Chapter 2
Higher Education in Science and Engineering

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Highlights

Overall Trends in Enrollments and Degrees in U.S. Universities

Enrollment in U.S. higher education is projected to continue rising over the next decade because of increases in the U.S. college-age population.

- Enrollment rose from 12.6 million in 1983 to 15.7 million in 2001.
- The number of individuals between the ages of 20 and 24 in the U.S. population is projected to rise through about 2015, although the demographic composition will shift. The number of people ages 20 to 24 is projected to decline from 2015 to 2020.
- Whites are projected to decline from 66% of the population mentioned above in 2000 to 58% by 2020, as the shares of Asians/Pacific Islanders and Hispanics increase from 4% to 6% and 15% to 22%, respectively. The percentages of blacks and American Indians/Alaska Natives are projected to remain at 14% and 1%, respectively.

The number of science and engineering degrees awarded at all levels is rising.

- The numbers of S&E bachelor's and master's degrees reached new peaks of 415,600 and 99,200, respectively, in 2002.
- The number of S&E doctoral degrees, after declining for 4 years, rose in 2003 for both U.S. citizens and temporary visa holders.

S&E bachelor's degrees have constituted about one-third of all baccalaureate degrees awarded for more than 20 years.

- S&E bachelor's degrees made up 32% of all bachelor's degrees awarded in 1983 and in 2002, fluctuating between 30% and 34% in the intervening years.
- Bachelor's degrees in the natural sciences (physical, life, environmental, and computer sciences, and mathematics) are about 12%, engineering baccalaureates are about 5%, and social/behavioral science baccalaureates are about 15% of all baccalaureates awarded.
- Percentages of all bachelor's degrees earned in the natural sciences, engineering, and social/behavioral sciences have fluctuated very narrowly over the past 20 years, but with an increase in the percentage of bachelor's degrees in psychology (from 4% to 6%) and a decrease in the percentage in engineering (from 7% to 5%).

S&E graduate enrollment in the United States reached a new peak of 566,800 in 2003.

- Following a long period of growth beginning in the 1970s, graduate enrollment in S&E declined in the latter half of the 1990s, but then rebounded in the past several years.
- Graduate enrollment in engineering and in life sciences drove most of the recent growth, but enrollment did increase in all major science fields.

After dropping from 1998 through 2002, the number of S&E doctorates awarded overall increased in 2003. Most major S&E fields also saw increases.

- U.S. citizens accounted for most of the decline between 1998 and 2002, but the number of permanent residents earning S&E doctorates also declined in this period.
- Temporary residents accounted for most of the 2003 increase. The number of U.S. S&E doctorates earned by temporary residents increased by 9% from 2002 to 2003, and the number earned by U.S. citizens increased by 2%.

The number of doctorate recipients with S&E postdoctoral appointments at U.S. universities more than doubled in the past two decades.

- Noncitizens account for most of the increase in S&E postdocs during the period.
- Noncitizens accounted for 58% of S&E postdocs in 2003.
- About two-thirds of S&E postdocs are in the biological/medical/other life sciences.

Financial Support of S&E Graduate Students

The federal government was the primary source of support for about one-fifth of full-time S&E graduate students in 2003.

- Federal support came mostly in the form of research assistantships (RAs), which accounted for 70% of federal support in 2003, up from 61% two decades earlier. The share of federally supported S&E graduate students receiving traineeships declined from 19% in 1983 to 12% in 2003.
- Federal support reaches relatively more students in the physical sciences; earth, ocean, and atmospheric sciences; agricultural sciences; biological sciences; and engineering. Relatively few students receive federal support in mathematics, computer sciences, social sciences, and psychology.

- The proportion of full-time S&E graduate students funded by the National Institutes of Health (NIH) rose to 30% in 2003, and the National Science Foundation (NSF) funded 24%. Support from the U.S. Department of Defense declined to 11% of full-time S&E graduate students.

Primary mechanisms of support differ widely by S&E field of study.

- Full-time students in physical, agricultural, and biological sciences and engineering are supported mainly by RAs.
- In mathematics, primary student support comes from teaching assistantships (TAs) and self-support.
- Full-time graduate students in the social and behavioral sciences are mainly self-supporting or receive TAs.

About one-fourth of 2003 S&E doctorate recipients still owed money from their undergraduate education, and one-third owed money related to their graduate education.

- The majority had no undergraduate debt (73%) or no graduate debt (66%).
- High levels of educational debt were most associated with graduate education: 13% had more than $35,000 of graduate debt, but only 2% had similar amounts of undergraduate debt.
- Levels of debt vary by field, with doctorate recipients in psychology, social sciences, agriculture, and medical/health sciences having higher levels of debt.

Enrollment of and Degrees to Women and Underrepresented Minorities

Women earned more than half of all bachelor's degrees and S&E bachelor's degrees in 2002, but major variations persist among fields.

- Women earned more than half of the degrees awarded in psychology (78%), biological/agricultural sciences (59%), and social sciences (55%), and almost half (47%) in mathematics.
- However, women received 21% of bachelors degrees awarded in engineering, 27% in computer sciences, and 43% in physical sciences.

Underrepresented minorities (blacks, Hispanics, and American Indians/Alaska Natives) do not enroll in or complete college at the same rate as whites. However, among those who do earn bachelor's degrees, similar percentages of underrepresented minorities and whites earn their degrees in S&E.

- The percentages of blacks and Hispanics ages 25 to 29 in 2003 who completed bachelor's or higher degrees were 18% and 10%, respectively, compared with 34% for whites.
- Among high school graduates, the percentages of blacks and Hispanics ages 25 to 29 in 2000 who had completed bachelor's or higher degrees stood at 21% and 15%, respectively, compared with 36% for whites.
- About one-third of all bachelor's degrees earned by every racial/ethnic group, except Asians/Pacific Islanders, are in S&E. Asians/Pacific Islanders, as a group, earn almost half of their bachelor's degrees in S&E.

The recent increase in S&E graduate enrollment occurred across all major demographic groups: women, minorities, white men, and foreign students.

- The number of women enrolling in S&E graduate programs has continued to increase for the past two decades (except for a decline in computer sciences in 2003).
- The number of white S&E graduate students decreased from 1994 to 2000, then increased through 2003.
- The number of underrepresented minority students enrolling in S&E graduate programs has increased each year since 1985.

Enrollment of and Degrees to Foreign Students

Students in the United States on temporary visas earned a small share (4%) of S&E bachelor's degrees in 2002.

- The number of S&E bachelor's degrees awarded to students on temporary visas increased over the past two decades from 14,100 in 1983 to 16,300 in 2002.
- In 2002, these students earned 8% of bachelor's degrees awarded in computer sciences and 7% of those awarded in engineering.

Although total enrollment of foreign S&E graduate students continued to increase, first-time full-time enrollment declined in fall 2002 and fall 2003.

- The number of S&E graduate students on temporary visas more than doubled between 1983 and 2003, rising from 19% to 27% of all graduate S&E students over that period.
- The number of first-time full-time S&E graduate students with temporary visas declined 5% in fall 2002, the first full academic year since September 11, 2001, and declined another 8% in fall 2003.
- These declines were concentrated mainly in engineering and in computer sciences; however, first-time full-time foreign enrollment increased in physical sciences and in psychology and remained stable in the other major science fields in 2003.

Students on temporary visas earned about one-third (32%) of all S&E doctorates awarded in the United States in 2003 (and more in some fields).

- More than half (55%) of engineering doctorates were awarded to students on temporary visas.
- Students on temporary visas earned 43%–44% of U.S. doctorates in mathematics, computer sciences, and agricultural sciences.

Historically, half or more of students on temporary visas have stayed in the United States immediately after degree conferral; however, this percentage has risen in recent years.

- Although the number of S&E doctoral degrees earned by foreign students declined after 1996, the number of students who had firm plans to remain in the United States continued to increase through 2001, then declined slightly in 2002 and 2003.
- In the period from 1992 to 1995, 68% of foreign S&E doctoral degree recipients stated they planned to remain in the United States after receiving their degrees. By 2000–03, 74% intended to stay in the United States.
- Stay rates vary by place of origin, with relatively high percentages of S&E doctorate recipients from China and India and relatively low percentages of those from Taiwan, Japan, South Korea, France, Italy, and Spain accepting firm offers for employment or postdoctoral research in the United States.

Global S&E Education

Global competition for foreign students has increased in the past two decades.

- The U.S. share of foreign students has declined in recent years, although the United States remains the predominant destination for foreign students, accounting for 40% of internationally mobile students in 2004.
- The shares of Australia and the United Kingdom have increased, accounting for 6% and 18%, respectively, of foreign students enrolled worldwide. Germany and France also attract large numbers of foreign students, accounting for 15% and 12%, respectively, of internationally mobile students in 2004.

Worldwide, a number of countries are expanding doctoral S&E education.

- About 78% of S&E doctorates worldwide were earned outside the United States.
- The numbers of natural sciences and engineering (NS&E) doctoral degrees awarded in China, South Korea, and Japan have continued to rise.
- In the late 1990s and early 2000s, the numbers of NS&E doctoral degrees leveled off or declined in the United States, the United Kingdom, and Germany.

Introduction

Chapter Overview

The importance of higher education in science and engineering is increasingly recognized around the world for its impact on innovation and economic development. S&E higher education provides the advanced skills needed for a competitive workforce and, particularly in the case of graduate S&E education, the research necessary for innovation. A number of key influences shape the nature of U.S. S&E higher education and its standing in the world.

In recent years, demographic trends and world events have contributed to changes in both the numbers and types of students participating in U.S. higher education. After declining in the 1990s, the U.S. college-age population is currently increasing and is projected to increase for the next decade. The composition of the college-age population is also changing, with Asians/Pacific Islanders and Hispanics becoming an increasing share of the population. Recent enrollment and degree trends reflect, to some degree, these changes. For example, graduate S&E enrollment and the number of S&E degrees at all levels are up, and the proportion of S&E degrees earned by minorities is increasing.

In the 1990s, the number of foreign students coming to the United States for higher education study, particularly from countries in Asia, increased substantially. The increases in foreign students contributed to most of the growth in overall S&E graduate enrollments in recent years. Although the number of foreign students remains high and is on the increase, the number of foreign students entering graduate school dropped since September 11, 2001. From fall 2002 to fall 2003, the number of foreign first-time full-time S&E graduate students dropped 8% (about 2,700 fewer students).

Finally, global competition in higher education is increasing. Although the United States has historically been a world leader in providing broad access to higher education and in attracting foreign students, many other countries are expanding their own higher education systems, providing comparable educational access to their own population and attracting large numbers of foreign students. In recent years, a number of countries, including the United Kingdom, Japan, Canada, Australia, and Germany, have expanded their recruitment and enrollment of foreign S&E graduate students.

Chapter Organization

This chapter describes the structure, student inputs, and degree outputs of the U.S. higher education system, followed by (and set in the context of) a description of increasing world capacity for advanced S&E education. It begins with characteristics of higher education institutions providing S&E education, and freshmen interest and enrollment in S&E fields. Trends in degree completions and postdoctoral study are discussed, including trends by sex, race/ethnicity, and citizenship; patterns of financial support while in graduate school; and doctoral degree student debt. The chapter highlights the flows of foreign students into the United States by country and their intentions to remain in this country. The chapter then presents various international higher education indicators, including comparative S&E degree production in several world regions and the growing dependence of all industrialized countries on foreign graduate S&E students.

Structure of U.S. Higher Education

Higher education institutions in the United States are diverse in terms of highest degree granted (associate's, bachelor's, master's, doctorate), institutional control (public or private), size, mission, and learning environment (NCES 2004a). New institutional forms featuring (alone or in combination) control by profit-making firms, certificate programs designed to enhance specific skills, or primary reliance on distance education have also emerged in recent years. Thus far, however, these new forms play a limited role in S&E education.

Institutions Providing S&E Education

In 2002, approximately 2,500 accredited institutions of higher education in the 50 states, the District of Columbia, and the U.S. territories and outlying areas awarded more than 1.8 million bachelor's or higher degrees, about 540,000 of them in S&E. In addition, approximately 1,700 2-year institutions primarily offer associate's degrees as the highest award (NCES 2004b). Two-year institutions are the largest segment of the higher education enterprise in the United States, accounting for 41% of all academic institutions. They provide S&E coursework that is affordable, remedial, and transferable (see sidebar "New Directions in Community Colleges"). They also serve as a bridge for students who go on to major in S&E at 4-year institutions. Almost 29% of students who began at a community college in the 1995–96 academic year had transferred to a 4-year institution as of 2001 (NCES 2003). Community colleges are not, however, major sources of degrees in S&E fields.

Research institutions, although few in number, are the leading producers of S&E bachelor's, master's, and doctoral degree holders (figure 2-1; appendix table 2-1). (See sidebar "Carnegie Classification of Academic Institutions," for definitions of academic institution types.) In 2002, they awarded 81% of S&E doctoral degrees, half of the master's degrees, and 42% of the bachelor's degrees in S&E fields. Master's (or comprehensive) institutions awarded another 28% of S&E bachelor's degrees and 24% of S&E master's degrees in 2002 (appendix table 2-2).

New Institutional Forms

Certificate programs, private for-profit colleges and universities, and various forms of industrial learning centers play a small but growing role in S&E higher education. Information technology (IT) is amplifying the delivery and learning of S&E within both traditional and nontraditional institutions.

New Directions in Community Colleges

Community colleges (2-year institutions) provide access to higher education for students who may lack the academic background, language skills, or financial means to go to 4-year academic institutions, or who may simply want additional job skills (NCES 2003). They are often the first college experience for many students who are the first in their family to seek education beyond high school (Adelman 2005; NSF 2004a). Most students in community colleges do not earn formal degrees, and most are enrolled part time.

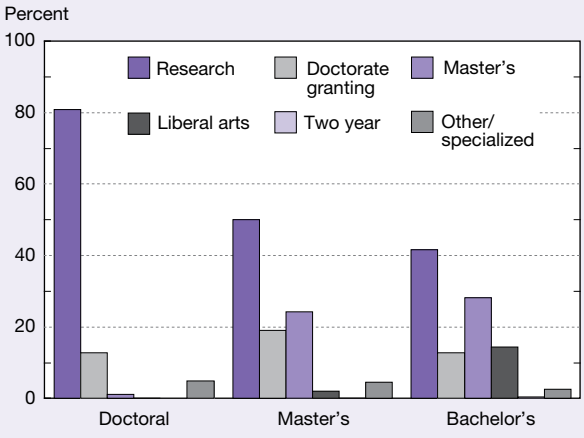
Community colleges provide the science and mathematics coursework for many K–8 teachers and high school science and mathematics teachers. New directions for community colleges include establishing baccalaureate programs in teacher education; establishing certification and associate degree programs for paraprofessionals, many with a mathematics and/or science focus (Shkodriani 2004); and establishing nondegree (alternative certification) programs for individuals already holding a baccalaureate degree who wish to earn a teaching credential in their specialty (Durdella 2003).

Community colleges are expanding their interaction with high schools and the type of degrees they offer. As part of the effort to decrease high school dropout rates and increase college attendance rates, particularly among disadvantaged students, some community colleges, particularly in California, are becoming the sites of "early college high schools." These small schools (400 students or less), situated on the campuses of community colleges, offer a curriculum that leads to students simultaneously receiving both their high school diploma and an associate of arts degree (Bill and Melinda Gates Foundation 2003). This effort is targeted at low-income, first-generation, non-English-speaking, and minority students.

Several hundred community colleges offer a bachelor's degree in some capacity, mostly in partnership with a related university. Most of these degrees are concentrated in applied fields such as protective services and information technology (IT). As of July 2004, 17 community colleges in at least 9 states offered 1 or more baccalaureate degrees. Most of these baccalaureates are in education, nursing, or IT. Of the 130 degrees listed, the preponderance was in secondary science or mathematics education (30) or in applied fields such as IT or engineering (36) with a few degrees in mathematics or the sciences (9) (American Association of State Colleges and Universities 2004). States offering teacher education baccalaureates at community colleges include Nevada, Florida, Louisiana, Minnesota, Utah, and Arkansas. Most of these states, along with Vermont, New York, and Georgia, offer baccalaureate degrees in technical subjects (American Association of Community Colleges 2004b).

Community colleges are also responsive to newly emerging science fields that have a high demand for technologists. For example, the first 2-year multidisciplinary nanoscience technology program in the United States debuted in fall 2004 at Dakota County Technical College in Rosemont, Minnesota (American Association of Community Colleges 2004a).

Figure 2-1
Distribution of bachelor's and higher S&E degrees awarded by U.S. higher education institutions, by Carnegie type: 2002



SOURCES: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, WebCASPAR database, http://webcaspar.nsf.gov.
See appendix table 2-2.

Science and Engineering Indicators 2006

Certificate programs have become a popular means for students to gain particular skills, for universities to be flexible in a changing environment, and for industry to upgrade the skills of its workers in emerging and rapidly changing fields. General characteristics of certificate programs are a focus on practical skills (e.g., hazardous waste management and infection control); fewer course requirements than for a degree; and, in many cases, an interdisciplinary scope (e.g., geographic information science). In 2002, about 22,300 S&E certificates were awarded in U.S. colleges and universities, up from about 4,100 in 1983 (table 2-1). Most (77%) were in computer sciences. Education units of various corporations (e.g., Microsoft, Cisco, Oracle, and Novell) also offer certificate programs.

Private for-profit institutions are growing in numbers and becoming increasingly important degree-granting institutions in certain fields. In 2002, about 2,500 private for-profit institutions in the United States accounted for about 5% of higher education enrollment (NCES 2004b, 2005b). About two-thirds of those students are enrolled in nondegree-granting institutions. However, for-profit institutions are among the top schools in the United States awarding degrees in certain fields. For example, Nova Southeastern University is among the largest awarders of

Carnegie Classification of Academic Institutions

The classification used here is the 1994 version of the Carnegie Foundation for the Advancement of Teaching. Although the classification variables reflect the early 1990s, the 1994 classification system better describes the different institutional characteristics for S&E than the subsequent 2000 version, which uses more aggregate categories. A complete revision of the classification system is currently being developed for 2005.

Research I and II universities offered a full range of baccalaureate programs and graduate education through the doctorate level, awarded 50 or more doctoral degrees a year, and received at least $15.5 million in federal research support annually.

Doctorate I and II institutions offered a full range of baccalaureate programs and graduate education through the doctorate level, but in a narrower range than research universities. They awarded at least 20 doctoral degrees annually in at least 3 disciplines; no federal research funds criteria were applied.

Master's (comprehensive I and II) institutions offered a broad range of baccalaureate programs and, generally, graduate education through the master's degree. The latter often focused on occupational or professional disciplines such as engineering or business administration. Minimum enrollment was 1,500 students.

Baccalaureate (liberal arts I and II) colleges are mostly 4-year institutions focused on awarding bachelor's degrees. A small number of highly selective ones awarded more than 40% of their baccalaureate degrees in liberal arts and science fields.

Associate of arts (2-year) colleges offered certificate or degree programs through the associate degree level and (with a few exceptions) offered no bachelor's degrees.

Professional and other specialized schools offered various degrees including doctorates, but they specialized in areas such as religious training; medicine and health; law; engineering and technology; business and management; art, music, and design; or education. This category also included corporate-sponsored institutions.

doctoral degrees in psychology and education; DeVry Institute of Technology, Strayer College, and the University of Phoenix are among the largest awarders of bachelor's degrees in computer sciences; and the University of Phoenix is among the top awarders of master's degrees in business.

