DOCUMENT RESUME

ED 344 780 SE 052 904

TITLE Science & Engineering Indicators - 1991. Tenth Edition.
INSTITUTION National Science Foundation, Washington, D.C. National Science Board.
REPORT NO NSB-91-1
PUB DATE 91
NOTE 587p.; For the 1987 and 1989 indicators, see ED 294 746 and ED 316 444.
AVAILABLE FROM Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402 (Stock No. 038-000-00587-1).
PUB TYPE Reports - Evaluative/Feasibility (142)

EDRS PRICE MF03/PC24 Plus Postage.
DESCRIPTORS *Employment Opportunities; Engineering Education; Faculty Publishing; *Financial Support; Foreign Countries; Government Role; Higher Education; *International Communication; Mathematics Achievement; Mathematics Curriculum; Mathematics Education; Mathematics Teachers; Overseas Employment; Patents; *Public Opinion; Research; *Research and Development; Science Curriculum; Science Education; Science Teachers; Secondary Education; State Aid; Student Characteristics; *Technology
IDENTIFIERS *Science Achievement

ABSTRACT

This report is designed to provide public and private policymakers with a broad base of quantitative information about United States science and engineering research and education and about United States technology in a global context. This document begins with a synopsis of United States science and technology. Chapter 1, "Precollege Science and Mathematics Education," discusses student's achievement, interest, and coursework, school and curriculum, teachers and teaching, and the policy context. Chapter 2, "Higher Education in Science and Engineering (S&E)," discusses the characteristics of higher education institutions, the undergraduate and graduate S&E student populations, major sources of financial support, and international science and engineering education. Chapter 3, "Science and Engineering Workforce," describes industrial S&E job patterns, demographic trends of recent S&E graduates and doctorate recipients, the supply and demand outlook for S&E personnel, and international employment of scientists and engineers. Chapter 4, "Financial Resources for Research and Development (R&D)," discusses national R&D spending patterns, federal support for R&D, state-based R&D expenditures, and international comparisons. Chapter 5, "Academic Research and Development: Financial Resources, Personnel, and Outputs," describes the financial resources for academic R&D, the doctoral scientists and engineers active in academic R&D, and outputs of academic R&D for scientific publications and patents. Chapter 6, "Technology and Global Competitiveness," describes the global markets for U.S. technology, industrial R&D, patented inventions, diffusion of technology in the industrial sector, small business and high technology, and technologies for future competitiveness. Chapter 7, "Attitudes Toward Science and Technology (S&T): The United States and International Comparisons," includes discussions on U.S. public attitudes toward S&T and international comparisons of attitudes toward S&T. Almost two-thirds of the document is composed of four appendixes which contain data tables, a list of contributions and reviewers, abbreviations, and an index. (KR)

# SCIENCE & ENGINEERING INDICATORS

## 1991
TENTH EDITION

NATIONAL SCIENCE BOARD

# National Science Board



### National Science Board Subcommittee on *Science and Engineering Indicators – 1991*

# SCIENCE & ENGINEERING INDICATORS

## 1991
## TENTH EDITION

NATIONAL SCIENCE BOARD

## The Cover

Buckyballs—$C_{60}$ buckminsterfullerene—as seen in selected snapshots from *quantum molecular dynamics* simulations of changes to the atomic structure of the molecule as it is heated from zero to 2000 degrees kelvin.

Buckyballs are new forms of carbon that open exciting new areas for experimental and theoretical investigations. The molecule holds promise for new superconducting materials and may someday be used to make new lubricants, batteries and high-strength polymers.

The computational method used to create the image reproduced above, called *quantum molecular dynamics*, takes advantage of the tremendous calculating power available only through state-of-the-art supercomputers. The soccerball-shaped image in the center of the above photograph shows the electron distribution of the molecule at one thousand degrees kelvin, with grey, green and orange denoting regions of successively greater electron density.

The ball and stick images spiraling outward from the central image show the changing atomic arrangements as the molecule is heated to 2000 degrees kelvin, with longer bonds appearing in yellow and the shorter ones in red. These calculations show that $C_{60}$ is stable at very high temperatures, despite undergoing substantial shape-distorting soccerball-football oscillations.

## The Image

The simulations were accomplished at the North Carolina Supercomputing Center. The *quantum molecular dynamics* code used to create the image runs at an average speed of over 200 MFLOPS on one Cray Y-MP processor. The graphics rendering of the picture was carried out on a Silicon Graphics 4D/280 GTX, using Wavefront and custom software. Work was done by T. Palmer, Cray Research, NC Supercomputing Center; J. Bernholc, Q.-M. Zhang, J.-Y. Yi, C. Brabec, NC State University. Further details are available in Q.-M. Zhang, J.-Y. Yi, and J. Bernholc, *Physical Review Letters* 66, 2633 (1991).

## Recommended Citation

National Science Board, *Science & Engineering Indicators – 1991*. Washington, DC: U.S. Government Printing Office, 1991. (NSB 91-1)

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402
Stock Number 038-000-00587-1

# Letter of Transmittal

December 1, 1991

My Dear Mr. President:

In accordance with Sec. 4(j) (1) of the National Science Foundation Act of 1950, as amended, it is my honor to transmit to you, and through you to the Congress, the tenth in the series of biennial Science Indicators reports—*Science & Engineering Indicators – 1991.*

These reports are designed to provide public and private policymakers with a broad base of quantitative information about U.S. science and engineering research and education and about U.S. technology in a global context.

U.S. Government and industry have led the world in recognizing the importance of science and technology for achieving national objectives. Their support for research and development (R&D), and especially basic research, is reflected in the data in these pages. But priorities and programs must be constantly redefined and reshaped to adapt to rapidly changing global economic, political, and social conditions. This report pulls together in a convenient format much of the data about science and technology pertinent to these decisionmaking processes.

The coverage is broad. U.S. and comparative foreign trends are tracked in precollege and college-level science, mathematics, and engineering education; scientists and engineers in the labor force; support and performance of research and development, with special detail on academic R&D; technological innovation and the international competitiveness of U.S. technology; and public attitudes toward, and knowledge about, science and technology.

Mr. President, the National Science Board is proud to call your attention to the fact that this tenth edition of the biennial Indicators marks 20 years since the Board initiated the report. It is widely used around the world for policymaking as well as serving as a model for national science policy data compilations. My National Science Board colleagues and I hope that your Administration and the Congress will continue to find this report useful as you seek solutions to our national problems.

Respectfully yours,

James J. Duderstadt
Chairman, National Science Board

The Honorable
The President of the United States
The White House
Washington, DC 20500

# Contents

# Introduction

## Twenty Years of Indicators

The publication of the 10th biennial volume in the *Science & Engineering Indicators* series signals the completion of 20 years of activity in the area. It is a time for celebration as well as a time for assessing the achievements and shortcomings of the activity. The anniversary also provides an opportunity for appraising the uses of the volumes in assisting the process of science and technology (S&T) policy formulation.

As the principal patron of *Indicators*, the U.S. Congress has already begun such an appraisal with the publication by its Office of Technology Assessment of *Federally Funded Research: Decisions for a Decade* (OTA-SET-490, Washington, DC: May 1991). The report contains a discussion of the *Indicators* volumes and adjudges them to be, "the most comprehensive look at the research system that is currently available" (p. 236). Critiques of the approaches taken in the *Indicators* volumes are noted and discussed. The authors further propose a variety of new indicators ranging from technology measures to fine detail indicators of the flow of research proposals and awards to Federal agencies.

## Globalization of Indicators

The U.S. *Indicators* volumes, as they evolved during the 1970s, served as a model for the rapid growth of *Indicators*-type reports around the world during the 1980s. Governments have increasingly come to see science and technology policy as a key ingredient in their strategies for development and economic competitiveness. As a result, there is a strong movement toward the globalization of S&T indicators involving the development of truly comparable measures of S&T functions in different countries. The Organisation for Economic Cooperation and Development (OECD) has long been a forum for the creation of such comparative indicators, and now the European Community is moving decisively into the creation of data systems for assessment and evaluation of science and technology among its 12 member nations. Finally, the rapidly developing economic powers of the Asia and Pacific region are making efforts to construct comparable measures of their S&T activities. A working group of the newly formed Pacific Economic Cooperation Council (PECC) is dedicated to this activity.

## What Is New in This Volume

*Science & Engineering Indicators – 1991* continues to consolidate and work out the changes in structure introduced in the 1987 edition:

- In keeping with the policy pre-eminence of school science and mathematics education, the chapter on this topic has been expanded. Especially important are new national data on levels of performance of U.S. minority schoolchildren of different ages on science and mathematics performance tests.
- In the higher education chapter, there are new materials on time to degree as well as new international comparative data on S&E degrees.
- The overall picture of financial support of R&D is complemented by an exploration of changes in inter- and intra-sectoral cooperative R&D linkages. In addition, the section presents new information on state R&D expenditures.
- The formerly separate sections on industrial R&D and U.S. technology in a global context were combined for this volume. New analyses have been conducted on patent data as well as in the area of small high-technology business.
- In keeping with the theme of globalization of indicators, analyses of public attitudes toward, and public knowledge of, science and technology are presented with comparative data from 15 countries.

# Acknowledgments

The National Science Board extends its appreciation to the staff of the National Science Foundation for preparing this report.

Organizational responsibility for the volume was assigned to the Directorate for Scientific, Technological, and International Affairs (STIA), Kurt G. Sandved, Acting Assistant Director. Gerard R. Glaser, Executive Officer, STIA, coordinated production and review of the document. The Directorate for Education and Human Resources (EHR), Luther S. Williams, Assistant Director, was assigned responsibility for the manuscript of one chapter.

Primary responsibility for the production of the volume within STIA was assigned to the Indicators Program, under the direction of Carlos Kruytbosch and Jennifer S. Bond of the Division of Science Resources Studies (SRS), Kenneth M. Brown, Director. Other units with major responsibilities for portions of the report were the Division of Policy Research and Analysis (PRA) in STIA, Peter W. House, Director, and the Office of Studies and Program Assessment (OSPA) in EHR, Kenneth J. Travers, Director.

The manuscript was written primarily by NSF staff:

| | |
|---|---|
| Overview: | Carlos Kruytbosch, SRS |
| Chapter 1: | Richard M. Berry, consultant, under the direction of Larry Suter, OSPA |
| Chapter 2: | Melissa J. Lane, PRA, with contributions from Jean M. Johnson, SRS, and Myles G. Boylan, PRA |
| Chapter 3: | R. Keith Wilkinson, SRS, with contributions from John Tsapogas, SRS, and Robert Dauffenbach, consultant |
| Chapter 4: | John E. Jankowski, Jr., SRS |
| Chapter 5: | Rolf F. Lehming, PRA, and Alan I. Rapoport, PRA |
| Chapter 6: | Lawrence M. Rausch, SRS |
| Chapter 7: | Lawrence Burton, SRS |

Lawrence M. Rausch, SRS, directed the physical production of the volume. Deborah A. Collins, SRS, made statistical contributions, and Vellamo Lahti, SRS, provided secretarial support.

Overall editing of the report was performed by Nita Congress, consultant. Patricia Hughes and Pat Bryant of the NSF Printing Services Branch were responsible for the desktop publishing and printing process.

# Overview of U.S. Science and Technology

## CONTENTS

# Overview of U.S. Science and Technology

## SYNOPSIS

The extraordinary, and continuing, global political and economic changes of the past half decade are forcing fundamental reassessments of policy in many areas of public endeavor. Science and technology (S&T) policy is no exception. Patterns of resource allocation—for example, to civilian and military research, to basic and applied research and development, etc.—that made sense under earlier political and economic conditions now appear inappropriate. Because decisionmakers are still groping toward new policy formulations, the impact of these changes are, by and large, still too recent to be clearly reflected in S&T indicators. Nevertheless, some trends *are* apparent; these are outlined below.

### Expenditures for Research and Development

In the United States the twin engines that powered the rapid growth of research and development (R&D) from the mid-1970s to the late 1980s have been decelerating—the economy has been in a recession, and the evaporation of the cold war has reduced the urgency for military R&D spending. The average annual increase in total U.S. R&D expenditures between 1985 and 1991 (in constant dollars) was 1.2 percent, compared with an annual growth rate of 6.9 percent from 1980 to 1985. The most recent estimates on change from 1989 to 1991 also show declining R&D expenditures.

Current estimates for *development* expenditures exhibit the sharpest downturn—a negative trend in constant dollars since 1988. The estimated trend in *applied research*, too, has been negative since 1989. The Federal Government is estimated to have reduced its R&D expenditures significantly from 1989 to 1991; estimates for U.S. industry R&D expenditures remained level during this period.

Only expenditures for *basic research* have continued to grow, albeit at a declining rate. The most recent estimate is for a 2.7-percent increase from 1990 to 1991. The statistics for expenditures for academic R&D also show continuing slow growth.

Internationally, total U.S. R&D expenditures continue to exceed those of its four closest industrial competitors combined, despite the fact that two of these countries (West Germany and Japan) outpace the United States in terms of R&D expenditures as a percentage of gross national product (GNP). However, as of 1989, these four countries together (the two named above plus the United Kingdom and France) spent 12 percent more than the United States on total nondefense-related R&D activities.

### U.S. Technological Innovation

The United States has seen further slow erosion of its shares in global markets for high-technology goods. For example, in 1988 the United States supplied 37 percent of the world's high-tech products, slightly down from 40 percent in 1980. Although the country continues to maintain a trade surplus in high-tech goods, its 1988 balance was half the size its 1980 balance.

A more positive trend in the area of technological innovation is the upturn in patenting by U.S. inventors between 1983 and 1989.

Lastly in this area, an incipient trend worth watching is a possible tendency for U.S. corporations to spend an increasing portion of their corporate R&D funds at facilities abroad.

### Academic R&D

Although academic R&D continued to grow during the late 1980s, it was at a slower rate than during the first half of the decade. Major investments were made during the decade in *research instrumentation* (with support coming primarily from Federal agencies) and the construction and refurbishment of *research facilities* (supported primarily by the institutions themselves). However, financial problems loom for research universities as the recession hits both state budgets and the various sources of income for private institutions, and as pressures mount for lower indirect cost reimbursement rates on Federal research grants and contracts.

### Science and Engineering Personnel

The U.S. science and engineering (S&E) workforce extended its long growth trend through 1989 at an annual rate of approximately 4 percent. Expansion of S&E employment continued at a faster rate in nonmanufacturing jobs (primarily in the services sector) than in manufacturing jobs. The proportion of S&E jobs within the nonmanufacturing sector increased from 1.2 percent in 1980 to 1.7 percent in 1989; this rise translated into a nearly 50-percent increase in S&E job opportunities in this sector during the decade. The increase in the S&E share of manufacturing jobs was also sizable—from 3.7 percent in 1980 to 5.1 percent in 1989—despite a decrease in total manufacturing jobs.

Adequacy of the supply of new scientists and engineers during the 1990s continued to prompt concern, especially in light of relatively unfavorable demographic factors. Indicators of supply and demand examined here suggest relative stability in S&E labor markets during the 1990s: lower demographic growth will be matched by generally slower economic growth. Within this framework, however, it can be expected that rapid technological change will almost certainly generate spot shortages and surpluses in specific areas.

### Precollege Science and Mathematics Education

Concerns also continued to be raised about the quality (and quantity) of U.S. science and mathematics education and the attractiveness of S&E careers to U.S. citizens. In international comparative achievement tests in science and mathematics, U.S. boys and girls score lower than their peers in many other countries. An exploratory study suggests that U.S. grade schoolers receive significantly less exposure to mathematics and science instruction in early years than do their peers in Japan and Taiwan.

### Higher Education for Scientists and Engineers

Undergraduate S&E degrees continue their long, gradual decline as a share of all degrees. Data on the plans of freshmen entering college in 1989 and 1990 suggest, however, that degrees in the natural sciences, engineering, and computer sciences may be bottoming out and might begin to increase in the early 1990s.

Meanwhile, the proportions of *foreign citizens* enrolled in U.S. natural science, mathematics, computer science, and engineering graduate programs and receiving S&E doctoral degrees continue to increase apace. In 1990 foreign citizens accounted for about one in four graduate students in these fields and for one in three doctoral degree awards in these fields.

### Public Perceptions of Science and Technology

As measured in the National Science Foundation's biennial survey of U.S. public perceptions of science and technology matters, U.S. adults remain strongly supportive of the scientific enterprise in general and of Federal support for basic research in particular—"even if it brings no immediate benefits." The public did, however, express increased concern about the use of animals in research.

U.S. adults exhibited mounting concern about the quality of science and mathematics education in U.S. schools. There was a significant increase between 1985 (60 percent) and 1990 (71 percent) in the proportions who felt that too little was being spent on education in the United States.

Comparative data from the United States, Canada, and the 12 countries of the European Community on public knowledge about S&T show strikingly similar degrees of knowledge. These new comparative data also indicate that Americans and Canadians view science and technology more positively than do Western Europeans.

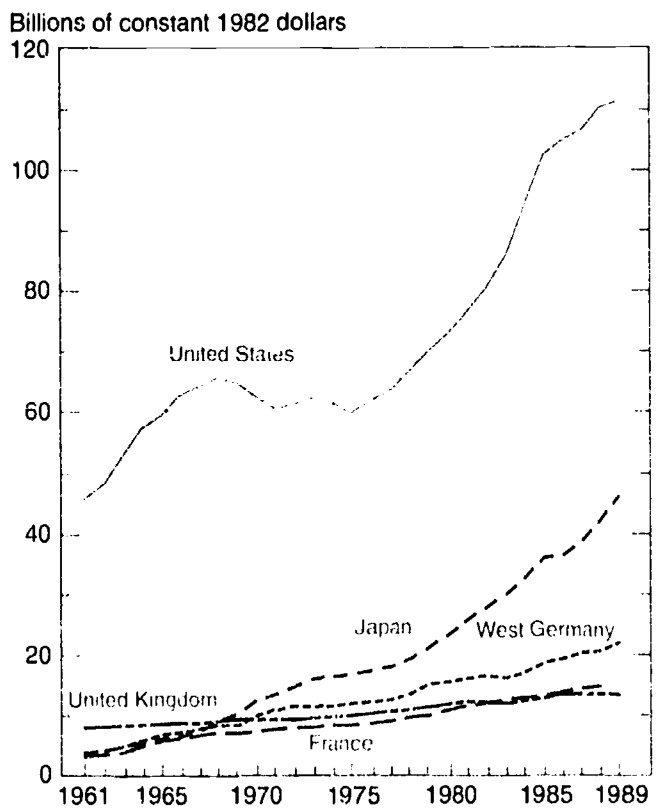
## U.S. R&D Expenditures in a Global Context

Total research and development (R&D) expenditures of the United States continue to exceed those of its four closest industrial competitors. (See figure O-1.) However, two of these countries, West Germany and Japan, continue to outpace the United States in terms of R&D expenditures as a percentage of gross national product (GNP). (See figure O-2.) Some other small industrial nations such as Sweden also outstrip the United States on this measure of relative national resources devoted to R&D.

In terms of economic competitiveness, a longstanding trend continued: the United States spent a significantly lower proportion of its GNP on nondefense R&D activities than did Japan and West Germany. (See figure O-2.) In 1989, Japan, West Germany, the United Kingdom, and France together spent 12 percent *more* than the United States on nondefense-related R&D activities. The bulk of this increase is attributable to rapid growth in Japanese nondefense R&D. (See figure O-3.)

R&D spending growth in the United States continued to slow. The average annual increase in total U.S. R&D expenditures between 1985 and 1991 was estimated at 1.2 percent in constant dollars. The annual growth rate from 1980 to 1985 was 6.9 percent. The sharpest downturn appears in the estimates for development expenditures—a negative trend, in constant dollars, between

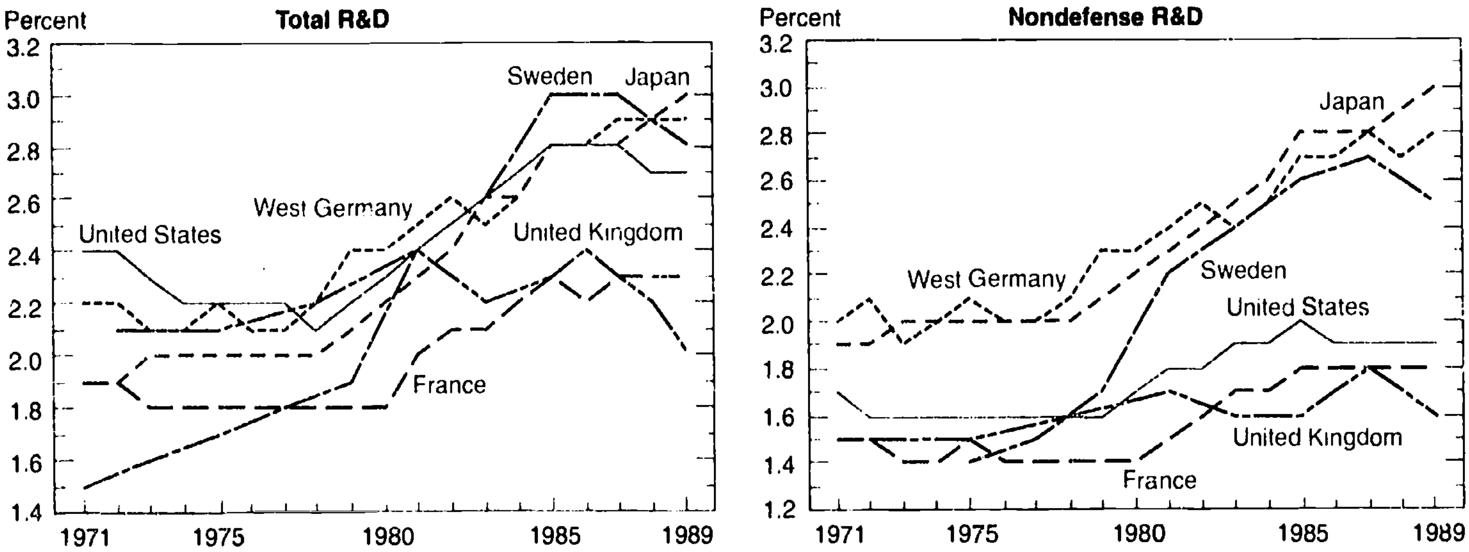
Figure O-1.
**R&D expenditures, by country**




See p. 107 and appendix table 4-26.

*Science & Engineering Indicators – 1991*

Figure O-2.
**R&D as a percentage of GNP, by country**



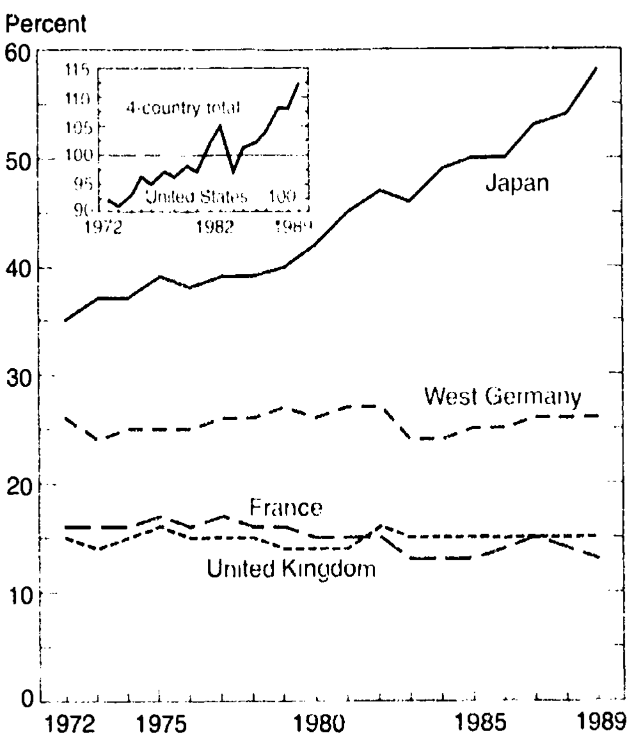

NOTE: Some data are estimates.
See p. 108 and appendix tables 4-26 and 4-27.

*Science & Engineering Indicators – 1991*

1988 and 1991. (See figure O-4.) A similar but less accentuated trend occurred in applied research expenditures. Only expenditures for basic research have continued to grow. This growth, though, has been at a declining rate: a 2.7-percent increase in basic research spending is estimated for 1990 to 1991. Because most academic R&D is basic research, the data also show a continuing slow growth of expenditures for academic R&D.

The decline in R&D growth stems from policy shifts in the two major sources of R&D funding—the Federal Government and U.S. corporations. Reduced Federal

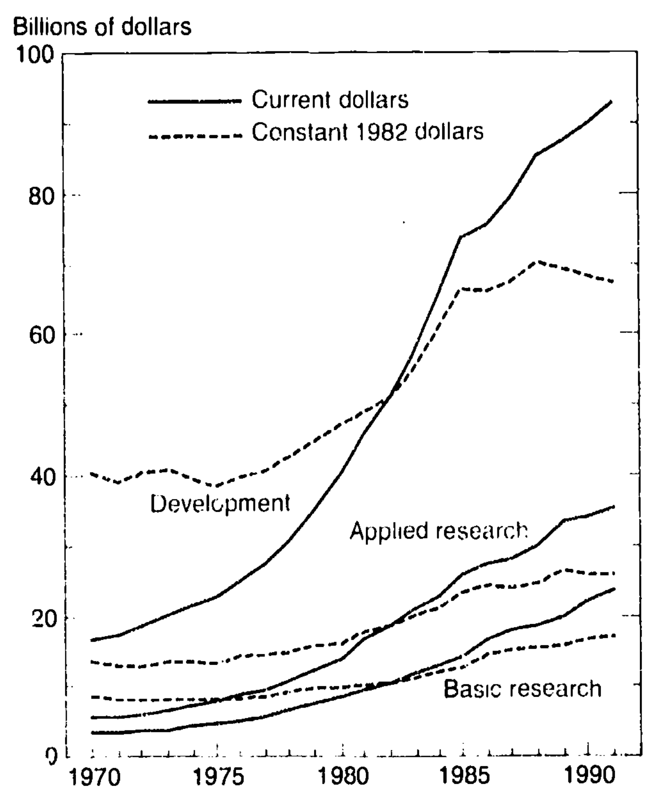
Figure O-3.
**Nondefense R&D: foreign spending as a percentage of U.S. spending**




NOTE: Some data are estimates.
See p. 109 and appendix table 4-27

*Science & Engineering Indicators – 1991*

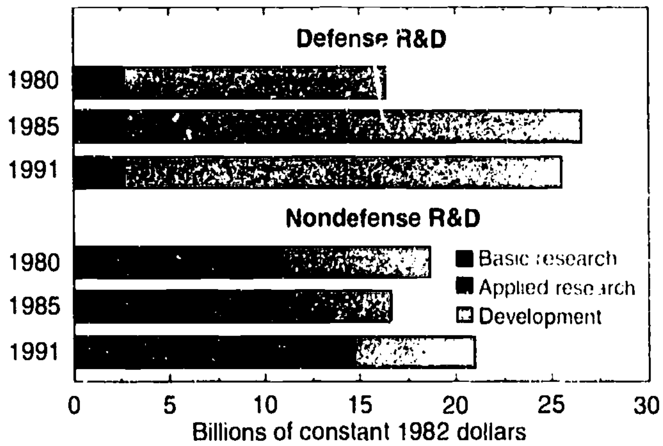
Figure O-4.
**U.S. R&D expenditures, by character of work**




NOTE: Data are preliminary for 1990 and estimated for 1991.
See p. 91 and appendix tables 4-4, 4-5, and 4-6.

*Science & Engineering Indicators – 1991*

Figure O-5.
**Relative changes in Federal obligations for defense and nondefense R&D, by character of work**




NOTE. Defense R&D equals the Department of Defense obligations for the designated year. Nondefense obligations include some defense-related obligations from the Department of Energy.

See p. 94 and appendix table 4-8.

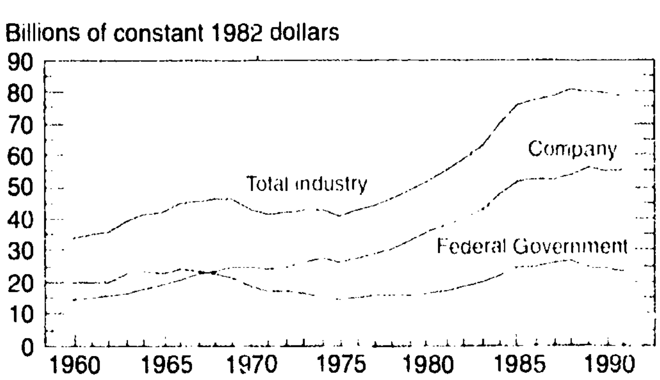
*Science & Engineering Indicators – 1991*

priorities for military R&D between 1985 and 1991 resulted in shrinking support for defense-related development work and increases in nondefense basic research. (See figure O-5.) Company-funded R&D, responding to the general economic slowdown, is estimated to have leveled off between 1989 and 1991. (See figure O-6.)

## Scientists and Engineers in the Workforce

The United States continued to lead the world of industrial market economies in nonacademic scientists and engineers per 10,000 people employed in the labor force. (See figure O-7.) The United States also led in the proportion of its science and engineering (S&E) labor force that is female.

Figure O-6.
**Expenditures for industrial R&D, by source of funds**

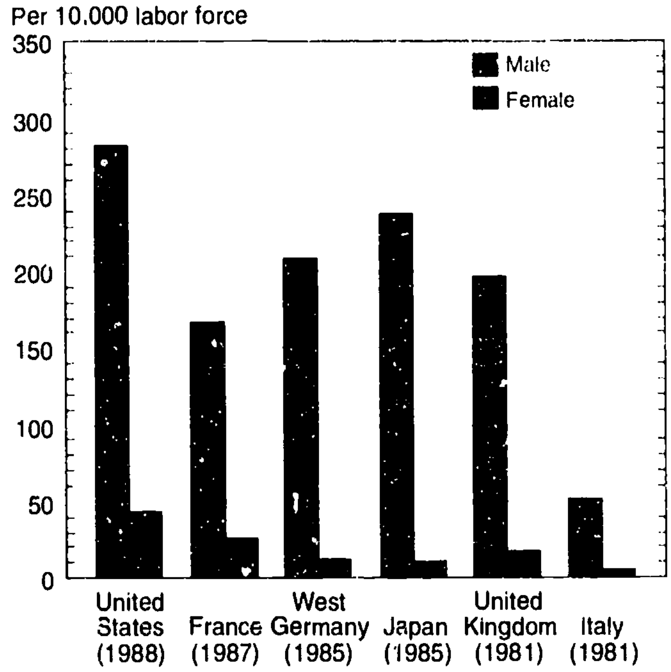



NOTE: Data are preliminary for 1990 and estimated for 1991.

See p. 91 and appendix table 4-2.

*Science & Engineering Indicators – 1991*

Figure O-7.
**Nonacademic scientists and engineers per 10,000 labor force, by country and gender**

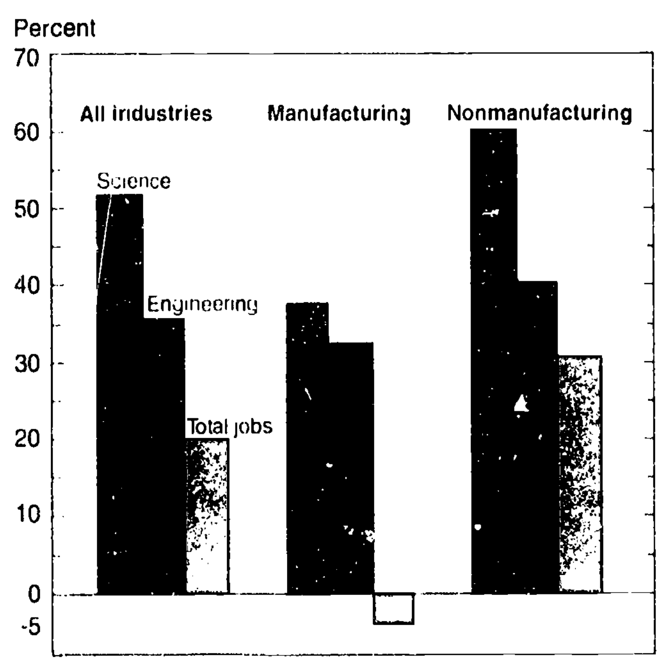



See p. 84 and appendix table 3-17.

*Science & Engineering Indicators – 1991*

The U.S. S&E workforce in private industry continued a long growth trend through 1989 at an annual rate of almost 4 percent. Expansion of industrial S&E employment continued at a faster rate in nonmanufacturing (primarily service) jobs than in manufacturing jobs. (See figure O-8.)

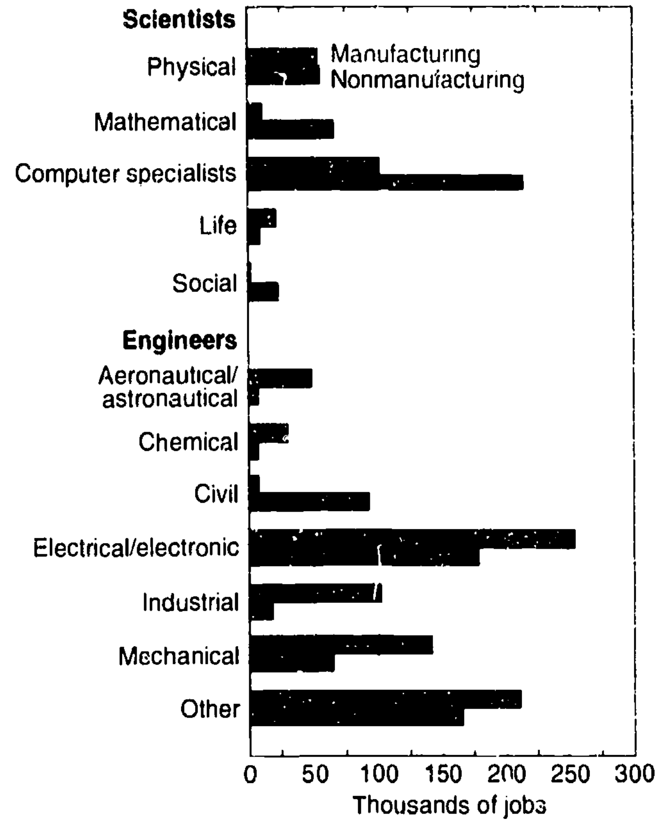
Figure O-8.
**Growth in science, engineering, and total jobs in private industry, by sector: 1980-89**




See p. 67 and appendix table 3-1.

*Science & Engineering Indicators – 1991*

Figure O-9.
**Private industry jobs in science and engineering, by occupation and sector: 1989**




See p. 70 nd appendix table 3-1.

*Science & Engineering Indicators – 1991*

The proportion of S&E jobs within the nonmanufacturing sector increased from 1.2 percent in 1980 to 1.7 percent in 1989, resulting in a nearly 50-percent increase in S&E job opportunities in this sector during the decade.

The increase in the S&E share of manufacturing jobs was also sizable—from 3.7 percent in 1980 to 5.1 percent in 1989, despite the overall decrease in total manufacturing jobs during the period. (See figure O-8.)

Employment patterns within U.S. private industry reveal strong twin tendencies (1) for scientists (except life scientists) to be employed in nonmanufacturing companies, and (2) for engineers (except civil engineers) to be employed in manufacturing enterprises (See figure O-9.)

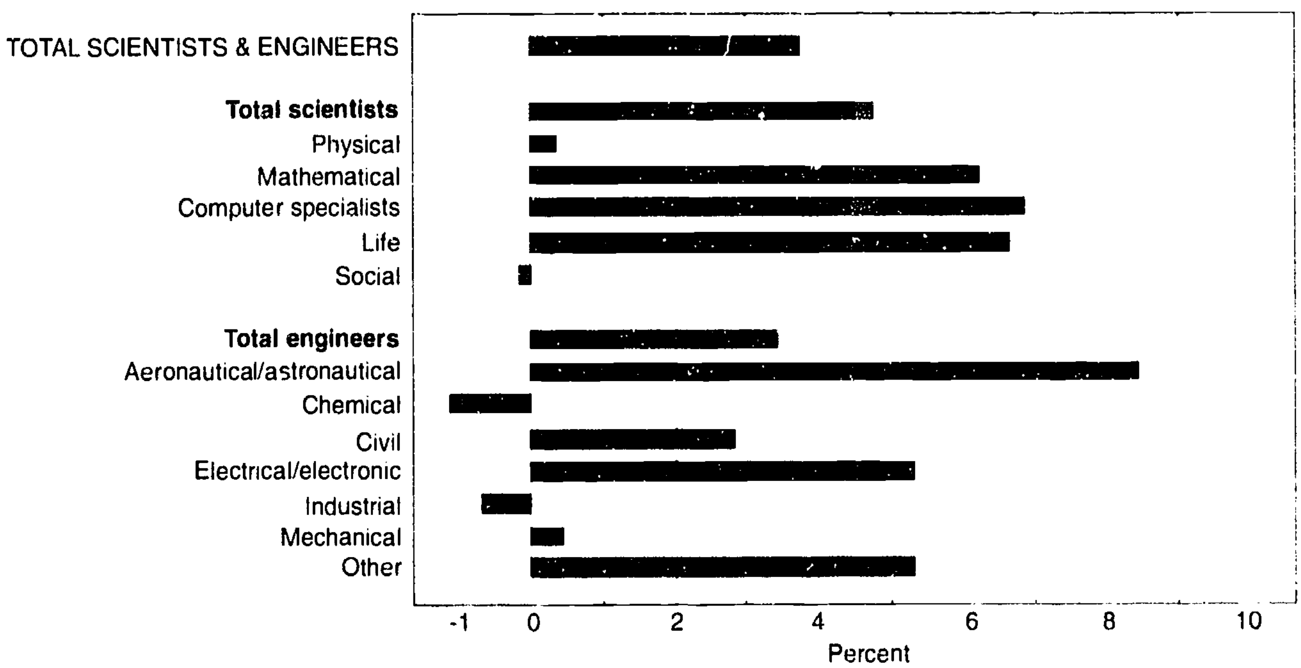
Scientific occupations—such as mathematical and life scientists and computer specialists—and engineering occupations—such as aeronautical/astronautical and electrical/electronic—grew at a faster rate than the average for all occupations. (See figure O-10.) Employment in physical science occupations grew less than 0.5 percent annually, while there was negative growth in social science and chemical and industrial engineering jobs.

A significant shift in the employment of U.S. doctoral scientists and engineers from 1977 to 1989 caused an increasing proportion of them to be employed in industry and a decreasing proportion to be employed in colleges and universities. (See figure O-11.)

## Precollege Education in Math and Science

The performance of U.S. schoolchildren on mathematics and science tests has been tracked for over 20

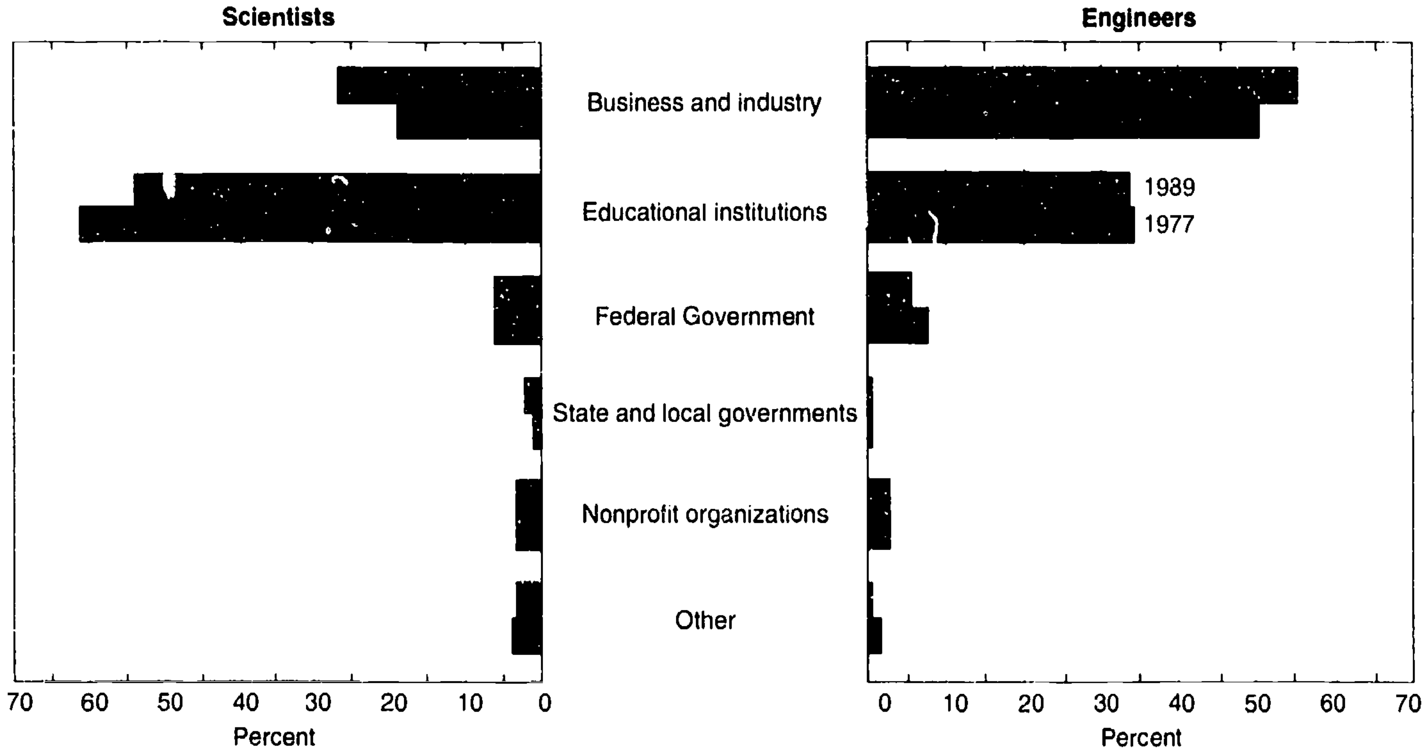
Figure O-10.
**Rate of job growth in private industry, by occupational specialty: 1980-89**




See p 70 and appendix table 3-1.

*Science & Engineering Indicators – 1991*

Figure O-11.
**Employed doctoral scientists and engineers, by sector of employment**



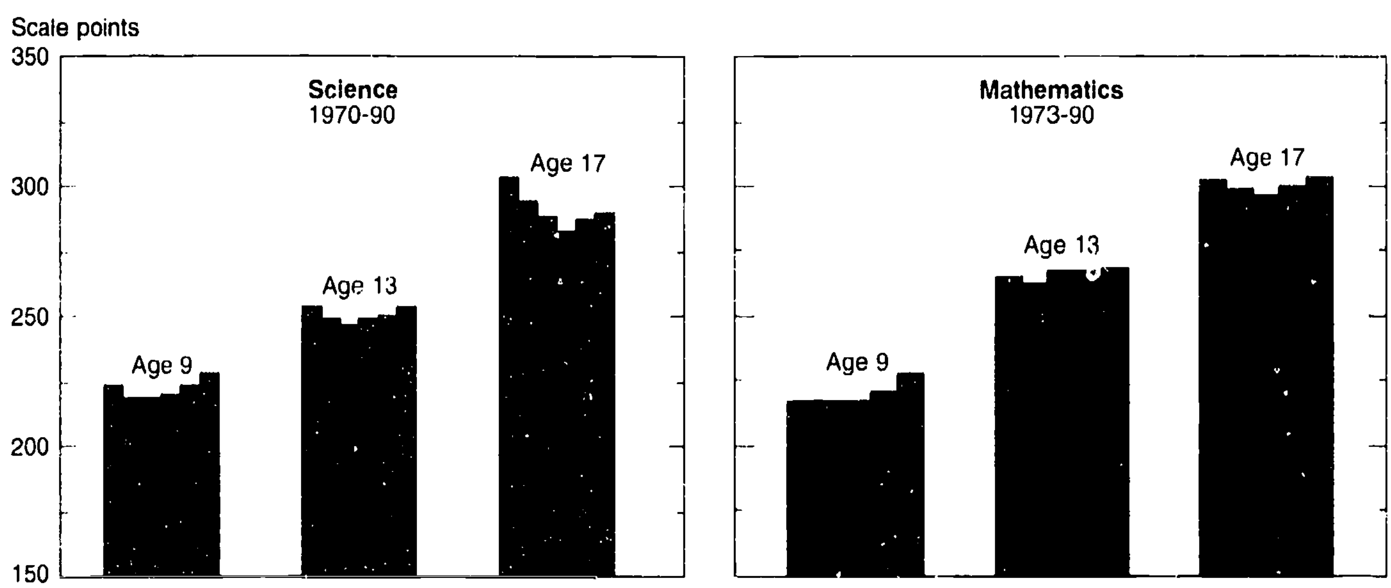

See p. 77 and appendix table 3-15.

Science & Engineering Indicators – 1991

years in the National Assessments of Educational Progress. The overall pattern in the two decades showed a decline in test scores during the 1970s, followed by recovery to the 1969 level by 1990. This pattern holds true for 9- and 13-year-old students in both mathematics and science. By 1990, 17-year-old students had regained their performance levels of 1973 in mathematics, but in science they remained below their achievement level in 1969. (See figure O-12.)

Minorities showed greater gains in test scores than did whites during the two decades. In science, black and Hispanic 9- and 13-year-old students showed gains

Figure O-12.
**Trends in average science and mathematics proficiency in the United States**

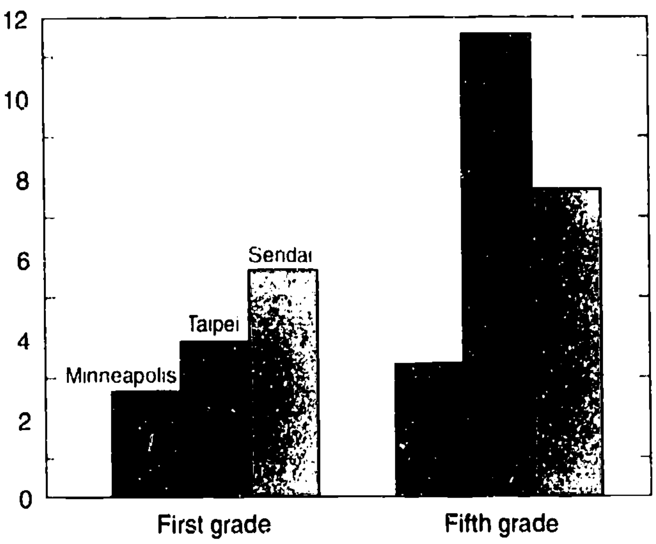



NOTE: Test years for science were 1970, 1973, 1977, 1982, 1986, and 1990. Test years for mathematics were 1973, 1978, 1982, 1986, and 1990.

See pp. 17-20 and appendix tables 1-1 and 1-4.

Science & Engineering Indicators – 1991

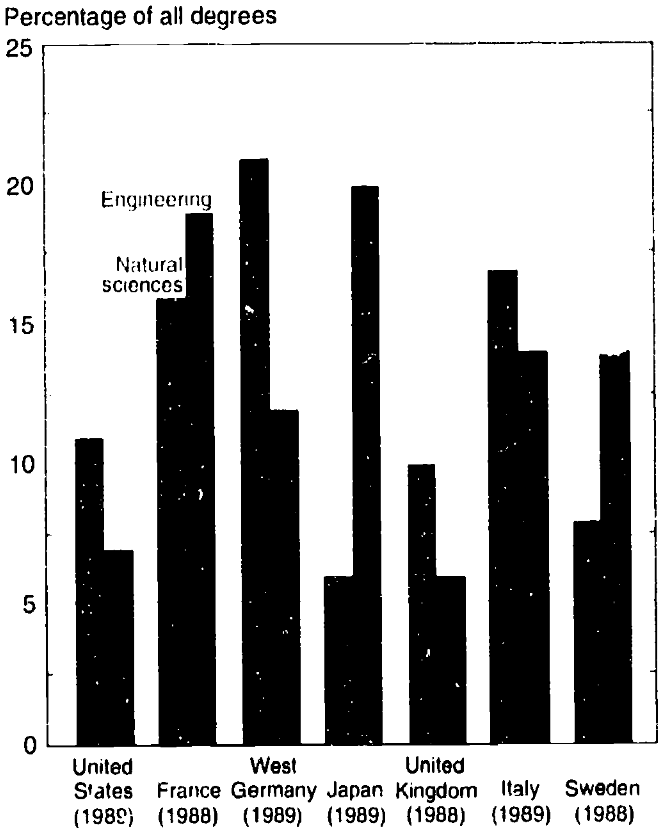
Figure O-13.
**Time spent on mathematics instruction**




See pp. 21-22. *Science & Engineering Indicators – 1991*

between 1970 and 1990, while 17-year-old minority students regained their earlier levels of achievement. In mathematics, Hispanic 9- and 13-year-olds made significant gains from 1978 to 1990, while all three age groups among blacks made gains during the period.

Figure O-14.
**First university degrees, by field for selected countries**




See p. 85 and appendix table 3-23.
*Science & Engineering Indicators – 1991*

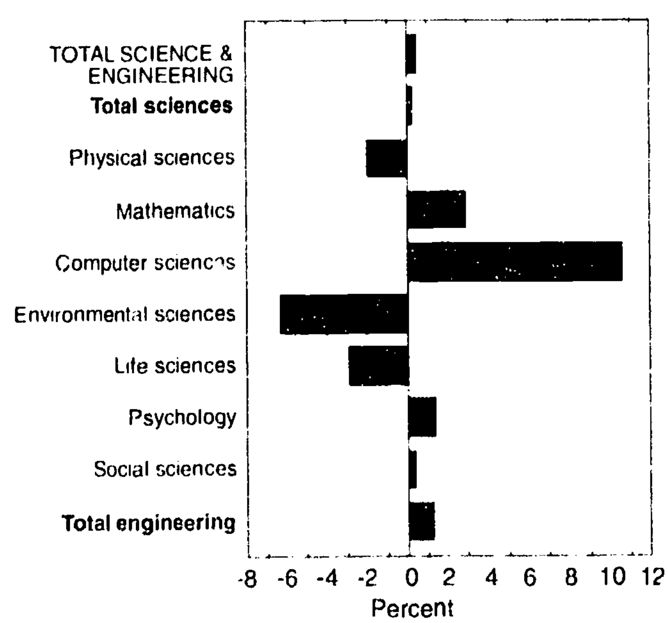
A new international comparative study of factors contributing to science and mathematics test performance sheds some light on findings reported in previous editions of *Science & Engineering Indicators* concerning the relatively poor performance of U.S. children on these international tests. Comparisons of first and fifth grade classroom time dedicated to mathematics in schools in Minneapolis, Sendai (Japan), and Taipei (Taiwan) showed that, on average, children in the two Asian cities spent over twice the amount of time on mathematics in the classroom as did Minneapolis children. (See figure O-13.) Other cultural and economic factors may also be affecting behavior, but degree of exposure to subject matter is an important variable.

## Higher Education in S&E

A seeming pervasive anomaly in the United States is the fact that it has the highest percentage of scientists and engineers in its labor force (see figure O-7), as well as practically the lowest (less than 20 percent) proportion among market economy countries of first university degrees in S&E fields. (See figure O-14.) The root of the situation lies in the magnitude of the U.S. higher education enterprise and the high proportion of young adults who participate in it.

There has been continuing concern over the long-term gradual decline in the choice of certain science majors by U.S. college students. (See figure O-15.) The growth in majors in the computer sciences and mathematics during the 1980-89 decade overshadows the decline in majors in the core physical and life sciences. However, data on the plans of freshmen entering college in 1989 and 1990 suggest that the level of degrees in the natural

Figure O-15.
**Annual change in science and engineering baccalaureates, by field: 1980-89**




See p. 51 and appendix table 2-7.
*Science & Engineering Indicators – 1991*

sciences, engineering, and computer sciences may be bottoming out and might begin to increase in the early 1990s. (See figure O-16.)

The decline in choice of S&E majors by U.S. undergraduate students has been accompanied by a rapid increase in the representation of non-U.S. citizens in S&E graduate enrollments and among S&E doctorate degree recipients. In 1989, about one-quarter of all S&E students enrolled in U.S. graduate S&E departments were non-U.S. citizens. Foreigners constituted about one-third of the graduate students enrolled in the physical sciences, mathematics, and engineering. (See figure O-17.) Among 1990 S&E doctorate recipients from U.S. universities, the foreign presence was even more marked—over one-third were non-U.S. citizens. In engineering, mathematics, and the computer sciences, the majority of Ph.D. degree recipients (over 55 percent) were non-U.S. citizens.

Figure O-16.
**Freshman choice of probable major**

| Probable major | 1982 | 1984 | 1986 | 1988 | 1990 |
|---|---|---|---|---|---|
| | Percent | | | | |
| Biological sciences | 3.7 | 4.2 | 3.9 | 3.7 | 3.7 |
| Engineering | 12.6 | 11.0 | 10.9 | 9.5 | 9.6 |
| Physical sciences[1] | 2.5 | 2.6 | 2.4 | 2.1 | 2.4 |
| Social sciences | 5.8 | 6.7 | 8.0 | 9.5 | 9.6 |
| Computer sciences | 4.4 | 3.4 | 1.9 | 1.7 | 1.7 |
| Business | 24.2 | 26.4 | 26.9 | 25.6 | 21.1 |
| Education | 6.0 | 6.5 | 8.1 | 9.3 | 9.9 |
| Arts and humanities | 8.2 | 7.7 | 9.0 | 9.3 | 8.9 |
| One of the professions | 13.3 | 14.1 | 11.7 | 12.2 | 15.2 |

[1]Includes mathematics.

SOURCE: Cooperative Institutional Research Program, University of California at Los Angeles. *The American Freshman: National Norms* (Los Angeles: Graduate School of Education, UCLA, ongoing annual series).

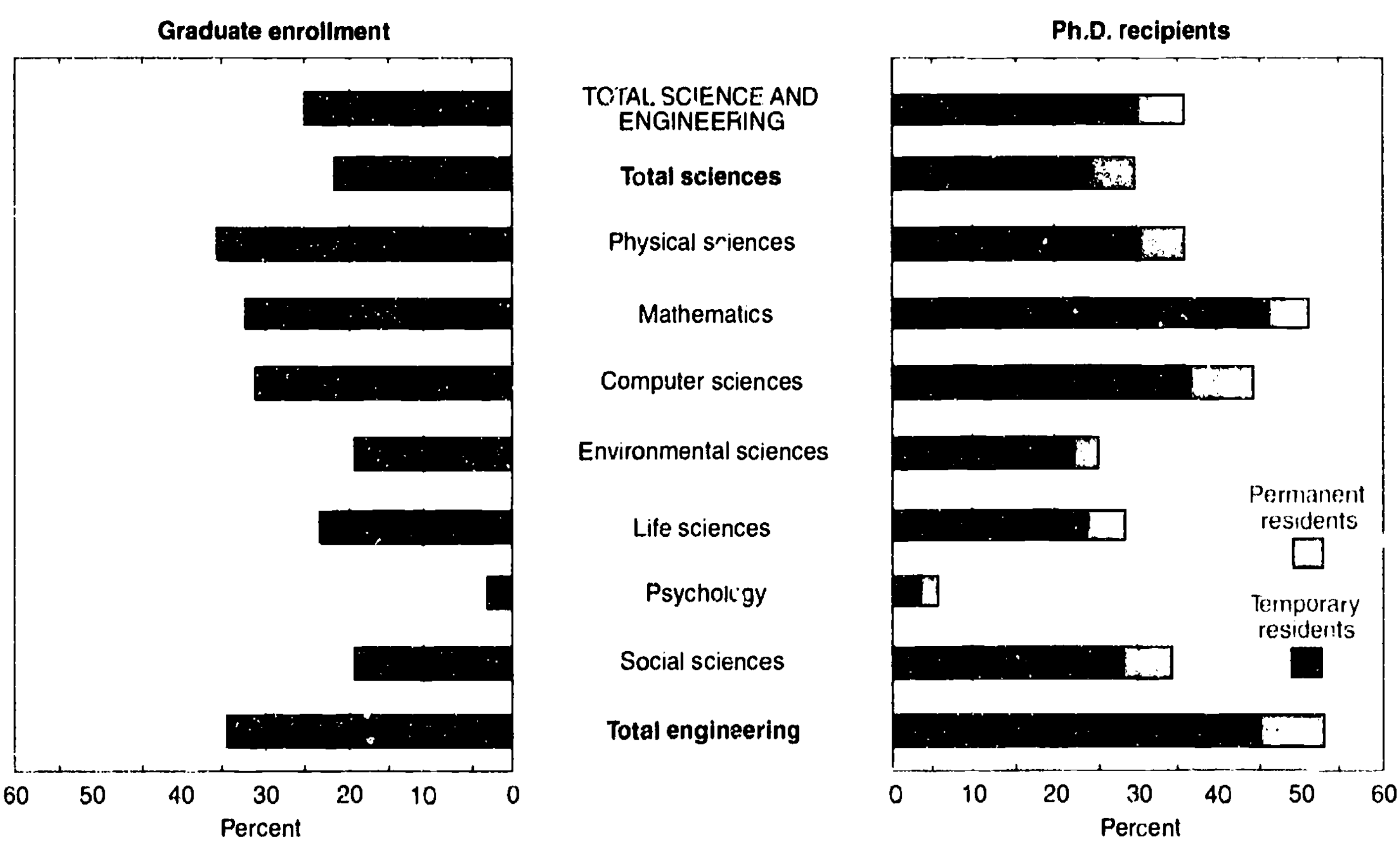
*Science & Engineering Indicators – 1991*

## Research Outputs and Academic Research

The percentage distribution of world scientific publications by country shows that U.S.-based authors produce slightly over one-third of all publications. (See figure O-18.) This proportion has changed little over the last two decades. Japan and Canada have made small and possibly significant increases in their shares of world literature. A new tabulation shows the world share of the European Community countries to be slightly more than one-quarter.

The bulk of world scientific publications are written in universities, and U.S. universities have been able to maintain a modicum of growth in their research expenditures in recent years despite the overall slowdown in

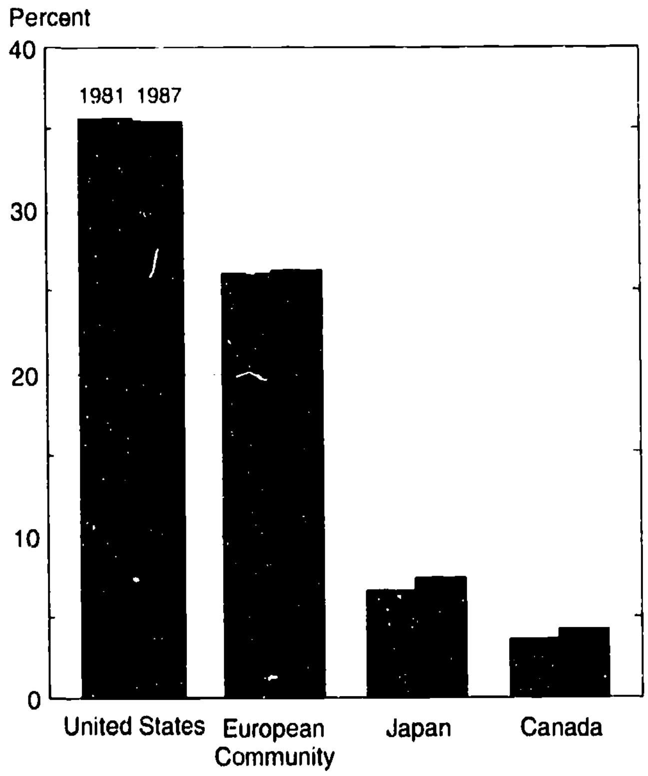
Figure O-17.
**Foreign citizen representation in 1990 U.S. science and engineering graduate education**




See p. 58 and appendix tables 2-23 and 2-24.

*Science & Engineering Indicators – 1991*

Figure O-18.
**Contributions of selected countries/regions to world literature**




See p. 130 and appendix table 5-27.
*Science & Engineering Indicators – 1991*

research funding. From 1985 to 1991, the annual rate of increase of academic R&D expenditures was 6.3 percent, but between 1990 and 1991 this rate shrank to 2.9 percent. (See appendix table 4-3.)

The past decade has seen a significant decline in the share of Federal funds for academic R&D—from roughly 65 percent in 1980 to close to 55 percent in 1991. (See figure O-19.) There have been corresponding percentage increases from several non-Federal sources including academic institutions themselves, industry, and state and local governments.

Non-Federal sources have also provided the lion's share of the decade-long increase in academic investments in R&D facilities construction and refurbishment. (See figure O-20.)

## Technological Innovation and Global Markets

Patenting is admittedly an imperfect indicator of technological innovation, yet it does provide a sense of the trends in innovative activities. From about 1978 to 1988, foreign-owned patents gradually increased their share of total U.S. patents—accounting for nearly half of all patents granted in 1988. Between 1988 and 1989, however, patents granted to U.S. inventors increased faster than did foreign-owned patent grants. (See figure O-21.) Japanese-owned patents continued to grow faster than those owned by any other industrial nation; Japanese inventors received just over 20 percent of all new U.S. patent awards in 1989.

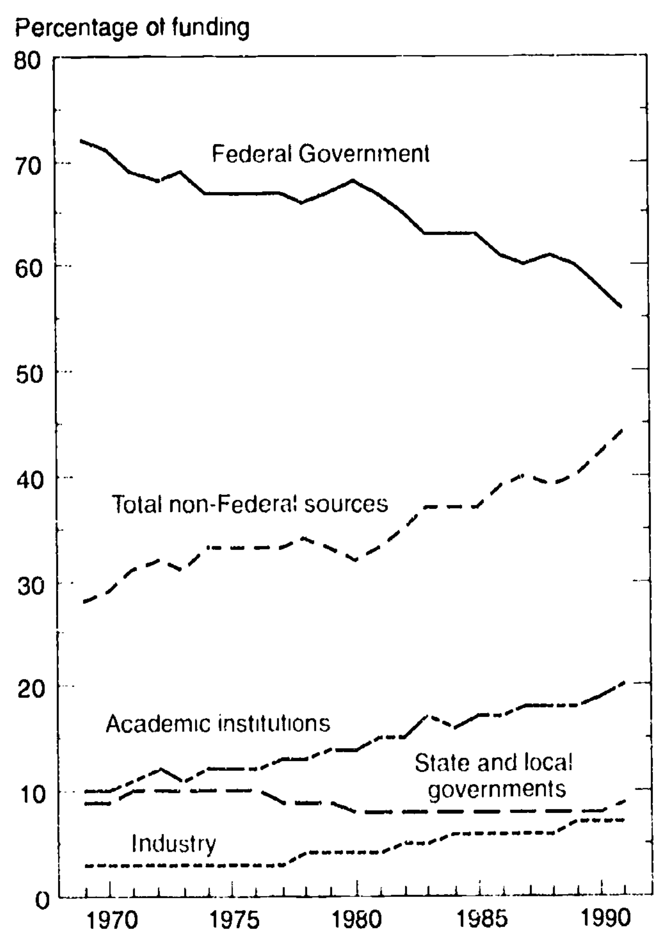
The strength of Japanese high-technology industry is also reflected in data on country shares of global markets for high-tech goods. Between 1980 and 1988, Japan increased its share of the global high-tech market from about 18 percent to nearly 27 percent. The United States and the European Community each lost about 4 percentage points of their respective global market shares in the same period. (See figure O-22.)

Trade balances in high-technology goods provide another indicator of economic strength in various areas. The overall pattern of trade balances between 1980 and 1988 mirrors the findings on country shares—the Japanese have tripled their positive trade balances, while the United States and the principal European countries have greatly reduced their positive balances. France, in fact, showed a negative balance for 1988. (See figure O-23.)

## Public Attitudes on Science and Technology

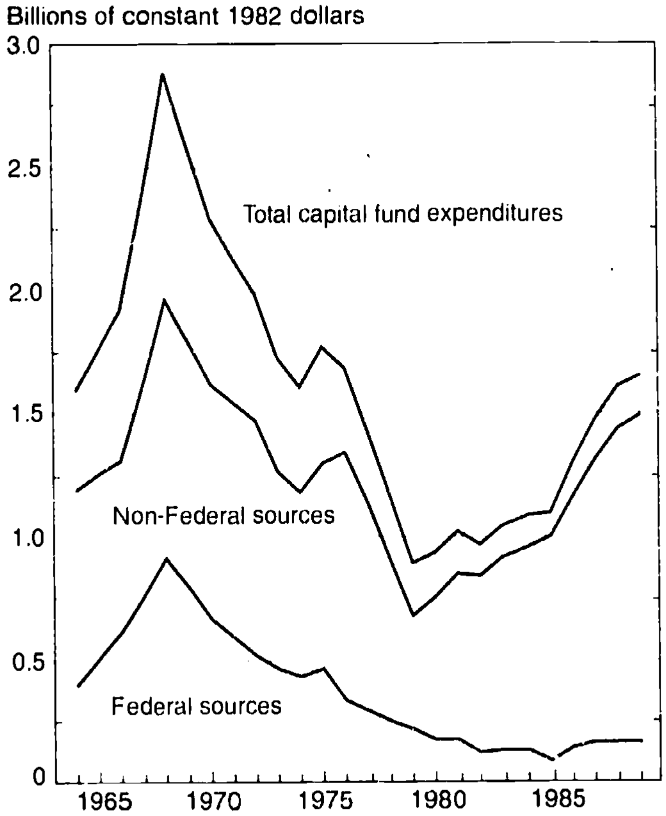
The U.S. public continues to give overwhelming approval to Federal support for basic research, "even if it

Figure O-19.
**Sources of academic R&D funding, by sector**



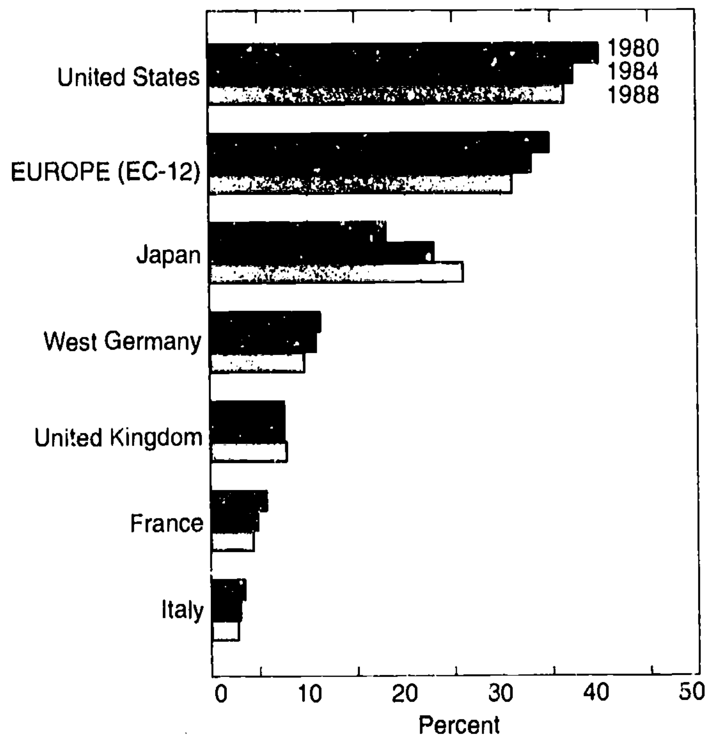

NOTE: Data for 1990 and 1991 are estimates
See p. 117 and appendix table 5-2.
*Science & Engineering Indicators – 1991*

Figure O-20.
**Federal and non-Federal capital fund expenditures for academic science and engineering**



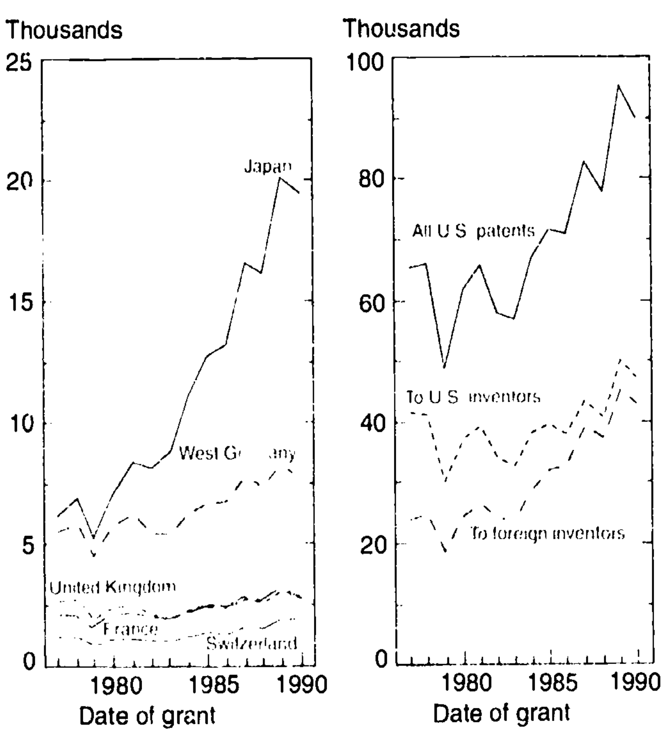

See p. 122 and appendix table 5-10.
*Science & Engineering Indicators – 1991*

Figure O-22.
**Share of global high-tech markets, by country**



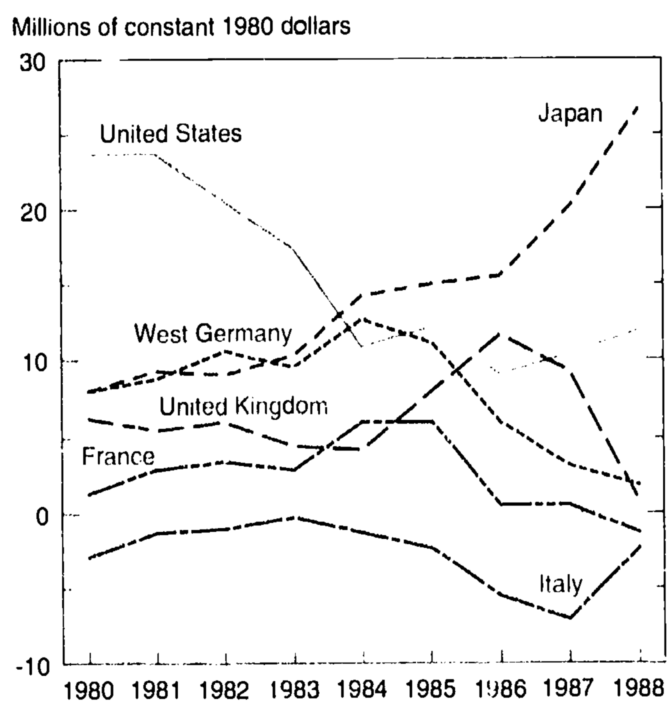

See p 137 and appendix table 6-3.
*Science & Engineering Indicators – 1991*

Figure O-21.
**U.S. patents granted to foreign inventors, by nationality of inventor**




See pp. 147-49 and appendix table 6-21.
*Science & Engineering Indicators –1991*

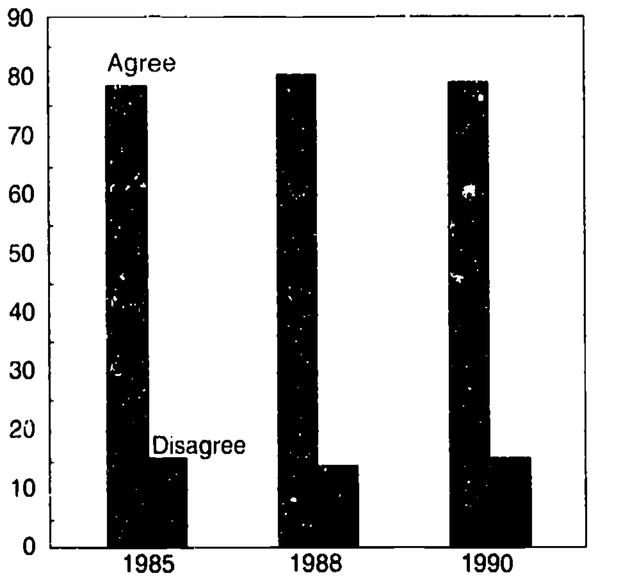
Figure O-23.
**Trade balances for high-tech industries in selected countries**




See p. 140 and appendix table 6-8.
*Science & Engineering Indicators – 1991*

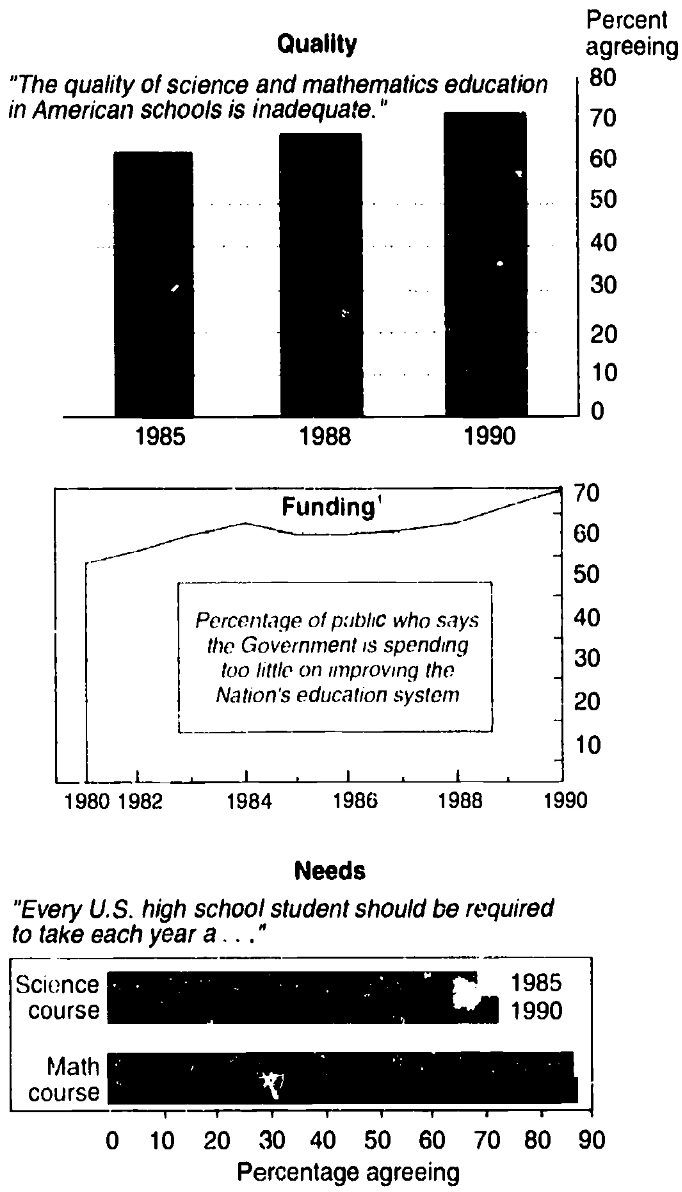
Figure O-24.
**Federal funding of basic research**

*"Even if it brings no immediate benefits, scientific research which advances the frontiers of knowledge is necessary and should be supported by the Federal Government."*




See p. 177 and appendix table 7-7.
*Science & Engineering Indicators -- 1991*

Figure O-25.
**Public attitudes toward education**




[1]Survey was not conducted in 1981.

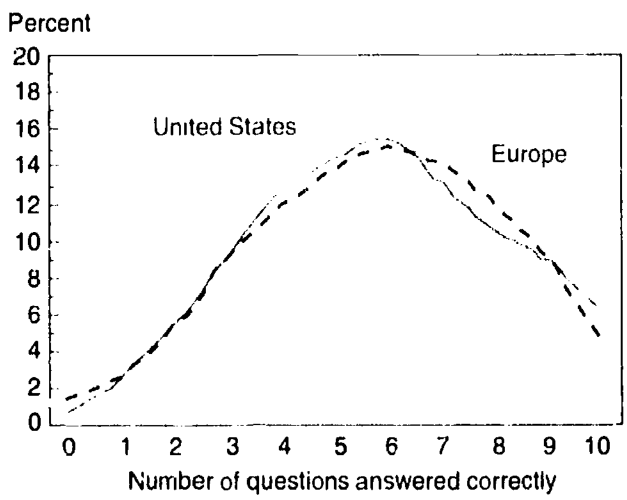
See pp. 179-80 and appendix tables 7-7 and 7-14.
*Science & Engineering Indicators – 1991*

three national U.S. surveys in 1985, 1988, and 1990 are remarkably stable. (See figure O-24.)

The U.S. public does, however, express an increasing concern with the quality of U.S. science and mathematics education in the schools. (See figure O-25.) The public increasingly believes the quality to be inadequate and feels that high school students should be required to take a science course every year. In a five-survey sequence from 1981 to 1990, there was a more than 15-percentage point increase in the proportion of the public that says the Government is spending too little on improving education.

The rapidly growing field of international comparative surveys of public attitudes toward, and knowledge about, science and technology is beginning to yield important findings. For example, the average level of scientific knowledge, as measured by a battery of 10 factual questions about science, was almost exactly the same in the 12 countries of the European Community as in a national U.S. survey. (See figure O-26.) However, the United States ranked below most of the advanced industrial European nations, generally outstripping the lesser developed countries of Europe.

Figure O-26.
**Scientific knowledge in Europe and the United States**




See pp. 187-88 and appendix table 7-20.
*Science & Engineering Indicators – 1991*

# Chapter 1
# Precollege Science and Mathematics Education

## CONTENTS

# Precollege Science and Mathematics Education

## HIGHLIGHTS

### Student Achievement

- **In both science and mathematics, test scores on national assessments showed improvements throughout the 1980s.** Achievement trends for 9-, 13-, and 17-year-old students showed a pattern of declining proficiency in the 1970s, followed by recovery in the 1980s. *See pp. 17-20.*

- **In science, the improvements 17-year-olds made in the 1980s did not offset the declines during the 1970s.** In 1990, average student proficiency among 17-year-olds remained below that in 1969. Among 9- and 13-year-olds, recent gains returned performance to levels students attained two decades ago. *See pp. 17-18.*

- **In mathematics, at ages 9 and 13, average student proficiency was somewhat higher in 1990 than in 1973.** Performance by 17-year-olds returned to its earlier level. *See p. 18.*

- **White students had consistently higher average achievements than their black and Hispanic counterparts in both science and mathematics.** However, both minority groups made considerable improvements compared to whites. *See pp. 17-18.*

- **The gains in student proficiency that occurred in science and mathematics during the 1980s appeared to be in lower level skills and basic concepts.** Nearly all students were learning basic facts and skills, but few showed a capacity for complex reasoning and problem-solving. *See pp. 17-20.*

- **North Dakota, Montana, Iowa, Nebraska, and Wisconsin were the only states where one-fifth or more of eighth grade students demonstrated a grasp of mathematics problems involving fractions, decimals, percents, and simple algebra.** These states were among the highest scoring states to participate in a 1990 state-level assessment. *See p. 20.*

- **U.S. high school seniors showed an overall weak grasp of geography.** Males outperformed females by a larger margin in geography than in any other subject tested. *See p. 20.*

- **In an assessment of mathematics achievement by students in one American and two Asian cities, the Americans were at a relative disadvantage in mathematics as early as grade 1.** This finding indicates that factors at home as well as at school must be responsible for these differences in achievement. *See pp. 21-22.*

### Student Interest in Science and Mathematics

- **Nearly 30 percent of all grade 7 students expressed a preference for a career in science or engineering, but the percentage of students expressing this interest declined steadily throughout the middle and high school years.** By grade 12, fewer than 1 in 4 male students and only 1 in 10 female students expressed similar interests. *See p. 24.*

- **Of high school seniors scoring above the 90th percentile on the quantitative Scholastic Aptitude Test in 1990, about 45 percent expressed an interest in majoring in science and engineering in college.** This finding shows that science and mathematics continue to be of considerable interest among top high school students. *See p. 23.*

### Student Coursework

- **Four times as much time was spent on reading instruction as was spent on science instruction in elementary school.** Only half of all third graders received science instruction on a regular basis. Twice as much time was spent on elementary mathematics lessons as on science. *See p. 27.*

- **Largely as a result of states raising their graduation requirements, the number of credits earned in science by high school graduates increased during 1982-87.** Recent data show that enrollment in biology continued to increase, while enrollment in chemistry and physics leveled off. *See p. 25.*

- **Mathematics coursetaking continued to increase from 1987 to 1990 in algebra, algebra 2, and calculus.** However, fewer than half of all high school graduates took algebra 2. *See pp. 25-26.*

### Teachers and Teaching

- **In middle schools, science teachers felt less qualified to teach their subjects than their colleagues teaching mathematics.** Fewer than half of all middle school biology teachers and about one-fifth of physical science teachers felt they were teaching the subject for which they were best qualified. Two-thirds of mathematics teachers felt they were teaching their best qualified subject. *See p. 31.*

- **About 40 percent of middle school biology teachers majored or minored in that subject in college,** compared with about 30 percent of middle school teachers of physical science and mathematics. *See p. 31.*

- **Less than half of all high school physical science teachers felt they were assigned to classes in the subject they were best qualified to teach,** compared with about three-quarters of biology and mathematics teachers. *See p. 32.*

### The Policy Context

- **Educational reforms increasing high school graduation requirements have exerted a powerful influence on schooling.** A study of six states found that reforms have led to different course offerings in science and mathematics, new coursetaking patterns, more attention to the knowledge and skills addressed by high school exit examinations, and adjustments in teacher assignments. *See p. 39.*
- **Implementation of state and local policies to increase the teaching of higher order thinking and analytical skills has been inhibited by lack of school resources** for staff development and for science laboratory facilities and equipment. *See p. 39.*

## Introduction

### Chapter Focus

Traditionally, American education has pursued several goals: developing intelligent and knowledgeable citizens, creating a skilled workforce, and ensuring fairness in access to education. Today, our educational system faces special challenges in achieving each of these goals. Citizens now need a basic understanding of science, for example, to make well-informed decisions about a variety of public policy areas—questions about health and related fields, such as those raised by research into our genetic inheritance; concerns about global warming and other environmental issues; and choices about explorations ranging from the atom to near-earth and outer space.

In the past, a relatively small number of highly skilled scientists and engineers flowing through the education and career "pipeline" were enough to maintain U.S. preeminence in science and technology. Today, the economy requires that rank and file workers in many industries possess the skills and abilities necessary to operate complex equipment and machinery and solve production problems as they arise. Today's production workers no longer simply wield tools; they also monitor quality, look for problems, repair complex equipment, and plan work loads and procedures. Office workers manipulate high-technology machines and handle large amounts of information (MSEB 1989, p. 3).

The requirements of today's economy make the need for fair access to education particularly acute. Both the entry-level workforce and the school population are composed of increasing proportions of women and minorities, groups that traditionally have not participated at a high rate in science and mathematics education and occupations.

White women comprise only 10 percent of all employed scientists and engineers, although they account for 43 percent of the U.S. population (Task Force 1989). Women appear to leave the pipeline by choice. As girls progress through the precollege science and mathematics curriculum, they differ little from boys in participation or achievement until the upper grades, when many of them decide to drop out of the higher level courses such as physics and calculus. Studies of gender differences suggest that most of these decisions are due to the accumulated effects of gender role experiences at home, in school, and in society (NRC 1989).

Blacks comprise 12 percent of the population and Hispanics 9 percent, but each group represents only 2 percent of all employed scientists and engineers. By the year 2000, one in every three American students will be a minority; by 2020, if current trends continue, today's minorities will become the majority of students in the United States. Many of these minorities turn away from science and mathematics courses early in life, partly because most go to large city schools and schools in impoverished areas where they receive an inadequate basic education, including poor instruction in science and mathematics (NRC 1989).

The schooling experiences of minorities play a substantial role in their decision to leave the pipeline. At the elementary level, the large majority of schools serving disadvantaged students treat only two subjects rigorously—reading and arithmetic (National Center for Improving Science Education 1989). Disadvantaged students therefore fall behind more advantaged students who are exposed to more rigorous academic subjects such as science and mathematics. At the secondary level, a large proportion of disadvantaged students decide to enroll or are placed in low-ability tracks or remedial programs that require few college preparatory courses (Oakes 1990a).

Each of these issues is addressed in the sections that follow.

### Chapter Organization

In response to a request in 1983 by the National Science Board Commission on Precollege Education in Mathematics, Science, and Technology, the National Science Foundation (NSF) supported a number of projects to identify and develop systematic and objective indicators of the quality of precollege education in the United States. The RAND Corporation developed one such set of indicators and the National Academy of Sciences/National Research Council (NAS/NRC) developed another (Shavelson et al. 1989 and 1987, Raizen and Jones 1985, and Murnane and Raizen 1988). These efforts modeled the science and mathematics education system in terms of inputs, processes, and outcomes. Specifically, the RAND model, for example, identifies the following components as the major domains of the education system:

- *Outcomes*—student achievement, participation, and attitudes and aspirations;
- *Processes*—school quality, curriculum quality, instructional quality, and teaching quality; and
- *Inputs*—fiscal and other resources, teacher quality, and student background.

The RAND model and others agreed that the primary goal of instruction in science and mathematics is student learning. The most explicit student outcome, and one that can be tied most closely to schooling variables, is the knowledge, understanding, and skills gained by students—that is, student achievement in science and mathematics. The input and process variables selected for the models were those that have some causal relationship to student outcomes.

In addition, the RAND model recognized that the larger policy environment in which schooling occurs profoundly influences education in a variety of ways and must be taken into consideration in attempting to explain changes in the major components of schooling. Federal, state, and local policies largely determine the level and type of resources available to education, and these policies also influence who is allowed to teach, what content is taught, and even how it is taught.

Overall, this chapter follows the general framework of the RAND and NAS/NRC models. It emphasizes student outcomes and discussions of the major issues related to schools and curricula and teachers. The chapter ends by putting these components of the educational system model in a policy context. Specifically, it provides an overview of national and state-level education reforms undertaken recently and their status and success to date.

## Students: Achievement, Interest, and Coursework

At the Education Summit in 1989, the President and the governors expressed concern about the country's ability to compete in the global economy and affirmed their commitment to equipping all U.S. children with a basic understanding of science, mathematics, and other subjects. A major result of this summit was the adoption of six ambitious education goals to be accomplished by the year 2000, three of them relating directly to science and mathematics achievement and literacy:

- American students will leave grades 4, 8, and 12 with demonstrated competency in challenging subject matter including English, mathematics, science, history, and geography; and every school in America will ensure that all students learn to use their minds well, so they may be prepared for responsible citizenship, further learning, and productive employment in our modern economy.
- U.S. students will be first in the world in science and mathematics achievement.
- Every American adult will be literate and will possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship.

### National Assessments of Educational Progress, 1970-90

Student achievement is measured by performance on national tests in special areas such as science, mathematics, and geography. For more than 20 years, the National Assessment of Educational Progress (NAEP)—conducted by the Education Commission of the States and, later, by the Educational Testing Service with the sponsorship of the National Center for Education Statistics—has been monitoring the educational achievement of American students and changes in that achievement across time. The results of the NAEP assessments have raised national concern about the level of student knowledge in science and mathematics. The latest NAEP results, for 1990, showed that many students appear to be graduating from high school with little of the science and mathematics knowledge required by the fastest growing occupations or for college work. For example, approximately half of the students in grade 12 graduating from school today appear to have an understanding of mathematics that does not extend much beyond multiplication and two-step problems (5th grade level) (Mullis et al. 1991b, p. 7). In addition, a series of international studies confirmed the low achievement level of U.S. students, showing that U.S. students in 8th grade mathematics—and even advanced 12th grade mathematics and science students—performed substantially below the levels of students in many other advanced countries.

In 1990, NAEP tested national samples of 9-, 13-, and 17-year-olds in science and mathematics. The 1990 results allowed NAEP to perform a 20-year trend analysis drawing on six assessments in science (1970, 1973, 1977, 1982, 1986, and 1990) and a 17-year trend analysis drawing on five assessments in mathematics (1973, 1978, 1982, 1986, and 1990). Also, for the first time, eighth grade student proficiency in mathematics was assessed in a Trial State Assessment Program that included 37 states, the District of Columbia, Guam, and the U.S. Virgin Islands (Mullis et al. 1991a and 1991b).

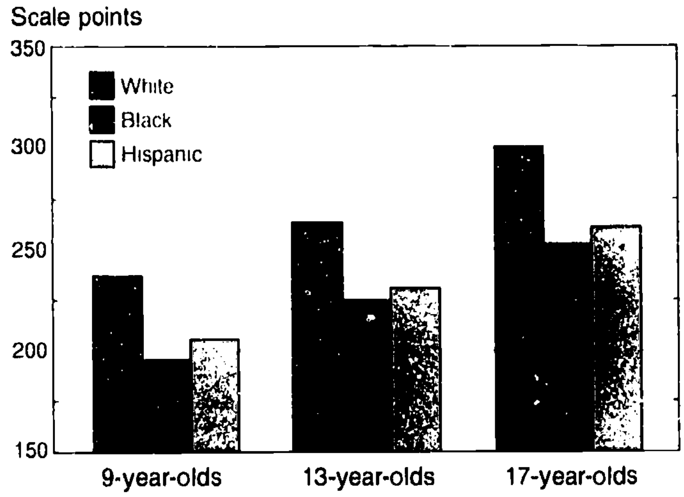
## Science Achievement

NAEP assessments suggest that science achievement levels were about the same in 1990 as they were in 1970. Levels of performance in the six assessments varied, however, over the 20-year span. Average scores declined somewhat in the 1970s and increased in the 1980s. Yet among 17-year-olds—unlike 9- and 13-year-olds—science performance did not return to the level achieved in 1970. (See figure 1-1.)

***Achievement by Minorities.*** Average science proficiency among blacks and Hispanics remained far below that of white students. However, from 1977 to 1986, the difference between minority and white students narrowed. For example, from 1977 to 1986, the difference between black and white 9-year-olds declined from 55 points to 36 points, from 48 to 38 points for 13-year-olds, and from 58 to 45 points for 17-year-olds. In 1990, the difference between white and black students remained about the same as in 1986. In all three age groups, gains by black students during the last 4 years were slightly less than those by whites. Among Hispanic students in all three age groups, gains in student achievement from 1986 to 1990 were nearly identical to those of white students. Figure 1-2 shows 1990 science proficiency by the three groups.

***Achievement by Females.*** In 1990, the average science performance of females in all three age groups was lower than that of males, continuing a trend that had existed since the first assessment in 1970. (See figure 1-3.) The difference between males and females in science achievement remained about the same over the two decades. At age 17, the differences were greater than at ages 13 or 9. For 17-year-olds, trends in performance were comparable for males and females, with both showing declines from 1970 to 1982, followed by improvements from 1982 to 1990. For 13-year-olds, average

Figure 1-2.
**U.S. average science proficiency, by race/ethnicity: 1990**



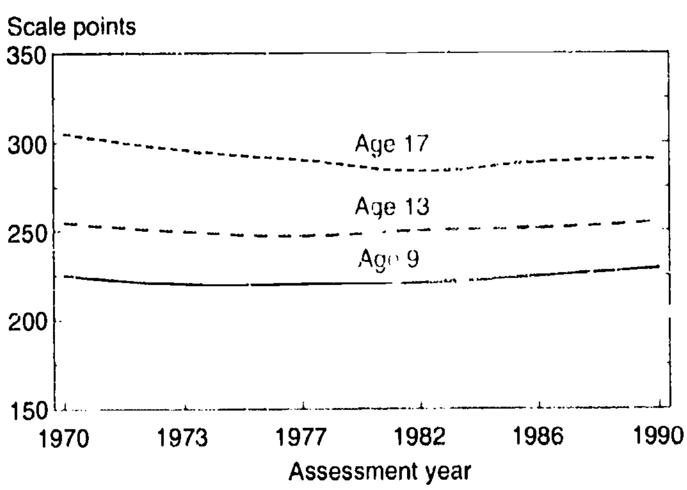

See appendix table 1-1. *Science & Engineering Indicators – 1991*

scores of both males and females declined from 1970 to 1977 and then increased significantly from 1977 to 1990 to reach levels approximately equal to those in 1970. For 9-year-olds, the science proficiency of males in 1990 was at the same level as in 1970, but significant improvements for females from 1986 to 1990 raised their proficiency to a level somewhat higher than in 1970. (See appendix table 1-1.)

## Level of Student Proficiency in Science

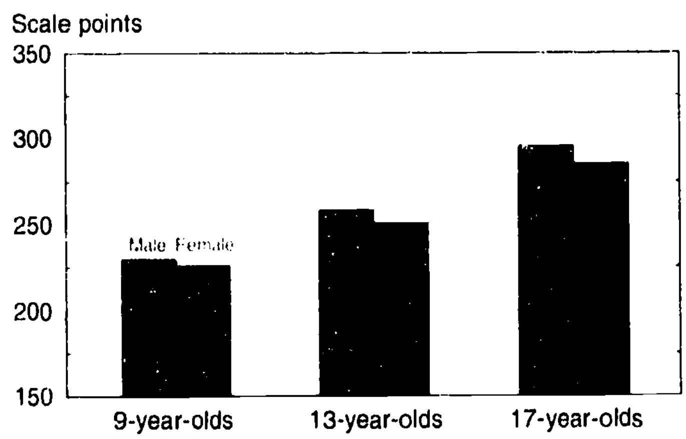
The NAEP science scale developed by the Educational Testing Service extends from 0 to 500. To aid interpretation of the scores, a group of science subject experts examined the test questions answered successfully by students scoring at each of five different levels. The experts described each of the levels in terms of what a student knows or can do in science. (See text table 1-1 and appendix table 1-2.)

Figure 1-1.
**U.S. average science proficiency**




See appendix table 1-1. *Science & Engineering Indicators – 1991*

Figure 1-3.
**U.S. average science proficiency, by gender: 1990**



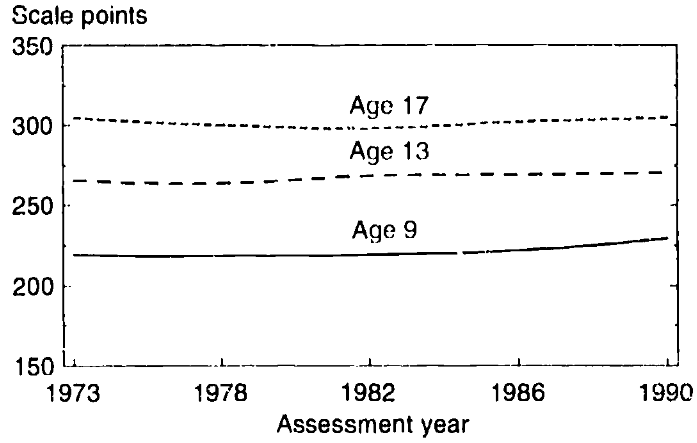

See appendix table 1-1. *Science & Engineering Indicators – 1991*

Text table 1-1.
**Overall science proficiency: 1990**

| Level | Description | Age 9 | Age 13 | Age 17 |
|---|---|---|---|---|
| | | Percent | | |
| 150 | Knows everyday science facts | 97 | 100 | 100 |
| 200 | Understands simple scientific principles | 76 | 92 | 97 |
| 250 | Applies basic scientific information | 31 | 57 | 81 |
| 300 | Analyzes scientific procedures and data | 3 | 11 | 43 |
| 350 | Integrates specialized scientific information | 0 | 0 | 9 |

See appendix table 1-2. *Science & Engineering Indicators – 1991*

Figure 1-4.
**U.S. average mathematics proficiency**




See appendix table 1-4. *Science & Engineering Indicators – 1991*

In general, students performed well on questions about scientific facts (level 150), particularly if the questions involved information likely to be encountered in everyday experience. However, performance levels decreased as students encountered questions that asked them to analyze, evaluate, apply, or otherwise deal with more complex and detailed information (Mullis 1991b).

From 1977 to 1990, increasing percentages of 9- and 13-year-olds were able to understand simple scientific principles (level 200) and apply their scientific knowledge (level 250). (See appendix table 1-2.) However, 17-year-olds made virtually no progress in scientific proficiency at any level. Fewer females than males were able to perform at the highest two proficiency levels, and fewer than 1 in 10 17-year-olds demonstrated the highest level of science understanding.

In summary, some progress occurred from 1977 to 1990 in the percentages of 9- and 13-year-old students who performed at or above the three lower levels on the proficiency scale. However, 17-year-olds showed little progress at any scale level, and their ability to integrate specialized scientific information remained low.

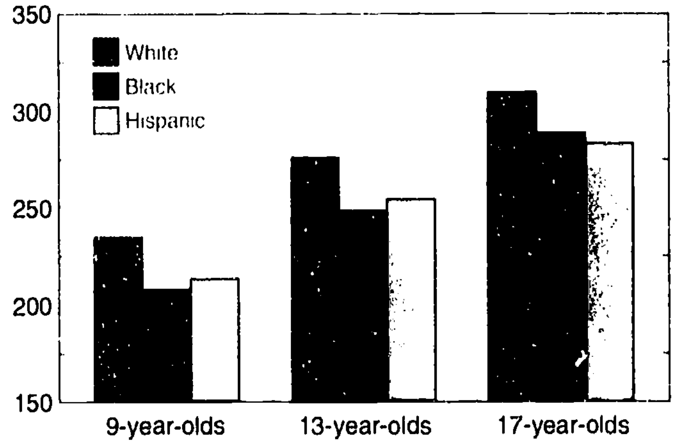
## Mathematics Achievement

Trends in student achievement levels in mathematics were similar to trends in science achievement. Declines in the 1970s were followed by increases in the 1980s. By 1990, average mathematics proficiency among 9-year-olds was significantly higher than in 1973; among 13- and 17-year-olds, performance surpassed or returned to earlier levels. (See figure 1-4.)

***Achievement by Minorities.*** Between 1973 and 1990, white, black, and Hispanic 9-year-olds all showed significant improvement in average mathematics proficiency, with much of this improvement occurring between 1986 and 1990. (See appendix table 1-4.) At age 13, black and Hispanic students made significant gains following 1973, with most of the improvement occurring between 1978 and 1986, while performance of white 13-year-old students remained relatively consistent across the assessments. Among 17-year-olds, blacks gained significantly, raising their scores about 19 points between the first assessment and 1990. Hispanic 17-year-olds made modest gains during the 1980s, while whites compensated for declines in the 1970s with small gains that returned them in 1990 to their original 1973 proficiency level.

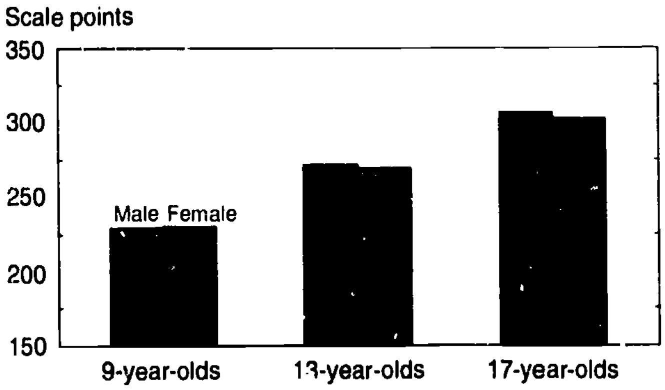
Thus, black students made significant progress at all ages. Hispanic students improved significantly at ages 9 and 13, and white students made significant gains at age 9. Although black and Hispanic students narrowed the gap shown in previous mathematics assessments between their performance and that of white students, these differences remained large in 1990 in all three age groups. (See figure 1-5.)

Figure 1-5.
**U.S. average mathematics proficiency, by race/ethnicity: 1990**




See appendix table 1-4. *Science & Engineering Indicators – 1991*

Figure 1-6.
**U.S. average mathematics proficiency, by gender: 1990**




See appendix table 1-4. *Science & Engineering Indicators – 1991*

***Achievement by Females.*** Both female and male 9-year-olds made significant gains between 1973 and 1990, with most of the improvements occurring during the 1980s. (See appendix table 1-4.) Male and female 9-year-old students showed approximately the same level of mathematics proficiency in all of the assessments from 1973 to 1990. Thirteen-year-old males and females also showed improvements between 1973 and 1990, but their progress was gradual. Virtually no difference separated the levels of performance by the two groups in any of the assessments. Among 17-year-olds, the performance of males improved during the 1980s, but did not return to the level of 1973. Trends for females showed the same patterns as males, but their gains were somewhat larger during the 1980s. As a result, the slight performance gap between male and female students at age 17 nearly disappeared between 1973 and 1990. Furthermore, as shown in figure 1-6, the difference in scores between males and females at any age group is minimal.

## Level of Student Proficiency in Mathematics

As in the science NAEP assessments, five levels of mathematics proficiency were established, in this case by a team of mathematics educators. (See text table 1-2 and appendix table 1-5.)

In the 1990 assessment, while the average 9-year-old student scored at about the expected level, scores for older students averaged substantially lower than the expected levels (Mullis, Owen, and Phillips 1990). The fact that the average student gained more between ages 9 and 13 (41 points) than between ages 13 and 17 (34 points) suggests that the U.S. mathematics curriculum facilitates more learning in the lower grades. (See appendix table 1-5.)

Significantly greater percentages of 9-year-olds showed proficiency in beginning skills and understanding and in basic operations and beginning problem-solving in 1990 than in previous assessments. (See appendix table 1-5.) These improvements in mathematics proficiency occurred in all three racial/ethnic groups and among both males and females. Gains were especially noteworthy among blacks. (See appendix table 1-6.)

Thirteen-year-olds as a group made significant gains in basic operations and beginning problem-solving: three-fourths performed at or above this level in 1990 compared to under two-thirds in 1978. Girls improved their proficiency, and by 1990 they performed at about the same level as boys. Large gaps in performance still separated whites and minorities in 1990, but minorities had made substantial gains. Compared to 1978, 20 percent more blacks and 21 percent more Hispanics were demonstrating proficiency in 1990 with basic operations and beginning problem-solving.

Of 17-year-olds in 1990, almost all (96 percent) were able to solve exercises involving basic operations and beginning problem-solving. This performance represented a significant improvement from 1978, when only 92 percent reached this level. Also, 56 percent of the 17-year-olds demonstrated a grasp of moderately complex procedures and reasoning, compared to 52 percent in 1978. Minority gains at this proficiency level were pronounced. Hispanics who demonstrated proficiency with moderately complex procedures increased from 23 percent in 1978 to 30 percent in 1990. The percentage of blacks virtually doubled—from 17 percent in 1978 to 33 percent in 1990. However, no group showed improvement in proficiency with multi-step problem-solving and algebra.

NAEP analysts found several encouraging aspects to the 1990 mathematics assessment findings. First, virtually all students showed gains in basic mathematics understanding, a result that was maintained and even improved slightly across the assessments. Second, all three ages showed significant increases in the percentages reaching the middle levels on the scale. Third, this phenomenon was most clearly evident in the trend results for black and

Text table 1-2.
**Overall mathematics proficiency: 1990**

| Level | Description | Age 9 | Age 13 | Age 17 |
|---|---|---|---|---|
| | | Percent | | |
| 150 | Simple arithmetic facts | 99 | 100 | 100 |
| 200 | Beginning skills and understandings | 82 | 99 | 100 |
| 250 | Basic operations and beginning problem-solving | 28 | 75 | 96 |
| 300 | Moderately complex procedures and reasoning | 1 | 17 | 56 |
| 350 | Multi-step problem-solving and algebra | 0 | 0 | 7 |

See appendix table 1-5. *Science & Engineering Indicators – 1991*

Hispanic students at all ages. Finally, the trends by gender showed systematic and generally equivalent rates of progress, with females narrowing the gap that existed at age 17 and at the higher scale levels.

On the other hand, concerns continue because few students demonstrated proficiency at the highest level and because trends across time show no increase in the percentage of students learning more advanced material (Mullis et al. 1991b, p. 102).

***State-Level Student Achievement.*** As part of the 1990 NAEP, states and territories could, on a voluntary basis, participate in the mathematics assessment of eighth graders.[1] The 1990 Trial State Assessment Program results showed that eighth grade students in 11 states scored an average of 270 points or higher. (See appendix table 1-7.) Eighth grade students in North Dakota attained the highest average score of 281, but North Dakota, Montana, Iowa, Nebraska, Minnesota, and Wisconsin had similar overall average proficiency. These six states also were the only ones where one-fifth or more of their eighth grade students demonstrated a grasp of problems involving fractions, decimals, percents, and simple algebra (level 300). Other states with relatively high average proficiency scores were New Hampshire, Idaho, Wyoming, Oregon, and Connecticut.

Considerable differences in overall average mathematics proficiency separated eighth grade students in the higher performing states from those in the lower scoring states. The higher performing states tended to have fewer students in cities with large populations, fewer students in free lunch programs, smaller percentages of black and Hispanic students, smaller percentages of students with both parents at home, and smaller percentages of students watching 6 or more hours of television each day. Higher performing states also tended to be in relatively less densely populated areas. The lower performing states tended to be in the Southeast.

## Geography Achievement

As previously indicated, a national education goal identified by the President and the Nation's governors is demonstrated student competence and understanding in geography. In 1988, the NAEP Center of the Educational Testing Service tested high school seniors on their knowledge of four areas of proficiency in geography—location and place, skills and tools, cultural geography, and physical geography.[2] The assessment results showed that, overall, U.S. high school seniors had a weak grasp of geography.

Students were most proficient in *locating* major countries. For example, 87 percent could identify Canada on a world map; 87 percent also knew where the Soviet Union was located. But when they were asked to identify cities and land features, only 58 percent could locate Jerusalem on a regional map, and just 36 percent knew that Saudi Arabia borders on the Persian Gulf and the Red Sea. (Note that this study was conducted before the Gulf War.)

Students also did not do well on questions testing *geography skills and tools.* For example, when shown a dot map of population distributions in Europe, India, China, and Japan, almost one-quarter of the test-takers indicated that the map represented abundance of mineral deposits; only one-half recognized that the map represented population concentrations.

Students performed relatively well on questions involving *cultural geography*, particularly when the questions related to events and locations featured in the news. Thus, 79 percent appeared to understand the primary way to control acid rain, and 69 percent identified a risk to the environment resulting from the use of pesticides. Scores declined, however, when questions probed for more indepth understanding. Only 59 percent recognized the consequences of cutting down the rain forests, and only 53 percent identified a cause of the greenhouse effect.

Finally, in terms of physical geography (climate, weather, tectonics, and erosion), most students could recognize major features, but a surprisingly large minority could not. For example, only about two-thirds of the students knew the cause of the Earth's seasons, and just three-fifths recognized evidence of faulting in a cross-sectional drawing depicting a sharp fracture in the Earth's crust.

***Achievement by Females and Minorities.*** Significant disparities in geography proficiency existed between white students and their black and Hispanic counterparts. Whites scored an average of 43 points above blacks and almost 30 points above Hispanics. The average performance of 12th grade males was about 16 points higher than that of their female classmates (Allen et al. 1990). Of the subject matter performance assessments conducted by NAEP in 1986 to 1988, the largest gap between average performance of males and females was in geography.[3]

***Geography Coursework.*** As part of the 1988 geography assessment, students were asked to report on their geography coursetaking and the extent to which they had studied in class the topics covered in the assessment. The information received suggested two conclusions:

- Overall, geography was not emphasized in U.S. high schools.
- As the amount of time devoted to the study of specific topics increased, student performance in these topic areas also rose (Allen et al. 1990).

[1] Altogether, 37 states, the District of Columbia, Guam, and the U.S. Virgin Islands participated in the mathematics assessment.

[2] The 1988 geography assessment (Allen et al. 1990) was based on a national probability sample of more than 300 public and private schools across the United States.

[3] National assessments were conducted during 1986-88 in reading, mathematics, science, U.S. history, civics, and geography.

The first conclusion is borne out by an analysis of high school transcripts (Westat 1988). Analysis showed that only 16.5 percent of all high school graduates had earned at least 0.5 credits in geography in 1987, approximately the same percentage of graduates as in 1982. Also, in a survey conducted in 1988, only nine states reported that they required students to take a geography course before they graduated from high school (CCSSO 1988).

## International Context of Achievement

International comparisons of science and mathematics achievement have consistently found that students in Japan, Korea, and Hong Kong scored far above U.S. students in middle school or high school (McKnight et al. 1989 and Lapointe, Mead, and Phillips 1989). Studies examined differences in school coverage of the test topics and found that Asian countries covered more of these subjects in school than did the United States. However, not all of the differences in student performance could be attributed simply to classroom coverage of test topics. Other factors were also found to be important, as described below.

A recent study assessed children's mathematics achievement in the first and fifth grades in three large metropolitan areas: Sendai, Japan; Taipei, Taiwan; and Minneapolis, Minnesota.[4] The researchers tested students' cognitive abilities, observed them and their teachers in classrooms, and interviewed the children and their mothers and teachers.

The researchers examined the children's achievement in relation to three major factors: their intelligence, their experiences in school, and their experiences at home. Based on a battery of cognitive tests, the researchers found no evidence that children in the two Asian cities were more intelligent than those in Minneapolis. They did find, however, that Minneapolis children were at a relative disadvantage in mathematics as early as the first grade. Because these differences in performance appeared so early in children's schooling, researchers concluded that factors at home as well as at school must be responsible for them. Upon further analysis of the study results, the researchers identified several factors that appeared to underlie the relatively poor mathematics performance of Minneapolis children; these are described below.

***Time Devoted to Academic Activities.*** There were significant differences in the amounts of time given to academic activities in classrooms in the two Asian cities and in Minneapolis. The percentage of time so devoted in Minneapolis classrooms was 64 percent, compared with 87 percent in Sendai classrooms and 92 percent in those in Taipei. Minneapolis fifth graders averaged 20 hours a week on classroom academic activities; fifth graders in the two Asian cities spent 33 and 40 hours, respectively, on such activities.

In Minneapolis classrooms, more of this academic time was dedicated to reading and language arts than to mathematics.[5] In the first grade, 2.7 hours were spent on mathematics instruction in Minneapolis compared to 4.0 hours in Taipei and 5.8 hours in Sendai classrooms. In the fifth grade, 3.4 hours of mathematics were taught in Minneapolis classrooms compared with 11.7 hours in Taipei and 7.8 hours in Sendai. Thus, on average, children in the two Asian cities spent over twice the amount of time on mathematics in the classroom as did Minneapolis children. (See figure O-13 in Overview.)

***Mothers' Goals and Standards for Academic Achievement.*** Unlike the mothers surveyed in the two Asian cities, Minneapolis mothers—although interested in their children's education—were less prone to require their children to demonstrate high levels of academic achievement. Minneapolis mothers generally became dissatisfied only when their children's school performance was well below average. On the other hand, academic performance dominated the attention of mothers in the two Asian sites, although they focused their concerns on different aspects of achievement. Sendai mothers, recognizing that grades have little relevance in Japan in gaining admission to prestigious schools, were most concerned that their children learn the information necessary to pass entrance examinations. For their part, mothers in Taipei viewed high grades as the primary measure of success in elementary school.

***Children's Perceptions of Their Own School Achievement.*** In self-ratings of how well they were doing in their mathematics schoolwork, Minneapolis children tended to give themselves the highest ratings, but they actually did less well on achievement tests of mathematics ability than the children in Taipei and Sendai. In ratings of their mathematics achievement in school, Sendai and Taipei fifth graders tended to rate themselves as near average, while Minneapolis fifth graders gave themselves the highest ratings.

