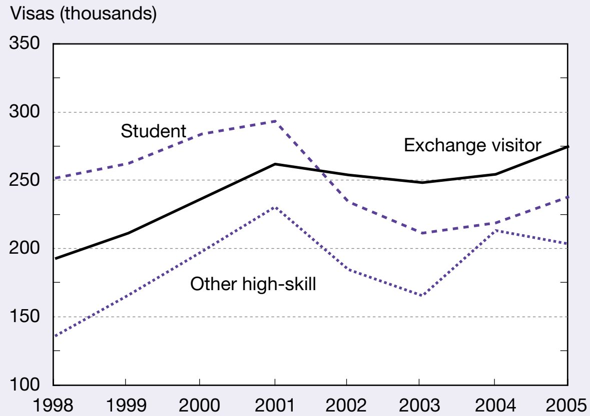
Visas for Scientists and Engineers

The ability and willingness of people to cross national borders crucially affects the science and technology enterprise in the United States. Foreign students help to fill graduate classrooms and laboratories. Visiting scientists facilitate the exchange of knowledge in ways that the telephone and the Internet cannot. Most importantly, foreign-born scientists constitute more than one-fourth of the S&E degree holders doing research in both academia and in industry (and a much higher proportion of doctorate degree-level researchers). For this reason, a great deal of concerned speculation has focused on the effects of the tragic events of September 11, 2001, on the mobility of scientists to the United States.

The visas issued in the categories most used by students and high-skilled workers peaked in FY 2001 (a fiscal year that ended on September 30, 2001). Between FY 2001 and FY 2004, the number of F-1 student visas issued dropped by 25.4%, a drop partly ameliorated by a 3.6% increase between FY 2003 and FY 2004 (see figure 3-40). The increase in F-1 student visas issued occurred despite a continued drop in applications: the adjusted rate at which the State Department refused student visa applicants fell from 25.3% to 22.6% (see table 3-23). Relatively few potential students were 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.

Figure 3-40
Student, exchange, and other high-skill-related temporary visas issued: FY 1998–2005



NOTE: Student visa = F-1; exchange visitor visa = J-1; and high-skill-related visas = L-1, H-1B, H-3, O-1, O-2, and TN.

SOURCE: U.S. Department of State, Immigrant Visa Control and Reporting Division (1998–2005).

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Table 3-23
Initial visa applications by major high-skilled categories: FY 2001–2005

	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
2005	333,161	19.8	311,728	5.8

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

SOURCE: U.S. Department of State, Immigrant Visa Control and Reporting Division, administrative data.

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annual cohort of new S&E doctorates in all fields. Stay rates differ by field of degree, ranging from only 36% in economics to 70% in computer and electrical engineering in 2003 (table 3-24).

The small increase in 5-year stay rates between 2001 and 2003 may reflect improvements in labor market conditions at the time each cohort entered the U.S. labor force. This increase occurred despite a small decline in the 5-year stay rate for Chinese students receiving U.S. S&E doctorates—from 96% to 90%.

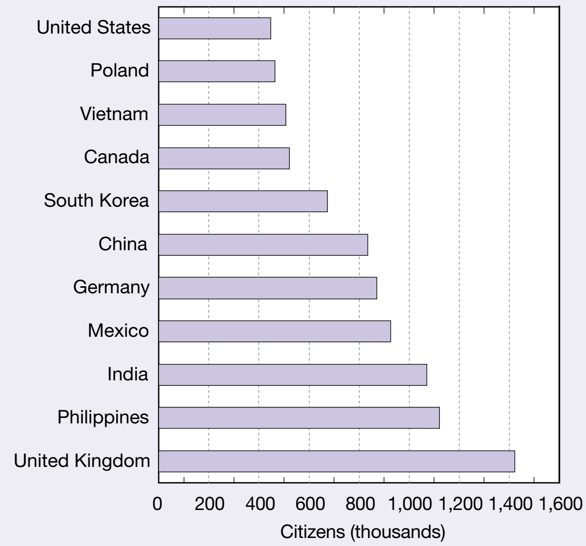
Within each discipline, the stay rate remained mostly stable for the 1998 graduation cohort between 1999 and 2003. Quite possibly, however, some of this stability came from individuals in this cohort who reentered the United States and thus replaced others in the same graduation cohort who left.