Various types of industrial learning centers, including corporate "universities," independent nonprofit institutions, and for-profit and nonprofit subsidiaries of institutions constitute another new institutional form delivering education in the United States. From 1988 to 2001, the number of corporate universities grew from 400 to 2,000 (National Research Council 2002). Most primarily offer noncredit, nondegree courses narrowly targeted at retraining the workforce and other company needs. However, some large industries have internal training at a higher education level in engineering and design, for example, Motorola University contracts with 1,200 faculty worldwide who teach business and engineering.

Table 2-1
Certificates awarded by U.S. academic institutions, by field: 1983–2002

Year	S&E	Agricultural sciences	Computer sciences	Engineering	Physical/ biological/ mathematical sciences	Social/ behavioral sciences
1983	4,126	943	2,657	94	136	296
1985	4,844	724	3,346	271	138	365
1987	5,089	422	3,005	236	481	945
1989	5,500	428	2,642	1,011	374	1,045
1991	8,117	659	5,551	364	415	1,128
1993	13,808	3,617	6,986	684	610	1,911
1995	15,235	3,057	8,073	799	861	2,445
1997	9,556	293	5,523	459	1,210	2,071
1998	9,915	305	6,469	593	706	1,842
2000	15,864	241	12,628	499	586	1,910
2001	19,889	802	15,691	540	648	2,208
2002	22,266	1,174	17,138	706	659	2,589

NOTE: Data not available for 1999.

SOURCES: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, Division of Science Resources Statistics, Integrated Science and Engineering Resources Data System (WebCASPAR), http://webcaspar.nsf.gov.

Science and Engineering Indicators 2006

Independent nonprofit institutions also provide training geared specifically to corporate needs. These institutions offer credit courses and degree programs through IT and distance education. Institutions such as the Western Governors University and the United States Open University are recently formed examples. Since 1984, the National Technological University (NTU), a consortium of some 540 institutions, has been developing and offering courses and degree programs for engineering-oriented companies. The programs target engineering professionals interested in obtaining master's degrees in 1 of 18 engineering, technical, or business areas. All 1,300 academic courses offered by NTU are supplied by 52 leading engineering universities, including 25 of the top engineering schools in the country (National Research Council 2002).

For-profit and nonprofit subsidiaries of institutions and partnerships between 4-year institutions and private companies comprise another type of industry learning center. Duke Corporate Education and eCornell are examples of for-profit or nonprofit subsidiaries of postsecondary education institutions. Both offer credit and noncredit courses to individuals and corporate universities. Many of their courses are offered online and draw from a worldwide student base (Blumenstyk 2003). Motorola has partnerships with traditional institutions for sharing technology, faculty, and facilities. For example, Motorola is part of a doctoral program at the International Institute of Information Technology (formerly the Indian Institute of Information Technology) in Hyderabad, India, and degree programs at Morehouse College in Atlanta and Roosevelt University in Chicago (Wiggenhorn 2000).

Higher Education Enrollment in the United States

Recent higher education enrollments reflect the expanding U.S. college-age population. This section examines trends in undergraduate and graduate enrollment by type of institution, field, and demographic characteristics. It also examines graduate financial support patterns and data on retention rates. For information on enrollment rates of high school seniors, see "Transition to Higher Education" in chapter 1.

Overall Enrollment

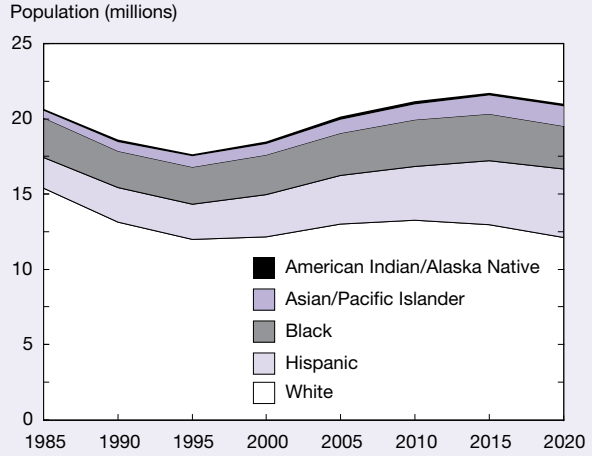
Over the past two decades, enrollment in U.S. institutions of higher education rose fairly steadily, from 12.6 million students in 1983 to 15.7 million in 2001 (the last year of available data), despite declines in the college-age population during much of that period (appendix tables 2-3 and 2-36). Of these, more than 6 million students (about 38% of all students enrolled in higher education institutions in the United States) were enrolled in 2-year institutions in 2001. The next two largest segments, research I universities and master's-granting I (or comprehensive) universities, together accounted for another 34% (5.3 million). (See sidebar "Carnegie Classification of Academic Institutions" for definitions of the types of academic institutions.)

Enrollment in higher education is projected to increase in the next decade because of increases in the college-age population. According to U.S. Census Bureau projections, the number of college-age (ages 20–24) individuals is expected to grow from 18.5 million in 2000 to 21.7 million by 2015, then decrease slightly to 21.0 million by 2020 (figure 2-2 and appendix table 2-4).

Increased enrollment in higher education is projected to come from minority groups, particularly Asians/Pacific Islanders and Hispanics. From 2000 to 2015, the Asian/Pacific Islander and Hispanic college-age populations are projected to increase by more than 50%, while the black and American Indian/Alaska Native college-age populations are projected to rise by 19% and 15%, respectively. The white college-age population is projected to increase slightly through 2010 and then decline (figure 2-2).

Changes in the demographic composition of the college-age population as a whole and increased enrollment rates of some racial/ethnic groups have contributed to changes in the demographic composition of the higher education student population in the United States.[1] From 1992 to 2001, overall enrollment increased by 7%, while underrepresented minority enrollment grew by 31% and Asian/Pacific Islander enrollment by 32%. Enrollment of foreign students (i.e., students on temporary visas) grew by 25% during that period. Almost half (47%) of underrepresented minority students and 42% of Asian/Pacific Islander students were enrolled in 2-year institutions compared with 36% of white students and 18% of foreign students.[2] Underrepresented minority students were less likely than other groups to be enrolled

Figure 2-2
U.S. population ages 20–24 years, by race/ethnicity: Selected years, 1985–2020



SOURCE: U.S. Census Bureau, Population Division, 1990 Census; and Population Projection Program, *Projections of the Resident Population by Age, Sex, Race, and Hispanic Origin: 1999 to 2100*. See appendix table 2-4.

Science and Engineering Indicators 2006

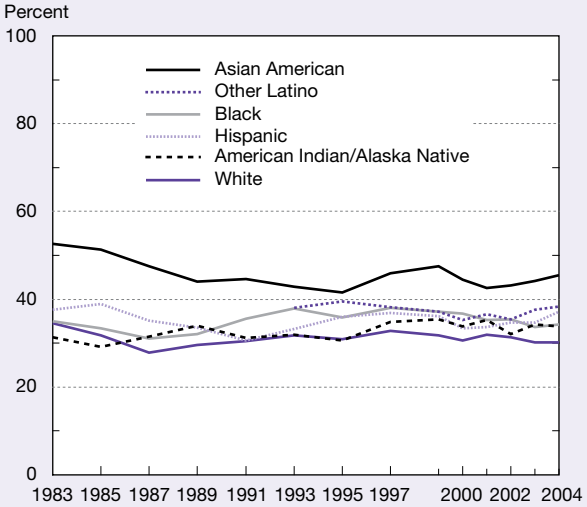
in research institutions (10% versus 20% of whites, 26% of Asians/Pacific Islanders, and 39% of foreign students.) For a breakout of enrollment trends in the 1990s by institutional type, race/ethnicity, and citizenship, see appendix table 2-5.

Undergraduate Enrollment in S&E

Freshmen Intentions to Major in S&E

Since 1972, the annual Survey of the American Freshman, National Norms, administered by the Higher Education Research Institute at the University of California at Los Angeles, has asked freshmen at a large number of universities and colleges about their intended majors. The data have provided a broadly accurate picture of degree fields several years later.[3] For at least the past two decades, about one-third of all freshmen planned to study S&E. In 2004, about one-third of white, black, Hispanic, and American Indian/Alaska Native freshmen and 46% of Asian/Pacific Islander freshmen reported that they intended to major in S&E (figure 2-3). The proportions planning to major in S&E were higher for men in every racial/ethnic group (appendix table 2-6). For most racial/ethnic groups, about 9%–14% planned to major in social/behavioral sciences, about 9% in engineering, about 8% in biological/agricultural sciences, 2%–5% in computer sciences, 2% in physical sciences, and 1% in mathematics or statistics. Higher proportions of Asian/Pacific Islander freshmen than of those from other racial/ethnic groups planned to major in biological/agricultural sciences (16%) and engineering (15%).

Figure 2-3
Freshmen intending S&E major, by race/ethnicity: Selected years, 1983–2004



NOTE: Data on "Other Latino" not collected before 1992.

SOURCE: Higher Education Research Institute, University of California at Los Angeles, Survey of the American Freshman: National Norms, special tabulations (2005).

Science and Engineering Indicators 2006

The demographic composition of students planning S&E majors has become more diverse over time. Women constituted 38% in 1983, rising to 45% in 2004. White students declined from 85% in 1983 to 72% in 2004. On the other hand, Asian/Pacific Islander students increased from 3% to 12%, Hispanic students increased from 1% to 8%, and American Indian/Alaska Native students increased from 1% to 2% (appendix table 2-7). Black students made up 10% of freshmen intending to major in S&E both in 1983 and in 2004.

In 2002, 20% of the respondents planning an S&E major reported needing remedial work in mathematics, and nearly 10% reported needing remediation in the sciences. These percentages are slightly higher than those of 1984 and vary by field and sex (appendix table 2-8). Fewer of those intending to major in mathematics, computer sciences, physical sciences, or engineering reported a need for remediation than did those intending to major in the social/behavioral or biological/agricultural sciences or in non-S&E fields. Within S&E fields and non-S&E fields, proportionately fewer male freshmen than female freshmen reported a need for remediation in mathematics or sciences. See "Transition to Higher Education" in chapter 1 for additional information on need of freshmen for remedial education.

Foreign Undergraduate Enrollment

The number of foreign undergraduates enrolled in U.S. academic institutions in all fields decreased almost 5% from academic year 2002–03 to 2003–04, the second consecutive decline after record increases during the 1990s. Decreases in foreign enrollments in recent years have been attributed to increased opportunity for higher education in the home country, competition from other countries for foreign students, rising U.S. tuition, and difficulties in obtaining U.S. visas (Institute of International Education 2004). (See sidebar "Price of Undergraduate Education.") Declines in particular fields may also be due to declining job opportunities in those fields. Among both undergraduate and graduate students, the number of foreign engineering students dropped 1% and the number of foreign computer sciences students dropped 7%. Other S&E fields, particularly the social sciences at 18%, experienced increases. Both physical and life sciences each registered small increases of 1%, and agricultural sciences rose 0.3%.

Japan and South Korea accounted for the largest numbers of foreign undergraduates in the United States in 2004 (appendix table 2-9). Although the number of undergraduates from China, Japan, and Taiwan was lower in 2004 than in 1999, enrollment of students from a number of other countries, including South Korea, Canada, India, and Mexico, increased.

Enrollment Trends in Engineering

For the most part, undergraduate enrollment data are not available by field. However, because engineering programs generally require students to declare a major in the first year of college, engineering enrollment data can serve as early indicators of both future undergraduate engineering degrees

Price of Undergraduate Education

Tuition increases at colleges and universities in the United States have outpaced inflation for the past two decades, although the net price to students has not increased as much as tuition. After adjusting for inflation, tuition and fees for in-state students at public 4-year colleges rose 51% in the 10-year period ending in the 2004–05 academic year (College Board 2004). Prices rose more at public 4-year colleges than they did at private 4-year or public 2-year colleges. Average tuition and fees rose the most in the Midwest and Southwest, and the least in the West and New England. (See chapter 8 for state indicators on average undergraduate tuition and state student aid expenditures.) The College Board's annual Survey of Colleges found that the rate of growth slowed in the 2004–05 academic year, when the price of attending a public 4-year college rose 10% compared with 14% in the 2003–04 academic year.

According to the U.S. Department of Education, National Center for Education Statistics, the single most important factor in the rise of tuition at public 4-year colleges and universities is the decline in state appropriations for higher education. Over the past two decades, the percentage of public institutions' revenue from state funding has decreased, thus the percentage from tuition and fees increased. State appropriations per full-time equivalent student at public higher education institutions declined in the late 1980s, rose through the end of the 1990s, and declined in recent years (College Board 2004). In FY 2005, total state appropriations for higher education rose 3.8% over FY 2004, slightly outpacing inflation (Hebel 2004). At private 4-year institutions, tuition increases were found to be related to declines in nontuition revenue (e.g., endowments), and increases in student aid and faculty compensation (NCES 2002).

Although tuition increased dramatically over the past decade, the net price to students did not increase as much and varied by family income. Students typically do not pay the full tuition amount, which averaged $5,132 for in-state students at public 4-year colleges and $20,082 for students at private 4-year colleges during the 2004–05 academic year. Student aid averaged $3,300 at public 4-year institutions and $9,400 at private 4-year institutions, making net tuition and fees about $1,800 at public 4-year institutions and about $10,700 at private 4-year institutions (College Board 2004). The net price of college for low-income students did not increase over the past decade, and the net price of college, after accounting for grants and loans, did not increase for middle-income students. Middle-income students, however, subsequently had higher levels of debt from educational loans. From 1993 to 2004, the percentage of degree recipients who borrowed and their median amount of debt increased (American Council on Education 2005). Increases in undergraduate debt for science and engineering students could potentially affect rates of graduate enrollment. See the sections later in this chapter titled "Retention in S&E" for graduate enrollment rates and "Undergraduate and Graduate Debt of S&E Doctorate Recipients" for data on trends in debt for undergraduate and graduate S&E education of doctorate recipients.

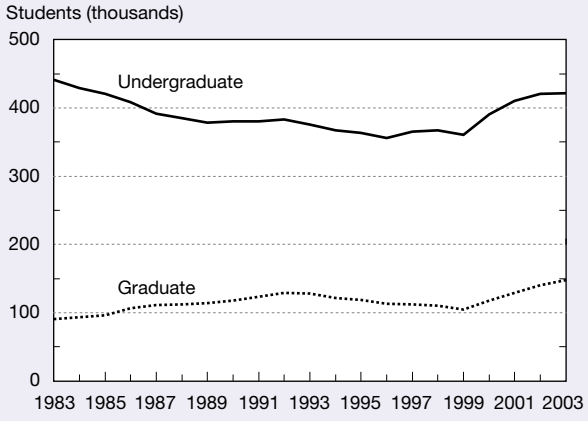
and student interest in an engineering career. The Engineering Workforce Commission administers an annual fall survey that tracks enrollment in undergraduate and graduate engineering programs (Engineering Workforce Commission 2004).

Undergraduate engineering enrollment declined through most of the 1980s and 1990s, then rose from 2000 through 2003.[4] From a 1983 peak of approximately 441,000 students, undergraduate engineering enrollment declined to about 361,000 students by 1999 before rebounding to about 422,000 in 2003 (figure 2-4; appendix table 2-10). Graduate engineering enrollment rose to about 129,000 in 1992, declined to approximately 105,000 by 1999, then soared to nearly 148,000 by 2003 (appendix table 2-11).

Retention in S&E

The National Science Foundation (NSF) National Survey of Recent College Graduates tracks retention in S&E as measured through further S&E education and entry into S&E occupations. About 28% of those who graduated with an S&E bachelor's degree in 2001 or 2002 were continuing

Figure 2-4
U.S. engineering enrollment, by level: 1983–2003



NOTE: Enrollment data include full- and part-time students.

SOURCE: Engineering Workforce Commission, *Engineering & Technology Enrollments, Fall 2003,* American Association of Engineering Societies (2004).

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in S&E graduate study (12%) or S&E employment (16%) in 2003. Retention rates in S&E declined from the 2001 and 1995 surveys (appendix table 2-12). However, many of those going into non-S&E occupations found employment in occupations with strong S&E components (see "U.S. S&E Labor Force Profile" in chapter 3).

Percentages of those going on for advanced study in S&E were higher for those with a high grade point average (GPA). About 18% of those with a 3.75–4.00 undergraduate GPA continued to study S&E. In contrast, relatively few (7%) of students with less than a 2.75 GPA continued to study S&E.

The retention rate in S&E after completion of a master's degree was higher than the rate after completion of a bachelor's degree. Around 44% of those who earned an S&E master's degree in 2001 or 2002 were continuing in S&E in 2003, either in school (15%) or in employment (29%). Overall, the S&E retention rate after a master's degree in 2003 was lower than the rate in either 1995 or 2001, with both a smaller percentage continuing advanced studies and a smaller percentage employed in S&E fields (appendix table 2-12).

Graduate Enrollment in S&E

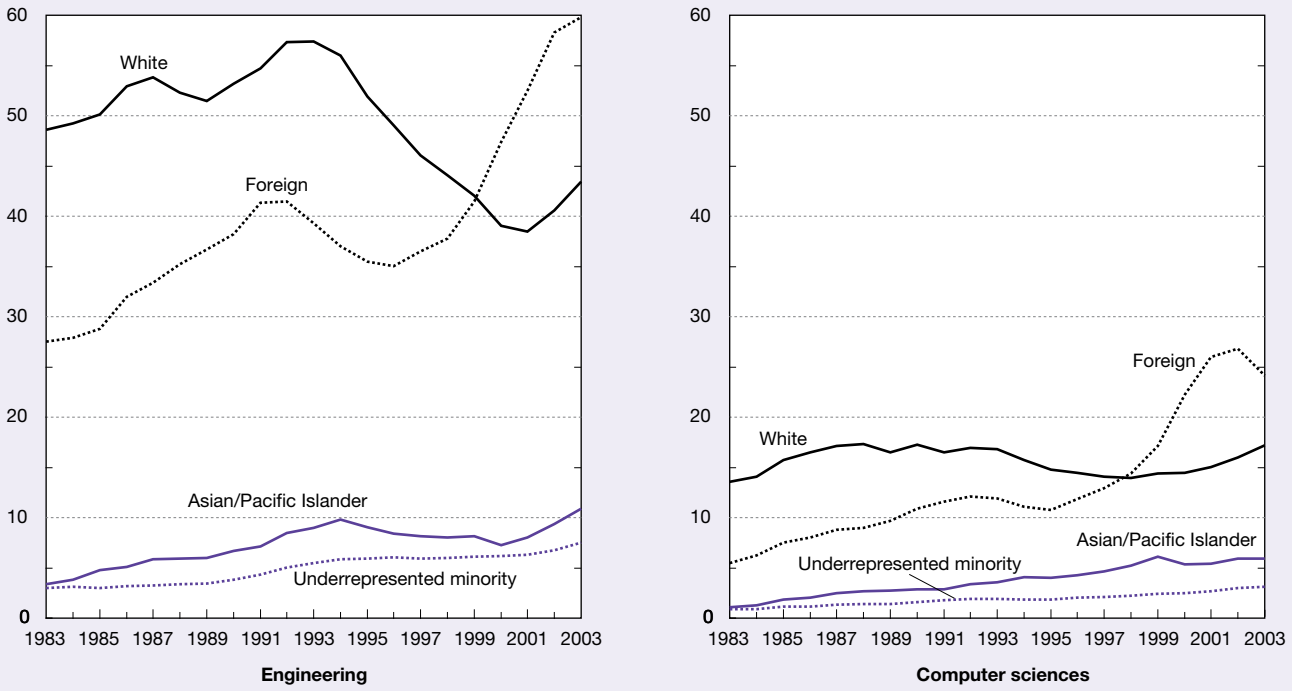
Graduate S&E educational institutions are a major source of both the high-skilled workers of the future and of the research needed for a knowledge-based economy. This section presents data on continuing key trends in graduate S&E enrollment, including trends in first-time enrollment of foreign students after September 11, 2001. Information is also included on patterns and trends in financial support for graduate education and in student debt.