In this regard, some of the strongest correlations obtained in the study were between the children's ratings of how good they thought they were in a subject and how much they liked the subject. Children clearly liked the subjects in which they thought they were doing well and disliked the subjects in which they thought they

---

[4]This study was conducted with 1,440 students attending elementary schools in the three cities (240 first graders and 240 fifth graders in each city). The children were selected from 20 classrooms at each grade in each city and constituted a representative sample of children from these classrooms. In a followup study, first graders were studied again when they were in the fifth grade. The children were tested with achievement tests in mathematics and reading constructed specifically for this study, the children and their mothers were interviewed, the children's teachers filled out a questionnaire, and interviews were held with the principals. In the followup study, achievement tests were administered, and the children and their mothers were interviewed. For more information, see Stevenson and Shin-Ying (1990).

[5]These same priorities are favored by American parents who may not appreciate the importance of mathematics in their children's later education and work. In interviews, American mothers cited reading as the subject that should receive increased emphasis in school.

were doing poorly. Why did the children in Minneapolis like mathematics and believe that they were good at it? The researchers concluded that the answer seemed to be that the mathematics curriculum in Minneapolis schools was easier than those of the two Asian cities. Analyses of mathematics textbooks used in the three cities seemed to support this conclusion. For example, mathematics concepts tended to be introduced somewhat earlier in Sendai than in Minneapolis schools.

***Roles of Mothers.*** The researchers gained the impression that Minneapolis mothers were dedicated to their children's development during their preschool years but that they abdicated some of their responsibilities to the teacher once the children entered school. This tendency was the opposite of what occurred in homes in the two Asian cities. In all three cultures, the preschool years were a time of freedom and indulgence, and there was no great concern about the child's learning academic skills. But from the time that the child entered school in Taipei and Sendai, the child, the mother, and the teachers began the serious task of education. The more years the child was in school, the stronger the emphasis on academic activities became. On the other hand, for the children in Minneapolis, the transition into elementary school was less notable—from the time that they entered school, their lives were not encumbered by strong demands for academic excellence or homework, and there was little increase in demands during the 6 years of elementary school.

***Ability Versus Effort in Student Accomplishment.*** Minneapolis mothers identified individual ability as one of the most important factors in academic performance. In contrast, mothers in the two Asian cities emphasized effort over ability in academic achievement. In other words, parents of schoolchildren in Minneapolis held that children of high ability need not work hard to achieve and that children of low ability would not achieve regardless of how hard they worked. The Asian parents, on the other hand, considered effort and self-discipline essential to accomplishment.[6] The researchers concluded that when parents believed that success in school depended more on ability than hard work, they were less likely to foster participation in activities related to academic achievement, i.e., requiring that their children spend time on homework and participate in after-school scholastic activities.

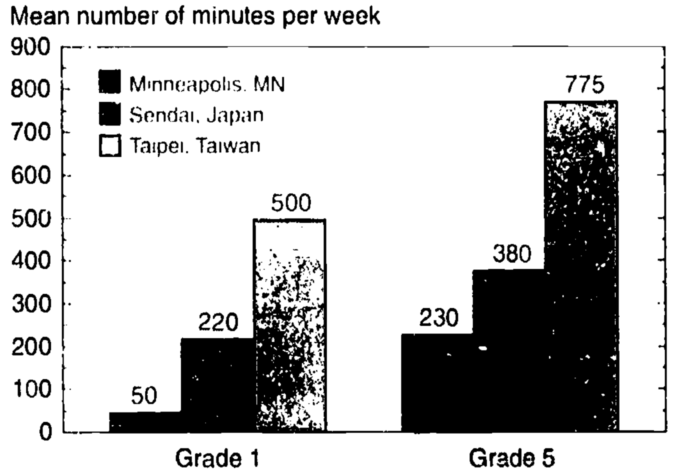
Not surprisingly, the children in the two Asian sites spent considerably more time on homework at both the first and fifth grade levels than the Minneapolis schoolchildren (Stevenson et al. 1990). According to estimates made by mothers of the schoolchildren, Sendai first graders spent more than 4 times as much time doing homework as first graders in Minneapolis; children in Taipei spent 10 times as much as the Minneapolis children. At the fifth grade level, Sendai children still spent over 50 percent more time and Taipei children spent over 336 percent more time than did their Minneapolis counterparts. (See figure 1-7.)

## Top Mathematics Test Scorers

Although overall trends in science and mathematics interests and coursetaking are useful, the science and engineering (S&E) preferences of talented high school students are particularly significant because these individuals represent a major source of future scientists and engineers. This section examines data on the proportion of top-scoring high school seniors (i.e., those scoring above the 90th percentile on the quantitative Scholastic Aptitude Test—SAT) who intend to pursue a college major in science, mathematics, or engineering. Although many high school seniors change their major field of study after they enter college, the SAT data serve as an approximation of how well the S&E professions are attracting high school seniors (Grandy 1990a, p. 4). Generally, the decision not to major in an S&E field means that students will not continue to acquire the skills necessary to move into these fields at a later time.

Of high school seniors who scored above the 90th percentile on the SAT quantitative exam in 1990, about 46 percent intended to major in S&E fields in college. (See figure 1-8.) By gender, 55 percent of all top-scoring males and 38 percent of top-scoring females planned to pursue an S&E major. Engineering was the S&E field selected by the largest proportion of top-scoring students regardless of gender, accounting for one-fifth of the total.

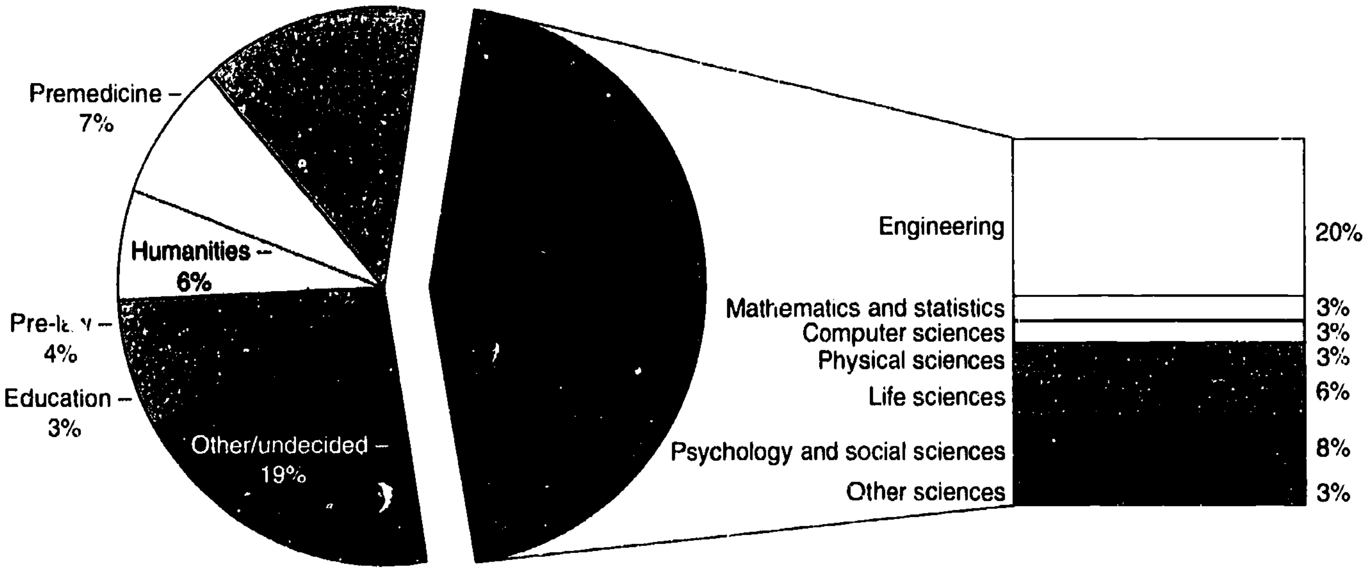
Figure 1-7.
**Mothers' estimates of time spent by their children on homework**




SOURCE: H.W Stevenson and L. Shin-Ying. *Contexts of Achievement.* Monographs of the Society for Research in Child Development. Serial No. 221. Vol. 55. Nos. 1-2 (1990).

[6] The researchers found no evidence in schools in Japan and Taiwan of grouping of students within grades according to level of ability nor were there special education teachers or special classes for slow learners. The researchers concluded that the Asian teachers sincerely believed that all children at the elementary level were capable of mastering the curriculum and that academic success was within the grasp of all children if they applied themselves to their schoolwork (Stevenson et al. 1990).

Figure 1-8.
**Intended majors of high school seniors scoring above the 90th percentile on the mathematics SAT: 1990**



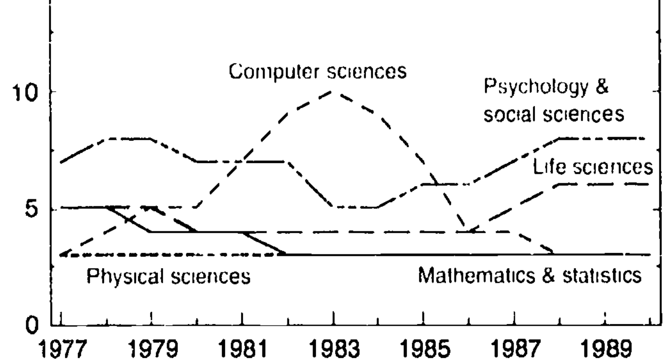

See appendix table 1-8. *Science & Engineering Indicators – 1991*

Overall, the proportion of top-scoring students intending to major in S&E fields increased by 6 percentage points from 1977 to 1990. (See appendix table 1-8.) From 1977 to 1987, interest in an engineering major increased, rising from 14 to 23 percent. Concurrently, interest in majoring in science fields declined until 1986, from 27 to 23 percent. Beginning in 1986, however, these trends began to reverse: interest in science and mathematics grew while interest in engineering dropped slightly. A precipitous drop occurred in the number intending to major in the computer sciences; interest in this field declined from a peak of 10 percent in 1983 to 3 percent in 1990. (See figure 1-9.) In non-S&E fields, business grew the most significantly, from 7 percent in 1977 to 15 percent in 1989.

Over these years, fewer top-scoring examinees indicated that they were undecided about their major field. In 1977, more than one-third of these students said that they were undecided about their college major, compared with 29 percent in 1984, and 19 percent in 1990. Thus, the growth in interest in some fields reflects a greater tendency for students to choose a field at all.

Disaggregating the data by gender and racial/ethnic group reveals that over this period groups traditionally underrepresented in engineering were showing increasing interest in this field. (See appendix tables 1-9, 1-10, 1-11, and 1-12.) For example, the proportion of top-scoring black females intending to major in engineering doubled from 7 percent in 1977 to 14 percent in 1990. Similarly, black males interested in an engineering major increased from 21 to 34 percent over the same period. The comparable portion of white females rose from 5 percent in 1977 to 9 percent in 1990.

Figure 1-9.
**Trends in intended majors of high school seniors scoring in the 90th percentile on the mathematics SAT**




See appendix table 1-8. *Science & Engineering Indicators – 1991*

## S&E Interests of Secondary School Students

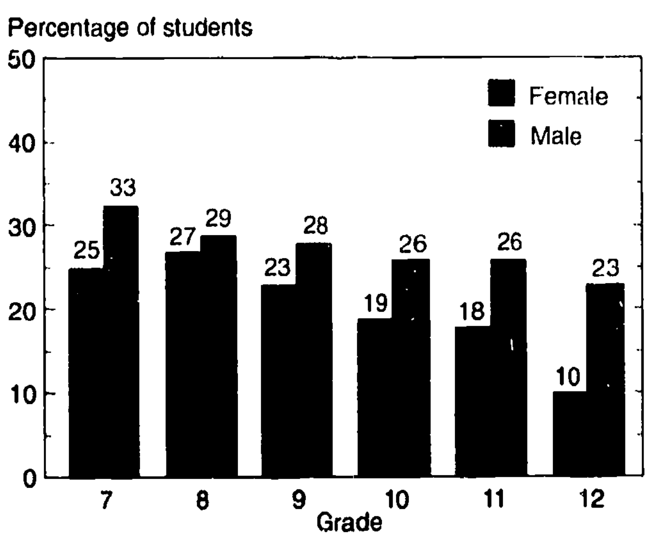
Why do some American secondary students develop a preference for a career in science, mathematics, or engineering (SME) and pursue courses toward that objective? The Longitudinal Study of American Youth (LSAY) was launched in response to this question, to determine the relative contributions of family, peers, teachers, classroom experiences, and school climate in shaping student preferences.[7]

Each semester, students were asked to list the two occupations they thought they would most likely be pursuing at age 40. Students who chose scientist, mathematician, engineer, or a graduate-educated medical professional as their first or second choice were classified as having a preference for an SME career.

Nearly 30 percent of seventh grade students—33 percent of males and 25 percent of females—expressed a preference for an SME career, but these percentages declined steadily throughout the remaining middle school and high school years. (See figure 1-10.) Moreover, the percentage of female students expressing a preference for an SME career declined at a faster rate than that for male students. By the 12th grade, fewer than 1 in 4 male students and only about 1 in 10 female students expressed an interest in an SME career (Miller et al. 1990).

[7] LSAY was a national probability sample of 6,000 students in 50 middle schools and 50 high schools. Students were followed in each year of their middle school and high school years and were administered science and mathematics achievement tests each fall. Questionnaires were filled out by each student in the sample to obtain course evaluation and attitudinal data. In addition, approximately 1,000 teacher reports were collected each year on all science and mathematics courses taken by students in the sample, and telephone interviews were conducted each spring to obtain family background information on each LSAY student. LSAY was conducted at the Public Opinion Laboratory from fall 1987 to fall 1990.

Figure 1-10.
**High school student preferences for careers in science, mathematics, or engineering: 1987-90**




SOURCE: J.D. Miller, et al., *Student Expectations of Careers in Science, Mathematics, or Engineering: Some Models from the Longitudinal Study of American Youth*, draft report to the LSAY National Advisory Committee (DeKalb, IL: Northern Illinois University, 1990).

*Science & Engineering Indicators – 1991*

The LSAY researchers found that the selection of an SME career in secondary school was a complex decision reflecting a wide array of influences, including

- *Parent encouragement* and pressure to achieve academically, to go to college, and to do well in mathematics;
- *Parental resources*, which reflect the level of parent education, availability of home learning resources, and employment of either parent in science or engineering;
- *Student gender;* and
- *Persistence in mathematics*—during high school in particular, persistence in advanced mathematics became a major predictor of SME career expectations.

The relative impact of these influences changed over time. For example, during the middle school years, students were uncertain about longer term career choices, and the expectation of an SME career was weakly associated with parent encouragement and parental resources.

In high school, as more students began to arrive at firmer conclusions about their career choices, parent encouragement, student gender, and persistence in mathematics all became increasingly important predictors of an expected career in SME. By grade 10, the influence of parent encouragement was evidenced by an increased likelihood of higher grades in science and mathematics courses and persistence in advanced mathematics courses. Students with higher levels of parental resources were significantly more likely to enroll in advanced mathematics courses, to participate in informal science education, and to earn higher grades in science courses.

Parent encouragement was especially important in the formulation of career expectations of high school girls. This result suggested that among families with higher levels of resources, males might tend to see an SME career as a natural and reasonable choice, but females needed more encouragement to choose a career in a traditionally male-dominated field.

## Course Enrollment in Secondary Schools

Recent research demonstrates the critical role that enrollment in particular courses in high school has on college attendance and completion rates among students, including minority and poor students. Accordingly, increased course requirements in a core of academic subjects was a central theme of educational reforms in the 1980s. However, a report that reviewed the coursetaking patterns of students between 1982 and 1987 concluded that while some states succeeded overall in strengthening their core high school curriculum, "the coursetaking requirements leave room for improvement in closing the gap among subgroups at all levels and in reducing differences that result from disparate social and economic backgrounds" (ETS 1989, p. 17).

***Enrollment Trends Over Time.*** Over the 25 years between 1965 and 1990, course enrollments in high school science and mathematics increased significantly following an initial decline. These trends reflected two distinct periods in American education. From the late 1960s until the late 1970s, the high school curriculum was undergoing increasing liberalization, resulting in a system in which students gained greater choice about what they studied. Subsequently, for several years after the late 1970s, high schools continued to offer a wide variety of courses, but students began to concentrate their coursetaking in more traditional academic courses. More substantial growth in academic coursetaking occurred after the early 1980s, when the states and local education agencies increased their graduation requirements to encourage achievement of academic excellence (Tuma et al. 1989).

As a result of these trends, the number of credits earned in science and mathematics was higher in 1987 than in 1969. (See text table 1-3.) The courses contributing most heavily to this increase were generally more advanced and core courses.[8] For example, in science, biology and chemistry had the most significant increases in credits earned. By 1987, nine-tenths of all high school graduates had taken a course in biology, and just under half (45 percent) had taken chemistry. Physics enrollment also increased, albeit not so dramatically: by 1987, one in five students took physics. (See figure 1-11.) In mathematics, the courses showing the greatest increases in credits earned between 1982 and 1987 were geometry and algebra 2. (See figure 1-12.)

[8]These data were drawn from a national sample of transcripts from four studies of high school students: the Educational Testing Service's Study of Academic Prediction and Growth (1969), the National Longitudinal Survey of Labor Force Experience—Youth Cohort (1975-78 and 1979-82), High School and Beyond (1982), and the NAEP transcript study (1987).

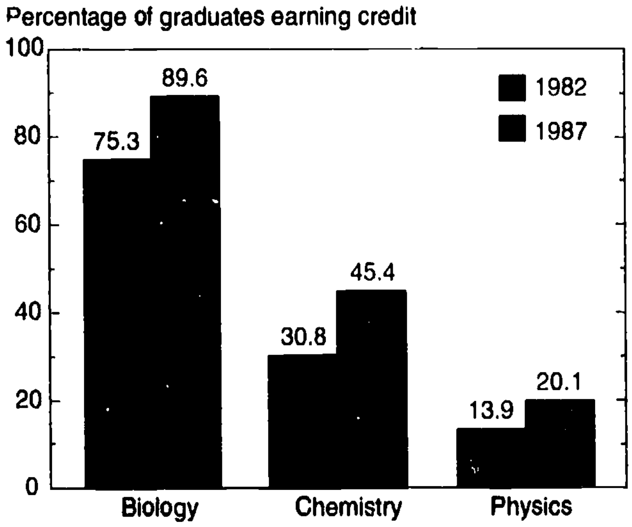
Text table 1-3.
**Average number of course credits earned by high school graduates in science and mathematics**

| | Science credits | Math credits |
|---|---|---|
| 1969 | 2.23 | 2.47 |
| 1975-78 | 2.26 | 2.35 |
| 1979-81 | 2.18 | 2.44 |
| 1982 | 2.17 | 2.55 |
| 1987 | 2.51 | 3.02 |

SOURCE: J. Tuma, A. Gifford, D. Harde, E.G. Hoachlander, and L. Horn, *Course Enrollment Patterns in Public Secondary Schools, 1969 to 1987* (Berkeley, CA: MPR Associates, Inc., 1989).

*Science & Engineering Indicators – 1991*

Figure 1-11.
**High school 1982 and 1987 graduates who earned science course credit**

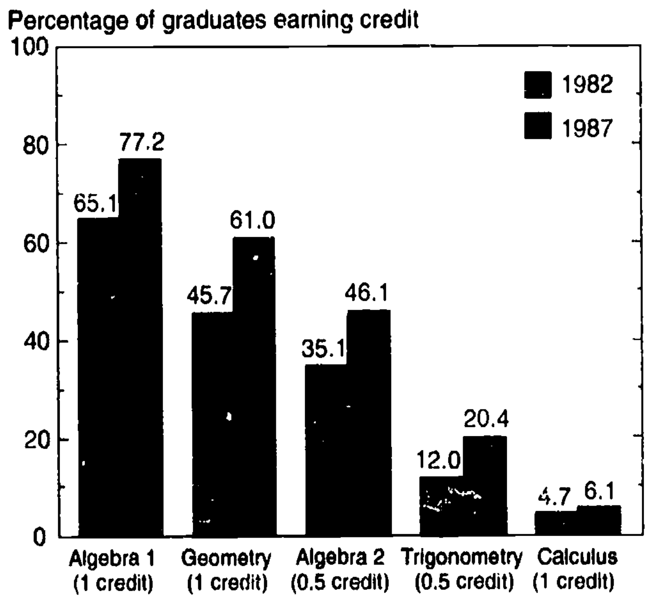



SOURCE: Westat, Inc., *Tabulations: Nation At Risk Update Study as Part of the 1987 High School Transcript Study* (Rockville, MD: 1988).

*Science & Engineering Indicators – 1991*

In the 1990 NAEP science assessment, general science and biology were the only courses reported by a majority of 17-year-olds as having been studied for at least 1 year. (See appendix table 1-13.) Only 1 in 10 of the students reported taking physics for a year or more.

Figure 1-12.
**High school 1982 and 1987 graduates who earned mathematics course credit**




SOURCE: Westat, Inc., *Tabulations: Nation At Risk Update Study as Part of the 1987 High School Transcript Study* (Rockville, MD: 1988).

*Science & Engineering Indicators – 1991*

Compared with 1982, significantly higher percentages of students reported having studied physical science, earth and space sciences, biology, and chemistry, with the largest increases occurring in chemistry and biology. The national trends were similar for both males and females and for white, black, and Hispanic students.

In mathematics, the NAEP assessment showed that higher percentages of 17-year-old students took upper-level courses such as algebra 2 in 1990 than in 1978. (See appendix table 1-14.) Thus, in 1990, more students completed the sequence of algebra 1, geometry, and algebra 2 than in 1978. Only relatively small numbers of 17-year-old students—6 percent in 1978, 8 percent in 1990—reported having taken precalculus or calculus.

***State-Level Enrollment.*** A study conducted in the 1989/90 school year by the Council of Chief State School Officers (CCSSO) indicated that secondary enrollment in biology had increased, while enrollment in chemistry and physics had essentially leveled off. The CCSSO study also found substantial differences in enrollment in secondary science courses among the states.[9] Chemistry, considered a gatekeeping course for continuing studies in science fields, ranged in enrollments from 26 percent (Idaho) to 62 percent (Connecticut). (See appendix table 1-15.) Eighteen of thirty-eight states had higher rates of enrollment in chemistry than the national average (45 percent). In first year physics, the state percentages varied from 10 percent in Oklahoma to 36 percent in Connecticut.

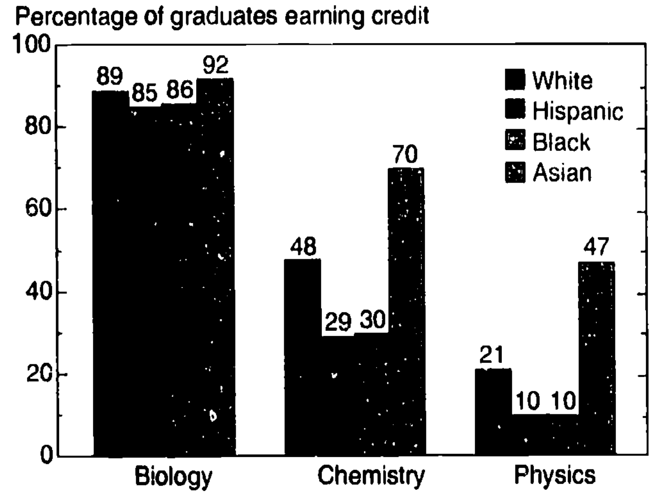
In mathematics, the CCSSO data also showed small continuing increases in three levels. By 1989/90, the estimated percentage of students taking algebra 1 had increased to 81 percent, algebra 2 increased to 49 percent, and enrollment in calculus classes increased to 9 percent. (See appendix table 1-16.) One of the important findings from the CCSSO study is the relatively small proportion of high school graduates—fewer than one-half—who took algebra 2. The state percentages of high school graduates who took algebra 2 varied from 29 percent in Wyoming to 65 percent in Montana.

***Enrollment by Females.*** Differences by gender in enrollments in both science and mathematics decreased over time. (See appendix tables 1-17 and 1-18.) In mathematics, males earned an average of 0.5 credits more than females in 1969, but by 1987 this difference had narrowed to 0.09 credits. Only slight differences separate males and females in the number of science credits earned. However, coursetaking patterns differ by gender. For example, in 1987, females tended to earn more credits in biology, and males tended to earn more credits in physics.

***Enrollment by Minorities.*** Asian students earned consistently more science and mathematics credits than any other racial/ethnic group, especially in chemistry and physics. (See figures 1-13 and 1-14.) Whites also tended to earn more science credits than black or Hispanic students. Racial/ethnic differences were not so pronounced in biology. (See appendix table 1-17.)

In mathematics, the more advanced the course, the more pronounced the difference in the number of credits earned by Asian students compared with other racial/ethnic groups. Between 1982 and 1987, the largest increases in the number of mathematics credits earned by Asians were in calculus and algebra. White students showed large increases in geometry; blacks, in geometry and algebra; and Hispanic students showed large

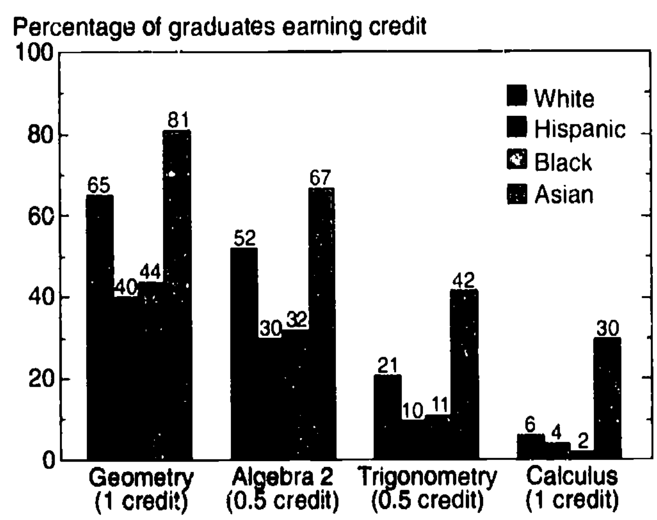
Figure 1-13.
**High school 1987 graduates who earned science course credit, by race/ethnicity**




SOURCE: J. Tuma, A. Gifford, D. Harde, E.G. Hoachlander, and L. Horn, *Course Enrollment Patterns in Public Secondary Schools, 1969 to 1987* (Berkeley, CA: MPR Associates, Inc., 1989).

*Science & Engineering Indicators – 1991*

Figure 1-14.
**High school 1987 graduates who earned mathematics course credit, by race/ethnicity**




SOURCE: J. Tuma, A. Gifford, D. Harde, E.G. Hoachlander, and L. Horn, *Course Enrollment Patterns in Public Secondary Schools, 1969 to 1987* (Berkeley, CA: MPR Associates, Inc., 1989).

*Science & Engineering Indicators – 1991*

---

[9]Data on course enrollment were reported by 38 states.

increases in the number of basic mathematics, algebra, and geometry course credits earned. (See appendix table 1-18.)

## School and Curriculum

This section examines factors that shape how students are taught—for example, how often they study a subject, how long they spend during these sessions, what activities predominate during the classes, and what "track" they are in. Beginning in grade 8, U.S. students are usually tracked into one of four kinds of mathematics classes (remedial, general, enriched, advanced), and students' achievement typically depends directly on the topics covered in these classes (Hafner and Horn in press, p. 48). In particular, this section emphasizes how tracking and related factors affect opportunities and access for groups underrepresented in science and mathematics.

### Classroom Activities

As part of the 1990 NAEP assessments, 9-year-old students were asked about their participation in several science activities in the classroom. These inquiries reflected research indicating that students learn science more effectively when they use scientific instruments and materials. According to the research, students are likely to begin to understand the natural world if they work directly with natural phenomena, using their senses to observe and using instruments to extend the power of their senses. The NAEP assessments also asked 17-year-old students about their classroom experience in mathematics. These questions reflected efforts to focus on mathematical problem-solving and logical/reasoning skills, learning to communicate mathematically, and making connections between the mathematics students study and its applications in other disciplines and activities (Mullis et al. 1991b).

The 1990 assessment showed a larger percentage of 9-year-olds using several types of scientific instruments (microscopes, calculators, and thermometers) than in 1977. However, the percentage who had done experiments with living plants decreased significantly, and the percentage of students who had used a scale or done experiments with batteries did not change significantly.

In mathematics, an attempt was made to find out the proportion of 17-year-olds who were engaged in active mathematics learning (for example, participating in discussions and making reports or completing projects), rather than passive activities (such as listening to the teacher and watching him or her do problems on the board). The results, termed "disappointing" by the NAEP researchers, showed that activities generally considered more student-centered remained far less prevalent than listening to teacher explanations, watching the teacher work problems, or taking tests. (See appendix table 1-19.) For example, most students reported that they "often" listened to a teacher explain a mathematics lesson, watched a teacher work mathematics problems on the board, and took mathematics tests, while only a small fraction of them reported that they often made reports or did projects in mathematics (Mullis et al. 1991b).

The NAEP results agreed with earlier surveys. When elementary and middle school teachers were asked in a 1985-86 survey to indicate what took place during their most recent science and mathematics classes, responses indicated that most of the lessons included lecture and discussion (Weiss 1987). Use of hands-on activities was far less frequent and became less so the higher the grade level. Particularly in science, use of hands-on activities was much more common in elementary science than in middle school classrooms.

In the National Education Longitudinal Study of 1988 (NELS:88),[10] 59 percent of the eighth grade students were in science classes where their teachers said that experiments were conducted at least once a week; 41 percent attended classes where teachers said that experiments were seldom conducted. (See appendix table 1-20.)

Other studies have examined how long classroom lessons tend to last and how much time teachers spend in total on a subject during a week. In the 1985-86 National Survey of Science and Mathematics Education, elementary teachers were asked to indicate the approximate number of minutes typically spent teaching science, mathematics, social studies, and reading. Only one-half of all third graders had science lessons on a frequent basis, and for those who did, teachers reported devoting an average of only 18 minutes a day to science instruction. These teachers spent twice as much time on mathematics instruction and four times as much on reading instruction. In grades 4-6, an average of 29 minutes per day was spent on science lessons, compared with 52 minutes on mathematics and 63 minutes on reading.

In the 1987/88 Schools and Staffing Survey (SASS), elementary teachers were asked how much time they spent per week teaching four core subjects—science, mathematics, social studies/history, and English/language arts. State-by-state data showed that the class time spent on science in grades 1-3 varied from 1.3 hours per week in Rhode Island to 3.5 hours in Texas and, in grades 4-6, from 2.2 hours per week in Utah to 4.1 hours in New Hampshire. (See appendix table 1-21.)

The time spent on mathematics/arithmetic in grades 1-3 varied from 4.2 hours per week in Ohio to 6.0 hours

[10]NELS:88 is a longitudinal survey sponsored by the U.S. Department of Education's National Center for Education Statistics. It surveyed 24,599 students in grade 8 and their parents, teachers, and school administrators. The student sample was selected from 1,035 public and private schools representing each of the 50 states and the District of Columbia. The students were administered tests of their knowledge of eighth grade science and mathematics and other subjects. The sampled subjects are being followed every 2 years through college and beyond to learn about their progress in school, their aspirations, their employment, and factors that affect their ability to complete their education.

## Science and Mathematics Curriculum Related to Student Learning and College Attendance

Several recent studies suggest that enrollment in certain courses has implications well beyond simple exposure to a certain body of knowledge. One of these studies, the LSAY, found a strong positive relationship between 12th grade students' ability to engage in abstract problem-solving and coursetaking in advanced mathematics (Miller et al. 1990). Specifically, the LSAY found that students who were enrolled in calculus courses had a much greater ability to solve abstract problems than those who were enrolled in "low math" courses. The same study found a similar result, although less pronounced, for science proficiency and student coursetaking: students who took physics were much better at understanding scientific systems or interacting processes than students who took "low science" courses.

Another longitudinal study of eighth grade students, NELS:88, found that students who were in an algebra or other advanced mathematics class were almost five times as likely as students in a regular mathematics class (in which fractions were taught as a major topic) to be proficient at higher level mathematics problem-solving. The same study found that students who were in science classes where experiments were conducted at least once a week had the highest scores on science achievement tests, while students who were in classes that only conducted experiments once a month or less had the lowest scores (Hafner and Horn in press).

Analyzing data from the High School and Beyond survey, a third study found that the best determinant of future college attendance was enrollment in high school geometry. Overall, a much lower proportion of minorities than whites attended college within 4 years of high school graduation. Among students who took geometry, however, this difference disappeared: 80 percent of black students in this group attended college, along with 82 percent of Hispanic students and 83 percent of whites. Even for students at the poverty level, taking geometry halved the gap in college attendance.

Fewer than one-third of students with no algebra or geometry in high school attended a college within 4 years of graduation, and only about 15 percent attended a 4-year college. (See text table 1-4.) By contrast, among students who took both algebra and geometry (about one-third of the high school population), more than four-fifths attended college—including community and junior college—and two-thirds attended a 4-year college within 4 years of graduation. Other high school courses associated with college attendance (but less so than geometry) were 1 year of laboratory science and 2 years of foreign language (Pelavin and Kane 1990).

The above information notwithstanding, analyses of student coursetaking cannot establish causal relationships for either student learning or college attendance. It cannot be determined, for example, whether students with higher proficiency are more likely than others to seek out rigorous courses or whether the courses themselves strengthen proficiency.

Text table 1-4.
**High school 1982 graduates who attended college within 4 years of graduation, by mathematics courses taken**

| Mathematics courses taken | Total | Within 4 years attended . . . Any college | A 4-year college |
|---|---|---|---|
| | Percent | | |
| All graduates | 100.0 | 55.4 | 36.9 |
| No advanced mathematics | 40.0 | 30.6 | 14.8 |
| Algebra only | 24.9 | 57.2 | 32.1 |
| Algebra and geometry | 34.9 | 82.6 | 65.6 |

SOURCE: S. Pelavin and M. Kane. *Changing the Odds: Factors Increasing Access to College* (New York: College Entrance Examination Board, 1990).

*Science & Engineering Indicators – 1991*

in the District of Columbia and, in grades 4-6, from 3.8 hours in Montana to 6.0 hours in Mississippi.

Tracking has a fundamental impact on what students study and thus what skills they have an opportunity to master, particularly in mathematics. The NELS:88 study found that approximately 29 percent of public school eighth graders reported attending an algebra or other advanced mathematics class, 17 percent attended general mathematics along with an algebra or accelerated program, 47 percent attended only general mathematics class, and 7 percent attended some sort of remedial class. Almost all of the eighth graders reported receiving science instruction.

### Barriers to Minority and Impoverished Students

Tracking programs—whether advanced or remedial—have a profound effect on the type of classroom instruction individuals receive. Those students who have shown an aptitude for mathematics are often given instruction in algebra and other more advanced subjects in grade 8.

Those who have not performed as well frequently have no access to mathematics classes that stress higher order thinking; instead, they are relegated to classes where learning computations involving fractions predominates. Evidence from the NELS:88 survey suggests that unequal opportunities to learn mathematics exist at the eighth grade level (Hafner and Horn in press).

The NELS:88 survey also found that blacks, Hispanics, Native Americans, and low socioeconomic status (SES) eighth grade students were all twice as likely as white students to be in remedial mathematics classes. Slightly fewer than half of low SES students were in mathematics classes where algebra was taught as a major topic compared with 75 percent of high SES students; 79 percent of low SES students and 52 percent of high SES students were in classes that emphasized the teaching of fractions as a major topic. Asian and white students were far more likely than blacks, Hispanics, or Native Americans to be in classes where algebra was a major topic. (See appendix table 1-22.)

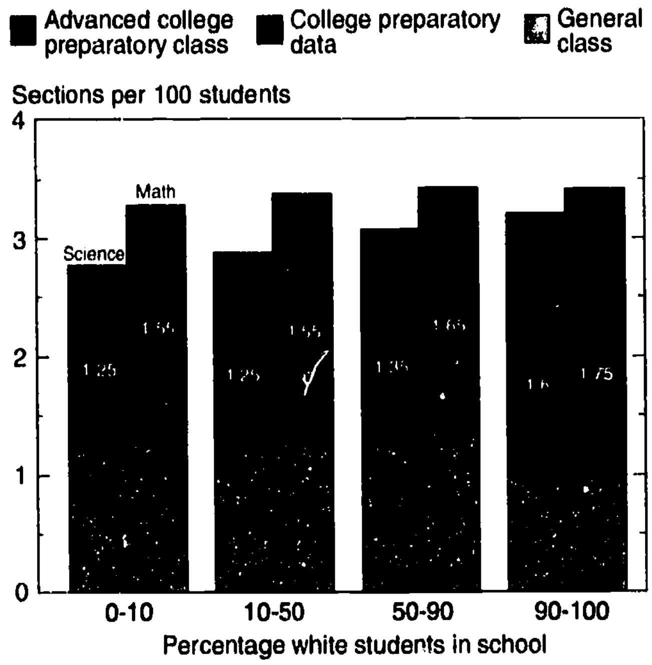
In science, only about 49 percent of low SES students were in classes where experiments were conducted at least once a week, compared with 72 percent of high SES students. Asian and white students were more likely than black, Hispanic, or Native American students to be in science classes that conducted experiments once a week or more. (See appendix table 1-20.)

Another recent study (Oakes 1990a) showed that high percentages of minorities faced several barriers to science and mathematics opportunities in secondary schools. First, their access to high-track science and mathematics classes diminished as the minority enrollment at their school increased. Second, minority students who attended racially mixed schools were more likely than their white peers to be placed in low-track classes. Third, minorities tended to have less access to "gatekeeping" courses at their schools, that is, courses that are especially important in qualifying students for college-level work in science and mathematics.[11]

***Minority Enrollment.*** The first of these barriers is demonstrated in figure 1-15, which shows the number of class sections in science and mathematics classified by the content and level of the class (general, college preparatory, or advanced college preparatory). Generally, as the proportion of minority students at a school increased, the relative proportion of college preparatory or advanced course sections decreased.

***Low-Track Classes.*** To determine the likelihood of minorities being placed in low-track classes, a recent study (Oakes 1990a) examined the proportion of secondary school science and mathematics classes at three

Figure 1-15.
**Sections of science and mathematics classes in high schools, by school racial composition: 1986**




SOURCE: J. Oakes, *Multiplying Inequalities: The Effects of Race, Social Class, and Tracking on Opportunities to Learn Mathematics and Science* (Santa Monica, CA: The RAND Corporation, 1990).

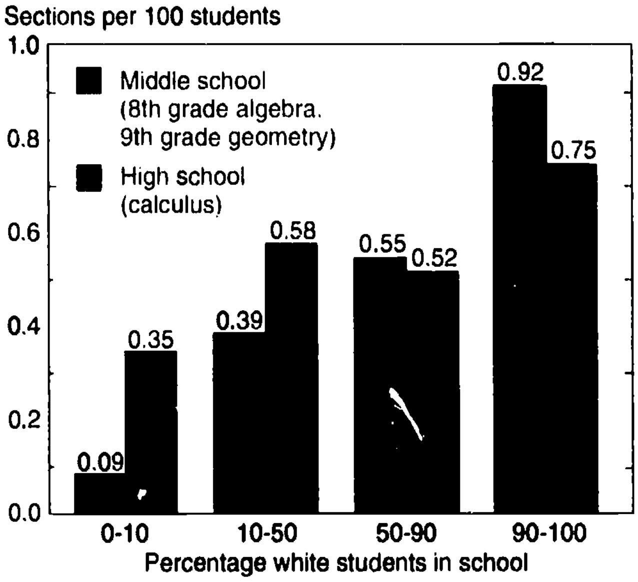
*Science & Engineering Indicators – 1991*

ability levels (as reported by classroom teachers) and by the racial composition of the classes. The proportion of high-ability classes increased significantly as the proportion of white students increased. Two-thirds of all classes whose minority enrollments were disproportionately high compared to the schools as a whole were judged by the teacher to be "low ability," while more than half of the classes with relatively high white enrollment were considered to be "high ability." Fewer than 1 in 10 of the classes with relatively high minority enrollment were classified as high ability by teachers of these classes. Thus, classes having disproportionately large numbers of minority students were seven times more likely than low-minority classes to be identified as low ability rather than high ability (Oakes 1990a, pp. 23-25).

***Gatekeeping Courses.*** Eighth grade algebra, ninth grade geometry, and high school calculus courses are considered "gatekeepers" because of their importance in the science and mathematics curriculum. Figure 1-16 shows the number of sections of these accelerated mathematics courses relative to the size of the student body of schools with high or low minority enrollment. In middle school, students attending predominantly white schools had far greater opportunities to take these gatekeeping courses. Among high schools that offered at least one section of calculus, racially mixed schools (10- to 90-percent white enrollment) had relatively comparable

[11]Analyses cited here are based on special tabulations of data from the National Survey of Science and Mathematics Education. For detailed information on this survey, see Weiss (1987).

Figure 1-16.
**Number of accelerated mathematics class sections offered, by school racial composition: 1986**




SOURCE: J. Oakes, *Multiplying Inequalities: The Effects of Race, Social Class, and Tracking on Opportunities to Learn Mathematics and Science* (Santa Monica, CA: The RAND Corporation, 1990).

*Science & Engineering Indicators – 1991*

numbers of sections of calculus per 100 students, but high-minority schools had far fewer sections than predominantly white schools.[12]

Oakes (p. 45) summarizes the study's major findings as follows:

> To the extent that they are enrolled in secondary schools where they are the majority, low-income students, African-Americans and Hispanics have less extensive and less demanding science and mathematics programs available to them, and they have considerably fewer opportunities to take the critical gatekeeping courses that prepare them to pursue science and mathematics study after high school.

## Teachers and Teaching

The quality of science and mathematics instruction that students receive is largely determined by the qualifications of their science and mathematics teachers (Shavelson, McDonnell, and Oakes 1989, p. 66). Although there is no consensus on what teacher qualifications are most important for effective teaching—or even on what constitutes good teaching—it is widely assumed that teacher competence is related to subject matter knowledge.

Past research on teacher quality indicators has been hindered by a general lack of nationally representative data bases. However, two recent large surveys of teachers and teaching conducted by the U.S. Department of Education—the Schools and Staffing Survey[13] and NELS:88[14]—permit examination of various indicators of the backgrounds and qualifications of science and mathematics teachers. More specifically, NELS:88 provided an indicator of teachers' educational background by collecting data on their coursetaking patterns. SASS reported on the match-up between (1) teachers' educational background and (2) their teaching assignments—a critical match-up from an instructional quality viewpoint.

This section focuses on these two broad topics—academic preparation and teaching assignments—to examine the issue of teacher quality in middle and high school science and mathematics classes. It also examines students' access to qualified teachers and, more broadly, the issue of teacher supply and demand.

### Teacher Training

NELS:88 found a positive relationship between teacher training in mathematics and student achievement in that subject. Mathematics proficiency among the eighth grade students in the survey was set at three proficiency levels:

- *Basic*—able to perform simple arithmetic operations on whole numbers;
- *Intermediate*—able to perform simple arithmetic operations with decimals, fractions, and roots; and
- *Advanced*—able to perform problem-solving, demonstrate required conceptual understanding, and/or develop a solution strategy.

Eighth grade students whose teachers had taken an advanced course in mathematics (defined as higher than college calculus) were more likely to be at the highest proficiency level than those students whose teachers had taken courses only at the calculus level or below. However, the relationship of student achievement to teacher coursetaking in mathematics education was mixed and therefore uncertain.

### Preparation: Middle School Teachers

SASS data suggest that large numbers of middle school teachers of science and mathematics could be classified as misassigned—that is, they may not be teaching courses appropriate for their training. Such misassignment can occur for any of several reasons. A school may, for instance, be too small to have a full-time chemistry or physics teacher and may assign classes in

[12] It should also be noted that this analysis included only high schools offering calculus, and that only about 50 percent of predominantly minority schools did so, compared with 80 percent of predominantly white schools (Oakes 1990a).

[13] SASS provides a snapshot of public and private elementary and secondary schools, principals, and other staff during the 1987/88 school year.

[14] A sample of the science and mathematics teachers of the NELS:88 students was included as part of the NELS:88 survey, and the college transcripts of these teachers were obtained to determine their coursetaking patterns. See footnote 10 for more information on NELS:88.

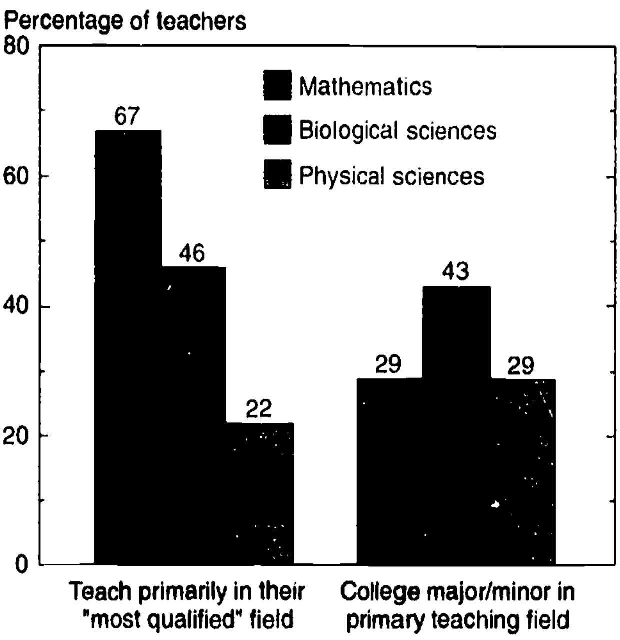
these topics to its biology teacher (Gilford and Tenenbaum 1990, p. 123). The misassignment, although understandable and frequently unavoidable, can affect the quality of instruction provided.

***"Best Qualified" Subjects.*** According to SASS data, fewer than half of all middle school teachers of biological sciences and only about one-fifth of teachers of physical sciences felt they were teaching the subject for which they were best qualified. Mathematics teachers were more sure of the appropriateness of their assignments. Two-thirds of teachers of middle school mathematics felt that they were teaching the subject they were best qualified to teach. (See figure 1-17.)

***College Coursework.*** Between 5 and 7 percent of all teachers of middle school science and mathematics had not taken any courses in the subject to which they were assigned. From 37 to 42 percent had taken 1 to 6 college courses, 27 to 35 percent had taken 7 to 12, and 22 to 26 percent had taken 13 or more college courses in the subject to which they were assigned. (See figure 1-18.)

***College Majors and Minors.*** In the sciences, 40 percent of teachers of middle school biological sciences had majored or minored in that subject in college; another 17 percent had majored or minored in science education. Among physical science teachers (chemistry and physics), 32 percent had majored or minored in that subject in college, and 16 percent had majored or minored in science education. Only 28 percent of middle school teachers of mathematics had majored or minored in that subject in college; an equal proportion had majored or minored in mathematics education.

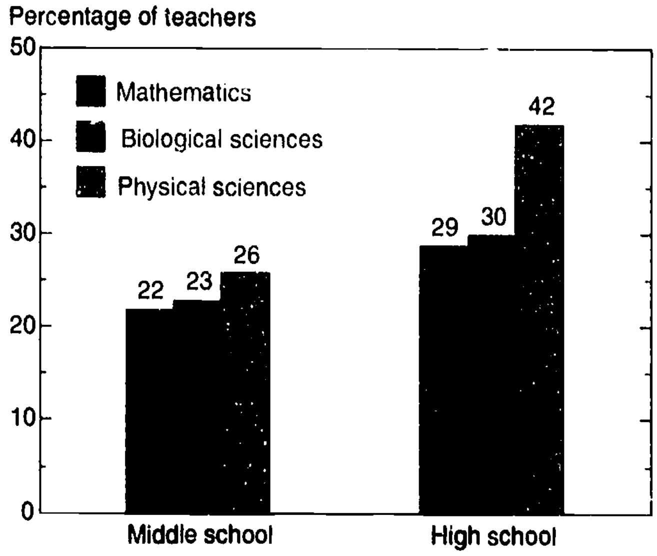
Figure 1-17.
**Qualifications of middle school teachers of science and mathematics: 1988**




SOURCE: National Center for Education Statistics, 1987/88 Schools and Staffing Survey, special tabulations by the RAND Corporation for the National Science Foundation.

*Science & Engineering Indicators – 1991*

Figure 1-18.
**Public school teachers who have taken 13 or more courses in their subject field: 1988**




SOURCE: National Center for Education Statistics, 1987/88 Schools and Staffing Survey, special tabulations by the RAND Corporation for the National Science Foundation.

*Science & Engineering Indicators – 1991*

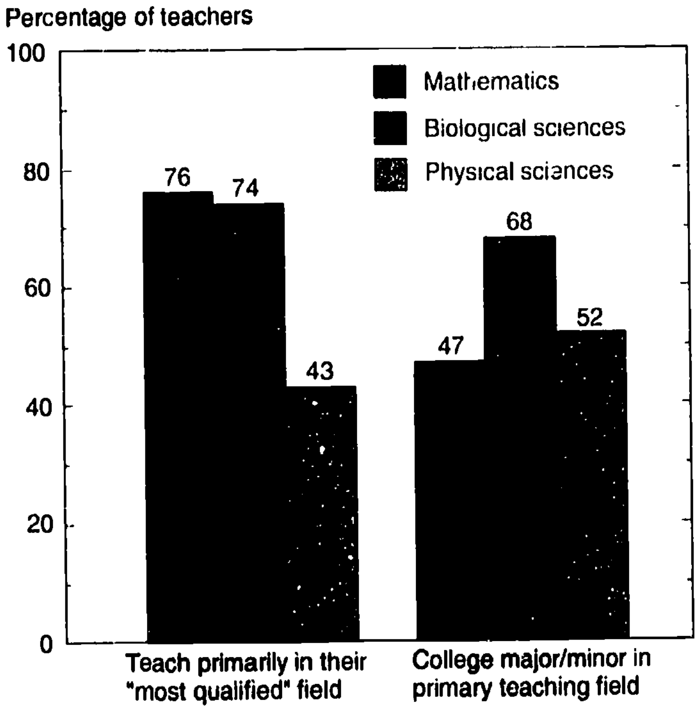
## Preparation: High School Teachers

***"Best Qualified" Subjects.*** Although teachers of high school science and mathematics appeared to have better qualifications to teach their assigned subjects than did their middle school counterparts, more than half of all teachers of physical sciences felt they were not assigned to the subject they were best qualified to teach. About one-quarter each of all teachers of biological sciences and mathematics expressed the same feeling. (See figure 1-19.)

***College Coursework.*** Four percent of teachers of science and mathematics had not taken any college courses in the subjects to which they were currently assigned. Nearly half of the teachers of high school mathematics had taken from 7 to 12 classes in college mathematics. More than 40 percent of physical science teachers had taken 13 or more college courses in the physical sciences; about 30 percent each of teachers of biological sciences and mathematics had taken a similar number of college courses. (See figure 1-18.)

***College Majors and Minors.*** Most high school science and mathematics teachers had pursued a college major or minor in the subject they taught. In mathematics, however, the proportion of teachers majoring/minoring in mathematics education was larger than the corresponding

Figure 1-19.
**Qualifications of high school teachers of science and mathematics: 1988**




SOURCE: National Center for Education Statistics, 1987/88 Schools and Staffing Survey, special tabulations by the RAND Corporation for the National Science Foundation.

*Science & Engineering Indicators – 1991*

these teachers were less likely to feel well-qualified to teach these subjects.

The qualifications of teachers of various track levels at low SES, high-minority, inner-city schools differed substantially from those of teachers at high-wealth, predominantly white, suburban schools. (See text table 1-5.) For example, only 39 percent of the teachers who taught low-ability classes in low SES, minority, inner-city schools were certified to teach science and mathematics at the secondary level, compared with 84 percent of the teachers at high-wealth, predominantly white, suburban schools. One of the most notable differences was that low-track students in the most advantaged schools (high SES, white, suburban) were likely to have better qualified teachers of science and mathematics than high-track students in the least advantaged schools (low SES, high minority, inner city) (Oakes 1990a).

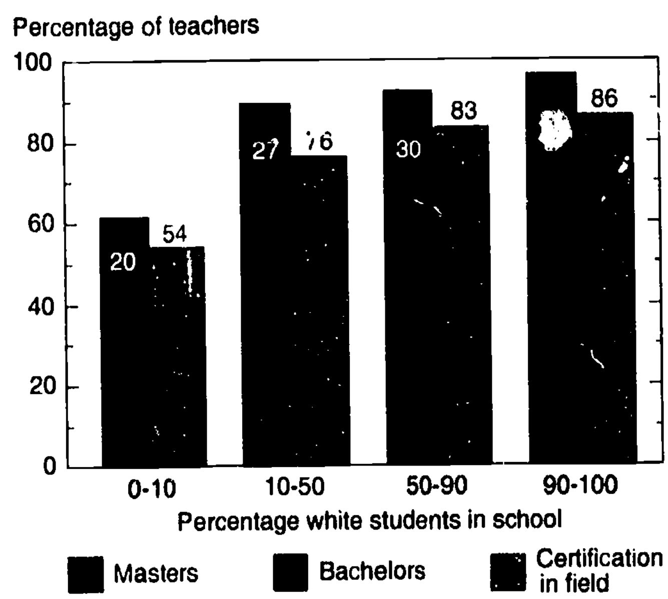
Eighty-four percent of public school students in the NELS:88 study had science teachers who felt well to very well-prepared to teach science.[15] But low SES students in middle schools were twice as likely as high SES students to have science teachers who felt only adequately prepared to teach science (16 versus 8 percent). Students in high-poverty schools (those in which more proportions of science teachers (28 percent for mathematics education compared with 17 and 16 percent, respectively, for biological sciences education and physical sciences education). Also, more than one-third of all high school teachers of physical sciences lacked a college degree in either the physical sciences or in physical science education. This finding is consistent with that of another study of secondary school teachers of physics (Neuschatz and Covalt 1988). In the second study, approximately one-third of all physics teachers were described as having their primary specialty in physics. Another third had begun their career in a different field but had taught physics regularly over the subsequent years; the remaining third were only occasional teachers of physics.

[15] In NELS:88, the teachers were asked to report how well-prepared they felt to teach their classes. Their choices were (1) very well-prepared, (2) well-prepared, (3) only adequately prepared, or (4) somewhat prepared or unprepared.

## Access to Qualified Teachers

Based on several measures of teacher qualifications (e.g., certification in science and mathematics and bachelors or masters degrees in these fields), it is clear that low-income and minority students have less access than other students to the best qualified science and mathematics teachers. As shown in figure 1-20, secondary schools with high proportions of economically disadvantaged and minority students employ teachers who, on the average, were less frequently certified to teach science and mathematics and were less likely to hold bachelors or masters degrees in these subjects. Moreover,

Figure 1-20.
**Degrees and certification of science and mathematics secondary school teachers, by school racial composition: 1987**




SOURCE: J. Oakes, *Multiplying Inequalities: The Effects of Race, Social Class, and Tracking on Opportunities to Learn Mathematics and Science* (Santa Monica, CA: The RAND Corporation, 1990).

*Science & Engineering Indicators – 1991*

Text table 1-5.
**Qualifications of secondary school teachers in high- and low-ability classes**

| Teacher qualifications | Low-ability classes: Low SES, minority, urban | Low-ability classes: High SES, white, suburban | High-ability classes: Low SES, minority, urban | High-ability classes: High SES, white, suburban |
|---|---|---|---|---|
| | Percentage of teachers | | | |
| Certified in science/mathematics | 39 | 82 | 73 | 84 |
| Bachelors in science/mathematics | 38 | 68 | 46 | 78 |
| Masters in science/mathematics | 8 | 32 | 10 | 48 |

SOURCE: J. Or  es, *Multiplying Inequalities: The Effects of Race, Social Class, and Tracking on Opportunities to Learn Mathematics and Science* (Santa Monica, CA: T e RAND Corporation, 1990).

*Science & Engineering Indicators –1991*

than 50 percent of students received free lunches) were seven times as likely as those in low-poverty schools (those with no free lunch programs) to have science teachers who reported they felt only adequately prepared to teach science.

## Teacher Supply and Demand

Recently, there has been increasing concern about shortages of qualified individuals to teach science and mathematics at the elementary and secondary school levels. The factors influencing teacher supply and demand include

- Changes in student enrollment;
- Changes in schooling policies and practices, e.g., increased graduation requirements; and
- The number of vacancies resulting from the creation of new positions and from teacher attrition.[16]

***Changes in Student Enrollment.*** Because of the rising number of annual births since 1977, enrollment will increase in elementary and secondary schools in the 1990s. This "echo" of the baby boom of the 1950s will cause increases in the preprimary and 5- to 17-year-old populations over the next decade (Gerald, Horn, and Husson 1989). Its effects are already being felt. Specifically, after declining during the early 1980s, total school enrollment increased to 45.4 million in 1988. Enrollment is projected to continue to increase, reaching 49.5 million by the year 2000. Secondary school enrollment alone is expected to increase from 12.6 million in 1990 to 14.9 million by 2000.

***Changes in School Policies.*** One study examined teacher supply and demand in relation to current reforms at the Federal, state, and local levels to improve the quality of education (Darling-Hammond 1984). The researchers concluded that these reforms will soon lead to critical shortages of qualified teachers unless (1) policies, such as those dealing with certification, that restrict the teaching profession are loosened and (2) teaching becomes an attractive career alternative for talented people. Otherwise, the researchers emphasized, schools will be forced to hire the less qualified to fill teaching vacancies; these teachers will then become the tenured workforce for the next several generations of schoolchildren.

***Attrition—Aging and Retirement.*** Evidence from state time series data showed that relatively few teachers had been hired because of low attrition rates.[17] However, both hiring and attrition rates are expected to increase over the next 15 years as midcareer teachers become eligible to retire and as expected enrollment increases open more positions and allow for more mobility and promotion (Center for the Study of the Teaching Profession 1989).

The SASS survey found that, of the approximately 250,000 secondary science and mathematics teachers in the United States, 19 percent of science teachers and 18 percent of mathematics teachers were at least 50 years old. (See figure 1-21.) Thus, the current science and mathematics teaching force faces the potential of losing up to 45,000 teachers over this decade through retirement. The same study also disclosed a relatively low commitment on the part of many teachers—especially new teachers—to staying in the teaching profession. For example, only 39 percent of new mathematics teachers and 46 percent of new science teachers said they would remain in teaching "as long as able" or "until eligible to retire." And more than one-third of the new teachers were undecided at the time surveyed as to how long they would remain in teaching. (See text table 1-6.)

[16] Although attrition is often considered a component of demand, it is also largely a supply factor, reflecting the decisions of individual teachers about whether to stay in or leave the teaching profession.

[17] Other reasons possibly contributing to the low hiring rates include the relatively stable school-age population in recent years, lack of state and local resources, and increased pupil-teacher ratios.

***Attrition—Job Satisfaction.*** Following up on a national sample of science and mathematics teachers from the 1985-86 National Survey of Science and Mathematics Education, Weiss and Boyd (1990) found that an average of 13,000 science and mathematics teachers left the profession annually. The annual rate of attrition for science and mathematics teachers (4.5 percent) was relatively low when compared with rates in other service professions such as nursing and social work. Nevertheless, at this rate, half of the current science and mathematics teaching corps will need to be replaced in 15 years.

The study researchers discovered that many current science and mathematics teachers were dissatisfied with various aspects of their jobs, citing adverse working conditions, student-related issues such as discipline problems, lack of adequate administrative support, low salaries and benefits, and a general lack of professional prestige. The followup study indicated that many teachers were dissatisfied with their salaries. (See figure 1-22.) Although fewer than 1 in 10 teachers named salaries as what they liked least about teaching, more than half cited higher teacher salaries as the single most important factor for teacher retention.

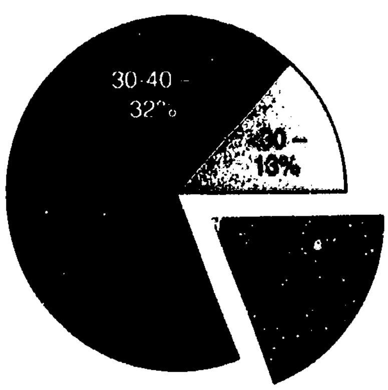
Text table 1-6.
**Plans of secondary school teachers of science and mathematics to remain in teaching**

| Teaching plans | Science: All teachers | Science: New teachers | Mathematics: All teachers | Mathematics: New teachers |
|---|---|---|---|---|
| | Percent | | | |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |
| Remain as long as able | 27.4 | 34.3 | 25.7 | 30.4 |
| Remain until eligible for retirement | 38.8 | 11.2 | 38.7 | 8.3 |
| Probably continue unless something better comes along | 13.9 | 13.8 | 17.1 | 22.5 |
| Definitely plan to leave as soon as can | 5.0 | 9.6 | 3.5 | 2.2 |
| Undecided at this time | 14.8 | 31.2 | 15.0 | 36.7 |

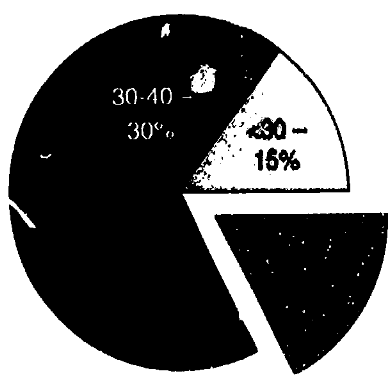
SOURCE: National Center for Education Statistics, 1987/88 Schools and Staffing Survey, special tabulations prepared by the RAND Corporation for the National Science Foundation.

*Science & Engineering Indicators – 1991*

Figure 1-21.
**Age distribution of science and mathematics secondary school teachers: 1988**




**Science**




**Mathematics**

SOURCE: National Center for Education Statistics, 1987/88 Schools and Staffing Survey, special tabulations by the RAND Corporation for the National Science Foundation.

*Science & Engineering Indicators – 1991*

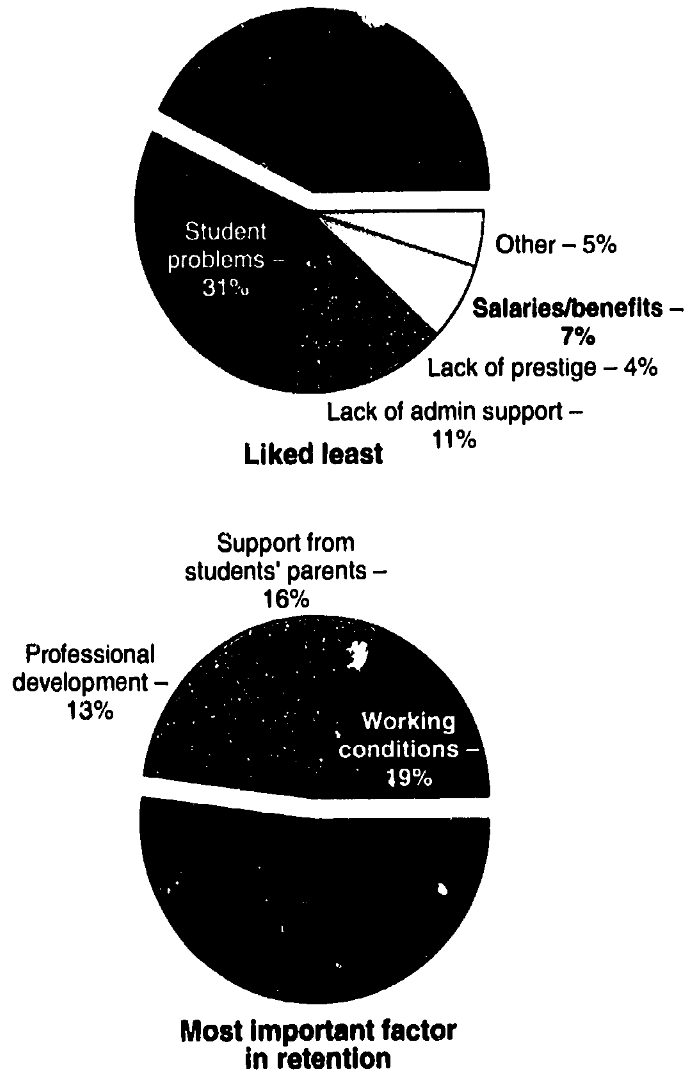
Other recent studies indicate that salaries and the opportunity to earn higher salaries in business and industry influence the median length of time that teachers remain in the teaching profession (Murnane and Olson 1989 and 1990). Analyzing data in teacher files in North Carolina, Michigan, and Colorado, researchers concluded that, depending on the state, an annual salary differential of $2,000 might induce teachers of science and mathematics to remain in the profession from 1 to 2 years longer than generally expected. New teachers were particularly susceptible to the influence of salary on career decisions. For example, chemistry and physics teachers who command higher salaries in nonteaching occupations were almost twice as likely to leave teaching during the first year of teaching as were social science teachers.

# The Policy Context

## National Initiatives and Reform Movements

Nationwide concern about the shortcomings of the American educational system sparked an unprecedented level of state activity during the 1980s. In almost every state, the education reform movement resulted in new legislation or state board regulations to increase standards for students; revise teacher licensure, training, and compensation practices; and/or enhance information about school performance (Fuhrman and Elmore 1990). In the wake of state-level efforts, national organizations established their own reform movements.

Figure 1-22.
**Teachers' opinions about science and mathematics teaching**




SOURCE: I.R. Weiss and S.E. Boyd, *Where Are They Now?: A Follow-up Study of the 1985-86 Science and Mathematics Teaching Force* (Chapel Hill, NC: Horizon Research, Inc., 1990).

*Science & Engineering Indicators – 1991*

This section describes significant, ongoing national and state initiatives to improve education quality, particularly in the area of science and mathematics. It also covers the effects of state-level reform on local education entities and classroom practices and highlights a special survey of state legislators gauging their reactions to educational reforms.

## The Federal Role

In 1989, the President and the 50 state governors adopted six ambitious national education goals, three of which related directly to precollege science and mathematics. (See "Students: Achievement, Interest, and Coursework, p. 16.) In addition, the President and governors provided policy guidance by developing specific objectives for each goal, with the following related specifically to precollege science and mathematics:

- The academic performance of elementary and secondary students will increase significantly in every quartile, and the distribution of minority students in each level will more closely reflect the student population as a whole.
- The percentage of students who demonstrate the ability to reason, solve problems, apply knowledge, and write and communicate effectively will increase substantially.
- Mathematics and science education will be strengthened throughout the system, especially in the early grades.
- The number of teachers with a substantive background in mathematics and science will increase by 50 percent.
- Every major American business will be involved in strengthening the connection between education and work.
- All workers will have the opportunity to acquire the knowledge and skills, from basic to highly technical, to adapt to emerging new technologies, work methods, and markets through public and private educational, vocational, technical, workplace, or other programs.

To coordinate the Federal portion of this effort, the Committee on Education and Human Resources (CEHR) was established in May 1990 under the Federal Coordinating Council for Science, Engineering, and Technology. The committee's initial challenge was to develop a systematic, comprehensive, and accurate inventory of existing Federal programs and budgets and to prepare a coordinated program budget for fiscal year (FY) 1992.

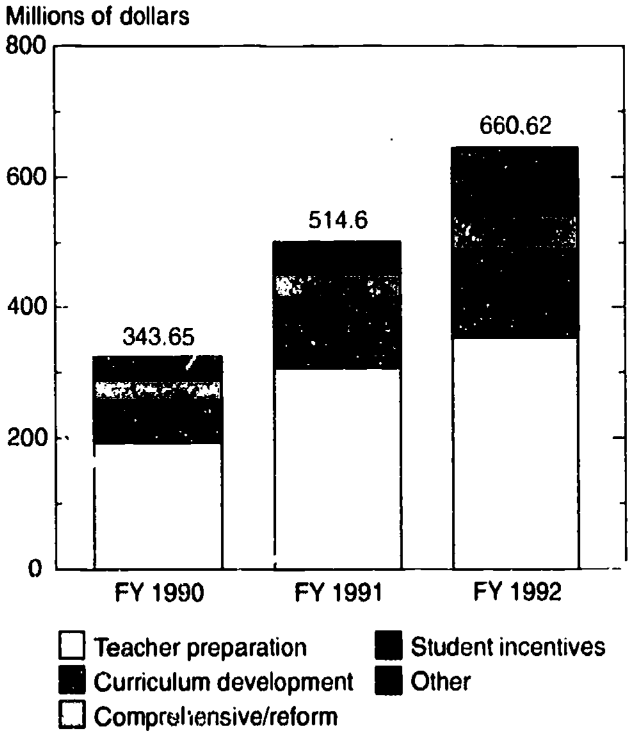
The committee established the following four budget planning priorities for the precollege level:

- Teacher preparation and enhancement;
- Curriculum and materials development, research in teaching and learning, program evaluation, dissemination, and technical assistance;
- Comprehensive programs/organization and systematic reform; and
- Student incentives and opportunities.

Throughout its planning, CEHR particularly emphasized (1) precollege education and (2) increasing the participation of groups currently underrepresented in science and mathematics fields.

Of the total FY 1992 budget request, 65 percent—$1.94 billion—was in precollege science and mathematics. Precollege activities accounted for $660.6 million, or 34 percent of the total (FCCSET 1991). The 1992 request represented a 28-percent increase over FY 1991 and a 92-percent increase over FY 1990. (See figure 1-23.) The Department of Education and NSF accounted for nearly

Figure 1-23.
**Federal investment in precollege science and mathematics education**




SOURCE: Federal Coordinating Council for Science, Engineering, and Technology. *By the Year 2000: Report of the FCCSET Committee on Education and Human Resources*, budget summary and final report, FY 1992 (Washington, DC: Office of Science and Technology Policy, 1991).

*Science & Engineering Indicators – 1991*

86 percent of the FY 1992 precollege budget request. (See appendix table 1-23.)

## Other National Efforts

Several national organizations independently launched parallel efforts to develop new support structures to help states and localities promote excellence in science and mathematics education. These efforts, highlighted below, include those of the National Council of Teachers of Mathematics (NCTM), the National Academy of Sciences/National Research Council, the American Association for the Advancement of Science (AAAS), and the National Science Teachers Association. These organizations adopted and released standards advocating fundamental changes in science and mathematics curriculum content, teaching approaches, and assessment techniques that place a strong emphasis on problem-solving and higher order thinking skills. These standards also maintain that all students can learn and that they deserve high-quality instruction.

***National Council of Teachers of Mathematics.*** NCTM undertook a monumental effort to set guidelines for mathematics curriculum and assessment. The standards encourage teaching and learning that (1) rely on applications of mathematics to relevant everyday problems and situations, (2) foster students' thinking skills, and (3) push them to use their minds to solve problems in unfamiliar and new settings and to discover alternative solutions. These standards also emphasize the use of calculators, computers, and other tools to relieve the tedium of hand calculations, provide a basis for more complex problem-solving situations, and engage students in mathematics learning. The standards advocate integrating teaching with assessment and evaluating what students know and how they think about mathematics (NCTM 1989 and 1990).

***National Research Council.*** NRC (1989) advocated a revitalization of school mathematics and emphasized how crucial it is for science, technology, and the economy that *all* students receive high-quality education in mathematics. Also under NRC auspices, the Mathematical Sciences Education Board (MSEB) prepared two reports on concepts and principles of mathematics. One, a statement of philosophy and curricular frameworks, provided a general structure to guide curriculum development for the future (MSEB 1990b). The other, on major strands of mathematical thought, was intended to stimulate creative development of new curricula that embody a broad interpretation of mathematics (MSEB 1990a). These actions, involving many different groups—mathematicians, scientists, educators, and administrators—were intended to form the basis of a national consensus for new directions in mathematics education.

***American Association for the Advancement of Science.*** AAAS (1989) emphasized the benefits of hands-on science experimentation and recommended that students engage more actively in "collecting, sorting, cataloging; observing, note-taking, and sketching; interviewing, polling, and surveying; and using hand lenses, microscopes, thermometers, cameras, and other common instruments" (p. 147).

***Other Efforts.*** Besides advocating significant changes in curriculum content, national organizations sought ways to help promote the changes recommended. For example, in a joint effort between AAAS and school districts, teams of teachers and researchers at six sites across the country designed curriculum and school structures for achieving the goals set forth in AAAS (1989) (see Rothman 1990, pp. 1, 21).

One current national science reform project is the Scope, Sequence, and Coordination (SS&C) project coordinated by the National Science Teachers Association. SS&C is an effort to undo the "layer cake" approach to science in which science classes are offered in discipline-specific classes (e.g., biology, chemistry, and physics) which are taken by progressively fewer students as they move into higher grades. SS&C aims to make science more attractive to students and encourage more students—especially minorities and females—to pursue

S&E careers. University educators and school teachers are working together to redesign science programs for schools in five pilot sites. Changes taking place include increased integration and coordination of the science disciplines, science instruction that progresses from the mostly empirical in the middle school grades to the increasingly theoretical and abstract in higher grades, and science courses covering fewer topics to provide students with more indepth coverage.

## State Reform Movements

To date, numerous education reforms have been enacted in every state. These reform efforts vary greatly in range and scope, but most of them basically address the need to improve academic standards and upgrade teacher quality.

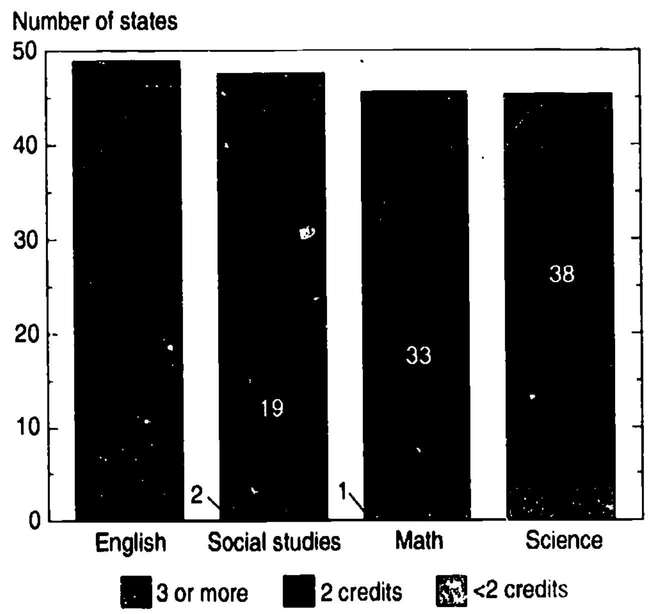
***Improving Academic Standards.*** In 1983, the National Commission on Excellence in Education recommended that high school students take a minimum of 4 years of English and 3 years each of mathematics, science, and social studies in order to graduate. By 1990, 4 states and territories required 3 years of science, and 12 required 3 in mathematics. (See figure 1-24.) States continued to upgrade their science and mathematics requirements. For example, from 1989 to 1990, one state increased its graduation requirements to 3 years of science, and two increased theirs to 3 years of mathematics.

Some local districts require more credits in these subjects for graduation than their states do, and many students are taking more science and mathematics credits than their states require. A study by the Center for Policy Research in Education (CPRE) found that some districts had raised their requirements more than they otherwise would have in order to continue to exceed the state's minimum (Fuhrman 1991).

The CPRE study also found that science gained the most in terms of coursetaking and requirements during the 1980s. New science requirements were high relative to pre-existing coursetaking, and science coursetaking showed the largest and most consistent gains. Growth occurred primarily in beginning academic courses like physical sciences and earth sciences. In mathematics, fewer students took remedial courses such as basic mathematics and general mathematics, and more students took courses such as pre-algebra and algebra.

Another study of state policies and coursetaking in science and mathematics found that states that required 2.5 to 3 science credits had a median of 9 percent more students enrolled in science than states requiring 2 credits or less. The high-requirement states had a median of 4 percent more students taking upper-level science courses, e.g., chemistry, physics, and advanced biology. There was some evidence that a science graduation requirement above 2 credits was related to more upper-level science coursetaking, but the data were not conclusive because of the small number of states with higher science requirements.

Figure 1-24.
**Number of course credits required by states for high school graduation: 1990**




NOTE: Not all states reported for each field.

SOURCE: R.K. Blank and M. Dalkilic, *State Indicators of Science and Mathematics Education: 1990* (Washington, DC: Council of Chief State School Officers, 1991).

*Science & Engineering Indicators – 1991*

In mathematics, the same study showed that states requiring from 2.5 to 3 credits for graduation had a median of 10 percent more students taking mathematics courses than states requiring 2 credits or less. However, the high-requirement states had a median of only 2 percent more students taking upper-level courses, i.e., geometry through calculus. These results indicated that, on average, higher state graduation requirements did not necessarily lead to substantially more students taking upper-level mathematics courses, although there were a few individual state exceptions to this pattern (Blank and Dalkilic 1991, p. 1).

***Upgrading Teacher Quality.*** In a study of state policy issues pertaining to teachers and teaching, Fuhrman (1991) reached three conclusions concerning teacher shortages:

- The national problem was not as severe as predicted in the early 1980s,
- Shortages varied markedly by state, and
- Answers to questions about supply and demand of science and mathematics teachers varied with the criterion of teacher quality used.

Many states devised policies to increase the supply of teachers in science and mathematics. States increased the pay scale of teachers to retain and attract teachers and provided loans for students entering training in shortage fields. States also raised requirements for teacher certification in science and mathematics at

## Attitudes of State Legislators Toward Science and Mathematics Education Improvements

Although there have been many studies on the attitudes toward education reform of various educational leadership groups, little is known about the corresponding attitudes and policy preferences of state legislators. To answer this need, an annual sample survey of state legislators was launched in 1990 (Miller 1990).

***Are New Programs Needed?*** As part of the study, the legislators were asked if their states should initiate any new programs to improve science and mathematics education. Most of the legislators (80 percent) thought that some new programs were needed; however, one in five was not sure what those programs ought to be.

Among those who could identify specific programs for improving science and mathematics education, there was little consensus as to what should be done. A slim majority advocated solutions related to *program delivery,* including increased emphasis on the subjects in the classroom, longer school days, and longer school years. The second most popular set of recommendations involved *new curricula and materials.* Legislators' next-cited program preference focused on improved teacher training and increased teacher pay to yield *better qualified teachers.* The two least-cited program options were increasing state standards or requirements and establishing science and mathematics academies and magnet schools.

***Is Education Sufficiently Funded?*** When asked about state financial support, 56 percent of the legislators indicated that too little was being spent on public elementary and secondary education in their states. In fact, legislators placed elementary and secondary education near the top of their list of underfunded state programs. Only a third of those surveyed indicated that their states' educational funding was adequate; another 8 percent thought that their states were providing too much support to public education.

Although there was no consensus as to what areas of education should receive the highest funding priority, 16 percent of the legislators supported *improved teacher programs.* Another 13 percent cited a need for *preschool and elementary school programs.*

Interestingly, hardly any of the legislators identified improvements in science and mathematics education as the primary target of additional state spending. Given legislators' general recognition of problems in science and mathematics education, this finding could indicate that most state legislators viewed these problems as only one aspect of a broader set of educational reform issues to be addressed.

elementary and secondary levels. Some states passed alternative certification policies intended to attract noncertified college graduates to teaching, and many states instituted mandatory teacher assessments to ensure that new teachers (and, in two states, *all* teachers) met standards for verbal ability, knowledge of their teaching field, and knowledge of education in general (Blank and Dalkilic 1991, p. 26).

The age distribution of science and mathematics teachers indicated little likelihood nationwide of greater shortages of teachers in these subjects than in other subjects. The fields of chemistry and physics had slightly more teachers older than age 50 than other teaching fields, but all the science and mathematics fields had teachers younger than the average for all high school teachers. A shortage of science and mathematics teachers could be anticipated in a few states with much higher percentages of their teaching force older than age 50 than other states.

In some states, the majority of science and mathematics teachers majored in college in the subject they teach. But other states had relatively few teachers with majors in their subject. About half of all high school science and mathematics teachers had a college major in their assigned field. In most states, school districts were able to hire and assign state-certified science and mathematics teachers, but many of these teachers did not meet higher standards for preparation such as having a college major in their assigned field or meeting standards set by professional societies (Blank and Dalkilic 1991, p. 42).

### Impacts of State Reforms: Case Studies

Several assessments of state-level reforms have been undertaken by individual states, the Center for Policy Research in Education, and the Center for the Learning and Teaching of Elementary Subjects in conjunction with the National Center for Research on Teacher Education. In general, these assessments attempt to address some or all of the following issues:

- Were the policies successful?
- What were the effects of the reforms?
- How were reforms implemented at the local level?
- How have policies affected teachers' choices about teaching practices and course content?

***Success of Policies.*** Some state reforms that were initially seen as unlikely to be implemented by local school districts may be yielding more benefits than anticipated. For example, both California and South Carolina have been systematically tracking the effects of their education reform packages for 4 years. Both sets of assessments reveal that, although there is substantial room for improvement, many of the initiatives have been successfully implemented, have led to important changes in districts and schools, have raised targeted indicators of student performance, and have not—as many observers anticipated—left at-risk students behind (Murphy 1989, pp. 217-18).

***Effects of Reforms.*** In a study of educational reform in six states (Arizona, California, Florida, Georgia, Minnesota, and Pennsylvania) undertaken by CPRE, investigators concluded that educational reforms to increase high school graduation requirements exerted a powerful influence over schooling (Fuhrman and Elmore 1990, p. 86). Among other effects, these reforms led to different course offerings by many districts and schools, new coursetaking patterns by large numbers of students, more attention to the knowledge and skills addressed by standardized tests, and adjustments in teacher assignments. These changes were effected even though many districts had already met or exceeded the new requirements.

The study found that many local districts enacted policies of their own that exceeded the state mandates. As a result, low-achieving students were more affected than others by changes in minimum graduation requirements, because higher achieving students were already likely to be taking courses imposed by new state standards (CPRE 1990, p. 4). This local activity took a variety of forms, e.g., enacting policies in anticipation of high state mandates and using the state policies to achieve their own district objectives. For example, of the 24 districts studied in the 6 states, 10 had a strong form of curriculum frameworks, course syllabi, tests, textbooks, and (in some cases) teacher evaluation instruments to produce a more uniform curriculum across district schools.

***Implementation of Reforms.*** According to the findings of the CPRE study, states that had significant effects on local education agencies appeared to rely more on multiple mechanisms of influence than on direct control. The following are examples of successfully used mechanisms of influence.

- *Mobilization of professional and public opinion*—the school reform packages of at least four states in the CPRE sample were heavily influenced by organized business interests, which mobilized public opinion around highly visible statements of the rationale for education reforms.
- *Using information about performance to shape the local school district policy environment*—California and Florida published the results of state performance assessments, using their extensive information on school-level performance to shape the terms of debate about the success of educational reform and school effectiveness.

***Effects on Teachers' Choices.*** The CPRE study also found that new state and district policies appeared to have affected teaching practices less than course content. States and districts had revised curriculum guides and frameworks in an effort to lend greater emphasis to higher order thinking skills and problem-solving. But the study evidence suggested that state and district activity in this area affected teachers only sporadically. Some teachers adopted new practices, while others continued to use the same pedagogy and emphasize similar kinds of knowledge as before.

Problems associated with the implementation of policies to increase higher order skill teaching included the fact that only limited resources were devoted to staff development in this area. Also, laboratory work continued to play a relatively small role in most science classes because many schools had inadequate laboratory facilities and lacked chemicals and equipment necessary to conduct basic laboratory exercises.

Another study focused on changes in elementary school mathematics classroom teaching practices as they related to a newly enacted California state policy of teaching mathematics for understanding.[18] The policy reflected an effort to shift mathematics teaching from mechanical drill and memorization toward reasoning and understanding. Unlike many similar policies that either set broad goals or required that certain courses be taken, the California reform used the concept of instructional "alignment" to improve mathematics teaching and learning. In accordance with this concept, the state recast its curriculum guidelines, textbooks, and assessments to convey clear messages of change to both teachers and students.

The policy challenged basic beliefs about mathematics, about how students learn mathematics, and about how teachers perceive their role and conduct their classes. Based on preliminary analyses, teacher responses to the new policy appear to vary widely. Several of the teachers viewed mathematics rather traditionally, as a sequence of topics to be covered serially. These teachers organized the new content into the existing structure of traditional school mathematics. Some teachers saw the policy as a new source of teaching strategies and fully exploited the policy's recommendation to transmit material more effectively through such tactics as classroom games, filmstrips, and concrete models. Other teachers used these strategies too; however, these individuals used the strategies as simply a novel means of capturing students' attention in memorizing the traditional rules and procedures without giving students an opportunity to explore on their own. Consequently, these teachers, like the first group described, filtered the new mathematics instruction policy through the traditional structure of rote learning.

[18]This study included nine teachers in six different elementary schools (half of which were high SES schools and half of which were low) in three different California school districts (Cohen 1990).

## Summary

Following an outpouring of Federal, state, and local educational reform, overall student achievement in science and mathematics since 1977 is beginning to improve—but the levels are only at those attained around 1970. There are positive results in terms of equality of educational attainment: gaps in performance in science and mathematics between black and Hispanic students and their white peers are being reduced. Attainment in analytical and higher order skills remains low and substantially unchanged.

Why there has not been more progress is a matter of continuing national debate. One significant finding in this regard is that inadequate resources for staff development and for laboratory equipment have inhibited effective implementation of state and district policies to increase school teaching of higher order thinking and analytical skills.

Numerous national and international studies point to a number of aggregated and individual variables (most of which have been reported in this chapter) that appear to be positively related to educational success. But no matter how detailed and careful the statistical analysis, causal relationships cannot be inferred based on these data alone—whether students with higher proficiency seek out more rigorous courses in school and pursue them with more rigid academic vigor, or whether the courses themselves strengthen proficiency.

Applebee, Langer, and Mullis (1989, p. 6) draw the following conclusion about the current status and condition of education in the United States:

> American education is at a crossroads. While academic achievement appears to be improving after years of decline, the continuing lack of growth in higher-level skills suggests that more fundamental changes in curriculum and instruction may be needed in order to produce more substantial improvements. The educational system in this country needs to extend its focus from the teaching and learning of skills and content to include an emphasis on the purposeful use of skill and knowledge.

## References


Allen, R., N. Bettis, D. Kurfman, W. MacDonald, I. Mullis, and C. Salter. 1990. *The Geography Learning of High-School Seniors.* Princeton, NJ: National Assessment of Educational Progress, Educational Testing Service.

American Association for the Advancement of Science (AAAS). 1989. *Science For All Americans: Project 2061.* Washington, DC.

Applebee, A.N., J.A. Langer, and I.V. Mullis. 1989. *Crossroads in American Education: A Summary of Findings.* Princeton, NJ: Educational Testing Service.

Blank, R.K., and M. Dalkilic. 1991. *State Indicators of Science and Mathematics Education: 1990.* Washington, DC: Council of Chief State School Officers.

Boyd, S.E., and A.R. Crawford. 1989. *Why Do They Stay? A Study of Science and Mathematics Teacher Retention.* Chapel Hill, NC: Horizon Research, Inc.

Center for Policy Research in Education (CPRE). 1990. *Reform Up Close: A Classroom Analysis (A Progress Report to the National Science Foundation).* New Brunswick, NJ: Rutgers University.

Center for the Study of the Teaching Profession. 1989. *Annual Report, October 1988 to September 1989.*

Chaney, B. 1990. *Preliminary Draft of Report, NELS:88 Teacher Transcript Study.* Internal response to NSF. Rockville, MD: Westat, Inc.

Cohen, D.K., P.L. Peterson, et al. 1990. *Effects of State-Level Reform of Elementary School Mathematics Curriculum on Classroom Practice.* Final report of the Center for the Learning and Teaching of Elementary Subjects and National Center for Research on Teacher Education. East Lansing, MI: College of Education, Michigan State University.

Council of Chief State School Officers (CCSSO). 1988. *Geography Education and the States.* Washington, DC.

Darling-Hammond, L. 1984. *Beyond the Commission Reports: The Coming Crisis in Teaching.* Santa Monica, CA: The RAND Corporation.

Darling-Hammond, L., and L. Hudson. 1990. "Precollege Science and Mathematics Teachers: Supply, Demand, and Quality." In *Review of Research in Education*, No. 16, edited by C.B. Cazden. Washington, DC: American Educational Research Association, pp. 223-64.

Dossey, J.A., I.V. Mullis, M.M. Linguist, and D.L. Chambers. 1988. *The Mathematics Report Card: Are We Measuring Up?* Princeton, NJ: Educational Testing Service.

Educational Testing Service (ETS). 1989. *What Americans Study.* Princeton, NJ: Policy Information Center.

Federal Coordinating Council for Science, Engineering, and Technology (FCCSET). 1991. *By the Year 2000: Report of the FCCSET Committee on Education and Human Resources.* Budget summary and final report, FY 1992. Washington, DC: Office of Science and Technology Policy.

Fuhrman, S.H. 1991. "Preview of Findings for Reform Up Close." Special analysis prepared for the National Science Foundation. New Brunswick, NJ: Center for Policy Research in Education.

Fuhrman, S.H., and R.F. Elmore. 1990. "Understanding Local Control in the Wake of State Education Reform." *Educational Evaluation and Policy Analysis* Vol. 12, No. 1 (Spr[illegible]): 82-96.

Gerald, D.E., P.J. Horn, and W.J. Husson. 1989. *Projections of Education Statistics to 2000.* NCES 89-648. Washington, DC: National Center for Education Statistics.

Gilford, D., and E. Tenenbaum, eds. 1990. *Precollege Science and Mathematics Teachers: Monitoring Supply, Demand, and Quality.* Washington, DC: National Academy Press.

Grandy, J. 1990a. "In Search of the Next Generation of Scientists: A New Challenge for Teachers." *The College Board* No. 156 (Summer): 2-9 and 28.

———. 1990b. *Major Field Selection of High School Seniors Scoring Above the 90th Percentile in SAT Mathematics.* Princeton, NJ: Educational Testing Service.

Hafner, A., and L. Horn. In press. *Survey Report: A Profile of American Eighth Grade Mathematics and Science Instruction.* Washington, DC: National Center for Education Statistics.

Lapointe, A.E., N. Mead, and G.W. Phillips. 1989. *A World of Differences: An International Assessment of Mathematics and Science.* Princeton, NJ: Educational Testing Service.

Mathematical Sciences Education Board (MSEB). 1989. *Mathematics Education: Wellspring of U.S. Industrial Strength.* Report of a symposium. Washington, DC: National Academy Press.

———. 1990a. "On the Shoulders of Giants: New Approaches to Numeracy." Washington, DC: National Academy Press.

———. 1990b. "Reshaping School Mathematics: A Philosophy and Framework for Curriculum." Washington, DC: National Academy Press.

McKnight, et al. 1989. *The Underachieving Curriculum: Assessing U.S. School Mathematics From an International Perspective.* A national report on the Second International Mathematics Study. Champaign, IL: Stipes Publishing Company.

Miller, J.D. 1990. *1990 National Study of State Legislators: Attitudes Toward Science and Mathematics Education.* DeKalb, IL: Public Opinion Laboratory, Northern Illinois University.

Miller, J.D., et al. 1990. *Student Expectations of Careers in Science, Mathematics, or Engineering: Some Models from the Longitudinal Study of American Youth.* Draft report to the LSAY National Advisory Committee. DeKalb, IL: Northern Illinois University.

Mullis, I.V.S., J.A. Dossey, M.A. Foertsch, L.R. Jones, and C.A. Gentile. 1991a. "Trends in Academic Progress: Achievement of American Students in Science, 1970-90, Mathematics, 1973-90, Reading, 1971-90, and Writing, 1984-90." Review draft. Washington, DC: National Center for Education Statistics.

Mullis, I.V.S., J.A. Dossey, E.H. Owen, and G.W. Phillips. 1991b. *The State of Mathematics Achievement: NAEP's 1990 Assessment of the Nation and the Trial Assessment of the States.* Washington, DC: National Center for Education Statistics.

Mullis, I.V.S., and L.B. Jenkins. 1988. *The Science Report Card: Elements of Risk and Recovery.* Princeton, NJ: Educational Testing Service.

Mullis, I.V.S., E. Owen, and G. Phillips. 1990. *Accelerating Academic Progress: A Summary of Findings From 20 Years of NAEP.* Princeton, NJ: National Assessment of Educational Progress, Educational Testing Service.

Murnane, R.J., and R.J. Olson. 1989. "The Effects of Salaries and Opportunity Costs on Duration in Teaching: Evidence from Michigan." *Harvard Educational Review* Vol. 59, No. 3.

———. 1990. "The Effects of Salaries and Opportunity Costs on Length of Stay in Teaching: Evidence from North Carolina." *Journal of Human Resources* Vol. 25: 106-24.

Murnane, R.J., and S.A. Raizen, eds. 1988. *Improving Indicators of the Quality of Science and Mathematics Education in Grades K-12.* Washington, DC: National Academy Press.

Murphy, J. 1989. "Educational Reform in the 1980's: Explaining Some Surprising Success." *Educational Evaluation and Policy Analysis* Vol. 11, No. 3 (Fall): 209-21.

National Center for Education Statistics. 1991. *The STATE of Mathematics Achievement: Executive Summary.* Washington, DC: Department of Education.

———. 1991. *The STATE of Mathematics Achievement: NAEP's 1990 Assessment of the Nation and the Trial Assessment of the States.* Washington, DC: Department of Education.

National Center for Improving Science Education. 1989. *Getting Started in Science: A Blueprint for Elementary School Science Education.* Washington, DC.

National Council of Teachers of Mathematics (NCTM). 1989. *Curriculum and Evaluation Standards for School Mathematics.* Reston, VA.

———. 1990. *NCTM Professional Standards for Teaching Mathematics.* Reston, VA.

National Governors' Association. 1990. *Educating Americans: State Strategies for Achieving the National Education Goals.* Washington, DC.

National Research Council (NRC). 1989. *Everybody Counts: A Report to the Nation on the Future of Mathematics Education.* Washington, DC: National Academy Press.

Neuschatz, M., and M. Covalt. 1988. *1986-1987 Nationwide Survey of Secondary School Teachers of Physics.* Washington, DC: American Institute of Physics.

Oakes, J. 1990a. *Multiplying Inequalities: The Effects of Race, Social Class, and Tracking on Opportunities to Learn Mathematics and Science.* Santa Monica, CA: The RAND Corporation.

———. 1990b. "Opportunities, Achievement, and Choice: Women and Minority Students in Science and Mathematics." In *Review of Research in Education*, No. 16, edited by C.B. Cazden. Washington, DC: American Educational Research Association.

Pelavin, S., and M. Kane. 1990. *Changing the Odds: Factors Increasing Access to College.* New York: College Entrance Examination Board.

Raizen, S., and L. Jones, eds. 1985. *Indicators of Precollege Education in Science and Mathematics: A Preliminary Review.* Washington, DC: National Academy Press.

Rock, D., J.M. Pollack, and A. Hafner. 1990. "The Tested Achievement of the National Educational Longitudinal Study of 1988 Eighth Grade Class." Contractor report to the National Center for Education Statistics. Washington, DC.

Rothman, R. 1990. "Two Science Groups Decide to Tackle Reforms Together." *Education Week* Vol. 9, No. 30 (April): 1, 21.

Shavelson, R.J., L.M. McDonnell, and J. Oakes, eds. 1989. *Indicators for Monitoring Mathematics and Science Education: A Sourcebook.* R-3742-NSF/RC. Santa Monica, CA: The RAND Corporation.

Shavelson, R.J., L.M. McDonnell, J. Oakes, and N. Carey. 1987. *Indicator Systems for Monitoring Mathematics and Science Education.* Santa Monica, CA: The RAND Corporation.

Stevenson, H.W., M. Lummis, L. Shin-Ying, and J.W. Stigler. 1990. *Making the Grade in Mathematics: Elementary School Mathematics in the United States, Taiwan, and Japan.* Reston, VA: National Council for Teachers of Mathematics.

Stevenson, H.W., and L. Shin-Ying. 1990. *Contexts of Achievement.* Monographs of the Society for Research in Child Development. Serial No. 221, Vol. 55, Nos. 1-2.

Task Force on Women, Minorities, and the Handicapped in Science and Technology. 1988. *Changing America: The New Face of Science and Engineering.* Interim report. Washington, DC.

———. 1989. *Changing America: The New Face of Science and Engineering.* Final report. Washington, DC.

Tuma, J., A. Gifford, D. Harde, E.G. Hoachlander, and L. Horn. April 1989. *Course Enrollment Patterns in Public Secondary Schools, 1969 to 1987.* Berkeley, CA: MPR Associates, Inc.

Weiss, I.R. 1987. *Report of the 1985-86 National Survey of Science and Mathematics Education.* Research Triangle, NC: Research Triangle Institute.

Weiss, I.R., and S.E. Boyd. November 1990. *Where Are They Now?: A Follow-Up Study of the 1985-86 Science and Mathematics Teaching Force.* Chapel Hill, NC: Horizon Research, Inc.

Westat, Inc. 1988. *Tabulations: Nation At Risk Update Study as Part of the 1987 High School Transcript Study.* Rockville, MD.

# Chapter 2
# Higher Education in Science and Engineering

## CONTENTS

# Higher Education in Science and Engineering

## HIGHLIGHTS

### Characteristics of Higher Education Institutions

- **Research I universities dominate science and engineering (S&E) doctorate production; they also award a sizable proportion of S&E baccalaureates.** In 1988, research I universities, which accounted for about one-quarter of the U.S. academic institutions that offered S&E doctorate study, awarded two-thirds of the year's S&E doctorates. The 5 percent of baccalaureate-granting schools classified as research I produced 30 percent of S&E bachelors degrees. *See pp. 46-47.*

- **Tracing the baccalaureate institutional origins of recent S&E doctorate recipients reinforces the significant role played by research-intensive universities.** About two-fifths of the people who earned S&E doctorates between 1985 and 1990 had received their bachelors degrees at research-intensive universities. Another one-quarter received their baccalaureates from other doctorate-granting institutions. *See pp. 47-48.*

- **Comprehensive I schools are more significant in baccalaureate and masters S&E education than in doctoral studies.** Roughly 29 percent of S&E bachelors degrees and 21 percent of masters degrees were granted by comprehensive I schools in 1988. In contrast, these schools accounted for about 1 percent of S&E doctorates. *See pp. 46-47.*

### Undergraduate Students

- **In the late eighties, female undergraduates outnumbered males, and the proportion of undergraduates in their late 20s or older continued to grow.** Despite declining enrollments by the traditional college-age group (18- to 21-year-olds) in the eighties, undergraduate enrollments increased by almost 2 million. Some of this increase was due to greater participation in higher education by females, particularly older females. In 1988, females represented over half of both undergraduate enrollment and high school graduates. *See p. 48.*

- **Increasingly, undergraduates have been enrolling part time and attending 2-year institutions.** Part-time students made up over 40 percent of undergraduate enrollment in 1988; this proportion was up from 25 percent 10 years earlier. Enrollments in 2-year colleges have also risen significantly, accounting for more than half the growth in ov[illegible] undergraduate enrollments in the last 10 years. *See p. 48.*

### Freshman Characteristics

- **Among freshmen intending to major in S&E fields, the proportion choosing natural science steadily declined in the last 20 years; concurrently, interest in engineering, which had faltered, began to recover.** The percentages of S&E freshmen who planned a major in mathematics or the physical sciences declined between 1971 and 1990. Interest in engineering, on the other hand, continued to increase until the early eighties at which point it declined; the latter part of the eighties saw a slow increase in freshman interest. *See p. 49.*

- **Underrepresented minorities are less likely than whites and Asians to plan a major in S&E fields.** In 1990, roughly one-third of blacks, Native Americans, and Hispanics reported an S&E field as their probable major. In contrast, over two-fifths of Asians planned to major in science or engineering. *See p. 49.*

### S&E Degree Production and Graduate Enrollments

- **Undergraduate degree production declined during the 1980s in most S&E fields.** Over the decade, the number of degrees dropped in most natural and behavioral science fields but rose in the computer sciences. Between 1985 and 1989, the number of undergraduate degrees awarded dropped in virtually all S&E fields except the behavioral sciences. *See p. 50.*

- **Some leading indicators suggest that the decline in the proportion of bachelors degrees awarded in S&E fields may level off in the near future.** Data on freshman plans predict that the long-term decline in the proportion of natural science degrees may have bottomed out in 1990 and that recovery may be evident in the proportions of computer science and engineering degrees in 1992. Bachelors degrees in the behavioral sciences are likely to peak as a percentage of all baccalaureates in the early nineties. *See p. 52.*

### Financial Support

- **Financial support for graduate education has shifted somewhat toward non-Federal sources.** Non-Federal sources of financial support were reported by a majority (53 percent) of S&E graduate students in 1990, up from 48 percent 10 years earlier. During the same period, Federal sources, which had declined in the early eighties, began to rebound in the latter half of the decade. *See p. 57.*

### Foreign Participation in S&E Graduate Education

- **Participation by foreign citizens in U.S. S&E graduate programs has increased.** S&E graduate enrollment of foreign citizens increased by more than two-fifths during the eighties; in 1990, foreigners accounted for more than one-quarter of the graduate students in these fields. Similarly, among S&E doctorate recipients, foreign participation almost doubled over the decade. In 1990, about one in three S&E doctorate recipients was on either a temporary or permanent visa. *See pp. 58-59.*
- **Foreign citizens tend to concentrate on engineering and certain natural science fields rather than on the behavioral sciences.** In 1990, the majority of doctorates in engineering (57 percent) and mathematics (56 percent) were granted to non-U.S. citizens. In comparison, foreign students received 36 percent of the doctorates granted in the social sciences and only 6 percent of those in psychology. *See p. 59.*

### International Comparisons of Baccalaureate Production

- **There has been a rapid rise in bachelors degree production in natural science and engineering (NS&E) fields in Asia.** Between 1975 and 1988, NS&E degrees more than doubled in South Korea, Singapore, and Taiwan. The comparable increase in developed countries was 16 percent. *See p. 60.*
- **Participation in NS&E education is highest in the USSR.** About 9 percent of 22-year-olds in the USSR earned baccalaureates in NS&E fields in 1988, compared to 5 percent in the United States and 0.6 percent in China. *See pp. 61-62.*

## Introduction

### Chapter Focus

This chapter focuses on higher education in science and engineering (S&E). Specifically, indicators are examined for the following three topic areas:

- *Characteristics of U.S. institutions that grant degrees in S&E.* Exploring the characteristics of the different types of institutions that grant S&E degrees reveals the very different roles that these institutions play in the educational process. Classifying universities and colleges by broad categories shows differences by both degree level and discipline.
- *Characteristics of the U.S. student population at the undergraduate and graduate levels.* Trends in degree production and enrollments among the U.S. student population indicate two phenomena. At all educational levels, increasing percentages of the postsecondary population are made up of women and older students. Partially reflecting these demographic trends, there has been a marked decline in the choice of many S&E fields as areas of study, especially at the baccalaureate level.
- *International issues.* S&E education is becoming increasingly internationalized. For example, the number of foreign students studying at U.S. institutions, particularly at advanced degree levels, has grown so much more rapidly than that of U.S. students that foreign students now account for more than half of the doctorates awarded in some S&E fields. Another international issue involves the comparison of the number of S&E degrees awarded by various countries. For example, in Japan, about 6.4 percent of the college-age population received first university degrees in the natural sciences and engineering. In the United States, this proportion was 5 percent.

### Chapter Organization

This chapter is divided into five major sections. The first of these provides information on indicators related to the characteristics of U.S. institutions including (1) the different types of institutions that award S&E degrees at various levels and (2) baccalaureate origin institutions of recent S&E doctorate recipients.

The second and third sections cover topics related to the characteristics of American college freshmen and high school graduates; graduate enrollment in S&E programs; and S&E degree production at the baccalaureate, masters, and doctorate degree levels. The fourth section explores a related indicator, that of major sources of financial support reported by undergraduate and graduate students in U.S. institutions.

The final section of the chapter revolves around two issues of international comparison: (1) the increasing number of foreign students at U.S. colleges and universities and (2) degree production trends for selected countries, including six Asian countries.

### Characteristics of Higher Education Institutions

There are more than 3,000 institutions of higher education in the United States, playing a variety of roles at each degree level in the S&E education process. To assess and examine the different characteristics of these institutions, a classification scheme was developed by the Carnegie Foundation for the Advancement of Teaching (Carnegie 1987). Widely used by the academic community as a means of viewing the overall structure of the U.S. higher education system, the classification system was first introduced in 1970 and revised slightly in 1976 and 1987. See "Classification of Academic Institutions," p. 47, for a brief description of the Carnegie categories used in this chapter.

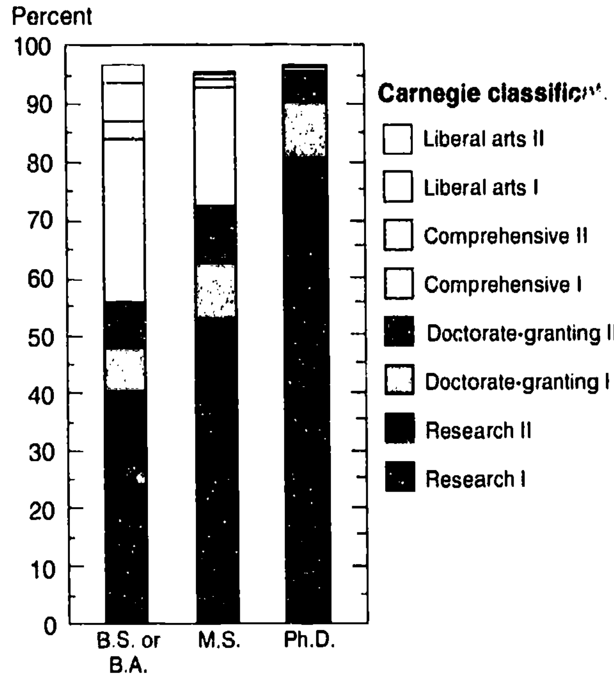
## Bachelors Level

Of the 1,700 institutions that granted baccalaureates, almost 1,400 granted degrees in S&E fields in 1988. (See text table 2-1.) Comprehensive I and liberal arts II schools accounted for over half of the institutions with S&E programs; research I and research II universities represented 5 and 2 percent, respectively, of all institutions offering S&E baccalaureates. These proportions change, however, by S&E field. For example, almost 17 percent of the schools offering undergraduate engineering degrees were in the research I category, while these schools represented 5 percent of undergraduate degrees in the natural sciences.

Research I and comprehensive I schools accounted for the largest fractions of S&E baccalaureates awarded: 30 percent and 29 percent in 1988. (See figure 2-1.) Liberal arts II schools, on the other hand, granted fewer than 4 percent of all S&E baccalaureates that year. Again, differences emerge by discipline. About two-fifths of all engineering graduates were from research I schools, and about one-third of natural science graduates attended comprehensive I institutions.

In terms of *percentage* of bachelors degrees awarded in science and engineering (i.e., S&E productivity),

Figure 2-1.
**Relative production of science and engineering degrees, by degree level and institution type: 1988**




See appendix tables 2-1, 2-2, and 2-3.
*Science & Engineering Indicators – 1991*

other types of institutions stood out. For example, almost 45 percent of the degrees awarded by liberal arts I schools were in S&E fields in 1988. Also, a third of the degrees in research II and doctorate-granting II schools were in these fields. In comparison, S&E degrees represented 25 and 20 percent, respectively, of the degrees awarded by comprehensive I and liberal arts II institutions. About 43 percent of the degrees conferred by research I schools were in science and engineering.

Historically black colleges and universities are vital to the undergraduate education of minorities in science and engineering. These schools comprise fewer than one-tenth of the number of institutions in the three Carnegie categories in which they are classified (comprehensive I and II and liberal arts II). Yet, historically black colleges and universities account for about one-third of natural science and engineering (NS&E) baccalaureates earned by minorities who are underrepresented in S&E (i.e., blacks, Native Americans, and Hispanics). In the aggregate, comprehensive I and II and liberal arts II schools graduate about 62 percent of minorities earning NS&E degrees.

Text table 2-1.
**Number of academic institutions with science and engineering (S&E) programs, by degree level: 1988**

| Type of institution | S&E bachelors programs | S&E masters programs | S&E doctorate programs |
|---|---|---|---|
| Total | 1,392 | 645 | 291 |
| Research I | 67 | 68 | 70 |
| Research II | 34 | 34 | 34 |
| Doctorate-granting I | 47 | 48 | 48 |
| Doctorate-granting II | 54 | 57 | 52 |
| Comprehensive | 394 | 275 | 35 |
| Comprehensive II | 163 | 43 | 2 |
| Liberal arts I | 138 | 28 | 3 |
| Liberal arts II | 380 | 26 | 1 |
| Two-year institutions | 15 | 0 | 0 |
| Specialized | 83 | 45 | 33 |
| Other | 11 | 19 | 13 |
| Not classified | 6 | 2 | 0 |

See appendix tables 2-1, 2-2, and 2-3.
*Science & Engineering Indicators – 1991*

## Masters Level

About 65,000 S&E masters degrees were awarded by 645 institutions in 1988. Comprehensive I schools made up the largest proportion of these masters-granting schools (43 percent); the next largest proportion (11 percent) was the research I category.

## Classification of Academic Institutions

Following are brief descriptions of the Carnegie categories used in this chapter (Carnegie 1987).

***Research I:*** institutions that offer a full range of baccalaureate programs, are committed to graduate education through the doctorate degree, and give high priority to research. They receive at least $33.5 million annually in Federal support and award at least 50 Ph.D. degrees each year.

***Research II:*** institutions that offer a full range of baccalaureate programs, are committed to graduate education through the doctorate degree, and give high priority to research. They receive between $12.5 and $33.5 million annually in Federal support and award at least 50 Ph.D. degrees each year.

***Doctorate-granting I:*** in addition to offering a full range of baccalaureate programs, the mission of these institutions includes a commitment to graduate education through the doctorate degree. They award at least 40 Ph.D. degrees annually in five or more academic disciplines.

***Doctorate-granting II:*** in addition to offering a full range of baccalaureate programs, the mission of these institutions includes a commitment to graduate education through the doctorate degree. They award at least 20 or more Ph.D. degrees annually in at least one discipline or 10 or more Ph.D. degrees in three or more disciplines.

***Comprehensive I:*** institutions that offer baccalaureate programs and, with few exceptions, graduate education through the masters degree. More than half of their baccalaureate degrees are awarded in two or more occupational or professional disciplines such as engineering or business administration. All of the institutions in this group enroll at least 2,500 students.

***Comprehensive II:*** institutions that award more than half of their baccalaureate degrees in two or more occupational or professional disciplines, such as engineering or business administration, and may also offer graduate education through the masters degree. All of the institutions in this group enroll between 1,500 and 2,500 students.

***Liberal arts I:*** highly selective institutions that are primarily undergraduate colleges that award more than half of their baccalaureate degrees in arts and science fields.

***Liberal arts II:*** primarily undergraduate colleges that are less selective and award more than half their degrees in liberal arts fields. This category includes a group of colleges that award fewer than half their degrees in liberal arts fields but, with fewer than 1,500 students, are too small to be considered comprehensive.

***Two-year community, junior, and technical colleges:*** institutions that offer certificate or degree programs through the associate degree level and, with few exceptions, offer no baccalaureate degrees.

***Professional schools and other specialized institutions:*** institutions that offer degrees ranging from the bachelors to the doctorate. At least half of the degrees awarded by these institutions are in a single specialized field. These institutions include theological seminaries, bible colleges, and other institutions offering degrees in religion; medical schools and centers; other separate health profession schools; law schools; engineering and technology schools; business and management schools; schools of art, music, and design; teachers colleges; and corporate-sponsored institutions.

S&E masters degree production is most highly concentrated in research I schools. Over two-fifths of the degrees awarded in 1988 were made by this type of school. By broad field, over half of engineering degrees and two-fifths of natural science degrees were from research I schools. In the social sciences and psychology, on the other hand, research I schools accounted for slightly more than one-quarter of degrees; comprehensive I schools accounted for another three-tenths.