Highly Skilled Migrants in OECD Countries

Estimates of international migrants residing in OECD countries were made by Docquier and Marfouk (2004) using estimates from the various national censuses. Based on their data, figure 3-41 shows the 11 countries with the largest number of citizens found residing 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 provide advantages for a country that help to mitigate any 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.

Figure 3-41
Citizens having at least tertiary-level education residing in OECD countries, by top 11 countries: 2000



OECD = Organisation for Economic Co-operation and Development

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

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Table 3-24
Temporary residents receiving U.S. S&E doctorates in 1998 who were in the United States, by degree field: 1999–2003
(Percent)

		In United States				
Degree field	Foreign doctorate recipients	1999	2000	2001	2002	2003
All S&E fields	7,958	66	64	63	62	61
Agricultural sciences	463	48	47	47	47	46
Computer sciences	328	71	71	72	72	70
Computer/electrical engineering	688	78	76	75	74	70
Economics	516	40	39	37	37	36
Life sciences	1,620	72	68	67	68	67
Mathematics	447	67	63	62	60	59
Other engineering	1,894	68	67	67	65	64
Other social sciences	583	39	38	37	37	37
Physical sciences	1,419	75	74	72	71	69

SOURCE: M. Finn, Oak Ridge Institute for Science and Education, unpublished tabulations.

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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 doctorate 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 science and technology 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.

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.

Note

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

Glossary

Career path job: A job that helps a graduate fulfill his or her future career plans.

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.

Involuntary employment outside of field: A person either employed outside his or her field because a job in that field was not available or employed part time in that field because a full-time job was not available.

Stay rate: In this chapter, the proportion of students on temporary visas who have stayed in the United States 1–5 years after doctorate degree conferral.

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

References

Barro R, Lee J. 2000. International data on educational attainment: Updates and implications. Cambridge, MA: Center for International Development at Harvard University.

Bureau of Labor Statistics (BLS), Office of Occupational Statistics and Employment Projections. 2001. National industry-occupation employment projections 2000–2010. Washington, DC: U.S. Department of Labor.

Bureau of Labor Statistics (BLS) 2004. National industry-occupation employment projections 2002–2012. Washington, DC: U.S. Department of Labor.

Docquier F, Marfouk A. 2004. International Migration by Educational Attainment. Bonn, Germany: Institute for the Study of Labor.

Finn M. 2003. *Stay Rates of Foreign Doctorate Recipients From U.S. Universities.* Oak Ridge, TN: Oak Ridge Institute for Science and Education.

Fuess SM. 2001. Highly skilled workers and Japan: Is there international mobility? Workshop paper presented at the Institute for the Study of Labor (IZA); 25 March; Bonn, Germany.

Fullerton H. 2003. Evaluating the BLS labor force projections to 2000. *Monthly Labor Review* October:3–12.

National Science Board (NSB). 1998. *Science and Engineers Indicators–1998.* NSB-98-1. Arlington, VA: National Science Foundation.

National Science Board (NSB). 2002. *Science and Engineering Indicators–2002.* NSB-02-1. Arlington, VA: National Science Foundation.

National Science Board (NSB). 2003. Report of the National Science Board Committee on Education and Human Resources Task Force on National Workforce Policies for Science and Engineering. Arlington, VA: National Science Foundation.

National Science Board (NSB) 2004. *Science and Engineering Indicators–2004.* NSB-04-1. Arlington, VA: National Science Foundation.

National Science Foundation, Division of Science Resources Statistics (NSF/SRS). 1999a. Counting the S&E workforce—it's not that easy. Issue Brief. NSF 99-344. Arlington, VA.

National Science Foundation, Division of Science Resources Statistics (NSF/SRS). 1999b. SESTAT and NIOEM: Two federal databases provide complementary information on the science and technology labor force. Topical Report. NSF 99-349. Arlington, VA.

Regets MC. 2001. *Research and Policy Issues in High-Skilled International Migration: A Perspective With Data From the United States.* Bonn, Germany: Institute for the Study of Labor. ftp://ftp.iza.org/dps/dp366.pdf

Stephan P, Levin S. 1992. *Striking the Mother Lode in Science: The Importance of Age, Place, and Time.* New York: Oxford University Press.