Enrollment by Field

S&E graduate enrollment in the United States reached a new peak of 566,800 in fall 2003. Following a long period of growth that began in the 1970s, graduate enrollment in S&E declined in the latter half of the 1990s before rebounding in the past several years. Graduate enrollment in engineering and in life sciences drove most of the recent growth, although enrollment did increase in almost all major science fields.[5] Computer sciences enrollment rose rapidly from the mid-1990s through 2002 but declined in 2003. The increase in computer science through 2002 and the continuing increase in engineering mainly reflect an increase in the number of foreign graduate students in those fields (figure 2-5).

The number of full-time students enrolled for the first time in S&E graduate departments offers a good indicator of developing trends. It declined in the mid-1990s in all major S&E fields but increased in most fields in the late 1990s and early 2000s (appendix table 2-13). Between 2000 and 2003, first-time full-time S&E enrollment grew 14%. Growth was greatest in physical sciences; earth, atmospheric, and ocean sciences; mathematics; and social and behavioral sciences.

Figure 2-5
Graduate enrollment in computer sciences and in engineering, by citizenship and race/ethnicity: 1983–2003



NOTES: Foreign includes temporary residents only. Race/ethnicity includes U.S. citizens and permanent residents. Underrepresented minority includes black, Hispanic, and American Indian/Alaska Native.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Graduate Students and Postdoctorates in Science and Engineering, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-15.

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In only a few fields, such as computer sciences (down 3%) and materials engineering (down 5%), did first-time full-time graduate enrollment decline during the period.

Enrollment by Sex and Race/Ethnicity

The recent increase in S&E graduate enrollment overall occurred across all major demographic groups: women, minorities, and white men. The number of women enrolling in all S&E graduate programs has increased for the past two decades except for a decline in computer sciences in 2003. In contrast, the number of male S&E graduate students declined from 1993 through the end of the decade before increasing in recent years (appendix table 2-14).

The long-term trend of women's rising proportions in S&E fields also continued. Women made up 36% of S&E graduate students in 1983 and 47% in 2003, although large variations among fields persist. In 2003, women constituted the majority of graduate enrollment in psychology (74%), medical/other life sciences (76%), biological sciences (55%), and social sciences (53%). They constituted considerable proportions of graduate students in mathematics (37%), chemistry (39%), and earth, ocean, and atmospheric sciences (45%). Their percentage in computer sciences (28%) and engineering (22%) remains smaller (figure 2-6; appendix table 2-14).

The proportion of underrepresented minority students in graduate S&E programs increased from about 6% in 1983 to about 11% in 2003 (table 2-2). Increases occurred in all major science fields between 1983 and 2003. Only in engineering have enrollment increases apparently stalled in recent years: underrepresented minorities have been 6% of graduate enrollment since 1995 (appendix table 2-15). In 2003, blacks, Hispanics, and American Indians/Alaska Natives as a group made up about 6% of graduate enrollment in most S&E fields (engineering; mathematics; physical sciences; earth, atmospheric, and ocean sciences; and computer sciences), 17% in social sciences, and 19% in psychology.

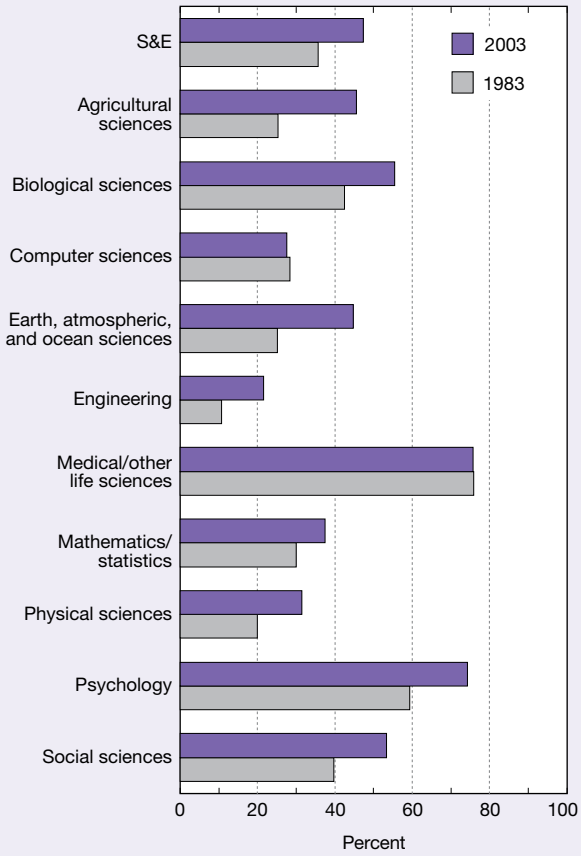
The number of white S&E graduate students decreased from 1994 to 2001 in most S&E fields, then increased through 2003, whereas the number of underrepresented minority students has increased every year since 1985. The long-term rise in the number of underrepresented minority graduate students occurred in most S&E fields, with the exceptions of engineering and mathematics. In those two fields, underrepresented minority enrollment plateaued in the 1990s before rising again from 2000 through 2003. The number of Asian/Pacific Islander S&E graduate students increased every year since 1983, with the exception of 2000. Increases occurred in most science fields except for a drop in physical sciences and engineering enrollment in the 1990s. Asians/Pacific Islanders accounted for about 7% of S&E graduate enrollment in 2003 (appendix table 2-15).

Foreign Student Enrollment

Foreign graduate student enrollment in S&E grew from 73,200 in 1983 to 154,400 in 2003. For all S&E fields combined, the proportion of foreign students increased from 19% to 27% over the period (appendix table 2-15). Foreign enrollment was highest in engineering (47%), computer sciences (45%), physical sciences (41%), and mathematical sciences (38%).

First-time full-time enrollment of foreign S&E graduate students offers a mixed picture. It declined 5% in fall 2002, the first full academic year since September 11, 2001. Declines continued in fall 2003 (an 8% decrease in S&E overall) but were concentrated mainly in engineering (down 12%) and in computer sciences (down 23%), fields heavily favored by foreign students. First-time full-time foreign enrollment increased in physical sciences (up 9%) and in psychology (up 10%) and remained stable in the other major science fields in 2003 (appendix table 2-16). These trends may indicate developing trends in total graduate enrollment in future years. Foreign students' share of first-time full-time graduate enrollment dropped from 35% to 29% between 2000 and 2003, with most of the decrease in computer science (from 71% to 52%) and engineering (from 61% to 50%) (figure 2-7).

Figure 2-6
Female U.S. graduate S&E enrollment, by field: 1983 and 2003



SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Graduate Students and Postdoctorates in Science and Engineering, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-14.

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Table 2-2
Underrepresented minority share of S&E graduate enrollment, by field: 1983 and 2003

Field	1983		2003	
	Number	Percent	Number	Percent
S&E	24,099	6.2	60,298	10.6
Engineering	2,999	3.3	7,492	5.9
Science	21,100	7.1	52,806	12.0
Natural sciences	9,198	4.9	27,277	9.3
Agricultural sciences	395	3.1	1,035	7.8
Biological sciences	2,179	4.8	5,847	9.0
Earth, atmospheric, and ocean sciences	365	2.4	817	5.6
Computer sciences	875	3.8	3,148	5.9
Mathematics/statistics	764	4.4	1,287	6.6
Medical/other life sciences	3,437	7.9	13,028	14.1
Physical sciences	1,183	4.0	2,115	6.2
Social/behavioral sciences	11,902	10.6	25,529	17.4
Psychology	3,829	9.4	9,674	18.6
Social sciences	8,073	11.3	15,855	16.7

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Graduate Students and Postdoctorates in Science and Engineering, Integrated Science and Engineering Resources Data System (WebCASPAR), http://webcaspar.nsf.gov.

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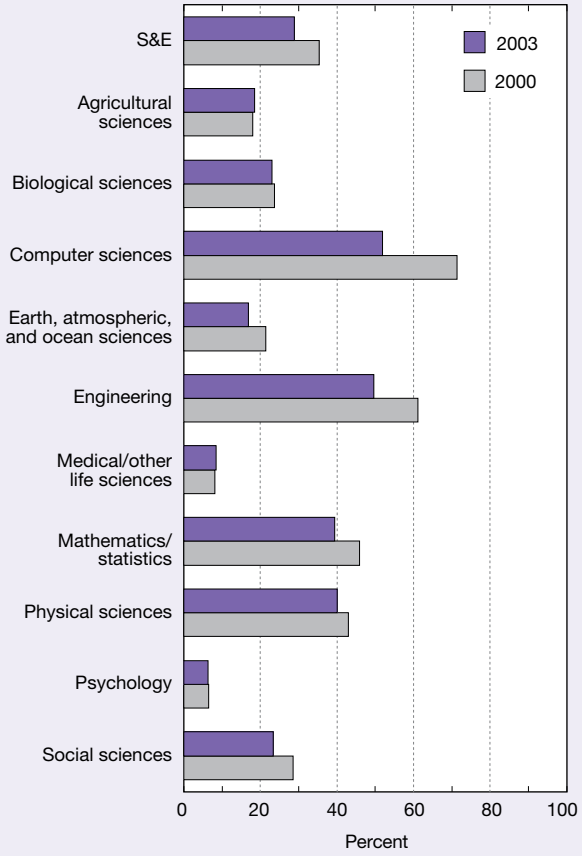
Figure 2-7
Foreign student share of U.S. first-time full-time graduate S&E enrollment, by field: 2000 and 2003



SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Graduate Students and Postdoctorates in Science and Engineering, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-16.

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According to data collected by the Institute of International Education, the overall number of foreign graduate students in all fields increased 2.4% from academic year 2002–03 to 2003–04. Graduate enrollment of students from India more than doubled between 1999 and 2004 and enrollment of students from China, South Korea, Taiwan, and Canada also increased (appendix table 2-17.) (See section "Global Higher Education in S&E" for degrees granted and enrollment of foreign students in other countries.)

Financial Support for S&E Graduate Education

About one-third of S&E graduate students are self-supporting; that is, they rely primarily on loans, their own funds, or family funds for financial support. The other two-thirds receive primary financial support from a wide variety of sources: the federal government, university sources, employers, nonprofit organizations, and foreign governments.

Support mechanisms include research assistantships (RAs), teaching assistantships (TAs), fellowships, and traineeships. Sources of funding include federal agency support, nonfederal support, and self-support. Nonfederal support includes state funds, particularly in the large public university systems; these funds are affected by the condition of overall state budgets. (See sidebar "Definitions and Terminology of Support.") Most graduate students, especially those who pursue doctoral degrees, are supported by more than one source or mechanism during their time in graduate school, and some receive support from several different sources and mechanisms in a given academic year. Self-support is derived from any loans obtained (including federal loans) or from personal or family contributions.

Other than self-support, RAs are the most prevalent primary mechanism of support for S&E graduate students. The

Definitions and Terminology of Support

Mechanisms of support: These may come from federal or nonfederal sources.

- Research assistantships (RAs) are given to students whose assigned duties are primarily research.
- Teaching assistantships (TAs) are given to students whose assigned duties are primarily teaching.
- Fellowships are competitive awards (often from a national competition) given to students for financial support of their graduate studies.
- Traineeships are educational awards given to students selected by an institution.

Other mechanisms of support include work-study programs, business or employer support, and support from foreign governments not in the form of a previously mentioned mechanism.

Sources of support: Except for self-support, funds may take the form of any mechanism; institutional support may take the form of tuition remission.

- Federal support is provided by federal agencies, chiefly in the form of RAs and traineeships. It also includes such items as tuition paid by the U.S. Department of Defense for members of the U.S. Armed Forces.
- Nonfederal support is provided by an institution of higher education, state and local governments, foreign sources, nonprofit institutions, or private industry.

percentage of S&E graduate students supported primarily by RAs increased in the late 1980s, rising from about 22% in the early 1980s to roughly 27%–29% of S&E graduate support from 1988 through 2003. Although the number of S&E graduate students relying primarily on fellowships, traineeships, and TAs rose over the past two decades, the percentage of students supported by these mechanisms stayed flat or declined. In 2003, 18% of S&E graduate students were primarily supported through TAs and 13% were primarily supported through either traineeships or fellowships. Self-support was the primary mechanism of support for roughly one-third of S&E graduate students over the past two decades (appendix table 2-18).

Primary mechanisms of support differ widely by S&E field of study. For example, in 2003, full-time students in physical sciences were supported mainly through RAs (44%) and TAs (39%). RAs also were important in agricultural sciences (58%), biological sciences (42%), and engineering (41%). In mathematics, however, primary student support is through TAs (54%) and self-support (19%). Full-time students in the social and behavioral sciences are mainly self-supporting (45%) or receive TAs (20%) (appendix table 2-19).

The federal government served as the primary source of support for about 20% of full-time S&E graduate students in 2003 (appendix table 2-20). This support was mostly in the form of RAs at 70%, up from 61% two decades earlier. The share of federally supported S&E graduate students receiving traineeships declined from 19% in 1983 to 12% in 2003. For students supported through nonfederal sources in 2003, TAs were the most prominent mechanism (40%), followed by RAs (32%) (appendix table 2-18).

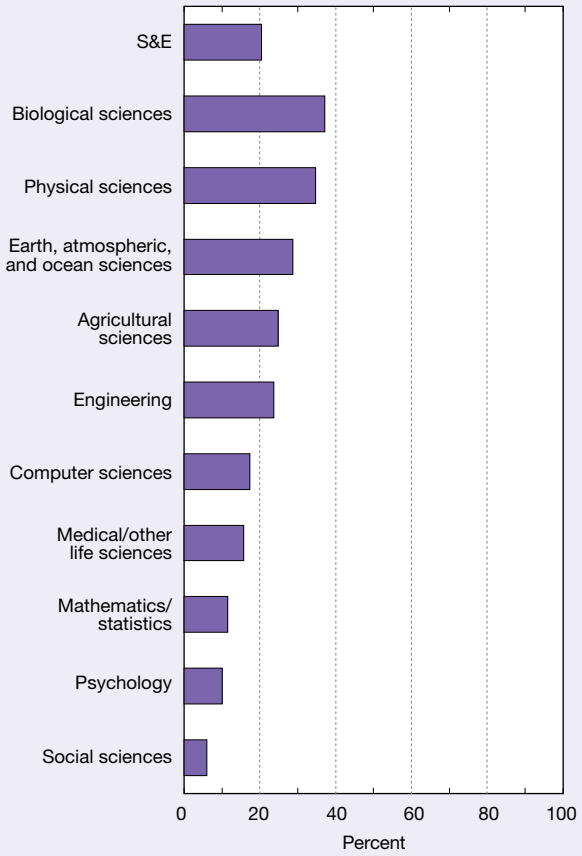
The federal government plays a substantial role in supporting S&E graduate students in some mechanisms and fields and a smaller role in others. For example, in 2003, the federal government funded 67% of S&E traineeships, 50% of RAs, and 22% of fellowships. Federal support reaches relatively more students in the physical sciences; earth, ocean, and atmospheric sciences; agricultural sciences; biological sciences; and engineering. However, relatively few students in mathematics, computer sciences, social sciences, psychology, and medical/other life sciences receive federal support (figure 2-8). Appendix table 2-20 gives detailed information by field and mechanism. (See section "Expenditures by Field and Funding Source" in chapter 5 for information on federal academic research and development funding by discipline.)

The National Institutes of Health (NIH) and NSF support most of the full-time S&E graduate students whose primary support comes from the federal government. In 2003, they supported about 24,300 and 19,300 students, respectively. Trends in federal agency support of graduate students show considerable increases from 1983 to 2003 in the proportion of students funded (NIH, from 23% to 30%; NSF, from 20% to 24%). Support from the U.S. Department of Defense declined during the 1990s from 15% to 11%, offsetting to some extent the increasing percentage that received NSF support (appendix table 2-21).

For doctoral degree students, notable differences exist in primary support mechanisms by sex, race/ethnicity, and citizenship. In 2003, male U.S. citizens were more likely to have been supported by RAs (29%) and female U.S. citizens were more likely to have supported themselves from personal sources of funds (27%). Among U.S. citizens, whites and Asians/Pacific Islanders were more likely than other racial/ethnic groups to have had primary support from RAs (26% and 28%, respectively), and underrepresented minorities depended more on fellowships (38%). The primary source of support for foreign doctoral degree students was an RA (46%) (appendix table 2-22).

U.S. citizen white and Asian/Pacific Islander men, as well as foreign doctoral degree students, are more likely than U.S. citizen white and Asian/Pacific Islander women, and underrepresented minority doctoral degree students, to receive doctorates in engineering and physical sciences, fields largely supported by RAs. Women and underrepresented minorities are more likely than other groups to receive doctorates in social sciences and psychology, fields in which

Figure 2-8
Full-time S&E graduate students with primary support from federal government, by field: 2003



SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Graduate Students and Postdoctorates in Science and Engineering, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-20.

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self-support is prevalent. Differences in type of support by sex, race/ethnicity, or citizenship remain, however, even accounting for field of doctorate (NSF 2000a).

The amount of funding received by graduate students varies widely by source of support (e.g., federal, nonfederal), mechanism of support (e.g., RA, TA), field of study, type and location of school (public/private, urban/rural), and length of contract (12-month or 9- or 10-month). For example, one study showed that average stipends for history TAs on a 9- or 10-month contract were about $11,200 and those for biology RAs were about $19,000 for 12-month contracts (Smallwood 2004). Benefits associated with support mechanisms vary as well. Tuition and fees are waived for most, but not all, TAs and RAs. Most federally funded graduate student fellowship programs stipulate that institutions waive tuition and fees for awardees (NSF 2004c). Most (77%) institutionally supported TAs and RAs include health insurance coverage for students, and a few (21%) include coverage for dependents as well (Smallwood 2004).

Undergraduate and Graduate Debt of S&E Doctorate Recipients

At the time of doctoral degree conferral, about one-fourth of S&E doctorate recipients have some undergraduate debt and about one-third owe money directly related to graduate education.[6] In 2003, 27% of S&E doctorate recipients reported having undergraduate debt and 34% reported having graduate debt. For some, debt levels were high, especially for graduate debt: 2% reported high levels (more than $35,000) of undergraduate debt and 13% reported graduate debt of more than $35,000 (appendix table 2-23).

Levels of debt vary widely by doctorate fields. High levels of graduate debt were most common among doctorate recipients in psychology, social sciences, agricultural sciences, and medical/other health sciences. Psychology doctorate recipients are most likely to report graduate debt and high levels of debt. One-third of psychology doctoral degree recipients compared with 13% of all S&E doctoral degree recipients in 2003 reported graduate debt of more than $35,000.[7] Doctorate recipients in biological sciences; computer sciences; earth, atmospheric, and ocean sciences; engineering; mathematics; and physical sciences were least likely to report graduate debt.