### Doctorate Level

The production of S&E doctoral degrees is concentrated in fewer than 300 institutions. Almost 70 percent of these schools were research or doctorate-granting institutions. The 300 doctorate-granting institutions awarded almost 21,000 S&E degrees in 1988.

Regardless of S&E field, research I schools produce [illegible] majority of S&E Ph.D. recipients. In 1988, more than two-thirds of natural science doctorates and almost three-quarters of engineering doctorates were conferred by research I institutions. Similarly, these schools accounted for over half of all social science and psychology doctorates awarded.

### Baccalaureate Institutions Attended by S&E Doctorate Recipients[1]

Recent S&E doctorate recipients cited approximately 1,400 U.S. colleges and universities as the sources of their undergraduate degrees. Using the Carnegie classification to examine the types of source institutions indicates that these are concentrated in two major

[1] This section explores the baccalaureate origin institutions for doctorate-holders who received their S&E Ph.D. degrees in academic years 1985-90. Cohorts were combined to ensure an adequate number of cases for analysis. Data in this section are from SRS (forthcoming [c]).

categories. These categories—research and doctorate-granting institutions—accounted for about two-thirds of the baccalaureate degrees awarded to new doctorate recipients; interestingly, together they represented only about 15 percent of the 1,400 schools.

Type of institution varied somewhat by field. For example, roughly half of the individuals who held Ph.D. degrees in either the computer sciences, agricultural science, or engineering received their bachelors degrees at a research university. Among psychology and social science Ph.D. recipients, on the other hand, about one-third earned baccalaureates from these schools.

Although research and other doctorate-granting schools are the primary S&E baccalaureate origin institutions of recent S&E Ph.D. recipients, non-doctorate-granting institutions are also significant. For example, about one-fifth of new Ph.D. recipients earned their undergraduate degrees from comprehensive institutions. These schools were especially prominent as institutional origins for Ph.D. recipients in the physical, biological, and social sciences and psychology. In addition, liberal arts colleges served as the baccalaureate origin institutions for 14 percent of new doctorate recipients.

## Undergraduate S&E Student Population

### Recent Trends in College Enrollments[2]

The composition of the undergraduate student body as a whole has changed markedly over the last 25 years. Increasingly over this period, higher fractions of undergraduates were

- Older,
- Female,
- Attending school part time,
- Attending 2-year institutions, and/or
- Returning to school after an interruption in their studies.

Larger fractions of these students contributed heavily to the unexpectedly high increases in undergraduate enrollment over the last decade. Many of these students, however, are less prone to earn bachelors degrees in S&E fields. Consequently, S&E degree production did not keep pace with growth in overall enrollment. Factors in this growth are described below.

In the last two decades, undergraduate enrollment grew considerably faster than did the traditional undergraduate age group (18- to 21-year-olds). Concurrent with the decline in this group was an increased demand for higher education by *all age groups*. The percentage of 18- to 24-year-olds enrolled as undergraduates rose from about 24 percent in the late seventies to 28 percent in 1989. For 25- to 44-year-olds, the increase was proportional to that of the younger group, rising from 4.5 percent to 5.3 percent.

*Women* are participating in postsecondary education in much greater numbers. By 1988, they comprised a greater share of undergraduate enrollment than they did of high school graduates: 54 percent versus 51 percent. Twenty years earlier, these percentages were 42 and 51, respectively.

*Part-time enrollment* in undergraduate programs rose significantly between 1979 and 1989. More than two-fifths of undergraduate students were enrolled on a part-time basis, up from about one-quarter. This increase reflects three trends: (1) a rising tendency among older women to return to college after dropping out to start families and/or work full time, (2) an increase in 2-year college enrollments, and (3) an increase in students who either delay entry to college or extend the period of their studies past the traditional 4 years.

Concomitant with growth in part-time enrollments is growth in *2-year college enrollments*. More than half of the increase in undergraduate students was accounted for in 2-year institutions. In addition, the share of all undergraduates who were enrolled part time in 2-year schools rose from 11 to 27 percent. Female part-time students accounted for two-thirds of the increase. In 1989, females accounted for 16 percent of part-time students at 2-year institutions, up from 5 percent in 1967. The increase in 2-year college enrollments of women reflects many factors, including the relative affordability of 2-year institutions and the larger number of evening classes offered by these schools.

Finally, a greater number of students appear to be either *returning to school* after interrupting their studies or beginning their studies several years after graduating from high school. An indication of these trends is that the number of first-time freshmen at 4-year universities and colleges remained fairly level over the last two decades, even though overall enrollments increased dramatically.

### Characteristics of American College Freshmen[3]

This section explores trends in the following selected characteristics of first-time full-time freshmen enrolled in 4-year universities and colleges over the last 20 years:

[2]This section discusses trends in undergraduate enrollments *overall*, not just in S&E programs.

[3]Data in this section are from the Higher Education Research Institute, University of California at Los Angeles, the American Freshmen Norm Survey, unpublished tabulations. Note that although the institutional population for this survey is drawn from all "eligible" institutions of higher education (i.e., all institutions that were operating at the time of the survey and had a freshman class of at least 25 students) listed in the annual U.S. Department of Education *Education Directory*, the actual sample is self-selected. For example, of the 2,725 eligible institutions invited to participate in the 1989 survey, 599 responded. Any biases that may result from this selection process are corrected in the stratification scheme.

- High school grades,
- Parents' education and occupations,
- Planned majors,
- Planned careers, and
- Highest degree planned.

***High School Grades.*** In the last two decades, grades reported by freshmen who intended to major in a science or engineering field leveled off after an initial increase. For example, the average percentage citing their high school grades in the "mostly A or A+" range rose from 10 percent in 1971 to 20 percent in 1978 but remained around 20 percent through 1990. The percentage of S&E students showing a B average or better has been about 80 percent since the early seventies. In comparison, over most of the last two decades, the distribution of grades reported by freshmen majoring in non-S&E fields was about 10 percent in the A range and about 70 percent in the B or better category.

***Parents' Education and Occupations.*** Between 1971 and 1990, there was a steady increase in the education levels of S&E freshmen's parents. For example, the fraction of fathers who held bachelors degrees rose from 22 to 23 percent, while the proportion of mothers who had earned these degrees increased from 18 to 23 percent. In addition, the proportion of fathers who held graduate degrees rose from 13 percent to 24 percent; for mothers, the increase was from 4 to 13 percent.

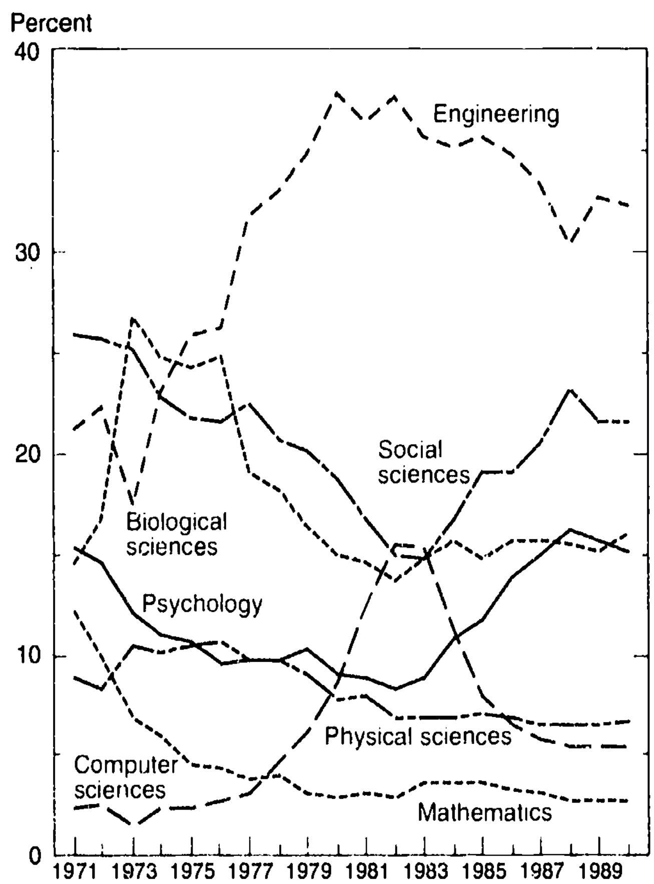
Regarding parental occupations reported by S&E freshmen, virtually no change was evident between 1971 and 1990 in the distribution of fathers' occupations. There was, however, a shift in the fraction who reported that their mothers held professional jobs. While the proportion of mothers who worked as skilled or semi-skilled operatives remained steady at 5 percent throughout this period, the proportion working as lawyers, health professionals, teachers, and clergy rose from 12 percent to 23 percent. Mothers' representation in business occupations also increased, rising from 5 to 14 percent.

***Planned Majors.***[1] The most notable changes in the planned S&E majors of college freshmen over the last two decades were in the fields of engineering, the computer sciences, and the social sciences. Interest in engineering as a probable major peaked in the early eighties, declined, and began to rise again at the end of the decade. Interest in the computer sciences also peaked in the early eighties but has not shown any recovery. In contrast, majors in the social sciences have increased steadily after a two-decade low in 1983. (See figure 2-2 for a more complete picture of the changes in distribution of freshmen's planned S&E majors.) Much of the rise in students planning to major in the social sciences and psychology is attributable to female freshmen. In 1990 about 55 percent of female S&E freshmen chose these fields of study, up from 39 percent in the early eighties.

Examining intended majors by racial/ethnic group reveals that members of those minorities that are underrepresented in S&E—blacks, Native Americans, and Hispanics—are less likely to choose an S&E field than are other groups. In 1990, about one-third of blacks, Native Americans, and Hispanics planned to major in an S&E field, while over two-fifths of Asian freshmen did so. By field, underrepresented minorities are more apt to choose social science or psychology fields; Asians are more inclined toward the physical sciences and engineering.

***Planned Careers.*** In 1990, engineering was the probable career chosen by the largest fraction of freshmen planning an S&E major (28 percent). Law (10 percent) and scientific research (6 percent) were the next most frequently cited occupations. (See figure 2-3.) Since 1970, the proportions of S&E freshmen choosing these three careers have differed substantially. While the fraction choosing law practically doubled over the 20-year period, interest in scientific research careers dropped by a third. Interest in engineering careers, on the other hand, followed a pattern similar to those of freshman intentions and baccalaureate production in the field: Interest peaked in the early eighties, declined, and began to rise again in the latter part of the decade.

Figure 2-2.
**Intended science and engineering majors of American freshmen**




See appendix table 2-5. *Science & Engineering Indicators – 1991*

[1]Data on agricultural sciences are not included in S&E fields for American freshmen.

Differences in career plans emerge when examined by gender. For example, 40 percent of male freshmen chose engineering; another 6 percent planned a computer programming career. Among female freshmen, the proportions citing these career choices were about 12 and 4 percent, respectively. Females were more inclined toward careers in psychology or social work than males (18 percent versus 2 percent). Females were also more likely to be undecided about their career plans than males (11 versus 7 percent).

***Highest Degree Planned.*** Interest in earning advanced degrees edged upward among S&E freshmen over the last two decades. For example, the fraction planning to earn a Ph.D. increased from 19 percent in the early seventies to 25 percent in 1990. In contrast, those who cited the baccalaureate as their highest degree planned fell from 31 to 19 percent. This general pattern of degree plans also existed among freshmen choosing non-S&E majors, although the largest increase for those students was in the proportion planning to earn a masters degree: 29 percent in 1971 to 42 percent in 1990.

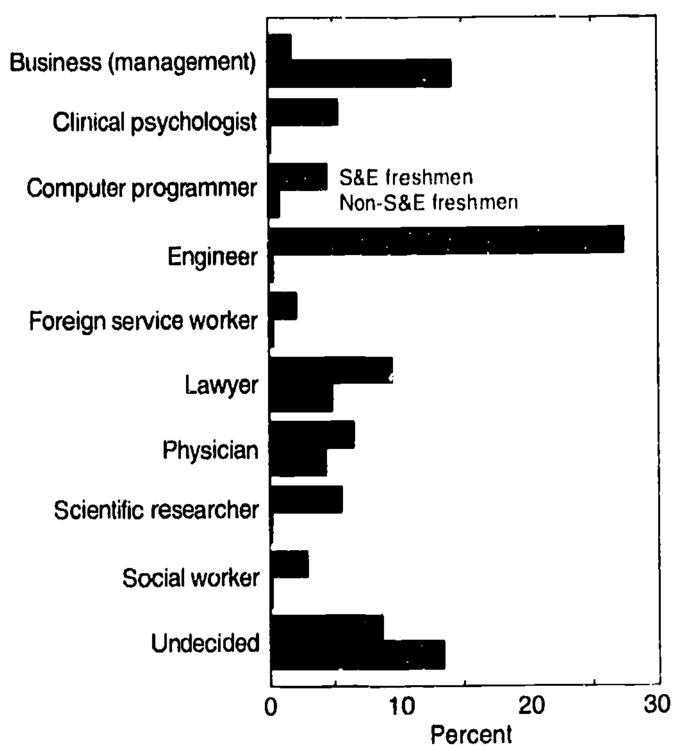
## Engineering Enrollments

In most fields, especially the sciences, students are not required to declare their majors until the second or third year. Exceptions to this general rule are engineering and engineering technologies. Undergraduate programs in these fields are often professional curricula that start in the first year. Surveys by the Engineering Manpower Commission provide trend data on full- and part-time engineering and engineering technology enrollments in both baccalaureate and 2-year programs.[5] Data on first-year enrollments in these fields provide early indicators of future degree production patterns as well as changes in student preferences toward engineering study.

Full-time enrollments in engineering programs rose from the late seventies until the early eighties and then fell sharply. In the fall of 1989, the number of freshmen enrolled in full-time engineering programs was about 95,000, down from a high of more than 115,000 during 1981 and 1982. (See figure 2-4.) Fluctuations in part-time enrollments indicate no consistent trend over the decade.

Trends in engineering technology programs mirror those in engineering. First-year enrollments dropped after the early eighties, although these numbers apparently stabilized in the latter part of the eighties. Comparatively, part-time enrollment in technology programs has been increasing during the last several years.

Figure 2-3.
**Probable careers of American freshmen in 1990**




See appendix table 2-5. *Science & Engineering Indicators – 1991*

## S&E Baccalaureate Production[6]

S&E bachelors degree production fluctuated during the 1980s. The number of S&E bachelors degrees awarded each year increased until about 1986, fell sharply in 1987 and 1988, and leveled off in 1989. Despite these fluctuations, people earning S&E baccalaureates accounted for increasingly larger fractions of the general population, rising from 68 per thousand 22-year-olds in 1980 to 84 in 1989.

In 1989, almost 308,000 bachelors degrees were awarded in S&E fields; these represented about 30 percent of all degrees granted in the United States. Although the trend in overall S&E degree production varied considerably, S&E degrees as a fraction of total degrees did not change markedly over the decade.

Annual growth rates of bachelors degrees within major S&E fields differed widely over the decade. (See figure 2-5 and figure O-15 in Overview.) Between 1980 and 1989, the numbers of degrees awarded in the physical, environmental, and life sciences all declined; in contrast, computer science baccalaureates rose dramatically.

Shorter term growth rates reveal a somewhat different picture. In the latter part of the eighties, 1985-89, degree production increased in the social sciences and

[5] Data are from Engineering Manpower Commission (1990). Enrollment data are collected on engineering programs approved by the Accreditation Board of Engineering and Technology. Upon successful completion of an engineering program, a student receives a bachelors degree or, in the case of a 5-year program, an engineering professional degree. Engineering technology programs are usually 2-year programs terminating in an associate degree; some technology programs, however, do offer 4-year programs of study.

[6] Data for bachelors degrees in S&E used in this section are from the National Center for Education Statistics's Annual Survey of Earned Degrees; the data have been adapted to National Science Foundation field classifications. See SRS (1991).

psychology but declined in virtually all major natural science fields and engineering.

In 1989, about four-fifths of the S&E baccalaureate degrees awarded were in science fields (240,000) and one-fifth in engineering (67,000). In the sciences, the largest fractions of degrees were in the social sciences (31 percent), life sciences (22 percent), and psychology (20 percent).

Using data on probable major field of study reported by incoming freshmen as a barometer of future degree production patterns indicates that current field trends may not continue.[7] Interest in the social sciences as a major field of study peaked in 1988, stemming an increase that began in 1982. On the other hand, interest in engineering, which was on the decline, began to rise. For a more detailed discussion of the relationship between bachelors degree production and the intended majors of American freshmen, see "Relationship Between S&E Baccalaureate Production and Freshman Intentions," p. 52.

***Degrees by Gender.*** The number of women earning bachelors degrees in S&E fields increased throughout the 1980s. This increase, coupled with a decline in S&E degree production among men since 1987, resulted in a rise in the representation of female degree-holders—from 36 to 40 percent between 1980 and 1989. Women account for higher shares of science than engineering degrees. For instance, in 1989, over 70 percent of psychology baccalaureates and more than 40 percent of those in mathematics, the life sciences, and the social sciences were awarded to women. In contrast, roughly 15 percent of 1989 engineering graduates were female.

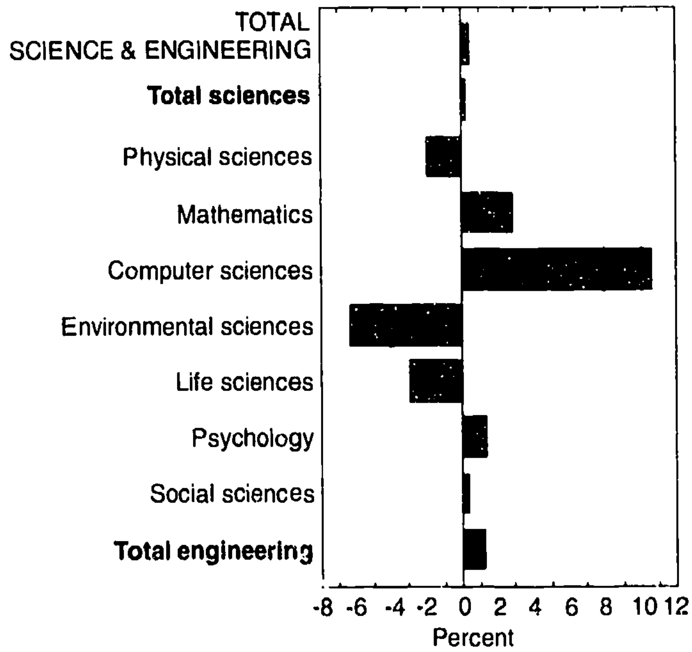
Although women made gains in all S&E fields between 1980 and 1989, the number earning degrees in some disciplines began to fall at the end of the decade. In fact, from 1988 to 1989, the S&E baccalaureates earned by women declined in all fields except psychology and the social sciences. The largest declines were in the computer sciences and engineering. Degrees earned by males experienced similar declines over the 2-year period.

***Degrees by Racial/Ethnic Group.***[8] In 1989, almost 34,000—10 percent—S&E bachelors degrees were granted to underrepresented minorities (blacks, Native Americans, and Hispanics). In 1979, this number was about 30,000 (9 percent of total degrees). Although the number of degrees granted to underrepresented minorities in general increased from 1979 to 1989, the number awarded to blacks changed very little, falling from 18,700 in 1979 to 18,400 in 1989. The rapid increases in engineering and computer science degrees earned by blacks over this period were countered by substantial declines in degree production in the life and social sciences and psychology.

[7] Data are from the Higher Education Research Institute, University of California at Los Angeles, the American Freshmen Norm Survey, unpublished tabulations.

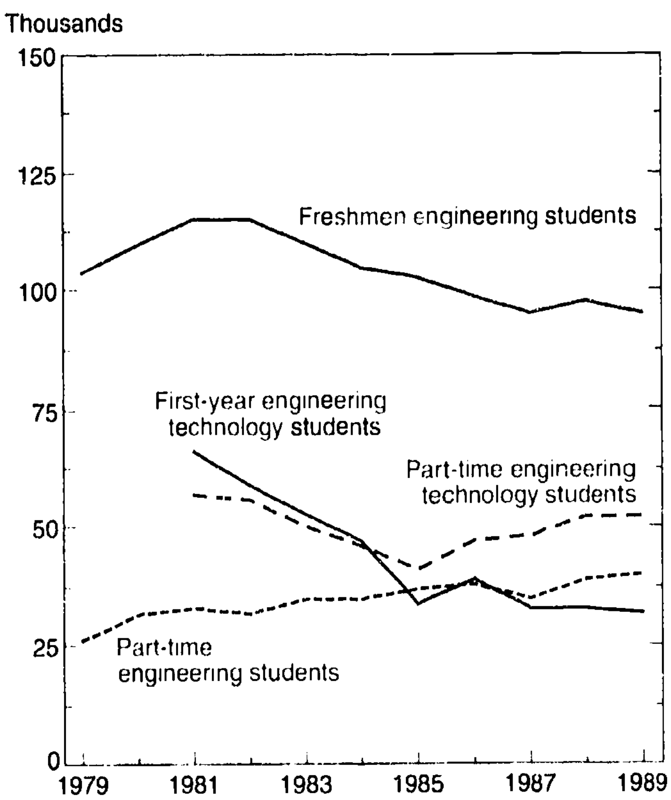
[8] S&E degree data by racial/ethnic group are for U.S. citizens and permanent residents.

Figure 2-5.
**Annual change in science and engineering baccalaureates, by field: 1980-89**




See appendix table 2-7. *Science & Engineering Indicators – 1991*

Figure 2-4.
**Undergraduate enrollment trends for engineering and engineering technology programs**




See appendix table 2-6. *Science & Engineering Indicators – 1991*

***Relationship Between S&E Baccalaureate Production and Freshman Intentions.*** This section discusses anticipated trends in degree conferrals in various undergraduate majors, a topic of interest for public policymakers and university officials. The discussion relies on intended majors reported by American first-time full-time freshmen; such data presage trends in subsequent bachelors degree conferrals, albeit more accurately in some fields than in others.[9]

To determine the relationship between freshman intentions and baccalaureate production in S&E, the actual proportion of all bachelors degrees in a given field was compared to the proportion of first-time full-time freshmen in 4-year institutions who indicated this field as their probable major. A 3-year lag time was found to best reflect the actual lag from freshman year to bachelors degree.[10]

As shown in figure 2-6, freshman intentions generally provide an accurate predictor of degree patterns in the natural sciences when computer science is excluded.[11] The less accurate "fit" in computer sciences may be attributable to differences in the characteristics of students who choose to major in this field. Computer science majors tended to be older than average: it is thus possible that a lower percentage of the students earning these degrees had been first-time freshmen 4 years earlier. Freshman intentions were not as accurate a predictor of absolute degree levels in engineering and the behavioral sciences, although they did serve as fairly successful leading indicators of trends.

Data on the actual number of bachelors degrees awarded are only available through 1989. Using a 3-year lag, these data can be used to suggest future patterns in bachelors degrees through 1994. This data projection suggests that the long-term decline in the proportion of bachelors degrees awarded in the natural sciences should bottom out in 1990 and start to recover in 1991. It also suggests that downturns in the proportions of computer science and engineering degrees will bottom out in 1991. Finally, the increased popularity in social science and psychology may peak in the 1991-92 period.

## Graduate S&E Student Population

### Recent Trends in Graduate Enrollments[12]

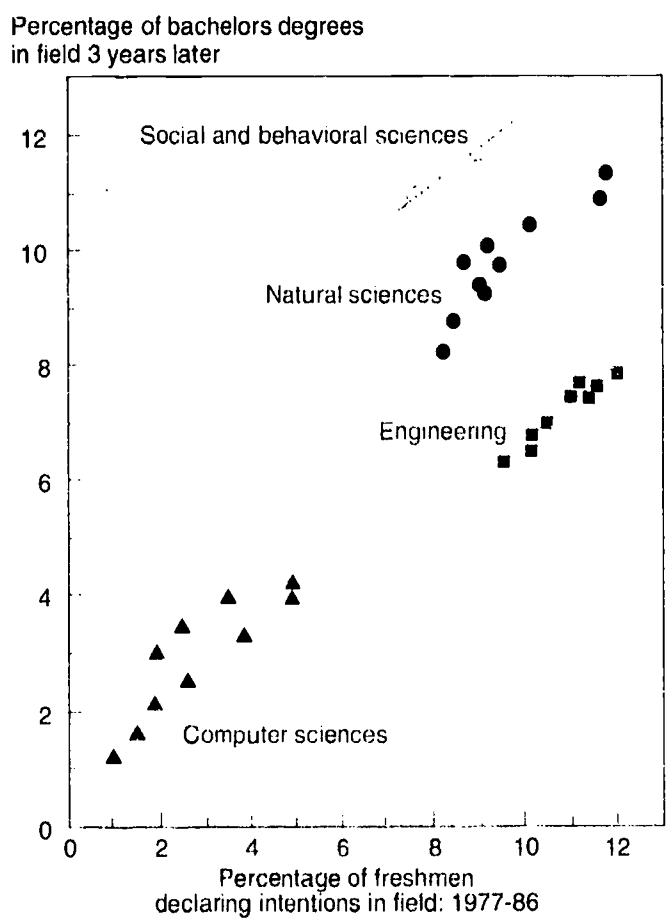
Graduate enrollment in S&E fields rose steadily at a rate of almost 2 percent per year throughout the eighties. By 1990, enrollment in these fields stood at about 401,600. Much of the growth in S&E graduate enrollments was driven by large increases in the numbers of women and non-U.S. citizens entering these programs. (See "Enrollments by Gender," p. 53, and "Foreign Students at U.S. Colleges and Universities," pp. 58-59.)

Enrollments in engineering rose much faster than in the sciences. Between 1980 and 1990, engineering enrollments increased at an annual rate of more than 3 percent compared to about 1 percent in the sciences. Much of this growth in engineering occurred in the first half of the eighties. Between 1986 and 1990, the annual growth rate in the sciences (1.8 percent) exceeded that in engineering (1.2 percent).

Over the long-term period, the only science field whose growth rate surpassed that of engineering was the computer sciences. Annual change among the other science fields ranged from a 0.3-percent decline (social sciences) to a 2.4-percent increase (mathematics).

In 1990, the science fields accounted for 73 percent of S&E enrollments, down from 77 percent in 1980. This change was a result of the rapid increases in engineering. The most dramatic proportional shift over the decade was the drop in the social sciences. About one in four graduate students was enrolled in social science programs in 1980; by 1990, the ratio had fallen to fewer than one in five.

Figure 2-6.
**Freshmen intentions as predictors of science and engineering bachelors degrees**




See appendix table 2-9. *Science & Engineering Indicators – 1991*

---

[9] Data on choice of major by American freshmen were collected at a relatively aggregate level until 1977 (e.g., social and behavioral sciences) and subsequently at more disaggregate levels (e.g., subfields of social and behavioral sciences such as economics, political science, psychology, sociology, anthropology, and social work). This analysis is confined to data on freshman intentions since 1977.

[10] It might be expected that intentions expressed in the first few weeks of the freshman year would be best reflected in bachelors degree data of 4 or 5 years later. One interpretation of the appropriateness of the 3-year lag is that those factors that influence freshmen also influence sophomores, and most students do not have to commit to a major until their sophomore year.

[11] In general, correlation coefficients fell between 0.95 and 0.97.

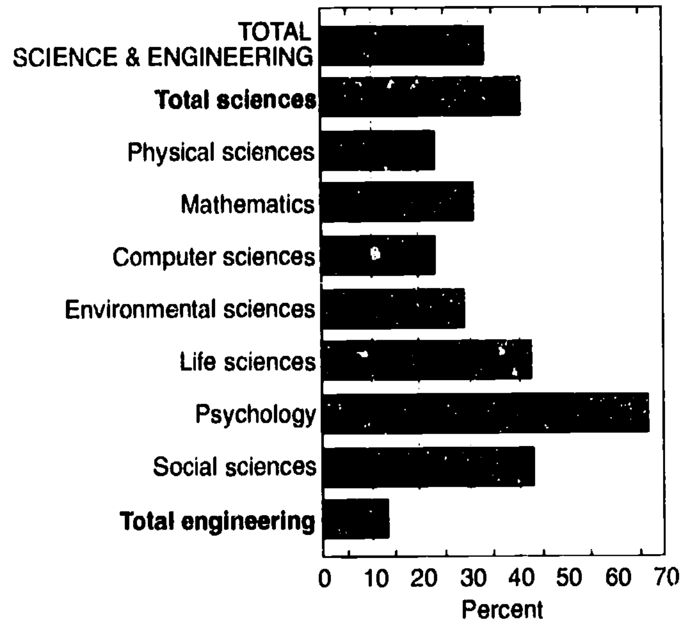
[12] Data presented in this section are from the National Science Foundation's Survey of Graduate Science and Engineering Students and Postdoctorates. See SRS (forthcoming [b]).

***First-Year Full-Time Enrollments.*** Slow growth in S&E enrollments overall may be partially explained by the very slow growth in first-year full-time enrollments. These students represented about 28 percent of all full-time S&E graduate students in 1990, down from 32 percent in 1982 (the earliest year for which comparable data are available). Between 1982 and 1990, first-year enrollments increased at only about half the annual rate of total full-time enrollments: 1.0 percent per year compared to 2.1 percent. First-year enrollments, however, began to turn sharply upward in 1989.

***Part-Time Enrollments.*** In 1990, about one out of every three graduate S&E students was enrolled part time. Since 1982, these enrollments—like first-year full-time enrollments—have been increasing at a somewhat slower rate than overall enrollments: 1.4 percent versus 1.8 percent.

Compared to graduate enrollment overall, part-time students are more highly concentrated in engineering, the social sciences, and the computer sciences. These fields accounted for 32, 22, and 13 percent of part-time S&E students, respectively. Overall, respective shares for these fields were 27 percent, 20 percent, and 9 percent.

Figure 2-7.
**Women as a percentage of science and engineering graduate students: 1990**




See appendix table 2-10. *Science & Engineering Indicators – 1991*

***Enrollments by Gender.*** The number of women enrolled in S&E graduate programs rose significantly from about 94,800 in 1980 to almost 135,300 in 1990. By 1990, about 34 percent of graduate S&E students were female, compared to 29 percent in 1980. Representation of women varied by field, however. (See figure 2-7.) The highest increases by women were in those S&E fields in which they historically have been the most underrepresented: the physical sciences, computer sciences, and engineering. Annual growth rates in these fields were 5, [illegible], and 8 percent, respectively. For men, respective growth rates in these fields were lower than 2 percent, 9 percent, and 3 percent.

In contrast to the rapid growth in female S&E enrollment, enrollment of men grew very slowly overall and declined in several fields. For the 1980-90 period, the number of male graduate students rose about 1 percent per year; the number of females rose 3 percent annually. By field, decreases in the number of men pursuing graduate work occurred in the environmental, life, and social sciences and in psychology.

***Enrollments by Racial/Ethnic Group.***[13] The number of U.S. citizen blacks, Native Americans, and Hispanics in S&E graduate programs increased from 20,900 in 1983 (the earliest year for which comparable data are available) to 24,400 in 1990. This change represents a growth rate slower than that of overall enrollments (1.4 percent versus 1.7 percent) but faster than that of total U.S. citizens (0.8 percent). Proportionally, these groups accounted for about 8.2 pe[illegible] of S&E enrollments of U.S. citizens in 1990, up from 7.5 percent in 1983. Growth patterns differed among racial/ethnic groups. (See figure 2-8.) Among blacks, for instance, enrollments declined until the mid-eighties and then turned upward; enrollment of Hispanics rose steadily throughout the decade.

Underrepresented minorities were less likely to be enrolled in engineering than the sciences compared to other racial/ethnic groups. In 1990, 14 percent of blacks and 19 percent of Hispanics were in engineering programs, compared to 22 percent of white and 38 percent of Asian graduate students. Within science fields, blacks and Hispanics were more highly concentrated in the social sciences. (See appendix table 2-11.)

## Masters Degree Production in S&E[11]

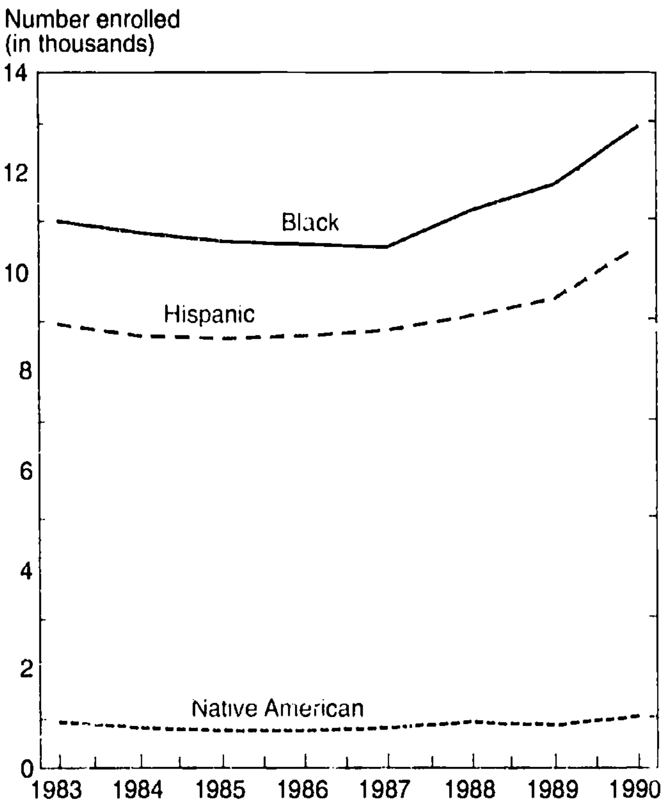
More than 66,000 persons earned masters degrees in S&E fields in 1989, representing about 21 percent of all masters degrees awarded in the United States. This proportion increased from 18 percent 10 years earlier. In the eighties, S&E masters degree recipients came to account for a larger fraction of the general population. In 1989, the number of S&E masters degree recipients per thousand 24-year-olds was 16, up from 13 in 1980.

Annual growth in S&E masters degree awards during the eighties was about 2 percent. By field, the rate in engineering (about 4 percent) was more than three times that registered in the sciences (1 percent). Among science fields, degree conferrals in the computer

[13] Data on S&E graduate enrollment by racial/ethnic group are only available for U.S. citizens.

[11] Data for S&E masters degrees are from the National Center for Education Statistics's Annual Survey of Earned Degrees; the data have been adapted to National Science Foundation field classifications. See SRS (1991).

Figure 2-8.
**Racial/ethnic minority enrollment in science and engineering graduate programs**




NOTE: Data are for U.S. citizens only.
See appendix table 2-11. *Science & Engineering Indicators – 1991*

sciences experienced the highest growth (10 percent per year) over the decade, although this growth slowed toward the end of the decade. For example, from 1988 to 1989, degrees in this field were up less than 3 percent. In comparison, growth in science fields that had been slow throughout most of the decade began to turn upward more rapidly by the end of the eighties. For example between 1980 and 1989, degrees in the physical sciences and psychology each rose at an annual rate of about 1 percent over the 1988-89 period, growth in these fields increased 14 percent and 9 percent, respectively.

Engineering degrees account for a greater percentage of the degrees at the masters level than at the doctorate level. (See figure 2-9.) In 1989, masters degrees in engineering represented about 36 percent of all S&E masters degrees; the computer sciences represented the largest portion of masters degree awards (14 percent) among the science fields.

***Degrees by Gender.*** As with baccalaureate production and S&E graduate enrollment, the number of women earning masters degrees rose faster than men. Degrees for women increased at an annual rate of 3.7 percent per year compared to a 1.2-percent rate for men. In 1989, about 31 percent of S&E masters degrees were granted to women, up from 26 percent in 1980.

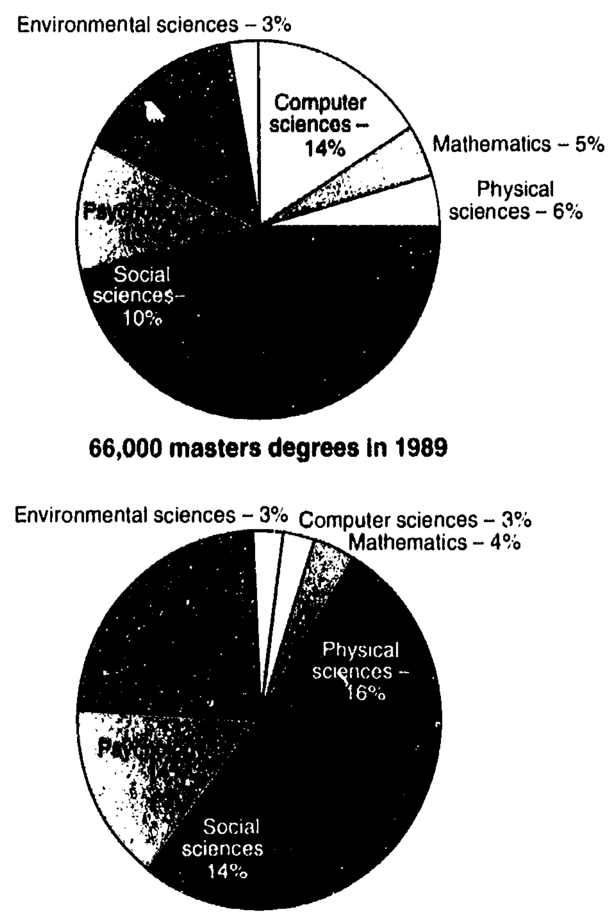
Women were much more likely than men to earn their degrees in science rather than engineering. They were also more concentrated in psychology and the life sciences. For example, in 1989, about 28 percent of women—compared to 6 percent of men—were granted masters degrees in psychology. In the life sciences, the percentages were 17 and 11, respectively.

***Degrees by Racial/Ethnic Group.***[15] Almost 3,500 S&E masters degrees—7 percent of total—were earned by blacks, Native Americans, and Hispanics in 1989. Differences in growth patterns by the individual minority groups existed. For example, between 1979 and 1989, the number of blacks earning masters degrees in S&E fell from 2,000 to fewer than 1,700; concurrently, there was a steady increase among Hispanics, whose numbers grew from 1,000 to about 1,600.

By S&E field, about 46 percent of blacks earned their degrees in either psychology or the social sciences; another 24 percent earned their masters degrees in engineering.

[15] Data on masters degrees by racial/ethnic group are for U.S. citizens and permanent residents only.

Figure 2-9.
**Science and engineering masters and doctorate degrees, by field**




**66,000 masters degrees in 1989**

**22,700 doctorate degrees in 1990**

See appendix tables 2-14 and 2-16.
*Science & Engineering Indicators – 1991*

These distributions changed substantially during 1979-89. For instance, in 1979, about 62 percent of blacks earned degrees in psychology and the social sciences, and 12 percent were granted engineering degrees.

## Doctorate Degree Production in S&E[16]

The rate of growth in the number of S&E doctorates awarded exceeded that of total doctorate production between 1980 and 1990. The respective annual growth rates were 2.4 percent and 1.4 percent. In 1990, almost 22,700 S&E doctorates were awarded, representing over three-fifths of total doctorate production by U.S. universities and colleges.

As at the baccalaureate and masters degree levels, degrees in engineering rose faster over the decade than those in the sciences (8 percent versus 5 percent). Much of the growth in engineering was attributable to significant numbers of foreign citizens earning these degrees. (See "Foreign Students at U.S. Colleges and Universities," pp. 58-59). Doctorate awards in engineering were up about 6.4 percent per year over the 10-year period; in science fields, the rate was 2.4 percent. Growth in degree production accelerated in the latter half of the decade for both engineering and science.

Within science fields, degrees in the computer sciences showed the highest growth with an annual rate of 11 percent. The next highest growth rate was held by the physical sciences which registered a 3-percent annual increase. Degrees in psychology and the social sciences each rose fewer than 0.5 percent per year during the 10-year period.

***Degrees by Gender.*** In 1990, about 28 percent of S&E doctorates were granted to women, up from 22 percent a decade earlier. The fastest growing fields for women were the computer sciences and engineering. Despite rapid growth in these fields, however, almost three-quarters of female degree recipients earned degrees in psychology and the life and social sciences in 1990.

Of the more than 13,000 Ph.D. degrees earned by women in 1990, almost half were in S&E; of these S&E doctorates, almost three-fifths were in either the life sciences or psychology. Engineering degrees accounted for 7 percent of the S&E degrees awarded to women. Men, in contrast, were much more likely to earn their S&E doctorates in engineering (27 percent).

***Degrees by Racial/Ethnic Group.***[17] The number of S&E doctorates awarded to underrepresented minorities in 1990 was 831, or 6 percent of all S&E doctorates. Ten years earlier, this number was 559, or 4 percent of total. Virtually all of this growth resulted from an increase in the number of Hispanics earning S&E doctorates: 213 in 1980 to 451 in 1990. Among blacks, S&E Ph.D. awards rose from 319 to 340 over the decade.

Blacks and Hispanics are much more heavily concentrated in the sciences than in engineering. In 1990, nearly 9 of every 10 S&E doctorates earned by members of these groups were in the sciences. The largest fractions of these science degrees were in psychology and the social sciences.

***Time to Degree.***[18] The number of S&E graduate students depends partly on the time it takes doctoral students to complete their Ph.D. degrees. Time to degree also influences students' decisions to enter and complete doctoral training. For people who received both baccalaureate and doctoral degrees from U.S. institutions, the average elapsed time between the dates of their bachelors and doctorate degrees increased unevenly in 10 of 11 S&E fields during the 1981-89 period. (See figure 2-10.) The time gap between degrees continued to grow in 7 of these 11 fields over the last 3 years of that period. From 1974 to 1981, only the social and behavioral science fields showed increases in elapsed time, but during 1968-74 all fields experienced a sharp upward rise averaging 0., years. For all S&E fields combined, average time to degree rose by 1.6 years during 1974-89; concurrently, time enrolled in graduate school rose by 1.1 years.

A 1989 National Science Foundation (NSF) study found that this rise in lag time for S&E doctorate awards was *not* the result of factors usually associated with such a rise—i.e., reduced financial aid (particularly fellowships), marital status, quality of the doctorate-granting institution, and gender.[19] Nor did changes in the aggregate tendency to switch fields after the bachelors or masters degree, switch institutions, or acquire a masters degree explain these increases. Although many of these factors were found to be important influences on an individual's time to degree, their *aggregate* influence was minor.

Instead, the study found that changes in the real value of starting salaries for doctorate-holders and the percentage of new doctorate recipients taking postdoctoral positions were highly correlated with the increased average time to degree. The percentage taking postdoctoral appointments rose from 21 to 48 during the 1968-84 period. This finding does not mean, however, that postdoctoral appointments were the direct source of increased time to degree, but rather that the rising fraction taking these appointments represents a reduced incentive for all doctoral students to complete their degree work aggressively.

---

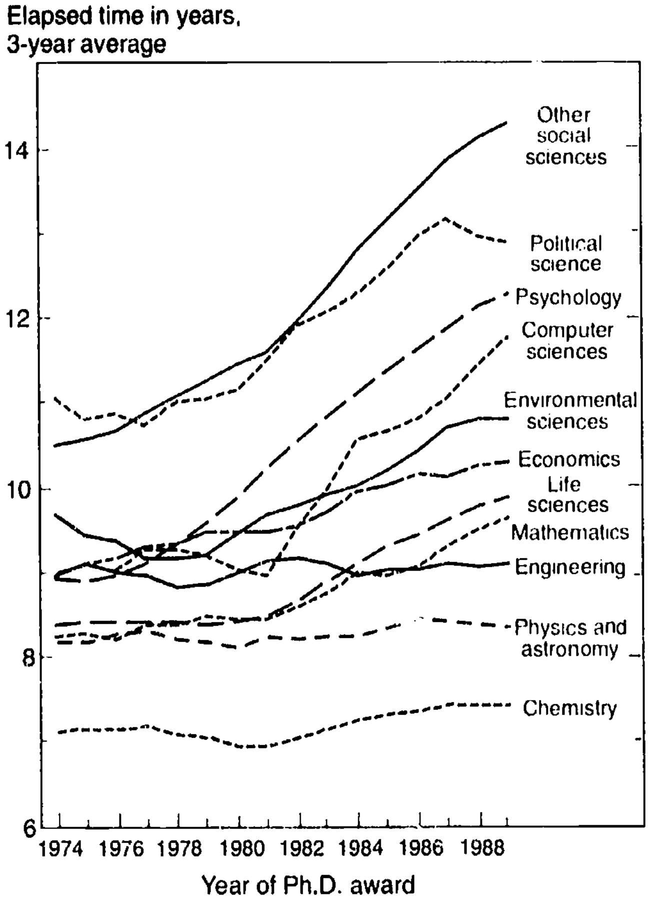
[16]Information on S&E doctorates granted in the United States are from the National Science Foundation's Survey of Earned Doctorates. See SRS (forthcoming [a]).

[17]Data reflect U.S. citizens and permanent residents only.

[18]"Time to degree" is the term used in NRC (1989). The annually representative time to degree has been calculated both as a median and as an average. See, for example, Bowen and Sosa (1989) and Nerad and Cerny (1991).

[19]The study covered 184,000 new S&E Ph.D. recipients (the majority of the new doctorates awarded from 1958 to 1987 in seven S&E fields). See PRA (1990), pp. 227-32.

Figure 2-10.
**Trends in elapsed time from bachelors to Ph.D. degrees, for selected fields**




See appendix table 2-18. *Science & Engineering Indicators – 1991*

Another factor was also recently identified as a definite source of the increase in time to degree.[20] Studies have found that if the number of graduate students entering doctoral programs declines for a period of time—which has been the case in several S&E fields—the eventual consequence of this decline is to increase the percentage of "slow finishers" among future Ph.D. graduating classes. The proportion of Ph.D. recipients in the social and behavioral sciences who required 10 or more years of elapsed time to finish their doctorates rose from 35 percent in 1974 to 60 percent in 1989; this proportion remained at 25 percent in engineering, chemistry, and physics.

Several fields experiencing increases in time to degree during 1974-81 also experienced large declines in the (approximate) percentages of bachelors recipients who were completing doctoral work. In these fields, these declining percentages indicate that new students may have been discouraged about pursuing further study, especially those who had the bulk of their time investment ahead of them. Since the early eighties, however, there has been no further tendency for doctorate awards to decline as a percentage of bachelors degree production in eight of the nine fields shown. (See figure 2-11.)

[20]This discovery was made both within NSF and by Bowen and Sosa (1989).

## Major Sources of Financial Support

Indicators of the health of undergraduate and graduate education are changes in patterns of support from Federal and other sources, the choices available among mechanisms of support, and—at the graduate level—in the number of Federal agencies that provide graduate S&E student support. These indicators are described in the following paragraphs.

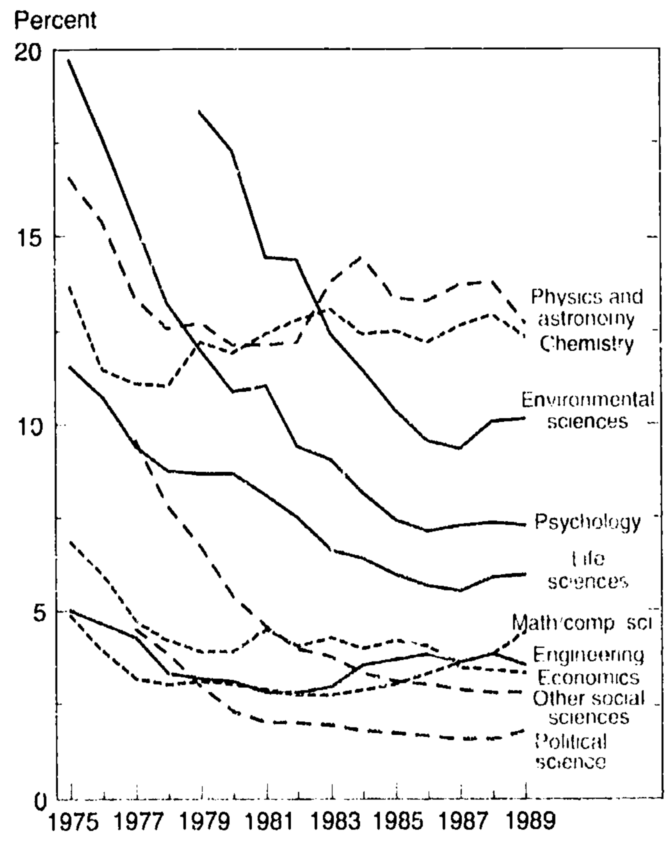
### Financial Support Reported by College Freshmen[21]

During the eighties, American freshmen relied increasingly on their parents or other relatives for financing their education. In 1990, more than three-fifths of freshmen who planned to major in an S&E field reported receiving $1,500 or more from these sources, up from fewer than two-fifths in 1980.[22] This trend was also evident among freshmen planning to major in non-S&E fields: The number of students reporting reliance on this source of support rose from 39 to 61 percent.

[21]Data in this section are from the Higher Education Research Institute, University of California at Los Angeles, the American Freshmen Norm Survey, unpublished tabulations.

[22]Note that the $1,500 lower limit used in the American Freshmen Norm Survey has not been adjusted for inflation. In constant 1990 dollars, this $1,500 in 1990 represented about $440 in 1970.

Figure 2-11.
**Ratio of Ph.D. awards to bachelors degrees lagged by average time to degree**




NOTE: Time to degree by field and year as shown in figure 2-10.

See appendix table 2-19. *Science & Engineering Indicators – 1991*

Two other sources that grew in importance over the decade were students' personal savings (7 percent to more than 17 percent) and college grants and scholarships (7 percent to almost 19 percent). Throughout the decade, the fraction that reported Federal loans as a source of financing remained about the same. Around 18 percent of American freshmen reported receiving at least $1,500 from either Federal guaranteed student loans or national direct student loans in both 1980 and 1990.

## Support of S&E Graduate Students[23]

Graduate students are less likely than undergraduate students to finance the largest fractions of their education from personal or family resources. Federal and institutional sources play a much more prominent role in financing their studies.

***Sources of Support.*** Three broad categories of support represent the majority of the reported funding sources for graduate S&E students:

- Federal sources,
- Non-Federal sources such as academic institutions and private industry, and
- Self-support.

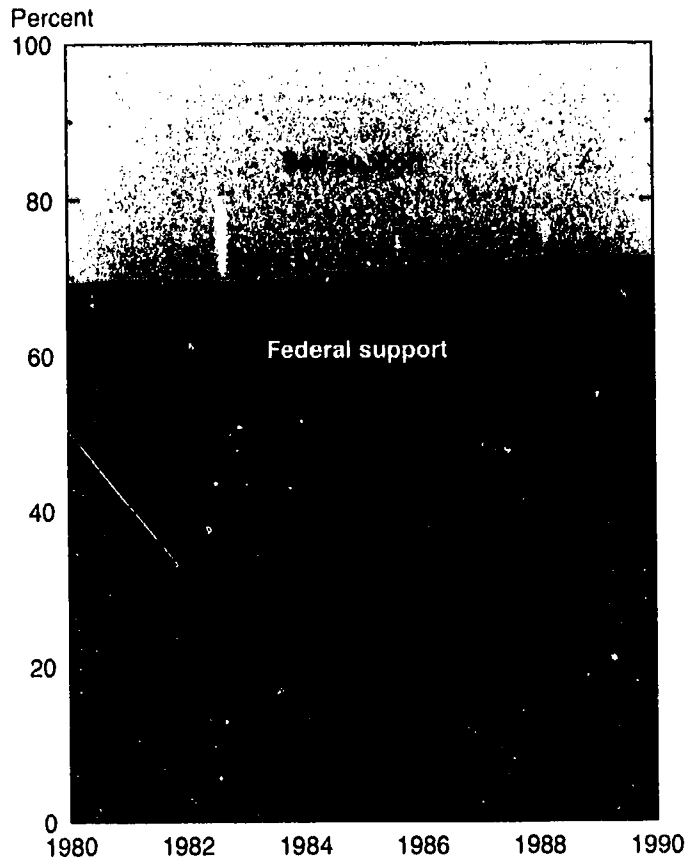
Of these, non-Federal sources of support increased most rapidly, registering an annual rate of about 3 percent, during the 1980s. (See figure 2-12.) For comparison, total full-time S&E graduate enrollment increased about 2 percent per year between 1980 and 1990. (See appendix table 2-20.) Increased support from non-Federal sources played the most crucial role in engineering and the computer sciences.

Federal support of graduate S&E students declined somewhat during the early eighties but turned strongly upward by mid-decade for some fields. This late eighties increase in Federal support was most evident in engineering, the life sciences, mathematics, and the computer sciences. Between 1986 and 1990, annual rates in these fields ranged from 4 percent (engineering and life sciences) to almost 8 percent (mathematics).

Not all fields, however, were affected by the resurgence in Federal support. In the social and environmental sciences, for example, the number of federally supported graduate students continued to decline as sharply as it had in the early eighties. Moreover, increases in support from non-Federal sources for these fields did not keep pace with declines in Federal sources of funding.

Different growth patterns in support sources resulted in a shift in the mix of these sources between 1980 and 1990. The proportion of students who reported support from non-Federal sources rose from 48 to 53 percent. Overall, the fraction of students who received Federal support fell slightly, dropping from 21 to 20 percent. Percentages varied, however, by science field. The proportional change in self-support over the decade was from 31 to 27 percent.

Figure 2-12.
**Trends in sources of financial support for science and engineering graduate students**




See appendix table 2-20. *Science & Engineering Indicators – 1991*

***Mechanisms of Graduate Student Support.*** Mechanisms of financial assistance fall into four major categories:

- *Fellowships*—usually received directly by students from sources other than the academic institution,
- *Traineeships*—competitive awards usually given by the institution,
- *Teaching assistantships*, and
- *Research assistantships.*

During the 1980-90 period, the highest growth rate among support mechanisms was for research assistantships, which increased at an annual rate of more than 4 percent. As a result of this growth rate, the share of graduate students supported by this mechanism increased from 23 to 29 percent. Fellowships and teaching assistantships each rose about 2 percent a year. Finally,

---

Many students fund their graduate education using several different sources of financial aid, some of which are not reported. Consequently, although the data in this section represent a *majority* of support sources, they do not represent *all* sources.

Data in this section on sources and mechanisms of support among graduate S&E students are for those enrolled full time. See SRS (forthcoming [b]).

the number of traineeships declined until about 1986; by 1990, however, the number of students supported by this mechanism had almost recovered its 1980 level.

Types of support mechanism differ among major S&E fields. In 1990, research assistantships supported the largest portion (roughly two-fifths) of students in the physical, environmental, and life sciences and in engineering. Teaching assistantships made up the bulk (about 56 percent) of support received by mathematics students. In contrast, other sources of support (a category including, for example, Federal student loans) accounted for the largest shares of support for students in psychology (59 percent) and the social sciences (48 percent).

***Support Mechanism by Source.*** Types of support mechanisms also vary between Federal and non-Federal sources. (See figure 2-13.) For example, Federal agencies provide a majority of their support in the form of research assistantships. In 1989, more than four of five students funded by NSF were supported by research assistantships. Comparatively, 28 percent of those receiving non-Federal support were on research assistantships; 45 percent held teaching assistantships.

Shifts occurred over the 1980-89 period in the types of support mechanisms used by the Federal and non-Federal sectors. In general, research assistantships increased in significance for both sectors. Concurrently, federally sponsored traineeships and nonfederally funded fellowships and teaching assistantships dropped off. (See appendix table 2-22.)

***Support of Recent Ph.D. Recipients.*** Graduates of doctorai S&E programs were supported by a number of different sources, primarily by universities. For example, of the 22,700 persons who earned Ph.D. degrees in S&E fields in 1990, over 18,100 reported at least some financial support from their institutions. Research and teaching assistantships were chief among the mechanisms of university support.

Academic institutions were cited as the major support source by Ph.D. recipients in all S&E fields. By field, this source played a somewhat larger role in financing degree programs in natural science fields; new doctorate recipients in psychology were less likely to rely on institutional support.

Among other support sources, roughly 9,000 of the 22,700 new S&E doctorate recipients indicated that their own earnings supported a portion of their education. Ph.D. degree recipients in psychology were most likely to rely on self-support.

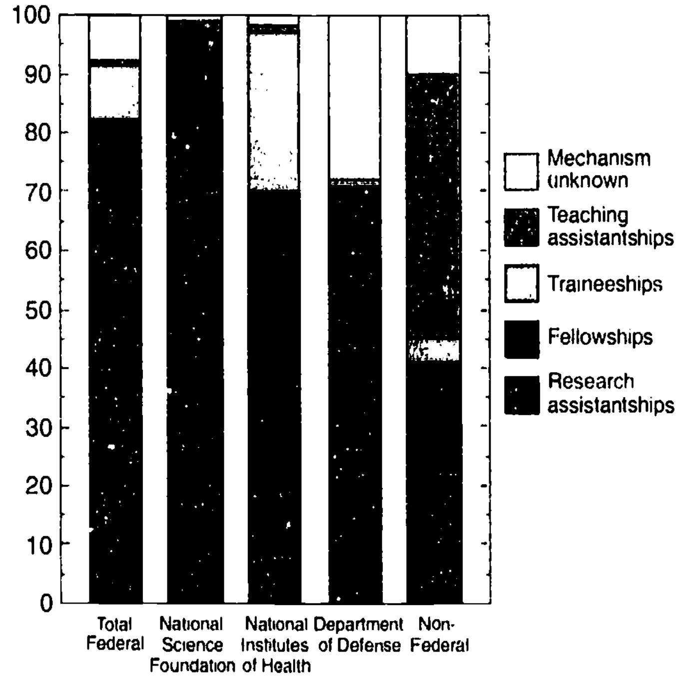
## International S&E Education

Viewing higher education in science and engineering internationally may be done from a number of perspectives. This section presents two aspects of this topic. First, the number of foreign students studying in U.S. universities and colleges is examined. Second, comparisons in baccalaureate production in natural science and engineering degrees are made across several different countries.

Information for 1990 on support mechanism by source was not available as of this writing.

Data in this section are from NSF's Survey of Earned Doctorates, unpublished tabulations.

Figure 2-13.
**Types of financial support mechanisms provided to 1989 science and engineering graduate students, by source**




See appendix table 2-22. *Science & Engineering Indicators – 1991*

### Foreign Students at U.S. Colleges and Universities

***Graduate S&E Enrollment.*** Participation of foreign citizens in S&E graduate programs at U.S. academic institutions rose dramatically during the eighties from about 20 percent of the total in 1983 (the earliest year for which comparable data are available) to 26 percent in 1990. There were almost 102,500 foreign students enrolled in S&E graduate study in 1990, up from 70,600 7 years earlier. In comparison, the number of U.S. citizens enrolled rose from about 279,000 to almost 299,100.

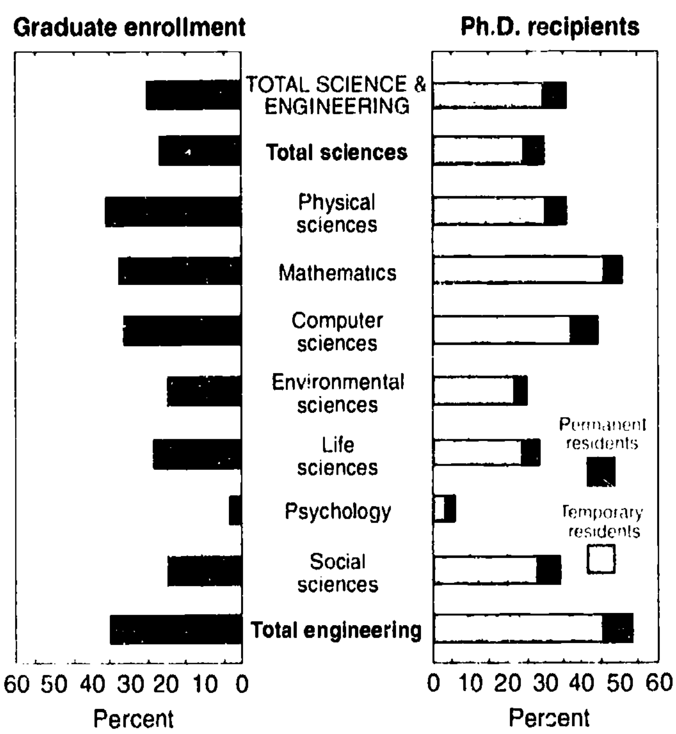
By field, foreign enrollment grew fastest in the computer, physical, and life sciences. Annual growth in these fields was between 7 percent (physical sciences) and 10 percent (computer sciences) during the 7-year period. At about 3 percent per year, the slowest growth rate was in the social sciences. Enrollment of U.S. citizens increased fastest in the computer sciences (4 percent). These differing growth patterns resulted in a higher representation of foreign students in almost all S&E graduate programs. (See figure 2-14 and figure O-17 in Overview.)

Foreign citizens tend to be concentrated in different fields of study than are U.S. citizens. For example, almost 37 percent were enrolled in engineering compared to 24 percent of U.S. citizens in 1990. Similarly, foreign students were more often in physical and computer science studies; U.S. citizens tended more toward the life and behavioral sciences. Thus, about 16 percent of U.S. graduate students were in psychology programs; less than 2 percent of foreign enrollment was in this field.

***S&E Doctorate Recipients.*** Data on new S&E doctorate recipients reveal a more detailed picture of participation by foreign citizens in U.S. graduate education. Much of the increase in S&E doctorate production during the eighties was attributable to increases in the number of temporary residents earning these degrees. Between 1980 and 1990, the number of S&E doctorates granted rose from 17,500 to 22,700. Degrees to temporary residents accounted for almost 70 percent of this increase. By 1990, about 28 percent of Ph.D. program graduates were on temporary visas; another 5 percent held permanent visas.

The representation of foreign citizens among S&E doctorate recipients varies considerably by field of degree. (See figure 2-14.) About one of every two Ph.D. recipients in mathematics and engineering studied in the United States on a temporary visa. In contrast, only about 1 in 20 Ph.D. recipients in psychology was a temporary resident.

Figure 2-14.
**Foreign citizen representation in 1990 U.S. science and engineering graduate education**




See appendix tables 2-23 and 2-24.
*Science & Engineering Indicators – 1991*

Comparisons of U.S. and non-U.S. citizen growth rates and distributions of doctoral degrees by S&E field reveal a pattern similar to that of S&E graduate enrollment. During the eighties, annual growth rates in the numbers of temporary residents exceeded those of U.S. citizens in all fields. For U.S. citizens, the numbers earning degrees in mathematics, the life sciences, psychology, and the social sciences showed declines. By S&E field, temporary residents were much more likely to receive degrees in engineering than were U.S. citizens. In 1990, about 35 percent of temporary residents and 14 percent of U.S. citizens earned their degrees in this field.

Most of the foreign citizens earning S&E doctorates are Asian. About 64 percent of temporary residents in 1990 were Asian; 23 percent were white. These proportions have changed significantly over the last decade. In 1980, about 45 percent of temporary residents were Asian and 34 percent were white.

## International Comparisons in Higher Education

Educational trends over the last 15 years in four world regions reflect a shift in global human resources for science from developed to developing countries.[26] Available data on bachelors degrees in natural science and engineering fields illustrate this shift.[27] (See figure 2-15.) Developing countries such as China are producing a growing share of the world's NS&E degrees.[28]

According to these data, the Asian region (even considering only six countries) surpassed the USSR region after 1986 in production of NS&E bachelors degrees. In engineering, the USSR is still the highest regional producer of bachelors degrees in the world. In the natural sciences, North America and the USSR have both declined slightly in the last few years, while Asia and Europe have increased in annual degrees.

---

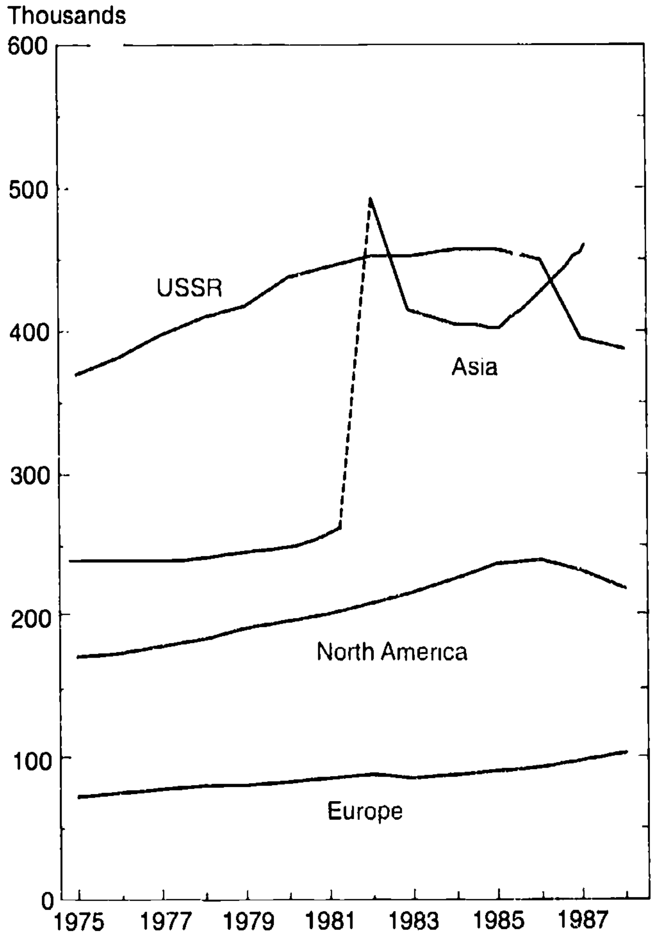
[26] Data in this section on degrees by country are for NS&E fields only. Natural science fields include mathematics and the physical, biological, environmental, agricultural, and computer sciences.

Countries in North America for which data were available for comparisons include the United States and Canada; Western European countries include France, Italy, Sweden, the United Kingdom, and West Germany (West German degree data do *not* include data for East Germany). Selected Asian countries include China, India, Japan, Singapore, South Korea, and Taiwan. The USSR contains all 15 republics. Therefore, the comparisons are among limited data sets of three world regions and one complete region (the USSR).

[27] The data base used here was developed from 15-year time series on university enrollments and graduates in NS&E fields, obtained from UNESCO's Division of Statistics. UNESCO data were updated and adjusted, and missing years added, with national educational statistics from each country over the same time period (1975-89). (See "References," pp. 62-63, for country data sources.) National statistics were then reclassified using NSF field taxonomies. In this chapter, first university degrees of other countries are referred to as bachelors degrees.

[28] Some of the increase in Asian bachelors degrees in the early eighties reflects the Chinese universities reopened in the late seventies and the surge of young people who entered universities or returned to complete science programs that had been interrupted during the Cultural Revolution.

Figure 2-15.
**Bachelors degrees in natural science and engineering, by selected world region**




NOTES: USSR = all 15 republics; Asia = China, India, Japan, Singapore, Korea, and Taiwan (data for China are not available prior to 1982); North America = United States and Canada; Europe = France, West Germany, Italy, United Kingdom, and Sweden.

See appendix table 2-25. *Science & Engineering Indicators – 1991*

Grouping countries by stage of development rather than by geographic region highlights differences in bachelors degree growth rates. (See text table 2-2.) During 1975-88, five Asian developing countries more than doubled their annual number of NS&E bachelors degrees awarded. The developed countries increased their annual bachelors degrees by 16 percent. In 1988, the developed countries led in the share of bachelors degrees. However, given demographic patterns in Asian countries, they have the capacity to reverse this order and rapidly surpass developed countries in human resources for science.

***Bachelors Degrees in the Natural Sciences.*** The USSR and the United States show declines in natural science graduates over the 15-year time period. (See figure 2-16.) Canada is steadily increasing in natural science graduates. Within Europe, only the United Kingdom has declined in natural science degrees since 1982. All other European countries have grown in natural science degrees.

The high number of bachelors degrees in the natural sciences in Asia is largely accounted for by India. India is the world's foremost educator of natural scientists; since the early seventies, it has annually produced more bachelors degrees in these fields than has the United States. India's preference for basic sciences is shown in the high ratio (0.26) of natural science degrees to total degrees. (See appendix table 2-28.) China will also be a main producer of natural science degrees for the Asia region. With about 40,000 degrees annually, China produces slightly fewer than one-third of the degrees that India produces.

***Bachelors Degrees in Engineering.*** In the USSR, most higher education degrees are given in technical fields: about 36 percent of all degrees granted in this country were in engineering in 1988. In 1986, engineering degrees began to decline annually in the USSR, but there are still over 280,000 such degrees granted per year. (See figure 2-17.) These engineering graduates receive technical training in highly focused engineering subspecialties, such as industrial lathes. This training is very different from the general and theoretical engineering education of other countries, where engineering principles can be applied to new products and processes.

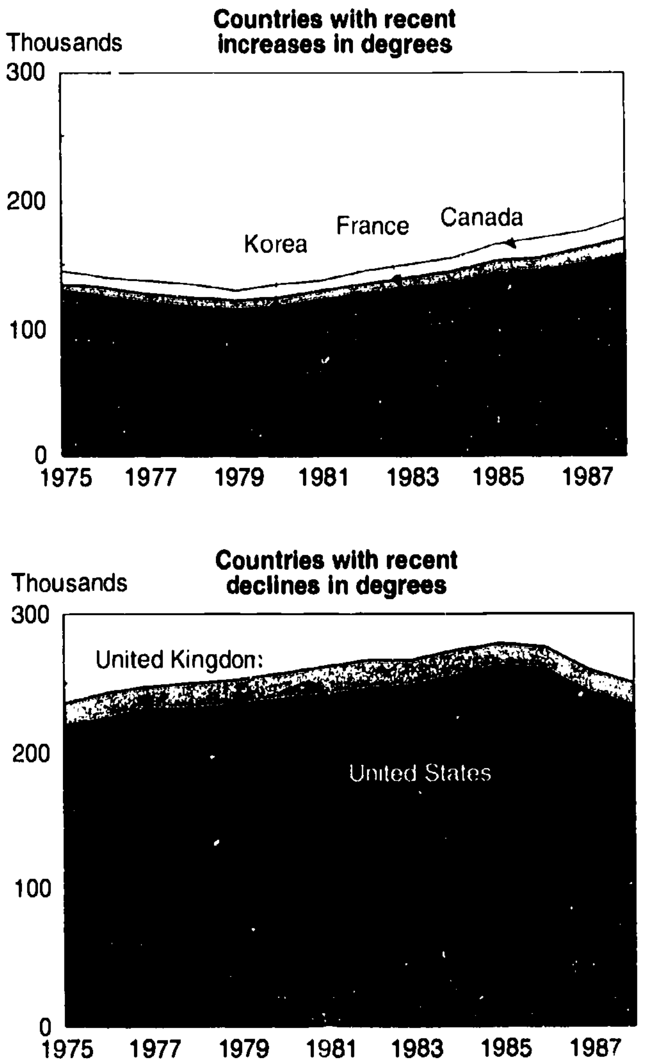
Text table 2-2.
**Annual growth rates in natural science and engineering NS&E degrees in developed and developing countries: 1975-88**

| | NS&E | Natural science | Engineering |
|---|---|---|---|
| | | Percent | |
| Total | 3.0 | 2.4 | 2.9 |
| **Developed countries** | 1.1 | 1.1 | 1.2 |
| Canada | 4.2 | 4.1 | 4.3 |
| France | 4.0 | 4.9 | 3.5 |
| Italy | 1.8 | 1.2 | 1.3 |
| Japan | 0.9 | 1.4 | 0.8 |
| Sweden | 2.7 | 3.2 | 2.5 |
| United Kingdom | -0.5 | -0.3 | -8.0 |
| United States | 2.5 | 1.0 | 5.0 |
| West Germany | 5.3 | 5.6 | 5.9 |
| USSR | 0.8 | 0.6 | 0.3 |
| **Developing Asian countries** | 5.2 | 4.1 | 6.6 |
| China | 6.9 | 5.0 | 7.8 |
| India | 3.3 | 3.0 | 5.3 |
| Singapore | 11.0 | 8.1 | 14.4 |
| South Korea | 11.3 | 11.2 | 11.1 |
| Taiwan | 3.6 | 3.8 | 3.7 |

NOTE: Growth rates were computed with time trends on latest available 10 to 15 years of data; for developing Asian countries total and for China, growth rates were computed with time trends on last 5 years.

See appendix table 2-25 *Science & Engineering Indicators – 1991*

Figure 2-16.
**Trends in natural science bachelors degrees, by selected country**




See appendix table 2-25. *Science & Engineering Indicators – 1991*

Both Canada and the United States peaked in engineering degree production in 1985, and their numbers have since been decreasing. In European countries, only the United Kingdom has declined in engineering graduates. Europe overall, like Asia, has increased its number of graduates, but from a smaller base than Asia.

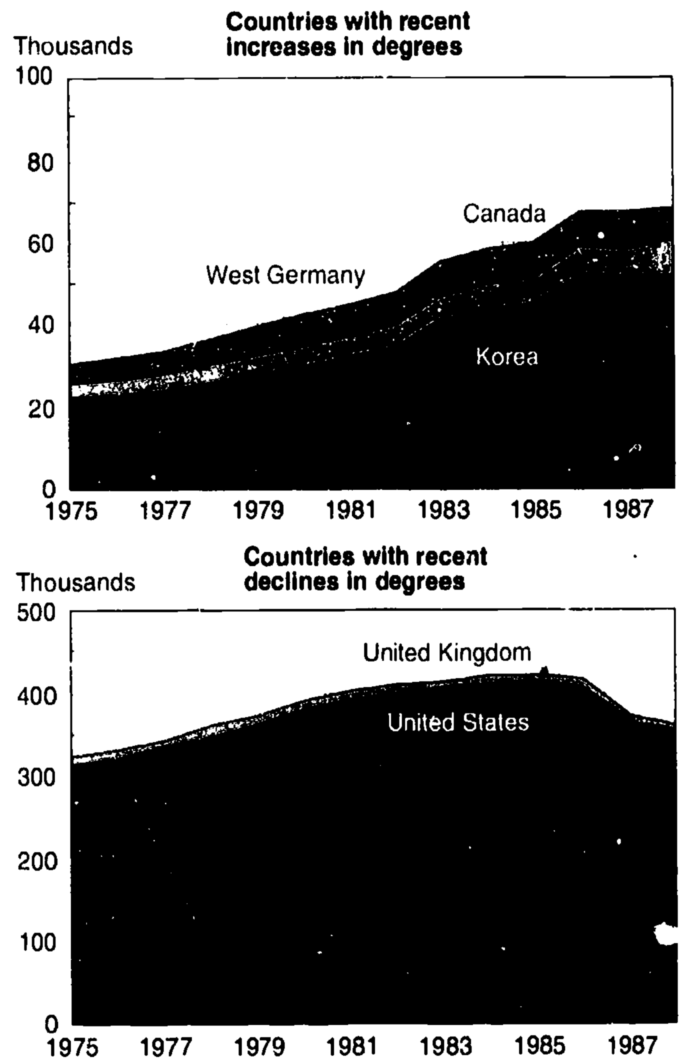
China and Japan are the main producers of engineering degrees for the Asian region. China has the highest number, with 93,000 graduates in 1987. Japan has the second highest production of engineers, with 77,000 graduates that same year. However, Japan has been producing approximately this number of engineering graduates for over 10 years, whereas the number of degrees in China is beginning to increase. In South Korea, the increasing number of engineering degrees has recently leveled off; for the past 3 years its degrees have remained stable.

***Demographics.*** The share shift in global human resources for science in these four world regions is reflected in the demographic trends of their 20- to 24-year-olds. (See appendix table 2-27.) Almost every country that increased its production of bachelors degrees in natural science and engineering did so with a growing college-age population. Only West Germany managed to increase NS&E degree production (5-percent growth rate over 15 years) with a declining college-age population since 1985.[20] The United States, the USSR, and the United Kingdom had a smaller pool of 20- to 24-year-olds and a falloff in technical degree production. The decline in college-age population in the USSR ended in 1990.

***Participation Rates in S&E Education.*** Among all countries, the USSR had the highest percentage of 22-year-olds who received bachelors degrees in natural science or engineering. (See figure 2-18.) Even with a slight decline over the last few years, over 8 percent of this age group in the USSR received technical degrees. Among Western countries, the United States had the next highest percentage of technical degree recipients among its

[20] West German demographic data combine the 20- to 24-year-old age groups of the united Germany. West German degree data, however, are for the former West Germany only.

Figure 2-17.
**Trends in engineering bachelors degrees, by selected country**



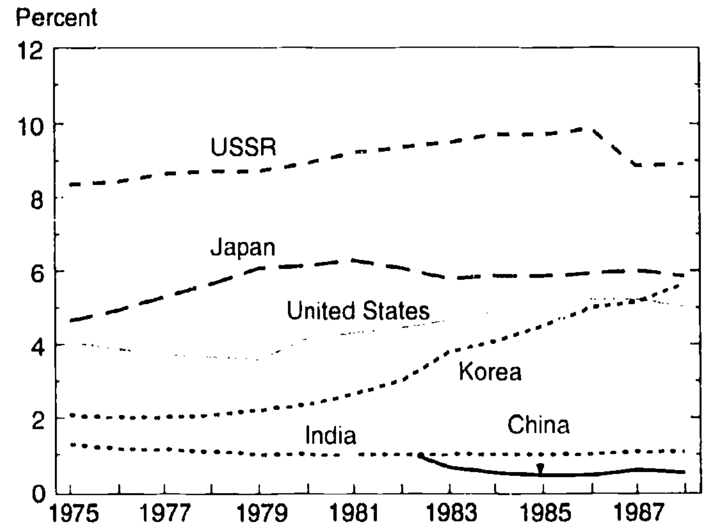

See appendix table 2-25. *Science & Engineering Indicators – 1991*

young people, approximately 5 percent. The United Kingdom dropped its participation rate in technical degrees during the eighties from 4 to 3 percent. France, Italy, and West Germany increased the percentage of their young people receiving technical degrees from between 1 and 2 percent to between 2 and 3 percent.

Japan's high percentage of young people obtaining NS&E degrees (6 percent) fell slightly in the last few years, as both preferences for natural science and engineering and the college-age population declined. Most Asian developing countries increased the percentage of 22-year-olds receiving NS&E baccalaureates over the 15-year time period. South Korea dramatically increased its NS&E degrees from 2 to 6 percent of its young people. Taiwan increased its NS&E degree awards from 2- to 3-percent for its college-age population over the last decade.

China and India, with their huge populations, are maintaining their participation rates of 0.5 percent and 1.09 percent, respectively. If China and India continue to maintain these rates, global human resources for science would be greatly augmented.

Figure 2-18.
**Natural science and engineering bachelors degrees as a percentage of 22-year-olds, by selected country**




See appendix table 2-26. *Science & Engineering Indicators – 1991*

## References

Bowen, W.G., and J.A. Sosa. 1989. *Prospects for Faculty in the Arts and Sciences.* Princeton, NJ: Princeton University Press.

Carnegie Foundation for the Advancement of Teaching. 1987. *A Classification of Institutions of Higher Education.* 1987 edition. Princeton, NJ: Princeton University Press.

Centre Européen Pour L'Enseignement Supérieur, UNESCO. 1983. *Higher Education and Economic Development in Europe.* Bucharest: UNESCO.

Engineering Manpower Commission, American Association of Engineering Societies. 1990. "Engineering and Engineering Technology Enrollments." *Engineering Education* Vol. 80, No. 6 (September-October): 599.

Government of Canada, Statistics Canada. Annual series. *S&T Indicators.* Ottawa.

Government of France, Ministère de L'Education Nationale. Annual series. *Repères et Références Statistiques sur les Enseignements et la Formation.* Vanves.

Government of Germany, Statistisches Bundesamt Wiesbaden. Annual series. *Prufungen an Hochschulen.* Reihe 4.2, Fachserie 11 Wiesbaden.

———. 1990. *Summary Document Prufungen an Hochschulen*, 1975-1988. Wiesbaden.

Government of India, Department of Science and Technology. 1990. *Research and Development Statistics*, 1988-89. New Delhi.

———. 1991. *Pocket Data Book, 1991.* New Delhi.

Government of Italy. Istituto Centrale di Statistica. 1988. *Statistiche dell'istruzione: Dati Sommari Dell'anno Scolastico* 1986-87. Rome.

Government of Japan, Ministry of Education, Science and Culture. Annual series. *Monbusho Survey of Education.* Tokyo.

Government of the People's Republic of China, State Education Commission. 1990. *Education in China, 1978-1988.* Beijing.

Government of the Republic of China, Ministry of Education. Annual series. *Educational Statistics of the Republic of China.* Taipei.

Government of the Republic of Korea, Ministry of Education. Annual series. *Yearbook of Educational Statistics.* Seoul.

Government of Sweden, Statistics Sweden. 1989. *Higher Education in ISCED Terms 1981-1988.* Orebro, Sweden.

Government of United Kingdom, University Grants Committee. 1988. *University Statistics 1987-1988.* Universities' Statistical Record. Cheltenham.

National Center for Education Statistics. 1989. *Digest of Education Statistics 1989.* Washington, DC: Department of Education.

National Research Council (NRC). 1989. *On Time to the Doctorate.* Washington, DC: National Academy Press.

Nerad, M., and J. Cerny. 1991. "From Facts to Action: Expanding the Educational Role of the Graduate Division." *Council of Graduate Schools Communicator,* special edition (May).

Policy Research and Analysis Division (PRA), National Science Foundation. 1990. *The State of Academic Science and Engineering.* NSF 90-35. Washington, DC: NSF.

Science Resources Studies Division (SRS), National Science Foundation. *Women and Minorities in Science and Engineering.* 1990. NSF 90-301. Washington, DC: NSF.

———. 1991. *Science and Engineering Degrees:* 1966-89, *A Source Book.* NSF 91-314. Washington, DC: NSF.

———. *Science and Engineering Doctorates: 1960-90.* Forthcoming (a). Washington, DC: NSF.

———. *Selected Data on Graduate Students and Postdoctorates in Science and Engineering, Fall 1990.* Forthcoming (b). Washington, DC: NSF.

———. *Undergraduate Origins of Recent Science and Engineering Doctorate Recipients.* Forthcoming (c). Washington, DC: NSF.

# Chapter 3
# Science and Engineering Workforce

## CONTENTS

# Science and Engineering Workforce

## HIGHLIGHTS

### Industrial Job Patterns

- **Employment growth of scientists and engineers in nonmanufacturing industries, primarily the services-producing industries, outpaced that in manufacturing during much of the 1980s.** Between 1980 and 1989, the number of science and engineering (S&E) positions in nonmanufacturing industries rose at an average rate of 4.5 percent annually, reaching 920,000 in 1989. Manufacturing industries also increased their utilization of S&E personnel. Between 1980 and 1989, the number of S&E positions in manufacturing industries increased at an average annual rate of 3.2 percent. *See pp. 68, 69.*

- **The 1980-89 S&E job growth in manufacturing and nonmanufacturing has stemmed from different factors.** In nonmanufacturing, S&E occupations increased their share of total jobs (from 1.4 percent in 1980 to 1.5 percent in 1989) and also benefitted from substantial economic growth as reflected in a 31-percent increase in total jobs. As a result, S&E job opportunities in nonmanufacturing increased by almost 50 percent during the eighties. In manufacturing, growth in S&E positions stemmed from an increased share of declining total manufacturing jobs. *See pp. 68, 69.*

- **Computer specialists, the fastest growing major S&E occupational group over the decade, reached 318,000 in 1989—more than all other scientist occupations combined.** Computer specialists almost doubled their numbers in both manufacturing and nonmanufacturing industries (to 103,000 and 216,000, respectively). Most of this growth was due to the rapid expansion of the business services industries, primarily computer and data processing services. *See p. 70.*

- **Over 60 percent of the 1.35 million private industry engineers were employed in the manufacturing sector in 1989.** However, the nonmanufacturing sector had a higher average annual growth rate in engineering jobs over the 1980-89 decade than did manufacturing—4.5 versus 3.2 percent. Electrical/electronic engineering was the largest specialty in both manufacturing (where it accounted for 32 percent of the sector's total engineering jobs) and nonmanufacturing (33 percent). *See p. 70.*

### Demographic Trends in S&E Employment

- **In 1990, the median annual salaries of recent female baccalaureate recipients employed as scientists and engineers were approximately 73 percent of the salaries of their male counterparts.** This difference in salaries is largely due to the concentration of women in relatively low-paying scientific fields. In fact, for many of the engineering fields, women report higher salaries than men. *See p. 74.*

- **In 1989, the population of doctoral scientists and engineers was about 485,000, an increase of 4 percent per year since 1977.** Over this period, the annual rate of retirement for doctoral scientists and engineers increased from about 0.5 percent between 1977 and 1979 to 0.8 percent between 1987 and 1989. The effect of this change was a dramatic increase in the proportion of the doctoral scientist and engineer population who were retired—from 3.2 percent in 1977 to 5.6 percent in 1989. Most of this increase occurred after 1985, when retirees accounted for 3.5 percent of the S&E doctoral population. *See pp. 75-76.*

- **Doctoral scientists and engineers had little trouble finding work during the 1977-89 period; their reported unemployment rate ranged from 1.2 percent in 1977 to less than 1 percent in 1989.** By contrast, the overall unemployment rate in the United States was 5.3 percent in 1989, while for professional workers it was 1.7 percent. The rate for scientists and engineers at all degree levels combined was 1.5 percent in 1988. *See p. 76.*

### Labor Market Supply and Demand

- **The 1990s should be a period of relative stability in overall S&E labor markets.** In contrast, during the early to mid-1980s, many S&E fields experienced temporary shortages due to the defense buildup of the period. Various demand scenarios have been processed to examine how alternative national economic growth patterns might affect S&E employment. Supply side simulations have been run to test the ability of the supply system to respond to these demand scenarios. *See p. 79.*

### Immigration

- **In 1988, 11,000 scientists and engineers immigrated to the United States.** Almost one-half of these immigrants came from Asia—three times the amount that came from Western Europe. The largest numbers of immigrants came from India, Taiwan, The Philippines, and the United Kingdom, each of which accounted for more than 750 such immigrants. *See p. 83.*

# Introduction

## Chapter Focus

The 1980s witnessed substantial growth in demand for workers in science and engineering (S&E) activities. New and expanded programs in research and development (R&D), defense, health, and higher education all contributed to this growth. There was also a shift in this decade in the industrial demand composition for S&E personnel, as nonmanufacturing industries began to overtake manufacturing ones as the major employment sector. These changes were generally accomplished through a flexible labor force and an educational system capable of providing the personnel and training required. An increasing use of foreign origin personnel was also a significant factor in meeting the demand, especially at more advanced levels.

The Nation's S&E workforce will face new and different challenges during the nineties. Demand for new S&E workers is expected to increase at a slower pace than that experienced during the 1980s; however, employers will need larger numbers of replacements for attrition from the overall growing S&E labor force.

On the supply side, concerns exist about the impact of a declining college-age population on future levels of new S&E graduates. If the fall in the number of S&E bachelors degrees awarded between 1986 and 1989 continues into the nineties, industry will have to rely more heavily on sources other than new graduates to fill their needs. Employers will need to focus more of their efforts on retaining and retooling their current workforce. These and other factors will together determine the future balance of the S&E labor market.

## Chapter Organization

This chapter examines past and projected growth of S&E jobs in the industrial sector, which forms the core of demand for S&E occupations (about two-thirds of total S&E employment). Information on the educational attainment of the science and engineering workforce is also presented. Finally, comparative data on international S&E employment are provided.

# Industrial S&E Job Patterns[1]

In 1989, U.S. private industry provided jobs for nearly 2 million scientists and engineers.[2] This total represented 2.4 percent of all private industry employment, up from 2.1 percent in 1980. Since the 1950s, industrial employment patterns for scientists and engineers have shifted significantly, with strong growth in the 1950-70 period, stagnation and decline in the early and mid-seventies, resurgence in the late seventies through 1980, and generally falling rates of growth since 1981 (SRS 1988a, p. 2).

S&E employment has continued to exceed the growth rate of the total industrial labor force. Between 1980 and 1989, the number of S&E jobs in private industry increased at almost twice the rate for all workers. (See figure O-8 in Overview.) These trends were accompanied by major changes in the industrial sector and occupational mix of S&E employment. Most strikingly, the concentration of industrial S&E employment has gradually shifted from manufacturing to nonmanufacturing since the late 1960s. (See figure 3-1.) This shift reverses the prior trend in relative shares: Between 1950 and 1967, the rate of S&E job growth in manufacturing industries exceeded that in nonmanufacturing. This section delineates other

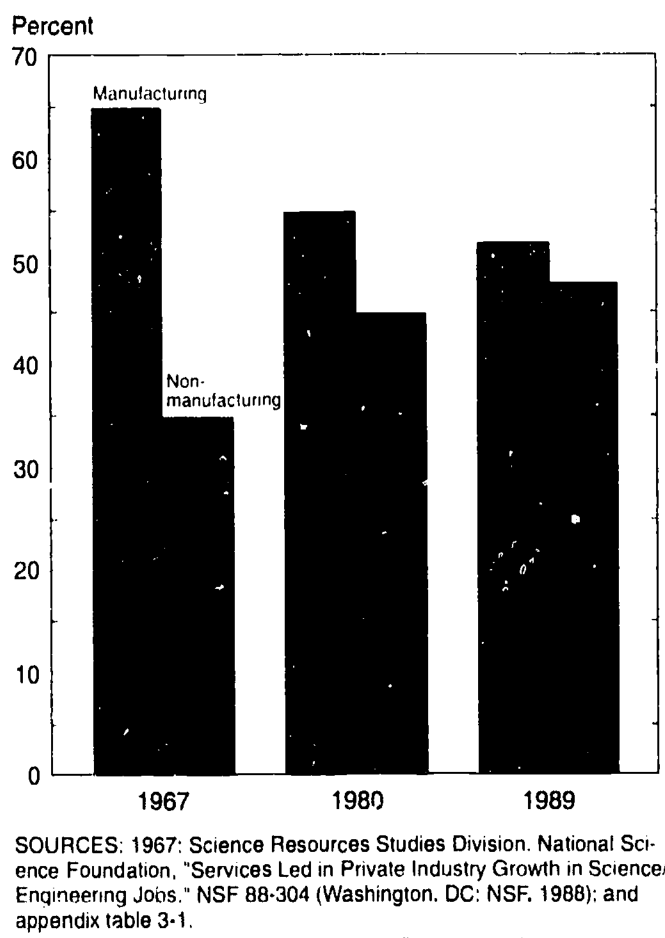
[1] Analyses in this section are based on data from the Occupational Employment Statistics (OES) Survey conducted annually by the Bureau of Labor Statistics. This large, establishment-based survey collects information on employment in S&E jobs. The individuals holding these jobs need not be formally trained in S&E but rather can have the equivalent of 4 years of training in a related S&E field.

Note that the OES data do not necessarily classify S&E personnel engaged in management as part of the S&E workforce. In the OES Survey, management is a unique occupation; in other surveys referenced in this chapter, management is a permissible S&E job function.

Annual data reported in this section are based on estimates generated by the National Science Foundation. For an explanation of the OES Survey and S&E job estimating methodology, see SRS (1990a), ndix A.

[2] In this section, "private industry" does not include hospitals and other health services, membership organizations, and other nonprofit industries.

**Figure 3-1.**
**Distribution of science and engineering jobs in private industry**




SOURCES: 1967: Science Resources Studies Division, National Science Foundation, "Services Led in Private Industry Growth in Science/Engineering Jobs," NSF 88-304 (Washington, DC: NSF, 1988); and appendix table 3-1.

*Science & Engineering Indicators – 1991*

specific growth and occupation trends within these two industrial sectors.[3]

## Manufacturing Industries

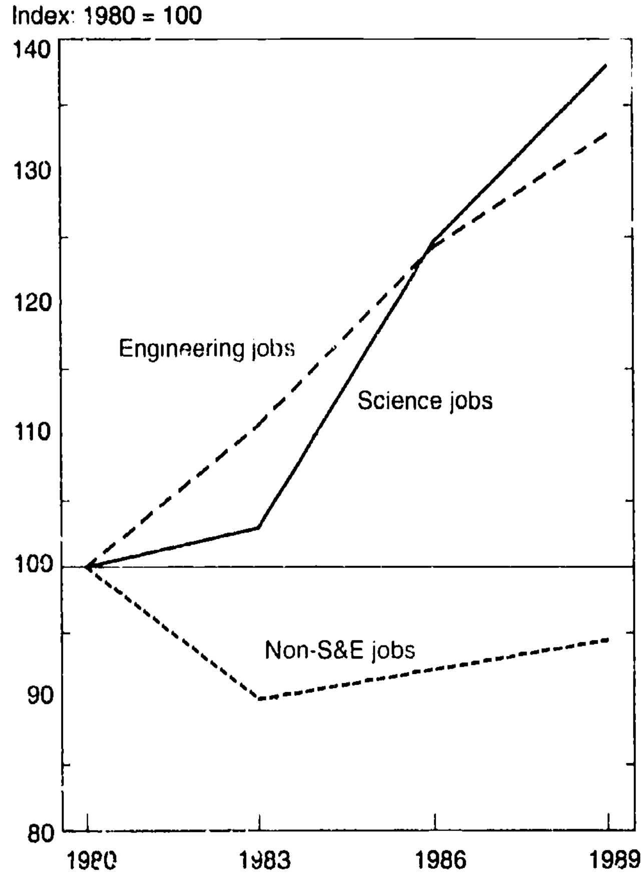
About 200,000 scientists and 800,000 engineers—52 percent of the total industrial S&E labor force—were employed in manufacturing industries in 1989. During the eighties, S&E employment grew in most manufacturing industries at an average annual rate of 3.2 percent. High-tech manufacturing industries, particularly the aerospace industries, accounted for much of the maintenance and increase in the sector's S&E job growth. (See chapter 6, "Performance of New High-Tech Companies," p. 158.) Factors contributing to the generation of high-tech employment included

- Increases in defense spending,
- Greater foreign technological competition,
- Pressure to increase productivity,
- High-technology capital investment, and
- Increased R&D expenditures.

(NSF 1988a, p. 3.)

***Growth in S&E Versus Non-S&E Employment.*** The relative growth rates in employment of S&E and non-S&E personnel in manufacturing industries have varied substantially during the eighties, particularly during the 1981-82 recession. (See figure 3-2.) While total manufacturing employment declined at an average rate of 3.1 percent per year between 1980 and 1983, the number of S&E positions in this sector *rose* by over 3.0 percent per year. Both S&E and total manufacturing employment rebounded—by 4.4 and 0.9 percent, respectively—between 1983 and 1986. The 1986-89 changes were a 2.3-percent average annual increase for S&E positions and, again, less than a 1-percent increase per year for all employees. In 1989, S&E positions represented slightly more than 5 percent of all manufacturing jobs.

Figure 3-2.
**Index of job growth in manufacturing industries**




See appendix table 3-1. *Science & Engineering Indicators – 1991*

***Employing Industries.*** In 1989, the manufacturing industries employing the largest numbers of scientists and engineers were

- Aerospace, with 183,000 S&E jobs;
- Instruments and related products, 137,000;
- Chemicals and allied products, 113,000; and
- Office and computing equipment, 97,000.

(See figure 3-3.)

The sector's largest S&E employer, the aerospace industry, experienced fairly rigorous growth in its S&E employment throughout the early and mid-1980s, before falling off in the latter part of the decade. Between 1980 and 1983, strong demand for U.S. missiles and military aircraft and consistent levels of space-related activities more than offset dwindling employment in the production of civil aircraft. These factors allowed S&E employment to rise at a rate of 5.3 percent per year. The aerospace industry experienced even more robust S&E job growth in the mid-eighties, with the number of S&E positions increasing by more than 10 percent annually between 1983 and 1986. This growth was buoyed by continued expansion of military orders and the production of large commercial aircraft. More recently, from 1986 to 1989, annual S&E job growth slowed to 2.1 percent, reflecting declining defense budgets in the United States and other developing countries and the attendant reduction in military procurements of aircraft and missile systems (ITA 1990, p. 25-1).

## Nonmanufacturing Industries

The nonmanufacturing sector provided jobs for an estimated 920,000 scientists and engineers in 1989, or 48 percent of total industrial S&E employment. (See appendix table 3-1.) The majority of the sector's S&E employees were engineers—545,000, versus 375,000 scientists. Most of these scientists and engineers were in the service-producing industries; a small proportion were in mining and construction. S&E employment in

[3] S&E occupational data discussed in this section are limited to Standard Industrial Classification industry groupings.

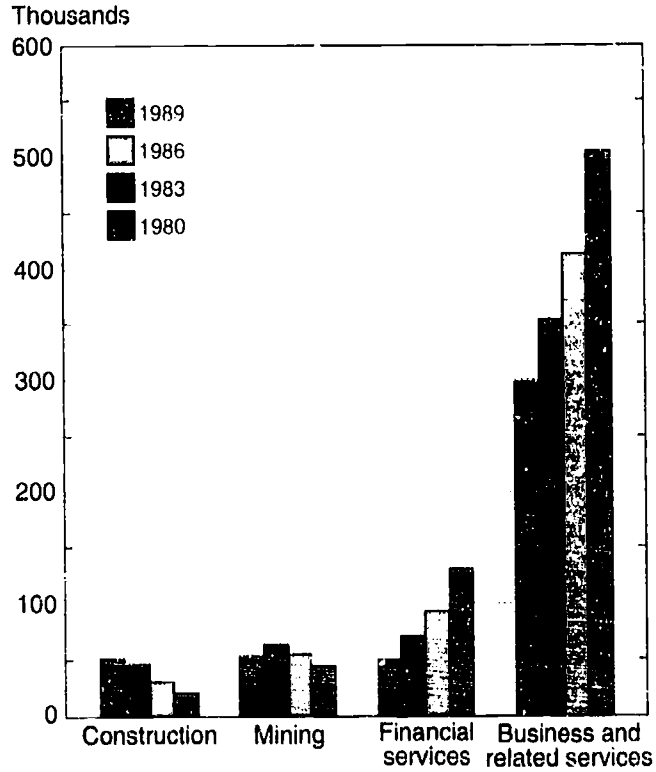
nonmanufacturing industries increased substantially during the eighties. This increase can be attributed to two main factors:

- A greater share of the total jobs in the nonmanufacturing sector were held by S&E personnel in 1989 versus 1980; and
- The nonmanufacturing sector, unlike the manufacturing sector, experienced general economic growth with attendant increases in overall total employment.

***Growth in S&E Versus Non-S&E Employment.*** Overall, total employment in nonmanufacturing industries grew at an average annual rate of 3.0 percent between 1980 and 1989, while the number of S&E jobs increased on average by 4.5 percent. The proportion of the nonmanufacturing workforce in S&E positions increased during this time from 1.4 percent of total employment to 1.5 percent.

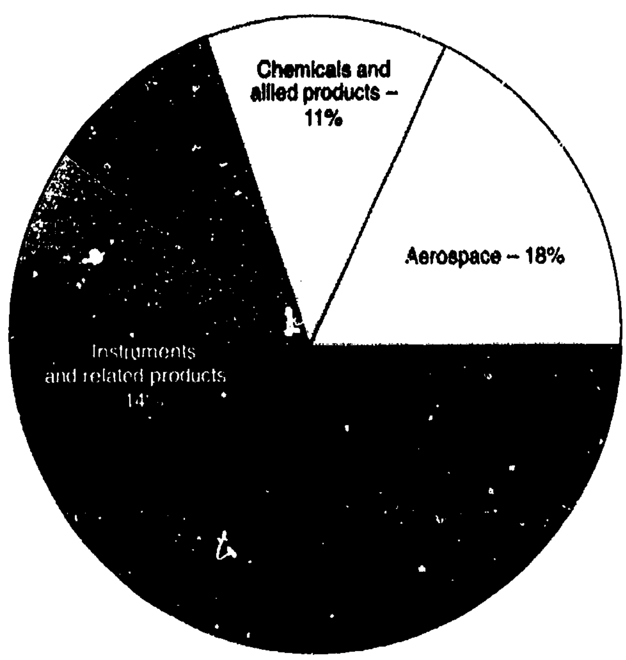
Although S&E job opportunities in nonmanufacturing increased substantially over the decade, growth was not uniform over time. Despite the recession, moderate growth characterized the 1980-83 period—4.5 percent per year on average. Losses of S&E jobs in the mining and construction industries contributed to a lowering of the overall annual rate of S&E job growth in the nonmanufacturing sector to 3.0 percent between 1983 and 1986.

Figure 3-4.
**Science and engineering jobs in selected nonmanufacturing industries**




See appendix table 3-1. *Science & Engineering Indicators – 1991*

Figure 3-3.
**Industry distribution of science and engineering jobs in manufacturing sector: 1989**




**Science and engineering jobs**
**N = 993,000**

SOURCES: Bureau of Labor Statistics, Occupational Employment Statistics Surveys, and appendix table 3-1

*Science & Engineering Indicators – 1991*

Average annual S&E job growth rebounded to 5.9 percent for the 1986-89 period, primarily because increased S&E job opportunities in the financial services and business and related services industries offset the continuing losses in mining and construction. (See figure 3-4.)

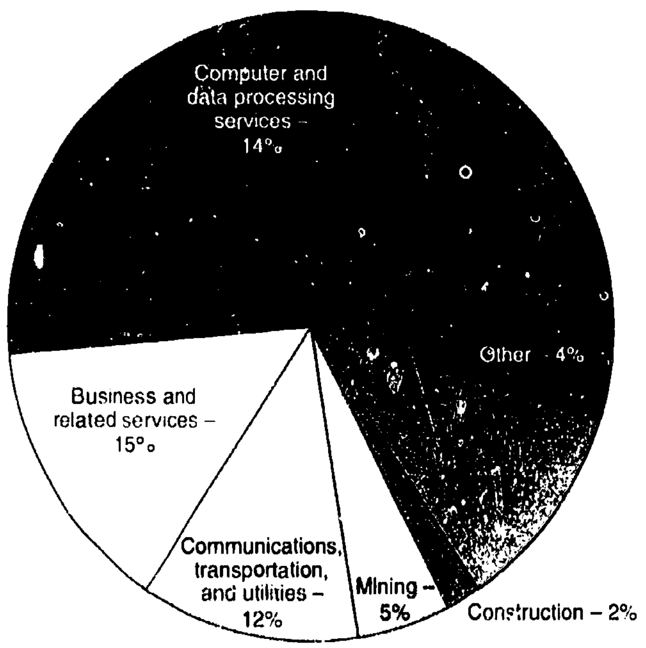
***Employing Industries.*** The major nonmanufacturing industries in terms of S&E employment in 1989 were:

- Engineering and architectural services, with 201,000 S&E jobs;
- Business services, 140,000;
- Financial services, 134,000; and
- Computer and data processing services, 125,000.

Together, these industries provided two-thirds of all S&E jobs in the nonmanufacturing sector. (See figure 3-5.) However, two industries are of particular interest, the first—engineering and architectural services—because of its position as the largest provider of S&E jobs in the nonmanufacturing sector and the second—computer and data processing services—because of its phenomenal job growth over the decade.

S&E employment in *engineering and architectural services* increased by more than 60 percent between 1980 and 1989 to over 200,000 personnel. The number of S&E positions in this industry rose at an average annual rate of 5.4 percent over the decade. Most of this growth

Figure 3-5.
**Industry distribution of science and engineering jobs in nonmanufacturing sector: 1989**




SOURCES: Bureau of Labor Statistics, Occupational Employment Statistics Surveys; and appendix table 3-1.

*Science & Engineering Indicators – 1991*

occurred in the early eighties as a result of strong growth in demand for engineering services by the construction industry.[1]

The extraordinary S&E job growth in *computer and data processing services*—an average 13.1 percent per year between 1980 and 1989—occurred in response to the revolution in information technologies and the strong demand for information services. The industry also includes computer software design, an industry segment that has experienced major growth as new methods of delivering information-related services—e.g., local area networks and electronic data interchange networks—have been developed. Demand for these and related services has resulted in an increase in the number of S&E positions in the computer and data processing services industry from 41,000 in 1980 to 125,000 in 1989.

## Occupations

In the eighties, the manufacturing sector remained the primary source of employment for engineers, while scientists continued to find more job opportunities in the nonmanufacturing sector. Nonmanufacturing industries increased their share of total science jobs from 63 to 66 percent during the eighties, while the proportion of engineering jobs in this sector increased from 39 percent to slightly over 40 percent. Conversely, manufacturing industries' share of total science jobs fell from 37 to 34 percent, while the proportion of engineering jobs in this sector increased from 60 to 61 percent. By occupational specialty, however, manufacturing and nonmanufacturing industries showed similar patterns of S&E employment in 1989. (See figure O-9 in Overview.) Employment trends in the largest of these occupational specialties—the computer specialties and electrical/electronic engineering—are described below.

***Computer Specialists.*** The computer specialties dominated science employment growth during the eighties. Between 1980 and 1989, the number of jobs for computer specialists grew almost 7 percent per year, rising to an employment level of 318,000. (See figure O-10 in Overview.) Representing more than half of science employment growth in private industry, job opportunities in this occupation benefitted from the rapid expansion of the computer services industry and the increasingly greater industrial computer use. This increased demand was met by an interdisciplinary supply of workers able to meet job qualifications. Computer specialist jobs could be filled by persons trained in mathematics, engineering, and other S&E fields as well as by those specifically trained in the computer sciences. Nonmanufacturing industries provided more than two-thirds of the job opportunities in this occupation in 1989, primarily in the financial services and computer and data processing services industries.

***Electrical/Electronic Engineers.*** Jobs in electrical/electronic engineering increased at an average rate of more than 5 percent per year between 1980 and 1989. A total 436,000 electrical/electronic engineers in 1989 made this the largest S&E occupational specialty. Manufacturing industries provided approximately three-fifths of the industry jobs in this discipline, largely in the electrical and electronic equipment, transportation equipment, and instruments and related products industries. Among nonmanufacturing industries, business services and engineering and architectural services were the primary source of electrical/electronic engineering jobs.

## S&E Jobs in R&D

During the 1980s, R&D employment opportunities increased for industrial scientists and engineers. Two key factors primarily accounted for this increase, which occurred in both manufacturing and nonmanufacturing industries:

- Emerging technology industries (see chapter 6, "Technologies for Future Competitiveness," p. 160) engaged in increasing levels of R&D activity, and
- Competitive pressures propelled U.S. companies to improve and update product designs more rapidly than in the past.

[1]For example, the services of civil engineers were required for the design and construction of transportation systems, water resource and disposal systems, and environmental control and waste management systems.

***Manufacturing Industries.*** In 1989 the manufacturing sector provided more than twice as many R&D employment opportunities for engineers as for scientists—78,000 versus 38,000.[5] Of the engineering R&D positions in manufacturing industries, 42 percent (32,000) were in electrical/electronic engineering (including 8,000 jobs in computer engineering). Engineers also found R&D job opportunities in

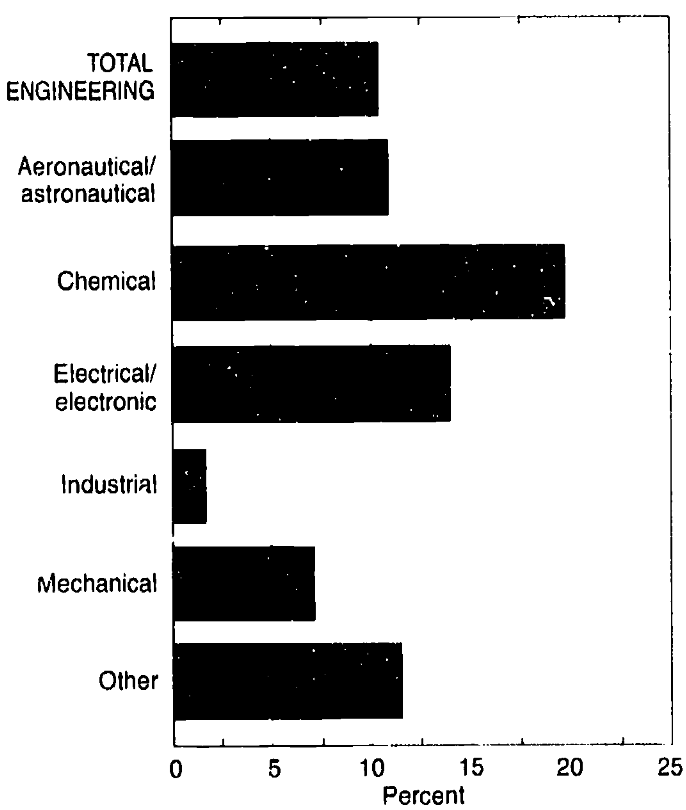
- Mechanical engineering (9,000),
- Chemical engineering (7,000),
- Aeronautical engineering (6,000), and
- Industrial engineering (2,000).

Almost 22,000 R&D jobs were located in other engineering specialties.

The proportion of engineering jobs in manufacturing that primarily involve R&D work differed greatly by subfield. (See figure 3-6.) In 1989 about 10 percent of the 804,000 total engineering jobs in manufacturing were in R&D. Chemical engineering accounted for the largest proportion of R&D work (19 percent); industrial engineering accounted for the smallest proportion (2 percent).

[5] As used here, R&D scientists and engineers refer to those who "spend the greater part of their work time on research and development."

Figure 3-6.
**Engineering jobs in manufacturing that primarily involve R&D, by field: 1989**




See appendix table 3-2.

*Science & Engineering Indicators – 1991*

Four industries provided 80 percent of the engineering R&D jobs in manufacturing in 1989. Transportation equipment employed 25 percent of the R&D engineers; nonelectrical machinery, 21 percent; electrical machinery, 18 percent; and instruments, 17 percent. These four industries also employed about 80 percent of the 726,000 non-R&D engineers, in almost the same proportions as of R&D engineers.

Three occupational groups accounted for almost all of the manufacturing R&D jobs for scientists:

- Physical scientists (56 percent),
- Life scientists (30 percent), and
- Computer specialists (12 percent).

Over 90 percent of the 12,000 R&D jobs for life scientists were in chemicals and allied products industries, as were 76 percent of the 21,000 R&D jobs for physical scientists.

***Nonmanufacturing Industries.*** In the nonmanufacturing sector in 1987, R&D job opportunities were slightly higher for engineers (40,000) than for scientists (34,000).[6] Practically all R&D positions (97 percent) were located in business and related services.

Unlike the manufacturing sector, the R&D jobs for scientists in this sector were distributed across all the major occupational groups, as follows:

- Physical scientists, 10,000 jobs;
- Computer specialists, 10,000;
- Life scientists, 8,000;
- Mathematical scientists, 3,000; and
- Social scientists, 3,000.

(See figure 3-7.)

Approximately 90 percent of the R&D jobs for physical scientists and 70 percent of those for computer specialists were in the business services industry (primarily computer and data processing services and commercial R&D labs). R&D jobs for life scientists were divided between business services (53 percent) and miscellaneous services (47 percent).