Higher Education Degrees

S&E degrees accounted for almost two-thirds of all doctoral degrees and almost one-third of all bachelor's degrees awarded in 2002. However, S&E fields account for relatively few associate's or master's degrees. Both the number of degrees overall and the number in S&E fields have been increasing over the past two decades. For information on the labor market conditions for recent S&E graduates, see "Labor Market Conditions for Recent S&E Graduates" in chapter 3 (S&E labor force) and "Trends in Academic Employment of Doctoral Scientists and Engineers" in chapter 5 (academic research and development).

S&E Associate's Degrees

Community colleges are often an important and relatively inexpensive gateway for students entering higher education. Associate's degrees, largely offered by 2-year programs at community colleges, are the terminal degree for some people, but others continue their education at 4-year colleges or universities and subsequently earn higher degrees. About 13% of all associate's degrees are awarded in S&E or engineering technology.

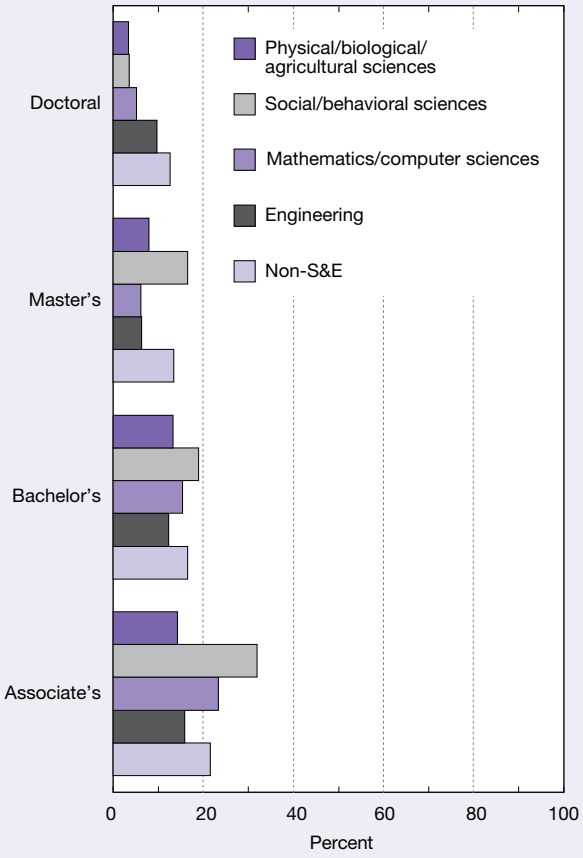
S&E associate's degrees from all types of academic institutions rose from 23,800 in 1983 to 42,200 in 2002. The increase in the late 1990s and the early 2000s was mainly attributed to computer sciences, which represented 64% of all S&E associate's degrees by 2002. In contrast, the number of associate's degrees awarded in engineering decreased. Degrees earned in engineering technology (not included in S&E degree totals because of their practice-focused nature)

declined from 51,300 in 1983 to 31,600 in 2002 (appendix table 2-24).

Women earned 45% of S&E associate's degrees in 2002, the same percentage they earned in 1983, and less than their percentage of S&E bachelor's degrees (51%). As is the case with men, computer sciences account for the majority of S&E associate's degrees earned by women (appendix tables 2-24 and 2-26).

Trends in the number of associate's degrees earned by students' race/ethnicity are shown in appendix table 2-25.[8] Students from underrepresented groups earn a considerably higher proportion of associate's degrees than they do of bachelor's or more advanced degrees (figure 2-9). In 2002, they earned 32% of associate's degrees in social and behavioral sciences and 23% in mathematics and computer sciences. The percentage of computer sciences associate's degrees earned by these students has almost doubled since 1983.

Figure 2-9
Underrepresented minority share of S&E degrees, by degree level and field: 2002 or 2003



NOTES: Doctoral degrees are 2003 data; other degrees are 2002 data. Underrepresented minority includes black, Hispanic, and American Indian/Alaska Native.

SOURCES: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, WebCASPAR database, http://webcaspar.nsf.gov. See appendix tables 2-25, 2-27, 2-29, and 2-31.

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S&E Bachelor's Degrees

The baccalaureate is the most prevalent degree in S&E, accounting for 77% of all degrees awarded. S&E bachelor's degrees have consistently accounted for roughly one-third of all bachelor's degrees for the past two decades. Except for a brief downturn in the late 1980s, the number of S&E bachelor's degrees has risen steadily, from 317,600 in 1983 to 415,600 in 2002 (appendix table 2-26).

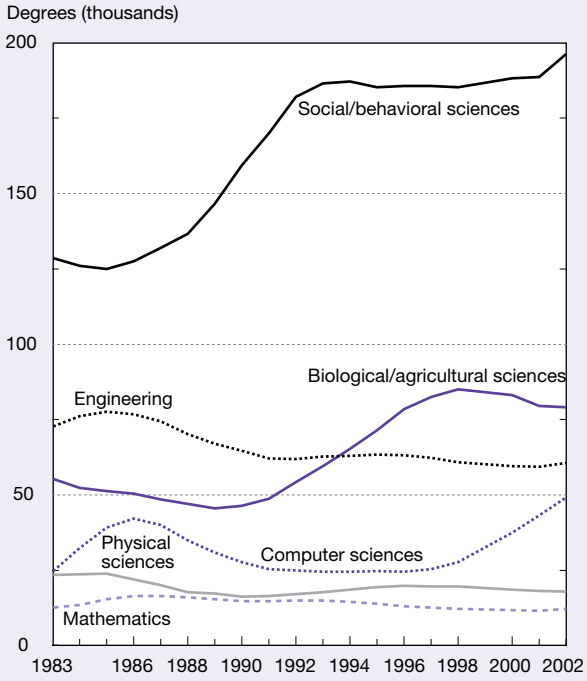
Trends in the number of S&E bachelor's degrees vary widely among fields (figure 2-10). The number of bachelor's degrees earned in engineering peaked in 1985, then dropped before leveling off in the 1990s. Bachelor's degrees in biological and agricultural sciences steadily increased in the 1990s before declining slightly in the 2000s. The number of social and behavioral sciences degrees awarded has been increasing since the mid-1990s. The number of bachelor's degrees earned in computer sciences dropped through the mid-1990s, then increased sharply from 1998 to 2002 to reach a new peak (appendix table 2-26).

S&E Bachelor's Degrees by Sex

Women have outnumbered men in undergraduate education since 1982 and earned 58% of all bachelor's degrees in 2002. They have earned at least half of all S&E bachelor's degrees since 2000. Within S&E, men and women tend to study different fields. Men earned a majority of bachelor's degrees awarded in engineering, computer sciences, and physical sciences (79%, 73%, and 57%, respectively). Women earned more than half of the bachelor's degrees in psychology (78%), biological/agricultural sciences (59%), and social sciences (55%), and close to half in mathematics (47%) (figure 2-11; appendix table 2-26). The share of bachelor's degrees awarded to women increased in almost all major S&E fields during the past two decades. One notable exception, however, is computer sciences: in this field, the number of awards dropped for both men and women from the mid-1980s to the mid-1990s, then increased thereafter. The earlier decline for women was greater than that for men, and the subsequent increase for women was less than that for men. From 1983 through 2002, the proportion of computer sciences bachelor's degrees awarded to women dropped from 36% to 27%.

The number of bachelor's degrees awarded to women rose from 1983 through 2002 in all fields and in S&E as a whole, with a brief drop in numbers of engineering and natural sciences degrees in the late 1980s and early 1990s. In contrast, the number of bachelor's degrees awarded to men in all fields and in S&E plateaued in the 1990s but increased in 2002. Within S&E, the number of engineering, physical sciences, and social and behavioral sciences degrees awarded to men dropped in the 1990s, whereas the number of bachelor's degrees in biological sciences generally increased.[9]

Figure 2-10
S&E bachelor's degrees, by field: 1983–2002



NOTES: Physical sciences include earth, atmospheric, and ocean sciences. Data not available for 1999.

SOURCES: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, Division of Science Resources Statistics, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-26.

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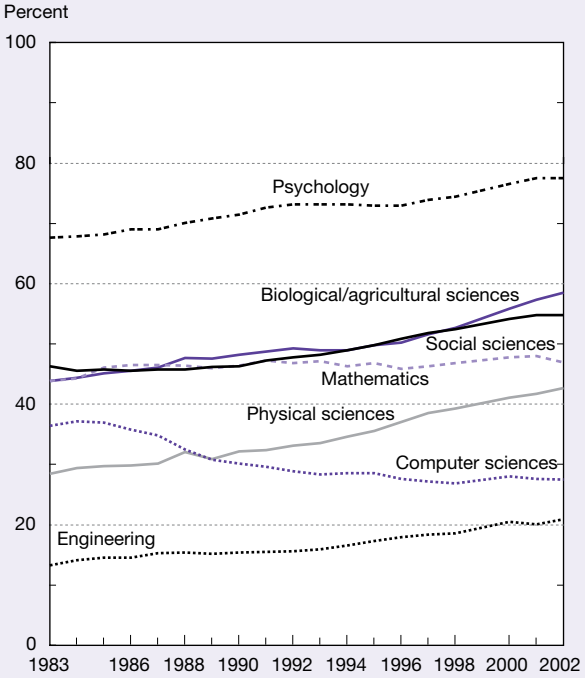
Figure 2-11
Female share of S&E bachelor's degrees, by field: 1983–2002



NOTES: Physical sciences include earth, atmospheric, and ocean sciences. Data not available for 1999.

SOURCES: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, Division of Science Resources Statistics, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-26.

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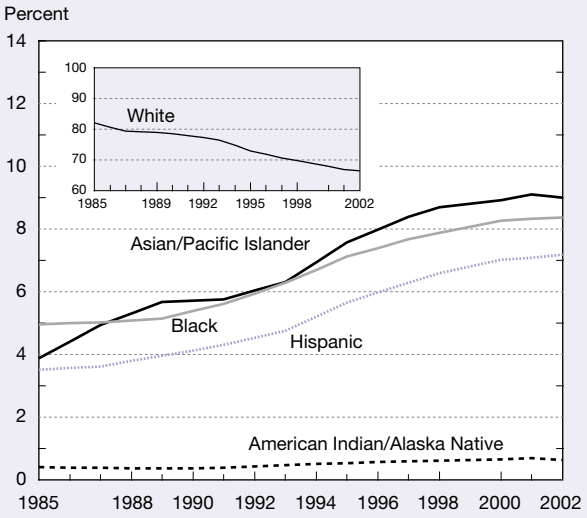
S&E Bachelor's Degrees by Race/Ethnicity

In the past two decades, the racial/ethnic composition of those earning S&E bachelor's degrees has changed, reflecting both population change and increasing college attendance by members of minority groups.[10] Between 1983 and 2002, the proportion of S&E degrees awarded to Asians/Pacific Islanders increased from 4% to 9%, and the proportion awarded to members of underrepresented minority groups grew from 9% to 16% (figure 2-l2). Conversely, the proportion of S&E bachelor's degrees earned by white students declined from 82% in 1983 to 66% in 2002. During the 1990s, the number of S&E bachelor's degrees earned by white students decreased but rose again in 2002.

Despite considerable progress for underrepresented minority groups between 1983 and 2002 in earning bachelor's degrees in any field, the gap in educational attainment between young minorities and whites continues to be wide. The percentage of blacks ages 25 to 29 with a bachelor's or higher degree rose from 13% in 1983 to 18% in 2003, whereas the percentage of Hispanics ages 25 to 29 with a bachelor's or higher degree was 10% in 1983 and 2003 (NCES 2005a). For whites ages 25 to 29, this percentage rose from 25% in 1983 to 34% in 2003. Differences in completion of bachelor's degrees in S&E by race/ethnicity reflect differences in high school completion rates, college enrollment rates, and college persistence and attainment rates. In general, blacks and Hispanics are less likely than whites and Asians/Pacific Islanders to graduate from high school, to enroll in college, and to graduate from college (see "Transition to Higher Education" in chapter 1 for information on immediate post-high school college enrollment rates). Among high school graduates, the percentages of blacks and Hispanics ages 25 to 29 with a bachelor's or higher degree were 21% and 15%, respectively, in 2000, compared to 36% for whites (NCES 2001). Among those who do enroll in or graduate from college, however, blacks, Hispanics, and American Indians/Alaska Natives are about as likely as whites to choose S&E fields; Asians/Pacific Islanders are more likely than members of other racial/ethnic groups to choose these fields. For Asians/Pacific Islanders, almost half of all bachelor's degrees received are in S&E, compared with about one-third of all bachelor's degrees earned by each of the other racial/ethnic groups.

The contrast in field distribution among whites, blacks, Hispanics, and American Indians/Alaska Natives on the one hand and Asians/Pacific Islanders on the other is apparent within S&E fields as well. White, black, Hispanic, and

Figure 2-12
Minority share of S&E bachelor's degrees, by race/ethnicity: 1985–2002



NOTE: Data not available for 1999.

SOURCES: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, Division of Science Resources Statistics, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-27.

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American Indian/Alaska Native S&E baccalaureate recipients share a similar distribution across broad S&E fields. In 2002, between 9% and 11% of all baccalaureate recipients in each of these racial/ethnic groups earned their degrees in the social sciences, 4% to 5% in the biological sciences, and 3% to 4% in engineering and in computer sciences. Asian/Pacific Islander baccalaureate recipients earned higher proportions of their baccalaureates in the biological sciences, computer sciences, and engineering (appendix table 2-27).

Trends in bachelor's degrees over the past 20 years are similar in many ways for most racial/ethnic groups. For all racial/ethnic groups, the number of bachelor's degrees in engineering, physical sciences, and mathematics generally dropped or flattened out, especially since the mid-1990s. Degrees in biological sciences generally increased through the late 1990s, then dropped in recent years. Degrees in computer sciences fell in the early 1990s but increased steeply from 1998 through 2002. All racial/ethnic groups, except for whites, generally show an increase in total bachelor's degrees and in social/behavioral sciences bachelor's degrees. The total number of bachelor's degrees awarded in all fields and in social/behavioral sciences to white students was fairly flat from 1993 through 2001, then increased slightly in 2002 (appendix table 2-27).

Bachelor's Degrees by Citizenship

Students on temporary visas in the United States earned a small share (4%) of S&E degrees at the bachelor's level. However, they earned 8% of bachelor's degrees awarded in computer sciences in 2002 and 7% of those awarded in engineering. The number of S&E bachelor's degrees awarded to students on temporary visas increased over the past two decades from about 14,100 in 1983 to 16,300 in 2002. Trends in the number of degrees by field generally followed the pattern noted above for all racial/ethnic groups except whites (appendix table 2-27).

S&E Master's Degrees

Master's degrees in S&E fields increased from 67,700 in 1983 to about 99,200 in 2002 (appendix table 2-28). Engineering, social sciences, computer sciences, and psychology accounted for most of the growth (figure 2-13). In recent years, computer sciences was the only field to experience substantial growth.

Master's Degrees by Sex

Since 1983, the number of S&E master's degrees earned by women has more than doubled, rising from 21,000 to 43,500 (figure 2-14). In contrast, the number of master's degrees that men earned grew only marginally, from 46,700 in 1983 to 55,700 in 2002. As a result, the percentage of women earning master's degrees rose steadily during the past two decades. In 1983, women earned 31% of all S&E master's degrees; by 2002, they earned 44%. In addition to earning increasing numbers of degrees in both social sciences and psychology, fields with a history of strong female representation, women also showed strong growth in engineering and computer sciences (appendix table 2-28).

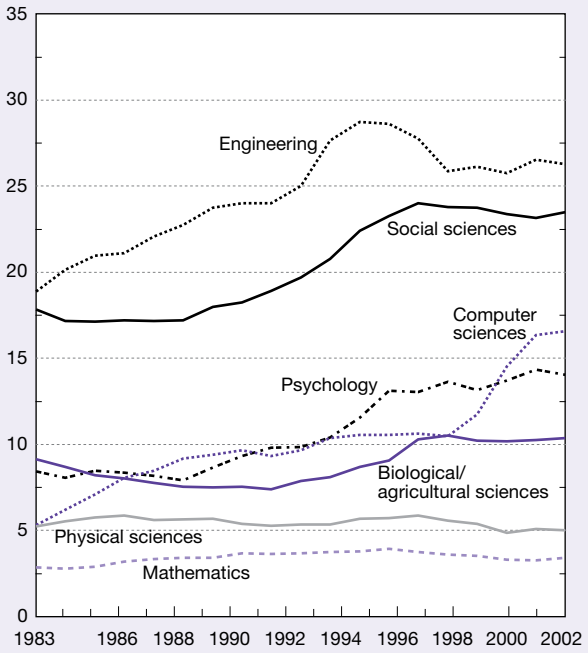
Women's share of S&E master's degrees varies by field. In 2002, women earned a majority of master's degrees in psychology (76%), biological sciences (58%), and social sciences (54%); they earned their lowest share in engineering (21%) (appendix table 2-28). The number and percentage of master's degrees awarded to women in all major S&E fields have increased since 1983.

Master's Degrees by Race/Ethnicity

The number of S&E master's degrees awarded increased for all racial/ethnic groups from 1985 to 2002 (figure 2-15).[11] The proportion of master's degrees in S&E fields earned by U.S. citizen and permanent resident racial and ethnic minorities increased over the past two decades. Asians/Pacific Islanders accounted for 7% of master's degrees in 2002, up from 5% in 1983. Underrepresented minorities also registered gains, increasing from 5% to 11% during this period. The number of S&E master's degrees awarded to whites decreased from 1995 through 2002. The percentage of S&E master's degrees awarded to white students fell from 68% in 1985 to 49% in 2002 (appendix table 2-29).

Trends in the number of master's degrees by field were similar for most racial/ethnic groups. The number of master's degrees in physical sciences rose through the mid-1990s, then dropped through 2002. For all groups, the number of master's degrees in biological sciences and agricultural sciences generally rose through at least the late 1990s, and for

Figure 2-13
S&E master's degrees, by field: 1983–2002



NOTES: Physical sciences include earth, atmospheric, and ocean sciences. Data not available for 1999.

SOURCES: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, Division of Science Resources Statistics, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-28.

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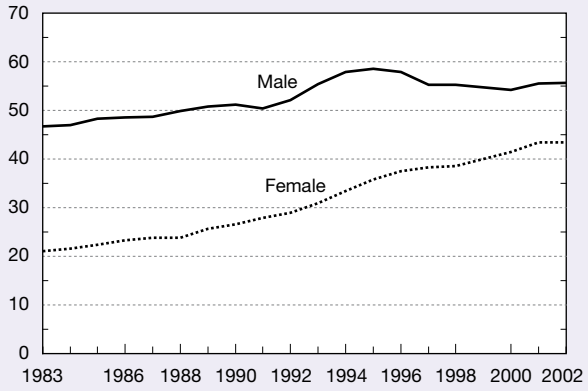
Figure 2-14
S&E master's degrees, by sex: 1983–2002



NOTE: Data not available for 1999.

SOURCES: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, Division of Science Resources Statistics, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-28.

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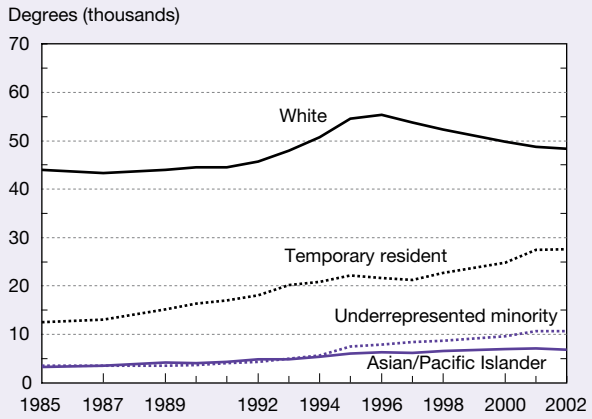
Figure 2-15
S&E master's degrees, by race/ethnicity and citizenship: 1985–2002



NOTES: Race/ethnicity includes U.S. citizens and permanent residents. Underrepresented minority includes black, Hispanic, and American Indian/Alaska Native. Data not available for 1999.

SOURCES: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, Division of Science Resources Statistics, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-29.

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all groups but whites and Asians/Pacific Islanders, master's degrees in engineering generally increased. Also, for all groups except white students, master's degrees in social and behavioral sciences and in computer sciences generally increased from 1983 through 2002. For white and Asian/Pacific Islander students, the number of engineering master's degrees dropped after the mid-1990s. For white students, the number of social and behavioral sciences master's degrees dropped from 1995 through 2002, and master's degrees in computer sciences dropped through 1997, then increased (appendix table 2-29).

Master's Degrees by Citizenship

S&E master's degrees awarded to students on temporary visas rose from approximately 12,500 in 1983 to about 27,600 in 2002, and increased in most S&E fields during that period. The sole exception was physical sciences. During that period, the share of S&E master's degrees earned by temporary residents rose from 19% to 28%. Foreign students make up a much higher proportion of S&E master's degree recipients than they do of bachelor's or associate's degree recipients. Their degrees are heavily concentrated in computer sciences and engineering, where they earned 46% and 41%, respectively, of master's degrees in 2002 (appendix table 2-29). These two fields accounted for 29% of all master's degrees earned by students on temporary visas, compared with 6% of all master's degrees earned by U.S. citizens and permanent residents. Men constitute a higher proportion of S&E master's degree recipients with temporary visas (66%) than they do of those earned by U.S. citizens and permanent residents (52%) (NSF 2004b).

New Directions in Graduate Education

New directions in graduate education, including professional master's programs, the growth of certificate programs, and distance education, parallel those in undergraduate education. Professional master's degree programs often stress interdisciplinary training for work in emerging S&E fields. (See sidebar "Professional Master's Degree Programs.") Professional certificate programs at the graduate level are typically amenable to distance delivery at corporate sites. These programs include a coherent set of courses for a specialty, such as engineering management.

S&E Doctoral Degrees

Global economic competition and the spreading conviction that highly educated workforces are key to successfully building growth economies have increased interest both in the United States and abroad in the supply of foreign and domestic doctorate recipients and their migration across borders.

The number of S&E doctorates conferred annually by U.S. universities rose from the mid-1980s through the mid-1990s, peaked in 1998, and then declined for the remainder of the 1990s. In 2003, the number of S&E doctorates increased slightly over the previous year. (For information on employment of recent doctorate recipients, see "Labor Market Conditions for Recent S&E Graduates" in chapter 3 [S&E labor force] and "Trends in Academic Employment of Doctoral Scientists and Engineers" in chapter 5 [academic research and development.]) The increase through 1998 largely reflected growth in the number of foreign degree recipients. The largest increases were in engineering, biological/agricultural sciences, and social and behavioral sciences degrees (figure 2-16). The post-1998 decline in earned doctorates reflects fewer degrees earned by both U.S. citizens and permanent residents (see "Foreign S&E Doctorate Recipients").

Doctoral Degrees by Sex

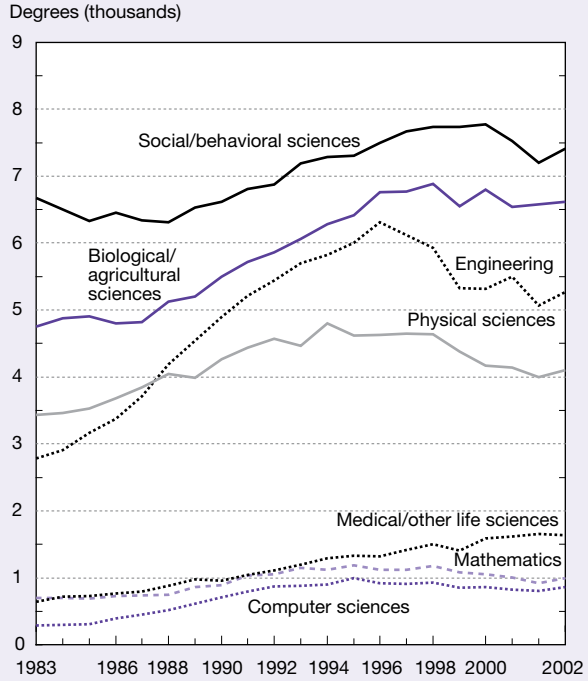
Among U.S. citizens, the proportion of S&E doctoral degrees earned by women has risen considerably in the past two decades, reaching a record high of 45% in 2003 (appendix table 2-30). During this period, women made gains in all major field groups. However, as figure 2-17 shows, considerable differences by field continue. Women earn half or more of doctorates in non-S&E fields and in social/behavioral sciences, and 19% of doctorates in engineering (appendix table 2-30).

The increase in the proportion of S&E doctoral degrees earned by women has been due to both an increase in the number of women and a decrease in the number of men earning such degrees. The number of U.S. citizen women earning doctorates in S&E increased from 4,325 in 1983 to 7,131 in 2003 (appendix table 2-30). Meanwhile, the number of S&E doctorates earned by U.S. citizen men declined

Professional Master's Degree Programs

As subdisciplines within sciences emerge and industry expresses needs for people with particular skills, universities are turning to professional master's degree and certificate programs as a means of preparing a needed workforce or as a means of mid-career change for professionals in such fields as biotechnology, nanotechnology, and computer sciences. Because of this rise of interest, particularly in the sciences, the Sloan Foundation launched a Professional Master's Degree project in 1997, limiting its focus to the natural sciences and mathematics. The program has grown to more than 1,100 students enrolled in 97 programs distributed among 45 universities (CPST 2005). These programs tend to be more interdisciplinary than traditional doctoral or master's degree programs and provide an alternative to doctoral education for students who enroll in them. Interdisciplinary fields within the biological sciences (e.g., bioinformatics, applied biotechnology, applied genomics) account for more than half of the students enrolled. A similar effort by the Council of Graduate Schools promotes the development of professional master's degree programs in the humanities and social sciences.

Figure 2-16
S&E doctoral degrees earned in U.S. universities, by field: 1983–2003



NOTE: Physical sciences include earth, atmospheric, and ocean sciences.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-30.

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from 9,808 in 1983 to 8,605 in 2003. The increase in the number of S&E doctorates earned by women occurred in most major S&E fields. A decrease in the number of S&E doctorates earned by men after 1995 occurred in most major S&E fields except biological sciences.

Doctoral Degrees by Race/Ethnicity

Although the proportion of S&E doctoral degrees earned by white U.S. citizens decreased in the past two decades, the number of S&E doctorates earned remained relatively stable, fluctuating from around 12,000 to 14,000 degrees awarded annually. Doctoral S&E degrees earned by whites peaked at 14,166 in 1995, then declined slightly each year since, mainly in the fields of engineering, physical sciences, mathematics, and computer sciences. The share of all doctoral S&E degrees earned by white U.S. citizens decreased from 66% in 1983 to 47% in 2003. Their share of degrees awarded to all U.S. citizens declined from 90% to 79% (appendix table 2-31).

The number of doctoral S&E degrees earned by white male U.S. citizens declined from a peak of more than 11,000 in 1975 to less than 7,000 in 2002 and 2003, accounting for most of the drop in doctoral S&E degrees earned by white U.S. citizens (figure 2-18). The number of degrees earned by white U.S. females generally increased over much of the past three decades, but lately has begun to decline.

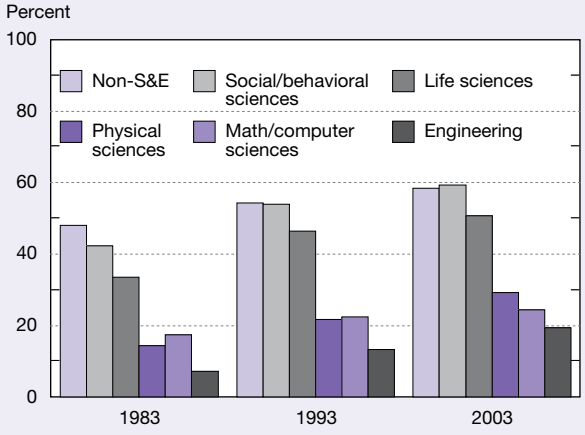
The number and proportion of doctoral degrees in S&E fields earned by U.S. citizen underrepresented minorities also increased over the past two decades. Blacks, Hispanics, and American Indians/Alaska Natives together earned about 1,500 S&E doctorates in 2003, accounting for 5% of all S&E doctorate degrees earned that year and up from 3% in 1983 (figure 2-19). (Their share of degrees earned by all U.S. citizens rose from 4% to 9% in the same period.) Gains by all groups contributed to this rise, as the number of S&E degrees earned by blacks, Hispanics, and American Indians/Alaska Natives more than doubled. Their largest gains came in social sciences and psychology. In 2003, the percentage of the doctoral degrees earned by underrepresented minorities in psychology was 11%, up from 6% in 1983, while the percentage of doctorates earned in the social sciences increased from 5% in 1983 to 8% in 2003 (appendix table 2-31).

In the mid-1990s, the number of doctoral degrees earned by Asian/Pacific Islander U.S. citizens showed a steep increase. Asians/Pacific Islanders earned just over 4% of S&E doctorates in 2003, up from 2% in 1983.

Foreign S&E Doctorate Recipients

Noncitizens, primarily those with temporary visas, account for the bulk of the growth in S&E doctorates awarded by U.S. universities from 1983 through 2003. The number of S&E doctorate recipients with temporary visas rose dramatically in the 1980s and 1990s, accounting for almost one-third of S&E doctorate recipients in 2003.

Figure 2-17
Doctoral degrees earned by female U.S. citizens in U.S. institutions, by field: 1983, 1993, and 2003



NOTES: Physical sciences include earth, atmospheric, and ocean sciences. Life sciences include biological sciences, agricultural sciences, and medical/other life sciences.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-30.

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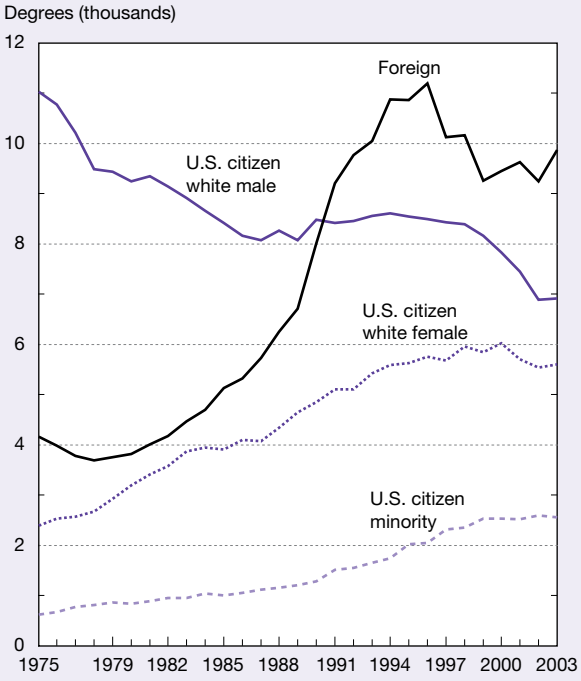
Figure 2-18
U.S. S&E doctoral degrees, by sex, race/ethnicity, and citizenship: 1975–2003



NOTES: Foreign includes permanent and temporary residents. Minority includes Asian/Pacific Islander, black, Hispanic, and American Indian/Alaska Native. Degree recipients with unknown citizenship omitted.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-31.

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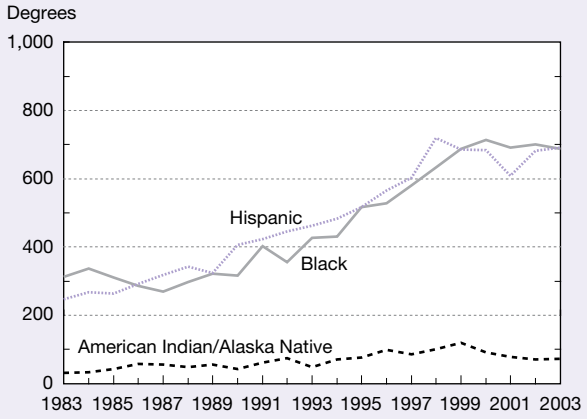
Figure 2-19
U.S. citizen underrepresented minority S&E doctoral degrees, by race/ethnicity: 1983–2003



SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-31.

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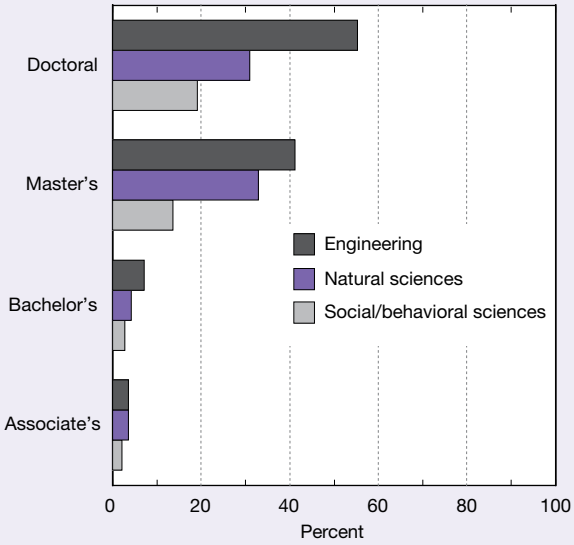
During this period, the number of S&E doctorates earned by U.S. citizens fluctuated from approximately 14,000 to about 17,000, and the number earned by temporary residents rose from 3,500 to a peak of 8,700 in 2003. The temporary resident share of S&E doctorates rose from 18% in 1983 to 32% in 2003. The number of S&E doctorates earned by U.S. permanent residents increased from about 900 in 1983 to a peak of 3,614 in 1995 before falling to about 1,200 in 2003 (appendix table 2-32). (In the mid-1990s, the number of doctorates awarded to U.S. permanent residents showed a steep increase when a large number of Chinese doctoral degree students on temporary visas shifted to permanent resident status under the 1992 Chinese Student Protection Act.)

Foreign students on temporary visas earn a larger proportion of degrees at the doctoral level than at any other level (figure 2-20). Their proportion in some fields is considerably higher: in 2003, foreign students on temporary visas earned 43% to 44% of doctoral degrees awarded in mathematics, computer sciences, and agricultural sciences, along with 55% of those awarded in engineering (appendix table 2-31).

Countries/Economies of Origin

The top 10 foreign countries/economies of origin of foreign S&E doctorate recipients together accounted for 64% of all foreign recipients of a U.S. S&E doctorate from 1983 to 2003 (table 2-3). More than half of those top 10 countries are located in Asia. The major Asian countries/economies sending doctoral degree students to the United States have been, in descending order, China, Taiwan, India, and South Korea. Canada and Mexico were also among the top 10. Major European countries of origin (not in the top 10) were Germany, the United Kingdom, Greece, Italy, and France, in that order.

Figure 2-20
Foreign share of U.S. S&E degrees, by degree and field: 2002 or 2003



NOTES: Doctoral degree data are for 2003; other data are for 2002. Foreign includes temporary residents only. Natural sciences include physical, biological, agricultural, computer, earth, atmospheric, and ocean sciences and mathematics.

SOURCES: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, WebCASPAR database, http://webcaspar.nsf.gov. See appendix tables 2-25, 2-27, 2-29, and 2-31.

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Table 2-3
Foreign recipients of U.S. S&E doctorates, by country/economy of origin: 1983–2003

Country/economy	Number	Percent
All foreign recipients	176,019	100.0
Top 10 total	111,959	63.6
China	35,321	20.1
Taiwan	19,711	11.2
India	17,515	10.0
South Korea	17,112	9.7
Canada	5,832	3.3
Iran	3,807	2.2
Turkey	3,413	1.9
Thailand	3,102	1.8
Japan	3,100	1.8
Mexico	3,046	1.7
All others	64,060	36.4

NOTE: Foreign doctorate recipients include permanent and temporary residents.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, special tabulations (2003).

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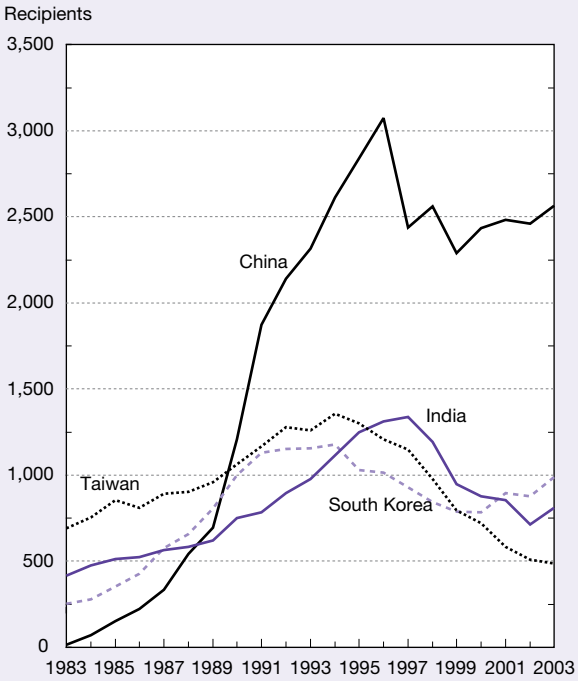
Asia. The number of U.S. S&E doctorates earned by students from Asia increased from the mid-1980s until the mid- to late 1990s, followed by a decline (figure 2-21). Most of these degrees were awarded in engineering and biological and physical sciences (table 2-4). From 1983 to 2003, students from four Asian countries/economies (China, Taiwan, India, and South Korea) earned more than 50% of U.S. S&E doctoral degrees awarded to foreign students (89,700 of 176,000), almost four times more than students from Europe (23,000).

China had the largest number of students earning U.S. S&E doctorates during the 1983–2003 period. These students received more than 35,300 S&E doctoral degrees from U.S. universities, mainly in biological and physical sciences and engineering (table 2-4). The number of S&E doctorates earned by Chinese nationals increased from 16 in 1983 to more than 3,000 in 1996 (figure 2-21). After this peak year, their number of doctorates earned from U.S. institutions declined and leveled off to about 2,500 in recent years.[12]

Students from Taiwan received the second-largest number of S&E doctorates at U.S. universities. Between 1983 and 2003, students from Taiwan earned more than 19,700 S&E doctoral degrees, mainly in engineering and biological and physical sciences (table 2-4). In 1983, they earned more U.S. S&E doctoral degrees than students from India and China combined. The number of U.S. S&E doctoral degrees earned by students from Taiwan increased rapidly for almost a decade, from 691 in 1983 to more than 1,300 at its peak in 1994. However, as universities in Taiwan increased their capacity for advanced S&E education in the 1990s, the number of students from Taiwan earning S&E doctorates from U.S. universities declined to 485 in 2003 (figure 2-21).[13]

Figure 2-21
U.S. S&E doctoral degree recipients, by selected Asian country/economy: 1983–2003



NOTE: Degree recipients include permanent and temporary residents.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, special tabulations (2005).