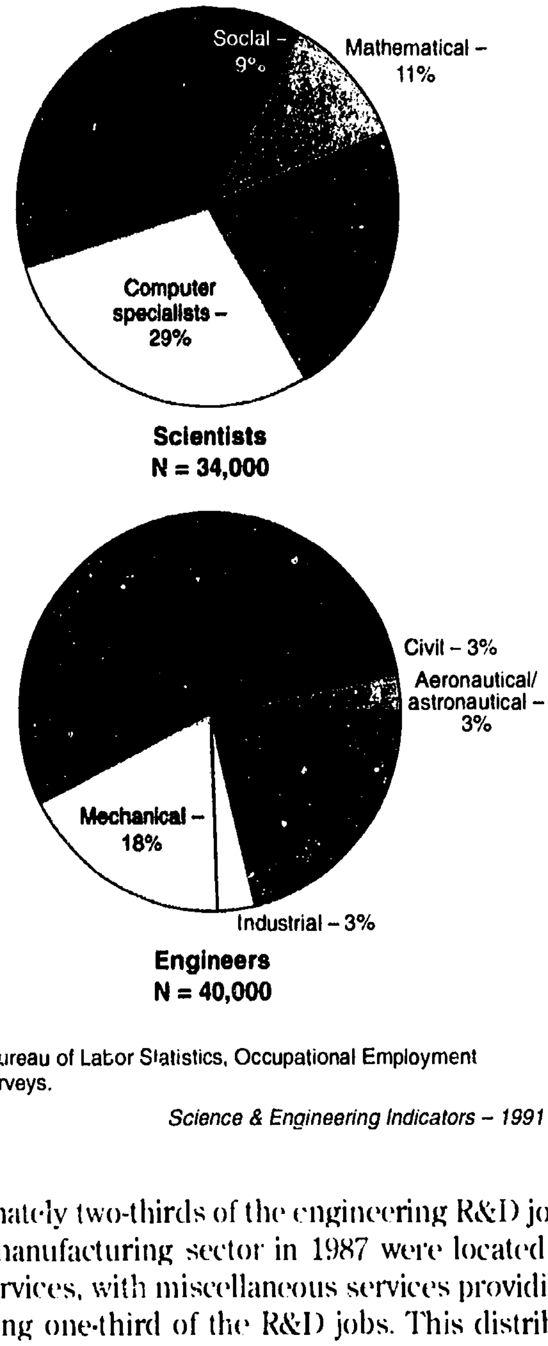
About half (21,000) of the engineering R&D jobs in the nonmanufacturing sector were in electrical/electronic engineering. The remaining R&D jobs were distributed as follows:

- Mechanical engineering, 7,000 jobs;
- Aeronautical engineering, 1,000;
- Civil engineering, 1,000; and
- Industrial engineering, 1,000.

Almost 9,000 R&D jobs were located in other engineering specialties.

[6] This is the latest year for which data are available; numbers are rounded to the nearest thousand.

Figure 3-7.
**Distribution of science and engineering R&D jobs in nonmanufacturing, by occupation: 1987**




SOURCE: Bureau of Labor Statistics, Occupational Employment Statistics Surveys.

*Science & Engineering Indicators – 1991*

Approximately two-thirds of the engineering R&D jobs in the nonmanufacturing sector in 1987 were located in business services, with miscellaneous services providing the remaining one-third of the R&D jobs. This distribution was uniform across most engineering occupations, with the exception of mechanical engineering. Approximately 80 percent of these R&D jobs were located in the business services industry.

## Demographic Trends: Recent S&E Graduates

Recent S&E graduates form a key component of the Nation's science and engineering workforce; they account for almost half of the annual inflow into the S&E labor market (SRS 1990a, p. 40). The career choices of recent graduates and their entry into the labor market affect the balance between the supply of and the demand for scientists and engineers in the United States. (See "Supply and Demand Outlook for S&E Personnel," pp. 79-83.) Analysis of the workforce status and other characteristics of recent S&E graduates can yield valuable labor market information.[7] These data have been used by government policymakers to determine the levels of support for education or other governmental programs, by employers as an input to staffing decisions, by educators to forecast enrollment patterns, and by students in making career choices.

This section provides several labor market measures that offer useful insights into the overall supply and demand conditions for recent S&E graduates in the United States. Among these measures are median annual salaries, unemployment rates, S&E employment rates, and in-field employment rates.

### Market Conditions

Upon graduation, new S&E bachelors and masters degree recipients must choose whether to enter the job market or continue their education. In 1990, three-quarters of these recent S&E degree recipients were employed on a full-time basis. The majority were employed in S&E occupations: More masters recipients than bachelors recipients were reported as so employed. A very low number of recent S&E graduates (3 percent of bachelors and 2 percent of masters degree graduates) were unemployed and actively looking for jobs. (See figure 3-8.) Of those recipients of S&E degrees who were not in the labor force 1 or 2 years after graduation, most (20 percent of bachelors graduates and 22 percent of masters graduates) were full-time graduate students.

### Median Annual Salaries[8]

Median annual salaries of recent S&E graduates serve as an excellent indicator of the relative demand for new workers in various S&E fields. The median annual salary reported by recent S&E baccalaureate recipients was $26,000 in 1990; at the S&E masters degree level, the median salary reported was $37,000. (See text table 3-1.) Historically, the annual salaries of recent engineering degree recipients have been higher than those of graduates with science degrees. Accordingly, in 1990, baccalaureate engineering degree recipients reported a median annual salary of $33,000; their science counterparts reported a median annual salary of $23,000. Among masters degree recipients, the median salaries were $41,400 and $33,800 for engineering and science, respectively.

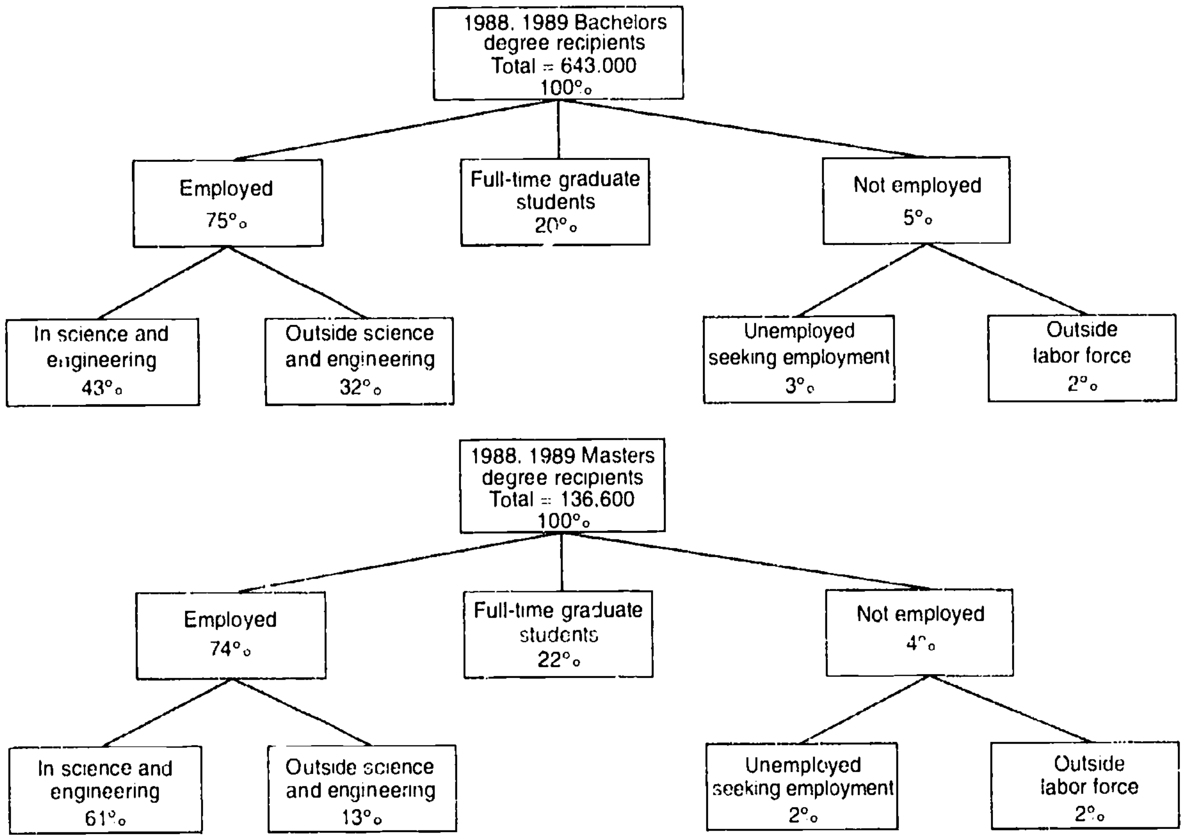
***By Field.*** Among science fields, there was considerable variation in median salaries. Recipients of bachelors and masters degrees in the computer sciences had much

---

[7] Data for this section are from the 1990 Survey of Recent Science, Social Science, and Engineering Graduates. This survey collected information on the 1990 workforce/other status of 1988 and 1989 bachelors and masters degree recipients in S&E fields. Surveys of recent S&E graduates have been conducted biennially for the National Science Foundation by the Institute for Survey Research, Temple University. For information on standard errors associated with survey data, see SRS (forthcoming).

[8] Median annual salary is that of full-time employed civilians rounded to the nearest $100.

Figure 3-8.
**Transition of recent science and engineering degree recipients: 1990**




See appendix tables 3-3, 3-4, 3-7, 3-10, and 3-11.

*Science & Engineering Indicators – 1991*

larger median annual salaries than did other science degree recipients. The next highest median salaries were reported by recipients of degrees in the physical sciences. The lowest median annual salary at the baccalaureate level was reported by recipients of psychology degrees; the lowest such salary at the masters level was received by recipients of life science degrees.

With the exception of civil engineering, median annual salaries among engineering subfields were fairly uniform at both the bachelors and masters degree levels. Median annual salaries reported by civil engineering degree recipients were significantly lower than for other engineering subfields at both the bachelors and masters degree levels.

***Growth in Salaries.*** During the eighties, median annual salaries rose at an average annual rate of 5.4 percent for bachelors degree recipients and 5.9 percent for masters degree recipients. Salary growth was not uniform throughout the decade, however. (See figure 3-9.) Between 1986 and 1990, median salaries for bachelors degree recipients increased at an average annual rate of less than 1.0 percent, while median annual salaries for masters degree recipients rose at an average rate of 3.3 percent annually.

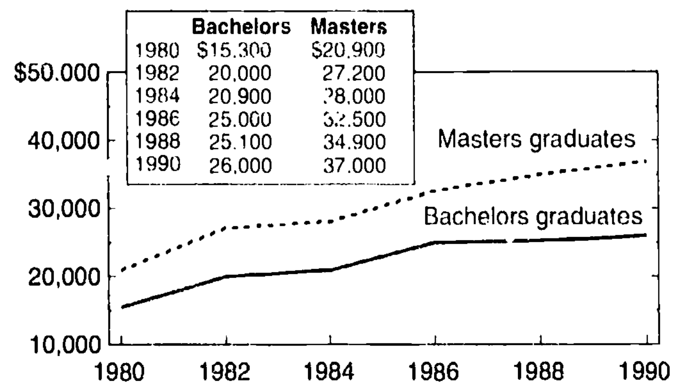
Text table 3-1.
**Median annual salaries of recent science and engineering graduates, by degree level and field: 1990**

| Field | Bachelors | Masters |
|---|---|---|
| Total science and engineering | $26,000 | $37,000 |
| Total sciences | 23,000 | 33,800 |
| Physical sciences | 25,100 | 34,900 |
| Mathematical sciences/statistics | 23,600 | 32,800 |
| Computer sciences | 30,100 | 42,100 |
| Environmental sciences | 23,700 | 33,800 |
| Life sciences | 21,000 | 26,900 |
| Psychology | 18,600 | 32,000 |
| Social sciences | 21,900 | 31,000 |
| Total engineering | 33,000 | 41,400 |
| Aeronautical/astronautical | 34,800 | 46,500 |
| Chemical | 35,100 | 40,200 |
| Civil | 30,100 | 35,200 |
| Electrical/electronic | 34,000 | 46,500 |
| Mechanical | 34,000 | 42,100 |

See appendix tables 3-5 and 3-6.

*Science & Engineering Indicators - 1991*

Figure 3-9.
**Median annual salaries of recent science and engineering graduates**




SOURCE: Science Resources Studies Division, National Science Foundation, unpublished tabulations.

*Science & Engineering Indicators – 1991*

***Salaries for Women and Minorities.*** In 1990, the median annual salaries of recent female baccalaureate recipients employed as scientists and engineers were approximately 73 percent of the salaries of their male counterparts. Much of this difference is due to the concentration of women in relatively low-paying S&E fields such as psychology and the life sciences (SRS 1990b).

By racial/ethnic group, new Asian baccalaureate recipients reported a median annual salary of $30,000 in 1990; this was almost 15 percent higher than the salary reported by whites ($26,100). Hispanics ($25,100), blacks ($24,000), and Native Americans ($21,900) all reported median salaries below that of whites. At the masters degree level, the median salary for Asians ($35,900) was approximately the same as for other minority groups, although less than for whites ($37,500).

## Unemployment Rates

A standard measure of labor market conditions is the unemployment rate, which measures the proportion of those in the workforce who are not employed but are seeking work. A high unemployment rate may indicate that the supply of S&E graduates is more than sufficient to meet market demands. A low unemployment rate, on the other hand, may indicate that the demand for graduates exceeds their supply in the marketplace.

In 1990, the unemployment rate reported by recent S&E graduates was 3.4 percent among baccalaureate degree recipients and 1.8 percent for masters degree recipients. By comparison, the overall unemployment rate in the United States was 5.5 percent in 1990 and 1.9 percent for professional workers (BLS 1991, p. 174). The unemployment rates for recent S&E graduates in 1990 were higher than comparable rates reported in 1988.

## S&E Employment Rates

The S&E employment rate measures the extent to which employed scientists and engineers have S&E jobs. Reasons for non-S&E employment include lack of available S&E jobs, higher pay for non-S&E employment, location, or preference for a job outside of S&E.

In 1990, approximately 62 percent of recent S&E bachelors degree recipients and 89 percent of recent S&E masters degree recipients were employed in science and engineering jobs. S&E employment rates for recent bachelors degree recipients were lower than those for masters degree recipients across almost all fields, although there was considerable variation in rates by field.

In the sciences, 28 percent of social science and 30 percent of psychology baccalaureate recipients worked in jobs related to science or engineering. In contrast, almost 88 percent of the people holding computer science bachelors degrees and 85 percent of those with physical science and environmental science degrees were employed in S&E jobs. Engineering rates did not vary as much by subfield. With some minor exceptions, more than 90 percent of *all* engineering degree graduates—both at the bachelors and masters degree levels—were employed in S&E jobs in 1990. Bachelors degree-holders in aeronautical/astronautical engineering (82 percent) and bachelors and masters degree-holders in industrial engineering (85 percent and 79 percent, respectively) were the exceptions to this.

## In-Field Employment Rates

Many recent S&E graduates find jobs directly related to their degree fields, although it is more common for masters degree recipients than for bachelors degree recipients to do so. In 1990, 59 percent of masters degree recipients and 38 percent of bachelors degree recipients were employed in fields directly related to their degrees. (See text table 3-2.) Regardless of degree level, the highest in-field employment rates were reported by recipients of computer science, civil engineering, and environmental science degrees.

At the bachelors degree level, in-field employment rates ranged widely from 10 percent for psychology to 82 percent for computer science. Among masters degree recipients, the range was much narrower, with 44 percent of social science graduates and over 77 percent of computer science graduates employed in jobs associated with their degree fields.

## Primary Work Activities

The work activities of recent S&E graduates varied by degree level in 1990. (See figure 3-10.). Bachelors degree recipients were more likely than masters degree recipients to be employed in jobs oriented toward production and inspection, sales and professional services, or general management. Masters degree recipients were

Text table 3-2.
**In-field employment rates of recent science and engineering graduates, by degree and field: 1990**

| Field | Bachelors | Masters |
|---|---|---|
| Total science and engineering | 37.8 | 59.0 |
| Total sciences | 33.2 | 59.6 |
| Physical sciences | 35.6 | 43.4 |
| Mathematical sciences/statistics | 39.6 | 57.4 |
| Computer sciences | 81.5 | 77.2 |
| Environmental sciences | 56.1 | 69.4 |
| Life sciences | 38.4 | 59.0 |
| Psychology | 9.9 | 48.1 |
| Social sciences | 14.1 | 43.5 |
| Total engineering | 50.7 | 57.8 |
| Aeronautical/astronautical | 48.9 | * |
| Chemical | 49.6 | * |
| Civil | 71.1 | 69.1 |
| Electrical/electronic | 53.3 | 57.7 |
| Mechanical | 44.3 | 60.4 |

* = too few cases to report

See appendix table 3-7. *Science & Engineering Indicators – 1991*

more concentrated in jobs focusing on R&D, R&D management, and teaching.

The primary work activities of recent S&E graduates varied substantially by field. At both degree levels in 1990, engineering graduates were more likely to be employed in R&D and production and inspection; science degree recipients were more likely to be employed in general management, teaching, or a combination of activities related to reporting, statistical work, and computing.

## Sectors of Employment

Industry was the primary employer of new S&E graduates in 1990, providing jobs for 65 percent of recent bachelors degree recipients and 60 percent of recent masters degree recipients. Educational institutions employed 10 percent of bachelors degree-holders and 17 percent of those with masters degrees. Only 4 percent of recent baccalaureate and 8 percent of masters degree recipients were employed by the Federal Government in 1990.

The employment distribution of recent S&E graduates by sector did not change markedly over the 1980-90 period. However, there were some sectoral shifts by field of degree—specifically, by engineering degree recipients. The percentage of recent graduates with bachelors degrees in engineering employed by the Federal Government increased from 4 percent in 1980 to 6 percent in 1990.[9] However, the Federal share of recent masters degree recipients in this field declined from 9 to 7 percent over the period. State and local governments similarly increased their share of recent bachelors degree recipients in engineering from 3 percent in 1980 to 5 percent in 1990 and decreased their share of masters degree graduates in engineering from 4 to 3 percent. These fluctuations in S&E employment can be attributed to shifts in defense spending over the decade.

Industry has accounted for the largest share of recent S&E graduate employment. The share of recent graduates with masters degrees in engineering employed by industry has increased from 76 percent in 1980 to 78 percent in 1990. Conversely, over the same period, baccalaureate engineering recipients have declined in their share of industrial employment, dropping from 88 to 78 percent. For science degree recipients, industry's share of recent graduates with masters degrees increased from 40 to 51 percent between 1980 and 1990, while its share of recent bachelors degree recipients rose from 58 to 60 percent.

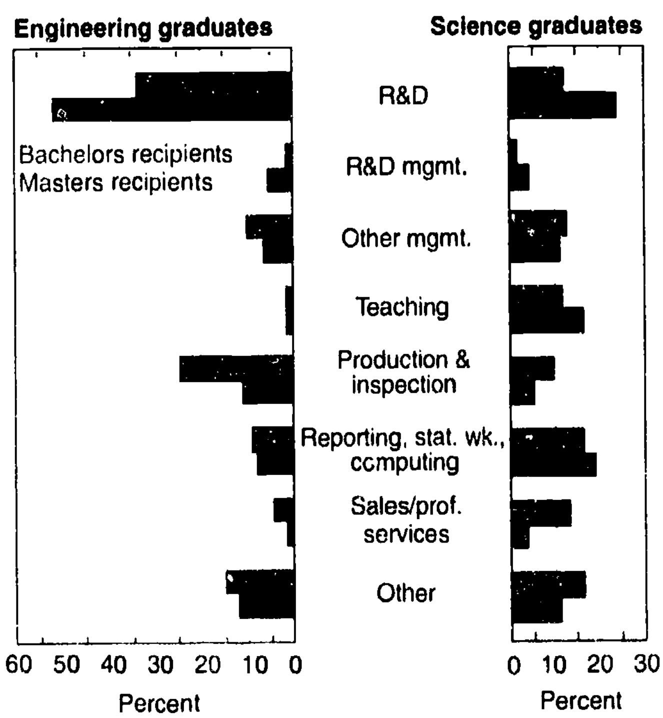
[9] Data for 1980 are from SRS (1982).

## Demographic Trends: Doctorate Recipients[10]

In 1989, the population of doctoral scientists and engineers was about 485,000, an increase of 4 percent per year since 1977 when it was almost 304,000. The annual

[10] Data for this section are from the National Science Foundation's Survey of Doctorate Recipients biennial survey series. The most recent survey was conducted in 1989. For information on standard errors associated with these survey data, see SRS (1991).

Figure 3-10.
**Distribution of bachelors and masters science and engineering graduates, by primary work activity: 1990**




See appendix tables 3-8 and 3-9.
*Science & Engineering Indicators – 1991*

rate of retirement for doctoral scientists and engineers increased from about 0.5 percent between 1977 and 1979 to 0.8 percent during the 1987-89 period.[11] The effect of this change was a dramatic increase in the proportion of the doctoral scientist and engineer population who were retired—a rise from 3.2 percent in 1977 to 5.6 percent in 1989. Most of this increase occurred after 1985, when retirees accounted for 3.5 percent of the S&E doctoral population. As larger proportions of doctoral S&E workers enter the 55 years and older age group, retirements may begin to have a significant impact on their supply.

Retirees varied considerably by degree field. In 1989, retirees accounted for between 6.5 and 8.5 percent of the doctorate-holders in the physical and social sciences and in chemical engineering. Rates were much lower—3.5 to 5.1 percent—among doctorate-holders in the mathematical and environmental sciences, psychology, and electrical and mechanical engineering. No retirements were reported by individuals in the computer sciences, a relatively new field.

## Market Conditions

The likelihood of scientists and engineers at the doctorate level to enter the workforce remained very high in 1989 and appeared to have been unaffected by swings in the Nation's economy during the late seventies and eighties. Throughout the 1977-89 period, the labor force participation rate of doctoral scientists and engineers was approximately 95 percent. Doctoral scientists and engineers had little trouble finding work during this period; their reported unemployment rate ranged from 1.2 percent in 1977 to less than 1 percent in 1989 (SRS 1991). By contrast, the overall unemployment rate in the United States was 5.3 percent in 1989 and 1.7 percent for professional workers (BLS 1991). The unemployment rate for scientists and engineers at all degree levels combined was 1.5 percent in 1988 (SRS 1990c).

## Employment Rates

Employment of doctoral scientists and engineers reached 449,000 in 1989, an increase of 57 percent (3.9 percent per year) over 1977. Since 1983, however, employment growth of S&E doctorate-holders has slowed. The annual rate of increase for the 1983-89 period was 3.3 percent per year, compared to 4.4 percent annually between 1977 and 1983.

Despite substantial variation within individual S&E fields, the overall proportions of employed doctoral scientists (83 percent) and engineers (17 percent) have remained constant since 1977. The higher proportion of science doctorate-holders reflects (1) their relative concentration in academia and (2) the higher level of education needed by scientists (compared to engineers) for professional status.

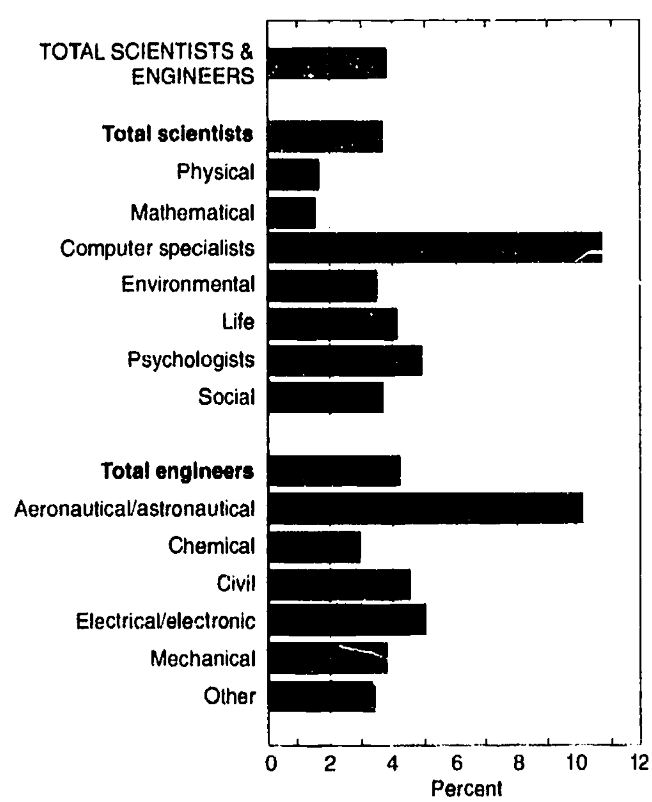
Within both science and engineering, growth rates for employed doctoral scientists and engineers varied considerably by field over the 1977-89 period. (See figure 3-11.) Among the sciences, where overall growth was approximately 4 percent per year, the lowest rate was in the mathematical sciences (1.6 percent per year). With almost 11-percent annual growth, the computer specialties was the fastest growing field. Growth among the engineering subfields varied within a narrower range. Overall employment of doctoral engineers also increased at an annual rate of slightly over 4 percent; by subfield, growth ranged from 3.0 percent per year for chemical engineers to almost 10 percent per year for aeronautical/astronautical engineers.

These differing growth rates altered the field distributions of the S&E doctoral workforce over the 1977-89 period. Among scientists, the proportions employed as computer specialists, psychologists, and life scientists increased while the percentages employed as physical, mathematical and social scientists declined. In contrast, there were relatively modest shifts among engineering subfields. (See figure 3-12.)

## Primary Work Activities

Between 1977 and 1989, the number of doctoral scientists working primarily in R&D increased by about 60 percent, while the number of their engineering counterparts rose 74 percent. Approximately 33 percent of

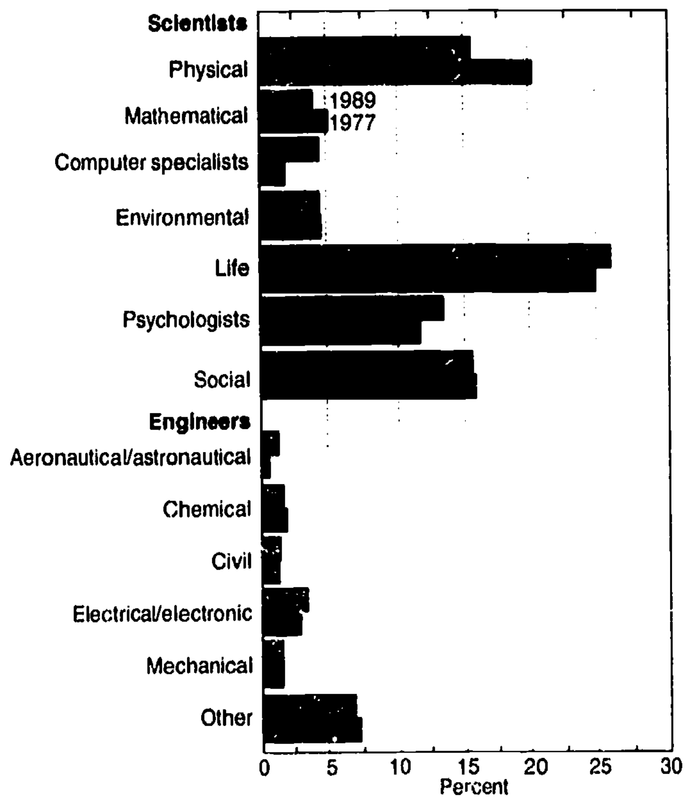
Figure 3-11.
**Annual rates of employment growth for doctoral scientists and engineers, by field: 1977-89**




See appendix table 3-12. *Science & Engineering Indicators – 1991*

[11]The retirement rate is the number of individuals who retired during a 2-year interval divided by the total population at the beginning of the interval—e.g., the number of individuals who retired between 1987 and 1989 expressed as a percentage of the 1987 population.

Figure 3-12.
**Distribution of employed doctoral scientists and engineers, by field**




See appendix table 3-12. *Science & Engineering Indicators – 1991*

Ph.D.-holding scientists and 30 percent of doctoral engineers reported basic or applied research as their primary work activity in 1989, up from 29 and 23 percent, respectively, in 1977. (See figure 3-13.) Another 3 percent of doctoral scientists and 16 percent of doctoral engineers were working in development in 1989.

The next most prevalent work activity was teaching. Approximately 27 percent of doctoral scientists and 17 percent of doctoral engineers reported teaching as their primary work activity in 1989. In 1977, these proportions were higher—34 and 20 percent, respectively; the downward trend reflects the shift in Ph.D. concentration from academia to industry.

About 7 percent of doctoral scientists and 15 percent of doctoral engineers cited R&D management as their primary work activity in 1989. These proportions were down from 9 and 19 percent, respectively, in 1977.

## Sectors of Employment

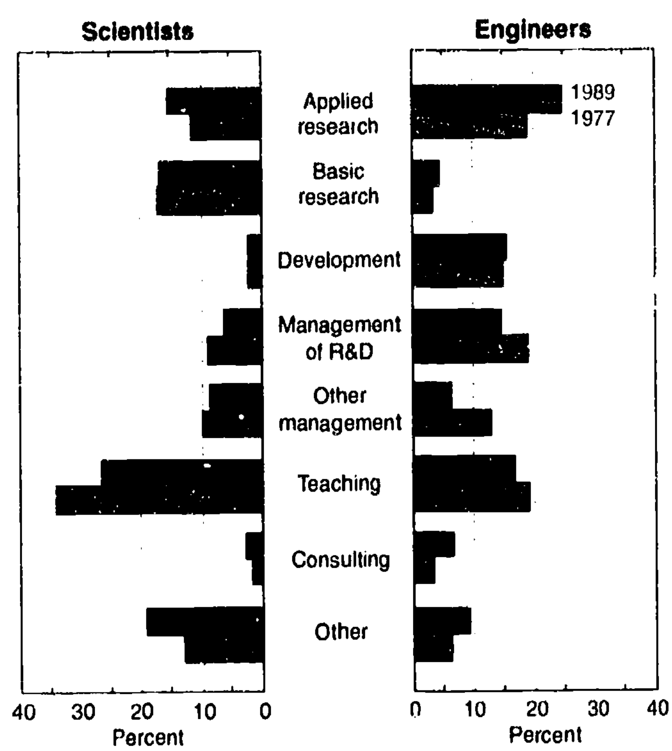
Although educational institutions remained the primary employer of S&E doctorate-holders in 1989, this sector's employment share has declined steadily since the late 1970s. Industry's share of doctoral scientists and engineers meanwhile has increased. In 1977, 62 percent of Ph.D.-holding scientists and 35 percent of their engineering counterparts were employed in academia; by 1989, the proportion of scientists had dropped to 55 percent and that of engineers to under 34 percent. (See figure O-11 in Overview.) Concurrently, the proportion of doctoral scientists employed in industry increased from 20 to 28 percent, and that of engineers from 51 to 56 percent. The following paragraphs further detail this shift from academia to industry.

***Educational Institutions.*** Between 1977 and 1989, doctoral S&E employment in educational institutions increased at an average rate of 2.9 percent per year; this was about half the 6.1-percent rate for industry. As a result of academia's slower growth, the proportion of the Nation's Ph.D.-holding scientists and engineers employed in this sector declined from 57 to 51 percent.

The relative importance of academia as a source of employment for S&E doctorate-holders varied considerably by field. Roughly three-fifths of all doctoral scientists were employed in this sector, compared to about one-third of all doctoral engineers. Educational institutions employed 71 percent of the Nation's social science doctorate-holders, 61 percent of the Ph.D.-holding life scientists, and 44 percent of doctoral psychologists.

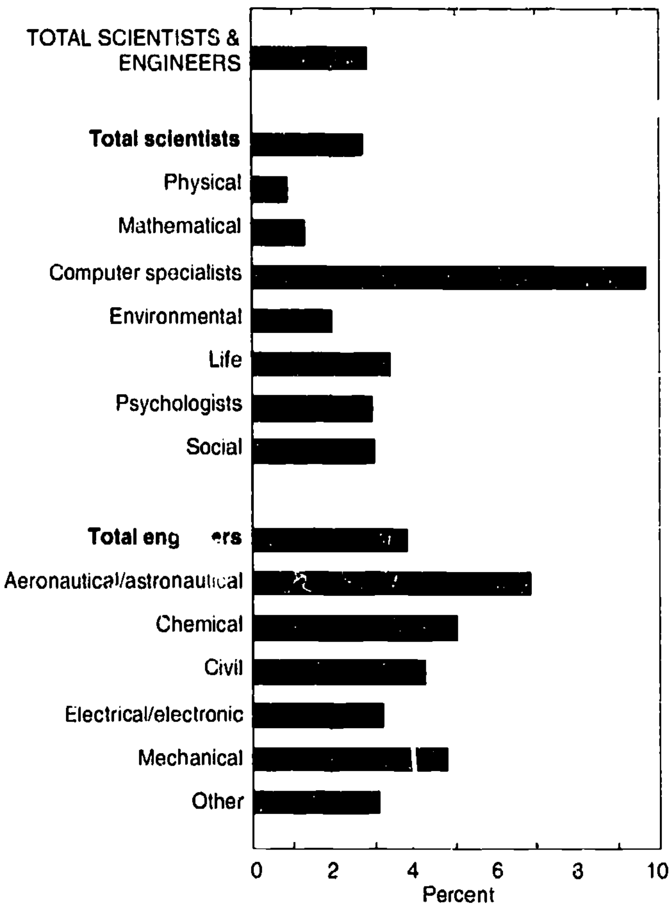
Growth in academic doctoral employment also varied by S&E field over the 1977-89 period. (See figure 3-14.) Doctorate-holding computer specialists increased at the fastest rate—an average annual rate of almost 10 percent. Life scientists and engineers in all subfields registered above average growth rates—3.5 percent and

Figure 3-13.
**Distribution of employed doctoral scientists and engineers, by primary work activity**




See appendix table 3-14. *Science & Engineering Indicators – 1991*

Figure 3-14.
**Annual rates of growth for doctoral scientists and engineers in academia: 1977-89**




See appendix table 3-15. *Science & Engineering Indicators – 1991*

almost 4 percent annually. Slower than average growth was recorded by physical and mathematical scientists, who increased by only 0.9 and 1.3 percent per year, respectively. These differing growth rates changed the field distribution of doctoral scientists and engineers over the period. For example, the proportion of physical scientists declined from about 17 to 13 percent, and the proportion of engineers rose from 10 to 11 percent.

After experiencing a slowdown in growth in the mid-eighties, doctoral scientist employment in academia has rebounded in recent years. Employment of Ph.D.-holding scientists increased at an average annual rate of 2.7 percent between 1987 and 1989, up substantially from an annual growth of 1.3 percent for the previous 2-year period. Opposite patterns were experienced by doctoral engineers, whose employment increased by 4.5 percent annually over the 1985-87 period and then dropped to less than 3 percent per year over the next 2-year period.

***Industry.*** Since the late seventies, the sectoral distribution of doctoral scientists and engineers has shifted toward industry, increasing at average annual rates of 6.5 and 5.2 percent, respectively. By 1989, 28 percent of all Ph.D.-holding scientists and 56 percent of all doctoral engineers worked in industry. The computer sciences, psychology, and the social sciences were the fastest growing science fields for doctorate-holders employed in industry; aeronautical/astronautical, civil, and electrical/electronic were the fastest growing engineering subfields.

Overall, industrial employment of S&E doctorate-holders has slowed since the early eighties. Between 1983 and 1989, the employment of doctoral scientists in industry increased at an average rate of 4.6 percent annually; doctoral engineering employment rose 3.3 percent per year. These declining growth rates reflect several factors, including

- A greater demand by academia for S&E doctorate-holders;
- A shortage of doctoral personnel in such high-demand S&E fields as the computer sciences and certain engineering specialties; and
- The relatively strong growth in development activities, which, as compared to basic and applied research, are generally carried out by less highly trained personnel (SRS 1988b, p. 22).

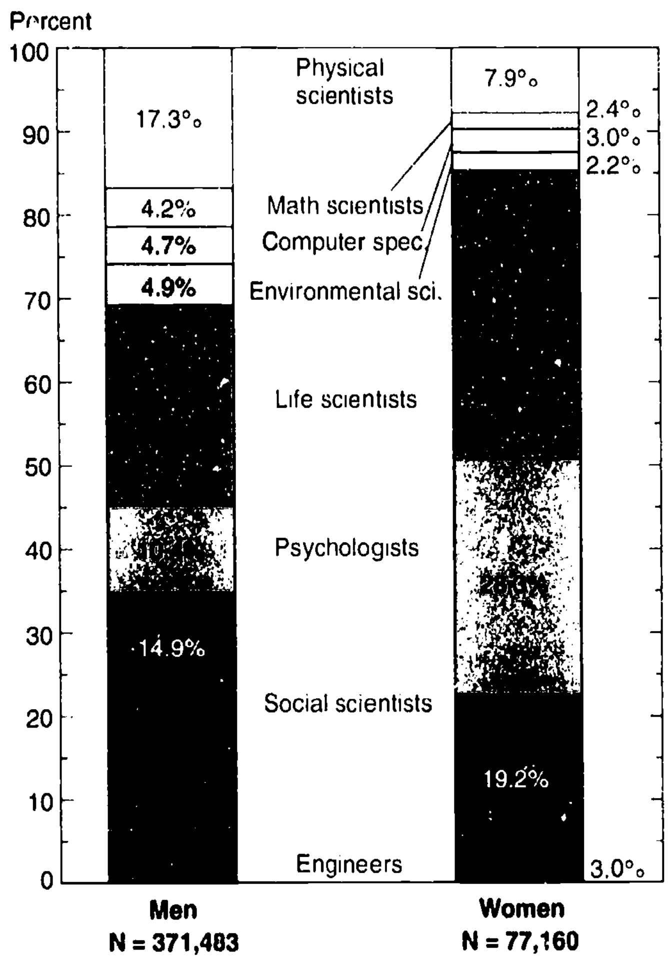
A few S&E fields/subfields did not experience a declining growth rate in the latter half of the 1977-89 period: These were the physical sciences and mechanical and civil engineering.

## Employment of Women and Minorities

***Women.*** Women continue to account for an increasing share of the employed Ph.D.-holding scientists and engineers. Their representation grew to 17.2 percent in 1989 compared to 9.7 percent in 1977. The fields with the greatest relative growth of women doctorate-holders were the computer sciences—which increased employment of doctoral women from fewer than 250 in 1977 to over 2,300 in 1989—and engineering—which increased employment from fewer than 300 to over 2,300 during the same period. Despite this rapid growth, only about 6 percent of doctoral women were either computer specialists or engineers in 1989. (See figure 3-15.) The life sciences, social sciences, and psychology together accounted for over 80 percent of the period's increase in the employment of doctoral women. Overall, the field distribution of women with science doctorates did not change greatly over the 1977-89 period. Women were, however, somewhat more likely to be psychologists or computer specialists and less likely to be mathematical or physical scientists in 1989 than in 1977.

***Minorities.*** During 1977-89, the numbers of employed black and Asian S&E doctorate-holders rose at average annual rates of 8.4 and 8.0 percent, respectively. (See figure 3-16.) These rates were over twice the 3.7-percent rate for whites. Recently (1987-89), S&E doctorate growth has slowed; black and Asian Ph.D.-holders increased at average rates of 6.1 and 6.3 percent per year, respectively; the corresponding rate for whites was 3.2 percent.

Figure 3-15.
**Distribution of employed doctoral scientists and engineers, by field and gender: 1989**




See appendix table 3-12. *Science & Engineering Indicators – 1991*

Despite their rapid employment growth, blacks accounted for only about 1.6 percent (7,200) of all employed doctoral scientists and engineers in 1989. This proportion represented a slight increase over 1977, when blacks accounted for only 1.0 percent of employed doctoral scientists and engineers. On the other hand, the more than 41,000 employed Asians with S&F Ph.D. degrees represented about 9.2 percent of the total in 1989, up significantly from 5.7 percent in 1977.

## Supply and Demand Outlook for S&E Personnel[12]

The 1990s should be a period of relative stability in S&E labor markets, particularly as compared with the defense buildup of the early to mid-1980s when many S&E fields experienced temporary shortages.[13] This conclusion has been reached after a careful examination of

- Various demand simulations to determine how alternative national economic growth patterns might affect S&E employment, and
- Supply side simulations to test the ability of the supply system to respond to these various demand scenarios.

The supply and demand models used to produce these simulations try systematically to account for the many institutional features, individual behavior patterns, demographic trends, and economic forces that govern S&E labor markets (Leslie and Oaxaca 1991). Results and features of these models are provided in this section.

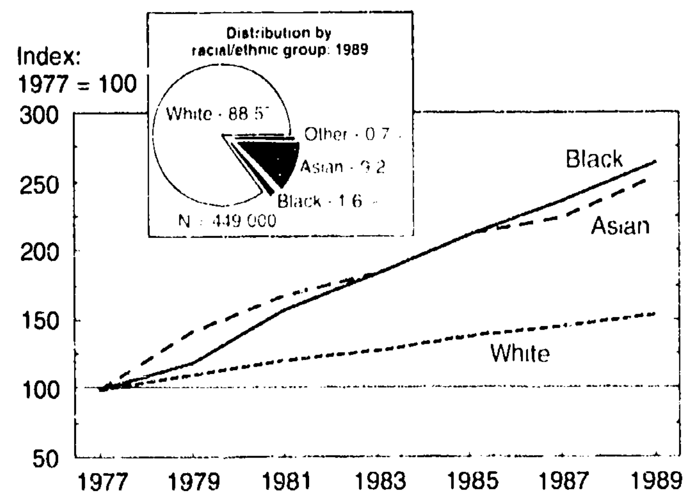
### Operations of the S&E Labor Market

Because the performance of the U.S. economy is a major influence on S&E employment, it is important to understand the fundamental operations of the economy in generating jobs for scientists and engineers (see "S&E Employment: Demand Side," p. 80), and in filling those jobs through education and training institutions (see "S&E Employment: Supply Side," p. 81). The models upon which the following results are based attempt to

[12] The model presented here represents one of several possible approaches to examining the outlook for S&E personnel. Equally robust models with different assumptions about demographic trends, or incorporating different personnel populations, job mobility, and other factors are likely to yield different results. Employment projections for the study were generated by NSF's PC occupations modeling system, developed by Data Resources, Inc./McGraw-Hill. The supply projections were based on a model that incorporates all major sources of response to changes in demand. Developed under grant to Dr. Robert Dauffenbach (Oklahoma University), these projections are intended to identify potential problems within the S&E labor market, as well as to assist in understanding the dynamics and flexibility of the S&E labor supply.

[13] The term "relative stability" indicates an overall balance between total supply and demand for scientists and engineers. It does not mean that supply and demand for each S&E field will be in perfect equilibrium throughout the decade. As has been the case in the past, spot shortages and surpluses will continue to occur across various S&E fields in response to supply/demand fluctuations.

Figure 3-16.
**Index of doctoral science and engineering employment, by racial/ethnic group**




See appendix table 3-13. *Science & Engineering Indicators – 1991*

## S&E Employment: Demand Side

From the demand perspective, employment of S&E personnel begins with "final industry demand"—that is, the output of goods and services from the various agriculture, mining, manufacturing, and service industries that is available for purchase by households, businesses, government, and foreigners. Because industries buy raw materials, products in intermediate stages of production, and services from other industries, the total volume of production in a given industry exceeds the total available for final purchase. ***Final demand*** in the various industries thus needs to be translated into ***total output*** per industry.

Once total industry output is known, productivity ratios—that is, output divided by labor input—can be used to compute employment by industry. From there, it is a simple matter to translate the industrial employment into occupational employment. This translation is accomplished through use of the occupational employment distribution per industry—the percentage of employees who are scientists and engineers, managers, clerical employees, blue-collar, etc. Summing the resulting employment by occupation across industries yields total occupational demand. Thus, through such models, it is possible to translate alternative final demand patterns into estimates of total employment by occupation.

capture these fundamental operations systematically. In this manner, alternative scenarios about the future and the ability of the supply system to meet such contingencies can be examined and assessed.

A variety of demand scenarios can be envisioned. For example, one scenario might involve high overall growth in U.S. output, a shift toward services and away from manufactured goods, lower military hardware production, and extensive defense and nondefense R&D. It is possible to imagine other scenarios that might involve slow overall growth of the U.S. economy, but with a shift in production of goods and services toward industries that rely heavily on S&E employment. Even though aggregate economic output would not change under such a scenario, S&E employment would expand. Many such scenarios could be developed and then tested relative to the ability of the supply system to respond.

Three adjustment mechanisms dominate supply responses in the present modeling framework: degree shares, employment retentions, and field mobility. In response to high levels of demand, degree shares (S&E degrees as a percentage of total degrees awarded) increase in the corresponding categories (Dauffenbach 1990). Also, retentions in S&E employment domains increase, which is to say that a high percentage of S&E graduates remain in S&E occupations rather than pursue alternative careers in marketing and management. In addition, workers with training in the shortage occupations become more concentrated in their respective fields of employment, and workers with training in related fields shift their employment to the occupations experiencing shortfalls. Final outcomes of the supply simulations show the leveling effects of the operations of the supply system. Both shortages and surpluses are lessened, exhibiting much more favorable balance than the initial changes in demand would indicate.

## Projected Demand for S&E Personnel

As described above, projections are forecasts that are conditional upon a variety of assumptions that depict economic, institutional, and social conditions. The analysis in this section was therefore designed not to provide a single numeric estimate of future employment requirements, but instead to provide a well-defined range within which employment growth is likely to occur during the 1990-2000 period.

Three projection scenarios—a "low,' a "mid," and a "high"—were analyzed with the demand model using alternative sets of assumptions designed to encompass likely economic performance during the simulation period 1990-2000.[11] (See text table 3-3 for a summary of these

[11] The economic assumptions used in the three projection scenarios (low, mid, and high) were provided by Data Resources, Inc./McGraw-Hill. The scenarios were run in the summer of 1991. Based on these assumptions, NSF's PC occupations modeling system generated estimates of projected total employment by sector. The occupational structure used by the Bureau of Labor Statistics was applied to the total employment projections.

The scenarios are *not* predictions; consequently, departures from the assumptions on which the scenarios are based may alter future outcomes significantly.

Text table 3-3.
**Summary statistics for macroeconomic scenarios: 1990-2000**

| Indicator | Macroeconomic scenarios Low | Mid | High |
|---|---|---|---|
| | **Average annual real growth** | | |
| | Percent | | |
| GNP | 1.7 | 2.2 | 2.7 |
| Consumption | 1.4 | 1.7 | 2.1 |
| Business fixed investment | 2.2 | 3.6 | 5.1 |
| Exports | 5.2 | 5.7 | 6.1 |
| Imports | 3.7 | 4.0 | 4.8 |
| | **Average annual growth** | | |
| Labor force | 0.7 | 1.2 | 1.6 |
| Productivity | 1.1 | 1.3 | 1.5 |
| Industrial production | 1.8 | 2.5 | 3.1 |
| | **Average level** | | |
| Inflation (GNP deflator) | 4.7 | 3.6 | 3.1 |
| Unemployment | 6.2 | 6.0 | 5.9 |

NOTES: Growth rates for the projection period are compound annual growth rates calculated between the years 1990 and 2000. Level variables are averages for the years 1991 to 2000.

SOURCE: Data Resources, Inc./McGraw-Hill.

*Science & Engineering Indicators – 1991*

assumptions.) S&E employment changes vary substantially from 1990 to 2000 under the three alternative economic growth scenarios:

- *Low growth*—S&E employment is expected to expand by 13.6 percent;
- *Mid growth*—S&E employment is expected to expand by 20.6 percent; and
- *High growth*—S&E employment is expected to expand by 26.7 percent.

(See text table 3-4.)

Growth differs dramatically among the five major groups of S&E employment: engineers, math and computer specialists, biological scientists, physical scientists, and social scientists. As shown in text table 3-4, the principal beneficiaries of growth in the 1990s are expected to be math and computer specialists and engineers. Under the low-growth scenario, demand is particularly weak for physical, biological, and social scientists. Under all scenarios, growth is concentrated among the engineering and math and computer specialties. This degree of concentration raises a concern as to the ability of the supply system to adjust to meet this demand.

## Supply Side Responses

There are many ways in which the supply system can adjust to meet this contingency of concentrated growth, including the following:

- Students presently enrolled can shift to high-growth majors.
- Recent graduates with related degrees can seek employment in high-growth fields.
- Experienced workers can seek retraining and become occupationally mobile into such jobs.
- Experienced workers with training in high-growth fields who are pursuing non-S&E careers can return to S&E employment.
- Those working in high-growth fields can extend their careers in those areas.
- Immigrants can make up some of the shortfall in high-growth areas.
- Later retirement could offset high demand.

The supply model needs to capture these various facets of flexibility in system operations. However, the amount of flexibility the supply model exhibits must be based on historical magnitudes (Collins 1988).

Supply model simulations were run on each of the three demand scenarios.[13] Overall, the low-growth supply simulations show about a 4.0-percent overall surplus by 2000—a particularly slow growth scenario. (See figure 3-17.) Below average surpluses are shown for math and computer specialists and physical scientists, while surpluses for the other occupational groups are slightly above average.

The mid-growth scenario indicates approximate balance—only about a 0.5-percent overall surplus. The balancing effects of supply system operations leave only a small percentage difference between the field of highest comparative shortage and highest comparative surplus.

The high-growth scenario, which yields an overall 26.7-percent growth in demand in the 1990s, results in an overall shortage, but not a significant one. Overall, total

### S&E Employment: Supply Side

On the supply front, there are many factors that must be considered. A large amount of attention is typically paid to the production of S&E college degrees at both the baccalaureate and graduate levels. Underlying demographic trends of prime college-age groups, their rates and trends in college attendance, their willingness to pursue S&E degrees, and their willingness to work in S&E jobs once they graduate must also be examined. Recent college graduates represent a flow of new S&E personnel into the supply system. (See "Demographic Trends: Recent S&E Graduates," p. 72.)

These flows of newly trained personnel are much smaller than the stocks of employed people in various S&E occupations. (See NSB 1989, pp. 77-80, for an extensive discussion of S&E labor market stocks and flows.) The stocks of employed persons in S&E occupations, in turn, are smaller than the total number of S&E personnel in the workforce. Take, for example, engineers. In 1989, there were 67,200 bachelors degrees awarded in engineering and about 1.6 million people employed in engineering jobs (not all of whom had engineering degrees). However, since World War II, the total number of engineering bachelors degrees earned in the United States exceeds 2.0 million. A very large percentage of these graduates are still in the workforce today. Thus, as important as the flows of new S&E graduates are in the supply system, these numbers are small compared to the stocks of people employed in S&E occupations and the number in the labor force who have training in S&E fields. Consequently, small changes in the behavior of experienced workers can have dramatic supply consequences. Supply models must capture the behavior of experienced workers through analysis of the longevity of S&E careers. Such models must also take into account the willingness and ability of S&E trained personnel to work in occupations that do not exactly match their training (Dauffenbach 1990). This latter concept is known as "field mobility."

[13] The S&E supply model used to produce these estimates was developed for NSF by Dr. Robert Dauffenbach under an NSF grant to Oklahoma State University. The current model builds upon an earlier model application (see Dauffenbach and Fiorito 1983).

Text table 3-4.
**Projected science and engineering job growth**

| Occupational group | 1990 | 2000 Low | 2000 Mid | 2000 High |
|---|---|---|---|---|
| Total scientists and engineers | 3,060 | 3,476 | 3,689 | 3,877 |
| Percentage change | | 13.6 | 20.6 | 26.7 |
| Engineers | 1,558 | 1,740 | 1,877 | 1,980 |
| Percentage change | | 11.7 | 20.5 | 27.1 |
| Math and computer specialists | 658 | 839 | 883 | 931 |
| Percentage change | | 27.5 | 34.2 | 41.4 |
| Biological scientists | 298 | 317 | 327 | 339 |
| Percentage change | | 6.2 | 9.7 | 13.9 |
| Physical scientists | 246 | 265 | 277 | 289 |
| Percentage change | | 7.5 | 12.5 | 17.6 |
| Social scientists | 300 | 315 | 325 | 338 |
| Percentage change | | 5.1 | 8.4 | 12.7 |

SOURCES: Bureau of Labor Statistics and National Science Foundation, unpublished tabulations.

*Science & Engineering Indicators – 1991*

supply equals 98.0 percent of total demand. There are only a few examples of detailed S&E occupations where the extent of the shortage exceeds 2.0 percentage points.

## Unanswered Questions

***The Questions.*** Despite modeling advances to assess S&E employment outlooks, uncertainty remains high on both sides of the supply/demand equation. The questions abounding on the *demand* side include the following:

- Will decreases in defense spending dramatically affect S&E labor markets?
- Will the threat of foreign competition drive U.S. manufacturers toward more R&D spending?[16]
- Will the generally slower growth prospects for the U.S. economy impinge on demand for S&E personnel (SRS 1988b)?
- Will the rebuilding of Eastern Europe lead to a surge in demand for capital goods that have sizable S&E components?
- Will Federal budget deficit problems lead to a slowing of Federal R&D spending?

As these questions show, the impacts of recent events do not lead in a consistent direction. Some lead to increases in demand; others, to decreases.

On the *supply* side, too, there are many unanswered questions:

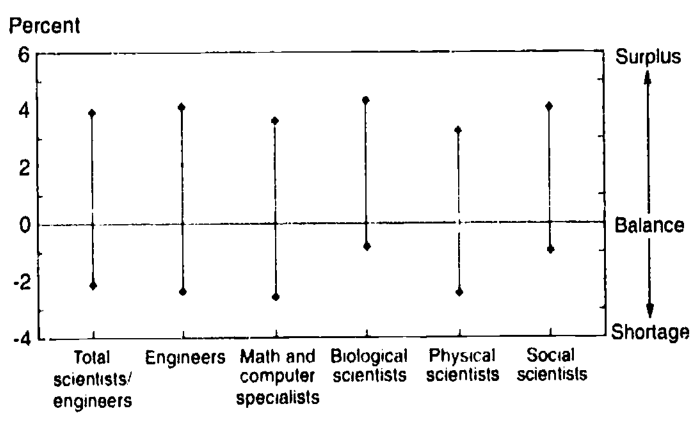
- Will the United States be able to continue its reliance on immigrants to fill Ph.D.-level jobs (Forrest 1990), or will rising international S&E demand begin to draw off this talent?
- Will the upheavals in Central and Eastern Europe and the former USSR, coupled with relaxation in emigration rules, lead to a massive exodus of S&E workers to the Western world?
- Will smaller youth cohorts in the prime college attendance years begin to have a dramatic impact on S&E degrees?
- Will women and minorities, who now make up a larger proportion of the college-age pool, begin to pursue S&E educational opportunities in increasing numbers (SRS 1990a, p. 31)?
- As larger proportions of S&E workers enter the 55 years and older age group, will retirements begin to have a much more significant supply impact?
- What are the implications of extending mandatory retirement to age 70?

As with demand, uncertainties in supply also do not point in the same direction.

***Answer Lies in Supply Flexibility.*** The supply system reveals a fairly high degree of flexibility in the face of uncertain demand shocks. It is not infinitely responsive, however. Other factors limit its flexibility:

- The adjustment mechanisms the supply system incorporates are not without costs in lost productivity; retraining expenses; and employer, industry, and occupational mobility.
- In the high-growth scenario, it may prove difficult for higher education to respond to the demand for degrees in fields experiencing relative shortages.

Figure 3-17.
**Estimated range of supply/demand differentials for scientists and engineers: 2000**




SOURCE: Science Resources Studies Division, National Science Foundation, unpublished tabulations.

*Science & Engineering Indicators – 1991*

[16] This circumstance could have a negative impact on demand for S&E workers if companies increase their fractions of R&D outside of the United States (where the labor involved is largely foreign nationals).

Moreover, since the more willing and sometimes more able are likely to be the first to engage in field mobility, the real and psychological costs of retraining and mobility will rise with each incremental need for change. It will prove increasingly costly to retrain personnel who are field-mobile to the areas of high demand.

As costly as such dislocations are, the supply system appears capable of adjusting to rather wide differentials in demand growth. The overall demand growth differential between the low and high scenarios is 13.1 percentage points (26.7-percent growth in the high-growth scenario versus 13.6-percent growth in the low-growth scenario). Supply system operations reduce this differential to half its former size: 2.0-percent shortage to 4.0-percent surplus, or a 6.0-percentage point differential. (That is, about half of the difference in demand between the high- and low-growth scenarios can be accommodated by adjustments in the supply system.)

Neither of these numbers represent a high degree of disequilibrium in the market for scientists and engineers. These demand scenarios and attendant supply processes can thus be said to exhibit relative *balance* for S&E labor markets in the 1990s. The possibility of spot shortages in certain S&E fields is not precluded, however. For example, the adjustment mechanisms in the supply system may be insufficient to meet the expected increase in demand for computer systems analysts.

Because of these many lingering uncertainties, S&E labor markets need to be followed closely and the scenarios and models improved continuously.

## International Employment of Scientists and Engineers

A country's employment of scientists and engineers is a significant indicator of its level of effort in and relative national priority for science and technology. International comparisons are complicated by differences in countries' definitions of specific jobs and in methods of data collection and estimation. Still, international employment data provide insight into the relative strengths of the S&E workforces in the United States and other countries.

This section explores trends in international S&E employment, including employment sectors, primary activities, and employee characteristics in France, Italy, Japan, Sweden, the United Kingdom, the United States, and West Germany.[17] Also included is a brief discussion of trends in the emigration of foreign scientists and engineers to the United States. (See "Immigration," above.)

### Immigration

Immigrant scientists and engineers are an important component of the S&E workforce in the United States. They represent a valuable resource to the Nation's economy.

In 1988, 11,000 scientists and engineers immigrated to the United States. Forty-five percent of these immigrants came from Asia—three times the number that came from Western Europe. The largest numbers of immigrants came from India, Taiwan, The Philippines, and the United Kingdom, each of which accounted for more than 750 immigrants.

Almost three-quarters of the S&E immigrants to the United States were engineers. Only 11 percent of the new immigrants were in the natural sciences, 11 percent were mathematicians or computer specialists, and just 4 percent were social scientists.

### International S&E Job Patterns

In the early to mid-1980s, the number of nonacademic scientists and engineers employed in the United States exceeded the combined total of those in France, Italy, Japan, the United Kingdom, and West Germany.[18] Examining the number of scientists and engineers as a proportion of each country's total labor force shows that the United States employed the highest percentage of scientists and engineers, followed by (in descending order) Japan, West Germany, the United Kingdom, and France. Italy employed the lowest proportion of scientists and engineers. (See figure O-7 in Overview.)

In the five countries compared here (France, Japan, the United Kingdom, the United States, and West Germany), the services sector is usually the most important employer of scientists, while most engineers are employed in the manufacturing sector. In the 1980s, the services sector was the largest employer of nonacademic scientists in all countries except West Germany; there, manufacturing industries employed the largest percentage of these scientists. (See figure 3-18.) The manufacturing sector was the largest employer of nonacademic engineers in all countries; it was particularly significant in the United States and the United Kingdom, where it employed half of the engineers. The services sector employed the next highest proportion of nonacademic engineers in all five countries.

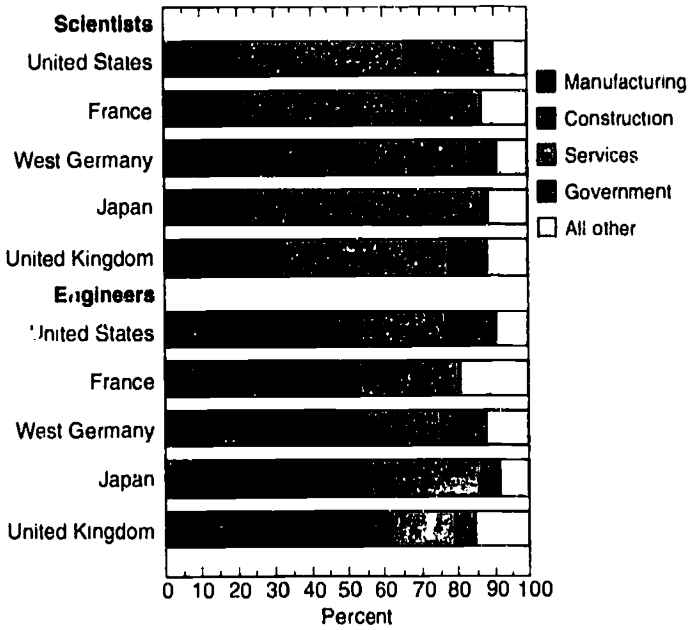
By occupation, industrial/mechanical engineers constituted over half of the S&E manufacturing workforce in the United States (1988) and the United Kingdom (1981). The proportion of these engineers was also high in France (1987) and West Germany (1985), where they accounted for between 43 and 45 percent of all scientists and engineers employed in manufacturing.

The distribution of the Japanese S&E manufacturing workforce differed from that of the other countries. In

[17] Italy and Sweden are excluded from several discussion areas because of a lack of comparable data. West German data are for West Germany only and do not include data for the former East Germany.

[18] Academic S&E employment is excluded from this discussion because data are not available.

Figure 3-18.
**Nonacademic scientists and engineers, by sector of employment**




NOTE: U.S. data are for 1988; France, for 1987; West Germany and Japan, 1985; and United Kingdom, 1981.

See appendix table 3-18. *Science & Engineering Indicators – 1991*

Japan (1985), the largest proportion of its S&E manufacturing workforce was civil engineers (32 percent) and industrial/mechanical engineers (27 percent). Japan also had a higher proportion of computer specialists (21 percent) than did the other four countries.

## R&D Activity

The United States had more full-time equivalent scientists and engineers engaged in R&D in 1987 than did Japan, West Germany, France, the United Kingdom, Italy, and Sweden combined. (See figure 3-19.) In fact, the United States had twice as many R&D scientists and engineers as Japan and about five times as many as West Germany: Japan and West Germany being the countries with the next highest numbers of R&D scientists and engineers. As a proportion of the labor force, however, other countries now have concentrations of R&D scientists and engineers approximating that of the United States. In 1987, Japan's ratio per 10,000 was close to that of the United States—68.8 versus 75.9, respectively.

## Employee Characteristics

***Age.*** The age profile of a country's S&E workforce is used as an indicator of how recently the population of scientists and engineers may have been trained. It also provides information on the potential need for replacements.

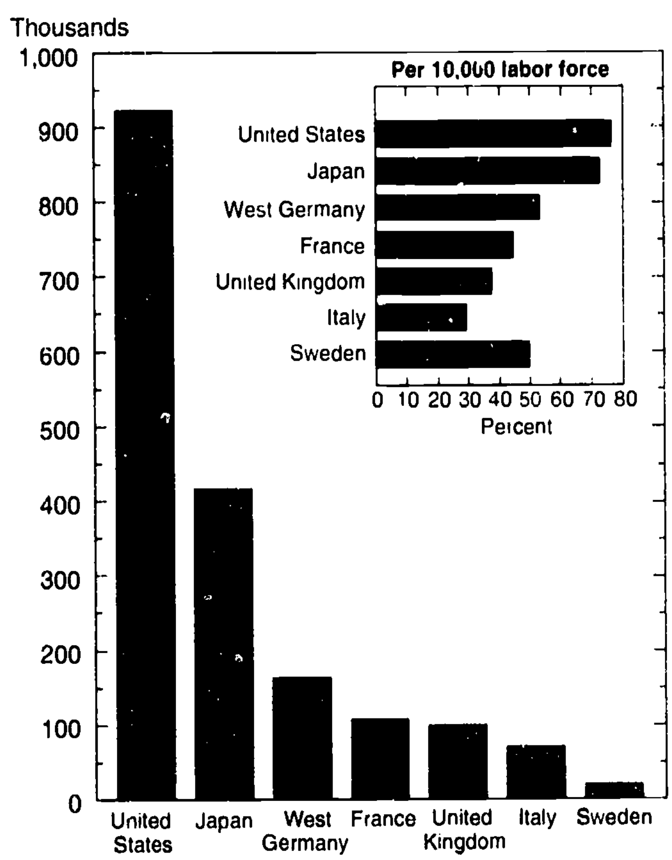
Japan has a younger nonacademic S&E workforce than do the other countries. Almost half of the nonacademic scientists and engineers in Japan (1985) were younger than 35. (See figure 3-20.) In comparison, slightly less than a third of U.S. nonacademic scientists and engineers were under 35 (1986). Moreover, Japan had the smallest proportion of scientists and engineers (7 percent) older than 55; the United States had the second highest (18 percent).

Internationally, most scientists and engineers were middle-aged: About half the scientists and engineers in France, the United States, and West Germany were between 35 and 54 years old.

***Gender.*** The vast majority of scientists and, especially, engineers in all countries compared here were male. (See appendix table 3-17.) However, the fractions for female S&E employment are increasing—slowly in engineering and more rapidly in the sciences. France, the United States, and the United Kingdom had the best records of employing female scientists and engineers (14 percent, 13 percent, and 9 percent, respectively).

***Educational Attainment.*** The quality of a nation's S&E workforce is greatly influenced by the level of education attained by its workers. Information on the field and level of S&E degrees awarded can therefore serve as a valuable indicator of the competitive potential of a country's workforce.

Figure 3-19.
**Scientists and engineers engaged in R&D, for selected countries: 1987**



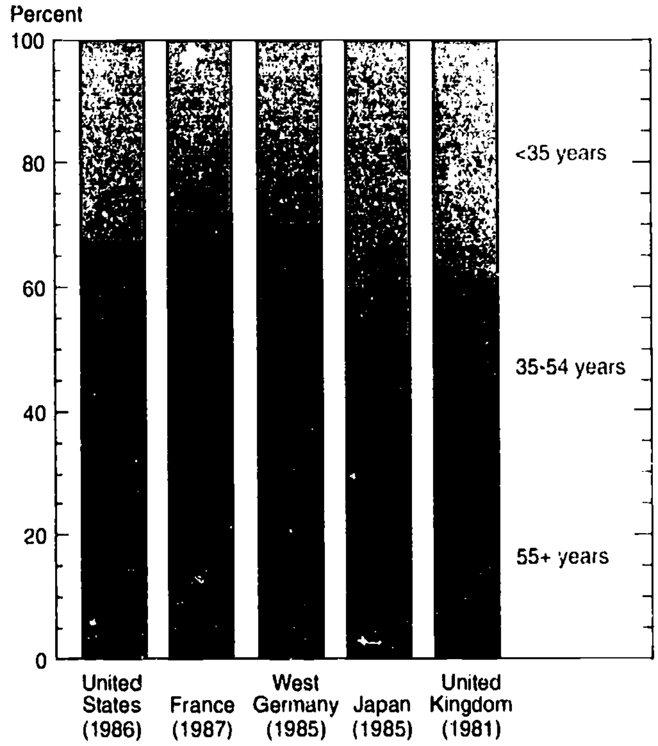

See appendix tables 3-19 and 3-20.

*Science & Engineering Indicators – 1991*

The United States (1988) and Sweden (1987) had significantly lower percentages of university graduates in the natural sciences and engineering than did the other five countries—20 and 12 percent, respectively. In contrast, in France (1987) almost half of first university degrees were awarded in either the natural sciences or engineering. Corresponding proportions were 37 percent in the United Kingdom (1988), 35 percent in West Germany (1988), 31 percent in Italy (1987), and 27 percent in Japan (1988). France, the United Kingdom, and West Germany all had greater concentrations of first university degrees in the natural sciences in 1986 than did the United States. In absolute numbers, however, the U.S. degree recipients were more numerous.

In 1988, more Japanese than U.S. students received first university degrees in engineering (76,000 versus 70,000) despite the fact that Japan's college-age population is only about one-quarter that of the United States. (See figure O-14 in Overview.) However, the United States awarded more than twice the number of engineering doctoral degrees and more than 10 times the number of natural science doctorates than did Japan in the same year.

Figure 3-20.
**Nonacademic scientists and engineers, by age for selected countries**




See appendix table 3-22. *Science & Engineering Indicators – 1991*

## References


Becker, G.S. 1975. *Human Capital*. New York: Columbia University Press.

Bureau of Labor Statistics (BLS). 1991. *Employment and Earnings* 38, No. 1 (January). Washington, DC.

Collins, E.L. 1988. "Meeting the Scientific and Technical Staffing Requirements of the American Economy." *Science and Public Policy* October: 335-42.

Dauffenbach, R.C. 1990. *Quality and Qualifications in the Market for Scientists and Engineers*. Stillwater, OK: Oklahoma State University.

Dauffenbach, R.C., and J. Fiorito. 1983. "Projections of Supply of Scientists and Engineers to Meet Defense and Nondefense Requirements, 1981-87." Contractor report to the National Science Foundation. Stillwater, OK: Oklahoma State University.

Forrest, L.R. 1990. *A Model of the Science and Engineering Ph.D. Labor Market*. Washington, DC: Data Resources, Inc./McGraw-Hill.

International Trade Administration (ITA), Department of Commerce. 1990. *1990 U.S. Industrial Outlook*. Washington, DC: DOC.

Leslie, L.L., and R.L. Oaxaca. 1991. *Scientist and Engineer Supply and Demand*. Tucson, AZ: University of Arizona.

National Science Board (NSB). 1989. *Science & Engineering Indicators – 1989*. NSB 89-1. Washington, DC: GPO.

Science Resources Studies Division (SRS), National Science Foundation. *Characteristics of Recent Science and Engineering Graduates: 1980*. Detailed tables. NSF 82-313. Washington, DC: NSF.

———. 1988a. "Services Led in Private Industry Growth in Science/Engineering Jobs but Manufacturing Rebounds and Tops 1 Million in 1987." *Science Resources Studies Highlights*. NSF 88-304. Washington, DC: NSF.

———. 1988b. *Science and Technology Resources in American Industry*. NSF 88-321. Washington, DC: NSF.

———. 1990a. *Science and Engineering Personnel: A National Overview*. NSF 90-310. Washington, DC: NSF.

———. 1990b. *Women and Minorities in Science and Engineering*. NSF 90-301. Washington, DC: NSF.

———. 1990c. *U.S. Scientists and Engineers: 1988*. Detailed tables. NSF 90-314. Washington, DC: NSF.

———. 1991. *Characteristics of Doctoral Scientists and Engineers in the United States: 1989*. Detailed tables. NSF 91-317. Washington, DC: NSF.

———. Forthcoming. *Characteristics of Recent Science and Engineering Graduates: 1990*. Detailed tables. Washington, DC: NSF.

# Chapter 4
# Financial Resources for Research and Development

## CONTENTS

# Financial Resources for Research and Development

## HIGHLIGHTS

### U.S. Research and Development (R&D)—the National Level

- **Growth in the Nation's R&D investments slowed in recent years.** U.S. support for R&D grew at an estimated average annual constant dollar rate of 1.2 percent between 1985 and 1991, one-sixth the rate of growth for 1980 to 1985. Total R&D expenditures reached an estimated $152 billion in 1991, or 2.7 percent of the gross national product (GNP). *See pp. 89-90.*

- **A decreasing fraction of U.S. R&D support is being provided by the Federal Government.** The Federal share of the Nation's R&D funding total edged downward, from 46 percent in 1985 to 44 percent in 1991. Industry's share of total was the same in both 1985 and 1991—51 percent. The combined share of support from state governments, universities, and nonprofit institutions rose from 3 to 5 percent. *See pp. 90-91.*

- **The university share of total U.S. R&D performance continues to grow.** Industrial firms' R&D performance accounted for 74 percent of the U.S. total in 1985 and 72 percent of national 1991 expenditures. The share of all R&D that was conducted in academic institutions grew from 12 to 15 percent over the same time period. Federal agencies accounted for 11 percent of the U.S. performance total in both years. *See p. 91.*

- **Federal R&D funding patterns reflect increased support for several nondefense policy objectives.** More than 90 percent of the growth in Federal R&D support from 1980 to 1986 was defense-related. Since then, the largest Federal R&D increases have been for health and space programs. Nonetheless, defense still accounted for 59 percent of the 1991 Federal R&D funding total. *See pp. 94 and 99.*

- **An increasing proportion of health R&D is funded by non-Federal sources.** Between 1985 and 1991, the Federal share of total health R&D dropped from 50 to 42 percent. Industry support grew from 40 to 47 percent of total. *See pp. 100-01.*

- **The use of Federal incentives to foster R&D growth and inter-sector research cooperation has increased rapidly.** Federal support for small business research has increased by more than 10 percent (in constant dollars) per year since 1985. Tax credits for R&D expenditures annually provide over $1 billion of indirect Federal support. More than 200 industry cooperative research ventures have been registered nationwide since 1985, and 868 cooperative R&D agreements between industrial firms and Federal laboratories have been negotiated since 1986. *See pp. 97 and 101-02.*

### U.S. R&D—the State Level

- **U.S. R&D performance is concentrated in a few states.** Half of the 1989 nationwide R&D effort was undertaken in five states—California, New York, Michigan, Massachusetts, and New Jersey. However, New Mexico and Delaware had the largest R&D to gross state product ratios. *See pp. 103-04.*

- **States continue to be heavily involved in fostering R&D growth and research cooperation among sectors.** Since 1985, at least 30 states have established institutions promoting local economic development through science and technology. At least 36 states award university-industry research grants to support growth strategies; no fewer than 20 provide tax incentives for R&D conducted in-state. *See pp. 104-05.*

- **Industry support of the U.S. academic R&D effort rose from a 4-percent share in 1980 to a 7-percent share in 1989.** Industry support comprises a notably higher fraction—up to 20 percent—of academic R&D in states whose universities' research performance is relatively small. *See pp. 106-07.*

### U.S. R&D—International Comparisons

- **The United States spent 16 percent more on R&D in 1989 than did Japan, West Germany, France, and the United Kingdom combined.** However, these four countries collectively spent 12 percent more on total nondefense R&D than did the United States. The United States, Japan, and West Germany each invested close to 3 percent of their respective GNPs on R&D. Excluding R&D for defense purposes, the U.S. R&D/GNP ratio (1.9 percent in 1989) trails those of Japan (3.0 percent) and West Germany (2.8 percent). *See pp. 107-08.*

- **Government R&D investment priorities differ among countries.** In the United States, France, and the United Kingdom, defense accounts for the largest share of total governmental R&D. Japan invests heavily in energy-related R&D, and industrial development accounts for the largest share of the West German Government's R&D total. *See p. 109.*

- **R&D activities are becoming increasingly global.** In 1989, the overseas R&D investment by U.S. companies was equivalent to 9 percent of industry's domestic R&D spending, compared to 6 percent in 1985. In 1988, foreign companies accounted for an amount equivalent to 11 percent of all industrial R&D expenditures in the United States, compared to their 9-percent share in 1985. *See p. 110.*

# Introduction

## Chapter Focus

Previous chapters focused on the *people* involved in science and technology (S&T) activities, including research and development (R&D). This chapter presents indicators of the *financial resources* devoted to the Nation's R&D base and of the growing complexity of inter- and intra-sector cooperative R&D relationships that have been forged during the past decade.

Despite their recent slowing, both public and private sector R&D funding grew considerably during the eighties. This growth is itself an indication of the heightened importance assigned to the R&D enterprise. Indeed, there is ample evidence that R&D is essential to the provision of public goods and services that benefit society as a whole; for example, R&D contributes directly to improvements in national defense, public health, and environmental quality. Several decades of study have documented the further contribution of private R&D investment to productivity growth and industrial competitiveness.[1] And, according to recent studies, even the basic research undertaken in academic institutions promotes industrial innovation and yields high economic returns to society.[2]

Alongside this growing recognition of the importance of R&D is an appreciation in recent years by public and private sector supporters of R&D of the need to leverage their R&D funds. It has become increasingly clear that (1) R&D done in Federal or university labs can benefit industry and, by so doing, enhance industrial competitiveness at both the local and national levels; and (2) Federal fostering of research cooperation within industry—so that companies might better maintain their technological competitiveness domestically and abroad—also serves the goals of the Nation.

## Chapter Organization

The first section of this chapter describes broad patterns among R&D-funding and -performing sectors—the Federal Government, industry, academia, and nonprofit institutions. A brief overview is provided of developments during the past 30 years that have led to the present R&D setting. Also discussed is the *character* of these activities—that is, whether they are basic research, applied research, or development.

The second section considers the Federal role more closely. Transfers of Federal funds to the various R&D-performing sectors are detailed, with specific attention given to the funding agencies, the fields of research funded, and the various socioeconomic objectives—including both defense and nondefense—supported. Data are provided on several Federal incentives that were put in place during the eighties to foster R&D growth indirectly—for example, R&D tax credits and cooperative R&D agreements. Additionally, for the first time in the *Indicators* series, data are included regarding Federal funding of R&D through the Small Business Innovation Research Program.

The third section takes a state-level view of the U.S. R&D base. Topics covered include the geographic distribution of domestic R&D investment, the research intensity of states' economies, state programs for S&T-based economic development, and direct funding of R&D by the states and within their universities.

The concluding section builds on the U.S. national and Federal details by providing comparisons on similar R&D topics among major industrialized countries. Indicators include level of funding, sector funders and performers, R&D/gross national product (GNP) intensities, and government R&D objectives. The globalization of the Nation's R&D effort is also discussed.

# National R&D Spending Patterns

The United States spent an estimated 2.7 percent of its GNP on R&D activities in 1991. This investment in the discovery of new knowledge—and in the application of knowledge to the development of new and improved products, processes, and services—totaled an estimated $152 billion.[3]

In this section, national R&D expenditure trends and sector-specific R&D funding and performance patterns are reviewed. Major turning points in R&D spending patterns over the past 30 years are suggested. The discussion concludes with a summary of 1991 R&D estimates.

## Overview: 1960 to Present

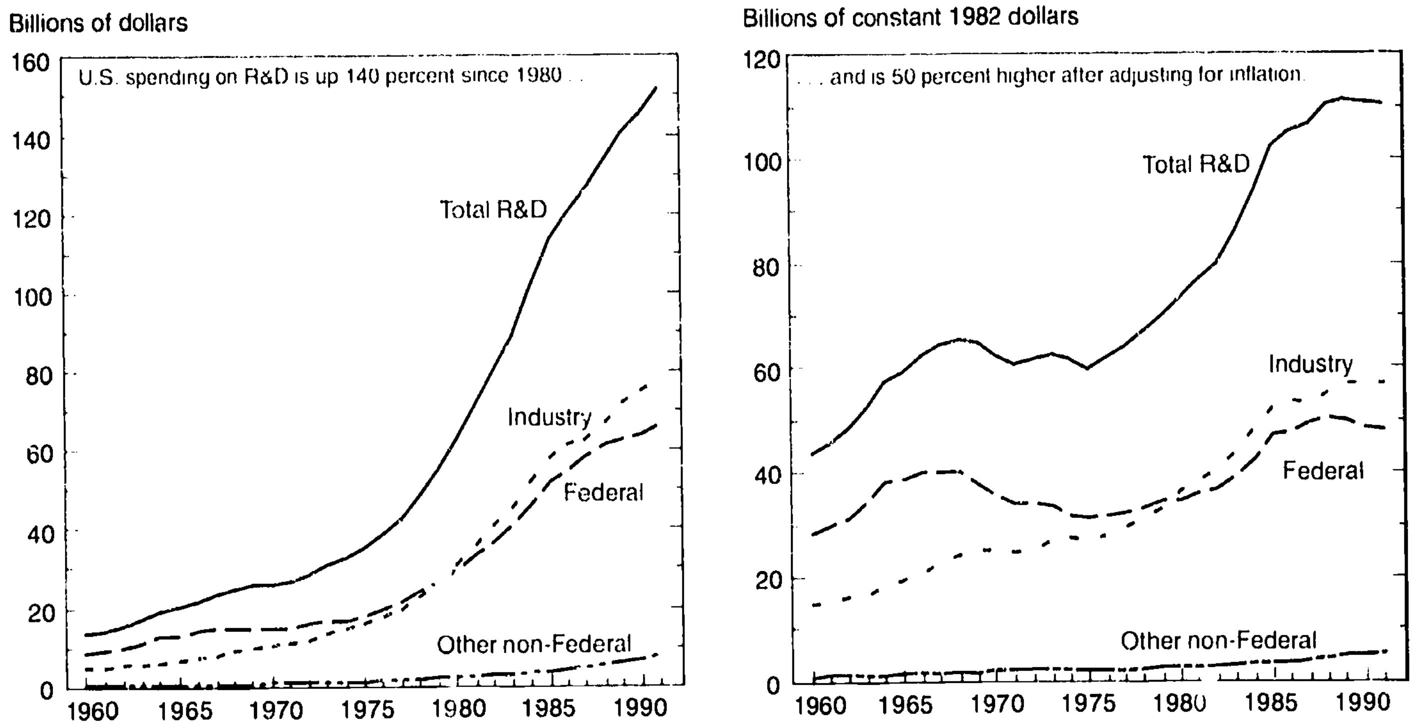
The Nation's R&D expenditures have more than doubled (in constant 1982 dollars) during the past three decades, rising from about $44 billion in 1960 to an estimated $110 billion in 1991. (See figure 4-1.) Because this growth has come in spurts, the history of U.S. R&D funding consists of several distinct stages. The period from 1960 to 1967 was marked by rapid growth in total R&D spending: Inflation-adjusted increases averaged 5.7 percent per year. The growth was spurred, to a large extent, by massive Federal investment in military and

[1] Results from numerous econometric studies on R&D and productivity growth and related measurement and theoretical issues are summarized in Sveikausk (1989).

[2] See Adams (19 0) and Mansfield (1991). These benefits are in addition to the more traditional offshoots associated with basic research, including the education and training of future scientists and engineers and the pursuit of knowledge for its own sake.

[3] Throughout this chapter, current funding or expenditure data are presented in nominal dollars. Trend data usually are deflated to 1982 constant dollars using the GNP implicit price deflator and are so indicated. (See appendix table 4-1.) There are exceptions to this choice of deflator; these exceptions are identified appropriately.

Figure 4-1.
**National R&D funding, by source**




See appendix table 4-2.

*Science & Engineering Indicators – 1991*

space technology.[1] Then, for nearly a decade, total R&D growth failed to keep up with either inflation or economic output as both business and government—encountering an economic and political environment that could no longer justify the current rate of R&D expansion—deemphasized funding for research programs. In particular, Federal R&D support for both defense and nondefense activities declined sharply during this period. Overall, real R&D fell 9 percent, dropping from 2.8 percent of GNP in 1967 to 2.2 percent in 1975.

A significant funding reversal occurred following the dual energy and economic crises of the mid-1970s. From 1975 to 1985, U.S. R&D grew on average by 5.5 percent annually, and the R&D/GNP ratio climbed to 2.8 percent. Initially the research growth was directed toward solutions to energy problems; major energy R&D programs were undertaken by both industry and government. In the early eighties, however, the focus of the national R&D effort shifted overwhelmingly toward defense-related activities.[2] In fact, more than 90 percent of the rapid increase in Federal R&D support between 1980 and 1985 was attributable to defense programs.

Sluggishness in the economy (including attendant shortfall in profits, out of which business R&D normally is funded) and budgetary constraints imposed on all government programs have since slowed R&D growth nationwide. Even with the skyrocketing number of cooperative relationships among the various R&D-performing sectors of the economy—relationships generally established in response to regional or international competitiveness concerns—R&D growth has fallen overall to a 1.2-percent average annual rate of increase during the 1985-91 period. Indeed, a slight decline in inflation-adjusted R&D expenditures—fueled particularly by a reduction in defense R&D spending—is indicated from estimates for 1990 and 1991 (SRS 1991e).

## Funders, Performers, and Character of Work

***R&D Funders.*** Considerable changes in the patterns of R&D support and performance have accompanied the 30-year expansion of R&D investment chronicled above. The most notable change concerns the relative roles of the Federal Government and private industry in funding, or supporting, R&D. The Federal share of total national R&D expenditures has fallen rather steadily, dropping from 65 percent in 1960 to an estimated post-World War II low of 44 percent in 1991. Indeed, since 1988, not only has the Federal Government's *relative* share of the total fallen, but—after adjusting for inflation—so has its *absolute dollar* contribution. (See appendix table 4-2 for background data.) Also during the 1960-91 period, U.S. firms have increased their relative share of support for total U.S. R&D activities from 33 to 51 percent. This increased support includes both in-house R&D and funding of R&D in other sectors. University and college support for

[1]Growth during this early period is a continuation of the rapid increases in the Nation's military R&D investment that began in the early fifties. From 1953 to 1960, U.S. R&D spending grew on average by 15 percent per year. The earliest year for which the National Science Foundation reports R&D expenditures is 1953.

[2]See SRS (1990b) for relevant statistics on energy and defense spending.

## Definitions

The National Science Foundation uses the following definitions in its resource surveys.

***Basic research:*** Basic research has as its objective a fuller knowledge or understanding of the subject under study, without specific applications in mind. In industry, basic research is defined as research that advances scientific knowledge but does not have specific commercial objectives, although such investigations may be in fields of present or potential interest to the reporting company.

***Applied research:*** Applied research is directed toward gaining knowledge or understanding necessary for determining the means by which a recognized and specific need may be met. In industry, applied research includes investigations directed to the discovery of new scientific knowledge having specific commercial objectives with respect to products, processes, or services.

***Development:*** Development is the systematic use of the knowledge or understanding gained from research directed toward the production of useful materials, devices, systems, or methods, including design and development of prototypes and processes.

***Obligations:*** Obligations represent the amounts for orders placed, contracts awarded, services received, and similar transactions during a given period, regardless of when the funds were appropriated or when payment is required.

***Outlays:*** Government outlays represent the amounts for checks issued and cash payments made during a given period, regardless of when the funds were appropriated or obligated.

***Budget authority:*** Budget authority is the authority provided by Federal law to incur financial obligations that will result in outlays.

R&D—which includes state government support to this sector—has grown over the past three decades, rising from 1 to 3 percent of the national total. Most of this growth in academia's relative share has been in basic research. (See appendix table 4-4.)

***R&D Performers.*** In terms of R&D *performance* patterns, the changes have been less pronounced. In contrast to its overall increased support for R&D, industry is estimated to have performed a smaller share of R&D in 1991 than in 1960: 72 versus 78 percent. Universities and colleges increased their share of R&D performance over the same period, rising from 5 percent to 11 percent of the national total. Particularly during the eighties, this growth in R&D performed on the Nation's campuses benefitted from steadily rising industry-university partnerships with both Federal and state government funding. Federal *in-house* R&D declined from 13 percent of the Nation's total in 1960 to 11 percent in 1991; it has remained level at approximately $12 billion per year (in inflation-adjusted 1982 dollars) since 1985. (See appendix table 4-2.)

***Character of Work.*** Although the Nation's total investment in R&D has grown significantly, its relative emphasis by character of work (see "Definitions," above.) has remained rather stable since 1970. (See figure O-4 in Overview.) As a proportion of total R&D,

- Development has fluctuated between 61 and 66 percent;
- Applied research, between 21 and 24 percent; and
- Basic research, between 13 and 16 percent.

(See appendix tables 4-3, 4-4, 4-5, and 4-6.)

### 1991 Spending Patterns

***R&D Funders.*** Funds for R&D in the United States came mainly from two sources in 1991—industry (at an estimated 51 percent of total) and the Federal Government (44 percent of total). The remaining 5 percent came from universities and colleges, state and local governments, and nonprofit institutions.[6] (See figure 4-2.)

The most recent estimates of change from 1989 to 1991 show Federal support declining 3 percent (in constant 1982 dollars), industry support remaining rather level, and support from other non-Federal sources climbing 15 percent. (See appendix table 4-2.)

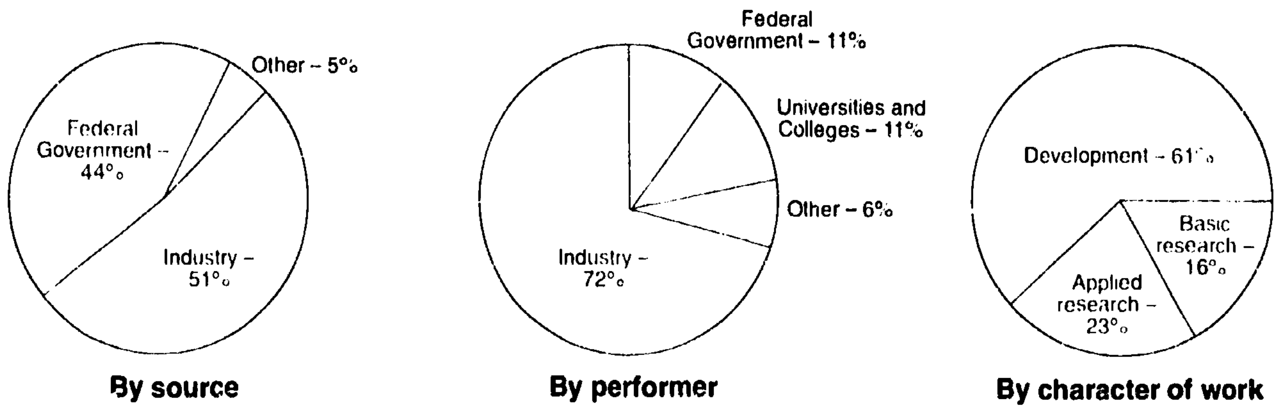
***R&D Performers.*** At an estimated $[illegible]08 billion in 1991, industry remained the largest performer of R&D in the United States: R&D performed by companies ($105.8 billion) and that performed by industry-administered federally funded research and development centers (FFRDCs) ($2.7 billion) accounted for 72 percent of the national R&D effort.[7] About one-third of this combined industry and FFRDC performance total was financed by the Federal Government (see text table 4-1), mostly by the Department of Defense (DOD). Aerospace companies accounted for about one-fourth of industry's perfor-

---

[6] Current estimates for state government *in-house* R&D are not available. In 1988, state labs' intramural performance reached $0.5 billion.

[7] An FFRDC is an organization exclusively or substantially financed by the Federal Government to meet a particular requirement or to provide major facilities for research and associated training purposes. Each center is administered by an industrial firm, an individual university, a university consortia, or a nonprofit institution. The 10 industry-administered FFRDCs receive the bulk of their funding from the Department of Defense and from the atomic energy defense programs of the Department of Energy.

Figure 4-2.
**National R&D expenditures: 1991**




See appendix tables 4-3, 4-4, 4-5, and 4-6.

*Science & Engineering Indicators – 1991*

mance total; companies in the chemicals, communication equipment, and motor vehicles industries each accounted for about 10 percent.[8] (See appendix table 4-7, which also reports estimates for industry-specific character of work splits.)

The second largest R&D-performing sector consists of the Nation's universities and colleges, exclusive of university-administered FFRDCs.[9] Federal funding accounted for an estimated 56 percent of their R&D activities ($17 billion) in 1991; this was down from 68 percent in 1980. (See appendix table 4-2.) Academic institutions themselves financed a larger proportion of their R&D—14 percent in 1980 and an estimated 20 percent in 1991. Funds from industry to universities and colleges also increased over the period, rising from 4 to 7 percent of the total R&D performed in these institutions. State and

[8] U.S. industrial R&D expenditures continue to be heavily concentrated in a small number of firms. In 1989, the four largest R&D-performing companies accounted for 22 percent of this sector's performance total. The 100 largest accounted for 70 percent of total (NSB 1991 and SRS 1991d). Fifteen years earlier, the 4 largest companies accounted for 20 percent of total and the 100 largest companies for 82 percent.

[9] One hundred universities accounted for about 82 percent of the R&D performed by this sector in 1989. Fifteen years earlier, the top 100 accounted for a similar 83-percent share of academia's total R&D effort.

Text table 4-1.
**Estimated national R&D expenditures, by performing sector and source of funds: 1991**

| R&D performers | Total | Sources of R&D funds: Industry | Federal Government | Universities and colleges[1] | Other nonprofit institutions | Percent distribution, performers |
|---|---|---|---|---|---|---|
| | Millions of dollars | | | | | |
| Total | 151,600 | 78,050 | 66,000 | 4,950 | 2,600 | 100.0 |
| Industry | 105,750 | 76,150 | 29,600 | — | — | 69.8 |
| Industry-administered FFRDCs[2] | 2,700 | — | 2,700 | — | — | 1.8 |
| Federal Government | 16,400 | — | 16,400 | — | — | 10.8 |
| Universities and colleges | 17,200 | 1,250 | 9,650 | 4,950 | 1,350 | 11.3 |
| University-administered FFRDCs[2] | 4,850 | — | 4,850 | — | — | 3.2 |
| Other nonprofit institutions | 4,200 | 650 | 2,300 | — | 1,250 | 2.8 |
| Nonprofit-administered FFRDCs[2] | 500 | — | 500 | — | — | 0.3 |
| Percent distribution, sources | 100.0% | 51.5% | 43.5% | 3.3% | 1.7% | |

— = unknown, but assumed to be negligible

[1] Includes an estimated $1.5 billion in state and local government funds provided to university and college performers.

[2] Federally funded research and development centers (FFRDCs) conduct R&D almost exclusively for use by the Federal Government. Expenditures for FFRDCs therefore are included in Federal R&D support, although some non-Federal R&D support may be included in the totals.

See appendix table 4-2.

*Science & Engineering Indicators – 1991*

local governments provided roughly 9 percent of the academic R&D total in 1991, slightly more than the 8-percent share the sector held in 1980.

Federal in-house R&D performance reached an estimated $16 billion in 1991, or 25 percent of all Federal R&D expenditures ($66 billion). Of this Federal funding total,

- 49 percent funded industry and affiliated FFRDCs;
- 15 percent went to universities and colleges;
- 7 percent funded FFRDCs administered by universities; and
- 4 percent was for institutions in the nonprofit sector, including FFRDCs administered by nonprofits.

(See text table 4-1 )

***Character of Work.*** Development continues to account for the lion's share—61 percent—of U.S. R&D funds. An estimated 23 percent of the 1991 R&D total was for applied research; the remaining 16 percent was for basic research. Each of the sectors funds and performs basic research, applied research, and development to varying degrees. Different sectors, however, dominate in these R&D work categories:

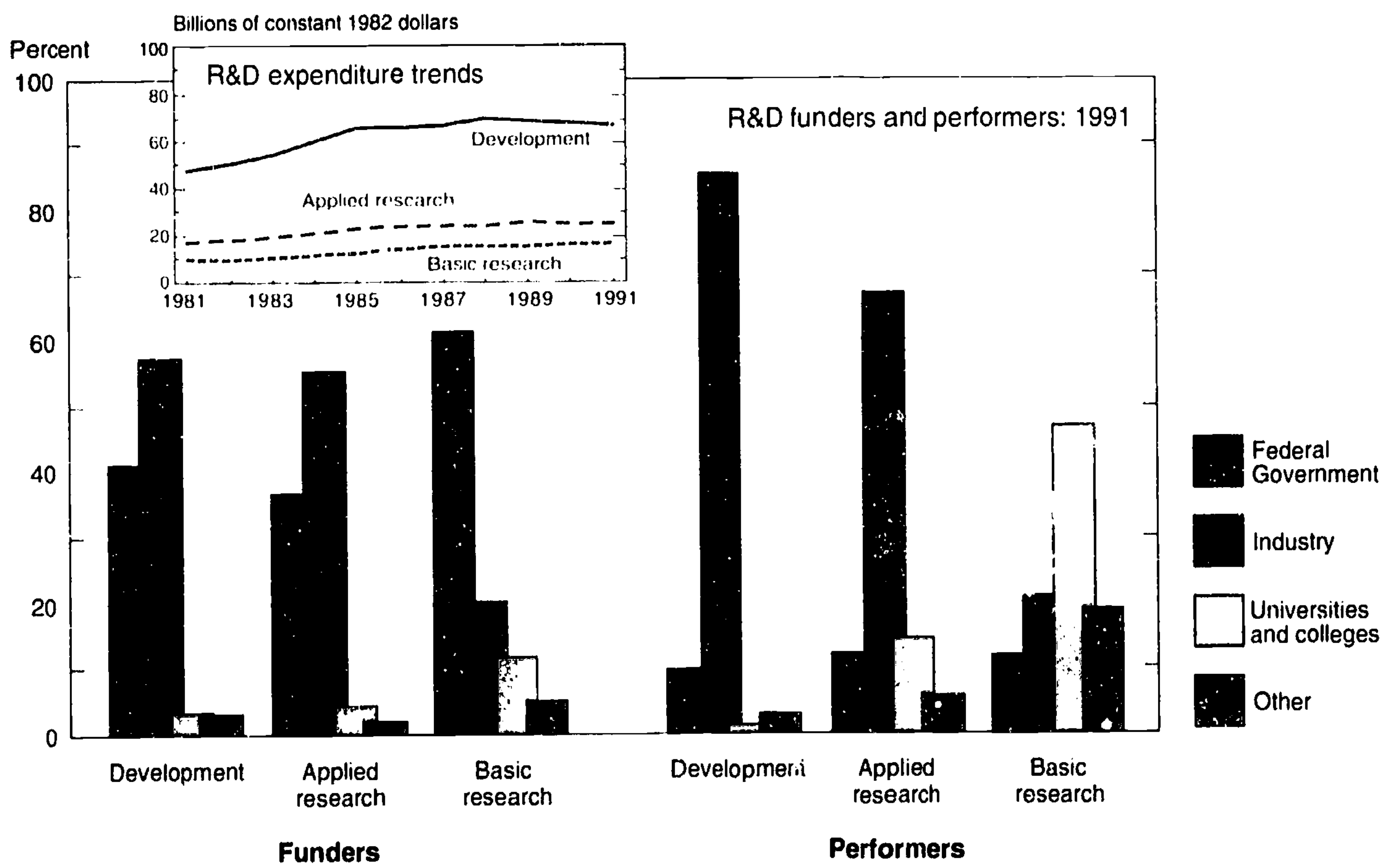
- In 1991, industry performed 86 percent and funded 58 percent of *development*. The Federal Government funded almost all—41 percent—of the rest.
- Industry performed 68 percent and funded 56 percent of the *applied research* total.
- The Federal Government funded 61 percent of all *basic research*: 47 percent was performed by universities and colleges.

(See figure 4-3.)

## Federal Support for R&D

Federal support for R&D is an important indicator of government's overall commitment to maintaining the Nation's S&T base and building its technological leadership. Undoubtedly, the most important means of Federal support for R&D is direct funding, which is now approaching close to $70 billion annually. This support includes funding for programs traditionally in the government purview—such as national defense—and for activities for which the government and the private sector share responsibility; for example, promoting long-term economic growth through small business research

Figure 4-3.
**National R&D expenditures, funders, and performers, by character of work**




See appendix tables 4-4, 4-5, and 4-6.

Science & Engineering Indicators – 1991

support.[10] Other key mechanisms of Federal support include the various tax and regulatory provisions that were enacted during the eighties to encourage greater research spending and cooperation among economic sectors. This section presents an overview of direct Federal R&D support, first by defining aspects and patterns of that support—character of work, agency, performer, and science and engineering (S&E) field—then by describing two specific R&D funding initiatives, and summarizing Federal R&D spending objectives. The section concludes with a discussion of indirect methods of Federal R&D support.

## Federal Obligations for R&D

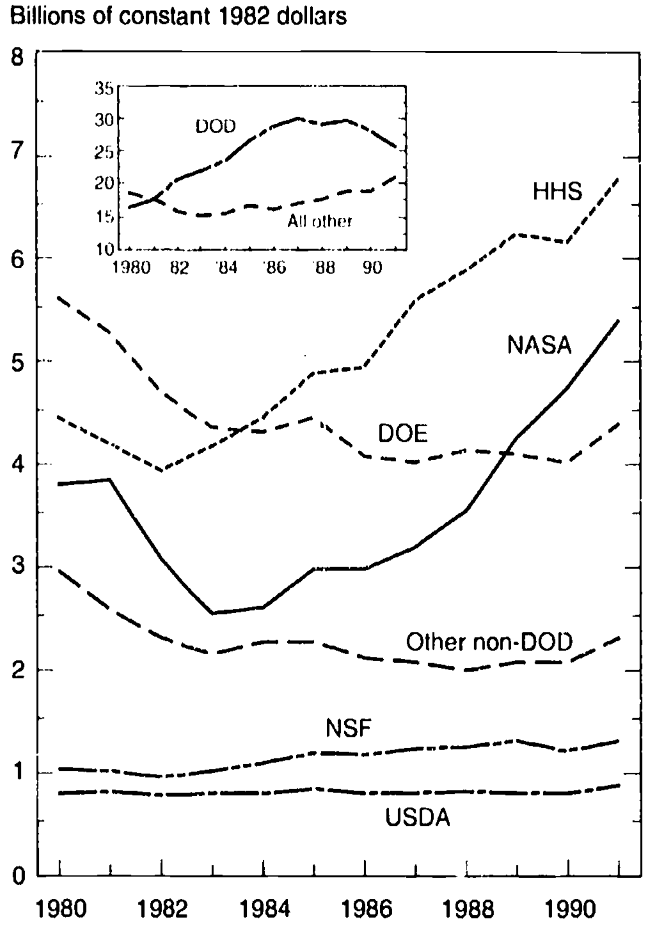
Federal R&D funding patterns over the past decade clearly reflect changing government investing priorities. The following sections explore these patterns and priorities by providing summary information on Federal R&D support by character of work, agency sponsor, category of performer, and scientific field of research support.[11]

***Trends in Basic and Applied Research and Development.*** From 1980 to 1991, development obligations (see "Definitions," p. 91) grew by about 40 percent (in constant dollars), mainly because of defense-related R&D work, which is 90 percent development. Most of these gains, however, occurred early in the decade; since 1987, both development and defense spending have tapered off, and even declined. (See appendix table 4-8.)

Over the same 1980-91 period, basic (mostly nondefense) research grew by more than 60 percent, with most of the growth occurring since the mid-1980s. This growth exemplifies the prevailing government view of basic research as essential to the Nation's scientific, technological, and socioeconomic future. In contrast, Federal funding for applied research has been rather flat since 1980, reflecting the Administration's policy that private industry can respond to nongovernmental market needs better than can the Federal Government in making civilian applied R&D investment decisions.[12]

***Patterns of Federal Agency Support.*** In 1991, the Federal Government obligated an estimated $68 billion in support of R&D and related facilities. Although some 25 Federal agencies contributed to this total, 95 percent of the 1991 Federal R&D support total was provided by just 6 agencies, as follows:

Figure 4-4.
**Federal R&D obligations, by selected agency**




See appendix table 4-8. *Science & Engineering Indicators – 1991*

- DOD, 55 percent;
- Department of Health and Human Services (HHS), 15 percent;
- National Aeronautics and Space Administration (NASA), 12 percent;
- Department of Energy (DOE), 9 percent;
- National Science Foundation (NSF), 3 percent; and
- Department of Agriculture (USDA), 2 percent.

(See appendix table 4-8.)

Since 1981, DOD has provided more R&D funds annually (for both in-house and external research) than all other agencies combined. (See figure 4-4.) This dominance in DOD's funding share peaked in 1986 at 64 percent of total and has since declined by about 10 percentage points.

HHS—and its National Institutes of Health (NIH) in particular—accounts for the second largest, and growing, share of the Federal R&D funding total. HHS is also the source of roughly 40 percent of Federal basic research funds disbursed nationwide, most of which are slated for research in the life sciences. Between 1986 and 1991, total R&D funding by HHS grew $4 billion, or

[10] Recent research has uncovered a complementary *indirect* relationship between government R&D funding and private R&D. Link, Bozeman, and Leyden (1990) found that increases in Federal R&D contracts to firms are positively related (in a causal sense) to increases in industry's self-financed R&D. Furthermore, increases in government R&D to industry stimulate a greater sharing of firms' technical knowledge.

[11] See also OTA (1991) for a review of issues related to Federal research support.

[12] For a discussion of recent Federal S&T policy, see OMB (1991), Council of Economic Advisers (1991), and OSTP (forthcoming).

37 percent in constant dollars. A substantial amount of this funding was for AIDS/HIV research.

NASA's recent R&D budget has also climbed significantly. Like that of HHS, it was up $4 billion—an estimated 81 percent—during the 1986-91 period. One-third of NASA's estimated 1991 R&D budget is slated for the controversial Space Station Freedom.

In contrast with the R&D *growth* for NASA and HHS, DOE R&D programs have *declined* (after adjusting for inflation); research funding provided by NSF and USDA has been relatively *level* since the mid-1980s.

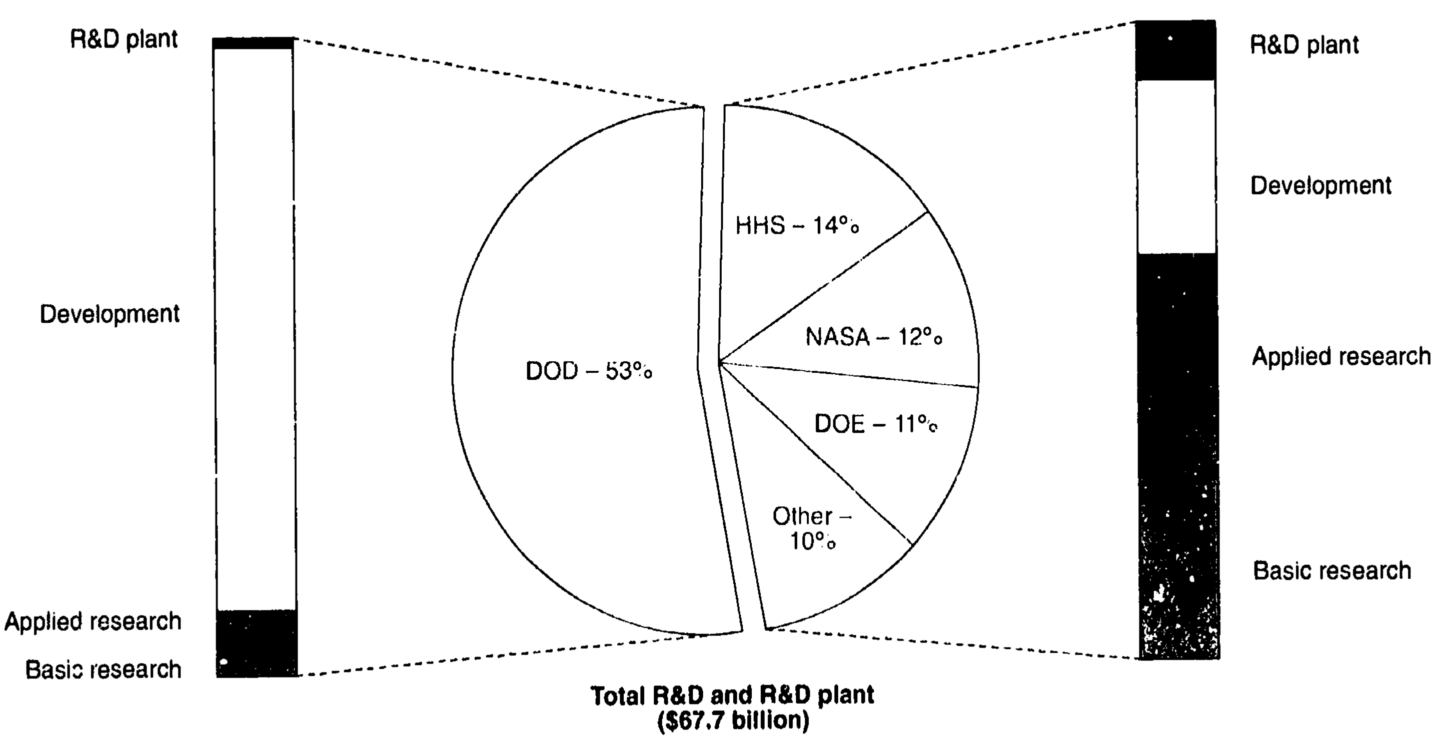
In terms of agency support by character of work, DOD emphasized programs in their development stage: Relatively little DOD funding was provided for basic or applied research. Aggregate funding by all other Federal agencies was more evenly distributed among the three R&D categories (about 30 percent of total for each); these agencies provided the remaining 10 percent of their total R&D funds for R&D plant projects. (See figure 4-5.)

***R&D Agency-Performer Patterns.*** Over the years, one or two Federal funding agencies have come to provide the bulk of R&D support to each of the different types of R&D performers. For example, total Federal R&D obligations to FFRDCs are dominated by funding from DOE and DOD; the largest shares of R&D funds for academic and other nonprofit performers originate in HHS. (See text table 4-2 and appendix table 4-10.) Similarly, DOD, NASA, and DOE sponsor applied research within industrial firms and FFRDCs administered by either universities, industry, or nonprofit institutions. NIH, in contrast, expends the bulk of its applied research and development funds at nonprofit institutes and the research hospitals of the academic sector.

The largest recipient of basic research funds (in terms of estimated 1991 total agency obligations) is universities and colleges (47 percent); this sector is primarily funded by HHS (51 percent), NSF (24 percent), and DOD (9 percent). DOE, as in its support of applied research and development, is the largest provider of basic research funds to FFRDCs under contract with universities. Federal obligations for basic research in private firms are concentrated in the budgets of NASA and DOD. Federal in-house work on basic research programs is distributed among at least six major agencies, with the largest portions conducted at NIH and NASA laboratories. Smaller portions are performed at the Department of the Interior's Geological Survey and USDA's Agricultural Research Service. (See appendix table 4-9.)

***Fields of Science and Engineering.*** Obligations for the life sciences dominate the Federal basic research support total. (See appendix table 4-12.) Such funding has grown steadily since the early eighties. (See figure 4-6.) By 1991, it accounted for 45 percent ($5.6 billion) of the Federal total ($12.3 billion). This growth—especially in the biological sciences—reflects the mission interests of NIH, the major funding agency for life sciences. DOE provides most of its funding for basic research in the physical sciences, which have also experienced steady growth over the past decade and now account for a 24-

Figure 4-5.
**Federal obligations, by agency and type of activity: 1991**




See appendix table 4-8.

Science & Engineering Indicators – 1991

Text table 4-2.
**Estimated Federal R&D obligations, by agency and performing sector: FY 1991**

| Performer | Performer total Federal obligations | Primary funding source | | Secondary funding source | |
|---|---|---|---|---|---|
| | —Millions of dollars— | | —Percent— | | —Percent— |
| Total R&D | 66,107 | DOD | 56 | HHS | 13 |
| Intramural laboratories | 16,396 | DOD | 55 | NASA | 16 |
| Industrial firms | 31,512 | DOD | 80 | NASA | 14 |
| Industry-administered FFRDCs | 2,062 | DOE | 83 | DOD | 14 |
| Universities and colleges | 9,191 | HHS | 54 | NSF | 16 |
| University-administered FFRDCs | 3,654 | DOE | 59 | NASA | 19 |
| Other nonprofit institutions | 2,302 | HHS | 62 | NASA | 10 |
| Nonprofit-administered FFRDCs | 482 | DOD | 65 | DOE | 29 |
| Basic research | 12,255 | HHS | 40 | NSF | 15 |
| Intramural laboratories | 2,782 | HHS | 36 | NASA | 20 |
| Industrial firms | 1,043 | NASA | 57 | DOD | 19 |
| Industry-administered FFRDCs | 194 | DOE | 93 | HHS | 5 |
| Universities and colleges | 5,721 | HHS | 51 | NSF | 24 |
| University-administered FFRDCs | 1,267 | DOE | 71 | NASA | 18 |
| Other nonprofit institutions | 1,077 | HHS | 69 | DOE | 13 |
| Nonprofit-administered FFRDCs | 68 | DOE | 90 | DOD | 6 |
| Applied research | 10,965 | HHS | 28 | DOD | 23 |
| Intramural laboratories | 4,084 | DOD | 25 | NASA | 20 |
| Industrial firms | 2,384 | DOD | 45 | NASA | 34 |
| Industry-administered FFRDCs | 311 | DOE | 77 | DOD | 8 |
| Universities and colleges | 2,635 | HHS | 62 | DOD | 10 |
| University-administered FFRDCs | 596 | DOE | 61 | NASA | 26 |
| Other nonprofit institutions | 720 | HHS | 64 | NASA | 8 |
| Nonprofit-administered FFRDCs | 70 | DOE | 60 | DOD | 13 |
| Development | 42,888 | DOD | 78 | NASA | 11 |
| Intramural laboratories | 9,530 | DOD | 80 | NASA | 12 |
| Industrial firms | 28,084 | DOD | 86 | NASA | 10 |
| Industry-administered FFRDCs | 1,557 | DOE | 83 | DOD | 17 |
| Universities and colleges | 835 | HHS | 53 | DOD | 34 |
| University-administered FFRDCs | 1,791 | DOE | 50 | DOD | 32 |
| Other nonprofit institutions | 505 | HHS | 44 | NASA | 25 |
| Nonprofit-administered FFRDCs | 345 | DOD | 88 | DOE | 11 |

DOD = Department of Defense
DOE = Department of Energy
FFRDC = Federally funded research and development center
HHS = Department of Health and Human Services
NASA = National Aeronautics and Space Administration
NSF = National Science Foundation

See appendix table 4-10.