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Students from India earned more than 17,500 S&E doctoral degrees at U.S. universities over the period. Like students from China and Taiwan, they mainly earned doctorates in engineering and biological and physical sciences. They also earned by far the largest number of U.S. doctoral degrees awarded to any foreign group in computer sciences (table 2-4). The more than decade-long increase in U.S. S&E doctorates earned by students from India ended in 1997, followed by 5 years of decline (figure 2-21). The number of S&E doctoral degrees earned by students from India increased slightly in 2003.

Students from South Korea earned more than 17,000 U.S. S&E doctorates, mainly in engineering and biological, social, and physical sciences. The number of S&E doctoral degrees earned by South Korean students increased from about 250 in 1983 to about 1,200 in 1994, declined to a low of about 800 in the late 1990s, and increased slightly to almost 1,000 in 2003.

Europe. European students earned far fewer U.S. S&E doctorates than did Asian students, and they tended to focus less on engineering than did their Asian counterparts (table 2-5). Western European countries whose students earned the largest number of S&E doctorates from 1983 to 2003 were Germany, the United Kingdom, Greece, Italy, and France, in that order. From 1983 to 1993, Greece and the United Kingdom were the primary European countries of origin; thereafter, their numbers of doctoral degree recipients declined. The numbers of U.S. S&E doctorate recipients from Germany, Italy, and France generally increased over the past two decades (figure 2-22). Scandinavians received fewer U.S. doctorates than did students from the other European regions, with a field distribution roughly similar to that for other Western Europeans (table 2-5).

The number of Eastern European students earning S&E doctorates at U.S. universities increased from fewer than 50 in 1983 to more than 700 in 2003 (figure 2-23). A higher proportion of Central and Eastern Europeans (89%) than Western Europeans (73%) earned U.S. doctorates in S&E fields. Within S&E, Western Europeans were more likely to study psychology and social sciences, and Eastern Europeans were more likely to study physical sciences and mathematics (table 2-5).

North America. The Canadian and Mexican shares of U.S. S&E doctoral degrees were small compared with those from Asia and Europe. The number of U.S. S&E degrees earned by students from Canada increased from less than 200 in 1983 to 350 in 2003. In all, 62% of Canadian doctoral degree students in U.S. universities earned S&E doctorates, mainly in social and biological sciences (figure 2-24; table

Table 2-4
Asian recipients of U.S. S&E doctorates, by field and country/economy of origin: 1983–2003

Field	Asia	China	Taiwan	India	South Korea
All fields	141,826	37,510	23,045	20,382	21,810
S&E	120,698	35,321	19,711	17,515	17,112
Engineering	44,213	10,202	9,156	7,685	6,469
Science	76,485	25,119	10,555	9,830	10,643
Agricultural sciences	5,142	1,148	745	411	670
Biological sciences	19,020	8,728	2,661	2,330	1,898
Computer sciences	5,169	993	958	1,399	674
Earth, atmospheric, and ocean sciences	2,832	1,221	418	236	340
Mathematics	5,823	2,372	773	570	740
Medical/other life sciences	3,547	678	697	628	353
Physical sciences	18,613	7,855	2,429	2,459	2,261
Psychology	1,871	254	276	224	288
Social sciences	14,468	1,870	1,598	1,573	3,419
Non-S&E	21,128	2,189	3,334	2,867	4,698

NOTE: Foreign doctorate recipients include permanent and temporary residents.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, special tabulations (2003).

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Table 2-5
European and North American recipients of U.S. S&E doctorates, by field and region/country of origin: 1983–2003

		Europe[a]			North America		
Field	Total	Western	Scandinavia	Central and Eastern	Total	Mexico	Canada
All fields	29,882	21,119	1,873	6,890	12,905	3,562	9,343
S&E	22,983	15,422	1,426	6,135	8,878	3,046	5,832
Engineering	4,807	3,281	266	1,260	1,465	680	785
Science	18,176	12,141	1,160	4,875	7,413	2,366	5,047
Agricultural sciences	694	536	61	97	779	527	252
Biological sciences	3,231	2,198	189	844	1,684	510	1,174
Computer sciences	1,071	688	64	319	232	72	160
Earth, atmospheric, and ocean sciences	905	642	76	187	335	142	193
Mathematics	2,351	1,204	104	1,043	456	167	289
Medical/other life sciences	511	419	53	39	523	84	439
Physical sciences	4,644	2,677	217	1,750	972	266	706
Psychology	894	733	81	80	828	88	740
Social sciences	3,875	3,044	315	516	1,604	510	1,094
Non-S&E	7,410	5,697	447	755	4,027	516	3,511

[a]See figure 2-23 for countries included in Western Europe, Scandinavia, and Eastern Europe.

NOTE: Foreign doctorate recipients include permanent and temporary residents.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, special tabulations (2003).

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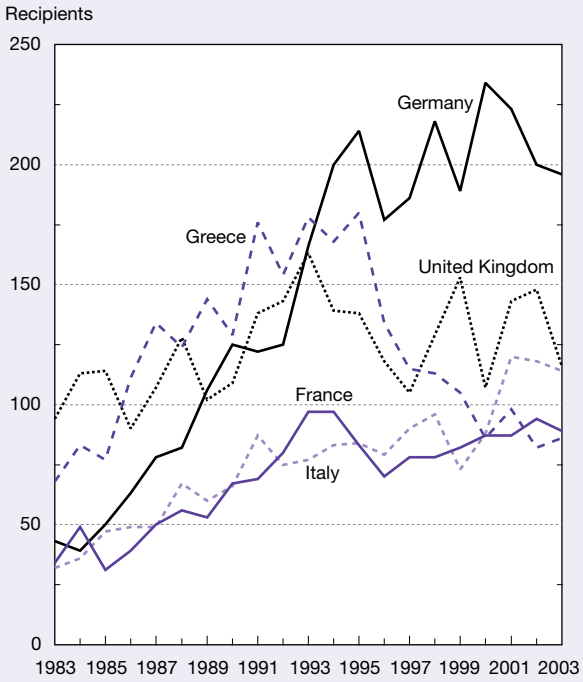
2-5). Mexican doctoral degree students in U.S. universities are more concentrated in S&E fields than are Canadian students: 86% of doctoral degrees earned by Mexican students at U.S. universities were in S&E fields, mainly engineering, agricultural, biological, and social sciences. The number of doctoral degree recipients from Mexico increased from 100 in 1983 to more than 200 in 2003.

Stay Rates

Almost 30% of employed S&E doctorate recipients in the United States are foreign born (see chapter 3), as are more than half of postdocs (appendix table 2-35). The majority of those working in the United States (excluding postdocs) obtained their doctorates from U.S. universities. Stay rates based on stated plans at receipt of doctorate indicate how much the

Figure 2-22
U.S. S&E doctoral degree recipients, by selected Western European country: 1983–2003



NOTE: Degree recipients include permanent and temporary residents.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, special tabulations (2005).

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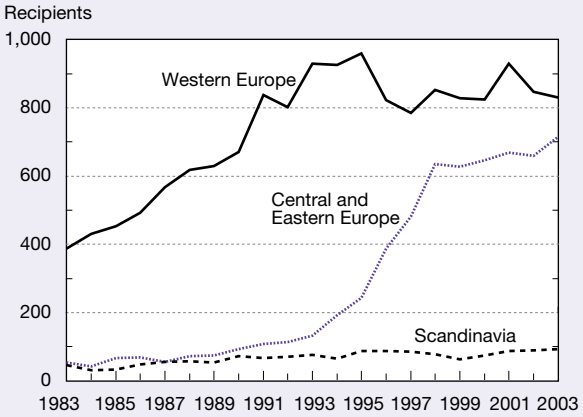
Figure 2-23
U.S. S&E doctoral degree recipients from Europe, by region: 1983–2003



NOTES: Degree recipients include permanent and temporary residents. Western Europe includes Andorra, Austria, Belgium, France, Germany, Gibraltar, Greece, Ireland, Italy, Luxembourg, Malta, Monaco, the Netherlands, Portugal, Spain, and Switzerland. Eastern Europe includes Albania, Bulgaria, Czech Republic, Slovakia, Hungary, Poland, Romania, Russia, Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Kyrgystan, Latvia, Lithuania, Moldova, Tadjikistan, Turkmenistan, Ukraine, Uzbekistan, Yugoslavia, Bosnia-Herzogovina, Croatia, Macedonia, and Serbia-Montenegro. Scandinavia includes Denmark, Finland, Iceland, Norway, and Sweden.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, special tabulations (2005).

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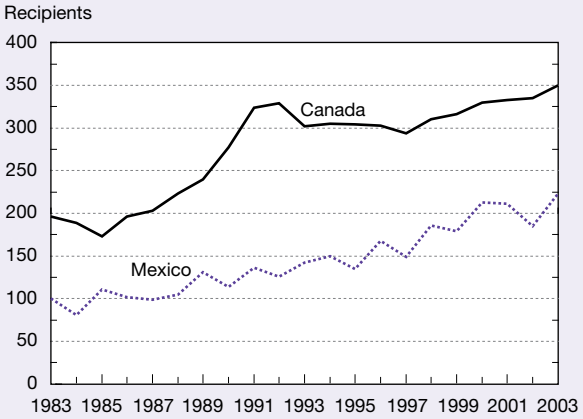
United States relies on inflow of doctorate holders from different countries and whether working in the United States remains an attractive option for foreign students who obtain U.S. doctorates. (See chapter 3 for an analysis using an alternative stay-rate measure based on examination of Social Security records several years after earning a doctorate.)

Until the early 1990s, about half of foreign students who earned S&E degrees at U.S. universities reported that they planned to stay in the United States after graduation, and about one-third said they had firm offers for postdoctoral study or employment (NSB 1998). In the 1990s, however, these percentages increased substantially. In the 1992–95 period, for example, of the foreign S&E doctoral degree recipients who reported their plans, 68% planned to remain in the United States after receiving their degree and 35% already had firm offers. By 2000–03, 74% of foreign doctoral recipients in S&E fields with known plans intended to stay in the United States and 51% had firm offers to do so (appendix table 2-33). Foreign doctorate recipients in physical sciences and mathematics/computer sciences were more likely, and those in social/behavioral sciences, less likely, to have firm plans to stay. Although the number of S&E doctoral degrees earned by foreign students declined after 1996,

Figure 2-24
U.S. S&E doctoral degree recipients from Canada and Mexico: 1983–2003



NOTE: Degree recipients include permanent and temporary residents.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, special tabulations (2005).

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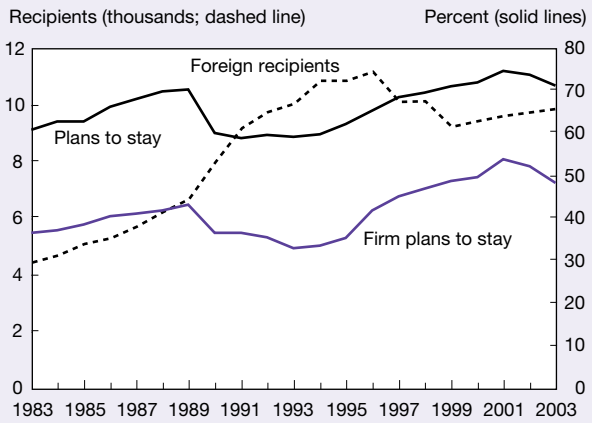
the percentage of students who had firm plans to remain in the United States continued to increase through 2001 before declining in 2002 and 2003 (figure 2-25).

Stay rates vary by place of origin. In the 2000–03 period, 64% of U.S. S&E doctoral recipients from China and 67% of those from India reported accepting firm offers for employment or postdoctoral research in the United States, up from 47% and 53%, respectively, in the period from 1992 to 1995 (figure 2-26; appendix table 2-33). Recipients from Taiwan, Japan, and South Korea were less likely to stay in the United States. Over the same 2000–03 period, 41% of S&E doctoral degree recipients from Taiwan, 42% of those from Japan, and 46% of those from South Korea reported accepting firm offers to remain in the United States. Although the number of S&E doctorate students from Taiwan and South Korea fell in the late 1990s (and in the case of Taiwan, into the 2000s), the percentage who intended to stay in the United States after receipt of their degree increased. Among U.S. S&E doctoral degree recipients from Europe, a relatively high percentage from the United Kingdom planned to stay, whereas relatively small percentages from France, Italy, and Spain (compared with other Western European countries) planned to stay after graduation. The percentage of 2000–03 doctoral degree students who had firm plans to stay in the United States was higher for Canada (54%) than for Mexico (30%) (appendix table 2-33).

Doctoral Degrees by Time to Degree

The NSF Survey of Earned Doctorates tracks patterns and trends in the time it takes to earn an S&E doctorate. The survey measures time to degree in several ways, including median number of years between baccalaureate receipt and doctorate receipt (also known as *total time to degree*) and median number of years registered in graduate school between graduate entry and doctorate receipt (also known as *registered time to degree*).

Figure 2-25
Plans of foreign U.S. S&E doctoral degree recipients to stay in United States: 1983–2003



NOTES: Degree recipients include permanent and temporary residents. Appendix table 2-33 includes plans to stay by country of origin and field of study in 3-year increments.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, special tabulations (2005). See appendix table 2-33.

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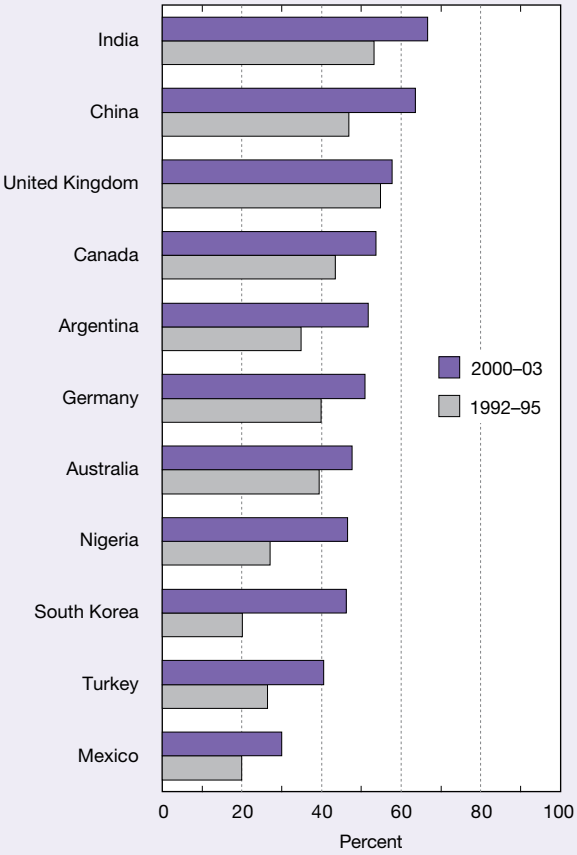
Figure 2-26
Short-term stay rates of foreign U.S. S&E doctoral degree recipients, by place of origin: 1992–95 and 2000–03



NOTES: Short-term stay rates are those with firm commitments of postaward or postdoctoral employment. Longer-term stay rates may differ. Appendix table 2-33 includes plans to stay by place of origin and field of study in 3-year increments.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, special tabulations (2005).

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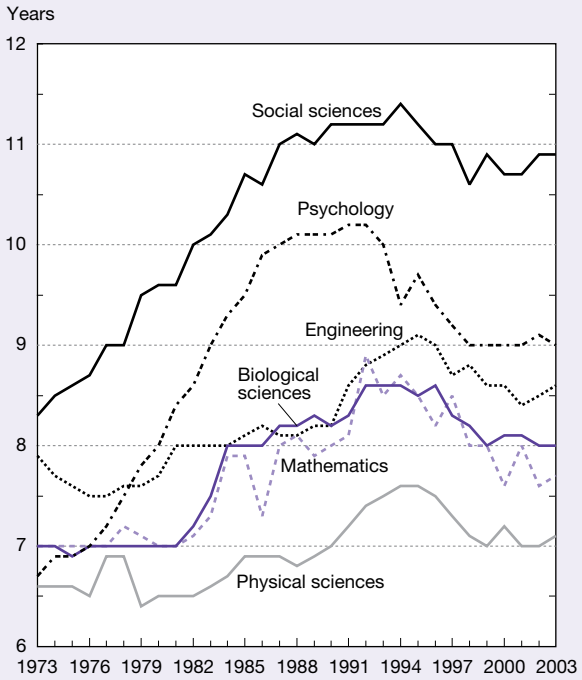
Data on the time from baccalaureate to doctorate show increases from 1973 through the early 1990s, followed by declines in all S&E fields. Over the past three decades, increases ranged from about 6 months longer in engineering, physical sciences, and mathematics to nearly 3 years longer in social sciences (figure 2-27). Total time to degree (as measured by elapsed time from baccalaureate) was longest in each of the S&E fields in the early to mid-1990s. By 2003, it had shortened considerably. Physical sciences had the shortest time to degree at 7.1 years, and social sciences, the longest at 10.9 years (appendix table 2-34).

Median registered time to degree, as measured by number of years registered in graduate school between entry and doctorate receipt, also followed a similar pattern of increase over the past 30 years for all fields. It averaged about 1 year

Figure 2-27
Time from bachelor's to S&E doctoral degree, by doctoral degree field: 1973–2003



NOTE: Median years between award of bachelor's degree and award of doctoral degree.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, special tabulations (2005). See appendix table 2-34.

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longer in most S&E fields and almost 2 years longer in agricultural sciences, psychology, and social sciences. Among S&E fields in 2003, registered time to degree was shortest in the physical sciences (6.4 years) and longest in the social sciences (8.3 years).

Postdocs

Postdoctoral fellowships provide recent doctorate recipients with "an opportunity to develop further the research skills acquired in their doctoral programs or to learn new research techniques" (Association of American Universities 1998). Typically, postdoctoral fellows or *postdocs* have temporary appointments involving full-time research or scholarship whose purpose is to further their education and training. The titles associated with these positions and the conditions of employment vary widely. The status of postdoctoral fellows within the academic hierarchy is not well defined and varies among institutions, although the concept that the postdoctoral experience represents the last step on a person's training for becoming an independent investigator and faculty member is generally accepted (COSEPUP 2000, 2004).

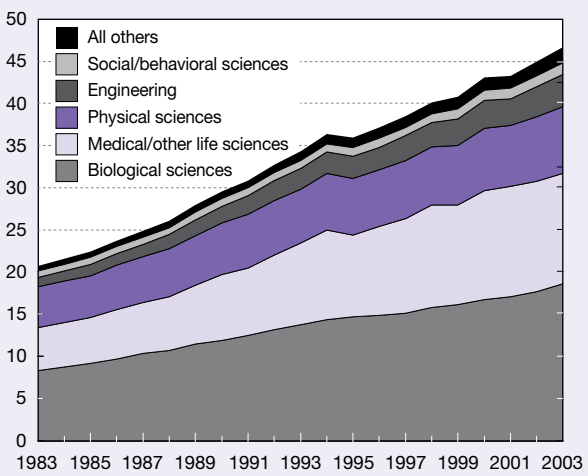
Since 1983, the number of doctoral degree recipients with science, engineering, and health postdoctoral appointments at U.S. universities more than doubled from 20,700 in 1983 to 46,700 in 2003. Approximately two-thirds of those were in biological, medical, and other life sciences (figure 2-28).