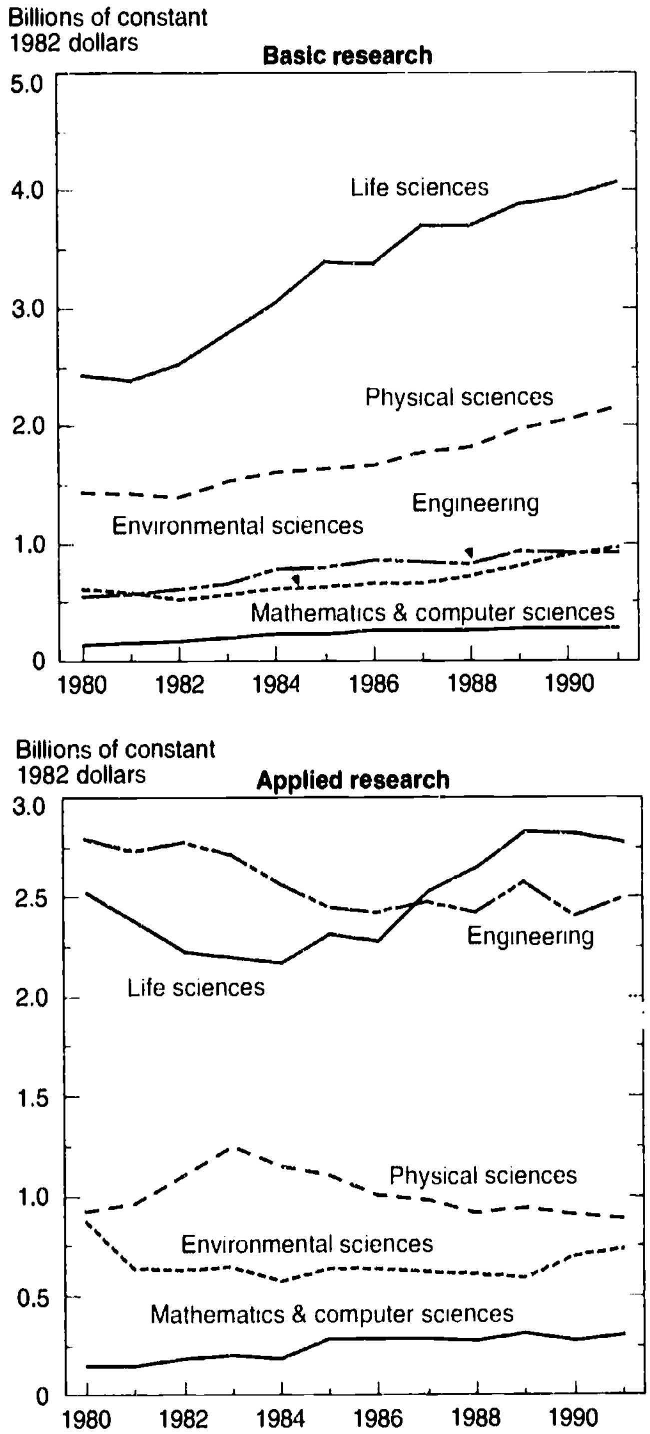
*Science & Engineering Indicators – 1991*

percent ($3.0 billion) basic research share.

The amounts obligated for applied research in Federal agency 1991 budgets were about three-fourths as much as estimated basic research obligations. Life sciences again received the largest funding support (see appendix table 4-13), and outstripped engineering in terms of relative shares: 35 percent versus 31 percent, respectively, in 1991. A decade ago, the funding shares of these two fields were reversed. This shift is explained not only by growth in the life sciences but also by a decline in engineering support (in constant 1982 dollars): Since 1980, Federal applied research support for engineering has fallen about 11 percent. Applied research funding for the physical sciences also fell in the 1980s, down approximately 30 percent since 1983.

An exception to these downward trends in Federal applied research support was the mathematics and computer sciences field, which grew nearly 9 percent per

Figure 4-6.
**Federal obligations for research, by field**




See appendix tables 4-12 and 4-13.
*Science & Engineering Indicators – 1991*

year from 1980 to 1991. Indeed, the largest rates of Federal growth in both basic and applied research funding were for mathematics and computer sciences. Total research for this field more than doubled (after adjusting for inflation) since 1980. Yet, however impressive the *rate* of funding growth, the *level* of support for this field changed only marginally—mathematics and computer sciences rose from a 2-percent share of the 1980 research total to an estimated 3 percent in 1991.

## Small Business R&D[13]

Congress enacted the 1982 Small Business Innovation Development Act (P.L. 97-219) with the intent of strengthening the role of small innovative firms in federally supported R&D. Specifically, the statute created the Small Business Innovation Research (SBIR) Program; the Small Business Administration (SBA) was named as its coordinator. Under this program, when an agency's external R&D obligations (that is, those exclusive of in-house R&D performance) exceed $100 million, the agency must set aside 1.25 percent of such obligations for SBIR projects. The SBIR Program encompasses the following three phases:

- **Phase I.** Phase I awards average $50,000 and are made to evaluate the scientific and technical merit and feasibility of an idea.
- **Phase II.** Phase I projects with the most potential are funded to further develop the proposed idea for 1 or 2 years. Most phase II awards are funded for less than $500,000.
- **Phase III.** Phase III is initiated when an innovation is brought to market by private sector investment and support. No SBIR funds may be used for phase III activities.

Eleven Federal agencies participated in the SBIR Program in 1989. (See appendix table 4-14.) From 1983 to 1989, obligations for SBIR awards totaled more than $1.8 billion; since 1985, they increased on average by more than 10 percent (in constant dollars) per year. Awards in 1989 alone—$432 million—accounted for 0.7 percent of all government R&D obligations. More than one-half of total SBIR obligations were disbursed by DOD, mirroring this agency's share of the Federal R&D funding total. (See figure 4-7.)

SBA classifies SBIR awards into various technology areas. (See appendix table 4-15.) In 1989, the advanced materials area received the largest share of phase I awards, and information processing was the leading technology area for phase II awards. Roughly one-fifth of all SBIR awards made during the 1983-89 period were computer-related, and one-fifth involved electronics. One-sixth of SBIR awards went to life science research; the bulk of such funding was provided by HHS. Materials-related research, which was funded largely by DOE and NSF, accounted for another one-sixth of total SBIR awards.[14]

[13]This section deals with Federal funding of research activities in small businesses; much of this information is drawn from the Office of Innovation, Research, and Technology of the Small Business Administration (1990). See chapter 6, "Small Business and High Technology," pp. 157-160, for further discussion on the role of small businesses within the entire S&T system.

[14]For a relatively recent—and favorable—assessment of the SBIR Program, see GAO (1989a).

## Independent Research and Development[15]

The Independent Research and Development (IR&D) Program enables industry to obtain Federal funding for R&D conducted in anticipation of government defense and space needs. Because it is initiated by private contractors themselves, IR&D is distinct from the R&D performed under contract to government agencies for specific purposes. IR&D allows contractors to recover a portion of their in-house R&D costs through overhead payments on Federal contracts on the same basis of reimbursement as for general and administrative expenses. All reimbursable IR&D projects must have "potential military relevance."

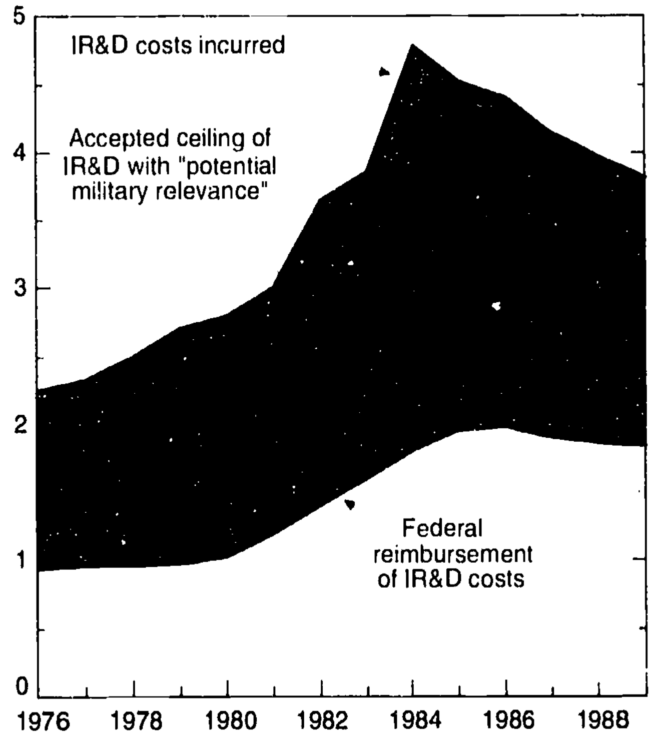
Briefly, the IR&D process is as follows: Contractors develop an IR&D plan, begin work, and then submit descriptions of all current and expected IR&D projects ("IR&D costs incurred" in figure 4-8). Subsequent transactions with the government may have marginal effects on these plans, but contractors proceed without awaiting government action. Following a DOD technical review of the plan, an advance agreement on the "allowable ceiling" for government reimbursement is negotiated as is the percentage of the costs that the government will reimburse.[16] This "fair share" percentage is in recognition of the fact that at least some part of industry's IR&D would have been undertaken solely or primarily for commercial purposes.

In 1989, industrial firms were estimated to have incurred $4.8 billion in IR&D costs, of which $3.8 billion were deemed to have potential military relevance. The government reimbursed $2.3 billion, or 48 percent of the IR&D total.[17] This figure is up from the 37-percent share—$0.9 billion—reimbursed in 1980; that is, at the start of the defense buildup early in the decade.

Both the amounts incurred and the amounts reimbursed have held rather steady since 1984: After adjusting for inflation, however, these funds have declined considerably. (See figure 4-8.) As an equivalent proportion

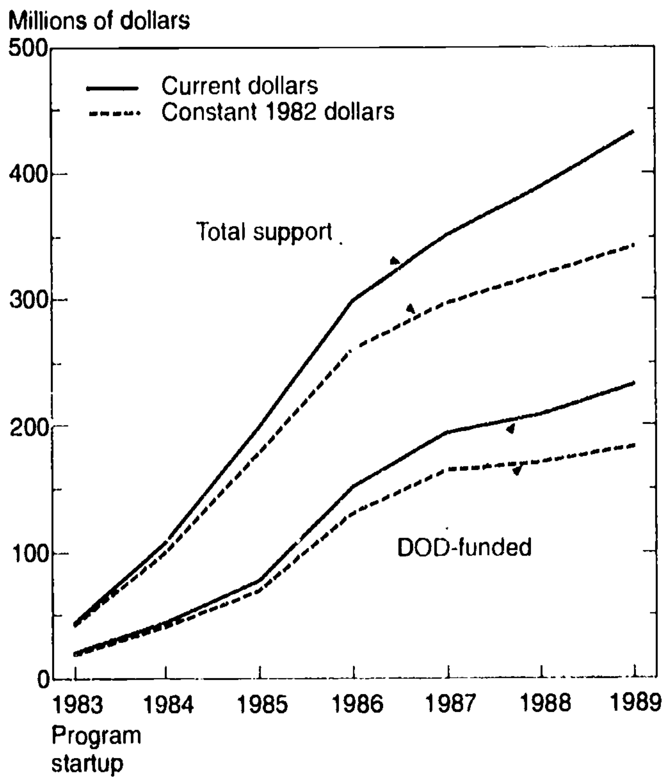
[15]For a thorough discussion of the independent research and development process—including an assessment of its benefits, costs, and justifications—see Winston (1985) and Alexander, Hill, and Bodilly (1989). Material in this section is based largely on these reports.

Figure 4-8.
**Independent research and development (IR&D) costs and reimbursements**




See appendix table 4-16. *Science & Engineering Indicators – 1991*

Figure 4-7.
**Federal R&D obligations for Small Business Innovation Research awards**




See appendix table 4-14. *Science & Engineering Indicators – 1991*

[16]NASA also reimburses some IR&D costs and closely follows DOD procedures. During the 1980s, the NASA reimbursements typically ran less than 5 percent of those by DOD. DOE—or, more precisely, its predecessor agencies—used to reimburse IR&D but does not at present.

[17]The IR&D data reported here are for only the 100 or so major defense contractors whose accounts are audited and reported by the Defense Contract Audit Agency (DCAA), in accordance with P.L. 91-441. These companies did, however, account for approximately 97 percent of all IR&D; the remaining 3 percent was accounted for by some 13,000 other defense contractors (Alexander, Hill, and Bodilly, 1989, citing 1979 statistics). Unfortunately, 1989 may be the last year for which IR&D data are readily available. The fiscal year 1991 Appropriations Act repealed the provisions that required DCAA to collect IR&D data. DCAA consequently no longer intends to compile these statistics.

of combined DOD and NASA industrial R&D support, IR&D fell from 11.4 percent in 1984 to 8.5 percent in 1989. (See appendix table 4-16.) Given the more recent slowing in Federal defense R&D support overall, this downward trend in IR&D is likely to continue.

## Federal R&D Support by National Objective

***Funding Trends.*** The Office of Management and Budget classifies all activities within the Federal budget into 20 functional categories. There are 15 "functions" that contain Federal R&D programs.[18] Trends in Federal R&D functional funding patterns go a long way toward defining overall national R&D trends. In each of the past three decades, major Federal R&D growth spurts were concentrated in a specific function: in the sixties, space; in the seventies, energy, especially nuclear energy; and in the eighties, defense. (See figure 4-9.) In each case, the R&D focus mirrors the national policy objectives of the period, as indicated in Federal spending documents.

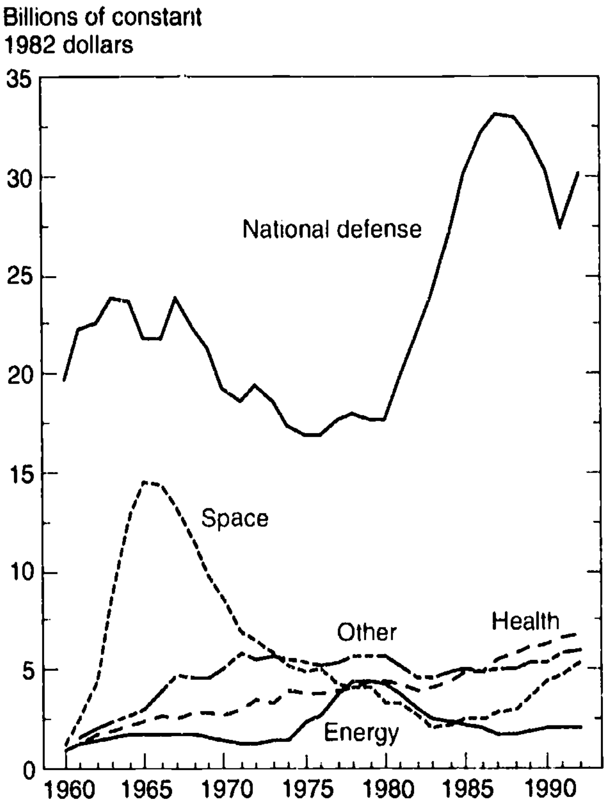
***1992 Funding Patterns.*** Funding for health (41 percent) and general science (21 percent) dominate the estimated 1992 Federal basic research authorizations.[19] (See appendix table 4-18 and "Definitions," p. 91.) In terms of Federal budget authority for total research and development, the following five functions account for 92 percent of estimated 1992 funds:

- National defense—60 percent, including both DOD and DOE funds;
- Health—13 percent;
- Space—11 percent;
- General science—4 percent; and
- Energy—4 percent.

(See figure 4-10.)

Three other functional areas of Federal concern each accounts for between 1 and 3 percent of R&D budget authority: transportation, natural resources, and agriculture. Recent actions suggest increased near-term R&D funding for each of these objectives. For example, funding for USDA's new National Initiative for Research on Agriculture, Food, and Environment was provided in fiscal year 1991. This initiative is designed to focus basic, applied, and mission-linked research on the Nation's food, forest, and agriculture system with particular attention given to environmental compatibility issues, the contributing role of modern technologies such as biotechnology and computer sciences, and the international

**Figure 4-9.**
**Federal R&D funding, by budget function**




See appendix table 4-17. *Science & Engineering Indicators – 1991*

competitiveness of U.S. industries.[20] The need for increased transportation R&D is similarly recognized: As of this writing, Congress and the Administration were in mid-debate as to how best address the needs of the Nation's aging transportation infrastructure.

## Combined Federal and Non-Federal R&D Support by Objective

For any given socioeconomic objective, the Federal Government accounts for only part of the Nation's R&D total. And in fact, as was noted earlier, the Federal Government is providing a declining share of national R&D funding. Non-Federal sources, including industry and state governments, are consequently playing a much greater role today in determining the Nation's R&D funding priorities than they did 30 years ago. Although it would be difficult to distribute the national R&D total among specific categories of national objectives, this section attempts to provide a perspective on Federal and non-Federal R&D trends for defense, health, and agriculture.

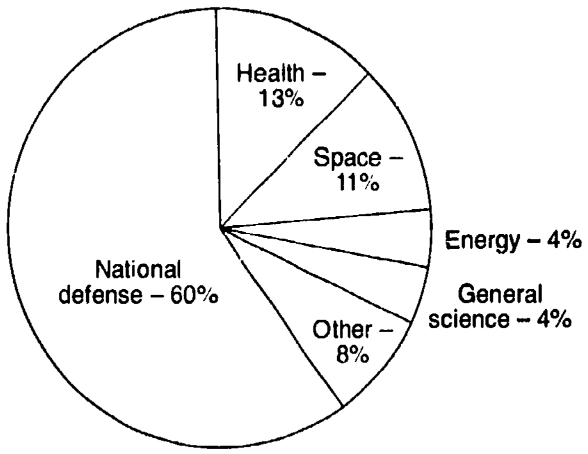
***Defense.*** Even for defense purposes, there is a substantial amount of private funds in addition to the

[18] For definitions and details, see SRS (1990a). Data reported here reflect estimates for R&D programs contained in the Administration's 1992 budget proposal submitted to Congress in February 1991.

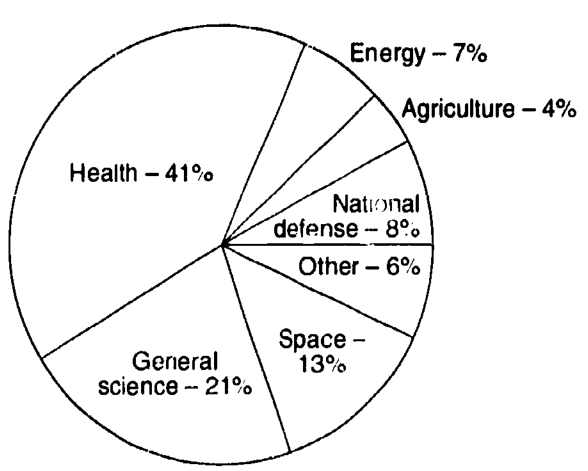
[19] By definition, virtually no applied research or development work appears in the general science category. In contrast, health accounts for about 7 percent of applied and development work combined.

[20] For further details on the National Research Initiative, see Department of Agriculture (1991).

Figure 4-10.
**Federal R&D funds, by budget function: 1992**




**Total R&D**




**Basic research**

See appendix tables 4-17 and 4-18.
*Science & Engineering Indicators – 1991*

Federal funding component. Federal defense funding comprises DOD spending from its research, development, test, and evaluation (RDT&E) account; and DOE's R&D for its atomic energy defense activities. As was previously mentioned, industry funds considerable IR&D that is only partially reimbursed by the government but that nonetheless has potential military relevance. Adding these IR&D costs that are either reimbursed as overhead on defense contracts or not reimbursed at all increases total defense R&D by 9 percent for 1989.[23] This figure is down slightly from the 10-percent IR&D share of defense total indicated for 1980. (See text table 4-3.)

***Health.*** As would be expected, non-Federal funding for national *nondefense* objectives plays an even more important role than does such funding for defense. For example, non-Federal sources for health R&D—primarily industry but also private nonprofit organizations such as the Howard Hughes Medical Institute—grew considerably faster than did Federal health R&D support during the eighties. (See figure 4-11.) According to NIH, public sector financing accounted for roughly two-thirds of the total health-related R&D in 1980; of this, about 60 percent was funded by the Federal sector, and the rest was funded by state and local governments. These sector shares had held rather steady since the mid-sixties. (See appendix tables 4-19 and 4-20.) By 1991, however, government's share of the estimated $25 billion health R&D total had fallen to just over one-half, with 42 percent of the total coming from the Federal Government—mostly NIH—and 7 percent from the states and localities. This decline in the Federal *share* was in spite of a 15-percent increase in the constant dollar support *level* over the

Text table 4-3.
**National defense-related R&D support**

| | 1980 | 1989 |
|---|---|---|
| | —Billions of dollars— | |
| Defense-related R&D investments | 16.2 | 43.9 |
| Department of Defense RDT&E | 13.4 | 37.5 |
| Technology base | 2.3 | 3.5 |
| Advanced technology development | 0.6 | 5.8 |
| Strategic programs | 2.2 | 6.4 |
| Tactical programs | 5.2 | 13.0 |
| Intelligence and communications | 1.2 | 4.5 |
| Defense-wide mission support | 1.9 | 4.2 |
| Department of Energy defense R&D | 1.1 | 2.6 |
| IR&D with potential military relevance | 1.7 | 3.8 |
| Reimbursed ceiling | 0.9 | 2.3 |
| Unreimbursed ceiling | 0.9 | 1.4 |

NOTES: Details may not sum to totals because of rounding. RDT&E = research, development, test, and evaluation; IR&D = independent research and development.

SOURCES: Science Resources Studies Division, National Science Foundation, *Federal R&D Funding by Budget Function*, annual series (Washington, DC: NSF); and Defense Contract Audit Agency, *Independent Research and Development and Bid and Proposal Cost Incurred by Major Defense Contractors*, annual series (Washington, DC: DCAA).

*Science & Engineering Indicators – 1991*

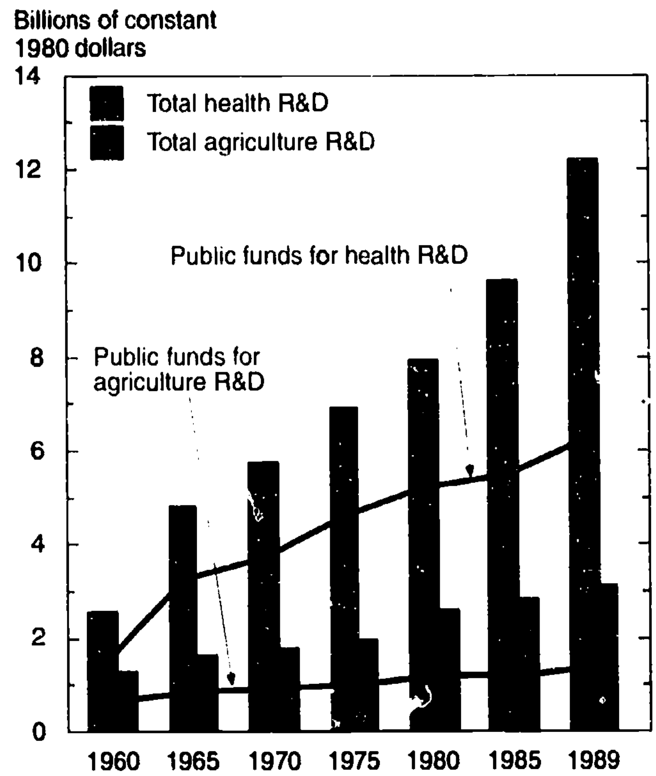
[23]This particular accounting approach is suggested by Carter (1989) in addressing the revitalized policy-relevant issue of dual-use technologies; i.e., technologies with both military and civilian/commercial applications. In text table 4-3, DOD's "technology base" consists of all basic and applied research expenditures (6.1 fundamental research and 6.2 exploratory development monies in DOD's nomenclature). The rest is what NSF calls "development," including funds for the somewhat generic nonsystems "advanced technology development" work (6.3A in the DOD vernacular). See also Branscomb (1989) for a discussion of dual-use technologies.

same 11-year period.[22] Private sector support, led by the R&D investments of drug and biotechnology companies, grew by 125 percent between 1980 and 1989.

***Food and Agriculture.*** As with health R&D, recent estimates show considerable private sector support for agricultural and food research; this support is, however, only one-quarter the level of private health-related R&D spending.[23] Public R&D support for agriculture also is about one-fifth that for health and is provided chiefly by USDA for in-house research by its Agricultural Research Service and Economic Research Service, and for extramural research by its Cooperative State Research Service. This last agency—along with state governments—contributes to the 57 state a cultural experiment stations affiliated, for the most part, with land-grant universities.

Spending on agriculture and food R&D was split rather evenly between the public and private sectors in 1975, with about $0.7 billion each. (See appendix table 4-20.) Since then, public agricultural research has fallen slightly to about 43 percent of the 1989 $5 billion national total; industry research has climbed to 57 percent. Neither source of support expanded very rapidly during the eighties. Increases in public spending averaged only 1.6 percent per year (in constant dollars) with the largest gains slated for the state agricultural experiment stations; industry support rose 2.5 percent annually. Industry's R&D expenditures for 1989 consisted of 40 percent food R&D and 60 percent R&D on agricultural inputs, mostly pesticides and farm machinery. R&D expenditures on biotechnology in food and agriculture grew from almost nothing in 1975 to an estimated $200 million in 1989—12 percent of all agricultural input industries' R&D.

Figure 4-11.
**Public and private R&D expenditures for health and agriculture**




NOTE: Separate deflators were used for health and agriculture. See appendix table 4-20. *Science & Engineering Indicators – 1991*

## Indirect Federal Encouragement of R&D

Improvement in global competitiveness and national economic welfare are central themes of current U.S. economic policy. To help achieve these goals, several Federal measures were put in place over the past decade, including incentive mechanisms specifically aimed at creating a more favorable environment for R&D investment and cooperative activities. Summary statistics for three such mechanisms—R&D tax credits, R&D consortia, and Federal cooperative research and development agreements—are presented in this section.[24]

***R&D Tax Credits.*** Since 1981, the government has attempted to stimulate corporate spending through tax credits on incremental research and experimentation (R&E) expenditures.[25] The current tax credit is 20 percent for the amount by which a company's qualified R&D exceeds a certain threshold.[26] The Tax Reform Act of 1986 allowed companies to claim a similar credit for basic research grants, contributions, and contracts to universities and other nonprofit institutions. Since 1986 both credits have been annually renewed and were in place at least through the end of 1991.

[22]Constant dollar estimates are based on the Bureau of Economic Analysis/NIH biomedical research and development price index. Using the GNP deflator on these health R&D data results in a 35-percent constant dollar increase in Federal support over the 1980-91 period and in a 230-percent increase in combined industry and nonprofit support. Since the index is designed to reflect price movements in biomedical R&D, it probably measures real changes in health R&D expenditures better than does the GNP deflator (Holloway and Reeb 1987). Pardey, Craig, and Hallaway (1989) similarly found reason to prefer an index specific to the agricultural research system over the GNP deflator. That price index is also used here to deflate these food and agriculture R&D data.

[23]Actually, these figures—recently made available by Dr. Carl Pray at Rutgers University—are for R&D *performance*, rather than *support*. In aggregate terms, however, there is little difference in choice of measures, since industry uses about 95 percent of its food and agriculture R&D funds for in-house activities and contract work to private research firms. Less than 1 percent of industry's in-house research is publicly funded (Pray and Neumeyer 1990).

[24]For a brief overview of recent policy provisions related to high-technology trade, see NSB (1989), pp. 158-60.

[25]Not all R&D is eligible for this credit, which is limited to expenditures on laboratory or experimental R&D.

[26]The current base structure for calculating a company's qualified R&D spending is complex and was put in place by the 1989 Reconciliation Bill, P.L. 101-239. (See Siboni and McCook 1990.) With various exceptions, a company's qualifying threshold is the product of a fixed-base percentage multiplied by the average amount of the company's gross receipts for the 4 preceding years. The fixed-base percentage is the ratio of R&E expenses to gross receipts for the 1984-88 period. See also a related analysis by Baily and Lawrence (1990).

As part of the budget process, the Treasury Department calculates the impact on Federal revenues of various preferential tax provisions, including the R&E tax credit. These estimates, called "tax expenditures," are calculated as the net difference between Federal revenues that would be collected with and without the preferential provision, given the otherwise current tax structure. In particular, Treasury provides outlay-equivalent figures for the R&E tax credit that are directly comparable to R&D budget outlays. (See "Definitions," p. 91.) These figures show that this indirect means of Federal R&D support ranged between roughly $1 and $3 billion annually over the past decade, an amount equal to about 3 percent of direct Federal R&D support. (See appendix table 4-21.) Based on early data from the Internal Revenue Service's *Statistics of Income*, companies taking the greatest advantage of the credit primarily have been large firms that produce scientific instruments, office and computing machinery, chemicals, and electrical equipment (see GAO 1989b and Cordes 1989).

***R&D Consortia.*** Certain Federal provisions have been set in place to help foster cooperative relationships within the private sector. For example, the National Cooperative Research Act of 1984 (NCRA) encourages research collaboration among industry competitors by better defining joint research and development ventures (JRVs) and protecting them from antitrust suits.[27] NCRA also requires a public disclosure of JRVs, which subsequently appears in the *Federal Register*. Through April 1991, more than 200 filings of U.S. cooperative research ventures had been registered under the act. Up to one-half of the filings are for project-specific—often two-member—ventures; about one-fourth of the filings appear to be for industry consortia conducting long-term R&D and/or for research corporations with their own facilities.[28] Although the exact amount of R&D funded through JRVs or industry consortia is unknown, anecdotal evidence suggests that less than 2 percent of industrial R&D involves interfirm collaboration.[29]

***Industry-Government Cooperative Agreements.*** The rise in the number of private cooperative research ventures has been accompanied by an increase in joint industry-government cooperative research arrangements. The Federal Technology Transfer Act (FTTA) of 1986 (P.L. 99-502) was enacted to promote the transfer of technology from Federal laboratories to state and local governments and the private sector. Approximately one-fourth of all Federal R&D funds support agencies' intramural research activities.[30] The act requires agencies to put the fruits of this R&D investment to commercial use. Specifically, FTTA authorizes government-owned and -operated laboratories to enter into cooperative R&D agreements (CRADAs) with private industry and to agree in advance on the rights of industry and Federal participants to resulting inventions.

The Federal Laboratory Consortium for Technology Transfer provides a support system to help U.S. firms capitalize on this Federal resource. Although it has taken several years for Federal agencies to make the necessary administrative arrangements, many have now successfully negotiated CRADAs with industry participants. (See DOC 1989.) By the end of fiscal year 1990, nine Federal agencies had entered into 868 cooperative agreements, with the number of active CRADAs growing substantially every year. USDA and HHS accounted for 85 percent of this CRADA total (DOC 1991).[31] (See text table 4-4.) Data on the dollar value of these CRADAs and other transfer activity indicators are not currently available.

## State-Based R&D Expenditures

Many studies suggest that a critical mass of research is one of the fundamental requirements for high-tech industries to locate and grow in a region. (See Malecki 1980.) Also, an apparent lesson of state competitions in the eighties for major research institutions such as DOD's Sematech (a consortium to develop manufacturing technologies) and DOE's Superconducting Super Collider was that those institutions usually locate where major research and educational facilities are already established (Osborne 1989).

This section presents summary material on the geographic distribution of the U.S. domestic R&D effort. The analysis covers state R&D concentration levels—in

[27] NCRA states that JRVs will not automatically be considered illegal as anticompetitive, but that such consortia will be judged after weighing potential benefits and costs. Further, NCRA limits potential liability for JRV behavior that ultimately is ruled anticompetitive to actual costs rather than treble damages as is otherwise the norm. See Link and Tassey (1989), Link and Bauer (1989), and Webre (1990).

[28] Any classification scheme for NCRA filings is bound to be somewhat subjective. Link and Bauer (1989) provided the framework used here. Complete filing information is available from the Office of Technology Commercialization (1991).

[29] See Webre (1990) and Bellcore (1990). In any event, most cooperative arrangements apparently are informal. For example, Link and Bauer (1989) estimate that up to 90 percent of all U.S. industry cooperative research arrangements in 1984 were informal partnerships.

[30] These R&D expenditures include administrative costs of intramural and *externally performed* R&D programs by Federal personnel.

[31] NASA relies on the National Aeronautics and Space Act of 1958, rather than FTTA, to guide its technology commercialization activities. Thus, although it enters into cooperative R&D agreements, these do not fall under the terms of FTTA. NASA estimates the number of its agreements similar to CRADAs as follows: 75 in 1987, 95 in 1988, 127 in 1989, and 147 in 1990. These cooperative research activities are *not* reflected in the above figures.

Other agencies—notably DOE—perform much of their research through government-owned and contractor-operated FFRDCs, rather than government-owned and -operated laboratories covered under FTTA; much of this research has commercial potential that is also not reflected in the above figures. The National Competitiveness Act of 1989 extended CRADA provisions to government-owned and contractor-operated FFRDCs, including those sponsored by DOE. As of July 1991, DOE laboratories had entered into a total of 24 CRADAs and were negotiating 19 more.

Text table 4-4.
**Number of active cooperative R&D agreements, by agency**

| Agency | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|
| Total, all agencies | 33 | 99 | 276 | 460 |
| Agriculture | 9 | 51 | 98 | 128 |
| Commerce | 0 | 9 | 44 | 82 |
| Defense | | | | |
| Air Force | 0 | 2 | 7 | 13 |
| Army | 2 | 9 | 32 | 80 |
| Navy | 0 | 0 | 2 | 20 |
| Energy | 0 | 0 | 0 | 1 |
| Environmental Protection Agency | 0 | 0 | 2 | 11 |
| Health and Human Services | 22 | 28 | 89 | 110 |
| Interior | 0 | 0 | 1 | 12 |
| Transportation | 0 | 0 | 0 | 1 |
| Veterans Affairs | 0 | 0 | 1 | 2 |

NOTE: Not all cooperative agreeements are included under the provisions of the Federal Technology Transfer Act. See text.

SOURCES: Data submitted to the Technology Administration Department of Commerce, by Federal agencies that own or operate laboratories.

*Science & Engineering Indicators – 1991*

the aggregate and by sector—and indicators of the research intensity of state economies. Also included is information on recent trends in state government support for science and technology, including growth in the number of state-sponsored S&T programs and in state funding for R&D activities.

## Distribution of R&D Funds by State[32]

***Top 10 States.*** Of the $140 billion spent on R&D in the United States in 1989, almost one-half was spent in just five states (California, New York, Michigan, New Jersey, and Massachusetts). Moreover, more than two-thirds of the national R&D effort was performed in 10 states—the preceding five along with Texas, Pennsylvania, Ohio, Illinois, and Maryland.[33] (See figure 4-12.) Performance of R&D in California alone reached $31 billion (23 percent of the U.S. total); R&D expenditures ranged between $5 and $10 billion in each of the other nine leading states. (See appendix table 4-22.) In contrast, the smallest 30 states collectively accounted for $15 billion (roughly 10 percent) of the R&D conducted nationwide in 1989.

[32]This section presents information on the state location of R&D performed by industry, academia, and Federal agencies, and the federally funded R&D activities of institutions that are part of the nonprofit sector. (See appendix table 4-22.) Consistent data on the state distribution of non-Federal R&D expenditures used by nonprofit institutions are not compiled. To account for differences in state sizes, these expenditure data are normalized by estimates of the states' economic activity.

[33]In this section, percentage shares and relative rankings are based on R&D performance expenditures that could be distributed among the states. Excluded from the $140 billion total are $2 billion of R&D performed in Washington, D.C., and an undistributed component of $5 billion. (See appendix table 4-22.)

Not coincidentally, most of the states that are national leaders in total R&D performance also rank among the leading sites of industrial and academic R&D performance. (See appendix table 4-23.) For example, of the 10 states that led in total R&D,

- All but 1 (Maryland) ranked among the top 10 industrial performers;
- All but 2 (Ohio and New Jersey) ranked among the top 10 academic performers;
- All but 2 (Michigan and New Jersey) ranked among the top 10 federally funded nonprofit performers; and
- All but 3 (New York, Michigan, and Illinois) ranked among the top 10 Federal intramural performers.

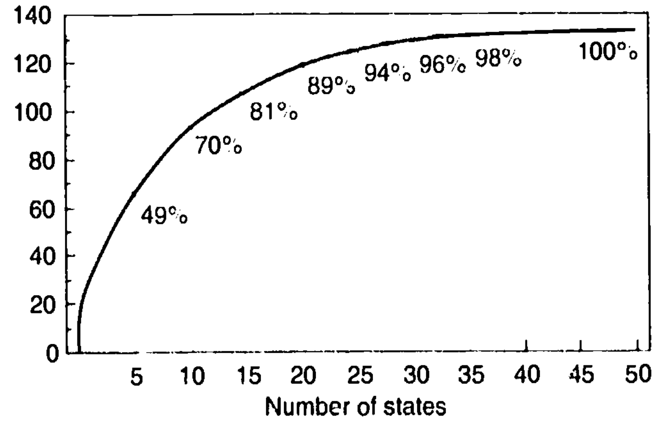
Furthermore, the 10 states that ranked highest in terms of R&D performance totals in 1989 were similarly ranked among the largest 10 in 1975.[34] The relative stability in research distribution indicates that leading R&D centers are not easily outcompeted, especially over short time periods.

***R&D Intensity of States.*** The absolute levels of R&D expenditures noted above are indicators of the current breadth and scope of S&T activities within states. To some extent, they also indicate a state's potential for further supporting such activities. Programs designed to broaden states' R&D infrastructure are discussed below; however, to make more meaningful comparisons between states, indicators that normalize for the size of a state's economy are also discussed.

The ratio of R&D expenditures to GNP is used to gauge a country's commitment to R&D and to measure the change in this commitment over time. (For the United

[34]The exact ranking of these 10 did shift somewhat between 1975 and 1989. See SRS (1989).

Figure 4-12.
**Cumulative distribution of R&D performance, by state: 1989**




See appendix table 4-22. *Science & Engineering Indicators – 1991*

States, the R&D/GNP ratio was about 3 percent in 1989.) Similarly, the ratio of in-state R&D performance to gross state product (GSP) can be used to measure the R&D intensity of a state's economy.[35] The largest R&D/GSP ratios were achieved in New Mexico (10 percent) and Delaware (6 percent). These two states were ranked 15th and 26th, respectively, in terms of total R&D performance. (See text table 4-5 and appendix table 4-23.) On the other hand, California and New York led the Nation in terms of total R&D performance but were 6th and 18th, respectively, in terms of their economies' R&D intensity—5 percent and 2 percent, respectively. The median R&D/GSP ratio was 1.5 percent in 1989: 25 states achieved a ratio higher than the median, and the ratio in 25 states fell below this figure.

## State S&T Programs[36]

A key indicator of the level of growth in state support for S&T is the existence of state government organizations established specifically for S&T development. The following sections describe the burgeoning of state S&T institutions and programs put in place during the eighties to support regional S&T-based economic growth.

***Overview.***[37] In recent years, most states have created one or more programs designed to enhance their technological and competitive capacities.[38] Although these S&T initiatives are as varied as the settings in which they have been launched, most seem to share three common goals: job creation, business development, and economic diversification. According to the Department of Commerce's clearinghouse (see footnote 37), by the middle of 1991 all states could identify a lead agency, board, or commission responsible for the promotion of S&T-based economic development programs. No fewer than 40 of these entities were established during the eighties; six states put such institutional arrangements in place only within the past 2 years. (See appendix table 4-24.) Agency responsibilities vary enormously, ranging from the simple provision of information and advisory services to active participation in multimillion dollar technology programs. Although some initiatives are obviously much farther along than others, each generally is designed to improve the state's economic environment by

- Strengthening linkages among the state's financial, academic, and business communities;
- Promoting entrepreneurship; and
- Upgrading the overall scientific and technological base of the local economy by building on existing regional strengths.[39]

Text table 4-5.
**State ranking of total R&D performance and research intensity: 1989**

| Rank: Total R&D | R&D/GSP[1] | Total R&D | R&D/GSP[1] |
|---|---|---|---|
| 1 California | 6 | 15 New Mexico | 1 |
| 2 New York | 18 | 26 Delaware | 2 |
| 3 Michigan | 5 | 4 Massachusetts | 3 |
| 4 Massachusetts | 3 | 10 Maryland | 4 |
| 5 New Jersey | 8 | 3 Michigan | 5 |
| 6 Texas | 23 | 1 California | 6 |
| 7 Pennsylvania | 15 | 29 Idaho | 7 |
| 8 Ohio | 13 | 5 New Jersey | 8 |
| 9 Illinois | 20 | 12 Washington | 9 |
| 10 Maryland | 4 | 13 Connecticut | 10 |
| 11 Florida | 27 | 37 Vermont | 11 |
| 12 Washington | 9 | 14 Missouri | 12 |
| 13 Connecticut | 10 | 8 Ohio | 13 |
| 14 Missouri | 12 | 17 Minnesota | 14 |
| 15 New Mexico | 1 | 7 Pennsylvania | 15 |
| 16 Virginia | 24 | 20 Colorado | 16 |
| 17 Minnesota | 14 | 34 Rhode Island | 17 |
| 18 Indiana | 21 | 2 New York | 18 |
| 19 North Carolina | 29 | 27 Utah | 19 |
| 20 Colorado | 16 | 9 Illinois | 20 |

[1] Research intensity is measured as the ratio of in-state R&D performance to gross state product (GSP).

See appendix tables 4-22 and 4-23.

*Science & Engineering Indicators – 1991*

[35] The Bureau of Economic Analysis has prepared GSP data through 1986 and is in the process of updating the data through 1989. GSP data used here were estimated based on annual state changes in employee compensation and proprietors' income. See Renshaw, Trott, and Friedenberg (1988) and appendix table 4-23.

[36] "S&T" is used here, rather than R&D, to emphasize the broad range of state activities in support of economic development based on science and technology.

[37] Information presented in this section is taken from a new data base developed by the Clearinghouse for State and Local Initiatives on Productivity, Technology, and Innovation in the Department of Commerce's Office of the Assistant Secretary for Technology Policy of the Technology Administration. The Omnibus Trade and Competitiveness Act of 1988 specified creation of the clearinghouse to serve as "a central repository of information on initiatives of State and local governments to enhance the competitiveness of American business through the stimulation of productivity, technology, and innovation and Federal efforts to assist State and local governments to enhance competitiveness."

The data base contains information on more than 100 different S&T program variables. The information contained here reflect data available as of August 1991. However, because programs are constantly coming into, and going out of, existence, accurate counts are difficult and there are bound to be a few errors of inclusion, interpretation, or omission. For another recent snapshot of state S&T programs, see Phelps and Brockman (1991).

[38] For a summary of states' historical involvement in S&T programs, see NSB (1989), pp. 98-101. For a detailed analysis of trends in the eighties, see Osborne (1988). Osborne (1989) provides a preliminary assessment of various state S&T mechanisms.

[39] This last point is in stark contrast to the type of state economic development programs prevalent in the sixties and seventies. Then, states often pursued a "smokestack chasing" practice of luring companies away from one state to relocate to another. Most S&T-based programs are concerned more with creating new businesses—spinoff companies—or modernizing existing in-state industries.

States have adopted several experimental approaches in fostering technology-driven development. Summary data on four of the more pervasive approaches are provided here. (See appendix table 4-24.) Two of these mechanisms—*research grants* and *research centers*—usually require heavy university participation; the other two—*R&D tax credits* and *business startup support*—affect only the industrial sector.[40] Although some states concentrate on the industrial sector and others focus on university-based research, most initiatives have a mixed university-industry orientation. States in the Northeast and Midwest—which were among the first states to initiate S&T programs in response to the downturn in their manufacturing sectors during the late seventies and eighties—generally seem to use a larger variety of S&T mechanisms than do other states. Five states—Arkansas, Indiana, Iowa, Kansas, and North Carolina—continue to use each of the four named development tools.[41] (See figure 4-13.)

***Research Grants and Centers.*** An important component of most state technology development strategies is research grants. At least 36 states use this mechanism for promoting local growth. Research grants usually

- Are made to universities based on joint proposals from a university and a private sector sponsor,
- Are intended to strengthen the *applied* rather than *basic* research base,[42] and
- Require matching funds from the private sector.

This last requirement ensures that state dollars are leveraged with outside funding and provides some assurance that the proposed research has commercial potential.

Although research grants are distributed through various means, by far the bulk of the money flows through state-initiated research or technology centers. Such "centers of excellence" have been established in 27 states and usually are located at universities—or at least affiliated with them. The centers generally concentrate on a specific field of research, drawing heavily on the strengths of an associated university and/or major industries in the state.

***Tax Credits and Startup Support.*** Often patterned after the Federal R&E tax credit (see "R&D Tax Credits," pp. 101-02), many states have designed their own tax incentives to encourage industry's in-state R&D investment. Provisions for R&D tax credits and/or exemptions are on the books in at least 20 states.

Many states also provide considerable S&T support for industry's post-R&D activities. In fact, no fewer than 31 states have given some kind of financial support for business startup programs, including either one-time capitalization or ongoing funding and oversight. Six states have seed capital programs to assist companies trying to develop a marketable product. Seven states have venture capital programs to assist developing companies that have established business plans and commercially feasible projects. Eighteen states have both.

## State Funding of R&D

Growth in state R&D funding is a direct indicator of a state's commitment to the building of its S&T base. It is also an indicator of expanding inter-sector research linkages, given the university-industry cooperative requirements increasingly associated with state funding. Two different data sources using different methodologies show growth in state support of R&D.[43] And, although state funding is not necessarily the causal factor, these data also show increasing support by industry for R&D performed on the Nation's campuses—an aim of many states' S&T policies.

***Funds for Academic R&D by State.***[44] Universities reported about $1.2 billion of support for R&D from state and local government sources in 1989, an amount equivalent to 8 percent of total R&D performed by the academic sector. (See appendix table 4-22.) Broken out by state, these same data reflect differing state resource patterns and show the effects of different institutional mixes in individual states.

Ten states accounted for over 50 percent of total national academic R&D expenditures from state and local sources. Texas alone, with a strong tradition of direct state government funding of institutional activities, accounted for the

[40]The programs covered here are not the only ones that states use to spur technological development. Other popular approaches include establishment of research parks—to encourage planned clustering of technology companies and foster university-private sector partnerships—and incubator facilities providing startup companies with below-market rates for office and lab space as well as shared clerical and computer services. A number of states also work with local Federal laboratories to assist small and medium-sized manufacturers to commercialize Federal technologies. Passage of FTTA in 1986 encouraged this development. (See "Industry-Government Cooperative Agreements," p. 102.)

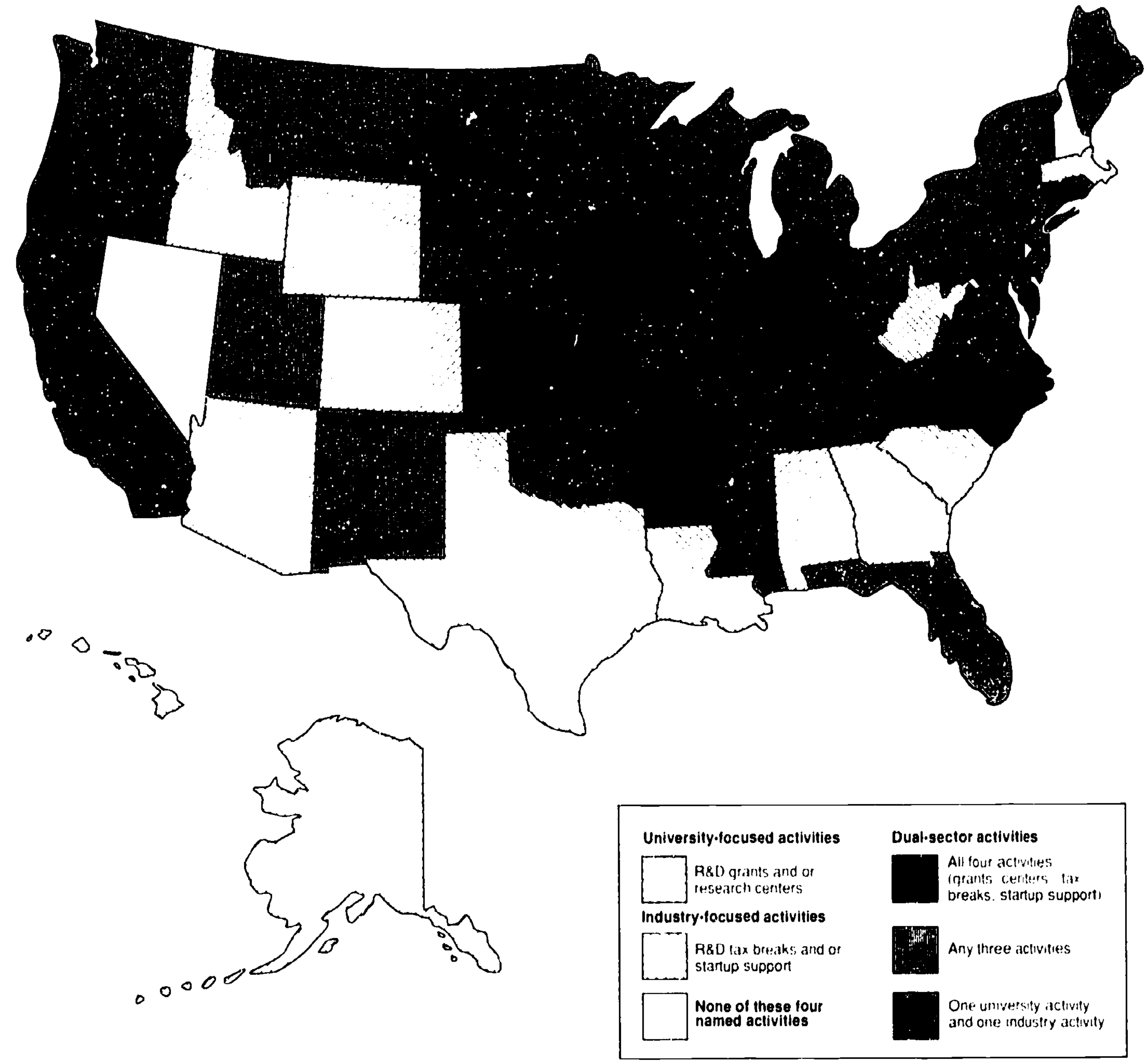
[41]Up until recently, Minnesota and Massachusetts also used all four S&T devices covered in this section. Minnesota discontinued its industry grant program in 1991 and merged two of its leading S&T institutions into a single entity. Massachusetts' S&T efforts underwent major restructuring during 1991, including the privatization of its six previously quasi-public Centers of Excellence. However, the state has enabled the creation of successor entities designed to continue the mission of S&T promotion. The newly formed Biotechnology Center of Excellence Corporation and the Massachusetts Foundation for Excellence in Marine and Polymer Sciences began operations in July 1991 and are stimulating S&T-based economic development in their areas of interest. In redefining the state role as one of facilitation, rather than program operation, the state legislature allocated no future funds for continued direct investment in many S&T programs that previously received state support (Phelps and Brockman 1991).

[42]That is, support of innovation and technology transfer for local economic development is the objective, and not the support of research for its own sake.

[43]The two NSF data sources are the annual Survey of Scientific and Engineering Expenditures at Universities and Colleges and the occasional Survey of State Government Research and Development.

[44]These data show only state and local government sources of funds that are separately budgeted for specific projects. General university funds used for academic R&D purposes are not included here. These data do not include R&D performed by university-administered FFRDCs.

Figure 4-13.
**State promotion of S&T-based economic development**




NOTE: Data are as of August 1991.
See appendix table 4-24.

*Science & Engineering Indicators – 1991*

largest share—10 percent—of nationwide non-Federal governments' R&D support to universities. These sources in Texas provided 12 percent ($124 million) of the funding for the state's total academic R&D. By comparison, universities in California—whose total R&D expenditure was the largest nationwide and nearly twice that of Texas in 1989—received 3.6 percent ($43 million) of its funding from state and local sources. This smaller proportion reflects (1) a large Federal funding share and (2) the presence of major private research universities that were less likely to receive state funding for R&D. (Nationally, private universities received only 2.4 percent of their R&D funding from state and local governments, compared to an 11.3-percent share at public universities.)

As a percentage of a state's academic R&D total, the state and local government share is relatively most important to universities in South Dakota—whose total R&D expenditure in 1989 was the smallest in the Nation—where it provided almost 40 percent of funds. Indeed, in many states where the academic R&D expenditure total was comparatively small, state government provided a relatively large proportion of the funding total. (See text table 4-6.)

Insofar as state S&T policy objectives include encouragement of university-industry interactions, industry support of university R&D may serve as one indicator of the success of those policies.[15] For all states combined, industrial sources of support for academic R&D have grown faster than all other sources of support, increasing 179 percent in constant dollars from 1980 to 1989. Support from other sources was up 60 percent. (See appendix table 4-2.) As a percentage of the Nation's total academic R&D effort, industry sources of support increased from 4 to 7 percent. Some states obtain a notably larger than 7-percent share of their academic R&D from industrial sources. This point is startlingly true of states in which university R&D performance is rather small. For example, total R&D activities on the campuses of Maine—$20 million—ranked that state 49th nationwide in 1989; yet industry provided a Nation-leading 20-percent share of total. (See text table 4-6.) Indeed, of the eight states that received the proportionately largest shares (10 percent or more) of their academic R&D funding from industry, six—Maine, Idaho, Nevada, Delaware, West Virginia, and Montana—ranked among the smallest nine states in terms of total academic R&D performance levels.

[15] See Feller (1990) and Berman (1990) for contrasting views on the role of universities in industrial development activities.

Text table 4-6.
**States where non-Federal government and industry comprise the largest shares of academic R&D funding: 1989**

| | Support for academic R&D | | | |
|---|---|---|---|---|
| Rank, total academic R&D | Non-Federal government share (percent) | Rank | Industry share (percent) | Rank, total academic R&D |
| U.S. average | 8.2 | | 6.6 U.S. average | |
| 51 South Dakota | 39.4 | 1 | 20.0 Maine | 50 |
| 38 Hawaii | 35.0 | 2 | 12.7 Idaho | 46 |
| 41 Arkansas | 27.9 | 3 | 12.1 New Mexico | 29 |
| 37 Mississippi | 27.3 | 4 | 12.0 Pennsylvania | 6 |
| 34 Nebraska | 24.5 | 5 | 12.0 Nevada | 45 |
| 46 Idaho | 24.4 | 6 | 11.0 Delaware | 44 |
| 47 Montana | 24.4 | 7 | 10.1 West Virginia | 43 |
| 26 Louisiana | 24.0 | 8 | 10.0 Montana | 47 |
| 33 Kansas | 22.4 | 9 | 9.9 Missouri | 19 |
| 17 Virginia | 19.0 | 10 | 9.7 North Carolina | 9 |
| 18 Minnesota | 16.4 | 11 | 9.7 Nebraska | 34 |
| 13 Wisconsin | 16.4 | 12 | 9.4 Arkansas | 41 |
| 15 New Jersey | 15.9 | 13 | 9.1 North Dakota | 48 |
| 23 Tennessee | 15.1 | 14 | 9.1 Massachusetts | 5 |
| 30 South Carolina | 14.5 | 15 | 8.9 Kentucky | 35 |
| 9 North Carolina | 14.4 | 16 | 8.5 Georgia | 10 |
| 28 Oregon | 12.9 | 17 | 8.4 Virginia | 17 |
| 3 Texas | 12.3 | 18 | 8.2 Vermont | 42 |
| 24 Iowa | 11.9 | 19 | 8.1 Indiana | 20 |
| 11 Ohio | 11.8 | 20 | 7.9 Rhode Island | 36 |

See appendix table 4-22. *Science & Engineering Indicators – 1991*

***State Agency R&D Expenditures.*** Although the most recently available NSF data on state agencies' R&D support are for 1988, their inclusion here provides for a more comprehensive overview of state R&D involvement. (See appendix table 4-25.) These data are only for state government expenditures that flow through state agency budgets; they therefore exclude, for example, all other funding for R&D activities by universities and colleges—including direct appropriations from state legislatures.

Like the academic data reported above, total state agency expenditures for R&D from state sources of funds have increased overall, doubling between 1977 and 1988 to about $630 million (in constant dollars). Nevertheless, these expenditures still accounted for only 1 percent of the national R&D funding total. State agency support for R&D facilities rose dramatically, resulting in a more than tenfold inflation-adjusted increase to $160 million. Some states, however, reported declines in real dollars. Care should be taken in using these data, because states differ considerably in their reliance on state agencies to disburse R&D funds. Some states appropriate most funds *directly* to institutions themselves, and this source of support for R&D is not reflected in these data.

# International Comparisons

Comparisons of S&T activities between the United States and other major industrialized nations provide an indication of the strength of each countries' overall S&T endeavors. The success of these endeavors depends in part on the adequacy of financial R&D inputs; comparisons of international R&D spending patterns are provided in this section.[16] Performer and source expenditure patterns are contrasted, trend data reviewed, and spending by socioeconomic objective summarized. The section closes by placing the U.S. industry R&D effort in a global context.

## R&D Funding by Source and Performer

The United States spent more money on R&D activities in 1989 than did any other country; in fact, it spent more than the next four largest performers—Japan, West Germany, France, and the United Kingdom—combined.[17] (See appendix table 4-26.) By sector, national governments and industry dominated as a percentage of each country's respective R&D funding and performance

[16] R&D data for the major industrialized countries are obtained from reports to the Organisation for Economic Cooperation and Development (OECD). Few R&D data are systematically collected for developing countries; UNESCO reports such estimates where they exist. Although there is a fairly high degree of consistency in the R&D data reported by OECD, data for countries reporting to UNESCO are less comparable—principally because of differences in national statistical collection capabilities and definitions. For a summary of the UNESCO and OECD data, see SRS (1991c).

[17] Data for Germany are for West Germany alone. R&D expenditures in the former East Germany are not included.

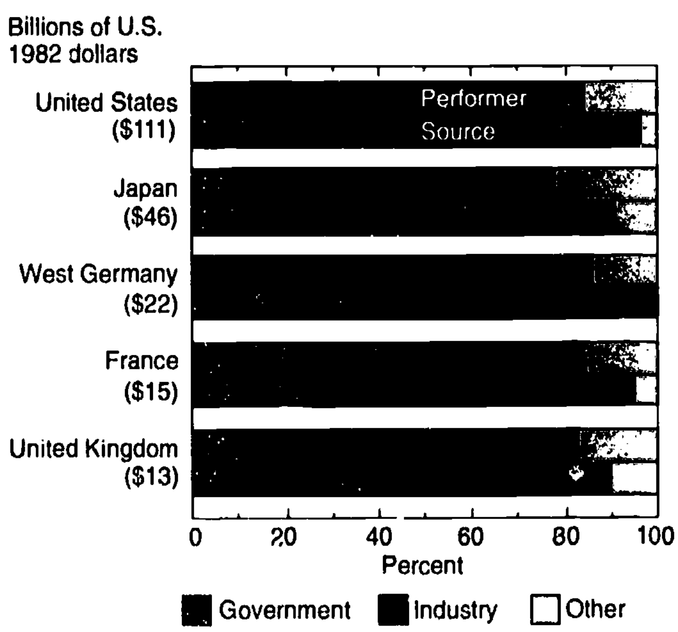
totals. Shares for these sectors, however, differed substantially from one country to the next. Although government was the source of 45 to 50 percent of R&D funds in the United States and France, it provided somewhat less in the United Kingdom (37 percent) and West Germany (33 percent), and considerably less in Japan (19 percent). (See figure 4-14.) Since 1975, government funding shares in all five countries declined, dropping most sharply in the United Kingdom (15 percentage points) and West Germany (14 percentage points). With the exception of France, industry provided more than half of the R&D funds in each of these countries in 1989. It provided 72 percent of Japan's R&D total.

Industry was the largest R&D performer in each of the five countries, with shares ranging from 60 percent in France to 72 percent in both the United States and West Germany. The industry R&D performance share grew most rapidly in Japan—from 57 percent of total in 1975 to 70 percent in 1989.[18] (See appendix table 4-28.) Government as an R&D performer was relatively smallest in Japan and the United States, accounting for 8 and 11 percent, respectively, of each country's R&D total. Government's R&D performance—including that in several nonprivatized industries—accounted for about one-fourth of France's R&D effort.

The United States and Japan devoted about the same proportion of their investments to basic research: 14 percent and 13 percent, respectively, in 1988. (See appendix table 4-29.) In dollar terms, the U.S. basic research investment ($15 billion) was three times that

[18]Detailed and more extensive data can be found in SRS (1991e).

Figure 4-14.
**International R&D funds, by performer and source: 1989**




See appendix table 4-28. *Science & Engineering Indicators – 1991*

of Japan ($5 billion). West Germany spent 19 percent of its total R&D on basic research ($4 billion), compared to 23 percent for France ($3 billion).[19]

## R&D Funding as a Percentage of GNP

***Total R&D.*** R&D expenditures as a percentage of GNP have become one of the most widely used indicators of a country's commitment to scientific knowledge growth and technology development. The industrialized nations of France, West Germany, Japan, Sweden, the United Kingdom, and the United States each maintained an R&D/GNP ratio of between 2 and 3 percent throughout the eighties. (In Italy, this ratio rested near 1 percent.) Generally, the R&D/GNP ratio increased annually in these countries, although the rate of change varied somewhat. The approximate 2.7-percent R&D/GNP ratio of the United States in 1989 was about half a percentage point higher than its 1980 ratio. (See figure O-2 in Overview and appendix table 4-26.) Even with this growth, the U.S. R&D/GNP ratio did not keep pace with the same indicator in Japan and West Germany, whose ratios were 2.9 and 3.0 percent, respectively. And, in spite of a recent decline in its R&D/GNP ratio, Sweden also invested a slightly larger GNP share on R&D (2.8 percent in 1989) than did the United States. In dollar terms, however, Sweden's R&D expenditures were only 3 percent of those in the United States.

***Nondefense R&D.*** Differences in R&D emphases among these countries become clearer when the data are disaggregated. Nondefense R&D expenditures as a percentage of GNP in both Japan (3.0 percent) and West Germany (2.8 percent) considerably exceeded those of the United States (1.9 percent); they have done so for more than two decades. (See figure O-2 in Overview and appendix table 4-27.) The nondefense R&D ratios of France (1.8 percent) and the United Kingdom (1.6 percent) were only slightly below that of the United States.

In absolute dollar terms, the U.S. international position was markedly different from that indicated by the nondefense R&D/GNP ratios. Between 1972 and 1989, only Japan and Italy had increased nondefense R&D spending (up 207 and 97 percent, respectively, in constant dollars) at a faster rate than had the United States (up 88 percent).[20] The result is that as a percentage of the U.S. nondefense R&D total, comparable Japanese spending jumped from 35 percent in 1972 to 58 percent in 1989. (See figure 4-15.) Japanese nondefense R&D reached $46 billion in 1989, compared with the $79 billion U.S. nondefense R&D total. Italy's nondefense R&D grew from an amount equivalent to 8 percent of the U.S. nondefense R&D total in 1972 to 10 percent ($8 billion) in 1989. West

[19]Comparable data for the United Kingdom are extremely outdated. The most recent figure (1981) indicates, however, that the basic research share was 13 percent.

[20]See appendix table 4-26 for details on conversion of national currencies to dollars.

Germany spent an amount equal to about 26 percent of U.S. spending on nondefense R&D in both years ($21 billion in 1989), while France annually spent an amount equivalent to about 15 percent of the U.S. total ($12 billion in 1989). United Kingdom nondefense R&D spending fell by 3 percentage points relative to that of the United States, dropping to 13 percent or $10 billion.

## R&D by Socioeconomic Objective[51]

Countries' relative shares of government R&D appropriations (excluding general university funds—GUF) reflect marked differences in national priorities. In the United States, 66 percent of total 1989 Federal investment in R&D was devoted to national defense, compared to 55 percent in the United Kingdom, 42 percent in France, 19 percent in West Germany, and 9 percent in Japan.[52] (See text table 4-7.) The U.S. Government also emphasizes health-related R&D (13 percent of total); this emphasis was especially notable in its R&D support given to academic and similar institutions.[53]

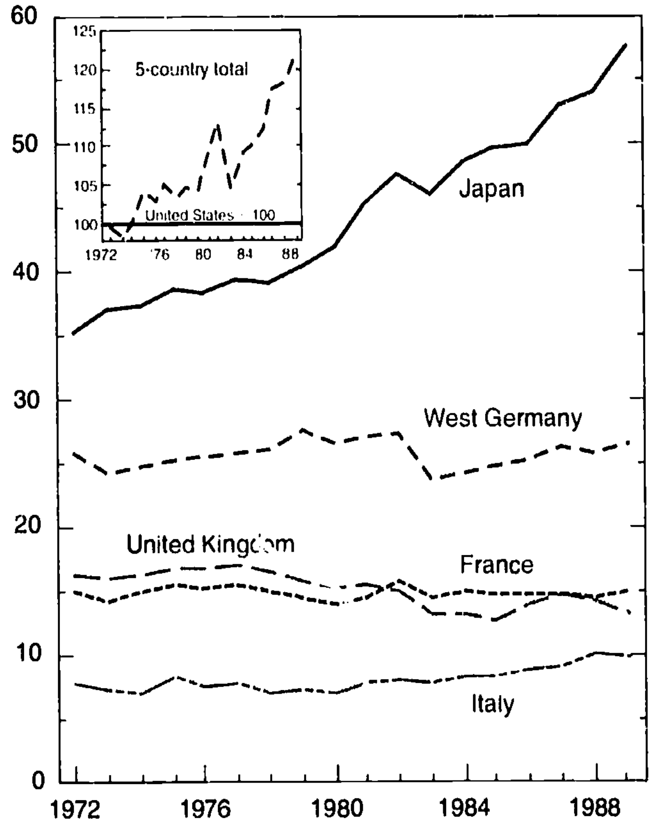
Energy-related activities accounted for 39 percent of Japanese Government R&D appropriations in 1989, reflecting the country's concern with its high dependence on foreign sources of energy. The Government of West Germany invested considerably in R&D related to industrial development and the advancement of research (each about one-fifth of the government total) as did France with 15 and 18 percent, respectively, of its 1989 R&D total. In the United Kingdom, R&D funding for industrial development—at 10 percent of total—trailed only defense in percentage share Industrial development accounted for 8 percent of the Japanese total, but just 0.2 percent of the government R&D funding total in the United States. The latter figure—which may be understated relative to other countries as a result of compilation differences—nonetheless reflects longstanding U.S. policy to rely on private sector investment decisions in this area.

[51]Data on the socioeconomic objectives of R&D funding are rarely obtained by special surveys. They generally are extracted in some way from national budgets which already have their own methodology and terminology, and thus are subject to comparability constraints not placed on other types of international R&D data sets. Notably, although each country adheres to the same criteria for distributing their R&D by objective (as outlined in OECD 1981), the actual classification may differ among countries because of differences in the *primary objective* of the various funding agents. Note also that these data are of government R&D funds only, which account for widely divergent *shares* and *absolute amounts* of each country's R&D total.

[52]The shares presented here and in text table 4-7 are adjusted to *exclude* general university funds which are reported separately for Japan and European countries. For example, GUF accounted for 18 percent of the government-funded R&D total in the United Kingdom: Unadjusted for GUF, its defense share was 46 percent in 1989. The United States does not have an equivalent GUF category: Funds to the university sector are distributed among the objectives of the Federal agencies that provide the R&D funds. (See appendix table 4-30 for further details.)

[53]For detailed comparisons of academic and academically related research, including GUF estimates, in the United States, United Kingdom, The Netherlands, France, West Germany, and Japan, see Irvine, Martin, and Isard (1990) and NSB (1989), pp. 98-99.

Figure 4-15.
**Nondefense R&D: foreign spending as a percentage of U.S. spending**




See appendix table 4-27. *Science & Engineering Indicators – 1991*

Text table 4-7.
**Government R&D support, by socioeconomic objective: 1989**

| | United States | Japan | West Germany | France | United Kingdom |
|---|---|---|---|---|---|
| | Percent | | | | |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Defense | 65.5 | 9.0 | 19.0 | 41.9 | 55.2 |
| Civil space | 7.3 | 11.1 | 8.5 | 8.7 | 3.8 |
| Advancement of research | 3.8 | 13.8 | 20.7 | 17.5 | 5.8 |
| Health | 12.9 | 4.8 | 5.2 | 3.7 | 6.2 |
| Industrial development | 0.2 | 8.1 | 19.0 | 15.0 | 10.3 |
| Energy | 3.9 | 39.2 | 9.5 | 4.0 | 4.0 |
| Agriculture, forestry, and fishing | 1.9 | 6.5 | 3.1 | 4.6 | 5.5 |
| Other | 4.5 | 7.6 | 14.9 | 4.5 | 9.2 |

NOTE: Data were adjusted to exclude general university funds for Japan (43 percent of the government-funded R&D total), West Germany (33 percent), France (12 percent), and the United Kingdom (18 percent). See text.

See appendix table 4-30. *Science & Engineering Indicators – 1991*

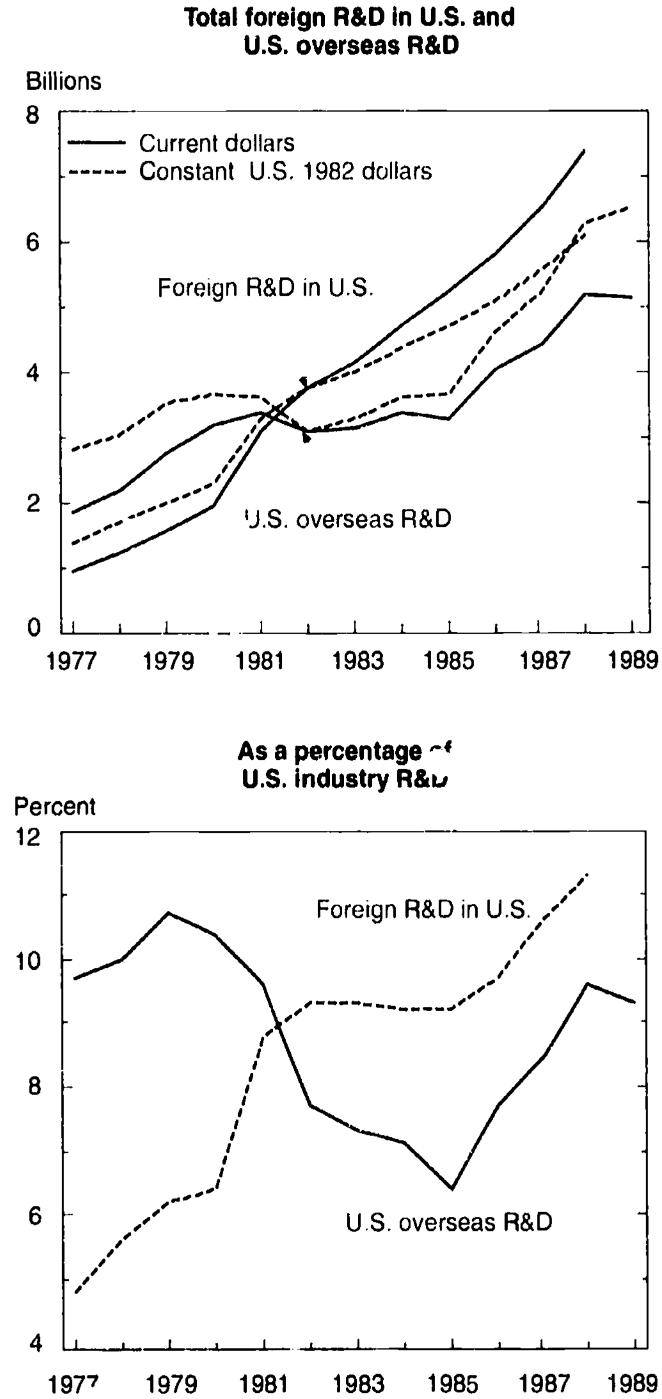
## Globalization of R&D

R&D investing has become increasingly global since roughly the mid-seventies. Stiff international competition in research-intensive, or high-technology, products has necessitated many firms' expansion into foreign markets. (See chapter 6, "The Global Market," p. 136.) As a factor in this global market shift, growing development costs and shortening product life cycles have compelled corporate managers to expand overseas research activities so as to tailor products for the specific needs of foreign customers. Thus, much of the R&D undertaken abroad is meant not to displace domestic R&D, but rather to support overseas business growth.[51]

Growth in R&D funds moving both into and out of the United States has been quite strong for the past decade or so. On average, U.S. overseas R&D investments grew by 5.3 percent per year between 1977 and 1989 (in constant dollars). This rate was slightly below that for growth in total U.S. industry R&D funding—5.7 percent annually. And since 1985, the overseas R&D component has grown at six times the rate of industry's domestic funding (11.9 versus 2.1 percent per year): R&D abroad is now equivalent to 9 percent of industry's onshore R&D expenditures. (See figure 4-16.) U.S companies and their foreign subsidiaries in the motor vehicles, machinery (including computers), and drug industries account for the largest shares of this foreign-based R&D activity. Together, they comprised 58 percent of the 1989 overseas performance total. (See appendix table 4-31.) Time series data are not available on which countries receive this U.S. R&D investment.[55]

About $6.3 billion was spent on R&D abroad by U.S. companies in 1988. Foreign companies spent about 17 percent more ($7.4 billion) on R&D in the United States. From 1977 to 1988, growth in this foreign-sourced R&D investment averaged 14 percent per year, or more than twice the rate of growth in domestic R&D activities by U.S. companies. As a result, foreign R&D was equivalent to 11 percent of all industry's R&D funding in the United States in 1988, up from its equivalent 5-percent share in 1977. (See figure 4-16.) Foreign funding came primarily from Canada, West Germany, and the United Kingdom; although the R&D flows from other European countries and Japan also increased steadily over the past decade. Foreign-funded research was concentrated in the industrial chemicals, drugs, and electrical equipment industries.[56] (See appendix table 4-32.)

Figure 4-16.
**Foreign and U.S. overseas R&D**




See appendix tables 4-31 and 4-32.
*Science & Engineering Indicators – 1991*

[51] Companies consider a myriad of factors before undertaking R&D overseas: Market access and accommodation of local requirements are but two of them. Tax and regulatory policies, as well as the availability of trained researchers and access to new scientific and technological developments in other countries, also influence R&D location decisions. See NSB (forthcoming) and Howells (1990a and 1990b).

[55] See, however, Bloom and Rubinger (1991) for information on U.S. firms' investment in R&D facilities in Japan.

[56] The foreign R&D data reported here come from an annual survey of Foreign Direct Investment in the United States conducted by the Bureau of Economic Analysis. The Bureau reports that the foreign R&D totals are comparable to the U.S. R&D business data published by NSF. Industry-specific comparisons, however, are limited because of differences between the two surveys in industry classifications. (See Quijano 1990.)

# References


Adams, J. 1990. "Fundamental Stocks of Knowledge and Productivity Growth." *Journal of Political Economy* Vol. 98, No. 4 (August): 673-702.

Alexander, A.J., P.T. Hill, and S.J. Bodilly. 1989. *The Defense Department's Support of Industry's Independent Research and Development: Analyses and Evaluation.* R-3649-ACQ. Santa Monica, CA: RAND Corporation.

Baily, M.N., and R.Z. Lawrence. 1990. "The Incentive Effects of the New R&E Tax Credit." Study sponsored by the Council on Research and Technology, unpublished. Washington, DC.

Battelle Memorial Institute. 1990. *Probable Levels of R&D Expenditures in 1991.* Columbus, OH.

Bell Communications Research (Bellcore). 1990. *U.S. Cooperative Research and Development.* SR-ARH-001792. Red Bank, NJ.

Berman, E.M. 1990. "The Economic Impact of Industry-Funded University R&D." *Research Policy* 19: 349-55.

Bloom, J., and D. Rubinger. 1991. *Survey of Direct U.S. Private Capital Investment in Research and Development Facilities in Japan.* NSF 91-312. Washington, DC: National Science Foundation.

Branscomb, L.M. 1989. *Dual-Use Technology: Optimizing Economic Security Interests Through National Technology Policy.* Science, Technology and Public Policy Program Discussion Paper 89-08. Cambridge, MA: Harvard University.

Carter, A. 1989. "Spin-Offs and Spin-Ons: The Relationship Between Civilian and Military R&D and Its Implications for National Security." In *Technology Advances & the Arms Control Agenda* (proceedings of the Fourth Annual American Association for the Advancement of Science Colloquium on Science, Arms Control, and National Security), edited by E.H. Arnett, E.J. Kirk, and W.T. Wander. Washington, DC: AAAS.

Cordes, J.J. 1989. "Tax Incentives and R&D Spending: A Review of the Evidence." *Research Policy* 18: 119-33.

Council of Economic Advisers. 1991. *Economic Report of the President.* Washington, DC: GPO.

Department of Agriculture. 1991. *Program Plan for the National Initiative for Research on Agriculture, Food and Environment.* Washington, DC.

Department of Commerce (DOC). 1989. *The Federal Technology Transfer Act of 1986: The First 2 Years.* Washington, DC.

———. 1991. *The Federal Technology Transfer Act of 1986: The Second 2 Years.* Washington, DC.

Feller, I. 1990. "Universities as Engines of R&D-Based Economic Growth: They Think They Can." *Research Policy* 19: 335-48.

General Accounting Office (GAO). 1989a. *Assessment of Small Business Innovation Research Programs.* GAO/RCED-89-39. Washington, DC.

———. 1989b. *The Research Tax Credit Has Stimulated Some Additional Research Spending.* GAO/GGD-89-114. Washington, DC.

———. 1991. *Diffusing Innovations: Implementing the Technology Transfer Act of 1986.* GAO/PEMD-91-23. Washington, DC.

Holloway, T.M., and J.S. Reeb. 1987. "The Biomedical Research and Development Price Index: Revised and Updated Estimates." Bureau of Economic Analysis Discussion Paper 20. Mimeo. Washington, DC: BEA.

Howells, J. 1990a. "The Globalisation of Research and Development: A New Era of Change?" *Science and Public Policy* Vol. 17, No. 5: 273-86.

———. 1990b. "The Location and Organization of Research and Development: New Horizons." *Research Policy* 19: 133-46.

Internal Revenue Service. *Statistics of Income: Corporation Income Tax Returns Documentation Guide.* Annual series. Washington, DC.

Irvine, J., B.R. Martin, and P.A. Isard. 1990. *Investing in the Future: An International Comparison of Government Funding of Academic and Related Research.* Sussex, England: Science Policy Research Unit.

Jankowski, J.E. Forthcoming. "Do We Need a Price Index for Industrial R&D?" *Research Policy.*

Link, A.N., and L.L. Bauer. 1989. *Cooperative Research in U.S. Manufacturing: Assessing Policy Initiatives and Corporate Strategies.* Lexington, MA: Lexington Books.

Link, A.N., B. Bozeman, and D.P. Leyden. 1990. *Federal and Industrial Innovative Activity.* Report prepared for the National Science Foundation under Grant No. SRS-8822824. Washington, DC: NSF.

Link, A.N., and G. Tassey, eds. 1989. *Cooperative Research and Development: The Industry-University-Government Relationship.* Norwell, MA: Kluwer Academic Publishers.

Malecki, E.J. 1980. "Dimensions of R&D Location in the United States." *Research Policy* 9: 2-22.

Mansfield, E. 1991. "Academic Research and Industrial Innovation." *Research Policy* 20: 1-12.

National Institutes of Health (NIH). 1990. *NIH Data Book 1990.* NIH Pub. No. 90-1261. Bethesda, MD.

National Science Board (NSB). 1989. *Science & Engineering Indicators - 1989.* NSB 89-1. Washington, DC: GPO.

———. Forthcoming. *The Competitive Strength of U.S. Industrial Science and Technology: Filling the Void.* Washington DC: GPO.

Office of Innovation, Research, and Technology, Small Business Administration. 1990. *Small Business Innovation Development Act: Seventh Year Results.* Washington, DC: SBA.

Office of Management and Budget (OMB). 1991. "Enhancing Research and Expanding the Human Frontier." *Budget of the United States Government: Fiscal Year 1992.* Washington, DC: GPO.

Office of Science and Technology Policy (OSTP). Forthcoming. *Science and Technology Report & Outlook.*

Office of Technology Assessment (OTA). 1991. *Federally Funded Research: Decisions for a Decade.* OTA-SET-490. Washington, DC: GPO.

Office of Technology Commercialization, Department of Commerce. 1991. "Research and Development Consortia Registered Under the National Cooperative Research Act of 1984." Unpublished. Washington, DC: DOC.

Organisation for Economic Cooperation and Development (OECD). 1981. *The Measurement of Scientific and Technical Activities: Proposed Standard Practice for Surveys of Research and Experimental Development.* (Frascati Manual: 1980). Paris: OECD.

Osborne, D. 1988. *Laboratories of Democracy.* Cambridge, MA: Harvard Business School Press.

———. 1989. *State Technology Programs: A Preliminary Analysis of Lessons Learned.* Washington, DC: Council of State Policy & Planning Agencies.

Pardey, P.G., B. Craig, and M.L. Hallaway. 1989. "U.S. Agricultural Research Deflators: 1890-1985." *Research Policy* 18: 289-96.

Phelps, P.B., and P.R. Brockman. 1991. *Science and Technology Programs in the States: 1991.* Alexandria, VA: Advanced Development Distribution, Inc.

Pray, C.E., and C. Neumeyer. 1990. "Trends and Composition of Private Food and Agricultural R&D Expenditures in the United States." *Agribusiness* Vol. 6, No. 3: 191-207.

Quijano, A.M. 1990. "A Guide to BEA Statistics on Foreign Direct Investment in the United States." *Survey of Current Business* Vol. 70, No. 2: 29-37. Washington, DC: Bureau of Economic Analysis.

Renshaw, V., E.A. Trott, and H.L. Friedenberg. 1988. "Gross State Product by Industry, 1963-86." *Survey of Current Business* Vol. 68, No. 5: 30-46. Washington, DC: Bureau of Economic Analysis.

Science Resources Studies Division (SRS), National Science Foundation. 1979. *Research and Development in State and Local Governments, Fiscal Year 1977.* NSF 79-327. Washington, DC: NSF.

———. 1989. *Geographic Patterns: R&D in the United States.* NSF 89-317. Washington, DC: NSF.

———. 1990a. *Federal R&D Funding by Budget Function, Fiscal Years 1989-91.* NSF 90-311. Washington, DC: NSF.

———. 1990b. *National Patterns of R&D Resources: 1990, Final Report.* NSF 90-316. Washington, DC: NSF.

———. 1990c. *Research and Development Expenditures of State Government Agencies: Fiscal Years 1987 and 1988.* NSF 90-309. Washington, DC: NSF.

———. 1991a. *Academic Science/Engineering: R&D Expenditures, Fiscal Year 1989.* NSF 90-321 Final. Washington, DC: NSF.

———. 1991b. *Federal Funds for Research and Development: Fiscal Years 1989, 1990, and 1991.* NSF 90-327 Final. Washington, DC: NSF.

———. 1991c. *International Science and Technology Data Update: 1991.* NSF 91-309. Washington, DC: NSF.

———. 1991d. *Research and Development in Industry 1989.* NSF 91-302. Washington, DC: NSF.

———. 1991e. "Two-Year Decline Expected in Real R&D Spending." SRS Data Brief No. 1. Washington, DC: NSF.

Siboni, R.S., and I.R. McCook. 1990. "The Research and Experimentation Credit and Software Development: A Confusing Past, an Uncertain Future." *TAXES-The Tax Magazine* September: 651-63.

Sveikauskas, L. 1989. *The Impact of Research and Development on Productivity Growth.* Bulletin 2331. Washington, DC: Office of Productivity and Technology, Bureau of Labor Statistics.

Webre, P. 1990. *Using R&D Consortia for Commercial Innovation: SEMATECH, X-ray Lithography, and High-Resolution Systems.* Washington, DC: Congressional Budget Office.

Winston, J.D. 1985. *Defense-Related Independent Research and Development in Industry.* Q125 U.S. D1. Washington, DC: Congressional Research Service.

# Chapter 5
# Academic Research and Development: Financial Resources, Personnel, and Outputs

## CONTENTS

# Academic Research and Development: Financial Resources, Personnel, and Outputs

## HIGHLIGHTS

### Funding for Academic R&D

- **The 1980s saw a continuation of a trend, observed over the last several decades, toward an increasing role for academic performers in total U.S. research and development (R&D).** From 1981 to 1991, real growth (in constant 1982 dollars) in academic R&D expenditures averaged 5.5 percent annually. In current dollars, funding over the period rose from just below $7 billion to an estimated $17 billion, increasing from a 9.5-percent share to an 11.3-percent share of total U.S. R&D expenditures. *See p. 116.*
- **Much of this R&D growth occurred between 1985 and 1991 when growth was much stronger for the academic sector than for any other performing sector,** an estimated 44 percent, compared to about 11 percent for federally funded research and development centers and other nonprofit laboratories, 4 percent for industrial laboratories, and about 3 percent for Federal laboratories. *See p. 116.*
- **The Federal share of academic R&D support has continued to decline as industrial and internal university support have been growing more rapidly than that of the Federal Government in recent years.** In 1991, Federal sources provided an estimated 56 percent of academic R&D support, down from 69 percent in 1971. In constant dollars, however, academic R&D financed by Federal support increased by 77.5 percent during this 20-year period. *See p. 117.*
- **After the Federal Government, academic institutions that performed the R&D provided the second largest share of academic R&D support.** From 1971 to 1991, the institutional share grew from 11 percent to an estimated 20 percent of academic R&D expenditures. *See p. 117.*

### Facilities and Instrumentation

- **The country's research universities have undertaken large increases in investment in academic R&D facilities and instrumentation during the 1980s.** Total capital expenditures for academic science and engineering (S&E) facilities (plant and fixed equipment) increased during the 1980s at an average annual rate of 6.6 percent in constant 1982 dollars. Expenditures for academic research instrumentation have averaged 9.6 percent annual growth for Federal support and 11.3 percent for non-Federal support since 1983 in constant dollars. The number of instruments available for R&D more than doubled between 1982/3 and 1988/9. *See pp. 121-22.*

### The Spreading Base and Geographic Distribution of Academic R&D

- **During the 1980s, a growing number of academic institutions have become major research performers, as evidenced by their sustained volume of real research expenditures.** In 1980, 277 academic institutions reported total R&D spending of at least $1 million (in constant 1988 dollars) in 1,162 of their S&E fields; by 1989, these same institutions reported such volume for 1,575 of their S&E fields. *See p. 124.*
- **Continuing a trend that was evident in the 1970s, the 1980s witnessed a slow but marked shift in the distribution of academic R&D toward the Sun Belt and away from the North, East, and—to a lesser degree—West. The South's share rose to 29 percent** from 26 percent in the early 1980s and 23 percent a decade earlier. Similar patterns exist for Federal and non-Federal R&D funds, and for most major fields. *See p. 124.*

### Characteristics of Doctoral Researchers in Academic R&D

- **During the 1980s, the number of academic doctoral researchers increased more rapidly than their total academic employment in every major field.** Total employment increased by 32 percent, from 153,220 in 1979 to 202,208 in 1989. The number with primary responsibility for teaching increased by 25 percent (82,643 to 103,115), while those with primary research responsibility rose by 60 percent (48,517 to 77,455). Concurrently, doctoral scientists and engineers reporting that R&D was their primary *or* secondary responsibility rose by 54 percent, from 100,562 in 1979 to 154,860 in 1989. *See p. 125.*
- **As a group, academic researchers are aging.** In 1973, only 25 percent of academic researchers had earned their Ph.D. degrees more than 15 years earlier; this fraction was 45 percent by 1989. The increasing age of academic researchers tends to reflect both the rising average age of doctoral academics in general and low academic hiring levels. *See p. 128.*
- **Each new cohort of Ph.D.-holders hired into academia tends to be more active in research than the preceding ones and to stay more active through the years.** Between 1979 and 1989, the proportion of all academic doctoral scientists and engineers whose primary or secondary work activity was research rose from 67 to 78 percent. *See p. 128.*

### Women and Minorities in Academic R&D

- **The number of doctoral women in academic R&D more than doubled between 1979 and 1989,** increasing faster than either the number of S&E Ph.D. degrees awarded to females or women's overall academic employment. Women in 1989 represented 17 percent of all academic researchers; almost half of female researchers were active in the life sciences. *See p. 126.*

- **Since 1979, increases in research participation for minorities have been stronger than for whites.** But the overall number of minority researchers—particularly of blacks, Hispanics, and Native Americans—remains very low. In 1989, minorities constituted 13 percent of academic doctoral S&E researchers; nearly three-quarters of these were Asians. *See p. 127.*

### Support of Academic Research Personnel

- **Despite a decline in the Federal share of academic R&D funding over the past decade, a rising proportion of academic researchers received at least some support from Federal sources:** 53 percent in 1979 versus 59 percent in 1989. Increases were evident for all age groups and most major fields. *See p. 129.*

- **In 1989, a record proportion—28 percent—of the growing number of full-time S&E graduate students were supported by research assistantships.** During the eighties, the number of graduate students for whom this mechanism was the primary source of support rose by 60 percent. *See p. 130.*

### Outputs of Academic R&D: Scientific Publications and Patents

- **U.S.-based authors continue to account for 36 percent of all publications in a set of about 3,200 major U.S. and international technical journals.** This percentage remained steady through the 1980s. *See pp. 129-30.*

- **Patenting by U.S. universities increased sharply in the 1980s.** More than one-fifth of all patents issued to academic institutions since 1969 were awarded in 1989-90. The 100 major research universities accounted for an increasing share of these patents. *See pp. 130-31.*

## Introduction

### Chapter Focus

Academic research and development (R&D) is an integral part of the national R&D enterprise. The sector now accounts for an estimated 11.3 percent of national R&D expenditures and almost half of national basic research expenditures. Moreover, the 155,000 doctoral scientists and engineers engaged in academic R&D activities in 1989 comprised almost a third of the U.S. doctoral science and engineering (S&E) workforce.

This chapter addresses the following three principal aspects of academic R&D:

- *Financial resources*—sources of funding, distribution among institutions and disciplines, the Federal Government's funding role, the financing of academic R&D facilities and instrumentation, the spreading base of academic R&D, and its geographic distribution;

- *Doctoral personnel*—characteristics of doctorate-level scientists and engineers employed by academic institutions; and

- *Research outputs*—the academic sector's publications and patents.

### Chapter Organization

The chapter opens with a discussion of trends in financial resources provided for academic R&D, including allocation across both institutions and fields, and of the changing importance of various key sources of financial support. Since the Federal Government has been the primary source of support for academic R&D for over half a century, its role is explored in greater detail. New this year is a discussion of the key Federal funding agency for each S&E field and how the importance of that agency to the field has changed over time. Also new this year is a discussion of the indirect cost component of the academic R&D budget based on National Science Foundation (NSF) and National Institutes of Health (NIH) data. The section also includes data on funding trends for two key elements of university infrastructure—facilities and instrumentation.

For the first time in the *Science & Engineering Indicators* series, data are presented about the expansion of the institutional base in which academic R&D is housed: the number of institutions, divisions, and departments that are active in R&D and their funding levels.

The second section of the chapter covers the academic R&D workforce and is limited primarily to scientists and engineers with doctoral degrees, since they are the major participants in academic R&D. (Also, very little data are available on nondoctoral academic research personnel.) Trends in the growth of various disciplines and in the numbers of women and minorities in academic R&D fields are addressed. The chapter presents new information about the changing age structure of academic researchers, the trend toward increased research participation in academia, and the extent of Federal support provided to academic doctoral researchers. Also included is a brief discussion of the number of graduate students involved as research assistants in academic R&D.

The chapter's final section discusses the outputs of academic R&D, specifically the publications in scientific and engineering journals and the patents issued to U.S. universities.

## Financial Resources for Academic R&D[1]

This section focuses on the levels and sources of support for R&D activities at U.S. universities and colleges. Beginning with an examination of the role of academic R&D in the context of the national R&D system, it covers R&D funding patterns in terms of funding sources and their distribution among academic institutions and across S&E fields. The role of the Federal Government in supporting R&D at universities and colleges is explored in some detail, including the support provided by certain key agencies to both overall academic R&D and specific S&E fields. Support for academic R&D facilities and instrumentation, particularly the levels of investment made in these during the 1980s, is examined, as are the spreading base and geographic distribution of academic R&D.

Additionally, two highly topical subjects related to the main discussion—Federal reimbursement of indirect costs and the Congressional earmarking of R&D funds—are covered in this section.

### Academic R&D in a National Context[2]

In 1991, an estimated $17.2 billion was spent for R&D at U.S. academic institutions.[3] (See figure 5-1.) This level of expenditure represents a continuing trend, observed over the last several decades, of an increasing role for academic performers in total U.S. R&D. Academic R&D in 1991 made up 11.3 percent of total R&D, compared with 9.4 percent in 1971. During the 1971-91 period, research performed in academic institutions rose from 25.4 percent to an estimated 27.7 percent of total U.S. research expenditures.

In constant 1982 dollars, academic R&D increased an estimated 74.2 percent between 1980 and 1991. R&D growth between 1985 and 1991 was much stronger for the academic sector than for any other performing sector—an estimated 44 percent—compared to about 11 percent for federally funded research and development centers (FFRDCs) and other nonprofit laboratories, 4 percent for industrial laboratories, and about 3 percent for Federal laboratories. However, the rate of growth for academic R&D from 1990 to 1991 is estimated at 2.9 percent, down from the estimated 5.4-percent annual growth rate from 1980 to 1990. As a proportion of the gross national product (GNP), the academic R&D share rose significantly over the past decade, from 0.23 to 0.31 percent.

Academic R&D activities are concentrated at the research (basic and applied) end of the R&D spectrum and include very little development activity.[4] Of 1991 academic R&D expenditures, an estimated 65 percent went for basic research, 30 percent for applied research, and 5 percent for development. (See figure 5-1.)

---

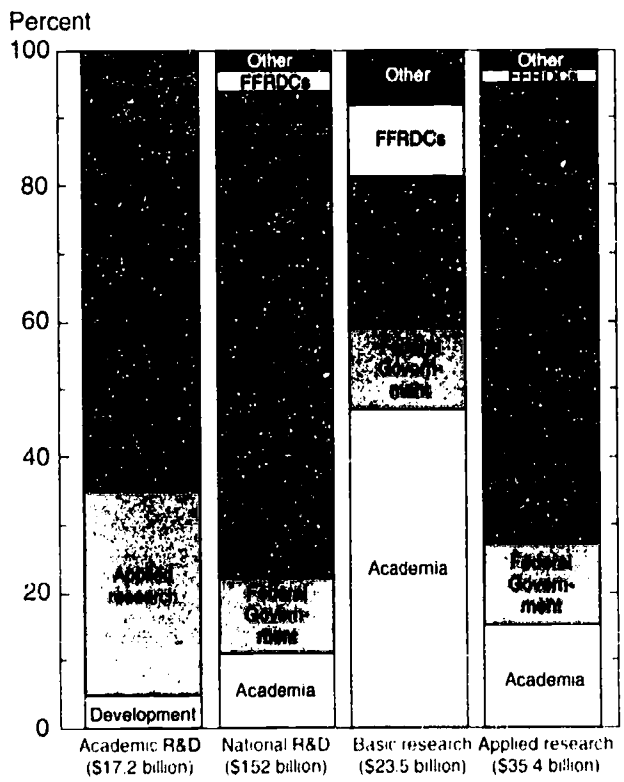
[1] Data in this section come from several different NSF surveys that do not always use comparable definitions or survey methodologies. The three main surveys concerned with academic R&D are (1) the Federal Funds for Research and Development Survey; (2) the Federal Support to Universities, Colleges, and Selected Nonprofit Institutions Survey; and (3) the Scientific and Engineering Expenditures at Universities and Colleges Survey. The results from this last survey, based on data obtained directly from the universities and colleges, do not generally match the data from the other two surveys. For descriptions of the methodologies of these and selected other NSF surveys, see SRS (1987).

[2] This discussion is based on data in SRS (1990c) and unpublished tabulations. For more information on national R&D expenditures, see chapter 4, "National R&D Spending Patterns," pp. 89-93.

[3] In this section, academic institutions generally comprise institutions of higher education that grant doctorates in science or engineering and/or spend at least $50,000 for separately budgeted R&D. Federally funded research and development centers associated with universities are tallied separately and are examined in greater detail in chapter 4.

[4] Notwithstanding this delineation, "R&D"—rather than just "research"—is used throughout this discussion; this is because almost all of the data collected on academic R&D do not differentiate between the "R" and the "D."

Figure 5-1.
**National and academic R&D expenditures, by character of work and performer: 1991**




NOTES: Data are estimates. FFRDCs = federally funded R&D centers.
See appendix tables 5-1 and 5-2.

*Science & Engineering Indicators – 1991*

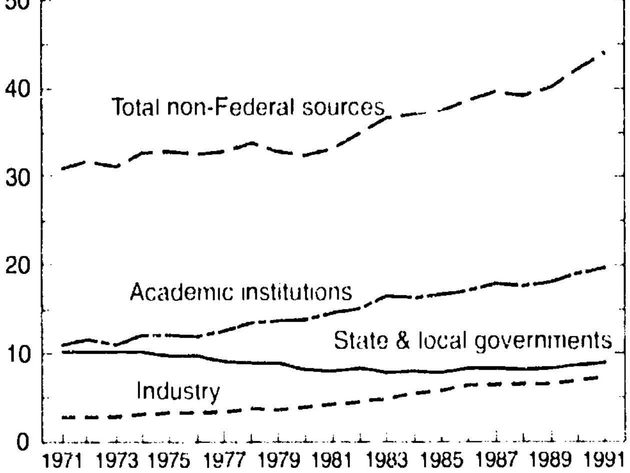
## Sources of Funds

The Federal Government provides the majority of funds for academic R&D, but participation by other sectors has been growing more rapidly than that of the Federal Government in recent years. This circumstance has resulted in a decline in the Federal share of academic R&D. (See figure 5-2.) In 1991 the Federal Government provided an estimated 56 percent of the funding for R&D performed in academic institutions, down from 69 percent in 1971. The academic institutions that performed the R&D provided the second largest share of funds. From 1971 to 1991, the institutional share grew from 11 percent to an estimated 20 percent of academic R&D expenditures.[5] Industry increased its share from 3 percent in 1971 to an estimated 7 percent in 1991, while state and local governments and other sources maintained shares of academic R&D funding ranging from 8 to 9 percent for the former and 6 to 8 percent for the latter throughout the 1980s.[6]

[5] Institutional funds are funds an institution spends on R&D, including unreimbursed indirect costs associated with R&D projects financed by outside organizations and mandatory cost sharing on Federal and other grants. Sources of institutional funds are (1) general-purpose state or local government appropriations, (2) general-purpose grants from industry, (3) tuition and fees, and (4) endowment income. There is some concern that part of the increase in the importance of institutional funds is due to accounting changes.

[6] Other sources of support include grants for R&D from nonprofit organizations and voluntary health agencies as well as all other sources not elsewhere classified.

Figure 5-2.
**Sources of academic R&D funding, by sector**




NOTE: Data for 1990 and 1991 are estimates.

See appendix table 5-2. *Science & Engineering Indicators – 1991*

*Industry funds* for academic R&D grew faster than did funding from any other source during the past two decades. Industry's contribution to academia represented about 1.6 percent of all industry-funded R&D in 1991, compared to 0.7 percent in 1971. The rapid rise in academic *institutions' own R&D funding* increased the ratio of those funds to total institutional operating expenditures from approximately 1.5 percent in 1973 to an estimated 3.0 percent in 1989.

*Private and public universities* differ in their major sources of R&D support. For public academic institutions, about 11 percent of R&D funding in 1989 came from state and local funds and about 23 percent from institutional funds. Private academic institutions received only 2 percent and 9 percent of their funding, respectively, from these sources. (See appendix table 5-3.) Between 1980 and 1989, the Federal share of support declined for both public and private institutions, dropping from 61 to 53 percent for public institutions and from 79 to 73 percent for private institutions. Both public and private institutions received approximately 7 percent of their R&D support from industry in 1989.

## Distribution of R&D Funds Over Academic Institutions

Most academic R&D is concentrated in relatively few of the 3,400 higher education institutions in the United States.[7] In fact, if all such institutions are ranked by their 1989 R&D expenditures, the top 200 ranked institutions account for 96 percent of R&D expenditures. In 1989,

- The top 20 institutions spent 32 percent of total academic R&D funds,
- The top 50 spent 58 percent, and
- The top 100 spent 82 percent.[8]

(See text table 5-1.)

## Academic R&D Expenditures by Field and Funding Source[9]

The distribution of Federal and non-Federal funding of academic R&D in 1989 varied by field. (See appendix

[7] The Carnegie Foundation for the Advancement of Teaching classified 3,400 degree-granting institutions as higher education institutions in 1987. (See chapter 2, "Classification of Academic Institutions," p. 47, for a brief description of the Carnegie categories.) These higher education institutions include 4-year colleges and universities, 2-year community and junior colleges, and specialized schools such as medical and law schools. Not included are more than 7,000 other postsecondary institutions (secretarial schools, auto repair schools, etc.).

[8] These percentages exclude the Applied Physics Laboratory (APL) at Johns Hopkins University. With an estimated $431 million in total and $422 million in federally financed R&D expenditures in fiscal year 1989, APL performs about two-thirds of the R&D at the university. Although not officially classified as an FFRDC, APL essentially functions as one. Its exclusion therefore provides a better measure of the distribution of *academic* R&D dollars and the ranking of individual institutions.

[9] The data in this section are drawn from NSF's Scientific and Engineering Expenditures at Universities and Colleges Survey. Parallel data by field from NSF's Survey of Federal Obligations to Universities and Colleges do not necessarily match these numbers for a variety of methodological reasons.

Text table 5-1.
**Distribution of R&D funds among academic institutions: 1989**

| Rank | Millions of dollars | Percentage of total |
|---|---|---|
| All institutions[1] | 14,556 | 100 |
| Top 10 | 2,606 | 18 |
| Top 20 | 4,612 | 32 |
| Top 50 | 8,484 | 58 |
| Top 100 | 11,901 | 82 |
| Top 200 | 14,023 | 96 |

[1]The Applied Physics Laboratory at Johns Hopkins University, with an estimated $431 million in 1989 R&D expenditures, is not included in these totals.

See appendix table 5-4. *Science & Engineering Indicators – 1991*

table 5-5.) For example, the Federal Government supported 65 percent of academic R&D expenditures in the medical sciences, but only 27 percent of academic R&D in the agricultural sciences. This latter figure reflects the traditionally strong role of states in supporting the agricultural sector.

By far, the majority of academic R&D expenditures in 1989 went to the *life sciences*, which accounted for 54 percent of total academic R&D expenditures, 53 percent of Federal academic R&D expenditures, and 55 percent of non-Federal academic R&D expenditures. The next largest block of total academic R&D expenditures was for *engineering*—16 percent in 1989. (See appendix table 5-5.)

Between 1979 and 1989, academic R&D expenditures for all fields combined grew at an average annual rate of 5.6 percent in constant 1982 dollars. (See figure 5-3 for constant dollar expenditures over the decade by field.) From 1988 to 1989, the rate increased to 6.8 percent. Funding for the *computer sciences* grew fastest during the decade, increasing at an average annual rate of 11.4 percent in constant dollars. R&D expenditures for the computer sciences in 1989 were about 3.1 percent of total academic R&D. *Engineering* and the *medical sciences* grew second fastest during the decade, both increasing at an average annual rate of 6.6 percent; for 1988 to 1989, the rates increased to 9.6 and 8.7 percent, respectively.

Academic R&D expenditures in the *social sciences*, which averaged annual decreases of 2.5 percent in constant dollars between 1979 and 1984, show increases since 1984. Between 1984 and 1989, funding for the social sciences increased at an average annual rate of 8.7 percent in constant dollars, with the growth rate for 1988 to 1989 estimated at 10.4 percent.

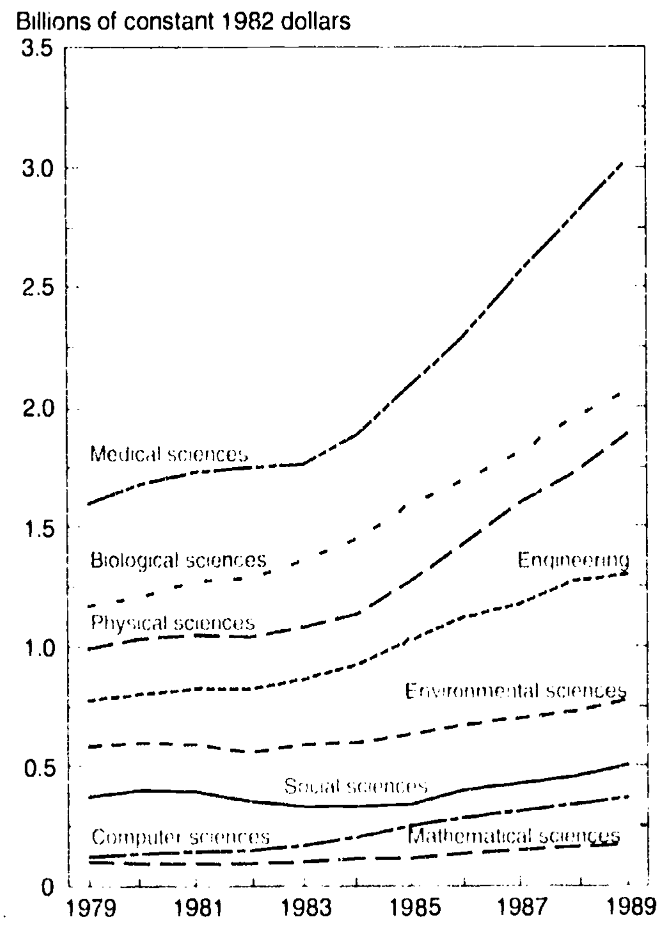
It is noteworthy that the declining Federal share in the support of academic R&D is not limited to specific S&E disciplines. The federally financed fraction of support for each of the S&E fields declined over the past two decades. (See appendix table 5-7.) The most dramatic decline occurred in the social sciences (57 to 33 percent); the smallest decline was in the mathematical and computer sciences (74 to 70 percent). This relative decline also holds for most S&E subfields.

## Support of Academic R&D by Federal Agencies[10]

Federal obligations for academic R&D are concentrated in three agencies: NIH, NSF, and the Department of Defense (DOD). Together, these agencies provided about 75 percent of total Federal financing of academic R&D in 1991, up from 66 percent in 1971. (See appendix table 5-8.) NIH was estimated to have provided 47 percent of Federal support for academic R&D in 1991; the NSF share was estimated at 16 percent. DOD, after increasing its share of Federal support from 9 percent in 1977 to just below 17 percent in 1986, declined to an estimated 12-percent share in 1991. During the 1981-91 period, however, the National Aeronautics and Space Administration (NASA), which is estimated to provide less than 6 percent of Federal support, had the highest estimated average annual growth in its funding of academic R&D, 7.7 percent per year (constant 1982 dollars), followed by NIH (4.0 percent) and NSF (3.6 percent).

[10] See "Congressional Earmarking to Universities and Colleges," p. 119, for a discussion of an issue related to Federal academic R&D support that engenders considerable debate.

Figure 5-3.
**Academic R&D expenditures, by field**




NOTE: See appendix table 4-1 for GNP price deflators used to convert current dollars to constant 1982 dollars.

See appendix table 5-6. *Science & Engineering Indicators – 1991*

## Congressional Earmarking to Universities and Colleges

Academic earmarking—the Congressional practice of providing Federal funds to educational institutions for research facilities or projects without merit-based peer review—is not a new phenomenon. Congress has traditionally earmarked most of the academic research funds from the Department of Agriculture to specific universities and colleges. The lack of an accepted definition for academic earmarking, combined with the difficulty of detecting many earmarked projects because they are either obscured or described vaguely in the legislation providing the funding, makes it difficult to obtain exact figures for either the amount of funds or the number of projects specifically earmarked for universities and colleges.

Despite such problems, several recent efforts have been made to estimate trends in academic earmarking. These estimates indicate that during the past 10 years significant increases have occurred in both the number of earmarked projects and the amount of money directed toward them.

- NSB (1985) reported that between fiscal years (FYs) 1983 and 1985, 15 universities that bypassed the merit review process received over $100 million for research facility construction by appealing directly to Congress. The data showed increases in funding appropriation or authorization from $16.5 to $29.8 to $60.6 million over the 3-year period; the number of projects for which funds were either appropriated or authorized rose from three to four to nine.
- In his recent study of academic earmarking, Savage (1989) defines an earmarked project as "one that would not exist without the intervention of Congress." Using Congressional Research Service estimates for FYs 1980-87 and data collected by the University of California for FYs 1988 and 1989, Savage reports an increase in funds for academic earmarking from about $10 million in 1980 to over $100 million in 1985, to over $200 million in 1989; the number of earmarked projects increased from 7 to 36 to 87 over the same period. These data include earmarks from appropriations bills, supplemental appropriations, and continuing resolutions.
- Cordes (1991) defines earmarking to include (1) projects for which agencies neither requested money nor sponsored merit-based competitions to determine which institutions should get the awards, (2) projects for which an institution had competitively obtained funds in previous years but which would have been discontinued if Congress had not insisted that an award be made, and (3) projects that had been competitively awarded for which Congress had ordered an agency to add a specific amount of money without any review. Based on this definition, Cordes estimated earmarking at about $200 million in FY 1988, slightly under $300 million in both FYs 1989 and 1990, and almost $500 million in FY 1991.
- The Office of Science and Technology Policy (OSTP) recently completed a detailed analysis of earmarking in the 1991 appropriations bills (see OMB 1991a, chapter IV.C, pp. 63-64). In all, 492 earmarks were identified (111 for R&D facilities, 381 for research projects) totaling $810 million($428 million for R&D facilities, $382 million for research projects). These figures, however, are not limited to Congressional earmarking to universities and colleges, but also include earmarks to nonacademic institutions.

***Support by Single Agencies.*** Although the overall dependence of universities and colleges on the Federal Government for their R&D funds has diminished over the past couple of decades, each of the S&E fields has become more dependent on a single agency for its Federal funds than it was in the past. The agency providing the largest share of Federal research funds for each of the seven S&E fields provided a larger fraction of the Federal funds for that field in 1989 than it did in 1971. (See figure 5-4.) This increased reliance on one agency for Federal support also pertains in general to most of the S&E subfields. Only for astronomy, oceanography, the computer sciences, and aerospace engineering did the principal funding agency provide a significantly smaller share of funds in 1989 than during the early(or late) 1970s.

***Indirect Costs.*** One aspect of Federal support of academic R&D that has engendered a great deal of discussion is universities' and colleges' indirect cost recovery from the Federal Government. (See "Indirect Costs of Federally Funded Academic Research," p. 120.) Although indirect cost *rates* at universities and colleges have been increasing during the 1980s, the indirect cost *shares* of the research budgets of NSF and NIH have not increased much, if at all, during this period.[11]

At NSF, the indirect cost share of its academic research budget exhibited a slight decline during this period from a high of 25.3 percent in 1983 to its current level of 24 percent. (See text table 5-2.)