Noncitizens account for much of the increase in the number of S&E postdocs, especially in biological sciences and medical and other life sciences. The number of S&E postdocs with temporary visas at U.S. universities increased from approximately 7,500 in 1983 to 27,000 in 2003. The number of U.S. citizen and permanent resident S&E postdocs at these institutions increased more modestly from approximately 13,200 in 1983 to 19,700 in 2003 (figure 2-29 and appendix table 2-35). Noncitizens accounted for 58% of S&E postdocs in 2003.

An increasing share of academic S&E postdocs are funded through federal research grants. In fall 2003, 56% of S&E postdocs at U.S. universities were funded through this mechanism, up from 48% in 1983. Federal fellowships and traineeships fund a declining share of S&E postdocs—14% in 2003, down from 24% in 1983. In 2003, the remainder (about 30%) of S&E postdocs were funded through non-federal sources (table 2-6).

Although the majority of postdocs are employed in academic institutions, federal agencies and federally funded research and development centers (FFRDCs) also employ sizable numbers of postdocs. NIH, for example, employed approximately 2,600 intramural postdocs in 2004 (NIH, Office of the Director, internal report). In 2003, almost 3,000 postdocs were employed in FFRDCs, which are federally funded but administered by universities and colleges, industrial firms, or nonprofit organizations. Most (16) of the 22 FFRDCs employing postdocs are funded by the U.S. Department of Energy. The largest FFRDC postdoc employers were Aerospace FFRDC (almost 700 postdocs) and Los Alamos National

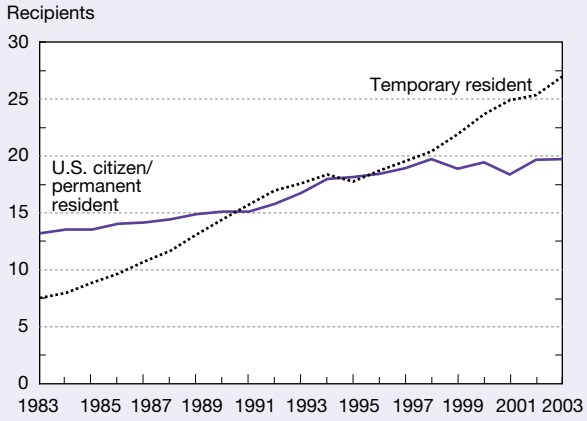
Figure 2-28
Postdocs at U.S. universities, by field: 1983–2003



SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Graduate Students and Postdoctorates in Science and Engineering, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-35.

Science and Engineering Indicators 2006

Figure 2-29
Postdocs at U.S. universities, by citizenship status: 1983–2003



SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Graduate Students and Postdoctorates in Science and Engineering, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-35.

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Table 2-7
Postdocs at federally funded research and development centers: 2003

Center	Postdocs
All FFRDCs	2,908
The Aerospace Corporation	696
Los Alamos National Laboratory	406
Lawrence Berkeley National Laboratory	303
Lawrence Livermore National Laboratory	222
Argonne National Laboratory	178
Stanford Linear Accelerator Center	171
Oak Ridge National Laboratory	150
Pacific Northwest National Laboratory	136
Sandia National Laboratory	127
Brookhaven National Laboratory	119
Jet Propulsion Laboratory	82
Ames Laboratory	77
National Center for Atmospheric Research	66
Fermi National Accelerator Laboratory	47
National Renewable Energy Laboratory	45
National Radio Astronomy Observatory	23
Idaho National Engineering and Environmental Laboratory	19
Savannah River Technology Center	11
Thomas Jefferson National Accelerator Facility	11
National Optical Astronomy Observatories	9
Princeton Plasma Physics Laboratory	7
National Astronomy and Ionosphere Center	3

FFRDC = federally funded research and development center

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Graduate Students and Postdoctorates in Science and Engineering, special tabulations (2003).

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Laboratories (about 400). Other large FFRDC postdoc employers include Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Argonne National Laboratory, and Stanford Linear Accelerator Center Research Division (table 2-7).

Chapter 3 provides more detail on postdoctoral employment, including reasons for postdoc, length of postdoc, salaries, and subsequent employment. See sidebar "Postdoctoral Appointments."

Global Higher Education in S&E

The 1990s saw a tremendous increase in international migration of students and highly skilled workers. In particular, migration of students occurred from developing countries to the more developed countries, and from Europe and Asia to the United States. Some migrate temporarily for education and others remain permanently. Some of the factors that influence the decision to migrate are economic opportunities, research opportunities, research funding, and climate for innovation in the country of destination (OECD 2002). The population of individuals ages 18 to 23 (a proxy for college-age population) decreased in Europe, the United States, China, and Japan in the 1990s and is projected to continue decreasing in Europe and Japan (appendix table 2-36). This decrease is an incentive for countries to encourage in-migration of students from other countries or to increase enrollment proportions of their own college-age population. New efforts are underway to better measure international migration. See sidebar "Developing

Table 2-6
Source of funding of S&E postdocs: 1994–2003
(Percent distribution)

Source	1983	1985	1987	1989	1991	1993	1995	1997	1999	2000	2001	2002	2003
All sources	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Federal fellowships	11.9	10.6	9.5	9.4	9.0	8.5	8.8	9.0	9.4	9.1	8.3	8.7	8.1
Federal traineeships	12.5	11.3	10.6	8.9	8.8	8.5	7.6	7.2	6.6	6.0	5.7	6.0	5.7
Federal research grants	48.0	50.0	50.9	51.6	51.8	52.1	51.9	51.7	53.2	54.5	54.7	55.8	56.0
Nonfederal sources	27.6	28.1	29.1	30.1	30.5	30.9	31.6	32.1	30.7	30.3	31.3	29.5	30.2

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Graduate Students and Postdoctorates in Science and Engineering, Integrated Science and Engineering Resources Data System (WebCASPAR), http://webcaspar.nsf.gov.

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Postdoctoral Appointments

Since the 2000 Committee on Science, Engineering and Public Policy (COSEPUP) report on the postdoctoral experience, postdoc associations, funding agencies, and employers of postdocs have sought ways to standardize the postdoc experience and improve employment conditions (COSEPUP 2000). Postdocs are paid less than other doctoral degree recipients: in 2003, the median salary for postdocs 1–5 years after completing their doctorate (across all S&E fields) was $40,000, and the median salary of nonpostdocs ranged from $48,500 to $80,000, depending on employment sector (see chapter 3). In addition, these positions often lack health insurance, retirement benefits, access to grievance procedures, pay raises, and annual reviews. Nevertheless, many doctoral degree recipients view postdocs as critical to their careers. Among postdocs in 2003 who earned their doctorate at U.S. universities, the most commonly cited reasons for taking a postdoc were that it was expected in their field (31%), to obtain additional training in their field (22%), and to work with a specific person or in a specific place (18%). Only 12% reported that they took a postdoc because no other employment was available.

Developing Internationally Comparable Data on Mobility and Careers of Doctorate Holders

A highly educated workforce contributes to economic growth, particularly in knowledge-based economies. Yet, little internationally comparable data exist on the link between education and careers of highly educated professionals and on the mobility of doctorate holders across borders. Currently available international data have been collected from surveys that have different objectives, perspectives, and methodologies, and thus have limited use in international comparisons. A project underway by the Organisation for Economic Co-operation and Development (OECD), the United Nations Educational, Scientific and Cultural Organization (UNESCO), and Eurostat endeavors to bring about standardization of questions asked, methodologies used, and output measures of surveys of doctorate holders. Internationally coordinated data collections about doctorate holders would build on the existing work currently being conducted by numerous countries (e.g., the United States, Canada, France, and the United Kingdom), which does not currently yield comparable information across countries. Work on standardizing survey frames, data collection methods, quality standards, questions, and tabular output for such internationally comparable surveys is under way.

Internationally Comparable Data on Mobility and Careers of Doctorate Holders."

The United States has, by far, the largest number of foreign students (undergraduate and graduate) of all Organisation for Economic Co-operation and Development (OECD) countries (figure 2-30), although other countries have higher percentages of students who are foreign. In Australia, Switzerland, New Zealand, Austria, Belgium, France, Germany, and the United Kingdom, 10% or more of students enrolled in higher education are foreign compared with about 4% in the United States (OECD 2004).

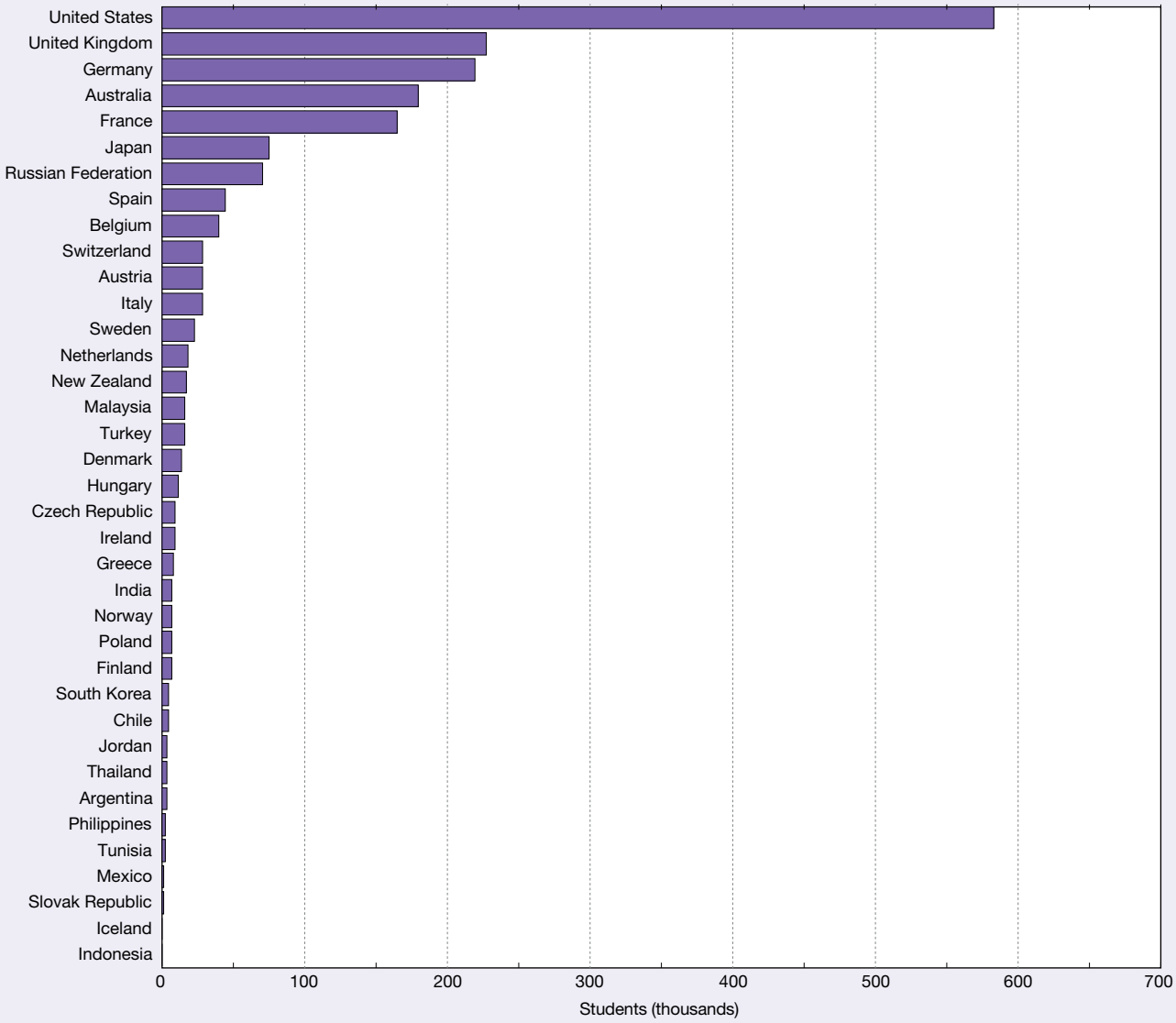
First University Degrees in S&E Fields

In 2002, more than 9 million students worldwide earned a first university degree.[14] Students earned more than 3 million of these in S&E fields (appendix table 2-37). These worldwide totals include only countries for which recent data are available (primarily countries in the Asian, European, and American regions) and therefore are an underestimation. Asian universities accounted for almost 1.5 million of the world's S&E degrees in 2002, more than 600,000 of them in engineering (figure 2-31). Students across Europe (including Eastern Europe and Russia) earned about 930,000, and students in North and Central America earned almost 600,000 S&E degrees in 2002.

The United States has historically been a world leader in providing broad access to higher education. The ratio of bachelor's degrees earned in the United States to the population of the college-age cohort remains relatively high at 33.9 per 100 in 2002. However, a number of other countries/economies, mainly in Europe, also provide a college education to approximately one-third or more of their college-age population. Costa Rica, Denmark, France, Finland, Iceland, Portugal, the Netherlands, Sweden, the United Kingdom, Bulgaria, Latvia, Lithuania, Mongolia, Australia, New Zealand, and Taiwan all have a high proportion of bachelor's degrees to the college-age population (appendix table 2-37).

For the past three decades, S&E degrees have constituted about one-third of U.S. bachelor's degrees. In several countries/economies around the world, the proportion of first degrees in S&E fields is higher than in the United States. In the most recent data available, the corresponding figures in Japan (64%), China (57%), and South Korea (47%) were considerably higher. Indonesia, Laos, Malaysia, Singapore, Taiwan, Iran, Israel, Eritrea, Ghana, Mauritius, Austria, Finland, France, Germany, Czech Republic, Canada, and Chile also have high proportions of first degrees in S&E fields. Many of these countries/economies, especially in Europe and Asia, have traditionally awarded a large proportion of their first degrees in engineering.

Figure 2-30
Foreign students enrolled in tertiary education, by country: 2002



SOURCE: Organisation for Economic Co-operation and Development, *Education at a Glance 2002* (2002).

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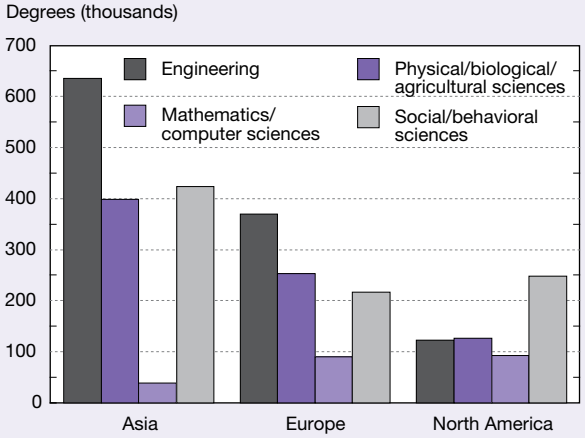
Over the past two decades, the number of first university S&E degrees awarded in China, South Korea, and the United Kingdom more than doubled, and those in the United States and Japan generally increased (appendix table 2-38). In Germany, first university S&E degrees increased gradually through 1997 and then declined.[15] Engineering first university degrees have trebled over the past two decades in China and South Korea, and increased greatly in Japan and the United Kingdom, far outpacing growth in engineering degrees in the United States (figure 2-32). (See sidebar "Educational Reforms in China.") In natural sciences, the number of first university degrees in the United States has been increasing since 1989 and far exceeds the rising numbers of natural sciences degrees awarded in China, the United Kingdom, Japan, and South Korea.

Global Comparison of Participation Rates by Sex

Among Western countries for which degree data are available by sex, Canada and the United States show relatively high percentages of first university degrees in S&E awarded to women. In many Asian countries, women generally earn about one-third or less of the first university degrees awarded in S&E fields. In 2002, women earned half or more of the S&E first university degrees in the United States, Canada, Portugal, Albania, Bulgaria, Estonia, Latvia, Poland, Slovenia, Mongolia, Bahrain, Israel, Lebanon, and Qatar (appendix table 2-39).

Figure 2-31
First university S&E degrees in Asia, Europe, and North America, by field: 2002



NOTE: Physical sciences include earth, atmospheric, and ocean sciences.

SOURCES: Organisation for Economic Co-operation and Development, Education database, http://www1.oecd.org/scripts/cde/members/EDU_UOEAuthenticate.asp; United Nations Educational, Scientific, and Cultural Organization (UNESCO), Institute for Statistics database, www.unesco.org/statistics; and national sources. See appendix table 2-37 for countries/economies included in each region.

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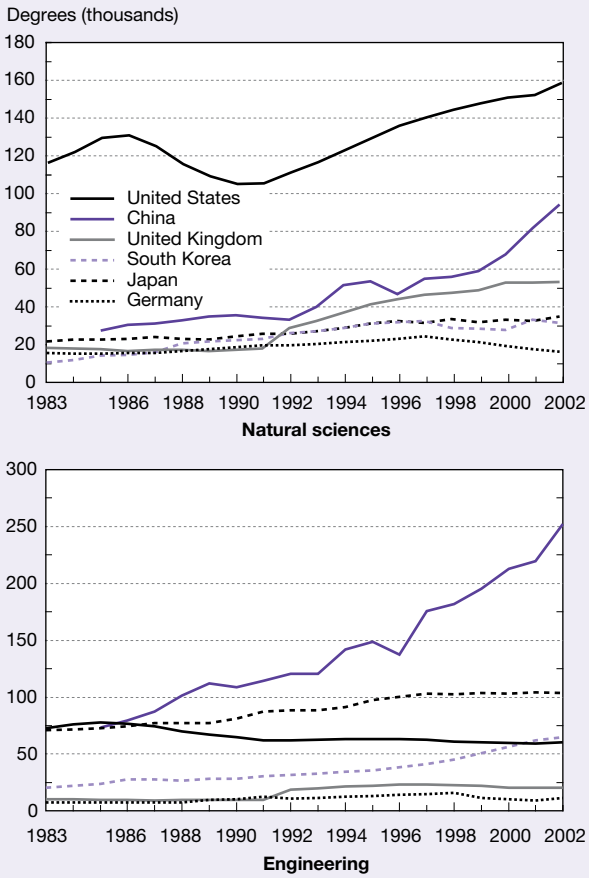
Figure 2-32
First university natural sciences and engineering degrees, by selected countries: 1983–2002 or most recent year



NOTES: Natural sciences include physical, biological, earth, atmospheric, ocean, agricultural, and computer sciences and mathematics. German degrees include only long university degrees required for further study.

SOURCES: China—National Bureau of Statistics of China, China Statistical Yearbook, annual series (Beijing) various years; Japan—Government of Japan, *Monbusho Survey of Education;* South Korea—Organisation for Economic Co-operation and Development, Education Online Database, http://www1.oecd.org/scripts/cde/members/EDU_UOEAuthenticate.asp; United Kingdom—Higher Education Statistics Agency; Germany—Federal Statistical Office, *Prüfungen an Hochschulen;* United States—National Science Foundation, Division of Science Resources Statistics, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-38.

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In the United States, Canada, Japan, and many European countries, over half of the S&E first university degrees earned by women are in the social and behavioral sciences.