At NIH, from 1983 to 1988 there was a leveling of indirect costs to about 31 percent of the total costs for NIH

[11] Aside from NSF, few Federal agencies keep detailed data breaking down their R&D awards to universities and colleges into separate budget components, including indirect costs. NIH, although it does not keep detailed budgetary data similar to NSF's, does provide information about the proportion of its funds going to indirect costs. See NIH (1990).

### Indirect Costs of Federally Funded Academic Research

Reimbursement of indirect costs, or overhead, as part of the budget for federally funded academic research is a subject that generates considerable discussion among researchers, university administrators, Federal officials, and members of Congress. Indirect costs are all the allowable costs of an academic institution's research that cannot be allocated or directly charged to a research grant or contract. Indirect costs associated with federally funded research at universities and colleges account for several billion dollars of the Federal academic research budget.

There is general agreement that (1) indirect costs are real costs of research and (2) if they were not at least partly recovered, accepting significant amounts of external research funds could put a strain on a university's budget. The Office of Management and Budget's (OMB's) Circular A-21 sets out the rules for specifying the direct and indirect costs of federally funded research and defines the cost pools that may be treated as indirect costs (OMB, 1991b). The circular leaves some flexibility in how various costs may be considered; the variation in schools' indirect cost rates in part reflects that flexibility.

Though administrative overhead costs have been the focal point of concern over rising indirect cost rates, charges for depreciation or use of facilities and equipment were the fastest growing indirect cost component over the last decade. Operation and maintenance costs were the second fastest growing component. One approach might be for these two components to be broken out into a separate indirect cost rate for infrastructure. Growth in such a rate may be easier to explain when it is clearly associated with facilities and equipment for research than when it is submerged in a more loosely defined aggregate.

Many proposals have been offered to contain the growth of indirect cost payments by the Federal Government. These proposals have generally called for limits on either the overall indirect cost rate or on the administrative portions of the rate by setting a uniform rate for all institutions or by setting a ceiling. In May 1991, OMB proposed that reimbursement on Federal research grants for the administrative cost portions of indirect costs be limited to 26 percent of "modified total direct costs." These modified costs are direct costs less equipment costs and subcontracts over a certain size. Similar proposals to cap administrative components of indirect costs have been made before. An interagency task force has been established by OMB to review and revise Circular A-21 in the interests of greater clarity, simplicity, and equity. The task force is expected to conclude its work by the end of 1992.

research grants. The variation during this period was less than half a percentage point. In 1989 the proportion of NIH funds for indirect costs rose slightly to 31.6 percent. Although the NIH indirect cost data are not limited to academic research awards, in 1989 74 percent of NIH's extramural support went to institutions of higher education.

Indirect cost *rates* can rise while the indirect cost *share* of a Federal agency's academic R&D budget can be flat or even falling for such reasons as

- A shift of Federal research funds to institutions with lower indirect cost rates,
- More awards that do not allow the recovery of full indirect costs,
- A larger fraction of dire t research costs that are not included in the "modified direct cost base" used for calculating indirect cost payments, and
- More awards that require cost sharing that take the form of a voluntary waiver of some of the indirect costs.

Without much more detailed data than are currently available, it is difficult to determine the extent to which each of these factors affects the behavior of indirect costs.

## Academic R&D Facilities and Instrumentation[12]

After an extended period of decreased support for academic R&D infrastructure beginning in the late 1960s, the country's research universities invested heavily in

[12] Data on facilities and instrumentation are taken primarily from the following sources:

- SRS (1991b)—as used in this survey report, "facilities" refers to capital investment expenditures for S&E research or instruction at those universities and colleges spending $50,000 or more annually on separately budgeted R&D.
- SRS (1988b) and SRS (1990d)—in these survey reports, "facilities" are physical plant, including infrastructure (power), fixed equipment (benches, fume hoods) and nonfixed equipment costing more than $1 million. Information on R&D space is included.
- SRS (1988a), SRS (1991a), and additional unpublished data and analysis tables.

Although terms are defined specifically in each survey, in general, "facilities expenditures"

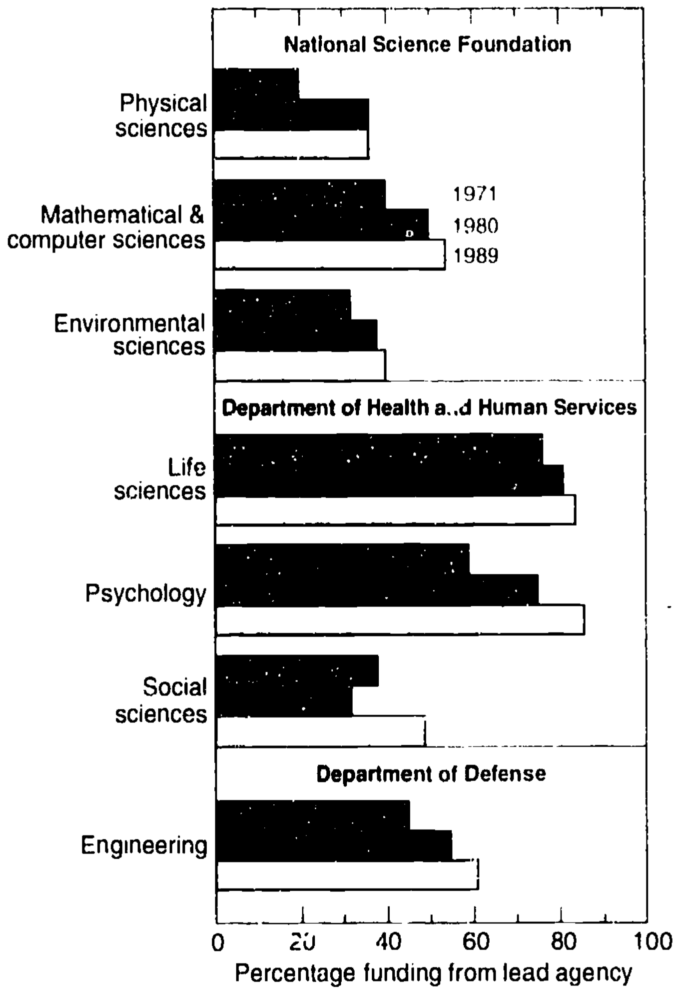
- Are classified as "capital" funds,
- Are fixed items such as buildings,
- Often cost millions of dollars, and
- Are not included within R&D expenditures.

"Equipment" and "instruments" (the terms are used interchangeably) are generally

- Movable,
- Purchased with current funds, and
- Included within R&D expenditures.

Because the categories are not mutually exclusive, some large instrumentation systems could be classified as either facilities or equipment.

Figure 5-4.
**Funding provided by current lead Federal R&D funder, by field**




See appendix table 5-9. *Science & Engineering Indicators – 1991*

academic R&D facilities and instrumentation during the 1980s. Recent surveys of both facilities and instrumentation indicate that these increases in expenditures have begun to address some of the needs in these areas.

***Facilities.*** In addition to the $15 billion that academic institutions spent for separately budgeted R&D activities in 1989, $2.1 billion was disbursed for capital investment in S&E facilities and fixed equipment to be used for R&D and instruction. (See figure 5-5.) In constant dollars, this amount represented an increase of 2.7 percent over 1988—significantly less than the 9.2-percent constant dollar increase that occurred between 1987 and 1988.

Total capital expenditures for academic S&E facilities (plant and fixed equipment) rose during the 1980s at an average annual rate of 6.6 percent in constant 1982 dollars. Among the S&E fields, engineering enjoyed the highest rate of growth in capital expenditures—an average of 12.0 percent annually in constant 1982 dollars since 1980. The physical sciences field was second with 8.3-percent average annual growth between 1980 and 1989. (See appendix table 5-11.) The lowest growth rate was experienced by psychology, which declined at an average annual rate of 7 percent in constant dollars.

Overall, the proportion of capital funds from non-Federal sources has been increasing—from 74 percent in 1972, to 81 percent in 1980, to just over 90 percent in 1989. Non-Federal sources, which include state and local governments, special bonds, donations, and other sources, grew an average of 7.8 percent a year in constant 1982 dollars between 1980 and 1989; concurrently, Federal spending declined at an average annual rate of 0.7 percent.

The survey data indicate that new facilities construction projects are becoming more expensive: in 1986-87, the cost of new academic R&D space in current dollars was $207 per square foot, compared to $231 per square foot in 1988-89, and an estimated $311 per square foot in 1990-91. (See appendix table 5-12.) Construction outlays for academic research facilities are expected to reach $3.5 billion (in current dollars) in 1990-91, up from $2.5 billion in 1988-89 and $2.1 billion in 1986-87.[13]

When the projects initiated between 1986 and 1989 are completed, they are expected to produce over 20 million square feet of new research space—the equivalent of about 19 percent of existing research space. This new research space is not expected to lead to any significant increase in the total amount of research space, however, but rather will replace obsolete or inadequate space. The new construction projects initiated in 1990-91 are expected to produce about 11 million square feet of new research space.

[13] Data are aggregated into 2-year units (1) because some data were only available aggregated for 1988 and 1989 and (2) to increase stability of the estimates. See SRS (1988b) and SRS (1990d).

Text table 5-2.
**Indirect cost share of total costs for National Science Foundation (NSF) and National Institutes of Health (NIH) research grants**

| | NSF | NIH |
|---|---|---|
| | Percent | |
| 1983 | 25.3 | 30.5 |
| 1984 | 24.6 | 31.2 |
| 1985 | 24.2 | 31.3 |
| 1986 | 25.1 | 31.4 |
| 1987 | 24.3 | 31.3 |
| 1988 | 24.4 | 31.2 |
| 1989 | 24.0 | 31.6 |

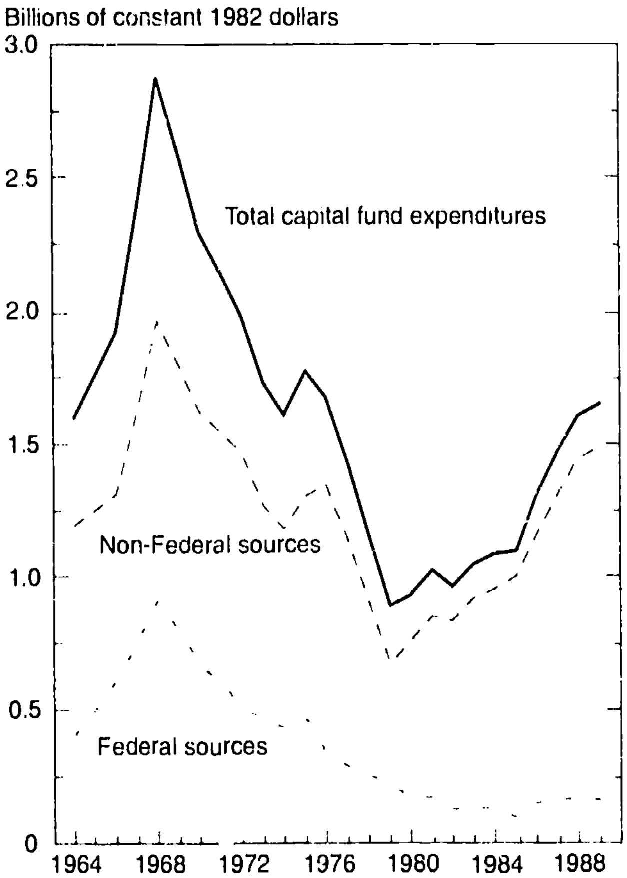
NOTES: NSF data include all academic awards (grants and contracts) from its five research directorates—Biological, Behavioral, and Social Sciences; Computer and Information Science and Engineering; Engineering; Geosciences; and Mathematical and Physical Sciences.

NIH data include all extramural research awards as well as all academic awards. In 1989, 74 percent of NIH's extramural support went to institutions of higher education.

SOURCES: National Science Foundation and National Institutes of Health, unpublished tabulations

*Science & Engineering Indicators – 1991*

Figure 5-5.
**Federal and non-Federal capital fund expenditures for academic science and engineering**




NOTE: See appendix table 4-1 for GNP price deflators used to convert current dollars to constant 1982 dollars.

See appendix table 5-10. *Science & Engineering Indicators – 1991*

More than 85 percent of the current academic research space is concentrated in five S&E fields:

- Biological sciences (22 percent),
- Agricultural sciences (18 percent),
- Medical sciences (17 percent),
- Engineering (15 percent), and
- Physical sciences (14 percent).

Between 40 and 60 percent of the institutions that perform research in these fields reported a need for more research space for work in the discipline. Although the increased facilities funding has been beneficial to the academic research infrastructure, survey results indicate that respondents believe there is still a construction backlog as well as considerable space that needs renovation and repair.

***Instrumentation.***[11] Current fund expenditures for academic research instrumentation have been growing steadily since 1983 in constant dollars.[15] (See appendix table 5-13.) About 60 to 65 percent of these expenditures were covered by the Federal Government during the 1980s. This percentage varied among individual fields, however, with two fields—the agricultural sciences and the social sciences—receiving considerably less than half of their research equipment funds from the Federal Government. Over the decade, Federal support did not grow as quickly as did non-Federal. Annual growth in Federal support averaged 9.6 percent since 1983, while non-Federal support grew 11.3 percent in constant 1982 dollars.

By field, expenditures for instruments for mathematical sciences, engineering, computer sciences, and physical sciences grew fastest, increasing at average annual rates, in constant 1982 dollars, of between 10 and 15 percent since 1983. Funds for research equipment for the social sciences and psychology grew the slowest, averaging less than 5 percent annual growth since 1983. During the last several years, the rapid growth in equipment expenditures of the mid-1980s has abated slightly. The annual growth rate for total R&D equipment expenditures fell from 6 percent in 1987-88 to 4 percent in 1988-89.

From 1981 through 1989, annual research equipment expenditures comprised 6 to 7 percent of total R&D expenditures, with a slight upward trend in this percentage over the decade. Equipment purchases as a percentage of R&D expenditures were consistently higher than average in the computer sciences, physical sciences, and engineering and consistently lower in the mathematical sciences and social sciences.

***Characteristics of Academic R&D Instrumentation.*** Although the data on annual expenditures for research equipment at universities and colleges provide useful information about spending trends, they indicate little, if anything, about other important characteristics of research instrumentation such as cost, adequacy, and age. Congressional concerns expressed during the late 1970s about the adequacy of research equipment in leading research universities pointed up the need for systematic data on the subject. In response, NSF initiated, with NIH sharing in the financial support, a triennial survey—the National Survey of Academic Research Instruments and Instrumentation Needs—to monitor the state of academic research instrumentation.[16]

[11] Data used here are limited to funds for research instrumentation and do not include funds for instructional equipment.

[15] Current funds—as opposed to capital funds—are those in the yearly operating budget for ongoing activities. Generally, academic institutions keep separate accounts for current and capital funds.

[16] To date, three cycles of the instrumentation survey have been completed using similar designs and data gathering methods. The first cycle was conducted in 1983-84, the second in 1986-87, and the third in 1989-90. Each of these cycles was conducted in two phases. During the first phase (1983, 1986, 1989), information was collected for the physical sciences, computer sciences, and engineering. During the second phase (1984, 1987, 1990), information was collected for the agricultural, biological, and environmental sciences, with the biological sciences portion of the survey including a separately selected sample of medical schools in addition to the sample of nonmedical universities and colleges that provided data for all the major S&E fields.

Approximately 38 percent of all instrument systems in use in 1988-89 had been acquired in the previous 3 years, a number almost identical to the 37 percent reported for instruments in use in 1985-86.[17] (See appendix table 5-14.) About 25 percent of instrument systems in use in 1982-83 had been retired from research by 1985-86, and about 27 percent of those in use in 1985-86 that were more than 3 years old had been retired from research by 1988-89. As a result of both retirement of older equipment and an increase in the size of the equipment stock, the age distribution of the research instrumentation changed significantly over the course of the three surveys. In 1982-83, 62 percent of the in-use instrument systems were 5 years old or less, and 38 percent were 6 or more years old. By 1988-89, 69 percent of the systems were 5 years old or less.

The survey data show increases in the number of instruments, the aggregate purchase price of instruments, and the mean price per system. (See appendix table 5-15.) The number of in-use academic R&D instrument systems in the fields surveyed increased by about 50 percent between both the 1982-83 to 1985-86 period (36,300 to 53,390) and the 1985-86 to 1988-89 period (53,390 to 78,950). The aggregate purchase price for these instruments in current dollars increased from $1.30 billion in 1982-83 to $2.04 billion in 1985-86 to $3.18 billion in 1988-89. Adjusted for inflation, these increases represent a real net increase of 44 percent between the first two periods and 51 percent between the last two periods. The mean price per in-use instrument system in current dollars increased from $36,000 in 1982-83 to $38,000 in 1985-86 to $40,000 in 1988-89. When adjusted for inflation, however, the average price per system was essentially unchanged during the entire 1982-83 to 1988-89 period.

During the 6 years of the three survey cycles, annual expenditures for both the purchase of research instruments and for the repair and maintenance of existing research instruments increased. (See text table 5-3.) After adjustment for inflation, expenditures for purchasing new or used equipment increased by 48 percent between 1982-83 and 1985-86 and by 11 percent between 1985-86 and 1988-89. Maintenance and repair expenditures increased by 26 percent during the first period and by only 5 percent during the second period. As a result of these expenditure patterns, for every dollar spent on purchasing research equipment, 25 cents was spent on maintenance and repair in 1982-83, 22 cents in 1985-86, and 21 cents in 1988-89.

Text table 5-3.
**Annual expenditures for research equipment purchases and for maintenance and repair of existing research equipment**

| | 1982-83 | 1985-86 | 1988-89 |
|---|---|---|---|
| | Dollars in millions | | |
| Purchase of nonexpendable research equipment | 400 | 678 | 831 |
| Maintenance/repair of existing research equipment | 101 | 149 | 175 |
| | Cents | | |
| Amount spent on maintenance/repair for each $1 spent on research equipment | 25 | 22 | 21 |

SOURCE: Science Resources Studies Division, National Science Foundation, *Academic Research Equipment and Equipment Needs in Selected Science and Engineering Fields: 1989-90*, NSF 91-311 Washington D.C., 1991, and unpublished tabulations.

*Science & Engineering Indicators – 1991*

The purchase of new equipment during the 1980s appears to have produced beneficial results for many academic departments. Most S&E department heads reported that the overall adequacy of their research equipment either remained about the same (32 percent) or improved (50 percent) over the past 3 years. Over the 6-year period of the surveys, there also was a reduction in the percentages of department heads citing important subject areas where department researchers could not perform critical experiments because necessary equipment was lacking. However, although the proportion decreased from 72 percent in the 1983-84 survey to 62 percent in the 1989-90 survey, it was still well above 50 percent in all fields except the biological sciences.

## The Spreading Base of Academic R&D

The number of institutions in which academic R&D is housed continued to expand during the past decade, as reflected in the R&D expenditure patterns of 277 academic institutions which have been surveyed annually by NSF since 1973; together, they have consistently accounted for more than 90 percent of total academic R&D spending.

Each of 26 S&E fields[18] in each of the 277 institutions was examined over a 10-year period to determine its R&D volume for 1980 through 1989. In 1980, these institutions reported *some* R&D expenditures (no matter how

[17] In all three surveys, information about current equipment needs and priorities was obtained with reference to actual survey year. Information about equipment dollar amounts and expenditures refers to the year preceding the survey. Therefore, the data discussed here for the physical sciences, computer sciences, and engineering were collected for 1982, 1985, and 1988; the data for the agricultural, biological, and environmental sciences were collected for 1983, 1986, and 1989. Data from these surveys are thus referred to as 1982-83 data, 1985-86 data, and 1988-89 data (see SRS 1988a and SRS 1991a). Unless otherwise noted, data are for instruments costing from $10,000 to $1 million.

[18] The 26 fields into which NSF categorizes academic R&D expenditures include

- Six in engineering;
- Four each in the physical, environmental, and life sciences;
- Two in the mathematical and computer sciences;
- Five in the social and behavioral sciences; and
- A category for fields not elsewhere classified, generally referring to interdisciplinary activities.

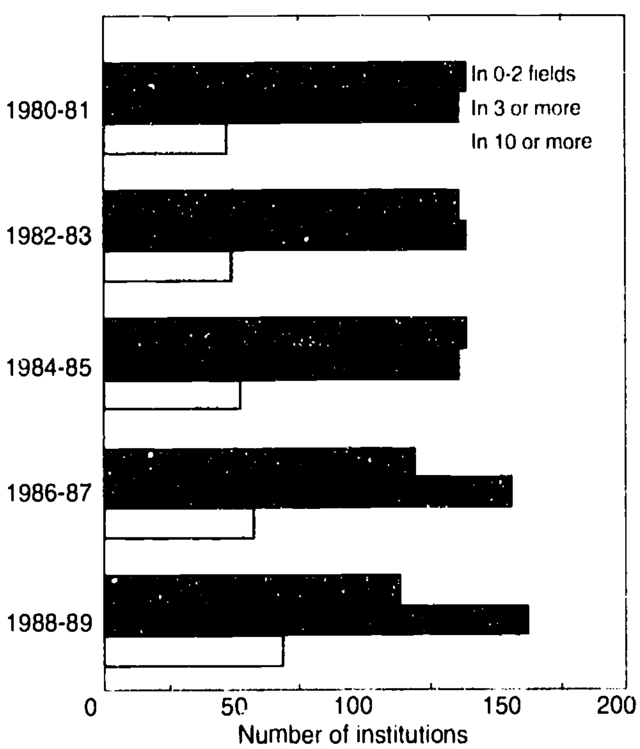
small) in a total of 3,621 fields; by 1989, the number of fields had increased by 2.7 percent to 3,717. (See appendix table 5-16.) Median constant dollar spending rose from $392,000 in 1980 to $683,000 in 1989.

In 1980, the 277 universities and colleges spent at least $1 million (in constant 1988 dollars) for R&D in 1,162 of their S&E fields. By 1989, the number of such fields had increased by 36 percent to 1,575. (See appendix table 5-16.) Viewed another way, just over half of the 277 institutions (144) had fewer than 3 fields in 1980 that exceeded the $1 million spending threshold; by 1989, this number had declined to 114. Conversely, the number with 10 or more fields above $1 million rose from 46 in 1980 to 69 in 1989. (See figure 5-6.)

## Geographic Distribution of Academic R&D

All regions of the country have shared in the growth of academic R&D funds, but not equally so. (See text table 5-4 and figure 5-7.) With new institutions and new departments entering academic R&D, there has been a slow but marked shift in the distribution of academic R&D spending toward the Sun Belt, away from the North, East, and—to a lesser degree—West. The South increased its funding steadily from 23 percent of total in 1973-74 to 26 percent in 1980-81 and 29 percent in 1988-89. (See appendix table 5-18.)

Figure 5-6.
**Academic institutions that exceeded $1 million in separately budgeted R&D, by number of S&E fields**




NOTES: Data represent 26 science and engineering (S&E) fields in 277 institutions. R&D funding reflects constant 1988 dollars.

See appendix table 5-17. *Science & Engineering Indicators – 1991*

The same general pattern can be observed for Federal and non-Federal R&D funds. (See appendix table 5-19.) The South, once the region with the lowest proportion of Federal funding, in 1988-89 was a close third behind the East and West. In non-Federal funding, the North and South tied for the highest share (28 percent) in 1973-74; by 1988-89, the South had by far the largest proportion—34 percent of the total—and was 15 percentage points ahead of the last-ranked West. (See text table 5-4.)

The same pattern—the South gaining in the share of Federal and total R&D Funds—holds for most S&E fields. Exceptions are mathematics and computer sciences and psychology, which lost share in Federal and gained share in non-Federal funds.

# Doctoral Scientists and Engineers Active in Academic R&D

Doctoral academic researchers are those Ph.D.-holding scientists and engineers who are employed by academic institutions and have reported that they are actively engaged in some aspect of R&D (i.e., basic research, applied research, or development).[19] This section

[19]Data on doctoral scientists and engineers are derived from the biennial Survey of Doctorate Recipients conducted for NSF by the National Research Council. In this section, "academic institutions" refer to universities, 4- and 2-year colleges (the latter generally contribute little to R&D activity), and medical schools, as identified by the respondents, but exclude university-managed FFRDCs.

A recent broad assessment of NSF's surveys of scientists and engineers (NRC 1989) has noted certain limitations of the doctorate surveys and has recommended improvements.

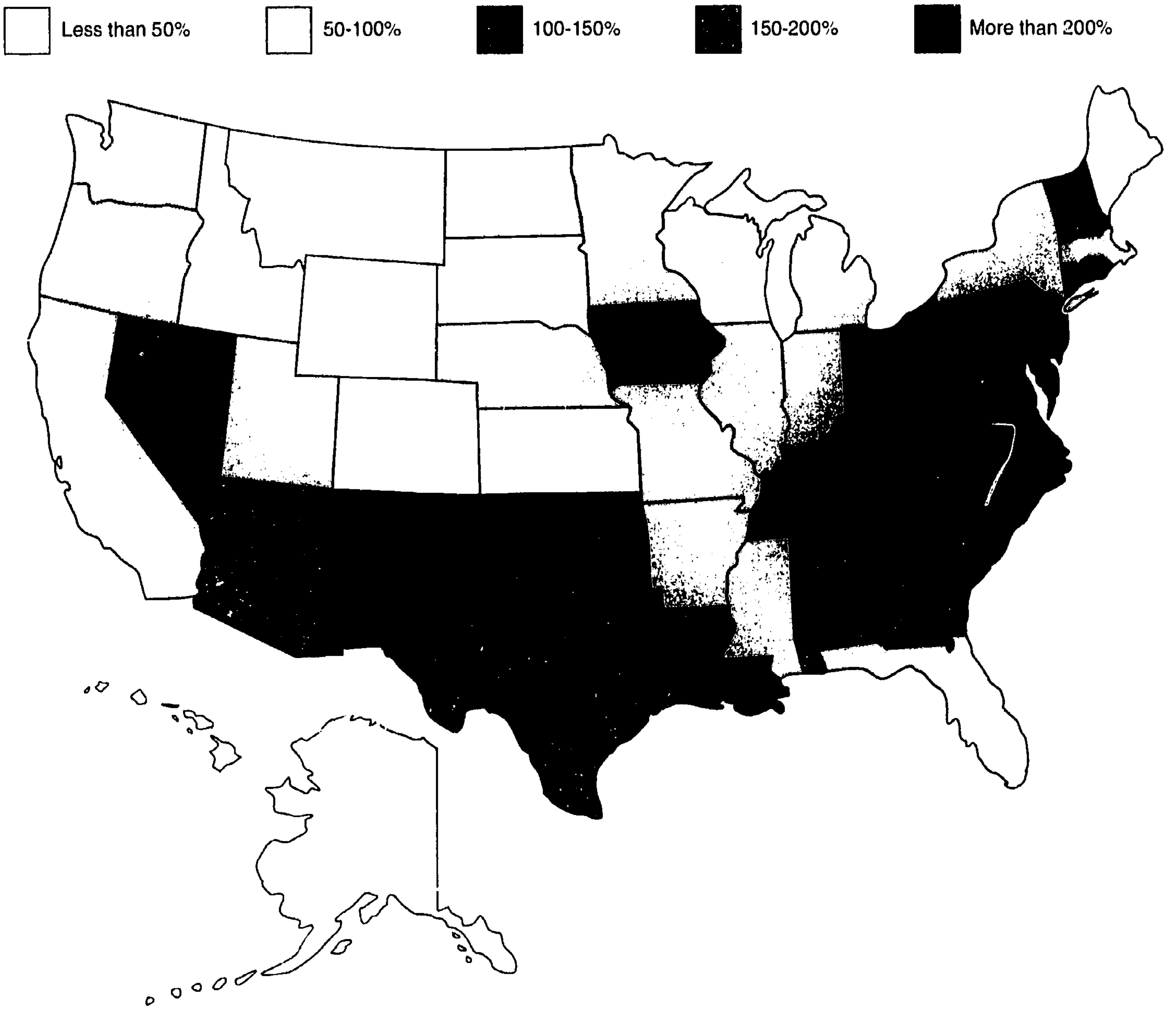
Except for some limited data on graduate research assistants, no data are available on nondoctoral academic research personnel.

Text table 5-4.
**Distribution of academic R&D expenditures, by major region and source of funds**

| | 1973-74 | 1980-81 | 1988-89 |
|---|---|---|---|
| | | Percent | |
| **All sources** | | | |
| East | 28.0 | 26.5 | 26.0 |
| West | 24.3 | 24.8 | 23.1 |
| North | 24.1 | 22.7 | 21.1 |
| South | 23.3 | 25.7 | 29.1 |
| **Federal** | | | |
| East | 29.9 | 29.2 | 28.6 |
| West | 26.7 | 26.7 | 25.7 |
| North | 22.2 | 21.0 | 19.6 |
| South | 21.0 | 22.8 | 25.5 |
| **Non-Federal** | | | |
| East | 24.0 | 21.1 | 22.2 |
| West | 19.1 | 21.0 | 19.3 |
| North | 28.1 | 26.1 | 23.4 |
| South | 28.1 | 31.3 | 34.3 |

See appendix table 5-18. *Science & Engineering Indicators – 1991*

Figure 5-7.
**Real growth in total academic R&D expenditures: 1973/74-1988/89**




See appendix table 5-19.

Science & Engineering Indicators – 1991

focuses on the characteristics of these researchers. Specifically, it presents data on their number, fields of concentration, age, gender, race/ethnicity, and sources of support. Some data are also presented on graduate research assistants supporting academic R&D.

## Number of Academic Researchers[20]

In 1989, there were 484,809 doctoral scientists and engineers, of whom 202,208 were employed in the academic sector (excluding those in FFRDCs managed by universities or university consortia). (See appendix table 5-20.) Of the doctoral scientists in academia, 189,768 held faculty rank, and 12,440 held other positions (e.g., research associate). In all, 154,860 were engaged in academic R&D as defined here, including 77 percent of those with faculty rank and 72 percent of those with other positions.

Over the past decade the academic doctorate-holding S&E workforce has become more ***research-intensive***, as measured by the proportion of those reporting some research activity. Between 1979 and 1989, the number of doctoral scientists and engineers employed in academia increased by 32 percent—from 153,285 to 202,208—but the number of doctoral academic S&E researchers increased by 54 percent—from 100,562 to 154,860. Consequently, the proportion of S&E Ph.D.-holders who reported some research activity rose from 66 percent in 1979 to 77 percent in 1989.

By field, the sharpest ***gain*** over the decade in research activity was experienced by the social sciences. In 1979,

[20]Number of academic researchers was determined based on responses to a survey question on primary and secondary work activity. Researchers are defined as respondents who indicate that research is their primary or secondary responsibility.

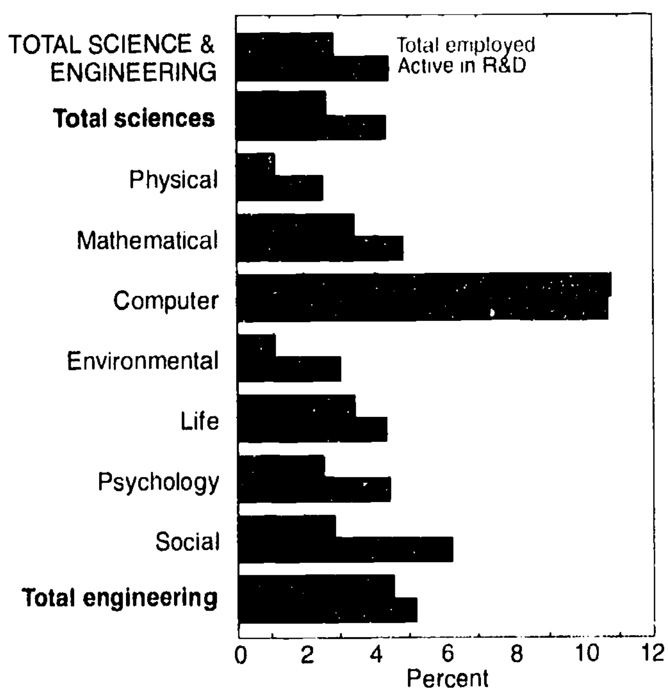
53 percent of all social scientists were involved in research; by 1989, this fraction was 74 percent. The highest *level* of research activity (89 percent) was in the environmental sciences. (See appendix table 5-20.)

## Academic Researchers by Field

The field composition of the academic research workforce underwent some changes in the past decade. Life sciences researchers remained the largest group, maintaining their 36-percent share of the S&E total. The number of researchers in the physical sciences grew more slowly than that in other fields—about 2 percent annually, compared with more than 4 percent for all the sciences and more than 5 percent for engineering. (See figure 5-8.) Consequently, the physical sciences declined from 15.4 percent to 12.8 percent of all investigators. Engineering increased its share of total S&E researchers from 10.6 to 11.5 percent, and the social sciences (which gained Ph.D.-level researchers more rapidly than did any other broad field—see "Number of Academic Researchers," p. 125) increased from a 14.9-percent share to a 17.6-percent share. The greatest increase (176 percent over the decade) was registered for researchers in the computer sciences. This increase was from a small base, however, and the overall computer sciences total still represents less than 3 percent of all academic S&E researchers.

The increase in researchers substantially exceeded the increase in S&E employment in each major field.

Figure 5-8.
**Annual growth rates of employed doctoral scientists and engineers and those active in academic R&D, by field: 1979-89**




NOTE: R&D includes both primary and secondary work responsibility.

See appendix table 5-20. *Science & Engineering Indicators – 1991*

Consequently, between 1979 and 1989 the rate of participation in academic R&D increased in all major fields, rising from 77 to 83 percent for engineering, and from 65 to 76 percent for the sciences. (See appendix table 5-20.)

## Women in Academic R&D

The overall academic employment of women Ph.D.-holders in S&E almost doubled between 1979 and 1989, jumping from 19,196 to 36,610. Over the same period, the number of women active in R&D more than doubled, increasing from 11,192 to 26,746. (See appendix table 5-21.) Because of this high rate of increase—albeit from a relatively small base—by 1989, women represented 17 percent of all academic researchers, up from 11 percent a decade earlier. (See text table 5-5.) The proportion of female researchers remained roughly in line with the increased percentage of female doctoral scientists and engineers in academic employment.

Almost half of all women doctoral researchers were active in the life sciences. Relatively large proportions of women, compared to men, were also found in the social sciences and psychology. These three areas accounted for 83 percent of all women researchers in 1989, compared to 58 percent of all men. (See figure 5-9.)

## Minorities in Academic R&D

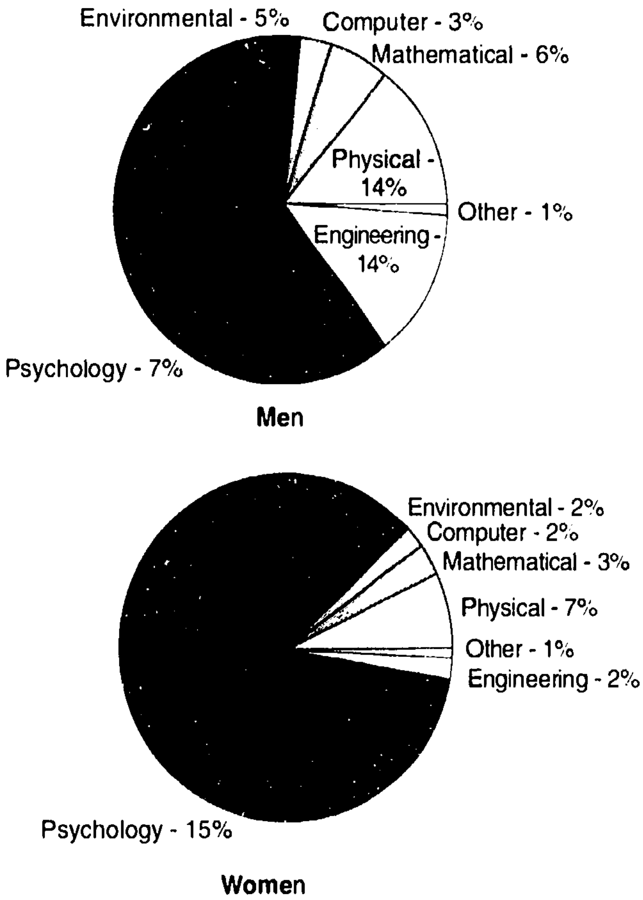
The number of minority Ph.D.-holders—blacks, Asians, Native Americans, and Hispanics—among academic scientists and engineers remained relatively small in 1989 (23,999), as did their number among academic researchers (20,138). (See appendix table 5-21.) Asians continued to predominate among racial/ethnic groups, comprising 68 percent of all minorities employed in academia and 73 percent of the minority researchers.

Text table 5-5.
**Women doctorate-holders in academic employment and in academic R&D, by field**

| | In academic employment | | In academic R&D | |
|---|---|---|---|---|
| | 1979 | 1989 | 1979 | 1989 |
| | Percent | | | |
| Total science and engineering | 12.5 | 18.1 | 11.1 | 17.3 |
| Total sciences | 13.7 | 19.9 | 12.3 | 19.1 |
| Physical sciences | 6.7 | 9.5 | 5.7 | 9.0 |
| Mathematical sciences | 7.4 | 10.1 | 6.1 | 8.8 |
| Computer sciences | 5.1 | 10.3 | 4.7 | 10.7 |
| Environmental sciences | 5.6 | 9.5 | 5.1 | 9.6 |
| Life sciences | 16.1 | 23.8 | 15.3 | 23.1 |
| Psychology | 22.1 | 33.0 | 20.7 | 32.0 |
| Social sciences | 14.4 | 19.7 | 13.2 | 19.8 |
| Total engineering | 1.0 | 2.8 | 1.1 | 3.1 |

See appendix table 5-21. *Science & Engineering Indicators – 1991*

Figure 5-9.
**Distribution of doctoral academic science and engineering researchers, by gender and field: 1989**




See appendix table 5-21. *Science & Engineering Indicators – 1991*

Although the absolute numbers of minority doctorate S&E researchers remained low, particularly for non-Asians, there were much stronger proportional gains over the decade for minorities—regardless of race/ethnicity—than for whites. The increase in minority doctoral employment from 1979 to 1989 exceeded 70 percent; that of researchers exceeded 90 percent. For specific fields, the gains were much greater: environmental sciences, 144 percent; engineering and psychology, 115 percent each; mathematics and computer science, 96 percent. (See text table 5-6.) As a result, minorities in 1989 comprised 11.9 percent of total academic S&E doctorate-holders (up from 9.2 percent in 1979) and 13.1 percent of researchers (up from 10.5 percent a decade earlier).

About one-third of all minority researchers were in the life sciences in 1989; this proportion was similar to that of whites. Otherwise, field concentrations vary by race/ethnicity. (See text table 5-7.) Asians disproportionately favor engineering and the mathematical and computer sciences compared to whites. Blacks and Hispanics disproportionately favor the social sciences. (The numbers for Native Americans in the sample survey are too small to allow for meaningful breakdowns.)

Black and Hispanic Ph.D.-holders experienced substantial percentage increases from 1979 to 1989 in both academic employment and academic R&D. (See text table 5-6.) For both doctoral blacks and Hispanics, the numbers employed in academic positions almost doubled. The numbers involved in R&D increased even more rapidly, rising by 137 percent for blacks and 151 percent for Hispanics. The number of Native Americans remained exceedingly low.

Text table 5-6.
**Percentage change in minority participation in academic R&D and total doctoral employment, by field and race/ethnicity: 1979-89**

| | White | Black | Asian | Native American | Hispanic | All minorities |
|---|---|---|---|---|---|---|
| | | | Percent | | | |
| **Academic R&D employment** | | | | | | |
| Total science and engineering | 49.9 | 137.3 | 79.0 | 46.6 | 150.9 | 91.8 |
| Physical sciences | 24.1 | 225.5 | 29.4 | * | 136.1 | 53.4 |
| Mathematical and computer sciences | 56.5 | 125.5 | 117.8 | * | 145.0 | 123.9 |
| Environmental sciences | 56.0 | * | 110.6 | * | 210.7 | 147.5 |
| Life sciences | 51.7 | 93.8 | 60.0 | 43.5 | 93.3 | 66.9 |
| Psychology | 49.3 | 130.9 | 326.5 | -13.2 | 183.3 | 171.7 |
| Social sciences | 75.9 | 115.1 | 121.4 | 50.8 | 311.1 | 141.9 |
| Engineering | 56.6 | * | 121.8 | * | 173.7 | 130.8 |
| **Total Ph.D. employment** | | | | | | |
| Total science and engineering | 28.3 | 91.7 | 64.8 | 44.9 | 92.8 | 71.8 |
| Physical sciences | 8.4 | 179.2 | 21.5 | * | 50.7 | 35.5 |
| Mathematical and computer sciences | 36.0 | 32.0 | 100.2 | * | 106.8 | 95.6 |
| Environmental sciences | 35.7 | * | 117.6 | * | 171.8 | 143.5 |
| Life sciences | 37.6 | 77.2 | 57.9 | 73.9 | 74.6 | 62.4 |
| Psychology | 25.4 | 87.0 | 115.5 | 15.8 | 285.1 | 114.6 |
| Social sciences | 29.0 | 82.1 | 45.2 | 58.9 | 168.3 | 69.8 |
| Engineering | 47.4 | * | 125.2 | * | 45.7 | 115.4 |

* = too few cases to estimate

See appendix table 5-21. *Science & Engineering Indicators – 1991*

This employment growth among minorities, however, came from small numerical bases. Despite these steep relative increases, only 3,299 black S&E Ph.D.-holders were employed in academia in 1989 (1.6 percent of total, up from 1.1 percent a decade earlier) and only 3,893 Hispanics (1.9 percent, up from 1.3 percent in 1979). Among researchers, corresponding percentages were 1.3 percent for blacks (from 0.9 percent in 1979) and 2.0 percent for Hispanics (1.2 percent in 1979).

## Changing Age Structure of Academic Researchers

The average age of academic researchers increased in the past decade, continuing a trend that began in the early 1970s. The median age of academic researchers rose from 38.7 years in 1973 to 39.7 years in 1979; it was 43.8 years in 1989.

Put another way, in 1973 only 25 percent of academic researchers had earned their Ph.D. degrees more than 15 years earlier; this fraction had risen to 28 percent by 1979 and to 45 percent by 1989. Conversely, "young" researchers (those who had earned their Ph.D. degrees within 7 years of the survey date) comprised 47 percent of the total in 1973, 36 percent in 1979, and only 28 percent in 1989. (See figure 5-10.)

The increase in mean age was most pronounced in the physical sciences and least pronounced in the life sciences. In the physical sciences, the proportion of researchers who had earned their doctorates more than 15 years ago increased from 25 percent in 1973 to 55 percent in 1989. In the life sciences, the change was from 30 percent in 1973 to 41 percent in 1989. (See appendix table 5-22.) The increasing age of academic researchers mirrors (1) the rising average age of doctoral academics in general, due to the large numbers of the Ph.D.-holding scientists and engineers hired during the 1960s and (2) the lower academic hiring levels since the mid-1970s.

## Increased Research Participation

A robust trend, evident over the past decade, shows increasing research participation across all age groups. (See figure 5-11.) Between 1979 and 1989, research participation for all doctoral scientists and engineers rose from 66.5 to 77.7 percent of total. This change was more pronounced for younger Ph.D.-holders, but was not limited to them. (See appendix table 5-23.)

For example, in 1979, 70 percent of all academic scientists and engineers within 7 years of receipt of their Ph.D. degrees were engaged in research. The percentage increased for the subsequent cohorts and reached 88 percent in 1989. This upward trend appears to be sustained as successive Ph.D. cohorts have aged. The rate of research participation declines with increasing age, but this decline was less in recent years than in the past. For example, research participation of those more than 15 years beyond the Ph.D. degree rose from 63 percent in 1979 to 72 percent in 1989. All major fields contributed to this increase. (See appendix table 5-23.)

Text table 5-7.
**Distribution of doctoral academic science and engineering researchers, by field and race/ethnicity: 1989**

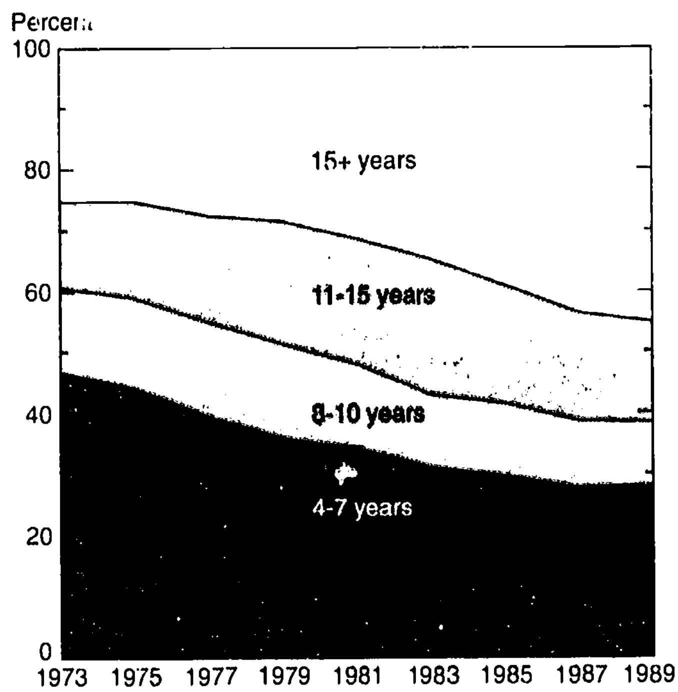
| | White | Black | Asian | Native American | Hispanic |
|---|---|---|---|---|---|
| | Percent | | | | |
| Total science and engineering | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Physical sciences | 12.6 | 14.9 | 13.12 | 2.5 | 13.7 |
| Math/computer sciences | 8.4 | 5.6 | 11.2 | 9.3 | 10.2 |
| Environmental sciences | 4.5 | 1.1 | 2.3 | * | 5.5 |
| Life sciences | 36.4 | 32.1 | 34.5 | 21.9 | 31.9 |
| Psychology | 8.7 | 10.6 | 2.0 | 10.9 | 2.7 |
| Social sciences | 17.9 | 26.3 | 12.4 | 29.5 | 22.3 |
| Engineering | 10.4 | 5.5 | 22.4 | * | 11.5 |

* = too few cases to estimate

SOURCE: Science Resources Studies Division, National Science Foundation, unpublished tabulations.

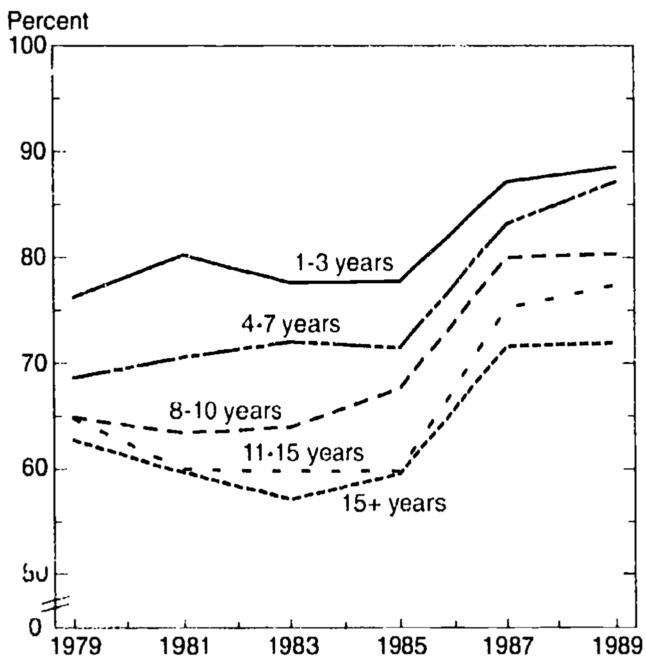
*Science & Engineering Indicators – 1991*

Figure 5-10.
**Age distribution of science and engineering researchers, by years since Ph.D. award**




See appendix table 5-22. *Science & Engineering Indicators – 1991*

Figure 5-11.
**Academic scientists and engineers active in research, by years since Ph.D. award**




See appendix table 5-23. *Science & Engineering Indicators – 1991*

## Federal Support of Academic S&E Researchers

Although the Federal Government's *share* of academic R&D funding has declined from 67 percent in 1979 to about 60 percent in 1989, a rising proportion of all academic researchers reported receiving at least some Federal support for their work. Increases occurred for all age groups and all major fields except the social sciences, which essentially maintained their 1979 level of Federal support. (See figure 5-12.)

The proportion of all S&E academic researchers with Federal Government support increased from 53 percent in 1979 to 59 percent in 1989. (See appendix table 5-24.) Between 65 and 75 percent of researchers in the physical, environmental, and life sciences and in engineering reported funding from a U.S. Government agency. These proportions were up from between 55 and 65 percent in 1979. Although only about 42 percent of those in the mathematical and computer sciences reported such support, this constitutes an increase from 28 percent a decade ago in these fields. The proportion of researchers in the social and behavioral sciences reporting Federal support remained unchanged. (See "Graduate Students in Academic R&D," p. 130, for related information on Federal support of academic researchers.)

## Rising Expenditures per Academic Researcher

Academic R&D expenditures rose by 71 percent between 1979 and 1989. Over the same period, the number of academic doctoral researchers rose 54 percent. Correspondingly, inflation-adjusted spending per academic Ph.D.-level researcher also increased: up by 12 percent, from $82,870 to $92,890. The increased trend in spending per researcher is similar to a rise in education and related spending (in constant dollars) per student.

# Outputs of Academic R&D: Scientific Publications and Patents

The primary output of university research is new knowledge, which is difficult to conceptualize and measure. An imperfect measure of knowledge, publication counts, is reported here; these counts are based on a fixed set of prominent U.S. and foreign journals.[21] Another indicator discussed in this section is patents awarded to U.S. universities.[22]

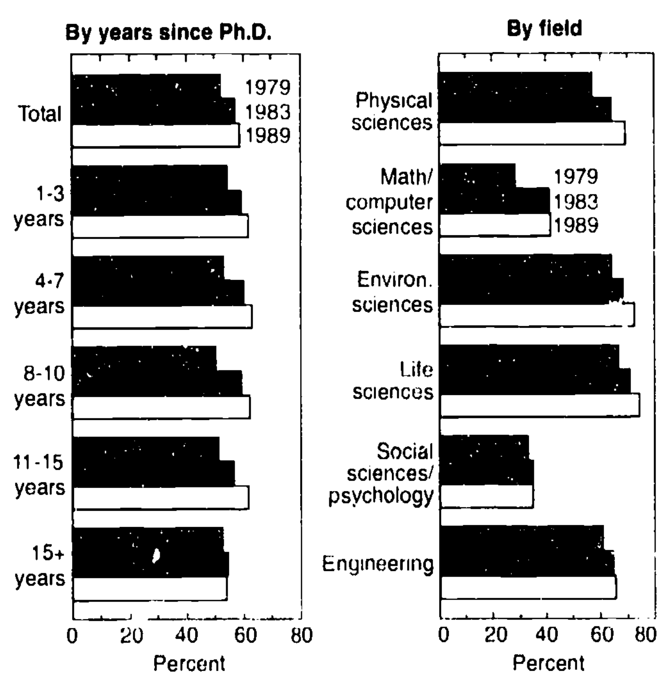
## World Literature in Key Journals

***U.S. Share.*** U.S. academic institutions continue to produce a substantial share of the world's new S&E knowledge. In 1987, publications of authors at U.S. institutions accounted for 36 percent of world publications in

[21] The publication counts data used in this section do not measure total world output volume. Instead, they are based on roughly 3,200 technical journals tracked by the Institute of Scientific Information in Philadelphia. It is unclear what share of the total world S&E publications this set of journals represents. Data before 1981 were based on a smaller set of journals, and discontinuities in some trends at that time probably are due to this change.

[22] See chapter 6, "Patented Inventions," p. 147, for a discussion of the limitations of patents data.

Figure 5-12.
**Academic science and engineering doctoral researchers who reported U.S. Government support**




See appendix table 5-24. *Science & Engineering Indicators – 1991*

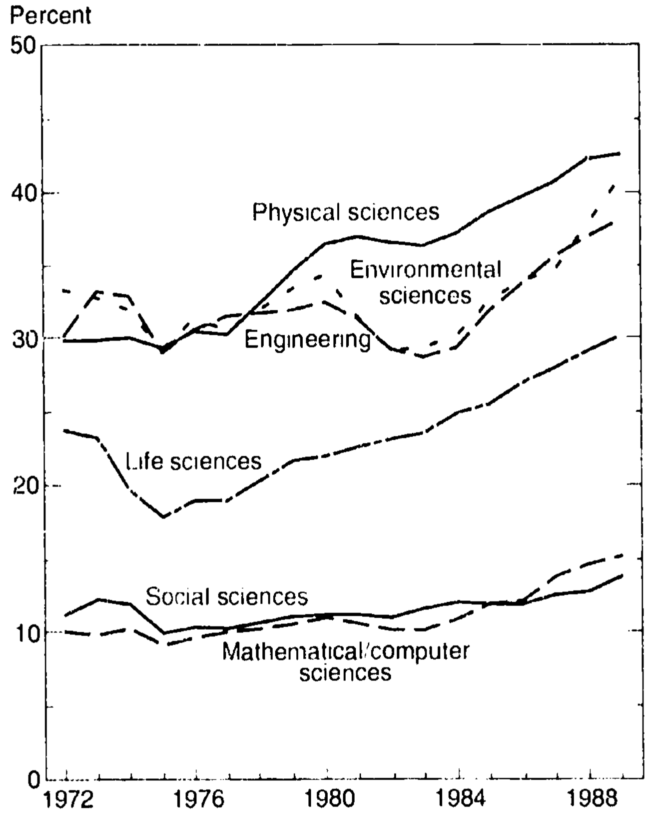
## Graduate Students in Academic R&D

In 1989, a record proportion—28 percent—of the growing number of full-time S&E graduate students was supported by research assistantships. (See figure 5-13.) Between 1979 and 1989, the *total number* of full-time S&E graduate students increased 23 percent (from 233,089 to 286,619) while *the number whose primary source of support* was a research assistantship rose by 61 percent (from 49,118 to 79,151). As a result, the percentage of all full-time S&E graduate students supported by research assistantships increased from 21 percent in 1979 to 28 percent in 1989.

Since 1972, the Federal Government has provided research assistantships to an increasing number—but roughly stable proportion—of all full-time graduate students (about 38,000 or 13 percent in 1989). However, both the number and proportion of non-federally supported research assistantships have increased over the period. This increase was particularly notable during the 1980s: The number of non-federally supported research assistantships increased from 21,000 in 1979 to 41,000 in 1989, or from 9 to 14 percent of all full-time S&E graduate students. (See appendix table 5-25.)

The physical and environmental sciences and engineering have the highest proportions of graduate students with research assistantships (between 38 and 43 percent), followed by the life sciences (30 percent). These four areas also experienced the strongest 1979-89 increases in proportions of students supported. In the mathematical and computer sciences, and in psychology and the social sciences, 20 percent or fewer of graduate students had research assistantships, and increases in the proportions so supported were low. (See appendix table 5-25; for more information on graduate student support, see chapter 2, "Support of S&E Graduate Students," p. 57.)

Figure 5-13.
**Full-time science and engineering graduate students with research assistantships, by field**




NOTE: Data for 1978 are estimated.

See appendix table 5-25. *Science & Engineering Indicators – 1991*

S&E. This figure has been steady since 1981, following a modest decline in the 1970s. (See appendix table 5-26.)

In all fields, the U.S. share of world publications exceeds that of any other country. In 1987, the United States produced

- 22 percent of the world literature in chemistry,
- 30 percent of physics publications, and
- Between 37 and 43 percent of the literature in the other major fields.

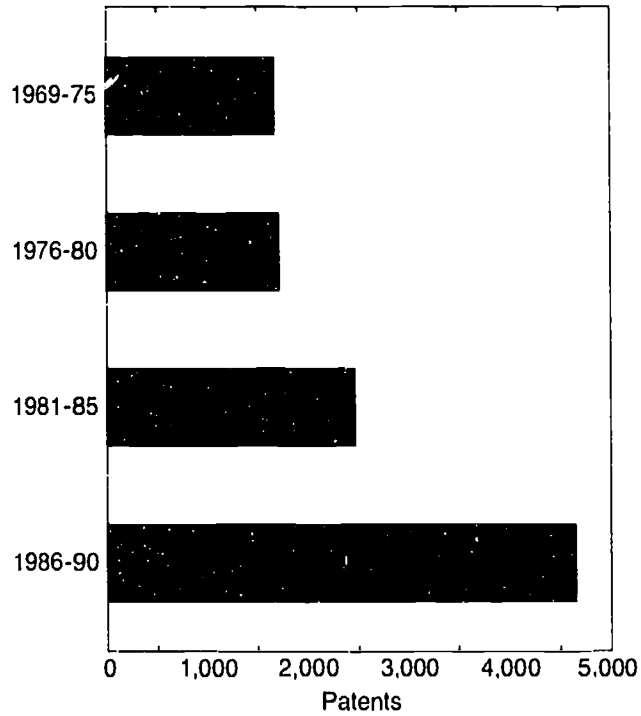
Not all fields have maintained their share of the world's production since 1981, although shifts through 1987 have not exceeded 3 percentage points. Since 1981, the U.S. share of papers in this set of journals has been steady in earth and space sciences; increased in chemistry, physics, and mathematics; and declined in the biomedical and biological sciences and in engineering and technology. (See appendix table 5-26.)

***Foreign Country Shares.*** The United States continues to dominate the publications output in the roughly 3,200 journals covered here. Contributions from U.S.-based authors accounted for 36 percent of the total in 1987; authors in all European Community countries together accounted for another 26 percent. The United Kingdom, West and East Germany (combined), the USSR, and Japan each accounted for 7 to 8 percent; France for 5 percent; and Canada for 4 percent. (See appendix table 5-27 and figure O-18 in Overview.)

### Patents Awarded to U.S. Universities

The recent marked increase in university patenting is an indicator of the expanding role played by academic R&D in technology development. The number of patents awarded to U.S. universities increased sharply during the 1980s compared to the 1970s. (See figure 5-14.) This increase was due in part to a 1980 change in U.S. patent

Figure 5-14.
**Patents granted to U.S. universities and colleges**



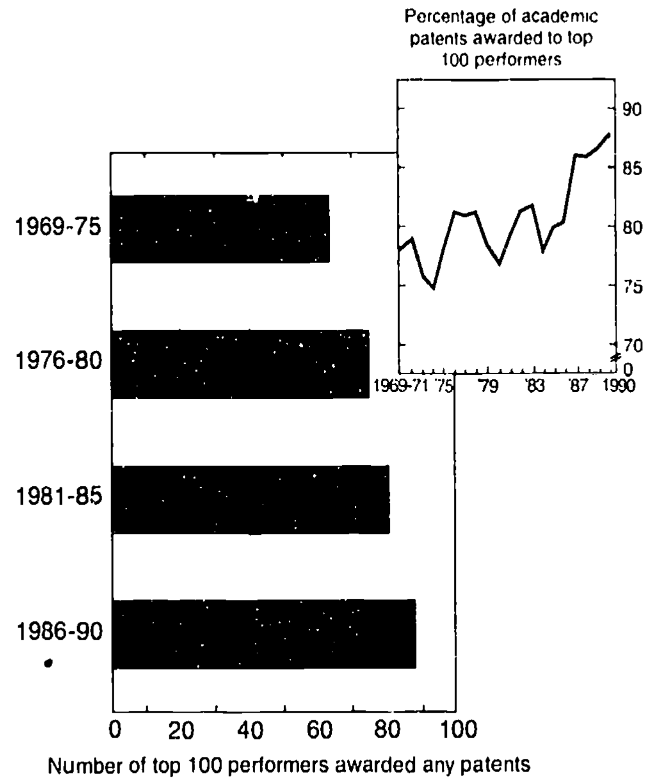

See appendix table 5-28. *Science & Engineering Indicators – 1991*

law that allows academic institutions and small businesses to retain title to inventions resulting from federally supported R&D. In 1990, U.S. universities received 2.4 percent of all U.S. origin patents, up from 1.0 percent a decade earlier.

University patenting increased particularly rapidly during the second half of the 1980s. In fact, 22 percent of all patents issued to U.S. academic institutions since 1969 were awarded in 1989-90. The strongest relative growth occurred in health- and biomedical-related areas, which rose from 12 percent of all academic patents in the early 1970s to 24 percent in the late 1980s. Chemistry (including instruments and processes) also experienced a relative growth spurt, rising from 23 to 30 percent over the same period. Concurrently, areas of electrical- and electronic-related technologies (including data and information processing) dropped from 24 to 16 percent of total academic patents. (See appendix table 5-28.)

The largest research universities account for a large and growing share of all academic patents. Among the 100 largest research universities, only 64 were awarded *any* patents during the 1969-75 period; 89 received patents during 1986-90. (See figure 5-15.) Over the same period, patents awarded to the 100 largest research universities rose from below 75 percent of all academic patents to about 85 percent. (See figure 5-15.)

Figure 5-15.
**Patents awarded to top 100 academic research performers**




NOTE: Data are based on 1987 R&D expenditures.
See appendix table 5-29. *Science & Engineering Indicators – 1991*

## References

Cordes, C. 1991. "Congress Earmarked $493-Million for Specific Universities; Critics Deride Much of the Total as 'Pork Barrel' Spending." *The Chronicle of Higher Education* Vol. 37, No. 24 (27 February): A1, A21-24.

National Institutes of Health (NIH). 1990. *NIH Extramural Trends FY 1980-89.* Washington, DC.

National Research Council (NRC). 1989. *Surveying the Nation's Scientists and Engineers: A Data System for the 1990s.* Washington, DC.

National Science Board (NSB). 1985. *Report of the NSB Committee on Excellence in Science and Engineering.* NSB 85-50. Washington, DC.

Office of Management and Budget (OMB). 1991a. *Budget of the United States Government: Fiscal Year 1992.* Washington, DC: GPO.

———. 1991b. OMB Circular A-21. Washington, DC.

Savage, J. 1989. "The Distribution of Academic Earmarks in the Federal Government's Appropriations Bills, FY 1980-1989." Oakland, CA: Office of the President, University of California.

Science Resources Studies Division (SRS), National Science Foundation. 1987. *A Guide to NSF Science/Engineering Resources Data.* NSF 87-308. Washington, DC: NSF.

———. 1988a. *Academic Research Equipment in Selected Science/Engineering Fields: 1982-83 to 1985-86.* SRS 88-D1. Washington, DC: NSF.

———. 1988b. *Scientific and Engineering Research Facilities at Universities and Colleges: 1988.* NSF 88-320. Washington, DC: NSF.

———. 1990a. *Federal Funds for Research and Development: Detailed Historical Tables, Fiscal Years 1955-1990.* Washington, DC: NSF.

———. 1990b. *Federal Funds for Research and Development: Fiscal Years 1989, 1990, and 1991.* NSF 90-327 Final. Washington, DC: NSF.

———. 1990c. *National Patterns of R&D Resources: 1990, Final Report.* NSF 90-316. Washington, DC: NSF.

———. 1990d. *Science and Engineering Research Facilities at Universities and Colleges: 1990.* NSF 90-318. Washington, DC: NSF.

———. 1991a. *Academic Research Equipment and Equipment Needs in Selected Science/Engineering Fields: 1989-90.* NSF 91-311. Washington, DC: NSF.

———. 1991b. *Academic Science/Engineering: R&D Expenditures, Fiscal Year 1989.* NSF 90-321 Final. Washington, DC: NSF.

———. 1991c. *Federal Support to Universities, Colleges, and Nonprofit Institutions: Fiscal Year 1989.* NSF 91-316. Washington, DC: NSF.

# Chapter 6
# Technology and Global Competitiveness

## CONTENTS

# Technology and Global Competitiveness

## HIGHLIGHTS

### The Global Markets for U.S. Technology

- **During the 1980s, the United States was consistently the leading supplier of high-tech products in the global marketplace.** However, its lead position declined from a 40-percent share in 1980 to a 37-percent share in 1988. Japan and, to a lesser extent, the United Kingdom increased their global market shares during this period. *See p. 136.*
- **The market competitiveness of U.S. high-tech industries varies by industry.** Of the seven industries that form the high-tech grouping, three U.S. industries—those producing scientific instruments, drugs and medicines, and aircraft—gained global market share during the 1980s. Estimates for 1989-90 show only the instruments industry continuing to gain market share. *See p. 137.*
- **Demand for high-tech products in the home markets of all industrialized countries was increasingly met by foreign suppliers during the eighties.** Import penetration of U.S. high-tech markets was deepest in the computer industry. Japan is still the most self-reliant among the major industrialized countries, followed by the United States. *See p. 138.*
- **During the 1980s, the United States maintained a consistent trade surplus in high-tech manufactures and ran consistent deficits in other manufactures.** The size of this surplus is declining, however: The U.S. 1988 trade surplus in high-tech manufactures was half the value of the 1980 trade surplus. *See p. 140.*

### Industrial R&D

- **In all industrialized countries, the industrial sector is the leading performer of R&D.** Except for France, the share of national R&D performed in the industrial sector of these countries grew. Japan and West Germany showed the largest shifts to the industrial sector between 1975 and 1988. *See p. 142.*
- **Private industry is the source of 50 percent of all funds spent for R&D in the United States.** In 1988, Japan and West Germany had considerably larger shares of their national R&D coming from private sources, 70 and 63 percent, respectively. *See p. 143.*
- **U.S. expenditures for industrial R&D nearly tripled during the 1980s in current dollars.** However, the rate of growth slowed considerably during 1984-89. In inflation-adjusted dollars, 1989 industrial R&D expenditures declined for the first time since 1975. Estimates for 1990 and 1991 show this decline continuing. *See p. 143.*
- **During the early 1980s, a renewed emphasis on defense spending led Federal funding of industrial R&D to grow at a faster rate than private funding, reversing the pattern set during the two previous decades.** Since 1987, however, the trend has reverted to the earlier pattern, with private financing again outpacing Federal support. *See p. 144.*
- **Company-financed R&D performed outside the United States increased but at a slower pace than that performed domestically during the first half of the 1980s; it increased at a faster rate during the late eighties.** U.S. chemical and transportation industries had the highest levels of R&D performed overseas. *See p. 146.*

### Patented Inventions

- **The number of U.S. patents granted to Americans has reversed its decline and has been increasing since 1983.** Foreign patenting trends in the United States generally followed the U.S. trend, although the number of foreign-origin patents granted declined somewhat slower during 1976-83 and increased somewhat faster after 1983. *See p. 147.*
- **Foreign patenting in the United States is highly concentrated by country of origin.** Inventors from the European Community and Japan account for 80 percent of all foreign-origin U.S. patents. Newly industrialized countries, in particular Taiwan and South Korea, dramatically increased their patent activity in the United States during the last half of the 1980s. *See p. 147.*
- **The patenting emphases of U.S. and Japanese inventors are reversed for many technology fields.** Japanese inventors patent primarily in photocopying, photography, dynamic information storage and retrieval, television, and motor vehicles. U.S. inventors tend to be least active in these fields, but emphasize biochemistry, petroleum, and communication devices—the first two of which are least emphasized classes for the Japanese. *See p. 150.*
- **Americans actively patent their inventions around the world.** In 1989, countries in which U.S. inventors received more patents than other foreign inventors included Japan, West Germany, the United Kingdom, Mexico, Brazil, and India. *See p. 150.*

### Industrial Use of Technology

- **Seven out of ten U.S. establishments surveyed use at least one advanced technology in their manufacturing operations.** Larger plants and those producing higher priced products are more likely to use advanced technologies. *See p. 154.*

- **The most commonly used advanced technology in U.S. manufacturing is the numerically controlled machine; this is followed closely by computer-aided design and engineering technology.** *See p. 155.*

### Small High-Tech Business

- **High-tech business startups declined sharply in the second half of the 1980s, following tremendous growth during 1975-84.** Companies involved in advanced materials and photonics and optics fields exhibited relative share growth during the latter half of the eighties. *See p. 157.*
- **Over 65 percent of new high-tech companies are located in 10 states.** Yet compared to just 2 years ago, the distribution appears to be leveling off with the top three states—California, Massachusetts, and New York—all experiencing share declines. *See p. 157.*
- **Approximately 11 percent of small high-tech companies are foreign-owned—up from 9 percent 2 years ago.** The United Kingdom is the largest foreign holder of U.S. high-tech companies, followed by Japan and West Germany. *See p. 158.*

### Emerging Technologies

- **A U.S. Government assessment of world leadership in 12 emerging technologies ranks the United States as the leader in 5:** artificial intelligence, biotechnology, high-performance computing, medical devices and diagnostics, and sensor technology; the United States trails Europe and Japan in just one area—digital imaging technology. By 2000, however, the United States is expected to have its leadership position challenged in all five technologies. *See p. 160.*

## Introduction

### Chapter Focus

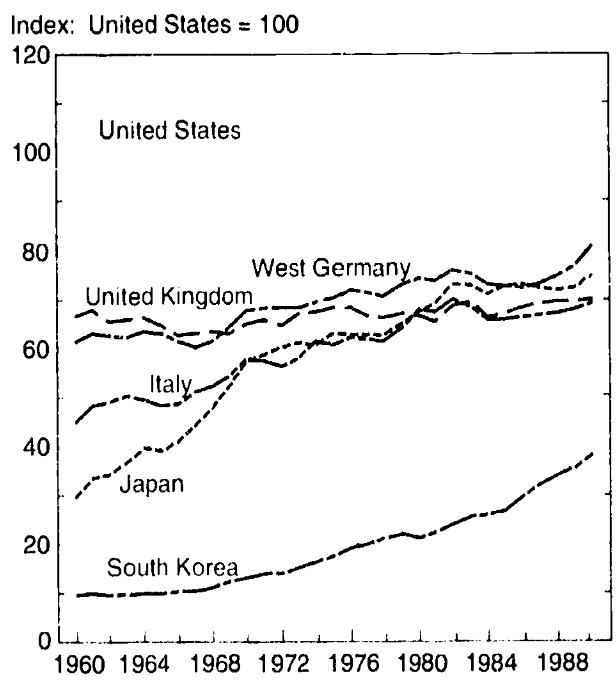
The United States has long been considered a leader in research and development (R&D), technology, and innovation. Standing at the forefront of technology and swiftly incorporating that technology into the country's industrial base contributed to a robust economy that provided Americans an enviable standard of living. (See figure 6-1.)

In the 1980s, however, U.S. leadership of the global economy was challenged as Japan, West Germany, and—more recently—certain newly industrialized countries grew to be equal and increasingly superior competitors in several U.S.-dominated markets. Contributing to the economic success of these nations have been large investments in R&D coupled with the development of an infrastructure that facilitates the incorporation and use of new technologies within their industrial sectors. Competition from the newly industrialized countries is expected to intensify during the 1990s as they increasingly undertake new product development (see Porter and Roessner 1991 and Balk 1991).

The recent U.S. technology policy articulated by the President's Office of Science and Technology Policy emphasizes the connection between a strong science and technology (S&T) base and future economic growth (see OSTP 1990). The development and deployment of new technology within the U.S. industrial sector is seen as "critical" for the United States to prosper in the global competition of the nineties and beyond (see National Critical Technologies Panel 1991). Although there are many other factors that determine a nation's ability to compete in the global marketplace, this chapter focuses on trends in industrial R&D and technology and the market competitiveness of U.S. high-technology products.[1]

[1] As competition in the global marketplace intensifies, the factors influencing a nation's economic competitiveness multiply. Several of these factors include the differing national standards addressing the environment, worker safety, product integrity, and worker compensation. Another such factor of growing concern is the quality of a nation's education system and its ability to train a workforce that can operate the new manufacturing technologies.

Figure 6-1.
**Real gross domestic product per capita**




See appendix table 6-1.

*Science & Engineering Indicators – 1991*

## Chapter Organization

The chapter opens with a discussion of the global competitiveness, in both foreign and domestic markets, of manufactured products that incorporate high levels of R&D. New data on royalties, fees, and technology agreements are used to gauge U.S. competitiveness in terms of intangible (intellectual) property and technological know-how.

The second section describes trends in industrial funding and performance of R&D, focusing particularly on the high-tech manufacturing sector as it compares with other sectors of the U.S. economy. A discussion of patent activity follows which describes trends in U.S. and foreign activity in the United States, technology field and industry, citation rates, and trends in foreign countries. Next, information gained from a new Census Bureau survey is presented on the industrial sector's use of advanced technologies in manufacturing operations.

The role of small business in high-technology industries is explored next, primarily through new information on the technology areas that seem to attract new business formations, generate employment and export activity, and attract foreign capital. Sources of startup funding for small business are also discussed.

The final section looks at the future in light of recent U.S. policy statements that tacitly acknowledge the connections between technology, industry, and U.S. competitiveness. A discussion of the U.S. position in several important technology areas vis-à-vis Japan and Europe is included.

## The Global Markets for U.S. Technology

The market competitiveness of a nation's technological advances, as embodied in new products and processes, can serve as an indicator of the effectiveness of that country's S&T system. The marketplace thereby provides a commercial-based evaluation of a country's science and technology.

In the United States, two parallel developments—the growing import penetration of the U.S. domestic market and the large U.S. trade deficits of recent years—have drawn attention to the country's ability to compete in an increasingly international economy. In particular, the recent erosion of U.S. competitiveness in high-technology product markets has led policymakers to examine the role of the Nation's S&T in supporting and restoring U.S. leadership in the global marketplace.

The fastest growing industries in the United States are predominantly high-tech ones (see ITA 1991, p. 16, tables 4 and 5). High-tech industries generally

- Invest more heavily in manufacturing technology than do other manufacturing industries, and
- Support higher compensation to the production workers employed.[2] (See text table 6-1.)

[2]For more extensive data on average earnings, see BLS (1991) and Hadlock, Hecker, and Gannon (1991).

Consequently, high-tech manufactures have become an important component of the U.S. gross economic output and thereby of the U.S. standard of living.

This section discusses U.S. "competitiveness," broadly defined as the ability of U.S. firms to sell products in the marketplace. The concept of a nation's global competitiveness incorporates both its ability to export and compete against imports in the home market. The analysis in this section relies heavily on data compiled by the Organisation for Economic Cooperation and Development (OECD) and the U.S. Department of Commerce (DOC).[3]

Throughout this section, industry-level data are presented for manufactured goods disaggregated by (1) those industries producing products that embody above average levels of R&D in their development (hereafter referred to as the *high-technology industries*) and (2) all other manufacturing industries.[4]

## The Global Market

The global market for high-tech manufactured goods is growing at a faster rate than that for other manufactured goods. In constant dollar terms (1980), global production by high-tech industries nearly doubled from 1980 to 1988, while production in other manufacturing industries grew by just 16 percent.[5] (See appendix table 6-2.) Output by high-tech industries represented 25

[3]The OECD member countries account for over 75 percent of global exports of manufactured goods and account for an even higher percentage of overall exports of high-technology goods (ITA 1985, p. 43). The 25 countries reporting to OECD are Australia, Austria, Belgium/Luxembourg, Canada, Denmark, Finland, France, Greece, Iceland, Ireland, Italy, Japan, The Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States, West Germany, and Yugoslavia (Yugoslavia participates in OECD with a special status).

Although the OECD data set does not include several nations of increasing importance in technology markets—most notably, the East Asian newly industrialized countries—it does provide a reasonable approximation of global commercial activity.

[4]For purposes of this analysis, the following industries make up the high-tech category (International Standard Industrial Classification—ISIC—codes are in parentheses):

- Industrial chemicals (ISIC 351),
- Drugs and medicines (ISIC 3522),
- Engines and turbines (ISIC 3821),
- Office and computing machinery (ISIC 3825),
- Communication equipment (ISIC 3832),
- Aerospace (ISIC 3845), and
- Scientific instruments (ISIC 385).

The categorization used here is more restrictive than the Department of Commerce's DOC-3 high-technology category which includes "space technologies" and ordnance. See ITA (1983). The other manufacturing category does not include agriculture or services.

[5]The conversion into constant 1980 dollars is done in two steps:

1. Product-specific price changes are removed by deflating the current dollar series for each product category (for all countries) using the price index (1980 = 1.0) for the corresponding industry in Data Resources, Inc./McGraw-Hill's 430-sector inter-industry model of the U.S. economy.
2. All production series for a given country are multiplied by the ratio of the U.S. gross national product deflator to the gross domestic product deflator of that country to adjust for differences in the general rate of inflation.

percent of global production of all manufactured goods in 1988, up from 17 percent in 1980.

During the 1980s, the United States reigned as the leading producer of high-tech products, although its lead was—and continues to be—challenged, primarily by Japanese industry. (See appendix table 6-3.) While the U.S. share of global shipments of high-tech manufactures declined from 40 percent in 1980 to 37 percent in 1988, Japan's market share increased from 18 to 27 percent. Estimates for 1989 and 1990 indicate a continued decline in U.S. market share.[6] European producers (those in the 12 countries of the European Community—EC) also experienced a decline in high-tech global market share during the 1980s. A notable exception among the EC countries was the United Kingdom, which increased its market share slightly during this period. (See figure 6-2.)

In the increasingly competitive environment of the 1980s, the United States, Japan, and Europe moved resources toward the manufacture of higher value, technology-intensive goods and away from more labor-intensive manufactures. In 1988, U.S. high-tech manufactures represented 29 percent of total U.S. production of manufactured output, up from 20 percent in 1980. High-tech manufactures accounted for 21 percent of Europe's total production in 1988, compared with 16 percent in 1980. (See appendix table 6-4.) But the Japanese economy made the greatest leap forward in this respect, virtually pulling even with the United States in 1984 and surpassing it by 1987.

The market competitiveness of individual U.S. high-tech industries varies. (See figure 6-3.) Of the seven

[6]Estimates for 1989 and 1990 were provided by Data Resources, Inc./McGraw-Hill.

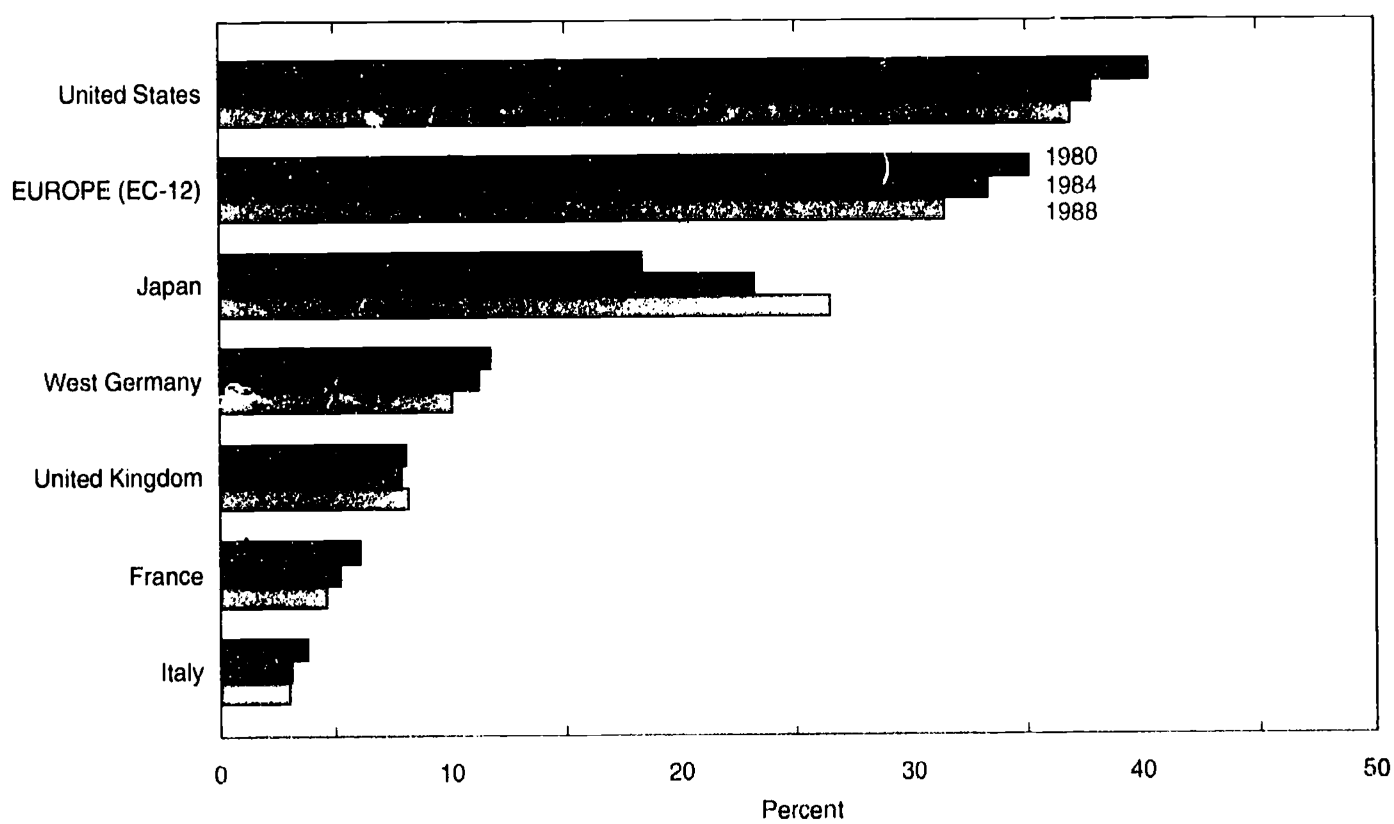
Text table 6-1.
**Capital expenditures and wages, by industry: 1988**

| Industry and SIC code | Capital expenditures per production worker | Average hourly wage |
|---|---|---|
| **High-tech manufacturing** | | |
| Space propulsion, 3764 | $16,642 | $17.25 |
| Aircraft, 3721 | 7,296 | 16.01 |
| Chemicals, 28 | 22,650 | 13.20 |
| Computers, 3571 | 20,581 | 10.75 |
| **Other manufacturing** | | |
| Furniture, 251 | 1,318 | 7.33 |
| Footwear, 314 | 642 | 6.11 |
| Apparel, 23 | 720 | 6.35 |

SOURCE: International Trade Administration, Department of Commerce, *1991 U.S. Industrial Outlook*, (Washington, DC: DOC, 1991).

*Science & Engineering Indicators – 1991*

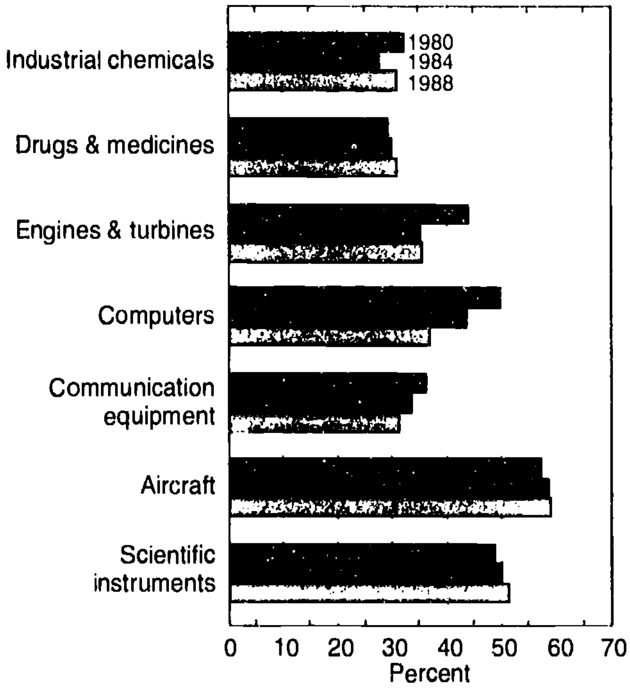
Figure 6-2.
**Country share of global high-tech markets**




See appendix table 6-3.

*Science & Engineering Indicators – 1991*

Figure 6-3.
**U.S. global market share, by high-tech industry**




See appendix table 6-3. *Science & Engineering Indicators – 1991*

industries that form the high-tech grouping, three U.S. industries—those producing scientific instruments, drugs and medicines, and aircraft—gained global market share during the 1980s. Estimates for these same industries for 1989-90 show only one, scientific instruments, continuing to gain global market share. Estimates for the U.S. aircraft industry are far less optimistic; they suggest a loss of market share, primarily to European aircraft producers.

## The Home Market

A country's home market is often thought of as the natural destination for its manufactured output. For obvious reasons—including proximity to the customer and common language, customs, and currency—marketing at home is easier than marketing abroad.

But in today's global marketplace, the most competitive product in terms of price, quality, and ability to satisfy the customer's needs wins the sale—regardless of its origin. Thus, in the absence of prohibitive trade barriers, the intensity of competition faced by domestic producers in their home market can approach and even exceed the level of competition faced in foreign markets. Given the large size and appetite of the U.S. market, examination of U.S. competitiveness at home is critical to an understanding of the country's global competitiveness.

***Import Penetration: High-Tech Markets.*** During the 1980s, demand for high-tech products in the home markets of the major OECD industrialized countries was increasingly met by foreign suppliers. (See figure 6-4.) Imports supplied about 8 percent of U.S. purchases of high-tech products in 1980; by 1988, this percentage had risen to 15 percent. European economies are more heavily dependent on foreign technologies than is the United States. For example, in 1980, imports supplied 29 percent of the United Kingdom's domestic consumption of high-tech manufactures; by 1988, the import share rose to 39 percent. West Germany imported 25 percent of its high-tech product needs in 1980 and 35 percent in 1988.[7]

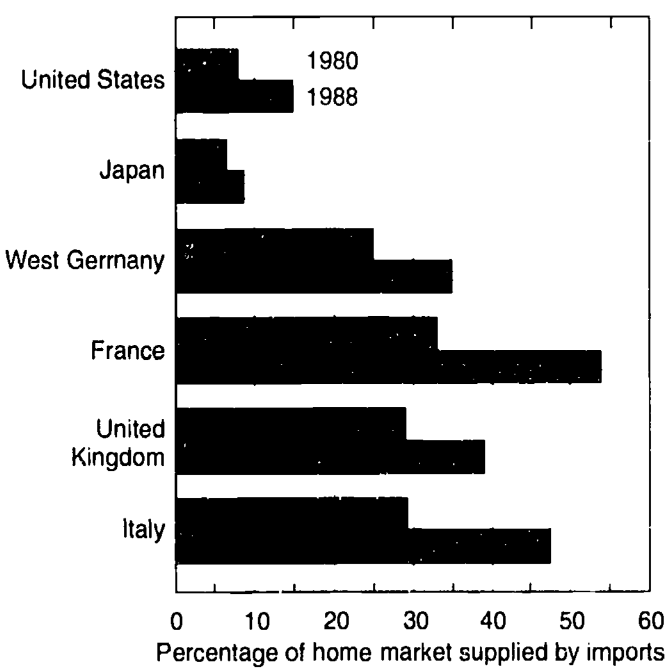
The Japanese home market, historically the most self-reliant, also increased its purchases of foreign technologies during the 1980s—but only during the latter half of the decade. From 1980 to 1985, imports of high-tech manufactures fluctuated around 6.5 percent of Japanese domestic consumption. By 1986, these imports rose to 8.4 percent and to 8.8 percent by 1988. Estimates for 1989 and 1990 suggest a continuation of this upward trend.

***Import Penetration: Japanese and U.S. Home Markets, by Industry.*** Both the U.S. and Japanese domestic markets are becoming increasingly internationalized in all high-tech industries. (See figure 6-5.) For example, during the 1980s, the U.S. computer industry experienced the greatest rate of increase in import competition from other industrialized countries, especially Japan.[8] Foreign suppliers made significant gains in several high-tech industries in Japan; however, these industries tended

[7] Throughout this chapter, data for Germany are for West Germany alone and do not include the former East Germany.

[8] Information on the source of imports is derived from product-level trade data.

Figure 6-4.
**Import penetration of high-tech markets**




See appendix table 6-5. *Science & Engineering Indicators – 1991*

to be product areas in which Japanese industry has yet to assert itself. In fact, the Japanese increase in imports of U.S.-made aircraft and engines may very well be linked to recent Japanese efforts to develop its own aerospace industry (see ITA 1991, p. 22-9).

## Overseas Markets for High-Tech Products

Historically, the United States has not been an economy oriented toward serving foreign markets. The sheer size of the U.S. economy provided the U.S. business community with large markets that supported its operations and typically accommodated most of its growth. In fact, exports account for a smaller proportion of manufacturers' shipments in the United States than in any other industrialized economy. Consequently, in the past U.S. commerce generally had relatively little need or incentive to investigate overseas markets (see Council of Economic Advisers 1989, pp. 234-38). The mounting trade deficits of the 1980s changed this situation, inciting concern about the need to expand U.S. exports.

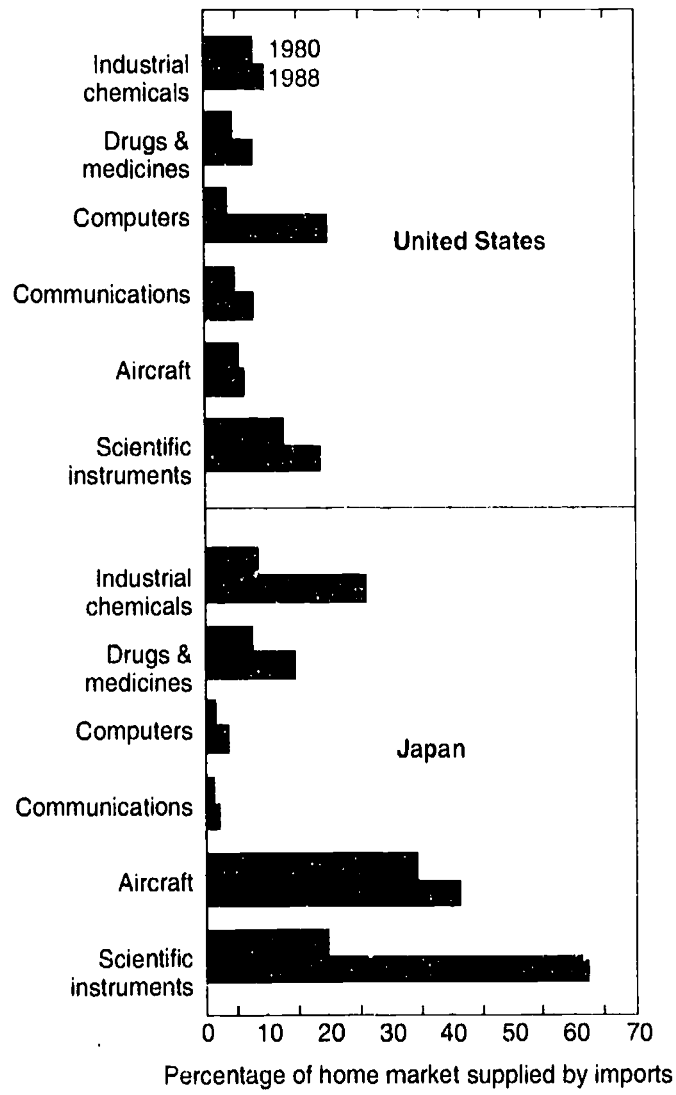
The following discussion examines trends in sales of U.S. high-tech manufactures outside the United States. These trends in U.S. competitiveness are analyzed in two ways. The broader view of U.S. competitiveness outside the United States is given by the U.S. *share of foreign markets*. The discussion of this topic examines U.S. producers' experience in competing against both foreign producers and other countries' domestic producers overseas.[9] The U.S. *share of export markets* is examined next; this measures U.S. producers' experience in competing against foreign producers in foreign markets.

***Foreign Markets.*** Despite their domestic focus, U.S. producers are important suppliers of high-tech products in overseas markets. Still, the 1980s proved to be a challenging time for them, as their share of foreign markets dropped from 10 percent in 1980 to 7.6 percent in 1985. The strength of the U.S. dollar during the early eighties hampered U.S. competitiveness globally. As a consequence, U.S. producers were challenged to be more innovative in improving both product performance and manufacturing efficiency. Better products coupled with a weakening dollar led to a steady rise in foreign market share after 1985 and through at least 1988. (See figure 6-6.)

During the early eighties, other (non-high-tech) U.S. industries experienced a similar loss of foreign market share. Unlike the high-tech industries, they were slower to regain market position. Throughout the 1980-88 period, high-tech industries held twice the foreign market share of other U.S. manufacturing industries.

[9]Foreign market size is calculated by subtracting U.S. apparent consumption of high-tech products from total OECD shipments of same. Foreign market share is differentiated from export market share by adding the *home market shipments* of non-U.S. producers to the denominator.

Figure 6-5.
**Import penetration of high-tech markets: United States and Japan**

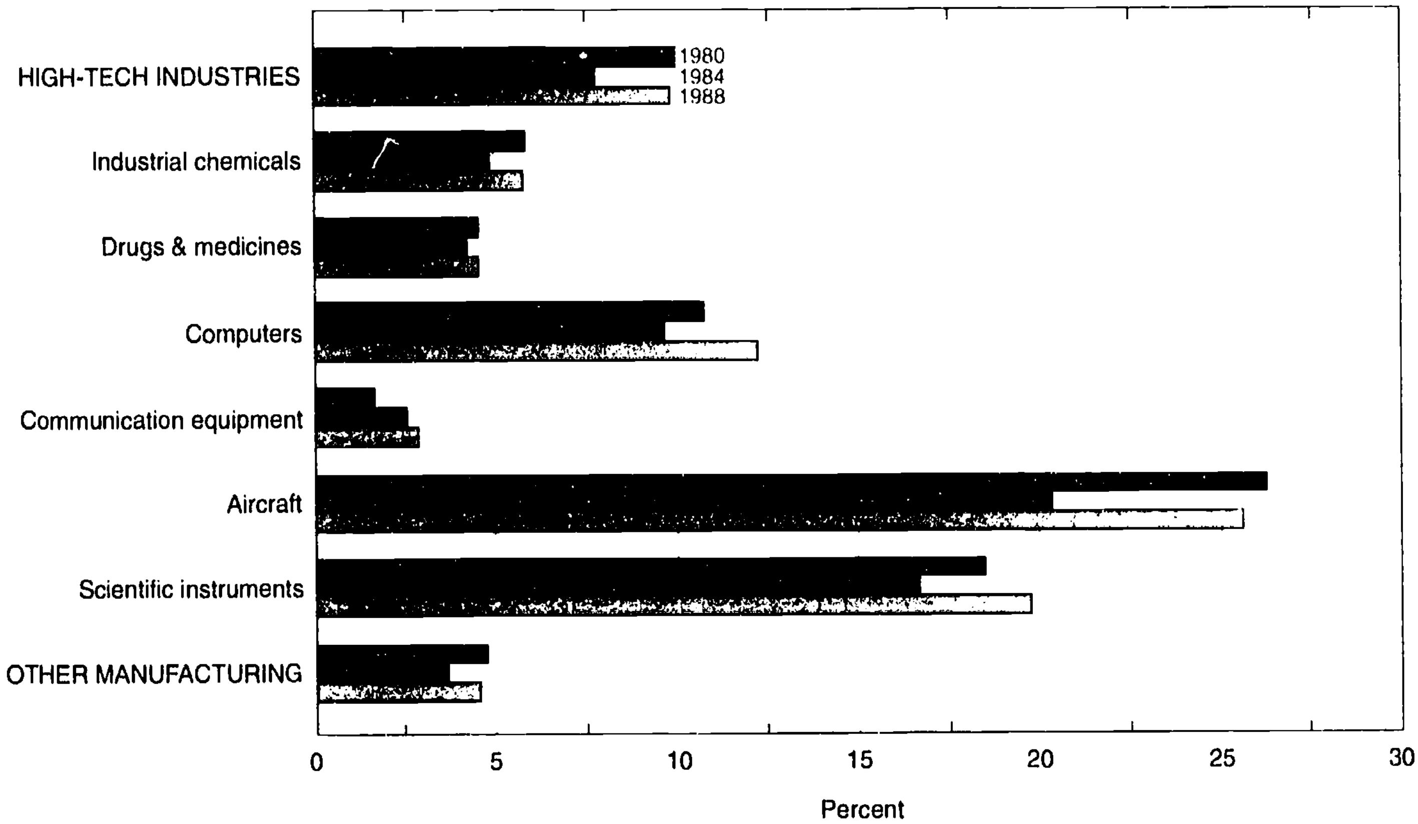



See appendix table 6-5. *Science & Engineering Indicators – 1991*

***Export Markets.*** U.S. industries are still the world's leading exporters of high-tech products.[10] U.S. industry accounted for 23 percent of global high-tech exports in 1988, compared with 15 percent for Japan and 14 percent for West Germany. Both the U.S. and West German shares declined during the eighties, while Japan's share of high-tech exports grew significantly. Of the high-tech industries examined, the U.S. 1988 export share was highest in the aircraft and computers industries. (See figure 6-7.) Japan's communication industry led all nations

[10]Trade data (exports and imports) are available on a product-level basis; production data are not. To conform with the production and trade data used elsewhere in this chapter, the discussions of export activity and trade balances are classified by industry. The industry-level definition of high-technology trade used here shows more midterm fluctuations in the U.S. trade than the trend portrayed using product-level data. Yet, using term endpoints, 1980 and 1988 reveals consistent trends regardless of the definition employed. See DOC (1983) and Abbott (1991) for technical discussions of alternative high-tech definitions.

Figure 6-6.
**U.S. share of foreign markets, by industry**




See appendix table 6-6.

*Science & Engineering Indicators – 1991*

in exports in 1988 as did West Germany's industrial chemicals and drug industries.

## U.S. Trade Balance

During the 1980s, the United States maintained a consistent trade surplus for the identified high-tech manufactures, but ran consistent deficits in other manufactures: Trade balances for both categories declined over the period. (See figure 6-8.) In several European countries, high-tech trade surpluses rose through the mid-eighties, then fell sharply through 1988. Among the industrialized countries, only Japan experienced steady growth of its high-tech manufactures trade surplus during the decade. (See figure O-23 in Overview.)

The U.S. trade surplus in high-tech manufactures in 1988 was half the size of its 1980 trade surplus. Again, the U.S. dollar's rollercoaster ride during the eighties affected U.S. competitiveness in the home market as well as in foreign markets. Six of seven U.S. high-tech industries showed deteriorating trade balances during the 1980s—three (communications equipment, engines and turbines, and scientific instruments) experienced trade deficits. The U.S. aircraft industry had a sharp decline in its trade surplus through the mid-eighties before recovering and exceeding the 1980 surplus in 1988.

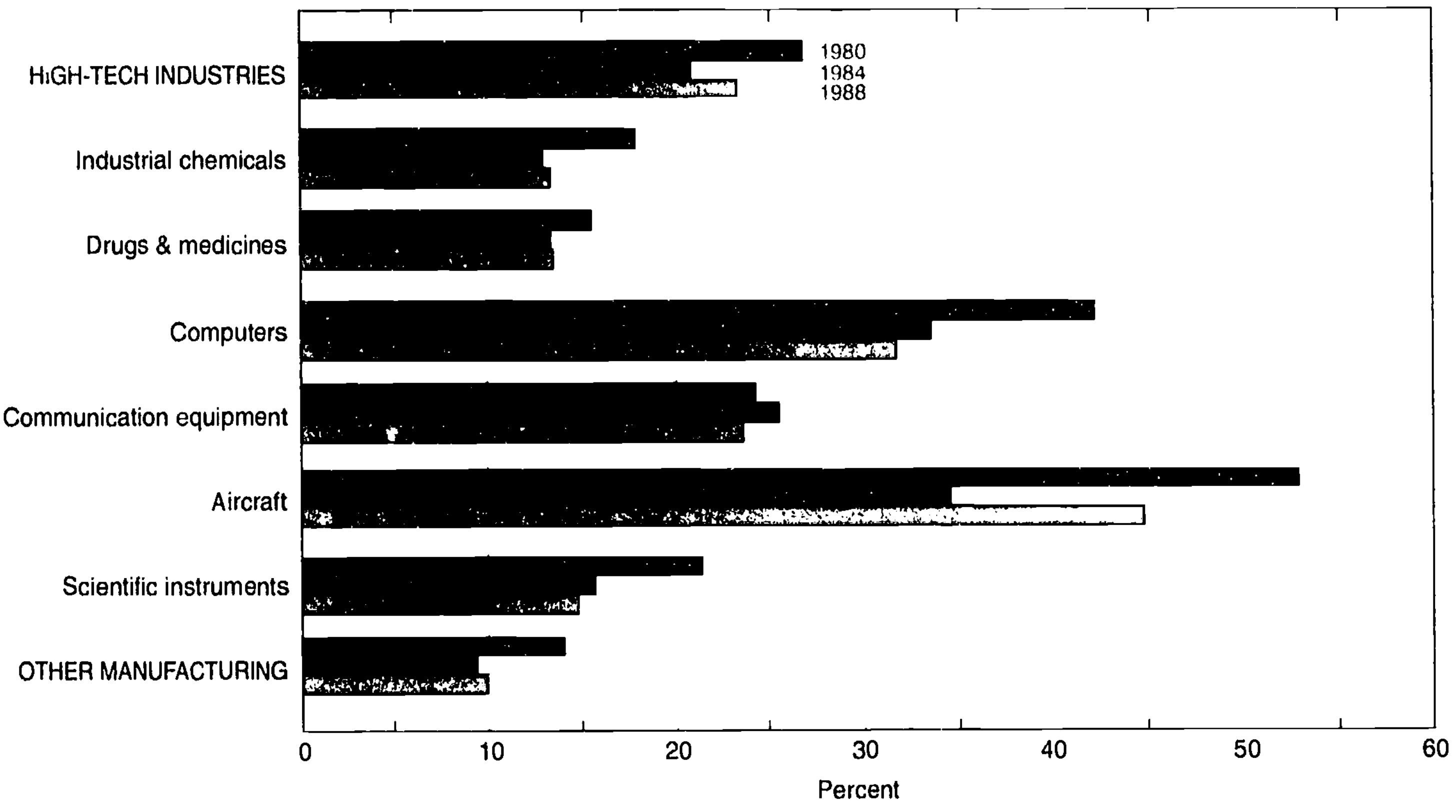
## Royalties and Fees From Technology Agreements

Receipts and payments for patents and technical knowledge are another indicator of firms' technological prowess. Transactions among unaffiliated firms—in which prices are set through a market-related bargaining process—tend to reflect the exchange of technology and its market value at a given point in time. The record of the resulting receipts and payments also provides an indicator of the production and diffusion of technical knowledge.

***All Agreements.*** The United States is a net exporter of technology sold as intellectual property. Royalties and fees received from foreigners have been, on average, almost four times that paid out to foreigners by U.S. firms for access to their technology. U.S. receipts from such technology sales totaled $1.9 billion in 1989, up from $1.6 billion in 1987. (See appendix table 6-9.)

Japan is the largest consumer of U.S. technology sold in this manner. In 1989, Japan accounted for 47 percent of all such U.S. receipts, while the Western European countries together represented 27 percent. South Korea increased its purchases of U.S. technological know-how sharply during the 3 years for which

Figure 6-7.
**U.S. share of global exports, by industry**




See appendix table 6-7.

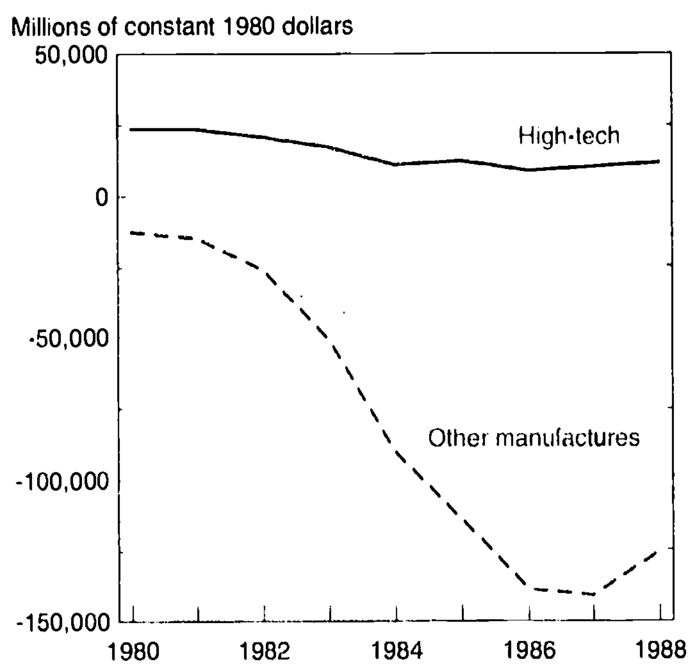
Science & Engineering Indicators – 1991

data are available, becoming the second largest consumer of U.S. industrial processes with a 9-percent share in 1989, up from just a 2-percent share in 1987. (See figure 6-9.)

To a large extent, the U.S. surplus in the exchange of intellectual property is driven by trade with Japan and the newly industrialized Asian countries. In 1989, U.S. receipts were nearly eight times its payments in licensing transactions entered into with Japan. On the other hand, the U.S. trade surplus with Europe in sales of technological know-how declined over the past 3 years (1987 to 1989). West Germany represented the largest European trading partner in these transactions; it was also the only country in the world with which the United States had a persistent technical knowledge trade deficit.

***New Agreements.*** The total flows of receipts and payments of royalties and license fees are generated both from new agreements and those made in previous periods that are still in force. The data discussed above thus do not reflect current U.S. technology flows resulting from new agreements. Although data on receipts and payments from new technology agreements are not available from U.S. sources, the Government of Japan has developed data that disaggregate receipts and payments by new and existing agreements. (See appendix tables 6-11 and 6-12.) Since Japan is the dominant customer for U.S. technology sold through this channel and is a major force in high-tech fields, these data provide useful insight about the relatively high level of U.S. technology sold via new technology agreements.

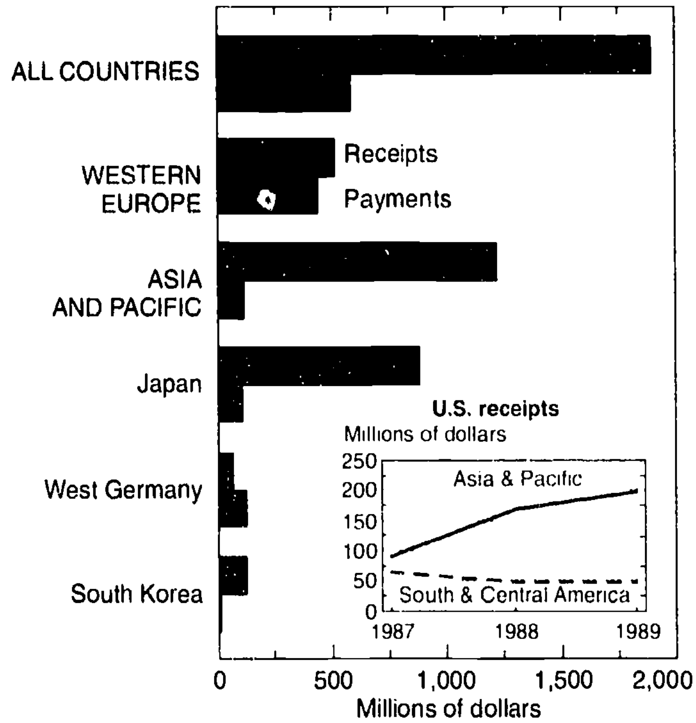
Figure 6-8.
**U.S. trade balance in manufactures**




See appendix table 6-8.

Science & Engineering Indicators – 1991

Figure 6-9.
**U.S. royalties and license fees generated by exchange of industrial processes: 1989**




See appendix table 6-9. *Science & Engineering Indicators – 1991*

From 1984 to 1988, the United States entered into, on average, over 900 new agreements per year with Japan involving the exchange (both purchase and sale) of technological know-how. There were close to three new agreements calling for U.S. exports to Japan of technological know-how for every one that represented a U.S import of Japanese technology. The average value of these agreements was fairly equitable—about 37 million yen ($285,000) per agreement for Japanese purchases and 34.7 million yen ($267,000) for those agreements involving Japanese sales of technological know-how to the United States.[11] The U.S. trade surplus in these high-tech sales with Japan nearly tripled in size during this 5-year period. In 1988, Japan entered into 11 times as many agreements for the purchase of technological know-how with the United States as with its next largest trading partner, West Germany.

Japan apparently continues to consider the United States a fertile field from which to harvest new advances in technology. The surplus the United States enjoys in its technological know-how trade with Japan does not rely solely on technological advances developed in the past but is supported by current inventive activity as well. Although sales of technological know-how contribute positively to the balance sheets of U.S. firms and the U.S. economy in the short term, there has been ongoing controversy regarding the long-term consequences.[12]

## Industrial R&D

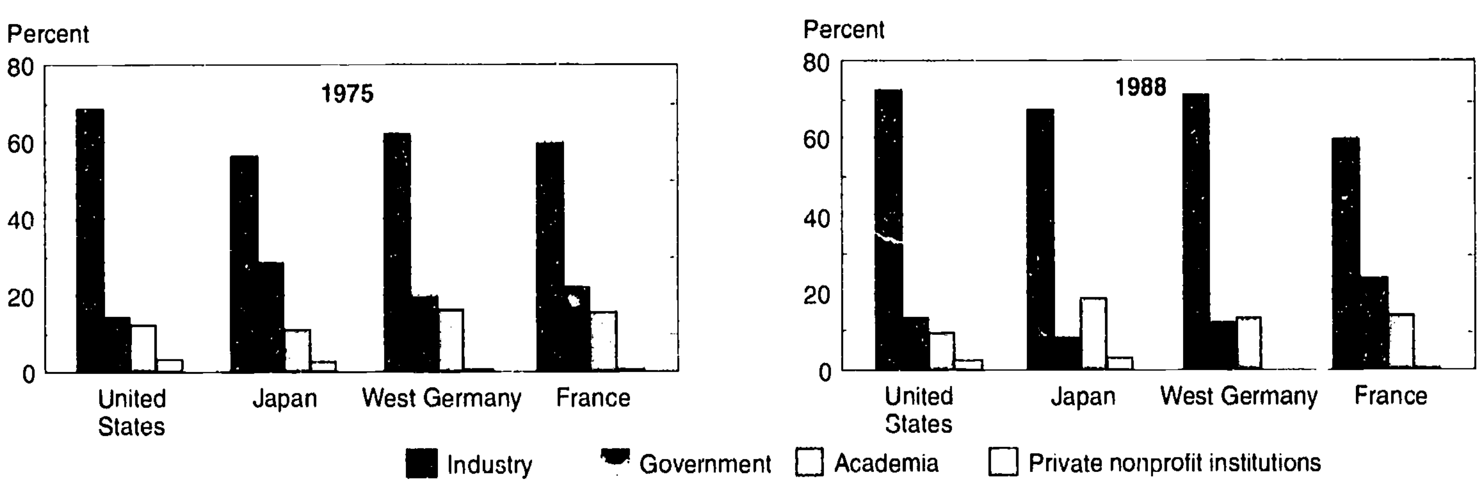
### International Comparisons

In all industrialized countries, the industrial sector is the leading performer of R&D. In the United States, more than 73 percent of all R&D expenditures are for R&D performed in industry (1988). (See appendix table 6-13.) Among other large industrialized market economy countries, West Germany has a similar share of R&D performed by industry. Japan, the United Kingdom, and—especially—France have somewhat lower shares, although even in France about 60 percent of national R&D expenditures are in industry. (See figure 6-10.) Except for France,

[11] Converted at an exchange rate of 130 yen per U.S. dollar.

[12] In 1988, the United States had a surplus of approximately $200 million generated from new technology agreements with Japan, but suffered a deficit in high-tech *merchandise* trade with Japan of $5 to $22 billion (depending upon the definition used). Recent developments in the aerospace industry typify the controversy. In this industry, as international joint production ventures grow (e.g., FSX codevelopment with Japan, General Dynamic's F-16 coproduction program with Turkey, and the F-18 coproduction program with South Korea), exports of complete U.S.-built aircraft could decline in the future.

Figure 6-10.
**National R&D expenditures, by sector of performance**




See appendix table 6-13. *Science & Engineering Indicators – 1991*

these percentages represent increases in the share of R&D performed in industry over the 1975-88 period. Japan and West Germany showed the largest shifts to the industrial sector.

Private industry was the source of 50 percent of all funds spent for R&D in the United States; the Federal Government funded most of the remainder. Nearly all of industry's funding was directed toward R&D that would be performed within industry. About 1 percent was spent on university research and almost 1 percent on research in nonprofit institutions. Compared to the United States, Japan and West Germany received considerably larger shares of their national R&D funds from private sources. France and, until recently, the United Kingdom had less of their R&D funded by industrial sources.[13]

Since the early 1970s, the trend in all five countries has been for an increasing percentage of national R&D to be financed by industry. (See figure 6-11 and appendix table 4-2.) In the United States, however, the trend rose until 1982 and remained more or less stable through 1991. This leveling off was primarily due to the buildup of federally supported R&D for defense during the 1980s.

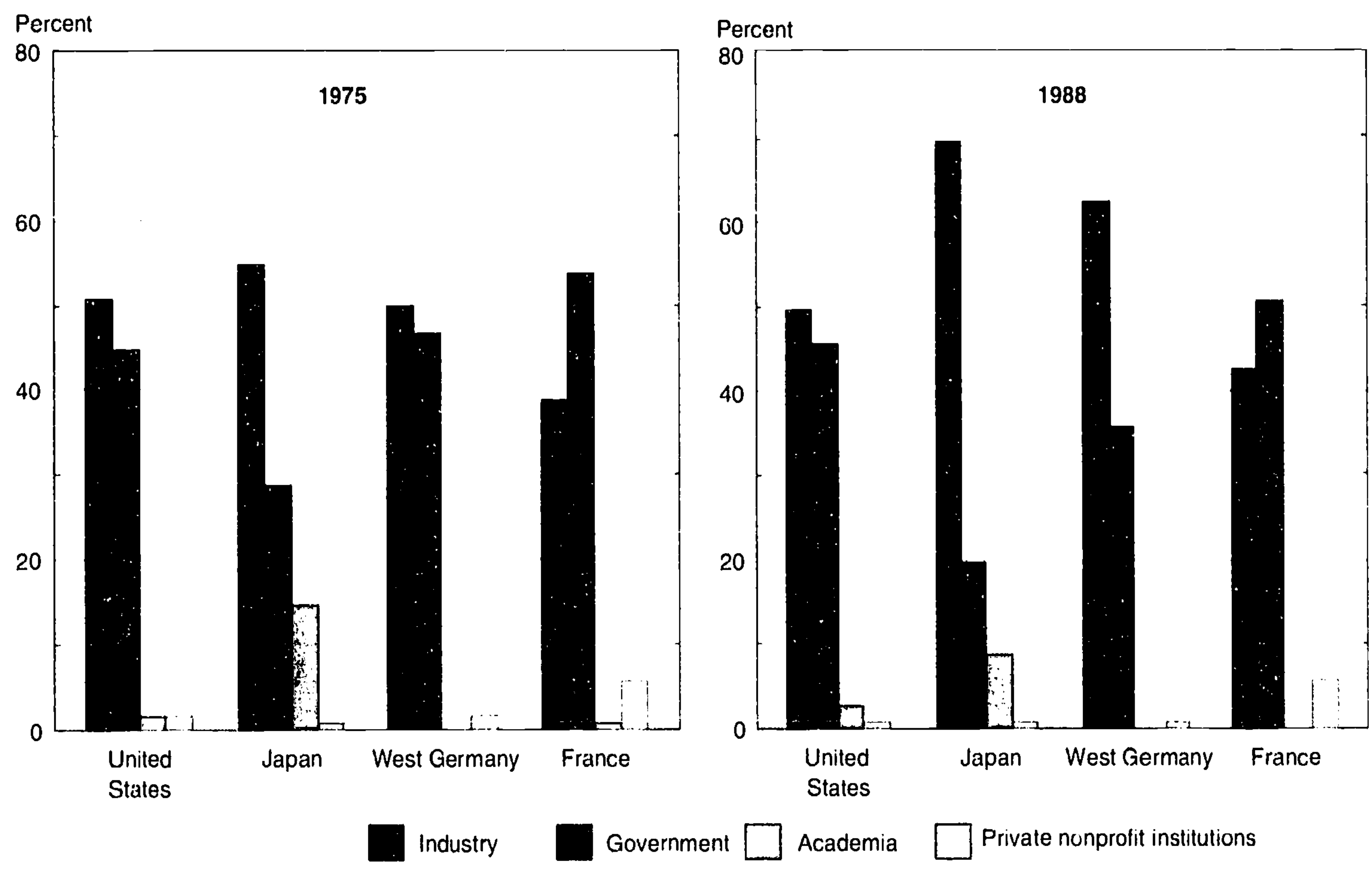
[13] The data for France and the United Kingdom include R&D funding provided by public, as well as private, corporations. The level of private funding for their industrial R&D was therefore lower than is shown on figure 6-10.

## Industrial R&D Expenditures

Funds for industrial R&D come almost exclusively from two sources: private industry itself and the Federal Government.[11] Total estimated current dollar expenditures in the United States for industrial R&D increased markedly between 1979 and 1989, rising from $38.2 billion to $101.6 billion—an average annual increase of close to 10.3 percent. Current dollar estimates for 1990 and 1991 show continued growth. (See appendix table 6-15.) After adjusting for inflation, however, the growth rate of industrial R&D is reduced to 5.2 percent per year during 1979-89, with a significant slowdown occurring during the last 5 years. From 1979 to 1984, industrial R&D expenditures grew at an annual rate of 7.4 percent

[11] Some companies perform "independent research and development." IR&D is in-house R&D intended to better prepare the companies to bid on National Aeronautics and Space Administration or Department of Defense projects. Some of these expenditures are later reimbursed by the agency as overhead charges allocated to contracts. IR&D expenditures represent less than 5 percent of total R&D expenditures by industry. See chapter 4, "Independent Research and Development," p. 98.

Figure 6-11.
**National R&D expenditures, by source of funds**




See appendix table 6-13.

Science & Engineering Indicators – 1991

in constant dollars compared with 3.0 percent during 1984-89. And by 1989, constant dollar expenditures actually declined—the first time this had occurred since 1975. Estimates for 1990 and 1991 indicate that industrial R&D expenditures continued to decline in inflation-adjusted dollars. (See figure 6-12.)

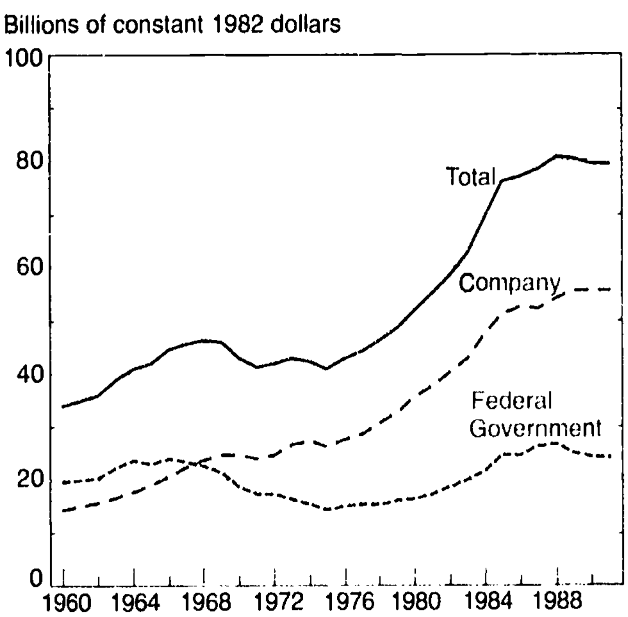
## Trends in Company and Federal Funding

From the early sixties through the early eighties, the share of industrial R&D funding provided by companies themselves increased steadily. By 1984, private financing supported close to 69 percent of industrial R&D performance; in the early sixties, only about 42 percent was self-financed. (See figure 6-12.) This trend was reversed as the military buildup that began in the early eighties led the Federal contribution to first keep pace with—and to later increase more rapidly than—the private contribution. Since 1987, however, private financing has again outpaced Federal support.

During the 1960s, private funding for industrial R&D increased at an average rate of 6.6 percent per year, in constant dollars, while Federal support increased by 1.4 percent per year. Both private and Federal support for industrial R&D were cut back in the seventies: Private funding growth slowed to 2.8 percent annually, and Federal funding actually declined in inflation-adjusted dollars.

In the 1980s, U.S. policy refocused Federal funding toward development and upgrading of military technologies. U.S. industry was driven to escalate new product development in the face of growing foreign competition. Consequently, both private and Federal funding of industrial R&D increased significantly when compared with the previous decade—private funding doubled its growth rate to 5.4 percent a year, while Federal funding actually grew almost as fast at 4.5 percent per year. Most of this growth took place in the first half of the decade. The average annual growth rate during the early eighties was twice that of the latter half.

Figure 6-12.
**U.S. industrial R&D expenditures, by source of funds**




See appendix table 6-15. *Science & Engineering Indicators – 1991*

Estimates for 1990 and 1991 indicate that both Federal and company funding of industrial R&D declined when inflation is taken into account. The decline in Federal support stems from concern over the Federal budget deficit. The decline in company R&D funding can be attributed to several factors, including the following:

- Profit margins have been squeezed for some time because of the rise in competition that accompanies the increasing globalization of markets.
- The above factor, combined with the general softness in demand for industrial outputs evident in the past few years, has caused industry to look for ways to reduce its costs.
- In some firms, R&D labs have been decentralized, bringing them closer to company manufacturing operations as the result of restructuring and/or corporate mergers (SRS 1989 and SRS 1989).

## Expenditures for Individual Industries

Individual industries show very different trends in their R&D expenditures and in the shares of those expenditures supported by private and Federal sources. For purposes of this analysis, industries are divided into three general groups: high-tech manufacturing, other manufacturing, and nonmanufacturing (including services).[15]

During the 1979-89 period, the high-technology manufacturing group's share of industrial R&D expenditures fluctuated narrowly around a 59-percent share of the total; concurrently, the share for all other manufacturing industries declined from 37 to 33 percent. Although nonmanufacturing industries accounted for the smallest share of the three groups, this was the only group whose share grew, doubling the 4-percent share it held in 1979 to an 8-percent share in 1989.

From 1979 to 1989—a rollercoaster period of economic slowdown followed by prolonged growth and a subsequent leveling off—total industrial R&D rose by an average of 5.2 percent per year in constant dollars. During this time, R&D within the three industry groups increased as follows:

[15] The nonmanufacturing category includes all service-related and mining Standard Industrial Classification (SIC) codes; it does not include agriculture SICs. Appendix table 6-16 lists the SIC codes included, along with trends in R&D expenditures.

The high-tech manufacturing industries selected are those generally identified as having comparatively higher levels of R&D as a proportion of sales. Due to Census Bureau requirements to protect the confidentiality of firm data, industrial R&D data are not available for all industries normally included in the high-tech category.

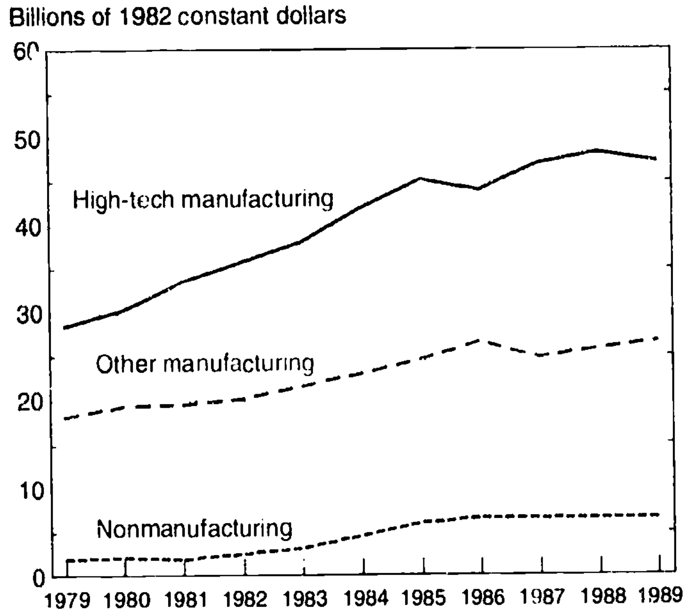
- High-tech manufacturing—5.2 percent per year,
- Other manufacturing—3.9 percent per year, and
- Nonmanufacturing—12.8 percent per year.[16]

Within the high-tech manufacturing group, several industries experienced above average R&D growth—chemical and allied products (including pharmaceuticals), electronic components, communication equipment, and aerospace. (See figure 6-13.) Firms whose primary activity involves providing computer-related and engineering services accounted for nearly half of the nonmanufacturing group's R&D expenditures and were responsible for most of the increases exhibited during 1987-89.

## Trends in Funding for Individual Industries

Company funding in high-tech manufacturing industries went up 5.2 percent per year during the 1980s after adjusting for inflation; it went up 4.8 percent per year in other manufacturing. (See appendix table 6-18.) Private funding of industrial R&D performed by nonmanufacturing industries grew at an average annual rate approaching 15 percent during this period, exceeding the 9.5-percent rate of growth in Federal support to this group. But in all three industry groups, funding of R&D slowed during the latter part of the decade. (See figure 6-14.) Two

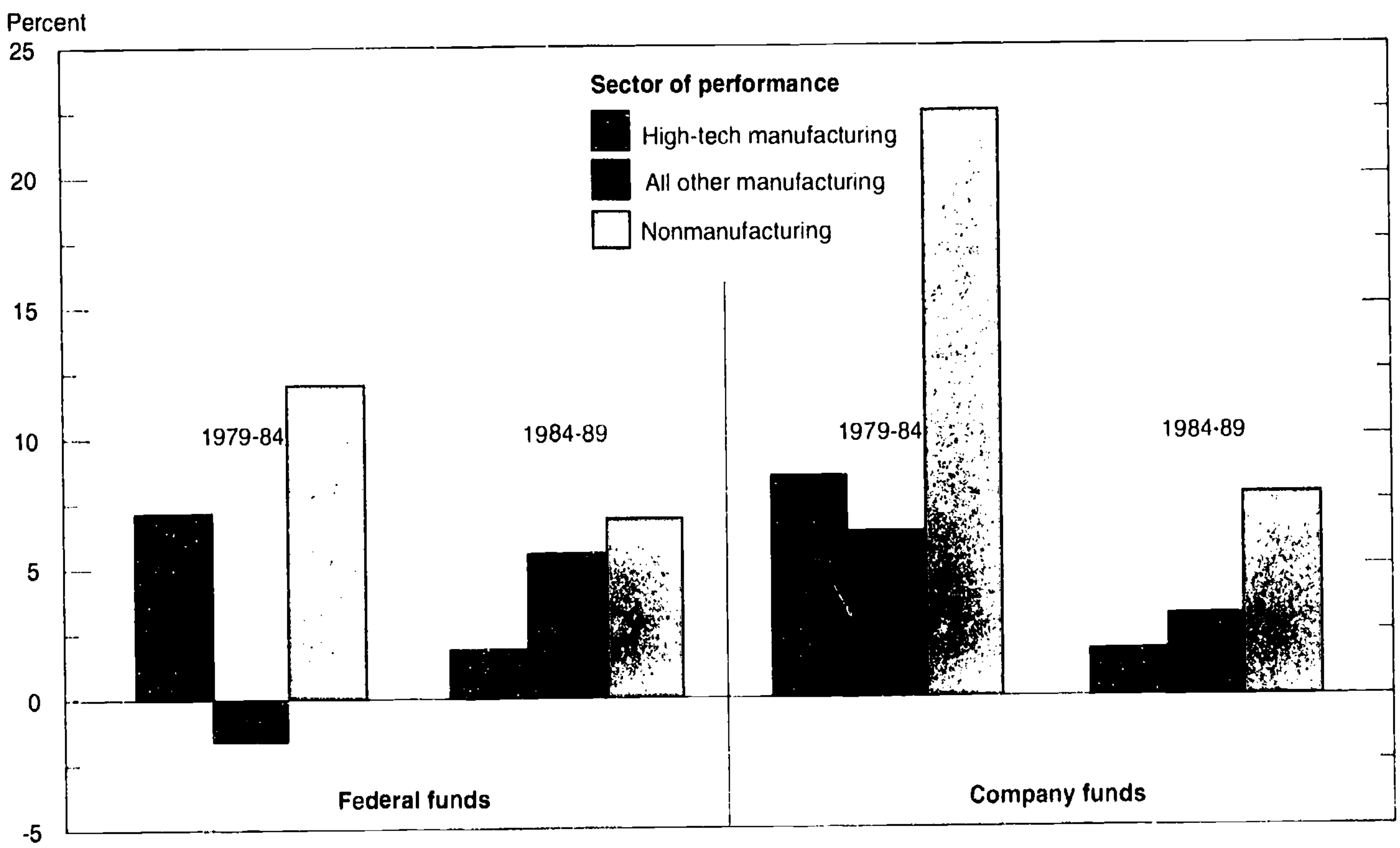
Figure 6-13.
**R&D expenditures, by industry group**




See appendix table 6-16. *Science & Engineering Indicators – 1991*

[16] The rapid rate of growth in R&D expenditures reported for the nonmanufacturing sector during the 1980s may be distorted by efforts to improve coverage of the service sector in the National Science Foundation's annual Survey of Industrial Research and Development starting with the 1987 survey. Although adjustments have been made to link data from previous samples, it remains uncertain whether the effects of the resampling have been completely removed.

Figure 6-14.
**Real growth rates in funding of industrial R&D, by source and sector of performance**

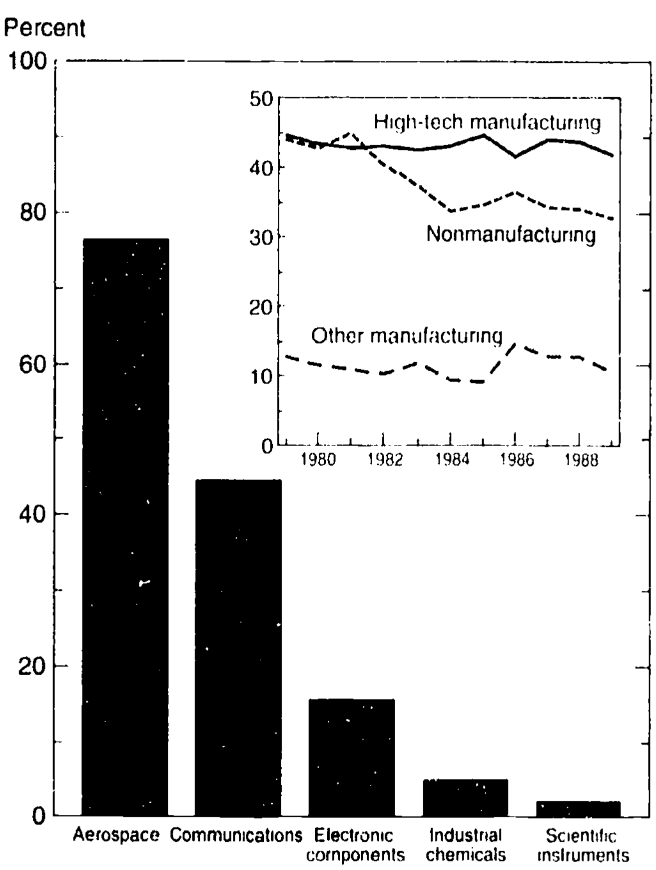



See appendix tables 6-17 and 6-18. *Science & Engineering Indicators – 1991* of the industries in which company-financed R&D grew fastest, the chemicals and computer manufacturing industries, were also faced with declining Federal support during this time.

Certain manufacturing industries—particularly aircraft and missiles and communication equipment, all of which have special military importance—received especially large portions of their R&D support from Federal sources. (See figure 6-15.) The Federal Government also provided a large share of R&D funding to certain nonmanufacturing industries. In 1989, it supplied nearly half of the R&D funds used by firms whose primary activity involves R&D and testing services and one-third of the R&D funds used by computer-related and engineering services firms.

In constant dollars, Federal support increased at an average rate of 4.5 percent per year from 1979 to 1989; this increase was directed to certain industries. In particular, Federal funding increased by an annual average of 7.7 percent per year in aerospace, 7.4 percent per year in fabricated metal products, and 7.7 percent per year in all nonmanufacturing. (See appendix table 6-17.) Federal support for R&D in the nonmanufacturing industries group more than doubled in constant dollars during this time, registering an annual increase of 9.5 percent. As noted earlier, Federal support to this group is substantially less in absolute dollars than that allocated to the manufacturing groups.

Figure 6-15.
**Share of industrial R&D funding provided by Federal Government: 1988**



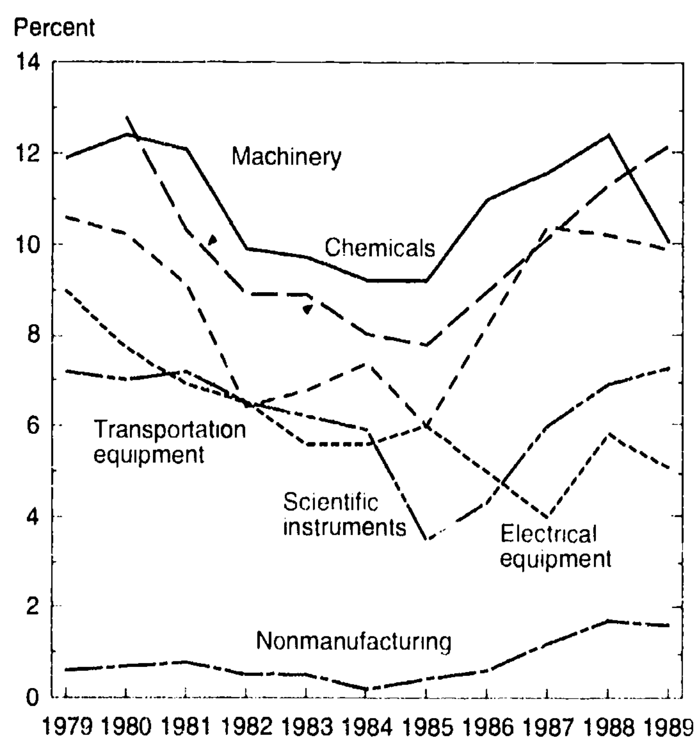

See appendix table 6-19. *Science & Engineering Indicators – 1991*

## Company-Financed R&D Performed Outside the United States

From 1979 to 1989, U.S. firms generally increased their funding of R&D performed outside the country. (See appendix table 6-20.) This funding growth did *not* keep pace with the rise in company-financed R&D performed within the United States, however. The share of total company-financed R&D performed outside the United States declined steadily from the period high of 9.7 percent in 1979 to a low of 6.0 percent by 1985. From 1985 to 1989, U.S. firms' overseas R&D increased faster than that performed domestically, with its share rising to 8.5 percent by 1989. Nonetheless, this share was still below the 1979 level.

The industries with the highest levels of company-financed R&D performed overseas in 1989 were chemicals and allied products—10.1 percent—and transportation equipment (especially motor vehicles and aircraft)—12.2 percent. (See figure 6-16.) Nonmanufacturing industries had the lowest share of privately financed R&D being conducted overseas, despite an almost threefold increase in this share during the eighties, from 0.6 percent in 1979 to 1.6 percent by 1989.

Figure 6-16.
**Share of company-financed R&D performed outside the United States, by industry**




See appendix table 6-20. *Science & Engineering Indicators – 1991*

## Patented Inventions[17]

One of the important benefits of R&D is the stream of new technical inventions that may in turn be embodied in innovations—i.e., in new or improved products, processes, and services. *Patenting trends* can serve as an indicator—albeit one with certain limitations—of the success of U.S. industry in producing such innovations.[18] Specifically, Griliches (1990) and others suggest that patent data provide good indicators for measuring technical change and inventive input and output over time. Further, U.S. patenting by foreign inventors enables measurement of the levels of invention in those foreign countries (see Pavitt 1985). Foreign patenting can also serve as a leading indicator of new competition in a country's home market. This section describes broad trends in patenting over time, by field, and by industry by both U.S. and foreign inventors. It briefly discusses patenting trends in foreign countries and describes an indicator that attempts to identify technically important patented inventions. In addition, information on patenting activity in other countries is presented. (See "Patenting Activity in Foreign Countries," p. 150.)

### Granted Patents by Owner

***Patents Granted to Americans.***[19] From 1977 through 1983, the number of patents granted to Americans declined irregularly.[20] This trend was reversed at about the time the United States came out of the recession of the early eighties; patent grants to Americans have been increasing fairly rapidly since then. By 1989, U.S.-origin patenting registered a new high when about 50,000 patents were granted to U.S. resident inventors. However, foreign patenting in the United States rose at a quicker rate in the post-recession period (1983-90) than did U.S. domestic patenting—8.6 versus 5.3 percent per year.[21] (See figure 6-17 and figure O-21 in Overview.)

Patents granted to American inventors can be further analyzed by patent ownership at the time of grant. Inventors who work for private companies or for the Federal Government commonly assign ownership of their patents to their employer; self-employed inventors usually retain ownership of their patents. The owner's sector of employment is thus a good indication of the sector in which the inventive work was done. In 1990, 71 percent of granted patents were owned by corporations.[22] This percentage has varied within a narrow range (between 70 and 74 percent) since 1970. Consequently, trends in U.S. patenting are by and large trends in patenting by corporations. (See figure 6-18.)

Individuals are the next largest group of patent owners. In 1970 individuals owned 21 percent of patents granted. Their share rose to 27 percent in 1980 and was 26 percent in 1990. The Federal share of patents has varied from a high of 4.1 percent in 1976 to a low of 1.8 percent in 1988 and 1989.[23] Finally, about 1 percent of patents granted to American inventors are owned by foreign corporations or governments.

In 1989 the number of patents granted in the United States jumped 22 percent.[24] U.S. inventors received 53 percent of the U.S. patents granted that year, representing the first upturn in their share of granted patents since 1977. The increase in U.S. share is a reflection of the successes of individual inventors. The patenting share for U.S. corporations actually declined in 1989, and U.S. Government-owned patents accounted for about the same share of total as in 1988.

***Patents Granted to Foreign Inventors.*** The number of U.S. patents granted with foreign origin also increased sharply in 1989, although not as dramatically as did those with U.S. origin. Thus, the share of total patents granted to foreign inventors in 1989 fell from 48.1 percent in 1988 to 47.5 percent. Of new U.S. patents

---

[17] Although the U.S. Patent and Trademark Office grants several types of patents (e.g., design patents), this discussion is limited to utility patents, which are commonly known as "patents for inventions."

[18] Patenting indicators, while instructive and convenient, have some well-known drawbacks, including the following:

- *Incompleteness*—many inventions are not patented at all, in part because laws in some States already provide for the protection of industrial trade secrets.
- *Inconsistency across industries*—industries vary consid rably in their propensity to patent inventions; consequently, it is not advisable to compare patenting rates between different technologies or industries.
- *Inconsistency in quality*—the inventions patented can vary considerably in quality. (Patent citation rates, discussed on pp. 152-53, are one method for dealing with this question of varying quality.)

Despite these and other limitations, patents provide a unique and convenient source of information on innovation.

[19] The U.S. Patent and Trademark Office grants patents to both U.S. and foreign inventors. Patent origin is determined by the residence at the time of grant of the first-named inventor as specified on the face of the patent. Patents "granted to Americans" are actually U.S.-origin patents.

[20] The number of patents granted to all countries dipped in 1979 because the Patent Office could not afford to print all the patents approved that year.

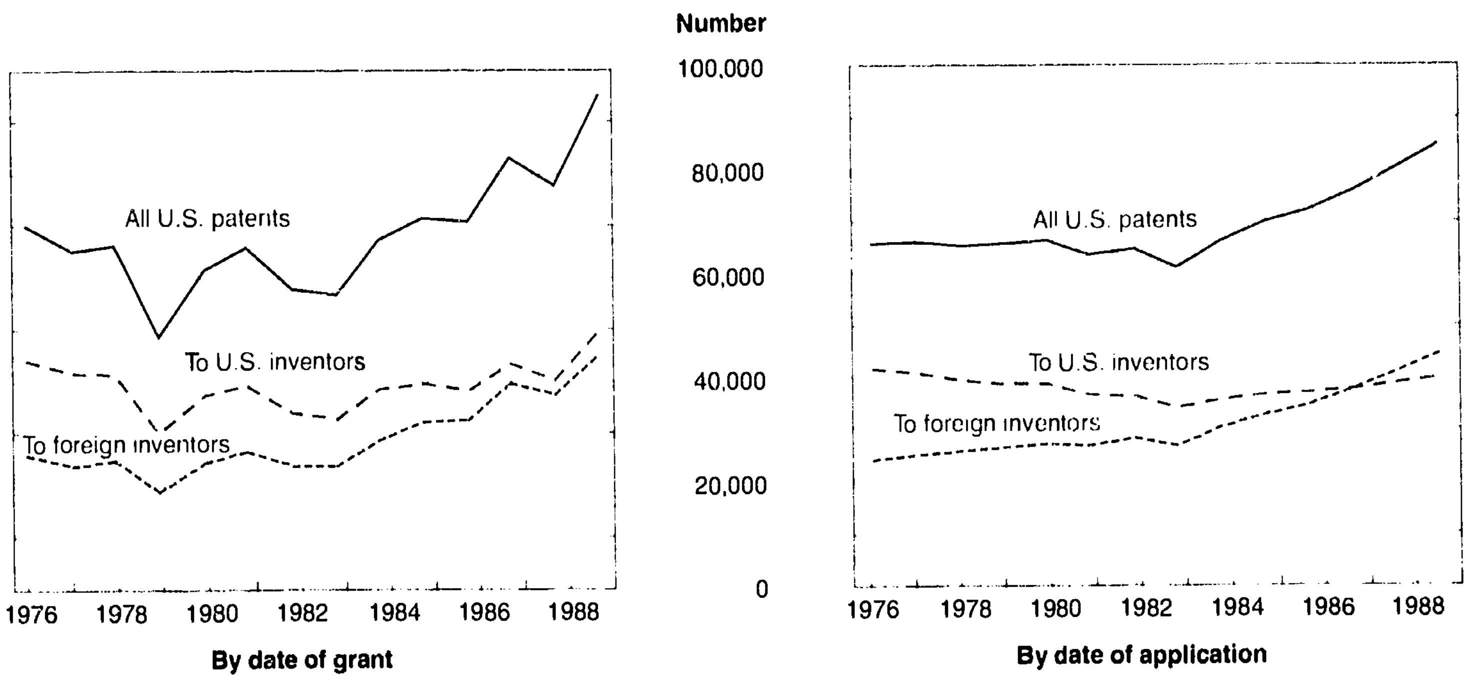
[21] Both U.S. and foreign patenting declined from 1987 to 1988. This decline, one of many oscillations that appear in patenting data by year of patent grant, may be due to the especially low number of patents awarded in 1986 because of budget restrictions at the Patent Office. This development, in turn, led to an unusually high number of patent grants in 1987 as patents were carried over into that year. Also, utility patent applications dropped in 1983. Since it can take 2 to 3 years before a successful application matures into a patent, this drop may also have contributed to the low number of patent grants in 1986. See "Granted Patents by Date of Application," p. 149.

[22] About 2 percent of patents granted to Americans in 1989 were owned by U.S. universities and colleges. The Patent Office counts these as being owned by corporations. For further discussion of academic patenting, see chapter 5, "Patents Awarded to U.S. Universities," pp. 130-31.

[23] Federal inventors frequently obtain a statutory invention registration (SIR) rather than a patent. An SIR is not ordinarily subject to examination and costs less to obtain than a patent. Also, an SIR gives the holder the right to use the invention but does not prevent others from selling or using the invention as well.

[24] Part of this increase may be attributed to Patent Office efforts to reduce "pendency," the time between receipt of a patent application and completion of its processing.

Figure 6-17.
**U.S. patents granted, by nationality of inventor**




NOTE: Estimates are shown for 1987-89 for patents by date of application.
See appendix tables 6-21 and 6-22.

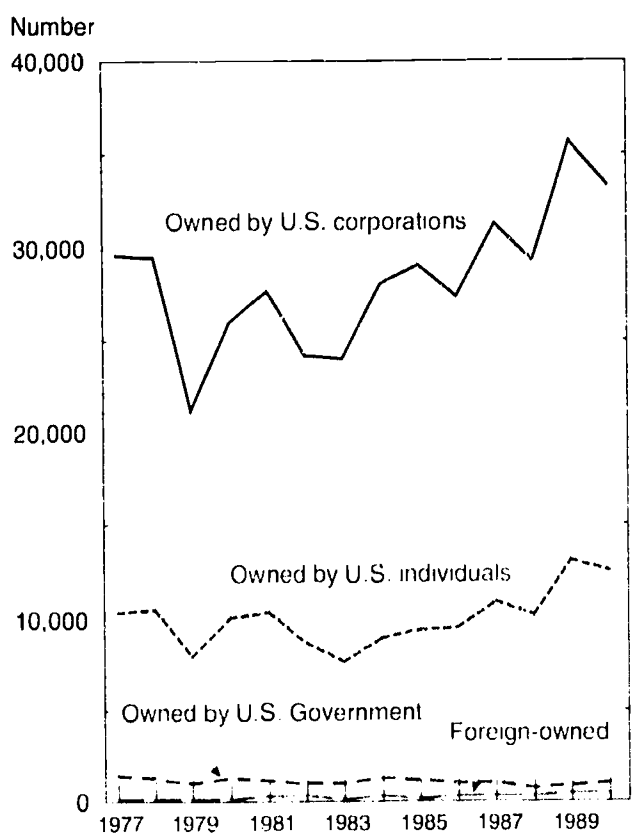
*Science & Engineering Indicators – 1991*

with foreign origin, those owned by individuals increased in number but declined as a share of the 1989 total, as did those owned by foreign governments. Foreign corporation-owned patents increased in sufficient numbers in 1989 to maintain their share of total from 1988. Among 1989 patents with foreign origin, only those granted to U.S. entities increased both absolutely and relatively.

Foreign patenting is highly concentrated by country of origin. (See figure 6-19.) Since 1975, Japan has received more U.S. patents than any other foreign country. Japanese inventors have steadily increased their share, receiving 22 percent of all U.S. patents in 1990, compared with under 10 percent in 1977. West German inventors received around 9 percent of U.S. patents from 1977 to 1990—generally rising slightly through 1986 and declining slightly thereafter. The share of U.S. patents owned by United Kingdom inventors followed an irregular but declining trend during 1977-90, dropping from a high of 4.1 percent in 1977 to a low of 3.1 percent in 1990. Over this same period, the French share fluctuated narrowly around 3.3 percent. (See figure O-21 in Overview.)

Comparing foreign patenting growth rates in the United States in the wake of the 1980s recession reveals the expanding roles of Japan and Europe as technology competitors as well as identifies several other countries with a demonstrated capacity to generate new technologies. During the 1983-90 period, the

Figure 6-18.
**U.S. patents granted, by class of owner**




See appendix table 6-21. *Science & Engineering Indicators – 1991*

average U.S. patenting growth rate was 8.6 percent per year among foreign countries. Countries with above average growth rates were

- Taiwan, 41.3 percent per year (731 patents granted in 1990);
- South Korea, 36.0 percent per year (224 patents);
- Hong Kong, 20.6 percent per year (52 patents);
- Japan, 12.0 percent per year (19,444 patents);
- Sweden, 10.5 percent per year (1,257 patents); and
- Switzerland, 9.2 percent per year (1,848 patents).

The patenting growth rate for the United States during this time was 5.3 percent per year (47,195 patents). Despite the dramatic recent increase in patent activity by the newly industrialized countries of East Asia—particularly Taiwan and South Korea—these countries, as a group, accounted for just over 1 percent of the U.S. patents granted in 1990.

## Granted Patents by Date of Application[25]

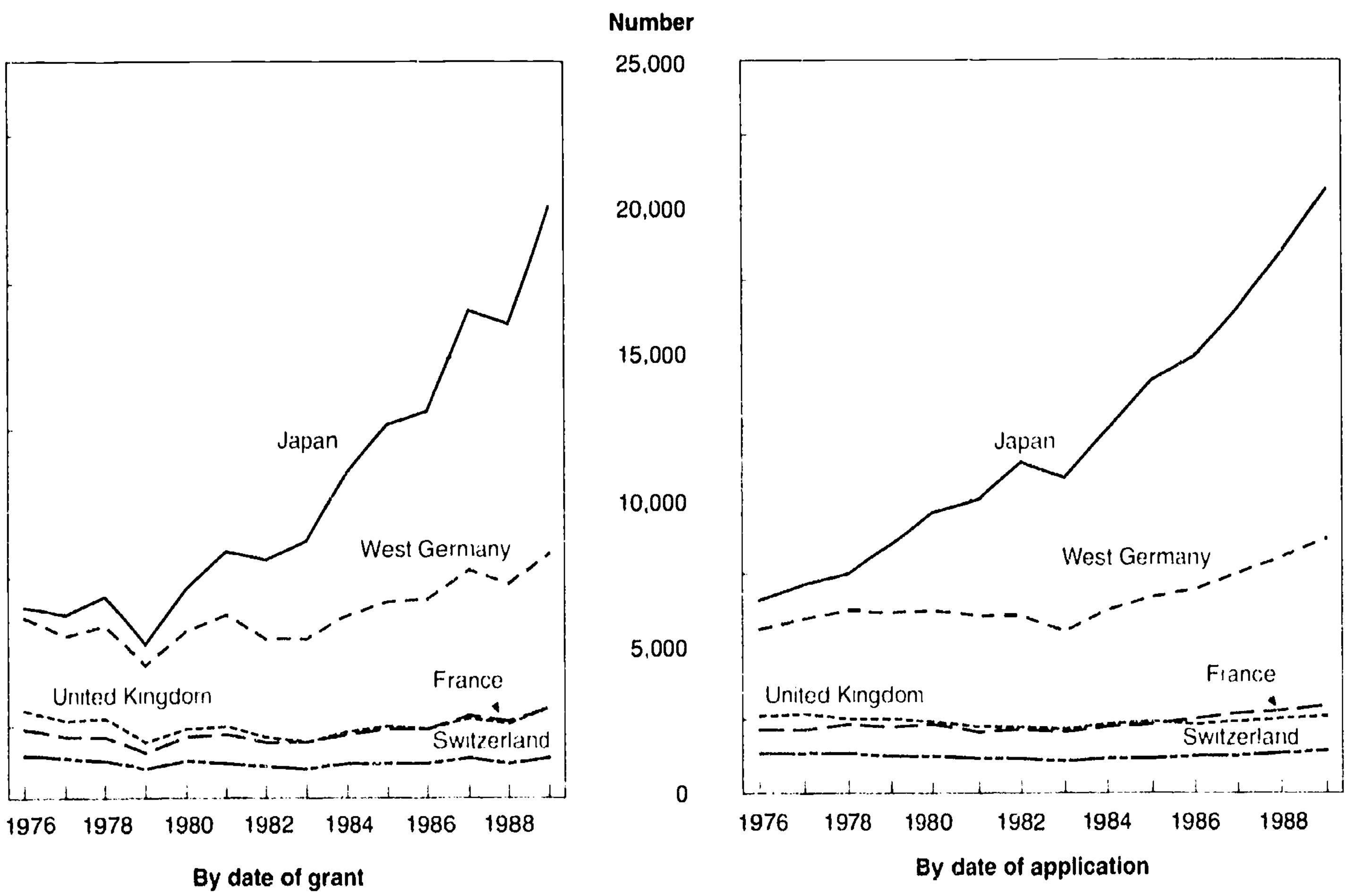
Patent data by year of grant show considerable oscillation from year to year, primarily because of fluctuations in the rate at which the Patent Office processes applications. To remove the effect of these fluctuations, granted patents can be allocated to the years in which they were applied for. The application date is roughly 2 or 3 years before the year of grant and is thus closer to the time at which the invention actually took place. When displayed by year of application, patenting data show much smoother trends.

---

[25] Because the Patent Office has not yet completed the examination process for numerous applications filed during 1987-89, it is not known how many of these applications will ultimately be granted. Consequently, this analysis of patenting trends by year of application is confined to the 1963-86 period.

Note, however, that the data series for patenting by date of application shows a dip in 1983 for several countries. In fact, the number of applications from many countries was especially high in 1982 and correspondingly low in 1983. A new schedule of higher fees was introduced in late 1982, contributing to an acceleration of filings in 1982 and fewer in 1983.

Figure 6-19.
**U.S. patents granted to foreign inventors, by nationality of inventor**



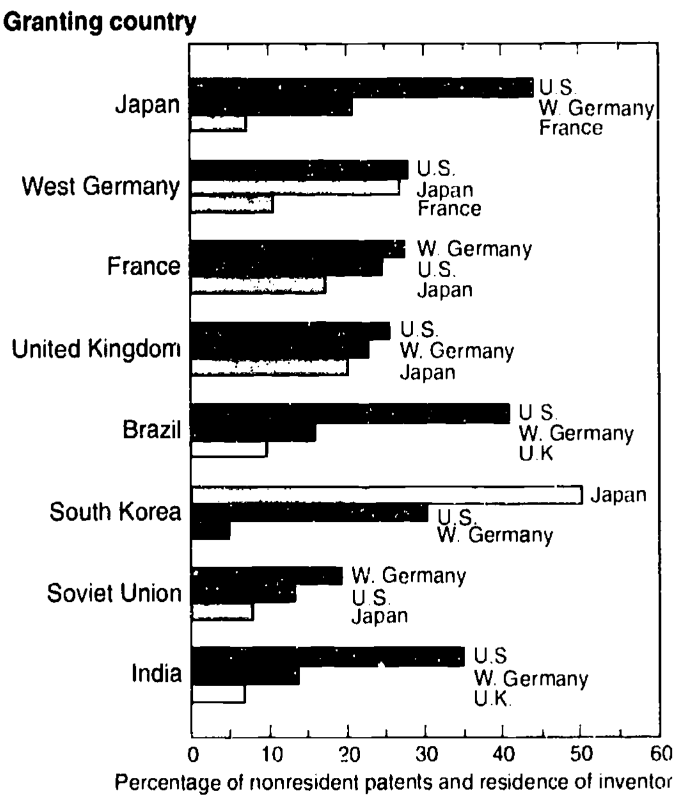

NOTE: Estimates are shown for 1987-89 for patents by date of application.
See appendix tables 6-21 and 6-22.

*Science & Engineering Indicators – 1991*

## Patent Activity in Foreign Countries

Nonresident inventors account for varying shares of total patent activity around the world. Countries that patent extensively in the United States—for example, Japan and West Germany—are active in other countries as well. Similarly, U.S. inventors are themselves active and successful in patenting inventions around the world. Contrary to the recent declining trend for U.S. inventors at home, recent foreign patent activity suggests that U.S. inventors are not only successful at obtaining patents in neighboring countries, but garner a large and increasing share of nonresident patents in Europe, Japan, South Korea, Brazil, and India. (See figure 6-20.)

Figure 6-20.
**Patents granted to foreigners in 1989, by granting country**




See appendix table 6-31. *Science & Engineering Indicators – 1991*

From 1976 to 1983, patented *applications* in the United States decreased at an average rate of slightly over 1 percent—primarily because the success rate of patent applications from U.S. inventors declined. In contrast, foreign-origin patenting grew at 1.6 percent a year. (See figures 6-17, 6-18, and 6-19.)

From 1984 to 1986, U.S. patenting by year of application exhibited a positive growth rate, bolstered by both U.S. and foreign inventors. Patenting by foreign inventors grew at an average annual rate three times that of U.S. inventors. (See appendix table 6-22.)

During the post-recession period for which data are available (1983-86), several countries demonstrated above average growth in patented applications, as follows:

- Italy, 14.0 percent per year;
- Belgium, 11.7 percent;
- Japan, 11.4 percent;[26] and
- West Germany, 8.0 percent.

But as with patent grant data, it was the East Asian newly industrialized countries that exhibited the highest growth rates during 1983-86, as follows:

- Taiwan, 44.4 percent a year;
- South Korea, 29.3 percent; and
- Hong Kong, 20.0 percent.

Although these growth rates are building on a far lower base of patent applications than the major industrialized countries, they suggest that these countries have begun to reap benefits from their R&D and technology-producing investments.

### Patents by Patent Office Classes[27]

A country's distribution of patents by technical area provides a key to understanding that country's contribution to important fields of technology. This section compares and discusses the various key technical fields favored by inventors from various countries in their U.S. patenting.

***Fields Favored by U.S. and Japanese Inventors.***[28] To some extent, there is an inverse relationship between U.S. and Japanese patenting. (See appendix tables 6-23 and 6-24.) For example, Japanese patenting in the United States emphasizes such technically and commercially important technologies as photocopying, photography, dynamic information storage and retrieval, television, motor vehicles, and internal combustion engines. All of these are technologies in which U.S. corporate inventors are least active. It is probably no coincidence that

[26] Japanese applications lead to grants more often than do applications from any of the other countries discussed here. For example, an estimated 68.3 percent of the patent applications filed by Japanese inventors in 1985 will lead to patent grants, compared to 65.9 percent for West Germany and 59.5 percent for the United States.

[27] Information in this section is based on the Patent Office's classification system which divides patents into approximately 370 active classes. Using this system, patent activity for U.S. and foreign inventors in recent years can be compared by developing an *activity index*. This index measures a country's patenting activity within a given class. For any given year, the activity index is the proportion of patents in *a particular class* granted to inventors in a specific country divided by the proportion of *all* patents granted to inventors in that country.

Because U.S. patenting data reflect a much larger share of patenting by individuals without corporate or government affiliation than do data on foreign patenting, only patents granted to *corporations* are used to construct the U.S. patenting activity indexes.

[28] Narin and Olivastro (1986) compare the fields emphasized by U.S. and Japanese inventors in their U.S. patenting; also see Narin and Frame (1989).

Japanese penetration of U.S. markets in many of these areas has followed.

U.S. patent activity is especially high in the wells and mineral oils classes, areas that are among those in which the Japanese patent the least. This inversion no doubt stems from the difference in natural resource availability between the two countries. U.S. corporations also emphasize patenting in chemical areas (including biochemistry); analytical and immunological chemical testing is a least emphasized class for Japan. Compared with Japanese patenting activity, Americans are also much more active in various biotechnology, pharmaceutical, and communication classes.

***Fields Favored by Other Major Industrialized Countries.*** As with Japan and the United States, patent data for West Germany, France, and the United Kingdom show each country's emphases among important technological areas. West German patent activity emphasizes printing, ammunition and explosives, and chemicals including fertilizers and plastics. West Germany has increased its activity in these areas substantially during the 1980-89 period. (See appendix table 6-25.)

French patent activity emphasizes, and has grown in, nuclear technology and communications. (See appendix table 6-26.) The French also show high activity in biotechnology; this may signal continued competition for U.S. biotech firms.

Like the French, the British are quite active in the biotech patent classes and communication technologies. (See appendix table 6-27.) They share the U.S. emphasis on aeronautics. Like the Germans, the British do not patent much in the United States in semiconductor manufacturing, nor do they particularly patent in areas of Japanese emphasis, such as dynamic information storage and retrieval and photography.

***Fields Favored by Newly Industrialized Countries.*** For the first time in the Science & Engineering Indicators series, patent activity data are presented for two of the more successful newly industrialized countries, Taiwan and South Korea. (See appendix tables 6-28 and 6-29.) Their recent patent activity in the United States can be seen as an indicator of areas of technological development as well as a leading indicator of U.S. product markets likely to see increased competition.

Taiwan illustrates the movement of the newly industrialized countries to new technology development and improvement of previously established technologies. As recently as 1980, patent activity by inventors from Taiwan in the United States was predominantly in the area of toys and other amusement devices. By 1989, however, Taiwan was emphasizing more highly technical classes, receiving patents in such areas as communications technology, semiconductor manufacturing processes, and internal combustion engines.

U.S. patenting by South Korean inventors is heavily concentrated in the patent classes that include electrical products and electronic component technologies. In fact, patents in these areas account for about half of the top 30 patent classes in which South Korean inventors are most active. Although Korea has high activity in less technologically significa t areas such as chairs and seats and amusement devices, it is also very active in such commercially important technologies as semiconductor devices and computer peripheral equipment. South Korea is already a major supplier of computers and peripherals to the United States, and these patent activity data show that the country's inventors may be developing the improvements that will support Korea's future competitiveness in this technology.[29] South Korea also patents heavily in the United States in television technology, and has made dramatic gains in penetrating this U.S. market (ITA 1991, p. 31-3). (See "Television Technologies," p. 152.)

## Patents by Standard Industrial Classifications

As an alternative to the U.S. Patent Office's system for classifying inventions, patents can also be classified by Standard Industrial Classification (SIC) industries.[30] Except for a moderate increase in the drugs and medicines industry, the U.S. share of patents dropped in the remaining nine industries shown on appendix table 6-30. The drop was especially great in

- Office, computing, and accounting machines—from 61 percent to 44 percent,
- Motor vehicles and other transportation equipment—from 53 to 41 percent,
- Communication equipment and electronic components—from 64 to 49 percent, and
- Aircraft and parts—from 51 to 44 percent.

The falloff in these industries was not due to a decline in U.S. patenting—which increased significantly from 1980 to 1989 in these and other important technology classes—but rather to a more rapid rate of increase by inventors from Japan, Canada, Taiwan, and South Korea. Overall, the share of U.S. patents held by inventors from West Germany, France, and—in particular—the United Kingdom declined.

Japan's share of U.S. patents approximately doubled from 1980 to 1989, going from 12 to 21 percent of the total. The Japanese share increased in each of the 10 industries shown, with an especially large increase in

[29]South Korea was the fifth largest foreign supplier of computers and peripherals to the United States in 1989. See ITA (1991), p. 28-2, and ITA (1990).

[30]In this classification system, each patent class is associated with the SIC industry that would produce the class's product or apparatus or carry out its process steps. See OTAF (1985), p. 26. The Concordance computer program maintained by the Patent Office converts patent counts from the Patent Office classification system into counts in terms of the 1972 SIC system. This section focuses on international comparisons of 10 commercially significant SIC industries; these are listed in appendix table 6-30.

### Television Technologies

In 1923, U.S. inventors revolutionized information transmission with the television receiver. Thirty-one years later, U.S. inventors ushered in a new era of television technology with color TV. U.S. manufacturers went on to dominate the consumer markets for television-related products, supplying 90 percent of the American market in 1970 (see Council on Competitiveness 1988). Since then, U.S. leadership as an innovator in television technologies declined: subsequently, so did its share of the consumer products market for television products. Japan then became the locus of television-related innovation; it soon became the recognized supplier of high-quality products in television and many other electronics products.

Now South Korea is also emerging as an innovative force in this field. Between 1980 and 1989, South Korean inventors received a total of 22 patents for television-related technologies. All of these were granted during the last 4 years of the period: 1 in 1986, 5 in 1987, 6 in 1988, and 10 in 1989. The 10 patents awarded to South Korean inventors in 1989 tied them with Italy for a seventh-place rank in that commercially important technology field. Moreover, one of Korea's largest manufacturers of television sets recently purchased a 5-percent share of the Zenith Electronics Corporation, the only U.S.-owned maker of televisions. Zenith also concluded licensing agreements that provided the Korean firm with access to Zenith's picture quality enhancement technology (*New York Times* 1991).

The television technologies market seems on the verge of revolutionary change with the advent of high-definition TV (HDTV). HDTV has attracted much attention from U.S. policymakers and has been represented as a pivotal technology that could provide the vehicle for reestablishment of a U.S. industry foothold in the consumer electronics market (Senate Committee on Governmental Affairs 1989). As noted, the United States currently claims only one U.S.-owned manufacturer of consumer televisions. (There are, however, several foreign-owned television manufacturing plants in the United States.) But the potential commercial value of the HDTV market and from other product markets that will incorporate HDTV technology may entice further U.S. business activity in this field (see OTA 1990 and American Electronics Association 1988).

office, computing, and accounting machines (rising from 17 to 40 percent). Japanese patenting in this field nearly reached the level of U.S. domestic patenting. Large increases in Japanese patenting also occurred in communication equipment and electronic components (from 15 to 31 percent) and in motor vehicles and equipment (from 16 to 32 percent).

The Canadian share of U.S. patents increased slightly over the period (from 1.7 to 2.1 percent), with the greatest share increases in drugs and medicines, industrial inorganic chemicals, and plastics and synthetic resins.

Although the *numbers* of U.S. patents granted to inventors from West Germany, the United Kingdom, and France increased between 1980 and 1989, their *shares* of total patents granted declined. Of the 10 commercially important industries examined, the West German share fell in 6. The French, whose overall share dropped the least among these three countries, also lost shares in 6 of the 10 product fields, and dropped sharply in 2 of these, motor vehicles and aircraft and parts. The number of U.S. patents granted to British inventors increased the least of the three in this year-to-year comparison; consequently, the United Kingdom declined the most in terms of share of total patents. The British share fell in 8 of the 10 commercially important industries, and fell sharply in 4.

The newly industrialized countries—Taiwan and South Korea in particular—once again showed the most dramatic increase in U.S. patent activity in 1989. Although their shares of total patenting remain quite small, it is noteworthy that their growth appears to have taken place in the more commercially important technologies. For example, in 1989 inventors from Taiwan were granted seven patents in the aircraft and parts industry and six in the engines and turbines industry compared with one and two, respectively, in 1980. These are two industries in which the United States has historically been very strong both in inventive activity and in global market share. South Korea, as noted earlier, is very active in television-related technologies. (See "Television Technologies," above.)

Products from Taiwan and South Korea currently compete with U.S., Japanese, and European products in the marketplace. Their recent patent activity portends even greater competition in the marketplace in the not-too-distant future.

## Citations From Patents to Previous Patents

Not all patents are equally significant. One method for gauging the relative values of different patents is analysis of interpatent citations. These citations, generally provided on the front page of a patent document, reference previous patents and are supplied by the patent examiner. These citations indicate the "prior art," i.e., they disclose technology in related fields of invention that should be taken into account in judging the novelty and "patentability" of the present invention. Therefore, the number of citations that a patent receives from the front pages of subsequent patents can serve as an indicator of the original patent's technical importance.[31]

***Citation to Patents, by Country.*** Of the 10 countries that received the most patents from 1980 to 1987, Japanese patents were most often cited and were cited with increasing relative frequency. (See text table 6-2.) U.S. patents were cited second most frequently, with the United Kingdom, The Netherlands, Canada, and West Germany following behind.[32]

These data suggest an order of technical significance for the patents granted to these countries. However, the frequency with which a country's patents are cited is explained in part by the technical fields in which it receives patents. Interpatent citation is more frequent in some fields than in others, and some countries (e.g., Japan and The Netherlands) concentrate their patenting somewhat in fields where citation is more frequent, but not necessarily more technologically valuable.

To correct for this, the data on text table 6-2 can be adjusted by giving every country the same distribution of patents by SIC field, i.e., the distribution that applies to the United States. The resulting citation frequencies per patent for the 1980 data are as follows:

- Japan, 3.63;
- United States, 3.58;
- Canada, 2.97;
- United Kingdom, 2.94;
- The Netherlands, 2.86;
- Sweden, 2.81;
- France, 2.63,
- West Germany, 2.61;
- Switzerland, 2.50; and
- Italy, 2.34.

Thus, although there are some changes in the ranking of countries, Japan remains first and the United States second in interpatent citations.

***Citation to Patents, by Country and Industry.***[33] The macro approach just discussed can yield distortions when used in international comparisons. These distortions are caused by the different mix of industries in which a nation tends to patent and the differing propensities of those industries to patent. Industry-level comparisons of citation rates help to refine the examination of the value of a country's patents in the United States.[34]

Japanese patents were the most highly cited in patent fields associated with 6 of 16 industries; they were the most highly cited in 10 industries when only foreign-owned patents are considered. Industries in which Japanese patents were highly cited are largely similar to those industries in which Japanese products are highly competitive.[35] (See appendix table 6-32.) British-owned patents were the most highly cited in 3 of the 16 industries and in 4 when comparing just foreign-owned patents. French and West German patents were each the most highly cited in only one industry.

U.S. patents granted were most highly cited in 5 of the 16 industries. Patents for drugs and medicines were especially strong, but familiarity with the procedures and requirements surrounding the development of such products for U.S. consumption may contribute to U.S. superiority in this field.

***Citations to U.S.-Owned Patents, by Sector of Owner.*** U.S. corporations own the patents that are most often cited, while patents owned by the U.S. Government and by U.S. individuals are cited least often. (See text table 6-2.) U.S. corporations, in 1975 and 1980, received patent citations as often as did Japanese holders of U.S. patents. Since almost all Japanese patents filed in the United States are owned by corporations,[36] it may be more appropriate to compare the citations received by Japanese (and other foreign) patents with those received by U.S. corporation-owned patents. By this measure, U.S. patents were cited a bit more often than Japanese patents in 1975 and 1980 but somewhat less often when considering the more recent and limited data of 1985 and 1987. Foreign-owned U.S. patents have citation rates slightly below that of U.S. corporate-owned patents but greater than all other owner sectors.

---

[31]Carpenter, Narin, and Woolf (1981) show that technologically important patents on average receive twice as many of these examiners' citations as does the average patent, thus helping to confirm the validity of interpatent citation as an indicator of patent quality.

In addition to examiners' citations on the front of the patent document, there are also citations from within the document, provided by the applicant, to earlier patents. Patents receiving high numbers of examiner citations also tend to receive high numbers of applicant citations. See Carpenter and Narin (1983).

[32]Text table 6-2 shows successive sharp increases in the number of citations per patent as the patents grow older. These increases occur because newer patents have had fewer years in which to be cited, not because of any general decline in the quality of patents. Data on citations received per patent are recorded as of the end of 1989. Consequently, the data shown for 1987 are especially incomplete.

[33]This discussion is based on an examination of the citation rates of patents granted in 1980 in 16 different industries; these industries are listed in appendix table 6-32.

[34]Of course, even an industry-level analysis is distorted somewhat by the diversity of product patents and their citation propensities within that industry.

[35]Japanese patents related to the aircraft and parts industry were also highly cited, but data in this field are confounded by the difficulty of distinguishing aircraft inventions from those in more conventional transportation technologies, such as motor vehicles. See Patent and Trademark Office (1985).

[36]In 1987, 96 percent of the U.S. patents granted to Japanese inventors were owned by foreign corporations, virtually all of which would be Japanese. Another 3 percent were owned by foreign individuals, and 1 percent had American owners.

Text table 6-2.
**Citations from U.S. patents to earlier U.S. patents, by country of inventor or sector of owner of cited patents**

| | Country of inventor | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Grant year of cited patents | United States | Japan | The Netherlands | United Kingdom | West Germany | Canada | France | Switzerland | Italy | Sweden | Average, all countries |
| | Citations per citable patent | | | | | | | | | | |
| 1975 ....... | 4.25 | 4.30 | 3.87 | 3.93 | 3.55 | 3.65 | 3.35 | 3.19 | 3.21 | 3.54 | 4.05 |
| 1980 ....... | 3.58 | 3.79 | 3.28 | 3.12 | 2.86 | 2.85 | 2.82 | 2.73 | 2.66 | 2.62 | 3.39 |
| 1985 ....... | 2.07 | 2.66 | 1.70 | 1.79 | 1.69 | 1.65 | 1.61 | 1.62 | 1.57 | 1.52 | 2.06 |
| 1987 ....... | 1.01 | 1.30 | 0.84 | 0.82 | 0.75 | 0.78 | 0.77 | 0.73 | 0.64 | 0.61 | 0.99 |

| | Sector of owner, for U.S. inventors | | | | |
|---|---|---|---|---|---|
| | All U.S. inventors | U.S. corporations | U.S. Government | U.S. individuals | Foreign owners |
| | Citations per citable patent | | | | |
| 1975 ............ | 4.25 | 4.49 | 3.29 | 3.66 | 4.36 |
| 1980 ............ | 3.58 | 3.88 | 2.81 | 2.90 | 3.87 |
| 1985 ............ | 2.07 | 2.25 | 1.66 | 1.57 | 2.07 |
| 1987 ............ | 1.01 | 1.10 | 0.74 | 0.77 | 1.01 |

NOTE: Numbers shown will increase, especially those for more recent years, as patents continue to receive more citations.

SOURCE: Computer Horizons, Inc., unpublished tabulations (1990).

*Science & Engineering Indicators – 1991*

## Diffusion of Technology in the Industrial Sector

Historically, the U.S. manufacturing base has operated in state-of-the-art factories using cutting edge technologies to produce manufactures more efficiently than its competitors. This advantage has been a key factor in the Nation's world economic success (see Council on Competitiveness 1991 and Wolf 1991). Moreover, U.S. industry's incorporation of the newest technologies in its manufacturing operations has given its workers a substantial edge in productivity. Recently, however, improvements in U.S. productivity growth have lagged behind those of several other industrialized countries (see BLS 1989). (See figure 6-21.) American industry's failure to reinvest adequately is often cited as a leading cause for this decline in productivity (see Wolf 1991). Since 1980 among the major industrialized countries, the largest increases in manufacturing productivity were registered in the United Kingdom (55.5 percent), Japan (54.4), and Italy (47.7). U.S. productivity increased 40.5 percent during the same period (1980-89). Although West Germany (15 percent) and Sweden (20.9) underperformed the United States, their success in the international marketplace lends evidence to the importance of other factors in building competitive economies.

### Industrial Use of Technology

In 1985, a report by the President's Commission on Industrial Competitiveness stressed the importance for U.S. industry's investment in the latest technologies and their rapid incorporation into U.S. manufacturing operations (President's Commission 1985). Recently, the Department of Commerce surveyed 10,526 manufacturing establishments concerning their current and planned use of advanced technology. The establishments were in five major industrial groups—fabricated metal products (SIC 34), industrial machinery and equipment (SIC 35), electronic and other electric equipment (SIC 36), transportation equipment (SIC 37), and instruments and related products (SIC 38).[37] Manufacturing establishments within these five categories accounted for nearly half of all employees and value added in the United States.[38]

The surveyed companies were asked for information on their current or planned use of 17 technologies in the following areas:

- Design and engineering (3 technologies),
- Fabrication/machining and assembly (5),
- Automated material handling (2),
- Automated sensor-based inspection and/or testing (2), and
- Communication and control (5).

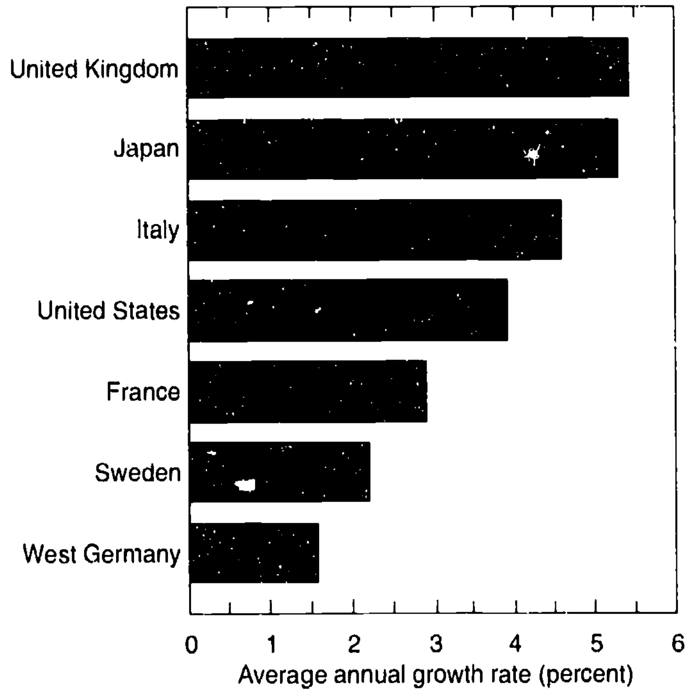
Appendix table 6-34 lists all 17 advanced technologies.

---

[37] The survey was performed by the Industry Division of the Bureau of the Census. (See Bureau of the Census 1989.) Surveyed establishments had 20 or more employees and were selected to represent the total universe of almost 40,000 manufacturing establishments classified in SIC's 34 to 38.

[38] Coverage estimates were derived from the 1987 Census of Manufactures. See Bureau of the Census (1988).

Figure 6-21.
**Manufacturing productivity growth rates: 1980-89**




See appendix table 6-33. *Science & Engineering Indicators – 1991*

Nearly 70 percent of the establishments surveyed indicated that they currently use at least 1 of the 17 advanced technologies in their manufacturing operations; 23 percent reported use of 5 or more technologies.[9] Several characteristics seem to be associated with establishments' use of advanced technology. For instance, most *large plants* (79 percent) reported widespread use of advanced technologies—that is, use of five or more—compared with just 13 percent of the small establishments.[10]

*Market value* of the establishment's output also appeared to influence degree of technology use. Establishments producing goods with market unit prices of $10,000 or more had the highest probability of using advanced technologies (82 percent used at least one), and establishments whose output had a market unit price of under $5 had the lowest probability (68 percent). Of establishments with products between these two price extremes, about three-quarters reported use of at least one advanced technology.

## International Comparisons of Technology Use

Surveys of technology use in manufacturing have been conducted in many other countries; two of these—those conducted in Canada and Australia—were modeled after the U.S. survey.[11] Despite their dissimilarities, the Canadian and Australian surveys provide an international context within which the U.S. survey data can be examined, albeit cautiously. For example, against the U.S. finding that technology use is positively influenced by plant size, the results from the Australian survey may be "artificially" low. The Canadian and Australian surveys also yielded certain qualitative information not developed in the U.S. survey that can contribute to an understanding of technology use by U.S. industry.

Compared with Canada and Australia, a significantly higher percentage of U.S. manufacturers use advanced technology in their operations.[12] (See appendix table 6-34.) In the U.S. survey of five major industries, 68 percent of the manufacturing establishments reported use of at least one advanced technology in their operations. Results from the Canadian and Australian surveys of all manufacturers show use of at least one advanced technology by 43 percent and 33 percent of respondents, respectively.

The most commonly used of the 17 advanced technologies in U.S. manufacturing is the numerically controlled machine, used by 41 percent of the surveyed establishments. Next most used was computer-aided design and engineering technology (CAD/CAE) which was reported in use by 39 percent of the establishments. (See figure 6-22.) Plants over 30 years of age were more likely to use numerically controlled machines than were plants under 5 years of age (50 percent versus 37 percent). When U.S. manufacturers were asked which of the specified advanced technologies they planned to use over the next 5 years, they selected those related to computerizing their production operations. Topping the list of such technologies were computers used for control on the factory floor. Coupled with present use of this technology, within 5 years 50 percent of the manufacturing plants will be using computers for controlling factory operations.

In the Canadian survey, programmable controller technology had the highest incidence of current use, followed by CAD/CAE technology. Like their U.S. counterparts, Canadian manufacturers planned to increase their use of CAD/CAE technology over the next 5 years, making it

[9] Information on the extent of use was not gathered by the survey. Thus, establishments using 1 robot are not differentiated from those using 100.

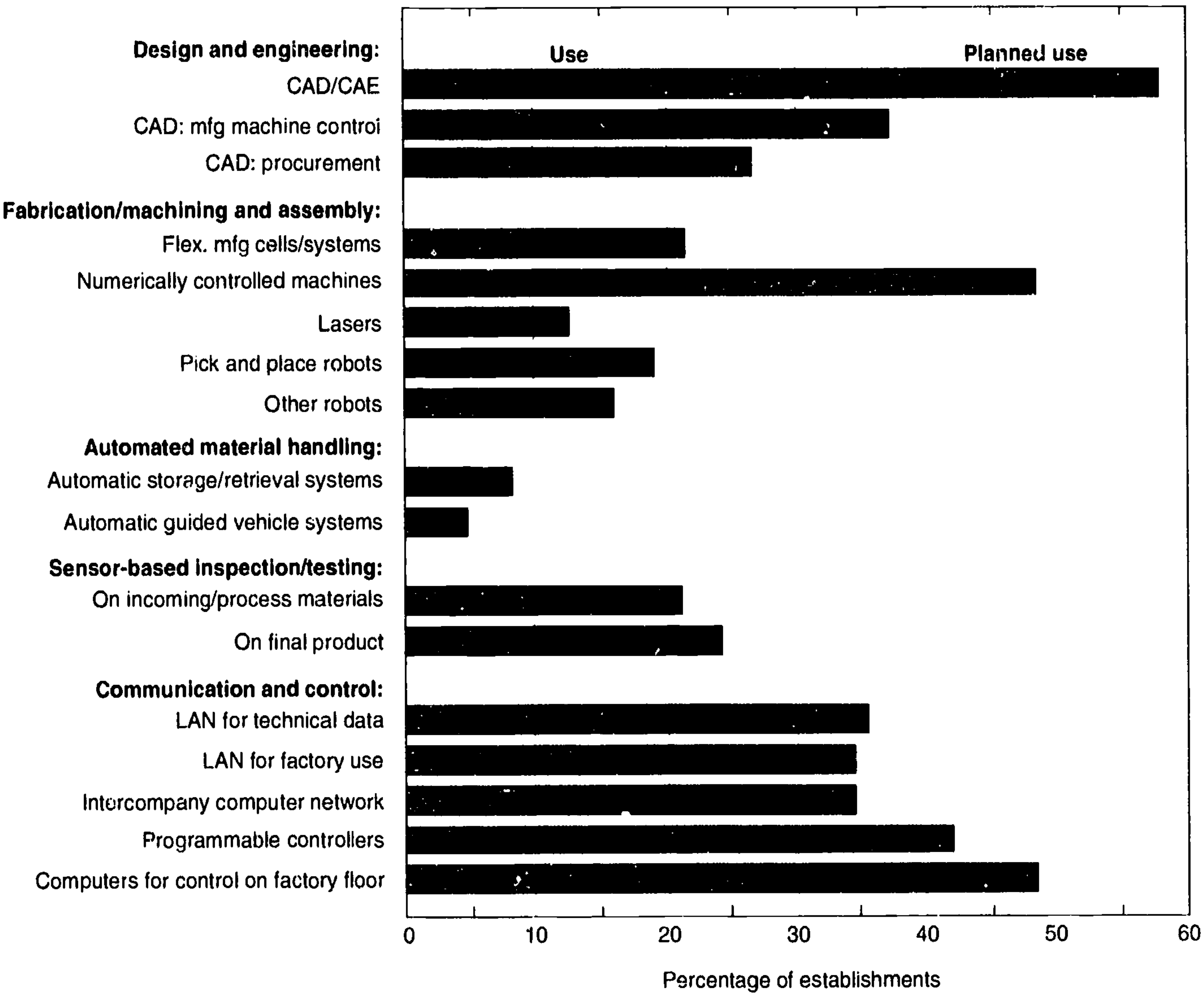
[10] The U.S. survey defined *large plants* as establishments with 500 or more employees and *small plants* as establishments with under 100 employees.

[11] The Canadian survey was conducted in March 1989 as part of a monthly industry survey. It was Canada's second survey of manufacturing technology use and covered the use of 22 advanced technologies (the first 17 are those used in the U.S. survey) by manufacturing plants in Canada. The Australian survey, also conducted in 1989, questioned manufacturers' "acquisition" rather than "use" of 19 advanced technologies (17 of these are comparable to those in the U.S. survey). Unlike the U.S. and Canadian surveys, which excluded manufacturing plants that employed fewer than 20 people, the Australian survey included smaller manufacturers and excluded only those employing fewer than 10.

Another possible source of bias to be aware of in comparing the findings of the three surveys is the differences in sample universes. The U.S. survey sampled establishments from five SICs which included many high-tech industries; Australia and Canada surveyed all manufacturers.

[12] This difference may simply be due to differences in the sampled populations of the three surveys.

Figure 6-22.
**U.S. manufacturers' use and planned use of advanced technologies**




See appendix table 6-34.

*Science & Engineering Indicators – 1991*

the most widely used of the 17 advanced technologies in Canada, with eventual use by 29 percent of manufacturers. When asked which of the 17 technologies they planned to use in the next 5 years, Canadian manufacturers—like their U.S. counterparts—selected computers for control on the factory floor.[13]

For all 17 advanced technologies common to the three surveys, Australian manufacturers reported acquisition significantly below the use reported by U.S. manufacturers.[14] The programmable electronic controller had the highest acquisition rate of any of the technologies included in the Australian survey: 14 percent of manufacturing establishments had this technology. CAD/CAE technology also had a relatively high acquisition rate. This technology topped the list for purchase over the next 5 years, which would make it the most prevalent technology in Australian manufacturing.

The U.S. and Canadian surveys solicited information on reasons why manufacturers did not use those advanced technologies that they reported least frequently. (See appendix table 6-35.) Both U.S. (54 percent) and Canadian (79 percent) manufacturers stated that materials working lasers were not applicable to their particular manufacturing operations. In Canada, pick and place robots were cited as not providing enough benefits to outweigh the cost of their incorporation into manufacturing operations. U.S. manufacturers provided the same reason for non-use of automatic guided vehicle systems.

[13] As noted earlier, the Canadian survey questioned manufacturers on 22 advanced technologies. Two manufacturing information systems technologies that did not appear on the U.S. survey were selected most often by Canadian manufactarers as the technologies they planned to use in the future. These two were followed by computers for control on the factory floor.

[14] Again, the Australian survey included smaller firms than did the U.S. and Canadian studies. It also differed by surveying *acqusition* of advanced technologies rather than *use*.

Finding skilled personnel to work in manufacturing operations that are becoming increasingly sophisticated technologically is a problem often reported by U.S. industry. Information from the Canadian and Australian surveys showed that manufacturers in these countries also had difficulty hiring employees with the skills needed to operate and maintain advanced technologies.[15] In Canada, 53 percent of the surveyed establishments reported having at least some difficulty in hiring skilled personnel to work with the technologies being incorporated into their manufacturing operations; 35 percent of the Australian respondents voiced a similar concern. Manufacturers in both countries made up for this shortfall by providing formal training to their employees. Canadian plants provided in-house training on site or elsewhere in the firm; Australian plants provided existing staff with on-the-job training, special in-house training courses, and external training courses.

## Small Business and High Technology

Small business is widely viewed as the source of many of the new products and processes introduced into the economy.[16] Surveys show that small businesses rely more heavily on new products to generate revenues than do larger businesses; consequently, they must be more efficient at producing commercially successful innovations. A keen receptivity to new product ideas found outside their own operations characterizes this efficiency (see Hanson 1991). Small businesses supplement internal product development with new product ideas drawn from dealings with customers, suppliers, government labs, universities, and others to ensure useful innovations. The creation and growth of small high-tech companies are of particular interest as they contribute to the Nation's ability to develop, adopt, and diffuse new technologies.

This section presents certain characteristics and performance indicators for small high-tech companies.[17] The discussion focuses on companies active in the following seven technology fields:

- Automation,
- Biotechnology,
- Computer hardware,
- Advanced materials,
- Photonics and optics,
- Software, and
- Telecommunications.

These fields encompass many of the technologies considered critical to the country's future economic competitiveness. (See "Technologies for Future Competitiveness," pp. 160-62.)

### Trends in New U.S. High-Tech Business Startups

The formation of high-tech companies was strongly accelerated during the second half of the 1970s and the early 1980s; this was followed by a sharp decline in formations in the late eighties.[18] (See figure 6-23.) About half of the new high-tech businesses formed during these two decades were computer-related companies; startups in factory automation and telecommunications followed. The number of new biotechnology companies formed during this period trailed the other six technologies, yet it was the only group that increased steadily as a share of all technology company formations. Other technology fields that exhibited relative share growth during the latter half of the 1980s were companies in the advanced materials and photonics and optics fields.

### Distribution of Companies by State

New high-tech companies are highly concentrated: Over 65 percent of these companies are located in just 10 states. (See figure 6-24.) Yet compared to just 2 years ago, the distribution appears to be leveling off, with the top three states—California, Massachusetts, and New York—all experiencing share declines (see NSB 1989, p. 364).

These declines notwithstanding, California leads all states by significant margins in six of the seven technology fields examined. Maryland stands out in the biotechnology field, ranking second among the 50 states. The presence of the National Institutes of Health and Johns

[15] The U.S. survey did not include a comparable question.

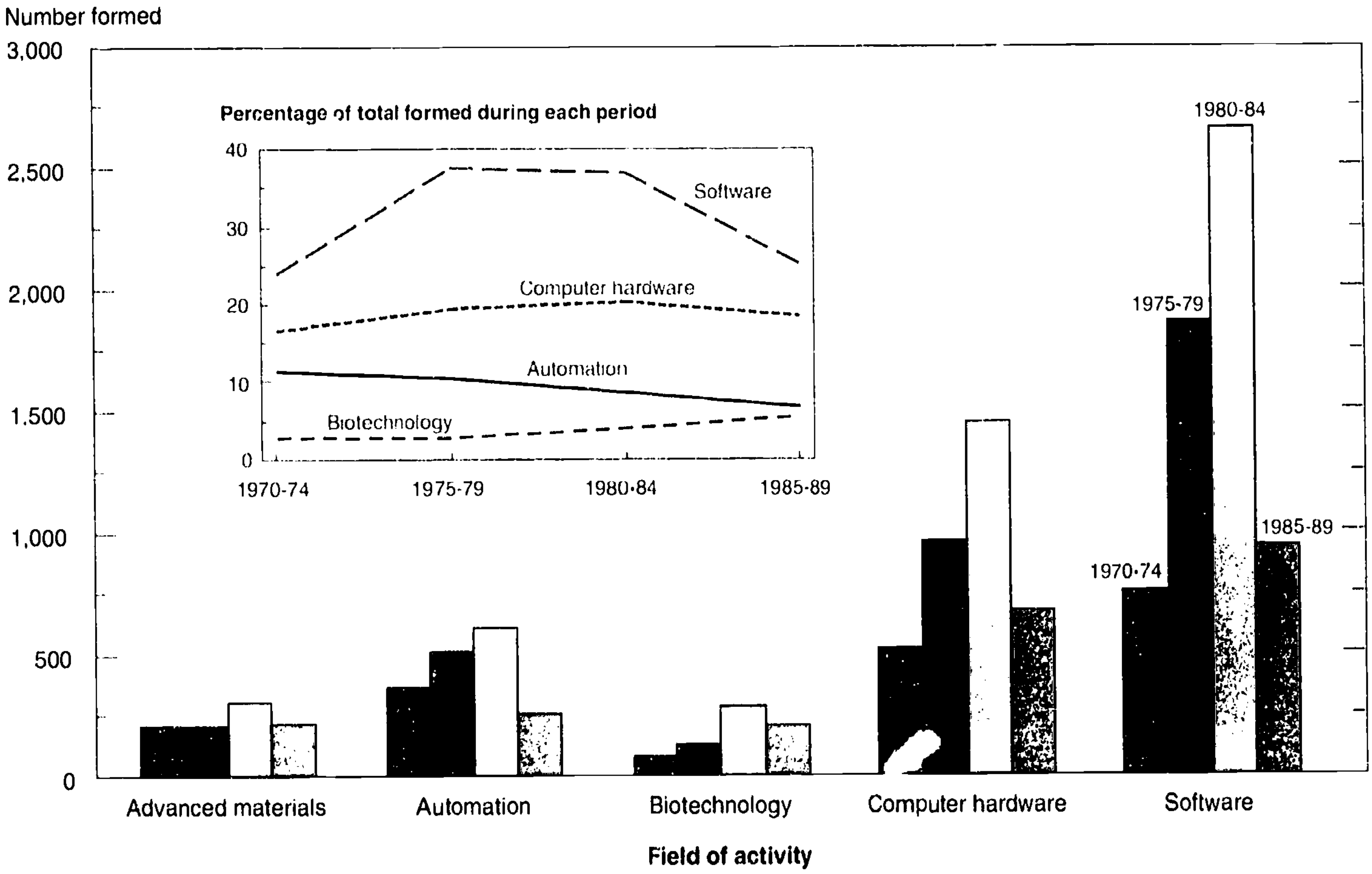
[16] In a 1982 study done for the Small Business Administration comparing innovation between small and large firms, it was found that, per employee, small firms produced 2.4 times as many innovations as large firms. See Futures Group (1984) and Hanson, Stein, and Moore (1984).

[17] Information in this section is derived from the CorpTech data base, owned by Corporate Technology Information Services, Inc., Wellesley Hills, Massachusetts. The CorpTech data base permits an inspection of small business entities by technology field. This data base includes many of the new startups and private companies often missed by other data bases and is one of the most current sources of information on small newly formed companies active in high-tech fields. The data base attempts to be all-inclusive: by CorpTech's own estimate, it includes 99 percent of large companies (over 1,000 employees), 75 percent of medium-sized companies with 250 to 1,000 employees, and 65 percent of companies with less than 250 employees. When prospective companies for inclusion in the data base are identified, they are sent questionnaires covering their size, status (private or public, independent, subsidiary, or joint venture), year formed, and product groups in which they are active. The version of the data base used here (Rev. 6.0 1991) includes about 35,000 independently managed companies.

[18] Throughout this discussion, the following terms are used (see SBA 1988):

- *Establishment or company*—a business entity that may or may not be part of a larger complex, and
- *Firm or enterprise*—an establishment that is either (1) a single location with no subsidiary or branches or (2) the topmost parent of a group of establishments.

Figure 6-23.
**High-tech business formation**




See appendix table 6-36. *Science & Engineering Indicators – 1991*

Hopkins University creates an environment in Maryland conducive to new business formations in the biotech field. Illinois and Ohio tend to attract companies active in factory automation technologies, probably reflecting the Midwest's manufacturing tradition.

## Foreign Ownership of U.S. High-Tech Companies

Approximately 11 percent of the high-technology companies are under foreign ownership—up from 9 percent just 2 years ago (see NSB 1989, p. 365, appendix table 6-16). (See appendix table 6-38.) The United Kingdom has, by far, the largest U.S. presence, followed by Japan and West Germany. Although these three countries own companies active in each of the seven technology fields examined, they each tend to be drawn to certain fields: the United Kingdom and West Germany to U.S. companies active in the development of advanced materials, and Japan to companies involved in telecommunications and computer hardware. Compared with the major industrialized countries, Taiwan and South Korea own relatively few U.S. high-tech companies; they have concentrated their acquisitions on U.S. companies active in computer hardware development.

## Sources of Capital

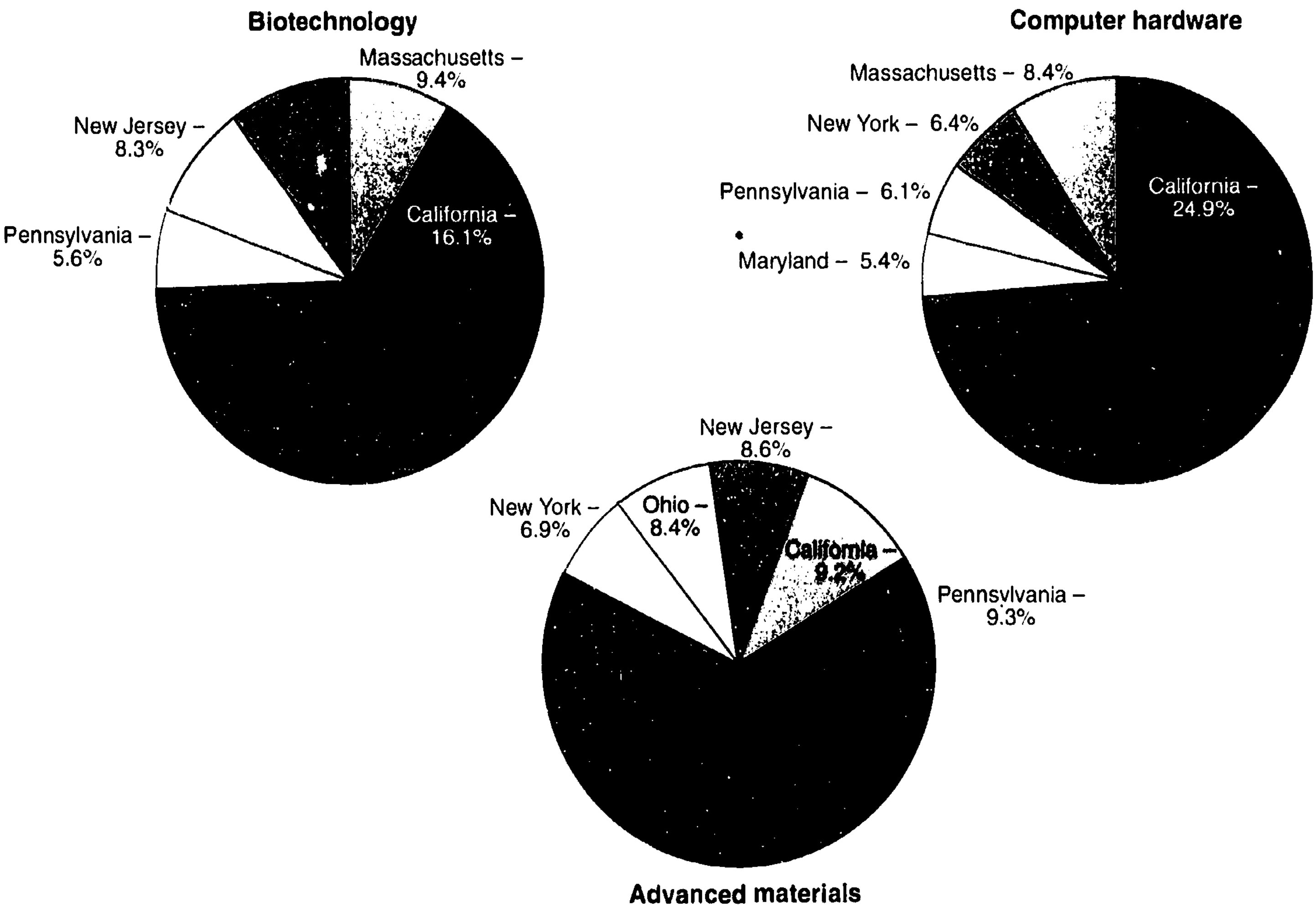
The creation and expansion of small business require access to capital. New small businesses engaged in the development of cutting edge technologies can find it difficult to secure traditional financial support—i.e., obtaining bank loans or selling equity in the stock markets. An overwhelming majority (70 percent) of the high-tech companies formed during the 1980s relied solely on private investment for business startup or expansion.[10] (See figure 6-25.) Private investment, in fact, is the primary funding source for each of the technology fields examined. A combination of private investment and venture capital ranked second among the companies, but only 11 percent financed operations in this manner. About 6 percent of the companies were financed solely with venture capital; companies active in telecommunications technologies led the other six fields in using this form of financing.

## Performance of New High-Tech Companies

The performance of high-technology companies slowed during 1990, yet they continued to outperform

[10] Private investment includes capital provided by principals of the company and by outside private individual investors.

Figure 6-24.
**U.S. locations of companies active in three technology fields**



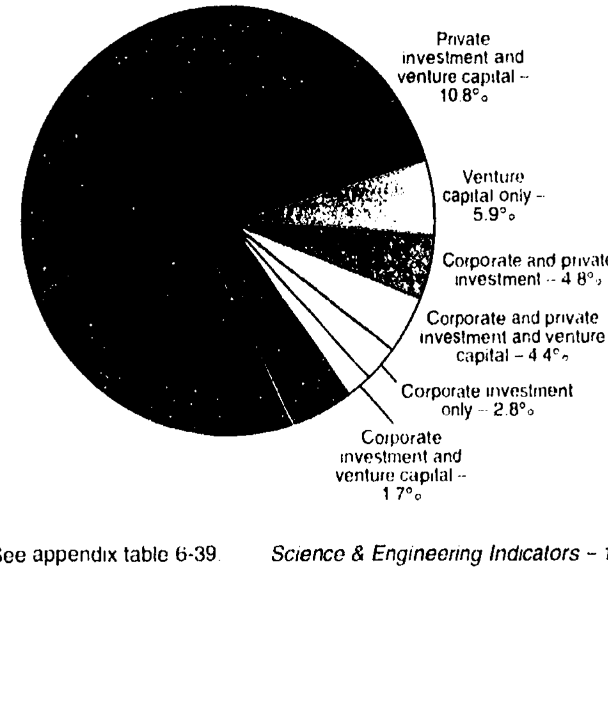

See appendix table 6-37.

*Science & Engineering Indicators – 1991*

other sectors of the economy (see Corporate Technology 1991, p. 1-viii). High-tech companies formed during the 1980s showed their importance to the U.S. economy by their performance in four indicators—employment growth, job creation, annual sales, and sales exports. (See text table 6-3.) Computer-related companies experienced the highest growth rate of the seven technology fields during 1990, increasing employment by about 14 percent and adding over 250,000 new jobs. Businesses developing computer hardware did somewhat better than the software companies.

The 1990 earnings recorded by these newly formed high-tech companies suggest an ability to generate high revenues even during sluggish economic periods as well as a capacity to offer products that meet the demands of the global marketplace. Annual sales productivity per employee ranged between $86,000 for biotech companies up to $173,000 for companies producing computer hardware. About 40 percent of these new companies generated over 10 percent of their revenues from sales to foreign markets. The advanced materials field had the highest

Figure 6-25.
**Sources of capital for new high-tech companies**




See appendix table 6-39.

*Science & Engineering Indicators – 1991*

percentage of companies involved in exporting (44 percent); the software field had the lowest (32 percent). Software suppliers may be somewhat less aggressive than other high-tech companies in seeking out foreign customers, in part because of persistent international disagreements surrounding the rules governing intellectual property rights (see ITA 1991, p. 28-15).[30]

## Technologies for Future Competitiveness

Several recent U.S. Government reports (National Critical Technologies Panel 1991, Technology Administration 1990, and DOD 1989) linked future U.S. economic and national security with the timely development and deployment of certain key technologies. Although these reports generally agree on the technology fields on which the United States needs to focus its attention, they differ in certain instances by the technologies emphasized within each field. (See text table 6-4.) This section focuses on the 12 emerging technologies singled out by the Department of Commerce as crucial to this Nation's future industrial competitiveness (Technology Administration 1990).These 12 technologies are categorized into four major areas—materials, electronics and information systems, manufacturing systems, and life sciences applications—and have an estimated potential for $1 trillion in annual product sales in the global market by 2000.[31]

Figure 6-26 summarizes the comparative condition of the U.S. effort, as seen by the Department of Commerce, in each of the 12 technologies vis-à-vis the positions of Japan and the European Community. Briefly, as of 1989, the United States was considered to be ahead of or even with Japan in 7 of the technologies and ahead of or even with Europe in 11. The United States was considered the world leader in five technologies—artificial intelligence, biotechnology, high-performance computing, medical devices and diagnostics, and sensor technology; it lagged behind both Japan and Europe in just one area—digital imaging technology.

However, according to DOC's Technology Administration (1990), if current trends continue, the United States could lose its leadership position to Japan and Europe in many of these technologies by the year 2000. (See figure 6-26.)

[30]In fact, copyright protection for software is a high-priority issue in the ongoing negotiations toward the economic integration of Europe. As of the end of 1990, this issue remained unresolved.

[31]An emerging technology is defined as ". . . one in which research has progressed far enough to indicate a high probability of technical success for new products and applications that might have substantial markets within approximately 10 years." DOC's Technology Administration identified its list of critical emerging technologies through consultations with scientists and engineers at the National Institute of Standards and Technology, analysts at DOC's International Trade Administration, and various U.S. science, engineering, and industrial experts.

This section focuses on the DOC list rather than those compiled by the Department of Defense or the National Critical Technologies Panel primarily because the DOC list (1) focuses on technologies with a *commercial* importance, (2) provides international comparisons with Japan and Europe by technology, and (3) overlaps most of the technologies contained on the other two lists.

Text table 6-3.
**Performance measures for newly formed companies active in certain high-tech fields: 1990**

| Field | Employment growth rate during past year | Number of jobs created during past year | Annual sales per employee | Percentage of companies exporting over 10 percent of total sales |
|---|---|---|---|---|
| Automation | ´2.6 | 58,471 | $126,330 | 40.7 |
| Biotechnology | 10.6 | 16,468 | 86,063 | 43.9 |
| Computer hardware | 14.5 | 148,304 | 172,752 | 42.9 |
| Computer software | 13.9 | 103,479 | 107,992 | 32.1 |
| Advanced materials | 5.8 | 32,452 | 155,198 | 44.4 |
| Photonics and optics | 8.4 | 27,654 | 103,592 | 36.8 |
| Telecommunications | 12.7 | 61,280 | 117,679 | 43.9 |

NOTE: Includes independent companies formed during 1980-89

SOURCE: Derived from the CorpTech data base (Rev. 6.0 1991), Corporate Technology Information Services, Inc., Wellesley Hills, MA.

*Science & Engineering Indicators – 1991*

Text table 6-4.
**Comparison of government lists of important technologies**

| National critical technologies | Commerce emerging technologies | Defense critical technologies |
|---|---|---|
| **Materials** | | |
| Materials synthesis and processing | Advanced materials | Composite materials |
| Electronic and photonic materials | Advanced semiconductor devices | Semiconductor materials and microelectronic circuits |
| | Superconductors | Superconductors |
| Ceramics | | |
| Composites | Advanced materials | Composite materials |
| High-performance metals and alloys | | |
| **Manufacturing** | | |
| Flexible computer-integrated manufacturing | Flexible computer-integrated manufacturing | |
| Intelligent processing equipment | Artificial intelligence | Machine intelligence and robotics |
| Micro- and nanofabrication | | |
| Systems management technologies | | |
| **Information and communications** | | |
| Software | High-performance computing | Software producibility |
| Microelectronics and optoelectronics | Advanced semiconductor devices | Semiconductor materials and microelectronic circuits |
| | Optoelectronics | Photonics |
| High-performance computing and networking | High-performance computing | Parallel computer architectures |
| High-definition imaging and displays | Digital imaging | Data fusion |
| Sensors and signal processing | Sensor technology | Data fusion |
| | | Signal processing |
| | | Passive sensors |
| | | Sensitive radars |
| | | Machine intelligence and robotics |
| Data storage and peripherals | High-density data storage | Photonics |
| Computer simulation and modeling | High-performance computing | Simulation and modeling |
| | | Computational fluid dynamics |
| **Biotechnology and life sciences** | | |
| Applied molecular biology | Biotechnology | Biotechnology materials and processes |
| Medical technology | Medical devices and diagnostics | |
| **Aeronautics and surface transportation** | | |
| Aeronautics | | Air-breathing propulsion |
| Surface transportation technologies | | |
| **Energy and environment** | | |
| Energy technologies | | |
| Pollution minimization, remediation, and waste management | | |
| | | No national critical technologies counterpart: high energy density materials, hypervelocity projectiles, pulsed power, signature control, weapon system environment |

NOTE: National critical technologies were designated by the National Critical Technologies Panel; emerging technologies were designated by the Department of Commerce; defense critical technologies were designated by the Department of Defense.

SOURCE: National Critical Technologies Panel, *Report of the National Critical Technologies Panel* (Washington, DC: 1991).

*Science & Engineering Indicators – 1991*

Figure 6-26.
**U.S. report card: 1989 status and trends**

**Status**

| | Versus Japan | Versus Europe |
|---|---|---|
| **Behind** | Advanced materials<br>Advanced semiconductor devices<br>Digital imaging<br>High-density data storage<br>Optoelectronics | Digital imaging |
| **Even** | Superconductors | Flexible computer-integrated manufacturing<br>Superconductors |
| **Ahead** | Artificial intelligence<br>Biotechnology<br>Flexible computer-integrated manufacturing<br>High-performance computing<br>Medical devices and diagnostics<br>Sensor technology | Advanced materials<br>Advanced semiconductor devices<br>Artificial intelligence<br>Biotechnology<br>High-density data storage<br>High-performance computing<br>Medical devices and diagnostics<br>Optoelectronics<br>Sensor technology |

**Trends**

| | Versus Japan | Versus Europe |
|---|---|---|
| **Losing Badly** | Advanced materials<br>Biotechnology<br>Digital imaging<br>Superconductors | Digital imaging<br>Flexible computer-integrated manufacturing |
| **Losing** | Advanced semiconductor devices<br>High-density data storage<br>High-performance computing<br>Medical devices and diagnostics<br>Optoelectronics<br>Sensor technology | Medical devices and diagnostics |
| **Holding** | Artificial intelligence<br>Flexible computer-integrated manufacturing | Advanced materials<br>Advanced semiconductor devices<br>High-density data storage<br>Optoelectronics<br>Sensor technology<br>Superconductors |
| **Gaining** | | Artificial intelligence<br>Biotechnology<br>High-performance computing |

SOURCE Technology Administration, Department of Commerce, "Emerging Technologies: A Survey of Technical and Economic Opportunities" (Washington, DC DOC 1990)

*Science & Engineering Indicators – 1991*

# References

Abbott, T.A., III. 1991. "Measuring High Technology Trade: Contrasting International Trade Administration and Bureau of Census Methodologies and Results." *Journal of Economic and Social Measurement* 17: 17-44.

American Electronics Association. 1988. *High Definition Television (HDTV): Economic Analysis and Impact.* Washington, DC.

Balk, A., et al. 1991. "ASIAPOWER, Technology's Pacific Tilt," *Spectrum* Vol. 28, No. 6 (June): 26-66.

Bureau of the Census. 1989. *Manufacturing Technology 1988.* SMT(88)-1. Washington, DC: GPO.

Bureau of Labor Statistics (BLS). 1989. *International Comparisons of Manufacturing Productivity and Labor Cost Trends 1989.* Washington, DC.

———. 1991. *Employment and Earnings.* (March). Washington, DC.

Carpenter, M.P., and F. Narin. 1983. "Validation Study: Patent Citations as Indicators of Science and Foreign Dependence." *World Patent Information* 1983: 180-85.

Carpenter, M.P., F. Narin, and P. Woolf. 1981. "Citation Rates to Technologically Important Patents." *World Patent Information* 1981: 160-63.

Corporate Technology Information Services, Inc. 1991. *Corporate Technology Directory 1991.* 6th ed. Woburn, MA.

Council on Competitiveness. 1988. *Picking Up the Pace: The Commercial Challenge to American Innovation.* Washington, DC.

———. 1991. *Gaining New Ground: Technology Priorities for American's Future.* Washington, DC.

Council of Economic Advisers. 1989. *Economic Report of the President.* Washington, DC: GPO.

Department of Commerce (DOC). 1983. *An Assessment of U.S. Competitiveness in High Technology Industries.* Washington, DC: 1983.

Department of Defense (DOD). 1989. *Critical Technologies Plan.* Washington, DC.

Dornbusch, R., J. Porteba, and L. Summers. 1988. "Business, Economics, and the Oval Office: Advice to the New President and Other CEOs." *Harvard Business Review* No. 6 (November-December): 76-80.

Futures Group. 1984. *Characterization of Innovations Introduced in the U.S. Market in 1982.* Washington, DC: Office of Advocacy, Small Business Administration.

Griliches, Z. 1990. "Patent Statistics as Economic Indicators: A Survey." *Journal of Economic Literature* Vol. 28 (December): 1661-707.

Hadlock, P., D. Hecker, and J. Gannon. 1991. "High Technology Employment: Another View." *Monthly Labor Review* (July).

Hanson, J.A. 1991. "New Innovation Indicator Data Validation." Final report to the National Science Foundation. Washington, DC: NSF.

Hanson, J., J. Stein, and T. Moore. 1984. *Industrial Innovation in the U.S., Survey of 600 Companies.* Boston: Boston University.

International Trade Administration (ITA), Department of Commerce. 1983. *An Assessment of U.S. Competitiveness in High Technology Industries.* Washington, DC: DOC.

———. 1985. *U.S. High-Technology Trade and Competitiveness.* Washington, DC: DOC.

———. 1990. *Competitive Status of the U.S. Electronics Sector: from Materials to Systems.* Washington, DC: DOC.

———.164 1991. *1991 U.S. Industrial Outlook.* Washington, DC: DOC.

Kelly, R.K. 1976. "Alternative Measures of Technology-Intensive Trade." *Staff Economic Report.* Washington, DC: Office of Economic Research, Department of Commerce.

Milberg, W. 1988. "The Product Line Life Cycle Model of Intra-Industry Trade." *Eastern Economic Journal* Vol. XIV, No. 4 (October-December): 389-97.

Mowery, D.C. 1987. *Alliance Politics and Economics: Multinational Joint Ventures in Commercial Aircraft.* Cambridge, MA: Ballinger Publishers.

Narin, F., and J.D. Frame. 1989. "The Growth of Japanese Science and Technology." *Science* 245 (August 11): 600-05.

Narin, F., and D. Olivastro. 1986. "Second Interim Report: Identifying Areas of Leading Edge Japanese Science and Technology." Report to the Science Resources Studies Division, National Science Foundation. National Technical Information Service Order No. PB87 204095/AS. Washington, DC.

National Critical Technologies Panel. 1991. *Report of the National Critical Technologies Panel.* Washington, DC.

National Science Board (NSB). 1989. *Science & Engineering Indicators - 1989.* NSB 89-1. Washington, DC: GPO.

*New York Times.* 1991. February 26, p. D1.

Office of Science and Technology Policy (OSTP). 1990. *U.S. Technology Policy.* Washington, DC.

Office of Technology Assessment (OTA). 1990. *The Big Picture: HDTV and High-Resolution Systems.* OTA-BP-CIT-64. Washington, DC: GPO.

Office of Technology Assessment and Forecast (OTAF), Patent and Trademark Office. 1985. "Review and Assessment of the OTAF Concordance Between the U.S. Patent Classification and the Standard Industrial Classification Systems: Final Report." Washington, DC: Patent and Trademark Office.

Patent and Trademark Office. 1985. *Trilateral Statistical Report: 1985 Edition.* Washington, DC.

Pavitt, K. 1985. "Patent Statistics as Indicators of Innovative Activities: Possibilities and Problems." *Scientometrics* 7: 77-99.

Porter, A.L., and J.D. Roessner. 1991. "Indicators of National Competitiveness in High Technology Industries." Final report to the Science Indicators Studies Group, National Science Foundation. Washington, DC: NSF.

President's Commission on Industrial Competitiveness. 1985. *Global Competition: The New Reality.* Vol. 1. Washington, DC: GPO.

Reich, R.B., and E. Mankin. 1986. "Joint Ventures with Japan Give Away Our Future." *Harvard Business Review* March-April.

Science Resources Studies Division (SRS), National Science Foundation. 1988. "Economic Outlook and Corporate Mergers Dampen Growth in Company R&D." *Science Resources Studies Highlights.* NSF 88-311. Washington, DC: NSF.

———. 1989. "Modest Increase in Company R&D Funding Estimates for 1989." *Science Resources Studies Highlights.* NSF 89-310. Washington, DC: NSF.

———. 1991. *Selected Data on Research and Development in Industry: 1989.* Washington, DC: NSF.

Senate Committee on Governmental Affairs. 1989. *Prospects for Development of a U.S. HDTV Industry.* Collection of papers presented at a hearing before the Committee. Washington, DC: GPO.

Small Business Administration (SBA). 1988. *Handbook of Small Business Data.* Washington, DC.

Technology Administration, Department of Commerce. 1990. "Emerging Technologies: A Survey of Technical and Economic Opportunities." Washington, DC: DOC.

Wolf, E.N. 1991. "Capital Formation and Productivity Convergence Over the Long Term." *American Economic Review* Vol. 81 (June): 565-79.

# Chapter 7
# Attitudes Toward Science and Technology: The United States and International Comparisons

## CONTENTS

# Attitudes Toward Science and Technology: The United States and International Comparisons

## HIGHLIGHTS

### U.S. Public Attitudes Toward Science and Technology

- **Most Americans have a positive attitude about science and technology (S&T).** For over 30 years, at least four out of five American adults have stated that S&T has a positive effect on their lives. *See pp. 174-76.*
- **Americans trust the motives of scientists.** Eighty percent agree that most scientists want to make life better for the average person. *See pp. 176-77.*
- **Americans support Federal funding of basic research.** Four-fifths agree with the proposition that even if it brings no immediate benefits, basic scientific research should be supported by the Federal Government. *See p. 177.*
- **Assessments of space exploration are changing, and in a negative direction.** Between 1985 and 1990, the proportion of Americans who felt that the costs of the space program exceed its benefits increased from 38 to 47 percent. *See pp. 177-79.*
- **Fewer Americans now approve of using large animals in scientific research.** Between 1985 and 1990, the percentage who approved of research causing pain to animals like dogs and chimpanzees—even if it results in new knowledge about human health—fell from 63 to 50 percent. *See p. 181.*

### U.S. Public Attitudes Toward Education

- **The U.S. public sees strong links between education, advancements in science, and U.S. economic competitiveness.** Seventy-five percent of the public feels that if more Americans could obtain a college degree, "big improvements" would result in science, medicine, and technology; 59 percent predict big improvements in U.S. competitiveness. *See pp. 179-80.*
- **Americans are increasingly concerned about the quality of science and mathematics education.** Since 1985, the percentage of adults who agree that science and mathematics education in U.S. schools is inadequate has risen from 63 percent to 72 percent. *See pp. 179-80.*

### International Comparisons of Attitudes Toward S&T

- **Public attitudes toward S&T are reported in this volume for 15 countries.** In 1989 and 1990, coordinated surveys were conducted in Japan, Canada, the United States, and 12 countries of the European Community. *See pp. 182-84.*
- **U.S. and Canadian adults are similar in their attitudes toward S&T and are more positive in these attitudes than Western European adults.** They are also more positive about the impacts of science. *See pp. 184-85.*
- **Notable differences in public support for governmental funding of basic research are evident among the national populations of Western Europe and the United States.** U.S., British, and French respondents were in strong agreement that government should support basic research. In contrast, only a bare majority of adults in West Germany agreed with this proposition. *See pp. 184-85.*
- **The Japanese seem less positive about S&T than Americans, but the indicators are unclear.** Larger percentages of Japanese than Americans disagree that S&T has positive effects on life. On other indicators, Japanese attitudes toward S&T are positive. *See pp. 185-86.*
- **Japanese and American respondents are similar in their assessments of the effects of science on moral issues.** About a third of the adults in each country are concerned that science has a negative effect on morals. *See p. 186.*

### Knowledge of Basic Facts About S&T

- **U.S. response patterns for several true/false questions about S&T are similar to Canadian and European (total) responses.** Mean accurate response rates are very similar, and similar distributions within the samples are also evident. Among the member countries of the European Community, however, there are considerable differences in both accurate response rates and distribution of such responses in the populations. *See pp. 187-89.*

### Perception of International Standing in S&T

- **Americans increasingly feel that the Japanese are ahead of the United States in basic scientific achievements.** Between 1985 and 1990, the proportion of adults placing Japan ahead of the United States in basic science increased from 29 to 50 percent. *See pp. 189-90.*
- **Americans today are less concerned about Soviet military technology than they were 5 years ago.** Between 1985 and 1990, the proportion of Americans considering the United States ahead of the Soviet Union in military technology increased from 33 to 46 percent. Americans with more education tended to be even more critical in their evaluations of Soviet military technology. *See p. 190.*

## Introduction

### Chapter Focus

A substantial majority of Americans value scientific research, and they perceive a strong link between advances in science and technology (S&T) and improvements in their own daily lives. Even if they are unsure about the actual processes of scientific work, Americans are positive about the institution of science, about scientists, and about government support for research. American optimism about science stands out among the industrialized countries; compared with Canada, Japan, and the nations of Western Europe, the United States scores high on a set of indicators of public confidence in science.

The U.S. public has maintained its strong support for science while remaining unaware of basic scientific concepts about the natural world. Most adults are not conversant with the broad scientific questions underlying a number of contemporary public policy issues. They often reject scientific explanations that disagree with other beliefs, and their otherwise strong support for science is more equivocal when scientific and moral questions conflict.

Americans are increasingly concerned about the quality of education in the United States and overwhelmingly favor more training in science and mathematics. And, in response to rapid global political and economic changes, the U.S. public is changing its perceptions of the country's world standing in S&T. A majority of American adults now think that Japan leads the United States in both technological development *and* basic scientific achievement, while evaluations of Soviet scientific and technological capabilities have dropped sharply.

### Chapter Organization

This chapter discusses indicators of these and related topics using data from a series of attitudinal surveys commissioned for this and previous *Indicators* reports.[1] The chapter is divided into two sections. The first contains indicators for the United States only and emphasizes trends over time. This section also contains an expanded discussion of U.S. public attitudes toward issues concerning education and includes a new scale of science and mathematics coursetaking. Many of the data displays show the different response rates for people with varying levels of formal training in science and mathematics.

The second section of this chapter discusses greatly expanded international comparisons on several of the indicators introduced earlier in the chapter. These comparisons are possible because of the rapidly growing number of researchers and sponsoring organizations around the world interested in public attitudes toward S&T.

## U.S. Public Attitudes Toward S&T

Many of the following indicators of U.S. public attitudes toward S&T have been collected over the 20-year history of *Indicators* at roughly 2-year intervals.[2,3] The information is organized around these three major questions:

- Who is interested in and attentive to issues concerning S&T, and how does the adult public learn about these aspects of the culture?
- What does the public know about science, including knowledge of scientific concepts, of basic scientific findings and theories, and of current public policy issues involving S&T?
- What are public attitudes toward S&T, that is, how does the public evaluate various aspects of organized science, the effects of science on their daily lives, and large public technology programs?

### Who Is *Interested* in Science?

In a modern society rich with information, people tend to specialize in the subjects they pay attention to. They also tend to use different media to learn about current affairs, and these habits of media use differ by level of education, age, and gender. Only television seems to be used by virtually all adults as a source of information about current affairs.

The following discussion focuses on adult Americans who tend to pay attention to scientific and technological matters and how these particular Americans differ from people who are more interested in other types of issues.[4]

[1]In a few cases, the measures extend back to 1957—just before the launching of Sputnik—to a study sponsored by the National Science Writers Association (Survey Research Center 1958). From 1979 through 1990, the survey data in this chapter are largely from Miller (1991a), and many of the concepts in this chapter were first proposed by Miller and Prewitt (1979) and by Miller, Prewitt, and Pearson (1980) under the sponsorship of the National Science Foundation. Miller (1991b) has since modified and expanded certain of these concepts.

[2]The most recent U.S. survey was conducted in September and October 1990. See footnote 3 and "Availability of Data," p. 183.

[3]The 1990 *Indicators* survey of 2,033 adults was performed, by telephone, from the Public Opinion Laboratory of Northern Illinois University. The response rate was 65 percent. The results of a survey of this size are certain at ±3 percent at the 95-percent confidence level—that is, of all possible samples of this size, responses would be within 3 percentage points of those reported here 95 percent of the time. Uncertainty for subsamples in this chapter would be somewhat greater. In the interests of space, confidence intervals of the data are not discussed here. The technical report for the 1990 survey and an integrated codebook from the five *Indicators* surveys are available (Miller 1991a and 1991b). See "Availability of Data," p. 183.

[4]This section discusses only six issue areas from the *Indicators* survey. (See text table 7-1.) The survey also asks about interest in and knowledge of international and foreign policy, economic issues and business conditions, military and defense policy issues, local school issues, and agricultural issues. For responses on these items, see appendix tables 7-1 and 7-2 and Miller (1991a).

The section presents the following three sets of indicators comprising different aspects of attentiveness:

- *Interest* in different sets of issues,
- *Level of information* about the sets of issues, and
- *Exposure to media* where learning about the issues might occur.