Global Comparison of S&E Doctoral Degrees

Of the more than 125,000 S&E doctoral degrees earned worldwide in 2002, 98,000 (78%) were earned outside the United States (appendix table 2-40). Figure 2-33 shows the breakdown of S&E doctoral degrees by major region and selected fields.

In 2003, women earned 39% of S&E doctoral degrees awarded in the United States. The percentage of S&E doctoral degrees earned by women in other countries and areas of the world varied widely. In Western Europe, the percentages earned by women varied from 27% in Germany to 45% in Italy. In Asia, women earned roughly one-fifth of all S&E doctoral degrees (appendix table 2-41).

For most of the past two decades, momentum in doctoral S&E programs has been strong in the United States and some Asian and European countries. By 2001, China was the largest producer of S&E doctoral degrees (more than 8,000) in the Asian region. The numbers of natural sciences and engineering (NS&E) doctoral degrees awarded in China, South Korea, and Japan have continued to rise.[16] (Natural sciences include physical, biological, earth, atmospheric, ocean, agricultural, and computer sciences, and mathematics.) (See appendix tables 2-42 and 2-43.) However, in the late 1990s and early 2000s, NS&E doctoral degrees leveled off or declined in the United States, the United Kingdom, and Germany (figure 2-34).

Global Student Mobility

International migration of students and highly skilled workers has expanded in the past two decades and countries are increasingly competing for foreign students. The U.S. share of foreign students declined in recent years while Australia's and the United Kingdom's shares have increased.[17] The United States remains, however, the predominant destination for foreign students, accounting for 40% of internationally mobile students in 2004. The United

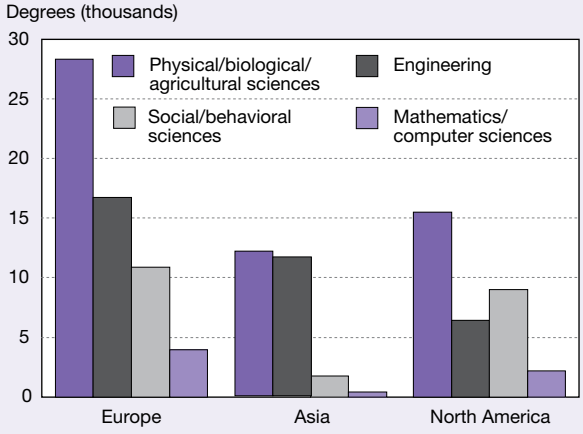
Educational Reforms in China

In 1998, China began an effort to consolidate institutions, increase funding, and reorganize its educational system, resulting in more efficient administration, reduction of competing programs, a more flexible curriculum, and rapid expansion of enrollment (Hsiung 2005). As a result of this effort, natural sciences (science, agriculture, and medicine) and engineering enrollment in Chinese universities grew from roughly 1.8 million students in 1995 to 5.8 million in 2003. More than half of all undergraduate students were enrolled in these fields in 2003. Despite reforms, several challenges remain, including increased class sizes, lack of autonomy from the government, and little academic freedom for faculty.

Kingdom accounted for 18%, Germany for 15%, France for 12%, and Australia for 6% (Institute of International Education 2004).

In addition to the United States, a number of countries worldwide have increased foreign student enrollment in recent years. Foreign student enrollment in the United Kingdom increased in the past decade. The proportion of foreign students studying S&E fields in the United Kingdom has increased, especially at the graduate level, with increasing flows of students from China and India. From 1994 to 2004, foreign graduate students studying S&E

Figure 2-33
S&E doctoral degrees earned in Europe, Asia, and North America, by field: 2001 or most recent year



NOTES: Physical sciences include earth, atmospheric, and ocean sciences. Asia includes China, India, Japan, South Korea, and Taiwan. Europe includes Western, Central, and Eastern Europe; see appendix table 2-40 for countries/economies included within each region.

SOURCES: Organisation for Economic Co-operation and Development, Education Online Database; United Nations Educational, Scientific, and Cultural Organization (UNESCO), Institute for Statistics database, http://www.unesco.org/statistics; and national sources. See appendix table 2-40.

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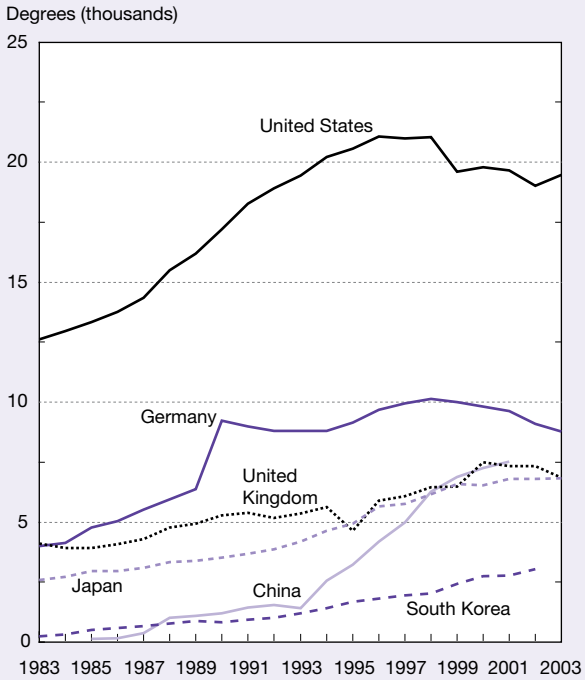
Figure 2-34
Natural sciences and engineering doctoral degrees, by selected country: 1983–2003



NOTE: Natural sciences and engineering include physical, biological, earth, atmospheric, ocean, agricultural, and computer sciences; mathematics; and engineering.

SOURCES: China—National Research Center for Science and Technology for Development; United States—National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates; Japan—Government of Japan, *Monbusho Survey of Education;* South Korea—Organisation for Economic Co-operation and Development, Education Online database, http://www1.oecd.org/scripts/cde/members/EDU_UOEAuthenticate.asp; United Kingdom—Higher Education Statistics Agency; and Germany— Federal Statistical Office, *Prüfungen an Hochschulen*. See appendix tables 2-42 and 2-43.

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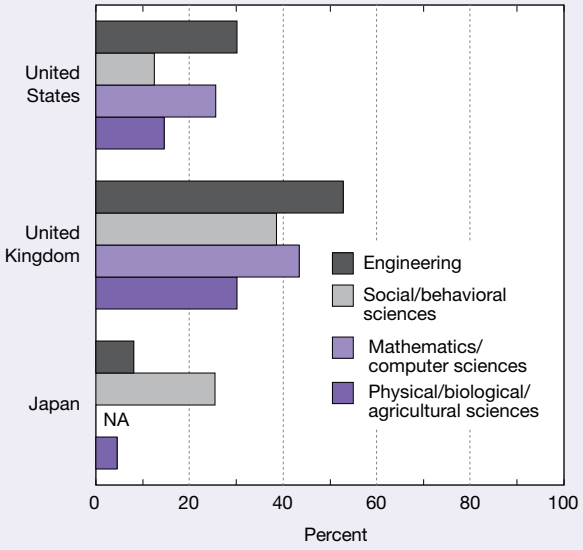
in the United Kingdom increased from 29% to 41%. In graduate engineering, foreign student enrollment more than doubled from 9,300 (35% of enrollment) to 20,500 (53% of enrollment) (figure 2-35; appendix table 2-44). Students from China, Greece, India, and Malaysia accounted for most of the increase in foreign graduate engineering enrollment.

Foreign students accounted for about 27% of the French S&E graduate enrollment in 2003. About half of the 30,000 foreign S&E graduate students in France come from Africa, and Asian students account for another 20%. Although educational reforms in the European Union (EU) are encouraging student mobility among countries, only 3% of all S&E graduate students and 10% of foreign S&E graduate students in France come from other EU countries (appendix table 2-45). (See sidebar "Education Reforms in Europe.")

In Japanese universities, more than 84,000 foreign students, mainly from the Asian region, were enrolled at the undergraduate and graduate levels in 2004. More than 50,000 of these students were enrolled in S&E fields. Foreign S&E

Figure 2-35
S&E foreign graduate student enrollment, by selected country and field: 2003



NA = not available

NOTES: Japanese data include mathematics in natural sciences and computer sciences in engineering. Foreign graduate enrollment in U.S. data includes temporary residents only; U.K. and Japanese data include permanent and temporary residents.

SOURCES: United States—National Science Foundation, Division of Science Resources Statistics, Survey of Graduate Students and Postdoctorates in Science and Engineering, WebCASPAR database, http://webcaspar.nsf.gov; United Kingdom—Higher Education Statistics Agency, special tabulations; Japan—Government of Japan, Division of Higher Education, special tabulations (2005). See appendix tables 2-31, 2-44, and 2-46.

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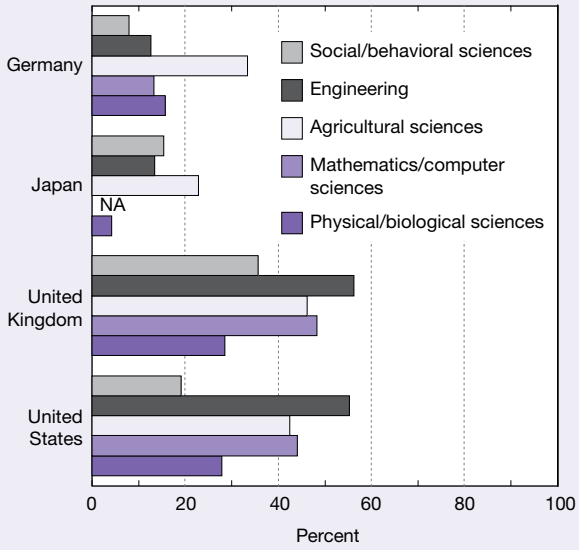
student enrollment in Japan was concentrated at the undergraduate level (34,000), mostly in the social and behavioral sciences.[18] About 17,000 foreign S&E students were enrolled in Japanese universities at the graduate level, representing 12% of the graduate students in S&E fields. Foreign S&E graduate students in Japan come mainly from China and South Korea (appendix table 2-46).

Foreign S&E students accounted for about 6% of undergraduate and 21% of graduate S&E enrollment in Canada in 2001. At both the undergraduate and graduate levels, foreign S&E students are concentrated in mathematics/computer sciences and engineering. Asian countries/economies were the top places of origin of foreign S&E graduate and undergraduate students in Canada. The United States is also among the top countries of origin of foreign students, accounting for 6% of foreign S&E graduate students and 2% of foreign S&E undergraduate students in Canada (appendix table 2-47).

International Comparison of Foreign Doctoral Degree Recipients

Like the United States, the United Kingdom and France have many foreign students among their S&E doctoral degree recipients. In 2003, 39% of S&E doctorates from the United Kingdom and 37% of S&E doctorates from U.S. universities were awarded to foreign students (both permanent and temporary visa holders). In both countries, foreign students accounted for more than half of the doctorates awarded in engineering. Foreign students account for about 14% of S&E doctorate recipients in Japan and Germany (figure 2-36; appendix table 2-48).

Figure 2-36
S&E doctoral degrees earned by foreign students, by selected country and field: 2003 or most recent year



NA = not available

NOTES: Japanese data for university-based doctorates only; excludes *ronbun hakase* doctorates awarded for research within industry. Japanese data include mathematics in natural sciences and computer sciences in engineering. For each country, data are for doctoral recipients with foreign citizenship, including permanent and temporary residents.

SOURCES: Germany—Federal Statistical Office, *Prüfungen an Hochschulen 2003*; Japan—Government of Japan, Division of Higher Education, special tabulations; United Kingdom—Higher Education Statistics Agency, special tabulations (2005); United States— National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, WebCASPAR database, http://webcaspar.nsf.gov. See appendix table 2-48.

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Education Reforms in Europe

In 1999, 29 European countries, through the Bologna Declaration, initiated a system of reforms in higher education in Europe. The goal of the Bologna Process is to harmonize certain aspects of higher education within participating countries by 2010 so that degrees are comparable, credits are transferable, and students, teachers, and researchers can move freely from institution to institution across national borders. Its aim is to replace the varied degree programs in existence that typically took 5 or more years to earn, with a standard 3-year bachelor's degree and a 2-year master's degree with a standardized credit system. The reform process has now been extended to more than 40 countries. It is not clear whether these new 3-year bachelor's degrees will be accepted in U.S. graduate programs. A survey of admissions officers at 90 U.S. institutions by Educational Credential Evaluators, Inc., in 2004 found that most would not consider applicants who had degrees from 3-year undergraduate programs (Bollag 2004). It is also not clear yet what effect the Bologna Process will have on the flow of foreign students into Europe.

Conclusion

The United States continues to be a world leader in S&E higher education. American freshmen continue to show interest in S&E fields. The number of S&E bachelor's degrees has held steady at about one-third of all bachelor's degrees in the United States. Meanwhile, the number of bachelor's degrees awarded in all fields and in S&E fields has continued to increase. Graduate enrollment in S&E fields is also increasing, reaching a new peak in 2003. The number of S&E doctorates awarded also increased in 2003.

Women now earn half of bachelor's degrees in S&E, although they earn much lower shares in some fields. Minority students from all groups are earning growing shares of S&E degrees at all levels. Underrepresented minorities (blacks, Hispanics, and American Indians/Alaska Natives) do not participate in higher education in the same proportion as whites, but among those who complete bachelor's degrees, similar percentages of underrepresented minorities and whites earn their degrees in S&E fields.

Foreign students continue to be a large presence in U.S. S&E graduate education. Foreign student enrollment in graduate S&E programs continues to increase. Students on temporary visas earned about one-third of S&E doctorates in the United States in 2003 and more than half of the engineering doctorates. An increasing fraction of them stay in the United States: about three-quarters of foreign doctoral degree recipients in 2003 planned to stay in the United States after graduation.

However, many other countries are now increasing their capacity for higher education and many attract large numbers of foreign students. In recent years, universities in other countries, including Australia, the United Kingdom, Canada, Japan, and Germany, expanded their enrollment of foreign S&E graduate students. And, although total foreign graduate enrollment in the United States is still increasing, first-time enrollment of foreign students has decreased in some fields in the past several years as a result of visa restrictions after the events of September 11, 2001, growth in non-U.S. higher education institutions, or declines in U.S. demand for engineers and computer scientists.

Notes

1. Data for racial/ethnic groups are for U.S. citizens and permanent residents only.

2. Higher percentages of Hispanic and American Indian/Alaska Native students are enrolled in 2-year institutions compared with students from other racial/ethnic groups. The percentage of black students enrolled in 2-year institutions is roughly similar to that of white students (NSF 2003).

3. The number of S&E degrees awarded to a particular freshmen cohort is lower than the number of students reporting such intentions and reflects losses of students from S&E, gains of students from nonS&E fields after their freshman year, and general attrition from bachelor's degree programs. (See "Retention in S&E" later in this chapter.)

4. White, Asian, and Hispanic U.S. citizens and permanent residents accounted for most of the gains in undergraduate engineering enrollment in recent years. For data by race/ethnicity, see http://www.nsf.gov/statistics/wmpd/pdf/tabb-9.pdf.

5. For more detailed information by field, see *Graduate Students and Postdoctorates in Science and Engineering: Fall 2002* at http://www.nsf.gov/statistics/pubseri.cfm?TopID=2&SubID=18&SeriID=9#recentpub/.

6. Debt is measured in discrete categories ranging from none to $35,001 or more.

7. Levels of debt vary within psychology as well. Psychology doctorates who earned PsyDs, those who graduated from professional psychology schools, and those in clinical psychology had higher levels of debt. Despite differences by field, doctorate recipients from most psychology subfields had higher levels of debt than doctorate recipients from other S&E fields (NSF 2000b).

8. Data for racial/ethnic groups are for U.S. citizens and permanent residents only.

9. See the NSF report series *Science and Engineering Degrees* (http://www.nsf.gov/statistics/showpub.cfm?TopID=2&SubID=5) for longer degree trends and *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2004* (http://www.nsf.gov/statistics/pubseri.cfm?TopID=2&SubID=45&SeriID=6#recentpub) for more detail on enrollments and degrees by sex and by race/ethnicity.

10. Data for racial/ethnic groups are for U.S. citizens and permanent residents only.

11. Data for racial/ethnic groups are for U.S. citizens and permanent residents only.

12. The number of doctoral S&E degrees earned by Chinese students within Chinese universities continued to increase throughout the decade, from 1,069 in 1990 to 6,788 in 1999 (NSB 2002).

13. A current science and technology policy debate in Taiwan focuses on whether to encourage more Taiwanese to study at U.S. universities for the subsequent benefits of networking between Taiwanese and U.S. scientists and engineers.

14. A first university degree refers to the completion of a terminal undergraduate degree program. These degrees are classified as level 5A in the International Standard Classification of Education, although individual countries use different names for the first terminal degree: for example, *laureata* in Italy, *diplome* in Germany, *maitrise* in France, and *bachelor's degree* in the United States and in Asian countries.

15. Poor labor market conditions for engineers in Germany in the 1990s contributed to the decline in degrees. Since 1999, the number of students enrolled in engineering increased and is expected to result in increased degrees in the future.

16. Doctoral degree recipients in Japan have faced high unemployment rates in recent years as the number of doctoral degrees has increased (Brender 2004). Similarly, Chinese college graduates are facing high unemployment rates. In 2004, roughly 30% of 2003 Chinese college graduates remained unemployed even as the number of 2004 graduates was expected to increase by 32% (Hsiung 2005).

17. Limited university capacity for foreign students in the United Kingdom and Australia may restrict the amount of future growth in foreign enrollment, whereas Japan and Germany have greater capacity to expand (OECD 2004).

18. At the undergraduate level, about 20% of foreign students are permanent residents in Japan. In contrast, at the graduate level, only a small percentage of foreign students (5%) are permanent residents.

Glossary

Bologna Process: An effort initiated by the 1999 Bologna Declaration to harmonize higher education within participating European countries by the year 2010 so that degrees are comparable; credits are transferable; and students, teachers, and researchers can move freely from institution to institution across national borders.

Distance education: Situations where students are not located with their teachers/learning institutions and therefore require specialized instructional techniques, technologies, and means of communication to promote learning.

Early college high school: Small school situated on the campus of a community college with a curriculum that leads to simultaneous award of both a high school diploma and an associate of arts degree.

Federally funded research and development center: R&D-performing organizations exclusively or substantially financed by the federal government either to meet particular R&D objectives or, in some instances, to provide major facilities at universities for research and associated training purposes; each FFRDC is administered either by an industrial firm, a university, or a nonprofit institution.

First university degree: completion of a terminal undergraduate degree program; these degrees are classified as level 5A in the International Standard Classification of Education, although individual countries use different names for the first terminal degree.

Industrial learning centers: Corporate "universities," independent nonprofit institutions, and for-profit and nonprofit subsidiaries of institutions; most offer noncredit, nondegree courses narrowly targeted at retraining the workforce and addressing other company needs.

Institutional control: Whether an academic institution is public or private.

Stay rate: The proportion of students on temporary visas who have plans to stay in the United States immediately after degree conferral.

Time to degree: the time it takes to earn an S&E doctorate; can be measured either as **total time to degree**—the median number of years between baccalaureate receipt and doctorate receipt—or **registered time to degree**—the median number of years registered in graduate school between graduate entry and doctorate receipt.

Underrepresented minority: blacks, Hispanics, and American Indians/Alaska Natives are considered to be underrepresented in S&E.

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