These indicators are then combined in indexes of "attentiveness" to scientific and other subjects.

***Interest in News About S&T.*** The first aspect of attentiveness is a measure of interest in different sets of issues. Like most of the other indicators in this chapter, interest in news issues involving new scientific discoveries remained relatively stable over the past decade: between 37 and 48 percent of people surveyed acknowledged a high interest. In 1990, 39 percent of U.S. adults said they were very interested in new scientific discoveries, and nearly 9 out of 10 were either "moderately" or "very" interested in these discoveries. (See appendix table 7-1.)

Compared with the 39 percent of respondents who say they are "very" interested in scientific discoveries and new inventions and technologies, larger percentages report being very interested in other issue areas, notably environmental pollution, military and defense policy, and new medical discoveries. (See figure 7-1.)

Medical discoveries and environmental pollution held the interest of significant percentages of Americans; about two-thirds of the adult population were "very" interested in these news items. In contrast, only about one-fourth of U.S. adults reported that they were "very" interested in space exploration, and a similar proportion was "not at all" interested in space exploration. This was the highest percentage reporting no interest in any of the issue areas. (See "Assessments of Three Technology Programs," p. 177-79.)

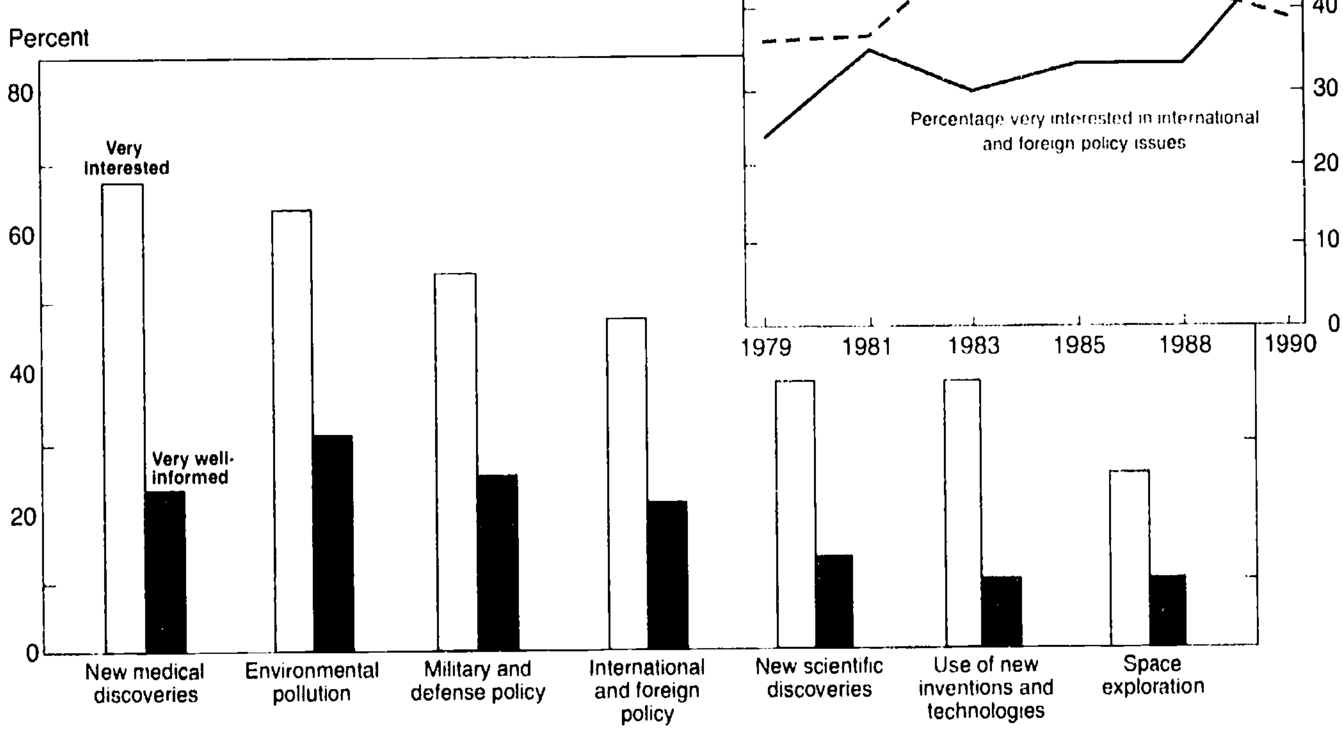
The percentages of Americans who were very interested in military and defense policy and in international and foreign policy were up sharply in 1990 over 1988. (See appendix table 7-1.) The 1990 survey was conducted in October and November, just after the Iraqi invasion of Kuwait and concomitant with the buildup of U.S. troops in Saudi Arabia. (See also footnote 20.)

***Level of Information About S&T.*** A second important aspect of attentiveness is a level of knowledge about the subject of interest. In contrast with their expressed high levels of interest in sets of news issues, American adults were less confident about their levels of knowledge of these subjects. Fewer than a third of adults felt very well-informed about *any* of the sets of issues, and as many as a third or more felt *poorly* informed about several.

A third of U.S. adults felt very well-informed about issues involving environmental pollution. On all of the other issues shown in appendix table 7-2, a quarter or fewer of U.S. adults felt very well-informed. Most judged their knowledge of issues to be "moderate."

Many Americans were pessimistic about their knowledge of some matters involving S&T but were more con-

Figure 7-1.
**Public interest in and knowledge of selected issues: 1990**




See appendix tables 7-1 and 7-2.

*Science & Engineering Indicators – 1991*

fident about others. Over 30 percent felt poorly informed about new scientific discoveries, 35 percent about new inventions and technologies, and 38 percent about space exploration. In contrast, only 20 percent felt poorly informed about new medical discoveries and 13 percent about environmental pollution. These contrasting response patterns on subjects with considerable S&T content are mirrored in the different demographic characteristics of the groups that pay attention to specific sets of subjects.

***Media Exposure to S&T.*** The third facet of attentiveness is a habit of exposing oneself to media where learning about issues might occur. The general population, not otherwise predisposed to seek exposure to science, might learn about S&T in the popular media: television, newspapers, and magazines. Newspapers have especially increased their coverage of science- and health-related topics over the past decade, often in special sections devoted to these articles (NSB 1987). More focused exposure to scientific information might be gained from science magazines, from television shows like "Nova," or from visits to such public places as natural history museums, S&T museums, zoos, and aquariums.

To gauge the extent of such contacts with S&T issues, the *Indicators* survey asks respondents about their habits in

- Reading,
- Television viewing, and
- Museum attendance.

About 57 percent of adults reported reading a daily newspaper, and men were somewhat more likely than women to use this source of information. (See appendix table 7-3.) Daily newspaper readership is also strongly correlated with increasing age. (See figure 7-2.) Older adults were about twice as likely as younger adults to read a daily newspaper. Also, older people were more attentive to new medical discoveries than were other groups. This characteristic of the newspaper reading population may help explain the growth in special health sections in U.S. newspapers (reported in NSB 1987), even though daily newspaper reading by the general population has been declining for several decades.[5]

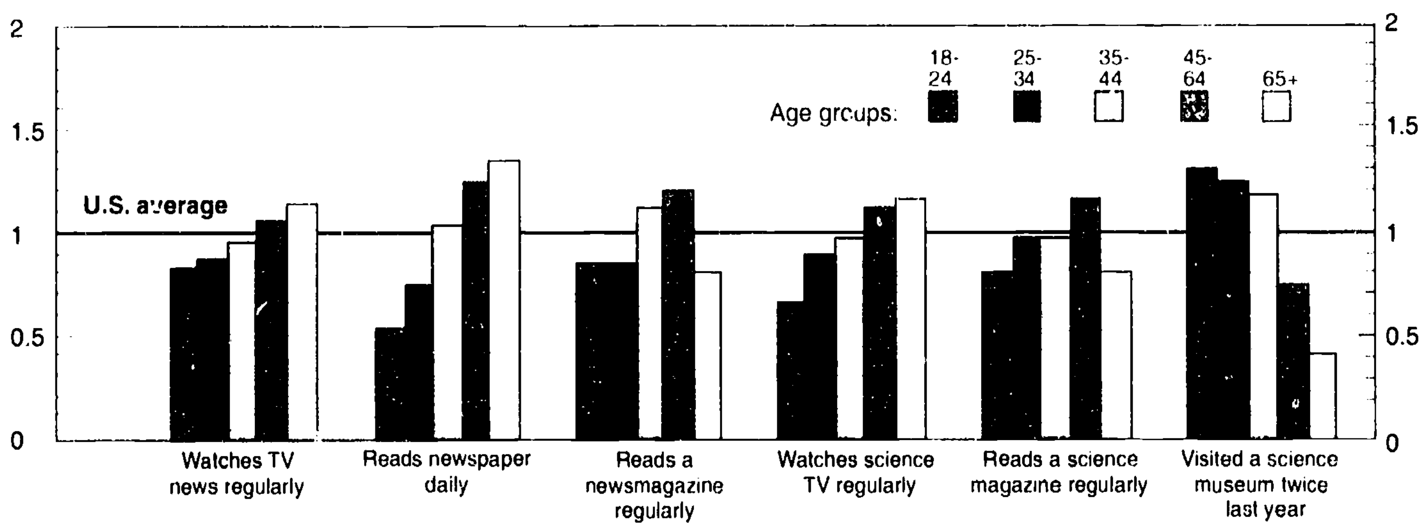
Education level is positively related to daily newspaper reading, and even more strongly to reading of national newsmagazines and science magazines. Adults who have graduated from college were almost four times as likely as those who had not finished high school to read newsmagazines; they were three times more likely to read science magazines regularly. (See figure 7-3.) Using these specialized sources of information is somewhat related to increased age, but only up through the 45- to 64-year-old age group; beyond these ages, general newsmagazine and science magazine readership drops sharply. (See figure 7-2.) Women were less likely than men to read science magazines: 81 percent stated that they never use this medium versus 66 percent of men.

Education level has virtually no effect on the likelihood of watching both television news and science shows.[6] (See figure 7-3.) Age is positively correlated with watching television news and science programs.

[5]Between 1972 and 1990, daily newspaper readership declined from 69 to 53 percent of the population (NORC annual series).

[6]Television science shows in the survey were defined as "Nova" and National Geographic specials.

Figure 7-2.
**Effect of age on media use and museum visits: 1990**




NOTE: U.S. average = 1.
See appendix tables 7-3 and 7-4 for absolute values and question wordings.

Science & Engineering Indicators -- 1991

Museum visits may result in casual learning about S&T. In 1990, 42 percent of the respondents indicated that they visited a science museum at least twice in the previous year.[7] Among college graduates, 64 percent reported such visits; this was more than three times the likelihood of persons with no high school degree. (See figure 7-3.)

Thus, each of the variables of age, gender, and education level is helpful in predicting the likelihood of exposure to opportunities for informal learning about S&T. As shown above, each of these variables is also identified with select media.

***"Attentiveness" to S&T.*** When considered together, the three sets of indicators discussed above—interest in, level of information about, and media exposure to S&T issues—identify segments of the adult population that are regularly "attentive" to different sets of issues in the news.[8] The *Indicators* series has used the attentiveness concept to distinguish among segments of the adult population that follow public policy matters with significant scientific and technological implications—e.g., nuclear energy policy, new medical technologies, and space exploration. Political leaders are likely to turn to these groups—or their representatives—in the course of setting policy in these areas.

The *Indicators* index of attentiveness to selected issues uses respondents' self-reports on

- *Inclination* to follow certain items in the news—a respondent must state that he or she is "very interested" in an issue area to be labeled attentive to that area;
- *Knowledge* of an area—a respondent must state that he or she is "very well-informed" about an issue area to be labeled attentive to that area; and
- *Behavior* that would expose a person to information about certain issue areas—a respondent must state that he or she is a regular reader of a daily newspaper, a national newsmagazine, or a science magazine to be labeled attentive to any issue area.

Text table 7-1 shows the proportions of adult Americans who meet all three of these criteria on each of six sets of issues.

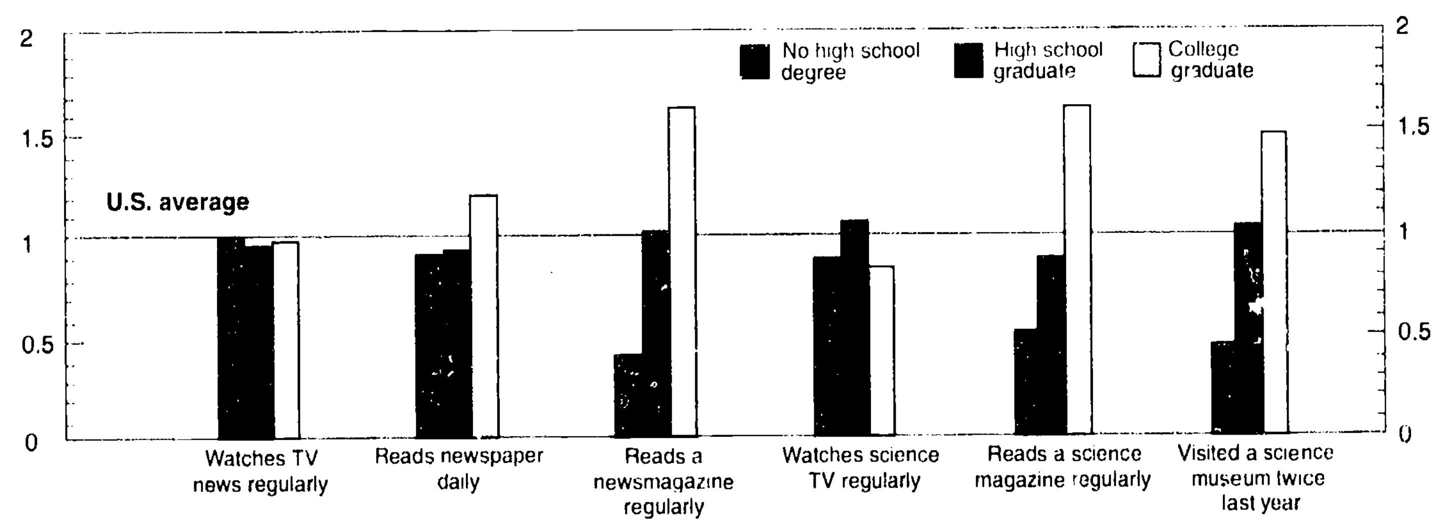
About 8 percent, or some 14 million U.S. adults, are attentive to new scientific discoveries.[9] Attentiveness to scientific matters is strongly dependent upon educational level, particularly education in mathematics and science. People who are college graduates are more than twice as likely to be attentive to new scientific discoveries, and people with more science and mathematics courses in high school and/or college are more

[7] "Science museum" here refers to a science or technology museum, a zoo or aquarium, or a natural history museum, each of which was asked about separately in the survey.

[8] Miller (1991b) has further refined this concept of attentiveness to various issues and has constructed a measure of "attentiveness to science and technology policy" which is a combination of attentiveness to scientific issues and attentiveness to issues involving new technologies.

[9] U.S. population estimates used throughout this chapter are from special tabulations of the Bureau of the Census, Current Population Survey, third quarter, 1990. The population estimates are based on civilians 18 years of age or older, not living in group quarters, and including military personnel living off-base in the United States.

Figure 7-3.
**Effect of education on media use and museum visits: 1990**




NOTE: U.S average = 1.
See appendix tables 7-3 and 7-4 for absolute values and question wordings.

*Science & Engineering Indicators – 1991*

Text table 7-1.
**Public attentiveness to news issues, by selected characteristics: 1990**

| | Attentiveness to . . . | | | | | | |
|---|---|---|---|---|---|---|---|
| | New scientific discoveries | New technologies | Nuclear energy | Medical discoveries | Space exploration | Environmental pollution | N |
| | | | Percent | | | | |
| Total public | 8 | 7 | 8 | 16 | 6 | 20 | 2,033 |
| **Gender** | | | | | | | |
| Male | 11 | 11 | 12 | 15 | 10 | 23 | 964 |
| Female | 6 | 4 | 4 | 17 | 3 | 18 | 1,070 |
| **Degree level** | | | | | | | |
| No high school degree | 7 | 5 | 7 | 19 | 3 | 5 | 495 |
| High school graduate[1] | 6 | 7 | 7 | 14 | 6 | 21 | 1,179 |
| College graduate | 16 | 12 | 12 | 18 | 11 | 27 | 359 |
| **Science & math education**[2] | | | | | | | |
| Low | 5 | 5 | 5 | 15 | 4 | 16 | 1,263 |
| Medium | 9 | 10 | 10 | 14 | 7 | 25 | 523 |
| High | 24 | 17 | 16 | 23 | 17 | 33 | 248 |
| **Age** | | | | | | | |
| 18-24 | 8 | 8 | 5 | 10 | 7 | 19 | 322 |
| 25-34 | 7 | 9 | 4 | 10 | 6 | 16 | 497 |
| 35-44 | 9 | 6 | 7 | 12 | 5 | 19 | 366 |
| 45-64 | 8 | 7 | 9 | 20 | 6 | 23 | 533 |
| 65 and older | 9 | 7 | 14 | 28 | 6 | 24 | 315 |

[1]Includes respondents with associate degrees.

[2]For an explanation of the education index, see "The Science and Mathematics Education Index," p. 172.

SOURCES: J.D. Miller, *Public Attitudes Toward Science and Technology, 1979–1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991); and unpublished tabulations.

*Science & Engineering Indicators – 1991*

than four times as likely to be attentive to scientific discoveries. (See "The Science and Mathematics Education Index," p. 172.) Men are nearly twice as likely to be attentive to new scientific discoveries as are women.

Between 6 and 8 percent of Americans are attentive to new technologies, nuclear energy, and space exploration. As with attentiveness to science, these groups of the adult public are highly educated compared to the general population, and they are dominated by men. Women seem particularly inattentive to these three areas.

Of the issue groups shown in text table 7-1, much larger percentages of the total adult population are attentive to medical discoveries and environmental pollution; women are more likely to belong to these attentive publics than to others. Older Americans regularly pay attention to medical discoveries, and attentiveness to environmental issues also increases somewhat with age. The effect of education in general disappears for the segment of the population attentive to medical discoveries; however, persons with more courses in science and mathematics are more likely to belong to this attentive group.

The attentive public for environmental pollution is about 20 percent, or 36 million Americans. Members of this attentive public are proportionately more highly educated and older.

In interpreting the various indicators discussed later in this chapter and analyzing the response patterns of the general population versus those of the attentive groups, it is helpful to note the different characteristics of the various attentive groups. People attentive to scientific discoveries or to space exploration are considerably more likely to be highly educated and to have had more science and mathematics courses than nonattentives. Also, although men account for only about 47 percent of the survey sample, they constitute two-thirds of the public attentive to scientific discoveries and over three-quarters of those attentive to space exploration.

## The Science and Mathematics Education Index

Many of the tables in this chapter display a cross-cut of the data by high, medium, and low levels of science and mathematics education. Miller (1991b) developed this index from the 1990 *Indicators* survey and has used it to explore variations on a scale of "scientific literacy."

The index was constructed from three sets of questions. First, respondents were asked if they had taken a high school course in biology, chemistry, or physics. Second, they were asked their highest level of mathematics coursework taken in high school. From this second question, a total number of courses of high school mathematics was *inferred* for each respondent based on a typical high school program of mathematics courses: first-year algebra, geometry, second-year algebra, precalculus, and calculus.

Third, respondents who reported having finished high school were asked how many college-level courses in biology, chemistry, or physics they had taken. (Some 70 percent of U.S. adults have never taken a college-level science course.) Typical responses were "one or two" or "15 or 20 courses" for some respondents. For the purpose of index construction, a maximum of 10 college-level science courses were counted for any respondent.

These three estimates (reports of high school and college courses in biology, chemistry, and physics and inferred high school mathematics courses) were then totaled and divided into three levels of courses: low, for four or fewer courses (62 percent of respondents); medium, for five to eight courses, representing a good high school program (26 percent); and high, representing a good high school program and some college coursework (12 percent). (See text table 7-2.)

Men were twice as likely as women to have high exposure to formal science and mathematics education in high school and college; some 70 percent of women in the United States reported low exposure to these courses. Older Americans, especially after age 45, have also had relatively less coursework in science and mathematics. High exposure to science and mathematics in school was most prominent for young adults up through age 44. As this group matures, higher percentages of the total population will be able to report more exposure to formal training in science and mathematics.

Text table 7-2.
**Index of science and mathematics education, by gender and age**

| | Low | Medium | High | N |
|---|---|---|---|---|
| | Percent | | | |
| Total public | 62 | 26 | 12 | 2,033 |
| **Gender** | | | | |
| Male | 53 | 30 | 17 | 964 |
| Female | 70 | 22 | 8 | 1,070 |
| **Age** | | | | |
| 18-24 | 47 | 41 | 12 | 322 |
| 25-34 | 57 | 26 | 17 | 497 |
| 35-44 | 58 | 26 | 16 | 366 |
| 45-64 | 69 | 22 | 9 | 533 |
| 65 and older | 80 | 16 | 4 | 315 |
| **Attentive publics** | | | | |
| New scientific discoveries | 37 | 27 | 35 | 168 |
| New technologies | 38 | 33 | 29 | 148 |
| Nuclear energy | 43 | 33 | 25 | 157 |
| Medical discoveries | 59 | 23 | 18 | 323 |
| Space exploration | 36 | 31 | 33 | 123 |
| Environmental pollution | 48 | 32 | 20 | 412 |

NOTES: This index is based on the number of high school science and mathematics courses and the number of college science courses taken. The index includes high school mathematics and high school and college courses in biology, chemistry, and physics; it excludes courses taken in other disciplines or in college mathematics. "Low" is four or fewer courses, "medium" is five to eight courses, and "high" is nine or more courses. Percentages may not total 100 because of rounding.

SOURCES: J.D. Miller, *The Public Understanding of Science & Technology in the United States*, report to the National Science Foundation (DeKalb, IL: Public Opinion Laboratory, Northern Illinois University, 1991); and unpublished tabulations.

*Science & Engineering Indicators – 1991*

### What Do People *Know* About Science?

Since 1979, the *Indicators* studies of public attitudes toward S&T have included indicators of the adult population's understanding of scientific terms and concepts.[10]

***Knowledge of Scientific Process.*** Most respondents have difficulty answering the first question in the short battery of open-ended inquiries about level of knowledge of scientific terms and concepts. This question asks: "In your own words, could you tell me what it means to study something scientifically?" In 1990, 18 percent of U.S. adults gave an acceptable definition of

[10] The survey has regularly requested open-ended definitions of "scientific study," "radiation," and "DNA." (Respondents are first asked if they have clear, general, or little understanding of a term. Those reporting little understanding are not asked for the followup definition.) These and other open-ended questions are coded by independent coders at the Public Opinion Laboratory, Northern Illinois University, and tests of intercoder reliability are performed and differences resolved. Multiple-choice questions designed to measure respondents' understanding of the concepts of "probability" and "controlled study" were added in 1988. In 1990, batteries of questions concerning two topical environmental issues—acid rain and the ozone hole—were added.

In addition, as part of ongoing studies of scientific literacy (Miller 1991b) the 1990 survey included a short battery of simple closed-ended questions that are used here to indicate the distribution of elementary scientific knowledge in the adult population. "Knowledge of Scientific Conclusions," pp. 187-89, reports on the use of several of these quiz-type questions for comparisons among the United States, Canada, Japan, and the European Community.

scientific study.[11,12] (See appendix table 7-5.) Significantly higher percentages of people with more education could correctly provide the definition.

Closed-ended questions concerned with aspects of scientific work elicited much higher correct response rates. For example, when asked a multiple-choice question involving probability, 70 percent of the adult population selected the correct answer. (See appendix table 7-5.) Similarly, 72 percent correctly answered a closed-ended question about controlled clinical trials. These very different rates of correct response on aspects of scientific study suggest that respondents may well know more about science than responses to the open-ended question would indicate.[13]

***Knowledge of Environmental Issues.*** In addition to the items concerning interest in and knowledge about issues involving environmental pollution (see "'Attentiveness' to S&T," pp. 170-71), the 1990 survey included short sets of questions about two timely environmental issues: acid rain and ozone depletion.

When asked to describe acid rain, 6 percent of the adult public was able to give a scientifically correct response. (See appendix table 7-6.) An additional 10 percent was able to name the cause or source of acid rain ("smokestacks," "plants that burn coal," etc.), and 31 percent referred to an unspecified "pollution" for a partially correct response. Higher percentages of respondents with more education—including more science education—were able to describe acid rain correctly, but overall fewer than one in five adults could knowledgeably engage in a conversation about acid rain. Even the attentive public for issues involving environmental pollution was surprisingly ignorant about this widespread and current public policy issue: 40 percent of this group failed to describe the scientific issue correctly, and another 36 percent were able only to identify acid rain with a general concept of "pollution."

A somewhat larger percentage of U.S. adults seemed to grasp the technical aspects involved in producing the ozone hole. One-fourth of the survey respondents gave a correct answer to the question "In your own words, why is there a hole in the ozone layer?"[14] An additional 18 percent mentioned "pollution" as the cause of the ozone hole problem.

Correct responses to this question were strongly related both to gender and level of education. (See appendix table 7-6.) About one-third of male and one-fifth of female respondents were able to identify the ozone hole problem correctly. Forty-five percent of the attentive public for environmental pollution was unable to describe correctly why the ozone hole exists.[15]

The public is also unclear about the *location* of the ozone hole.[16] Only 11 percent could identify the Antarctic, and another 4 percent mentioned both the South and North Poles. As with other questions on the survey, men and people with higher levels of education were more likely to place the ozone hole geographically. Over 90 percent of U.S. adult women did not know the location of the ozone hole.

In sum, 25 percent of the *general* U.S. adult population were able to offer correct information about these two significant public policy issues of environmental pollution. Similar results hold for the public *attentive* to issues involving environmental pollution. The findings suggest that, although these environmental issues cause emotional responses and high levels of concern among adults, this concern is poorly grounded in factual information.

***Knowledge of Scientific Concepts.*** The 1988 and 1990 *Indicators* surveys included short batteries of closed-ended simple questions about S&T to test respondents' knowledge of widely accepted scientific and technological phenomena that they would most likely have learned in primary or secondary school.[17]

Of the 13 questions shown in figure 7-4, about 15 percent of adults could answer half of them correctly. Just over 1 percent answered all of the questions correctly.

Over three-fourths of the respondents knew simple facts about the natural world: that the center of the earth is hot, that plants produce oxygen, that hot air rises, and that light travels faster than sound. Seventy-seven percent agreed with the concept of continental drift.

Respondents had more trouble with several simple questions involving common technologies: 37 percent claimed not to know whether lasers generate light waves or sound waves. And a full 70 percent did not know if

---

[11]For coding purposes, responses referring to theory or hypothesis testing, to experimentation, or to thorough study or comparison are considered acceptable definitions. Coded separately, but not accepted as correct, are responses referring to measurement or classification.

[12]Withey (1959) found that 12 percent of American adults had an acceptable understanding of "scientific study" in 1957.

[13]Miller (1991b) uses the open-ended question as one component of scientific literacy. In addition to requiring a correct response on this question, he also requires respondents to reject astrology as having any scientific basis. In 1990, 13 percent of the adult population passed this component of his literacy construct.

[14]"Correct" in this case refers to the ability to describe correctly the roles of chlorofluorocarbons (CFCs) or chlorine atoms in the process of creating the hole, or the ability to identify the technologies—aerosol sprays, refrigerants, and styrofoam manufacturing—that release most of the CFCs.

[15]This finding, and others shown in appendix table 7-6, underlines the need for sensitivity to the differences between *attentiveness* to an issue and *knowledge* of an issue.

[16]This question may also indicate a lack of knowledge of world geography.

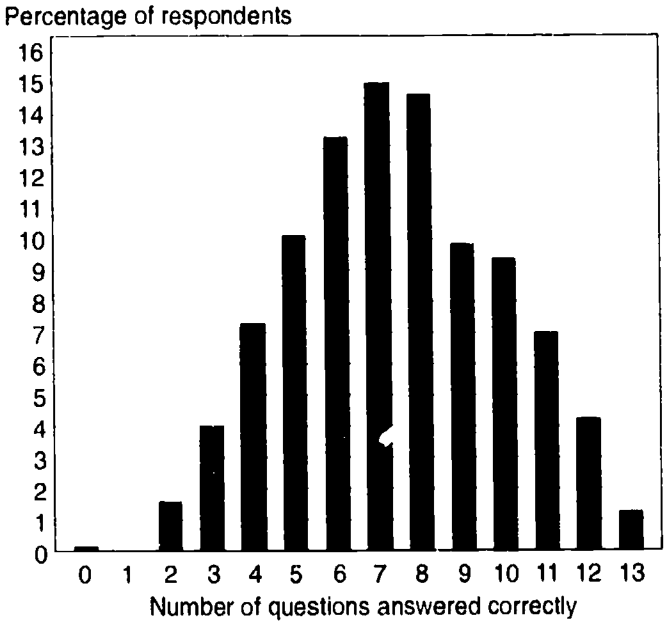
[17]The questions discussed in the following sections were developed by Jon Miller of Northern Illinois University, John Durant of the Science Museum, London, and Geoffrey Thomas of University of Oxford, England. See Miller (1987).

Most of these questions are asked in a true/false format; a "don't know" response is accepted but not offered for every question. Rather, the introduction to the knowledge battery states that "If you don't know or aren't sure, just tell me so, and we will skip to the next question."

A few questions that virtually all respondents can answer correctly are included to bolster respondent confidence. In 1990 these questions included "Sunlight can cause skin cancer" and "Smoking causes lung cancer." Ninety-five percent of U.S. adults over 18 agreed with these statements. These are examples of scientific findings that have become common knowledge; they also underline the extent to which Americans experience S&T through medicine.

Figure 7-4.
**Knowledge of 13 scientific conclusions: 1990**

**Distribution of correct responses in the U.S. population**




**Responses to individual questions**

| | Correct | Incorrect | Don't know |
|---|---|---|---|
| 1. "The center of the earth is very hot." | 79% | 7% | 14% |
| 2. "The oxygen we breathe comes from plants." | 85 | 10 | 6 |
| 3 "Lasers work by focusing sound waves." | 37 | 26 | 37 |
| 4. "Hot air rises." | 95 | 2 | 3 |
| 5. "Electrons are smaller than atoms." | 41 | 24 | 35 |
| 6. "Antibiotics kill viruses as well as bacteria." | 30 | 60 | 11 |
| 7. "The universe began with a huge explosion." | 32 | 33 | 35 |
| 8. "The continents on which we live have been moving their location for millions of years and will continue to move in the future." | 77 | 8 | 15 |
| 9. "Human beings as we know them today developed from earlier species of animals." | 45 | 41 | 14 |
| 10. "The earliest humans lived at the same time as dinosaurs." | 47 | 36 | 18 |
| 11. "Which travels faster: light or sound?" | 75 | 20 | 6 |
| 12. "Does the earth go around the sun, or does the sun go around the earth?" | 73 | 20 | 7 |
| *Asked if question 12 was answered correctly:* | | | |
| 13. "How long does it take for the earth to go around the sun? One day, one month, or one year?" | 48 | 18 | 33[1] |

[1]Includes respondents who could not answer #12 correctly.

SOURCES: J.D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991); and unpublished tabulations.

*Science & Engineering Indicators – 1991*

antibiotics kill viruses, displaying a fundamental misunderstanding of the differences among types of microorganisms and the efficacy of antibiotics in fighting common diseases.

More than half of U.S. adults are confused about very long timespans in the history of the earth: 36 percent agreed that humans lived alongside dinosaurs, and 18 percent did not know the answer to this question.[18]

On questions that might conflict with some religious teachings, the response rates in the 1990 survey show that adults often chose belief over a scientific interpretation of natural history. In the case of evolution, 41 percent rejected the idea that "Human beings as we know them today developed from earlier species of animals"; another 14 percent claimed not to know the truth or falseness of evolutionary theories of human development. In all, then, 55 percent of American adults either rejected outright or were uncertain about the theory of evolution. In a similar vein, when asked about the origin of the universe, 33 percent disagreed that "The universe began with a huge explosion," and another 35 percent claimed not to know.

The motions and timing of the solar system were confusing to many respondents. While 73 percent knew that the earth goes around the sun, only 48 percent knew that this journey takes 1 year. Respondents also have trouble with the atomic world: only 41 percent could answer correctly that "Electrons are smaller than atoms"; 35 percent said they didn't know.

These response patterns indicate that most Americans are not familiar with fundamental scientific theories and do not understand basic characteristics of simple technologies.[19]

On the other hand, one of the clear findings of the *Indicators* studies is that the low level of knowledge of science in the U.S. adult population contrasts sharply with its consistently strong and positive attitudes toward science. Support for S&T among the U.S. population has remained high. Even if some observers are correct in predicting that the low level of scientific knowledge endangers the material progress of the Nation, there is no evidence of a decrease in general public support for the institution of science. So, at least for now, the lack of *knowledge* of science may not figure prominently in the public's *support* for science and scientists.

### What Do People *Think* About Science?

For over 30 years, at least four out of five Americans have stated that science and technology have a positive

[18] Interpretation of this indicator is problematic, since some creationists also believe that humans and dinosaurs co-existed. Failure to answer this question correctly may thus reflect respondents' lack of *knowledge* or lack of *belief*.

[19] But the extent of U.S. knowledge on these items is generally comparable to that of other countries, as discussed in "Knowledge of Scientific Conclusions," pp. 187-89.

effect on their lives. These and similar indicators of public attitudes toward S&T are discussed in this section.[20]

The following paragraphs discuss measures of public attitudes toward research, scientists, and Federal support of scientific research. Attitudes toward three large and visible technology programs are then discussed, followed by a closer look at data indicating the public's attitude toward education and the importance of education for S&T.

***Attitudes Toward Scientific Research and Scientists.*** The *Indicators* survey asks a number of questions designed to measure attitudes of the adult public toward S&T.[21] (See appendix table 7-7.) No single assessment of public attitudes toward S&T is presented in this chapter; it is important that all of the measures be taken together as indicators of an overall public assessment and that no undue significance be attached to any one question.

In 1957, 94 percent of the American public agreed that "Science and technology are making our lives healthier, easier, and more comfortable." Between 1957 and 1979, the percentage agreeing with this claim dropped to the low 80-percent range, but this apparent drop may be an artifact of different survey methodologies. In any case, the percentage agreeing with the statement has not changed in the four surveys since 1979. The very low percentage that either says "don't know" or refuses to answer (from 2 to 3 percent) suggests that respondents are unequivocal when making this assessment.

Respondents also feel that science is important in their own lives. About 85 percent disagree with the statement that "It is not important for me to know about science in my daily life."

Between 1979 and 1990, decreasing proportions of respondents agreed with the statement that "Science makes our way of life change too fast"—a statement deliberately worded with a negative bias. (See figure 7-5.) In 1990, 60 percent disagreed with the statement, while 37 percent agreed; this represented a shift from 53 percent and 44 percent, respectively, since 1979.

The *Indicators* survey also asks about general attitudes toward scientific research in a more complex formulation. Rather than being presented with a simple agree/disagree choice, respondents are asked to balance positive and negative effects in the question "Would you say that, on balance, the benefits of scientific research have outweighed the harmful results, or have the harmful results of scientific research been greater than its benefits?"[22] (See text table 7-3.)

Figure 7-6 shows the strongly positive responses to this question by gender and education level. Men are more likely than women to have strongly positive

---

[20] Only people, not nations or other groups, possess attitudes. Hennessy (1972) defines an attitude as a rather enduring orientation toward an object or set of objects. Hennessy sets "attitudes" midway between "opinions" and "belief systems" in his typology:

- *Opinions* are orientations of the moment toward some specific, and passing or contemporary, object;
- *Attitudes* are more diffused orientations toward an object or a class of objects, not necessarily of the moment or controversial, and more stable over time; and
- *Belief systems*, or ideologies, are organizations of integrated opinions and attitudes closely identified with oneself.

Hennessy (p. 38) argues that to have attitudes, an individual must possess "minimal cognitive activity, integrative capacity, and motivational arousal." Based on these criteria, it is likely that few individuals actually possess attitudes toward science.

Miller (1991b) argues that most persons who qualify as attentive to a set of issues actually have attitudes toward those issues. (Note that in this chapter, the idea of an "attitude toward science" refers to an *inference* of an attitude based on survey question responses.)

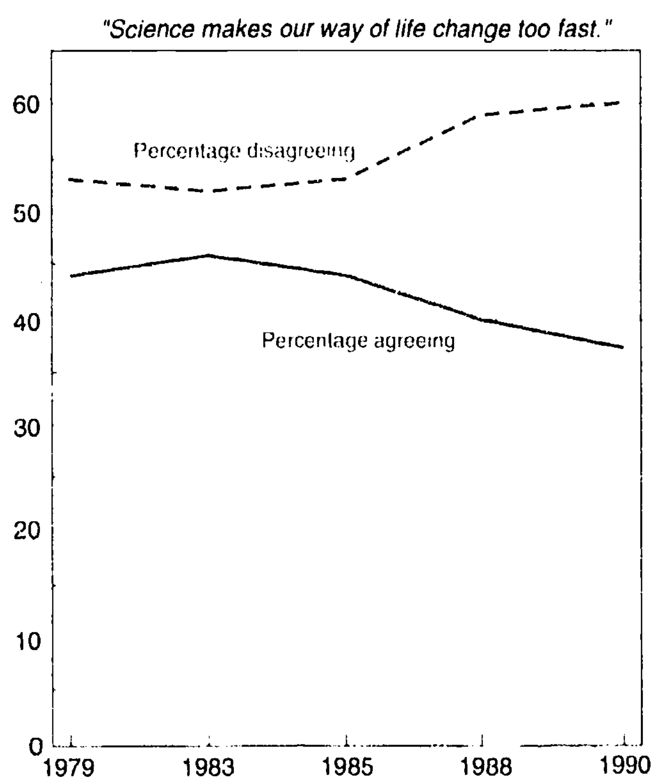
Many of the response patterns shown here are for the attentive publics and for more highly educated groups of the adult population. It may be assumed that the responses of these groups are more stable and represent more consistent orientations toward the subjects being asked about than would be the case for the rest of the population. In short, responses for attentive and educated persons are more likely to reflect attitudes, not opinions.

An example of the volatility in public opinion is shown in figure 7-13. In the spring of 1980, there was an increase in public opinion noting that too little was being spent on the military. At the time, the Nation was deeply embarrassed over the Iranian hostage crisis, and the Soviets had just invaded Afghanistan. This very strong and short-lived change was probably a strong shift in opinion, not attitudes. The moderately changing response patterns just before and after this shift were probably more reflective of attitudes.

[21] The questions are purposefully designed to tap (1) general attitudes and (2) assessments of more specific aspects of science.

[22] The question is then followed by a probe for degree of harm or benefit: "Would you say that the balance has been strongly in favor of beneficial [harmful] results, or only slightly?" Such probes encourage the respondent to continue to focus on the subject introduced in the first question, and ideally lead to a more considered and thorough response overall from the individual respondent.

**Figure 7-5.**
**Science and the pace of life**




See appendix table 7-7.

*Science & Engineering Indicators – 1991*

**Text table 7-3.**
**Public assessments of scientific research**

*"Would you say that, on balance, the benefits of scientific research have outweighed the harmful results, or have the harmful results of scientific research been greater than its benefits?"*[1]

| | 1972 | 1974 | 1976 | 1979 | 1981 | 1985 | 1988 | 1990 |
|---|---|---|---|---|---|---|---|---|
| | Percent | | | | | | | |
| Benefits greater. . | 70 | 75 | 71 | 70 | 74 | 68 | 76 | 72 |
| About equal[2] . . . . | 13 | 14 | 15 | 13 | 11 | 4 | 5 | 7 |
| Harms greater . . . | 8 | 5 | 7 | 11 | 14 | 19 | 12 | 13 |
| Don't know/ no answer . . . | 9 | 6 | 7 | 6 | 1 | 8 | 7 | 8 |
| N = | 2,209 | 2,074 | 2,108 | 1,635 | 1,536 | 2,005 | 1,042 | 2,033 |

NOTE: Percentages may not total 100 because of rounding.

[1]1972-76 wording: "Do you feel that science and technology have changed life for the better or for the worse?"

[2]Volunteered by the respondent.

SOURCES: National Science Board, *Science Indicators - 1972* (Washington, DC: GPO, 1973); *Science Indicators - 1974* (Washington, DC: GPO, 1975); *Science Indicators - 1976* (Washington, DC: GPO, 1977); J.D. Miller, *Public Attitudes Toward Science and Technology, 1979–1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991); and unpublished tabulations.

See appendix table 7-8. *Science & Engineering Indicators – 1991*

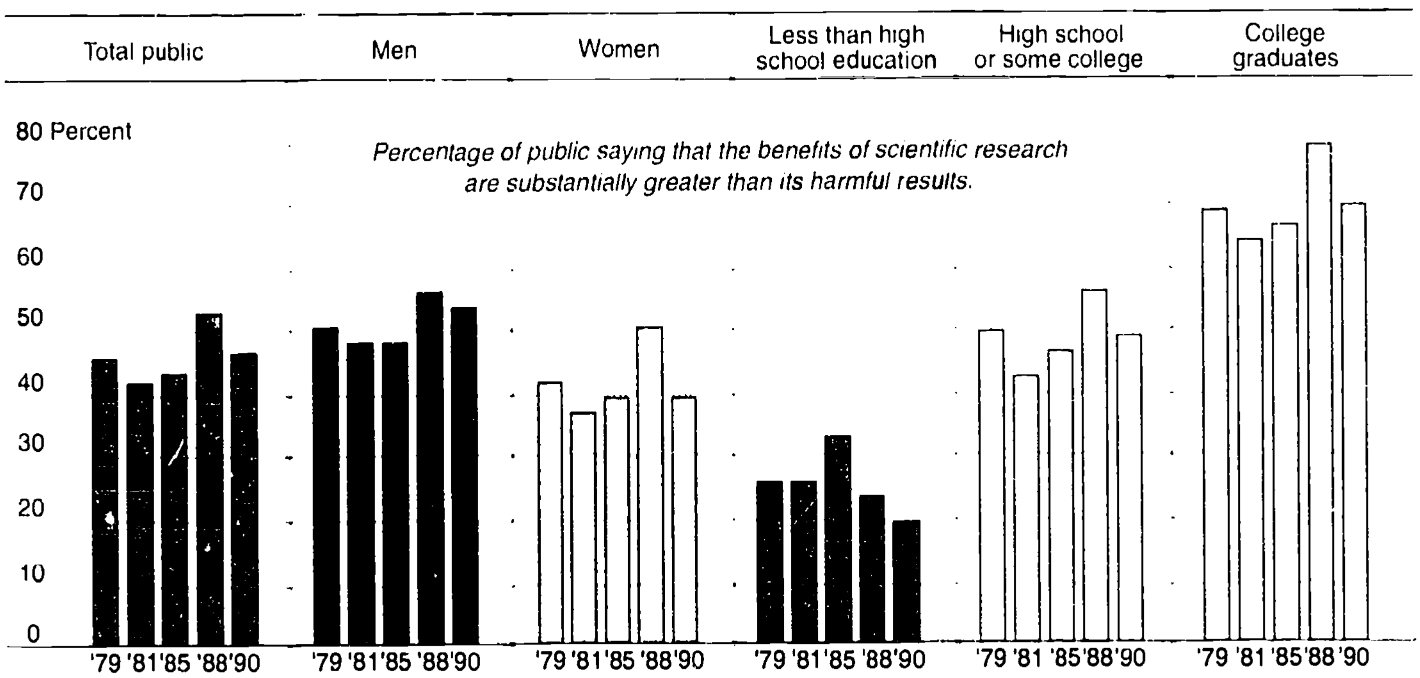
attitudes toward scientific research, by about 10 percentage points. Strongly positive evaluations of scientific research also increase sharply with increasing levels of education: college graduates are two to three times more likely to view the benefits of scientific research as "strongly beneficial" than are people without a high school diploma.

The survey also explores people's perceptions of *scientists* by asking respondents to agree or disagree that "Most scientists want to work on things that will make life better for the average person." In the 1985, 1988, and 1990 surveys, 80 percent of the respondents agreed with this statement, indicating a strong trust in the individual practicing scientist in the United States.[23] (See appendix table 7-7.)

Another long-term measure of public perceptions of science comes from the General Social Survey (GSS) of the National Opinion Research Center (NORC) at the University of Chicago. The survey asks: "As far as the people running these institutions are concerned, would you say you have a great deal of confidence, only some confidence, or hardly any confidence at all in them?" Since 1973, between 36 and 45 percent of the respondents have expressed a "great deal" of confidence in the people running science. (See figure 7-7.) The ratings for

[23]Sharply contrasting results from some European countries on a similar question are presented in "Attitudes Toward S & T," pp. 184-86.

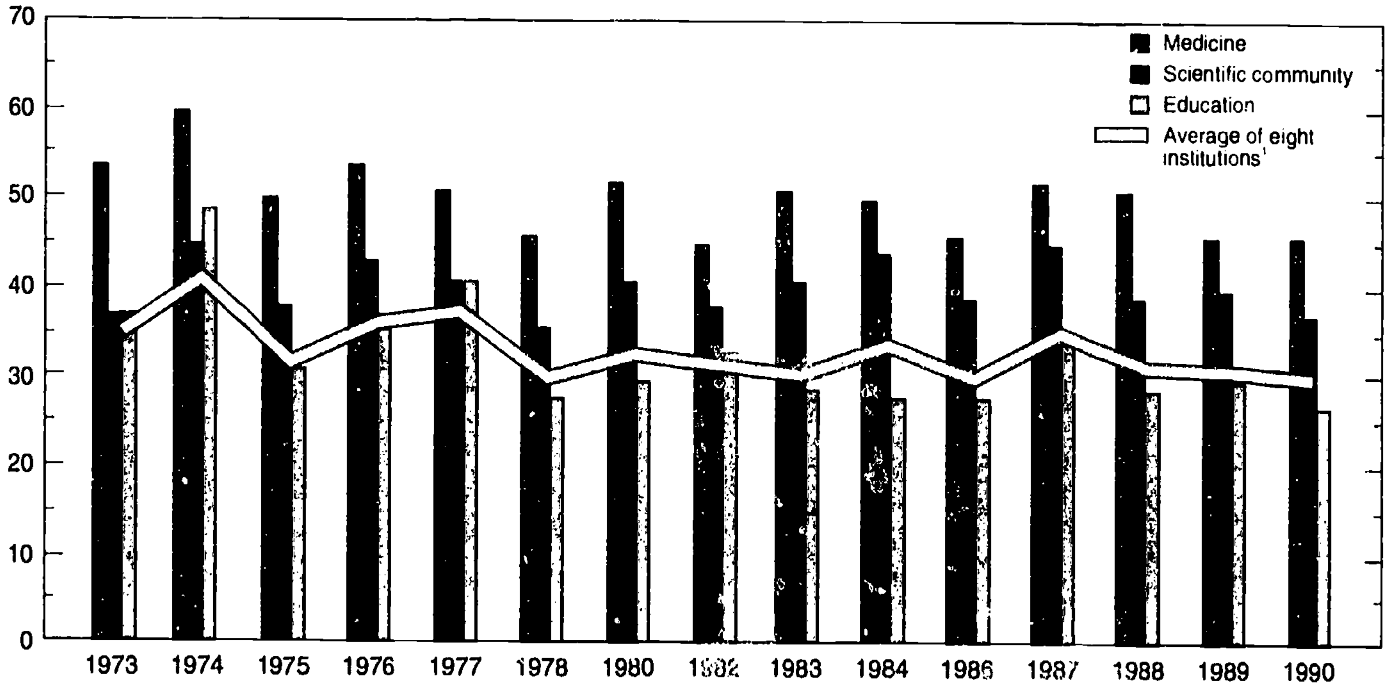
**Figure 7-6.**
**Assessments of scientific research**




See appendix table 7-8. *Science & Engineering Indicators – 1991*

Figure 7-7.
**Public confidence in people running selected institutions**

Percentage expressing a "great deal" of confidence




NOTE: Survey not conducted in 1979 or 1981, and question not asked in 1985.

[1]The eight institutions are medicine, the scientific community, U.S. Supreme Court, the military, education, major companies, organized religion, and the press.

See appendix table 7-9. *Science & Engineering Indicators – 1991*

science have usually been second only to medicine, and contrast with generally downward evaluations of people running educational and political institutions, religion, and the press. (See appendix table 7-9.)

***The Federal Role in Science.*** In 1985, 1988, and 1990, the *Indicators* survey asked respondents about their attitudes toward Federal funding of scientific research even if it has no apparent, immediate benefits. ("Even if it brings no immediate benefits, scientific research which advances the frontiers of knowledge is necessary and should be supported by the Federal Government.") About four-fifths of the adult population agreed with this statement in all three surveys, and 15 to 16 percent disagreed. (See figure O-24 in Overview.) These responses suggest a strong public support for Federal funding of basic research.[24]

***Assessments of Three Technology Programs.*** The U.S. public is less optimistic when assessing the costs and benefits (or risks and benefits) of technological programs than of scientific research generally.

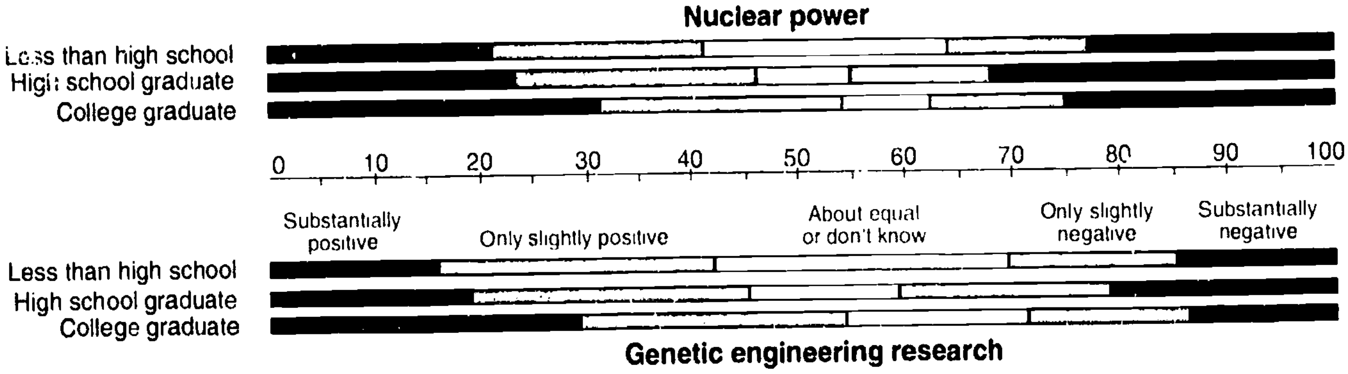
Between 1985 and 1990, assessments of the risks and benefits of genetic engineering research changed hardly at all. In both 1985 and 1990, over 45 percent of respondents stated that the benefits of genetic engineering research either substantially exceed or slightly exceed the potential risks. Relatively large proportions overall refused to answer or responded "don't know," suggesting that public attitudes toward such research and development (R&D) have not stabilized. (See appendix table 7-10.) In this question, the use of the phrase "creation of new life forms through genetic engineering research" may influence response patterns in a negative direction.[25] Men and people with college degrees are somewhat more positive about the benefits of genetic engineering research programs.

Patterns of public attitudes toward the "use of nuclear reactors to generate electricity" show greater entrenchment of attitudes on both positive and negative extremes than genetic engineering. (See figure 7-8.) Larger proportions of both the total public and people at all education levels judge the risks of nuclear power to be substantially greater than its benefits, and fewer people respond "don't know" or refuse to answer. Men are more likely to evaluate nuclear energy positively than women, and women are more likely to respond "don't know." From 1985 to 1990, some reduction in negative assessment may have occurred among college graduates,

[24]For data on Federal funding of basic and other research, see chapter 4, "Federal Support for R&D," pp. 93-102.

[25]See OTA (1987) for further findings on public attitudes toward biotechnologies.

Figure 7-8.
**Assessments of nuclear power and genetic engineering: 1990**




See appendix tables 7-10 and 7-11 for exact question wordings.

*Science & Engineering Indicators – 1991*

though a quarter of these respondents still felt that the risks of nuclear power substantially exceed its benefits.

Assessments of space exploration are changing—and in a negative direction. Between 1985 and 1990, the proportion reporting "benefits exceed costs" fell from 53 percent to 42 percent, and the proportion more concerned with costs outweighing benefits grew from 38 to 47 percent. (See figure 7-9.) These changes were reported by both men and women (though men overall were more positive) and by all education levels. The proportion of college graduates perceiving substantially greater costs than benefits in space exploration grew from 17 to 24 percent. (See appendix table 7-12.)

Another dimension of declining positive attitudes toward space exploration can be seen in the changing extremes of positive versus negative assessments. Respondents were asked if they felt that the benefits [risks] *slightly* or *substantially* exceed risks [benefits]. In the case of space exploration, the extreme assessments favoring benefits *fell* by 9 percentage points, and assessments of substantially excess costs *grew* by 7 percentage points between 1985 and 1990.[26]

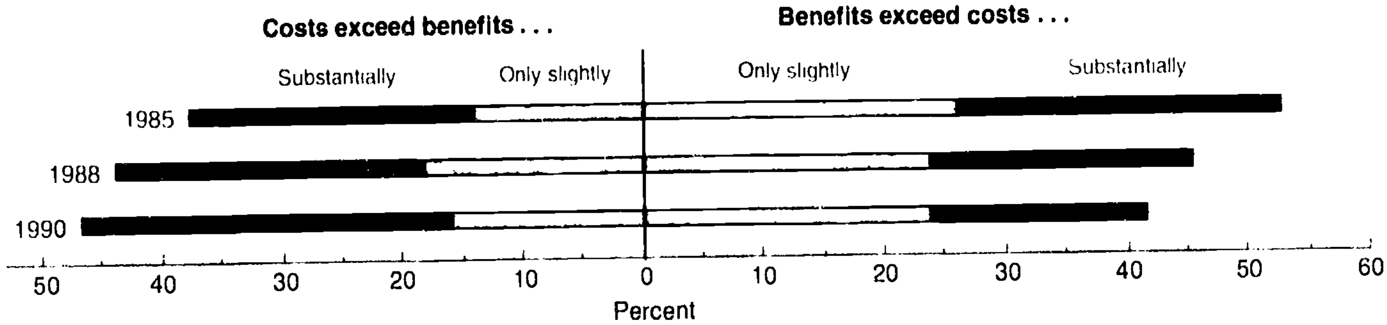
[26]Compare this with public preferences for spending on several programs; see "Spending Preferences," p. 180.

These changing assessments of the space program provide an opportunity to stress the different patterns of attitudes between the attentive publics and the general public. Over two-thirds of the attentive public for space exploration—a highly educated group of respondents—continued to feel in 1990 that the benefits of space exploration exceed its costs, compared with 42 percent of the general adult population. (See appendix table 7-12.) While in 1990 fewer of the attentive public for space exploration considered the benefits of the program to be "substantially" greater than its costs than was the case in 1988, relatively more considered the benefits to be "slightly" greater.

Several interpretations of this decline in positive attitudes toward the space program are possible. Miller (1991b) stresses the different patterns for this indicator for the general public and the attentive public for space exploration, stating that the attentive public is able "to place short-term advances and setbacks in a broader context." He points out that there are no active antispace groups, as is the case with nuclear reactors, and believes that space exploration, while highly visible, has relatively low political saliency to citizens not attentive to space exploration.

Another interpretation of these changing attitudes might hold that the Challenger accident (which occurred

Figure 7-9.
**Assessments of space exploration**




NOTE: Responses for "about equal" and "don't know" are omitted.
See appendix table 7-12.

*Science & Engineering Indicators – 1991*

just a few months after collection of the 1985 data reported here),[27] the long-grounded and troubled shuttle fleet, the current debates about the costs of the space station, and the debate about the benefits of unmanned versus manned spaceflights, have combined to increase public consciousness of the human and financial costs of the space program and what might be achieved if the resources were put to other uses.

In any case, the changes in these indicators of public support for space exploration stand out among the indicators discussed in this chapter. Public attitudes toward S&T in the United States have been notably stable over the past decade, and changes in attitude of this magnitude and consistency toward a large, publicly funded, technological program warrant continued attention and interpretation.

### Public Attitudes Toward Education

Recent increased attention in the United States to the quality and amount of education, especially education in science and mathematics, is reflected in public attitudinal data.[28] The following indicators of three themes in public attitudes toward education are presented below:

- The links people make between education and achieving other national goals;
- Public concerns about and assessments of the quality of education in the United States; and
- Public spending preferences for a number of national objectives, including education.

[27] See NSB (1987) for a discussion of the effects of the Challenger accident on attitudes.

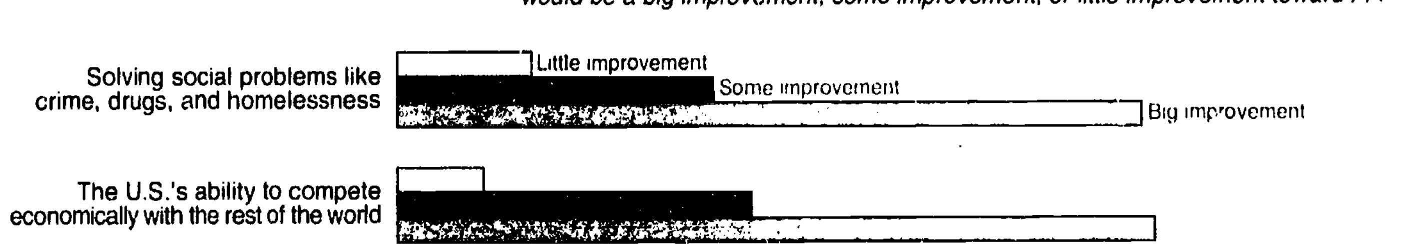
[28] Measures of student performance are reported in chapter 1, "Students: Achievement, Interest, and Coursework," pp. 16-27; reform movements are covered in chapter 1, "The Policy Context," pp. 34-40.

***The Role of Education.*** The American public sees a clear link between education and other national goals. In 1990, a representative sample of the adult U.S. population was asked to assess the impact of an increase in the number of college-educated Americans on three general areas: solving social problems; competing in international trade; and advancing science, medicine, and technology. Seventy-five percent stated that if more Americans were to complete college, a "big improvement" would result in advancements in science, medicine, and technology. (See figure 7-10.) Fifty-five to sixty percent felt that big improvements would result in solving social problems such as crime, drugs, and homelessness, and in the U.S. ability to compete economically with the rest of the world. Respondents were more pessimistic about solving social problems than about achieving advances in international trade and in S&T.

In another national poll taken in 1989, respondents were given a list of choices in answering the question, "Which is the best policy for improving productivity in the United States?" Given the choices of investing in new plants and equipment, reducing government regulation of business, increasing R&D expenditures, and improving education and job training, 54 percent felt that improved education and job training would be the best policy (Times Mirror 1989). (See figure 7-11.) Only 10 percent felt that increasing R&D expenditures would be the best policy for improving productivity.

***Concerns About Education.*** Since 1985, the percentage of U.S. adults who agree that the "quality of science and mathematics education in American schools is inadequate" has risen from 63 to 72 percent. (See figure O-25 in Overview.) The adult public also thinks that the quantity of science and mathematics education should be increased. Nearly 90 percent agree that "every U.S. high school student should be required to take a mathe-

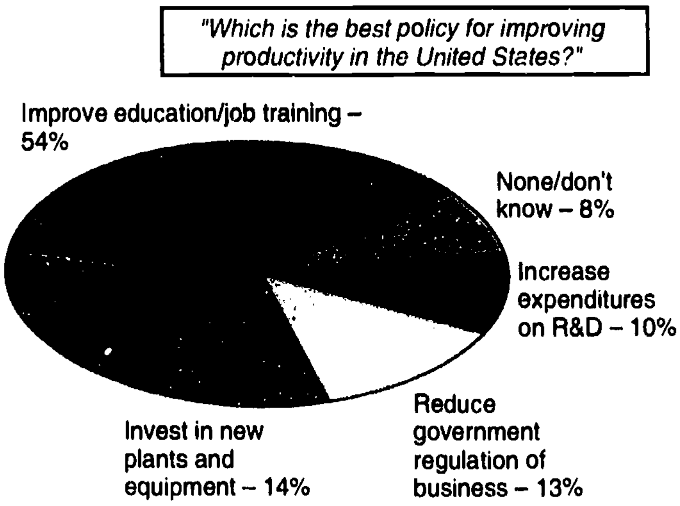
Figure 7-10.
**Benefits of college education: 1990**




NOTE: N = 1,014.
SOURCE: Council for Advancement and Support of Education, *Attitudes About American Colleges 1990* (Washington, DC 1990), p. 21.

*Science & Engineering Indicators – 1991*

Figure 7-11.
**Proposals for improving U.S. productivity: 1989**




NOTE: N = 2,048.

SOURCE: Times Mirror Center for the People and the Press, "The People, Press, and Politics," data diskette (Washington, DC, 1989).

*Science & Engineering Indicators – 1991*

matics course each year," and about 73 percent agree that high school students should take a science course every year.

The Gallup Organization and the Times Mirror Center for the People and the Press have been tracking American concern over educational and other issues. In 1988, 89 percent of the adult public stated that they were concerned about "a decline in the quality of education" in the United States, and 53 percent were "very" concerned about such a decline (Times Mirror 1989). (See text table 7-4.) Further, 75 percent were concerned about "the loss of U.S. leadership in science and technology"; overall, 33 percent were "very" concerned.

In 1989, on a similar set of questions, Americans were asked to assess whether the United States "is very strong, strong, weak, or very weak compared to other countries" in a number of areas. Fewer than half felt that the United States is either very strong or strong in "our system of public education," and half felt that the United States is weak or very weak compared to other countries in educating its citizens. (See figure 7-12.) For contrasting measures, respondents on this survey were asked to compare the United States with other countries on "technical and engineering innovation" and "scientific research." Sixty-nine percent rated the United States as strong or very strong on innovation, and 79 percent assessed U.S. scientific research as strong or very strong in comparison with other countries.[29]

***Spending Preferences.*** Americans say they are willing to spend more for education. Since 1973, the General Social Survey has been asking people if they think "we're spending too much money, too little money, or about the right amount" on various national problems. Through 1977, about half the public felt that not enough money was being spent on education. (See figure 7-13 and figure O-25 in Overview.) By 1985, that percentage had risen to 60 percent; it then climbed sharply to over 71 percent in 1990. Percentages responding "about right" and "too much" both fell throughout the decade (NORC annual series).

Education is a problem area in which Americans have felt too little money is being invested; other such areas are "improving and protecting the Nation's health" and "improving and protecting the environment." By 1990, over 70 percent of Americans felt too little was being spent on these three problem areas. In contrast, around 10 percent thought too little was being spent on the space exploration program.[30]

## Second Thoughts About S&T

Americans are not always oriented positively toward science. To probe these dimensions of U.S. attitudes toward S&T, several questions have been asked over the years to elicit respondents' attitudes when conflict occurs between science and other values. These questions are discussed in the following paragraphs, along with public confidence in new technologies.

***Science and Values.*** In 1957, 50 percent of U.S. adults agreed that "We depend too much on science and not enough on faith." (See appendix table 7-7.) In 1990, that proportion did not change. Further, in 1990,

[29] However, contrast these findings with similar questions comparing specific countries; see "Perception of International Standing in S&T," pp. 189-96.

[30] Compare these responses with the cost/benefit assessments of the U.S. space exploration program noted in "Assessments of Three Technology Programs," pp. 177-79. For an interpretation of the remarkable 1980 deviation in preferences on military spending, see footnote 20.

Text table 7-4.
**Public concern about U.S. science, technology, and education: 1988**

*"I am going to read you a list of potential problems facing the United States. For each one, please tell me how concerned you are that it will happen."*

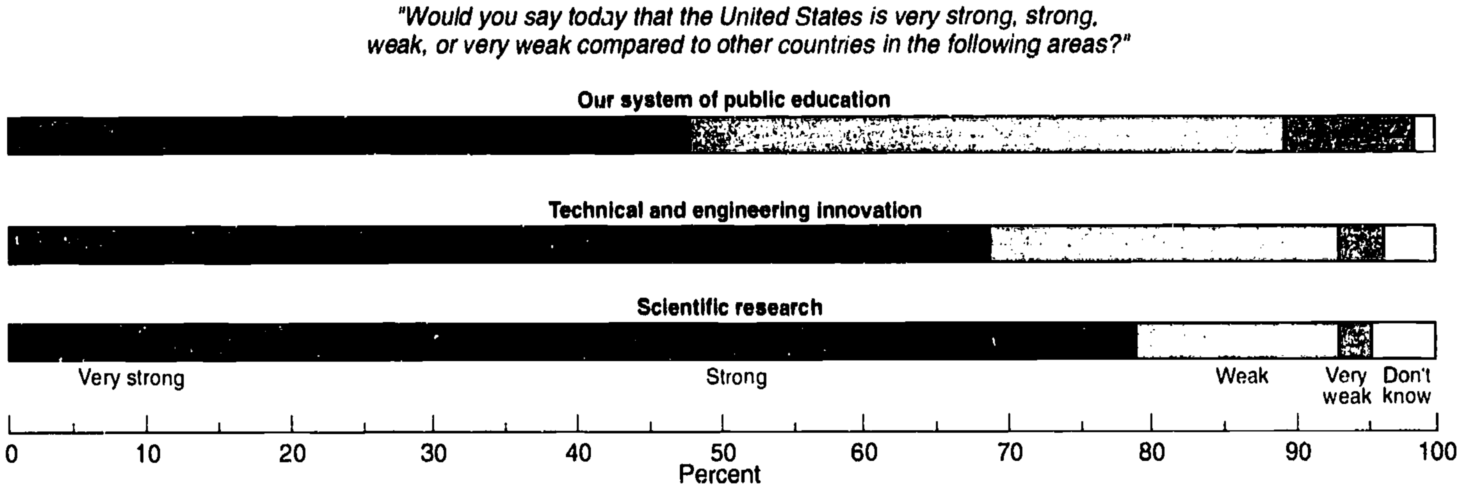
| | Degree of concern | | | | |
|---|---|---|---|---|---|
| | Very | Somewhat | Not too | Not at all | Don't know |
| | Percent | | | | |
| The loss of U.S. leadership in science and technology | 33 | 42 | 18 | 3 | 5 |
| A decline in the quality of education in the U.S. | 53 | 36 | 8 | 2 | 2 |

NOTES: N = 3,021. Percentages may not total 100 because of rounding.

SOURCE: Times Mirror Center for the People and the Press, "The People, Press, and Politics," data diskette (Washington, DC, 1989).

*Science & Engineering Indicators – 1991*

Figure 7-12.
**U.S. strength in education, innovation, and science: 1989**




SOURCE: Times Mirror Center for the People and the Press, "The People, Press, and Politics," data diskette (Washingt n, DC, 1989).

See appendix table 7-13. *Science & Engineering Indicators – 1991*

about a third of the respondents agreed with the related proposition that "One of the bad effects of science is that it breaks down people's ideas of right and wrong"; this percentage has changed little over the past decade. About 60 percent disagreed, however, that science breaks down ideas of right and wrong. Rejection of scientific explanations for natural phenomena suggests an undercurrent of fundamental adherence to religious and other explanations, even if most adults highly value science and think it has improved their daily lives.

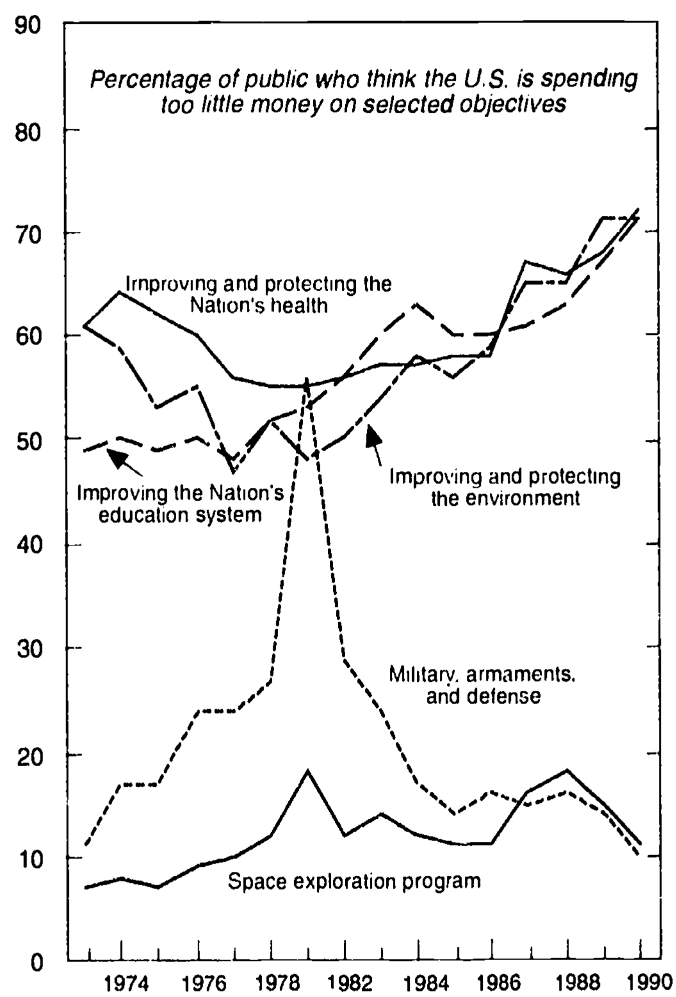
***Use of Animals in Research.*** Over the past 5 years, attitudes toward the use of animals in research have changed in the United States. Between 1985 and 1990, the percentage of respondents feeling that research causing pain or injury to animals is justified if such research results in new knowledge about human health has fallen, dropping from 63 percent to 50 percent.[31] (See figure 7-14.) Over the same period, the number of Americans who reject such use of animals has grown from 30 to 44 percent.

Support for anti-vivisectionist positions has grown in the U.S. population, but it has not yet reached the level found in other countries. In Britain, a 1988 survey found that only 36 percent agreed that research causing pain or injury to animals is justified if it results in new knowledge about human health (NSB 1989). In Canada in 1990, only 44 percent agreed with the same statement (Einsiedel 1990).

***Expectations for New Technologies.*** Optimism about the development of technology "to counteract any

[31]The *Indicators* question is designed to stress the payoffs for *human health* of such use of animals. The question is also purposefully provocative by using "dogs" and "chimpanzees"—rather than mice—in order to elicit attitudes toward use of these larger mammals.

Figure 7-13.
**Preferences for national spending**




NOTE: Survey not conducted in 1979 and 1981.

SOURCE: National Opinion Research Center, *General Social Surveys Cumulative Codebook* (Chicago: University of Chicago, annual series).

See appendix table 7-14. *Science & Engineering Indicators – 1991*

harmful consequences of technological development" has declined since 1985. (See figure 7-15.) In that year, 47 percent agreed that new inventions would always be found to counteract technological damage; by 1990 that percentage had dropped to 37 percent. The proportion of respondents who disagreed with the proposition grew from 45 to 56 percent.

Americans have been inundated with news of disasters like the Valdez oil spill, the Challenger accident, the Chernobyl explosion, and other problems. The decreased optimism about the availability of technological fixes for these problems may reflect growing doubt about the tractability of much of this damage.

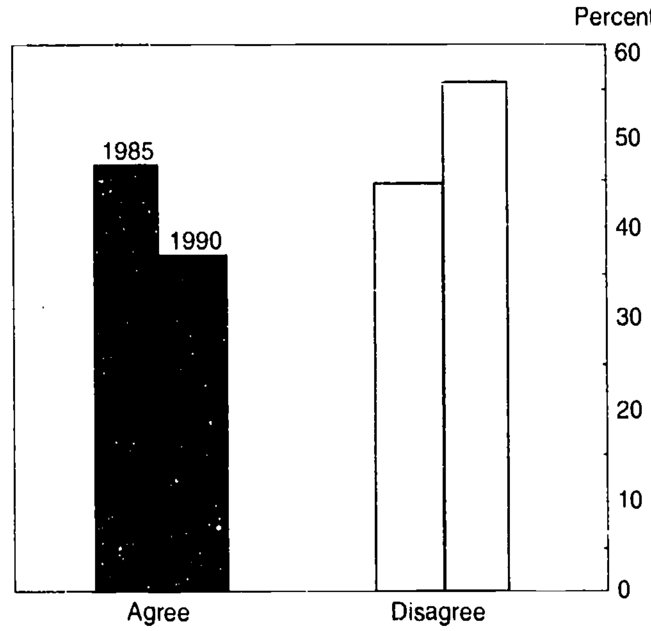
## International Comparisons of Attitudes Toward S&T

As countries have increasingly measured and assessed their national efforts in S&T over the past decade, they have also demonstrated a growing interest in national public attitudes toward S&T—and the comparability of these attitudes.[32] Occasional, internationally comparative survey work has been reported in *Indicators* from as early as 1980. By the end of the decade, the governments of Great Britain, France, and Japan were all sponsoring national attitudes surveys, usually with some coordination on questions and themes with the U.S. *Indicators* series. National surveys of the adult publics in Canada in 1989 and Japan in 1990 featured extensive coordination with U.S. researchers, thus adding valuable data to this growing body of comparative research (Einsiedel 1990 and Office of the Prime Minister of Japan 1991).

In 1989, the European Community (EC), through the Eurobarometer program of the Commission of the European Communities, sponsored an EC-wide survey of public attitudes toward and knowledge of S&T (CEC 1989).[33] In one stroke, the number of countries with comparable data on some of the traditional *Indicators* measures increased from 4 to 15. (See "Availability of Data," p. 183.) The following comparisons are based on the EC survey of 12 nations of Europe (1989) and surveys in Japan (1990), Canada (1989), and the United States (1990).[34]

Figure 7-15.
**Trust in technology**

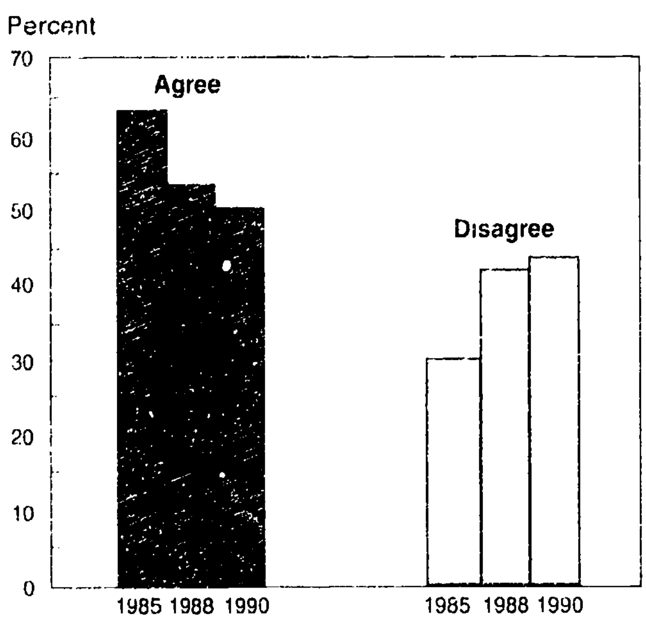
*"New inventions will always be found to counteract any harmful consequences of technological development."*




See appendix table 7-7. *Science & Engineering Indicators – 1991*

Figure 7-14.
**Research with animals**

*"Scientists should be allowed to do research that causes pain and injury to animals like dogs and chimpanzees if it produces new information about human health problems."*




See appendix table 7-7. *Science & Engineering Indicators – 1991*

[32] The recent growth in the number of researchers conducting surveys of attitudes toward S&T, and of governments and other bodies sponsoring such surveys, led to the formation in 1990 of the International Council for the Study of Public Attitudes Toward S&T. The Council meets once a year to coordinate survey plans and discuss technical and other questions involving comparability of the data. The Council's next meeting will be in 1992 in Tsukuba, Japan.

[33] NSB (1989) reported some early data from this EC survey, but none at the national level.

[34] Comparing survey results from this many countries is not unproblematic, despite the coordinative efforts made and the attention given to technical comparability of survey operations. The indicators discussed in this section should be interpreted cautiously both because of the normal measurement errors encountered in any public survey as well as the following considerations:

## Availability of Data

The following paragraphs provide information for potential users of the large data sets discussed in this chapter.

***Canada:*** The telephone survey of 2,000 Canadians was performed by Decima Research of Toronto under the direction of Edna Einsiedel, University of Calgary, in November and December 1989. The survey performers telephoned adult Canadians at random, stratified according to the population in each province.

Data diskettes containing the Canadian survey results can be obtained from Professor Einsiedel, Graduate Program in Communication Studies, University of Calgary. Other details on survey methodology and results as well as the questionnaire are in Einsiedel (1990); further analyses of the data are presented in Einsiedel (1991).

***European Community:*** The 12-nation survey for the Eurobarometer program of the EC was coordinated by Faits et Opinions in Paris and conducted by affiliated survey groups in each country in March 1989 (CEC 1989). The data are stored at the Belgian Archives for the Social Sciences (1 Place Montesquieu, B-1348 Louvain-La-Neuve). The in-person interviews were conducted with adults 15 years of age or older using a variety of sampling methodologies in the different countries. See also Bauer, Durant, and Evans (1991) and Durant et al. (1991) for analyses using these data.

This chapter reports data from the EC-sponsored survey for the 12 member countries and for the Community as a whole (reported as "Europe"). Country-level data are weighted to the population profile of the individual country, and data for Europe are separately weighted to the total of the Community member nations.

***Japan:*** The Japanese survey was conducted in January 1990 by Shin Joho Center of Tokyo for the Office of the Prime Minister of Japan. Using a two-stage stratified probability sample, the survey performers conducted in-person interviews with 2,239 adults 18 years or older.

Further details on survey methodology and extensive data tables are presented in Office of the Prime Minister (1991). As of this writing the data diskettes have not been made available.

***United States:*** Tabulations from the 1979, 1981, 1983, 1985, 1988, and 1990 surveys are reported in Miller (1991a), and the data diskettes with complete documentation for these surveys are available from the International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 2001 N. Clark Street, Chicago, IL, 60614 (telephone: 312-549-0607). A codebook incorporating the results from 1979 through 1990 is also available at a nominal charge from the center.

The 1985 survey data set includes two additional interview cycles, one each following the Challenger and Chernobyl accidents. Data from before 1979 are reported in NSB (1973, 1975, and 1977).

See Miller (1987) and Miller, Prewitt, and Pearson (1980) for discussions of question design and survey methodology; see Miller (1991b) for further analyses.

Because of technical and other uncertainties in the indicators that follow, this section adopts a somewhat more cautious tone than the preceding section. Broad patterns are emphasized rather than absolute differences on indicators, except where these differences are notably large or intriguing. The discussion reports measures for total national populations only and does not provide cross-cuts for otherwise interesting subpopulations.

Despite these caveats, the following indicators of public attitudes toward S&T add an important new dimension to understanding the different postures of national populations toward S&T. Even these broadstroke comparisons reveal striking differences—and important similarities—among Japan and the countries of North America and Western Europe.

This section opens with comparisons of national response rates on a set of questions designed to indicate general public attitudes toward S&T. Country-level responses are then compared on the degree of interest in, and knowledge about, issues concerning S&T. Next, in a discussion of the distribution of scientific knowledge among the adult populations of these countries, two indicators of knowledge about science are introduced. One deals with the extent to which the public describes astrology as "scientific"; the other is a set of simple true/false questions on elementary knowledge of S&T.

The section concludes with a comparison of how the adults of these different countries assess the relative standings of the United States, Europe, and Japan in scientific achievement and in technological innovation. The

---

• *Language*—even basic terms like "science" and "technology" may have different cultural connotations and thus lead to apparent, but not necessarily real, differences in survey results.

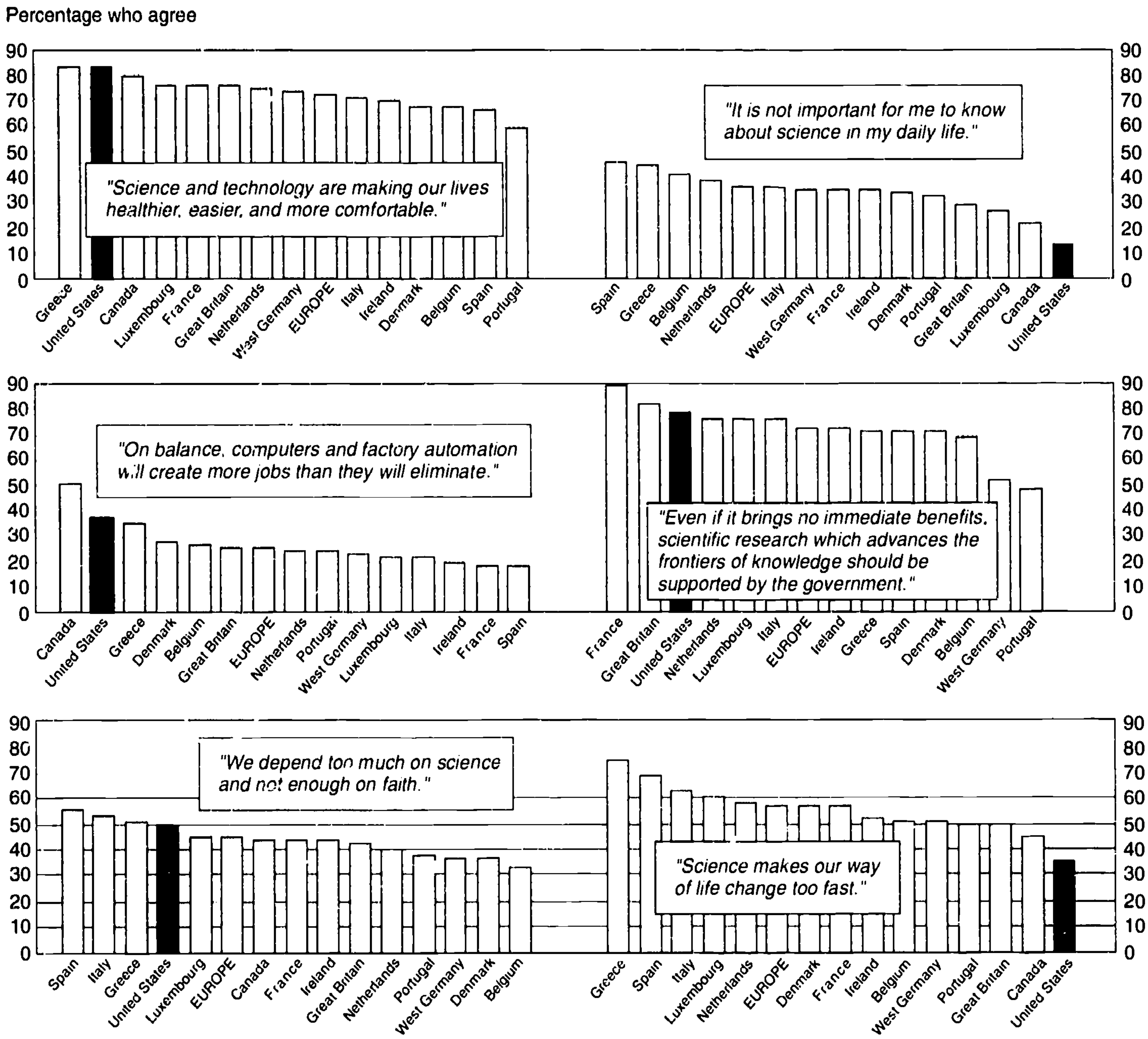
• *Public polling practices*—differences among countries in the state of the art of their polling practices may influence the technical quality and comparability of the data.

• *Propensity to participate in polls*—different national propensities to participate in public polls, or to respond openly and honestly when polled, may affect the survey results.

• *Survey instruments*—measurement differences surely resulted from the use of different national survey instruments. Differences in question order and questionnaire content can affect survey results, but the extent of this effect is unknown.

• *Survey timing*—for comparison purposes, the surveys ideally should have been conducted simultaneously. The effect of the difference in timing is unknown.

Figure 7-16.
**International comparisons of public attitudes toward science and technology**




See appendix tables 7-7 and 7-15. *Science & Engineering Indicators – 1991*

widely diverging response patterns show the different ways national populations view their country's relative position in research and technological development: these patterns complement several of the indicators reported in chapter 6.

## Attitudes Toward S&T

***The United States, Canada, and Europe.*** Six common questions are available to compare the attitudes toward S&T of adults in 12 European countries and the United States. Canadian measures are available for five of these.[15] (See figure 7-16.)

Respondents in the United States and Canada gave similar responses to several questions. For instance, a majority of adults in both countries agreed that "Science and technology are making our lives healthier, easier,

---

[15] The survey questionnaire of the European Community gave respondents a choice of "neither agree nor disagree"; the Canadian and U.S. questionnaires did not. The effect of this difference in response choices is not known. Only the totaled responses for "agree" and "agree strongly" are reported here.

and more comfortable,"[36] and most often disagreed that "It is not important for me to know about science in my daily life." Respondents in these two countries also most often disagreed that "Science makes our way of life change too fast."

The response patterns of the United States and Canada on these and other items suggest that the populations of the two countries are largely similar in their general attitudes toward S&T. They agreed in similar proportions—and were more optimistic compared to the European nations—that "On balance, computers and factory automation will create more jobs than they will eliminate."

However, a higher percentage of the U.S. respondents than of the Canadian felt that "We depend too much on science and not enough on faith." The United States has traditionally registered relatively large percentages that agree with this proposition. Comparing the U.S. response on this item to that of other countries shows that the United States ranks just below Spain, Italy, and Greece and just above Luxembourg in its agreement. These four European countries all register above the EC's average agreement with this statement. (See appendix table 7-7 for the U.S. time trend on this question.)

Another question measured approval by the adult population of *governmental* support of scientific research "even if it brings no immediate benefits."[37] The U.S. respondents were generally in high agreement with this proposition, but France and Great Britain registered even higher levels of agreement. The French, in fact, approached unanimity (over 90-percent agreement) for a strong governmental role in the support of basic research. In very sharp contrast were the response rates of West Germany: barely a majority agreed with the statement. These very different response patterns of two large and scientifically influential European countries are not easy to explain.[38]

The Netherlands also had anomalous response patterns on several of these questions (Second Chamber 1990). Although registering rather high approval of governmental funding of research, well over a majority of the adults in Holland agreed that science makes life change too fast. Moreover, nearly half of the Dutch adults *disagreed* that the benefits of science are greater than any harmful effects, with a full 26 percent "strongly" disagreeing.[39]

The Netherlands public also seemed unwilling to leave decisions to scientists; well over half disagreed with the statement that "Scientists can be trusted to make the right decisions."[40] Majorities in Denmark and Great Britain also disagreed with this statement. Responses to this question varied considerably across Europe, suggesting fundamentally different degrees of trust in scientists' decisionmaking.

***The United States and Japan.*** The 1990 U.S. and Japanese surveys each gauged agreement with the proposition that "Science and technology are making our lives healthier, easier, and more comfortable." Figure 7-17 compares the national totals of the two countries on this indicator. While similar percentages *strongly* agreed with the proposition, Japanese adults were far more likely to disagree, to disagree strongly, or to answer "don't

[36]See below for a comparison of the United States and Japan on this question.

[37]The U.S. question asked about support by the *Federal* Government, while the European questions referred only to "government." The Canadian survey did not include this question.

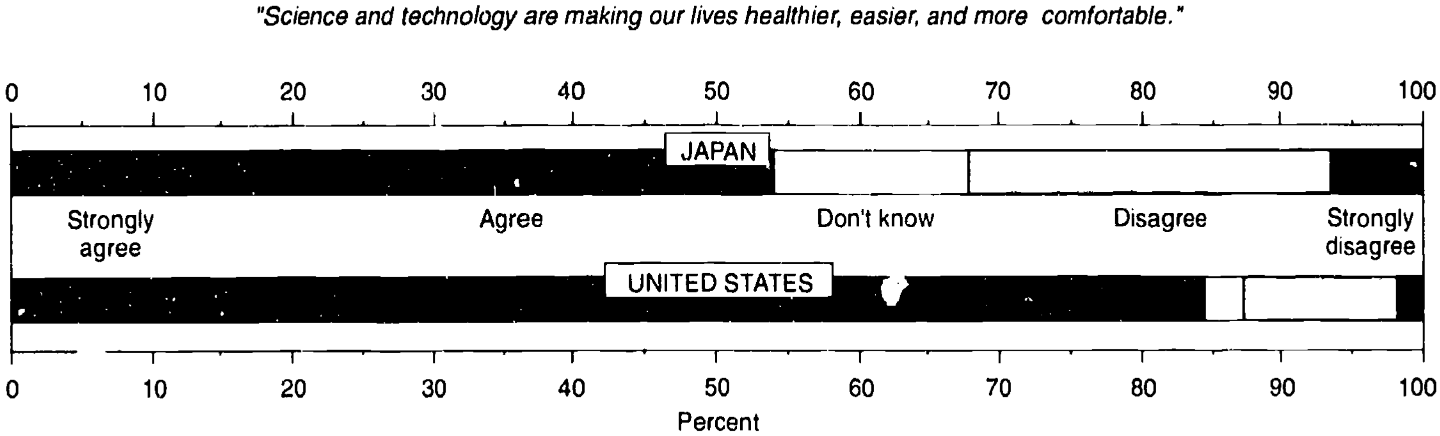
[38]See R&D expenditure patterns for these countries in chapter 4, "International Comparisons," pp. 107-10.

[39]This question and others not asked in the U.S. survey are reported in appendix table 7-15.

Similar results from an earlier survey were reported for The Netherlands. In response to the question "In the long run, do you think the scientific advances we're making will help or harm mankind?," 36 percent responded "will harm," 22 percent "will help," and 34 percent "both" (NSB 1987, pp. 18 and 332).

[40]For a related question in the 1990 U.S. survey, 80 percent of U.S. adults agreed that "Most scientists want to work on things that will make life better for the average person." See appendix table 7-7.

Figure 7-17.
**Japanese and U.S. assessments of science and technology**



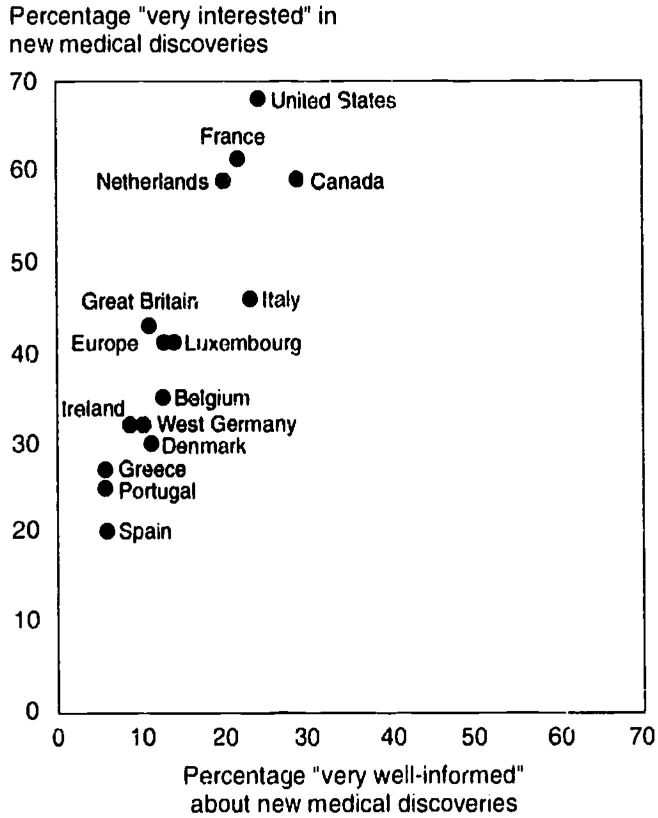

See appendix tables 7-7 and 7-16. *Science & Engineering Indicators – 1991* know." Overall, about 85 percent of the U.S. respondents acknowledged the beneficial effects of S&T on their daily lives compared to about 55 percent of the Japanese. Fewer than half of the Japanese respondents agreed, in answer to a question not raised in the U.S. survey, that S&T has had a positive impact in Japan on working conditions. (See appendix table 7-16.)

On two other questions not asked of the U.S. respondents, however, the Japanese displayed attitudes toward S&T that were both more positive and more mixed. When asked whether S&T has "improved, worsened, or not changed" the standard of living, three-fourths agreed that the standard of living has been improved. A related question asked: "Science and technology have both positive and negative effects. Which do you think has been greater—the positive effects or the negative effects?" Fifty-three percent of the Japanese responded that positive effects have been greater, 31 percent responded "about the same," and 7 percent favored the negative assessment.

About 38 percent of the Japanese respondents felt that S&T has "worsened" morality. Thirty-five percent felt there was no change, and about one-fifth declined to answer the question. On a related question asked in the United States, about one-third of adults agreed that "One of the bad effects of science is that it breaks down people's ideas of right and wrong." (See appendix table 7-7.)

In sum, on these sets of comparisons, U.S. and Japanese responses were not dissimilar. In the United States, somewhat larger majorities overall expressed positive attitudes toward S&T and its impact on daily life, but on several questions with different wordings the Japanese were also strongly positive. About a third of the adults in each country indicated a concern with the effects of science on moral issues.

Figure 7-18.
**Interest in and knowledge about new medical discoveries**




See appendix tables 7-1, 7-2, and 7-17.

*Science & Engineering Indicators – 1991*

## Attention to Issues in S&T

The adult publics of the countries of Western Europe and of Canada and the United States appear to have different patterns of interest in and knowledge about issues involving S&T.[11]

For all the countries surveyed, by far the greatest degree of interest was in new medical discoveries. Four countries dominated in this degree of interest: the United States, France, Canada, and The Netherlands. (See figure 7-18.) Adults in these countries (and in Italy) also ranked high on the percentages very interested in science and new inventions and technology. Of all the countries, French respondents claimed most often to be very interested in scientific discoveries and in inventions and technology.

The adult populations of the United States and Canada reported similar rates of being "very interested" in new scientific discoveries, new inventions and technologies, and new medical discoveries. Their rates were generally higher than in Western Europe. (See appendix table 7-17.) U.S. and Canadian respondents also reported similar degrees of feeling "very well-informed" about these sets of issues. The similar responses of Canadian and U.S. adults on these questions indicate the close cultural ties between the two countries.

Respondents in Greece, Spain, and Portugal consistently reported lower rates of being "very interested" in or "very well-informed" about any of the three sets of issues. (The adult publics in these three countries also ranked lowest on knowledge of basic scientific ideas; see "Knowledge of Scientific Conclusions," pp. 187-89.)

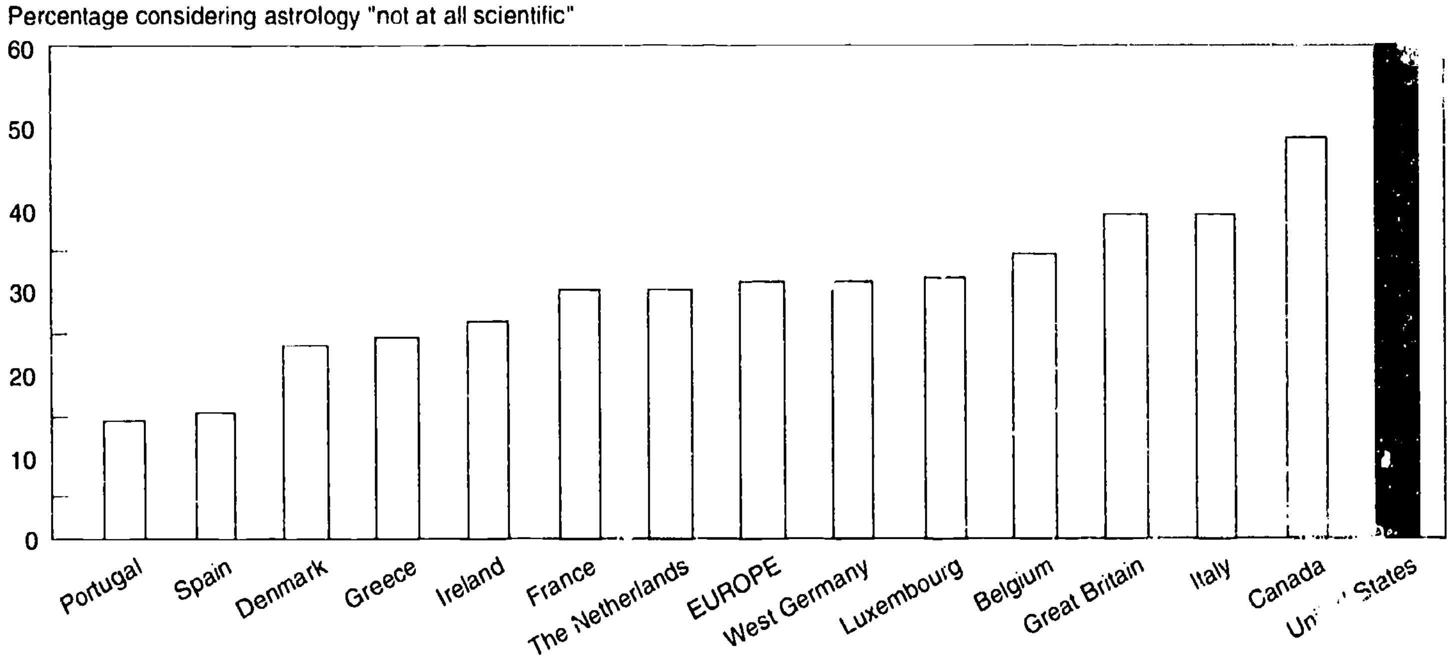
Two interesting results among the European nations were the low self-reports of interest and knowledge by adults in Denmark and West Germany for all three of the areas. The Danes have traditionally scored high on international tests of science and mathematics ability, and they outranked adults in all other nations on the knowledge questions discussed below (see pp. 187-89). In West Germany adults reported being very interested and very well-informed at rates 50 percent or lower than in other European countries. Reasons for these differences are not immediately clear. Both of these countries have significant R&D budgets and both have high levels of education.

## Is Astrology Scientific?

To ascertain the public's degree of belief in pseudoscience, the U.S. *Indicators* series has tracked the extent

[11] No measure of attentiveness is developed here for Canada, Europe, or Japan. However, see Einsiedel (1990) on Canadian attentiveness and Durant et al. (1991) on European.

Figure 7-19.
**Perceptions of astrology**




See appendix table 7-18.

*Science & Engineering Indicators – 1991*

to which respondents feel that astrology is scientific. Astrology and science might appear, to the uninitiated, to use similar arcana: jargon, symbols, and astronomical bodies as reference points.

Rejection or acceptance of astrology as a science may be considered an indicator of the understanding of the scientific method and of the nature of scientific knowledge. Rejection of astrology as scientific may be interpreted as an indicator of scientific understanding.[12]

Majorities of respondents in several European countries accepted astrology as either "very" or "sort of" scientific, whereas about 60 percent of U.S. respondents rejected astrology as "not at all scientific." (See figure 7-19 and appendix table 7-18.) In no country in Europe did more than 40 percent of the respondents state that astrology is not scientific. Education level seems surprisingly unrelated to rejection of astrology. In Denmark, for example, some 60 percent of the adult population thought astrology is very or sort of scientific; similar findings were reported for other countries with high education levels.

"Don't know" responses were high for this question in most European countries (but not in France, Great Britain, and Luxembourg). In several countries, 20 to 25 percent claimed not to know the answer to the question.

## Knowledge of Scientific Conclusions

The Canadian, European, Japanese, and U.S. surveys each contained several questions designed to measure knowledge of various basic scientific concepts and facts. These questions can be used to compare (1) total national average accurate responses and (2) distributions within the national populations of accurate responses.

***The United States and Canada.*** On 11 questions available to compare scientific knowledge of the Canadian and U.S. populations, the mean number of correct responses was slightly higher in Canada—7.3 versus 7.0 in the United States. (See appendix table 7-19.) The two countries exhibited very similar response patterns on all but one question: the theory of evolution. U.S. respondents answered this question correctly only 45 percent of the time, versus 58 percent in Canada. The distributions of correct responses on these 11 questions were strikingly similar for the two populations. (See figure 7-20.)

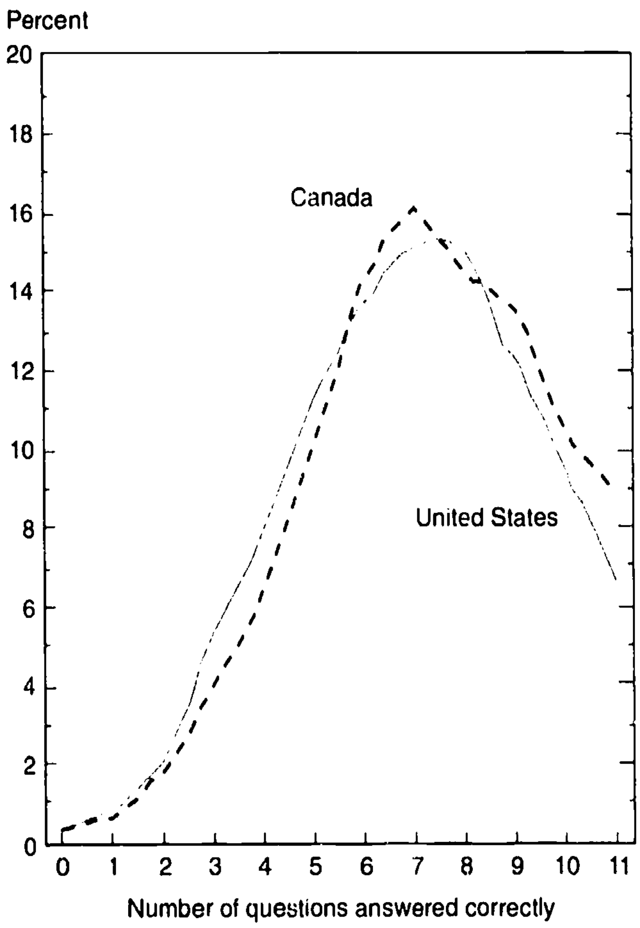
***The United States and Europe.***[13] Ten questions were available to compare the 12 members of the

[12] Interpretation of this indicator is problematic. For example, in the United States, relatively large percentages of otherwise educated respondents report that they sometimes read their horoscopes. Far fewer, however, report that they base their actions on what their horoscopes say (NSB 1989).

In an analysis of French data not shown here, Boy (1991) points out that in France belief in different practices of the parasciences differs according to education level. For example, relatively more French adults with higher educational levels believe in telepathy. In contrast, belief in astrology is inversely related to education level. Boy (p. 5) goes on to note: "An analysis of the correlations shows that, as a rule, irrational beliefs scarcely affect support for science."

[13] This discussion borrows heavily from Bauer, Durant, and Evans (1991). In their analysis of only the European data, and using a slightly expanded question set, the authors discuss relationships among attitudes, knowledge, and other socioeconomic variables.

Figure 7-20.
**U.S. and Canadian knowledge of science and technology**




See appendix table 7-19 for questions.
*Science & Engineering Indicators – 1991*

European Community with the United States on a scale of scientific knowledge. (See appendix table 7-20.) The average (mean) national rankings of these countries on these 10 questions are shown in figure 7-21. Denmark ranked highest and Portugal lowest, with a general tendency of increasing rank on this measure from south to north among European countries.

The United States's mean accurate response rate was virtually the same as that for the European Community overall. Response rates on individual questions were also similar for the United States and the EC, except for rather lower knowledge in the United States of planetary motion and higher knowledge of continental drift.

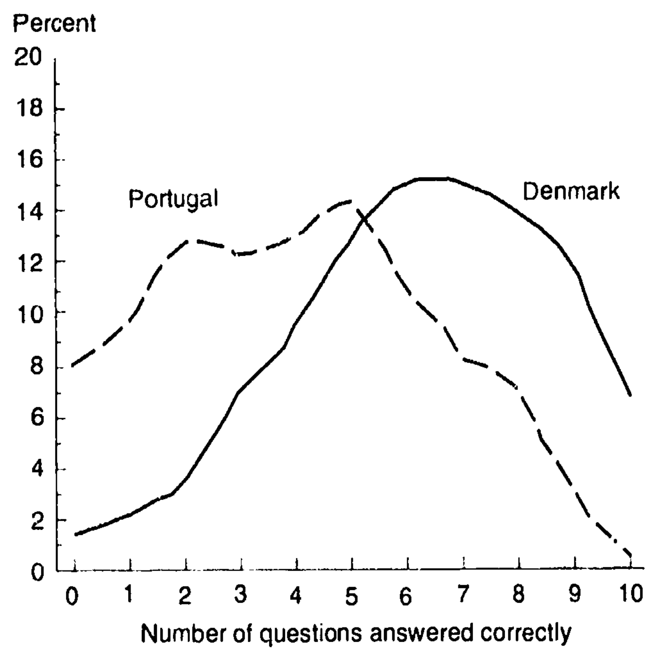
Patterns of scientific knowledge distribution are also of interest. Figure O-26 in the Overview shows that correct responses to these 10 questions were nearly identically—and fairly normally—distributed in the U.S. and EC populations. Within Europe, however, these distributions varied widely, with particularly uneven distributions in both countries with high levels of knowledge (e.g., Denmark and Britain) and those with low levels (Spain, Greece, and Portugal).[11] (See figure 7-21.)

[11]Bauer, Durant, and Evans (1991) note that the Chronbach Alphas of Spain and Portugal are unusually high compared to the countries' knowledge measures. (Alphas are measures of consistency in individual responses; they show the extent to which persons responding correctly to one item also tended to respond correctly to other items. The alphas shown in appendix table 7-20 are all moderate to moderately high.)

To explain this relationship, they propose (p. 7) that the tendency for respondents to give consistent answers may increase in countries with sharp contrasts in educational attainment and that "in lower [knowledge] level countries the social structure seems to be more important for the distribution of science than in higher level countries." Figure 7-21 shows a strong bimodal distribution in Portugal compared with Denmark. Such a distribution shows that some people have little scientific knowledge, while others have much more. A country with such a distribution may have a more elitist science education system.

Figure 7-21.
**Distributions of scientific knowledge**

| | Mean number of 10 questions answered correctly | N |
|---|---|---|
| Denmark | 6.23 | 1,013 |
| Great Britain | 6.17 | 976 |
| Luxembourg | 6.17 | 303 |
| France | 6.11 | 1,004 |
| Netherlands | 6.05 | 1,025 |
| West Germany | 5.97 | 1,024 |
| United States | 5.79 | 2,033 |
| EUROPE | 5.75 | 11,677 |
| Italy | 5.66 | 1,022 |
| Northern Ireland | 5.27 | 300 |
| Belgium | 5.24 | 1,000 |
| Ireland | 5.19 | 1,006 |
| Spain | 5.03 | 1,001 |
| Greece | 4.71 | 1,000 |
| Portugal | 4.09 | 1,000 |




See appendix table 7-20. *Science & Engineering Indicators – 1991*

Text table 7-5.
**U.S. and Japanese knowledge of science and technology**

| | Correct | | Don't know[1] | |
|---|---|---|---|---|
| | United States | Japan | United States | Japan |
| | Percent | | | |
| 1. "The center of the earth is very hot." | 79 | 78 | 14 | 18 |
| 2. "Lasers work by focusing sound waves." | 37 | 14 | 37 | 45 |
| 3. "Electrons are smaller than atoms." | 41 | 37 | 35 | 48 |
| 4. "Antibiotics kill viruses as well as bacteria." | 30 | 8 | 11 | 21 |
| 5. "The universe began with a huge explosion." | 32 | 54 | 35 | 34 |
| 6. "The continents on which we live have been moving their location for millions of years and will continue to move in the future." | 77 | 82 | 15 | 15 |
| 7. "Human beings, as we know them today, developed from earlier species of animals."[2] | 45 | 79 | 14 | 11 |

NOTE: Incorrect responses were omitted.

[1]Response categories in the U.S. surveys were "true," "false," or "don't know." In the Japanese survey, respondents were offered choices of "strongly agree," "agree," "disagree," "strongly disagree," or "don't know."

[2]Japanese wording: "What do you think about the following statement? Human beings developed from earlier species of animals."

SOURCES: Office of the Prime Minister of Japan, Public Relations Office, *Opinion Survey on Science, Technology, and Society*, T. Welch, trans. (Washington, DC: Science Resources Studies Division, National Science Foundation, 1991); and J.D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991); and unpublished tabulations.

*Science & Engineering Indicators – 1991*

***The United States and Japan.*** Seven common questions concerning simple S&T concepts were asked on the 1990 U.S. and Japanese surveys. (See text table 7-5.) The responses of these culturally very different populations displayed both strong similarities and striking differences:

- On questions dealing with purely scientific conclusions, and on those that did not concern subjects on which U.S. respondents have traditionally held strong moral beliefs, the U.S. and Japanese response patterns were very similar.
- On two questions dealing with lasers and antibiotics, the Japanese correct responses were much lower than American.
- On two questions involving topics about which Americans feel strongly—evolution and the origin of the universe—U.S. respondents answered incorrectly more often than the Japanese by 20 to 30 percentage points.

## Perception of International Standing in S&T

The U.S., Japanese, and Western European populations have different conceptions of their countries' relative international ranking in S&T capabilities.[15] The following paragraphs describe these different assessments, first in terms of basic scientific capabilities, then in terms of military capabilities.

***Basic Scientific Achievements.*** U.S. respondents were confident that the United States is ahead of Europe and the Soviet Union in basic scientific achievements. (See text table 7-6.) The percentages of adults placing the United States ahead of Europe and the Soviet Union in basic scientific achievements increased directly with educational level. The attentive publics for S&T-related issues were also generally more positive in their assessments of U.S. standing in basic science. (See appendix table 7-21.)

In sharp contrast, 50 percent of Americans believed that the United States is behind Japan in basic scientific achievements. This proportion is up considerably from the 29 percent of Americans who held this belief in 1985 (NSB 1987). Higher percentages of women and younger adults cited Japanese superiority in basic science. (See appendix table 7-21.)

These results are surprising since Japan has, until recently, been engaged in relatively little basic research. It is possible that U.S. respondents confused "science" with "technology" in their answers. Two attentive publics—one for scientific discoveries and one for space exploration—both placed the United States behind Japan in basic science less often. As noted earlier, these publics were among the most highly educated of the attentive groups discussed in this chapter. (See text table 7-1.)

[15]Questions on this topic were not asked in the Canadian survey.

Text table 7-6.
**U.S. assessments of basic science and military technology**

| | Versus Europe | Versus the Soviet Union | Versus Japan |
|---|---|---|---|
| | Percent | | |
| **Basic science** | | | |
| U.S. is ahead | 46 | 61 | 23 |
| U.S. is at same level | 36 | 28 | 25 |
| U.S. is behind | 14 | 7 | 50 |
| **Military technology** | | | |
| U.S. is ahead | 69 | 46 | 71 |
| U.S. is at same level | 26 | 42 | 18 |
| U.S. is behind | 3 | 9 | 7 |

NOTE: "Don't know" responses were omitted.

See appendix tables 7-21 and 7-23.

*Science & Engineering Indicators – 1991*

The 46 percent of Americans who felt that the United States is ahead of Europe in basic science is matched by 46 percent of Europeans who agreed with them. However, within the member countries of the EC, strong differences are evident on this indicator. (See appendix table 7-22.) Large majorities in Italy, Spain, Ireland, and Greece place Europe behind the United States: populations in the other countries viewed Europe more favorably in the comparisons. In these assessments, it is possible that the respondents were making reference to *national* rather than *European* standing.[16] On the other hand, each national group may view "Europe" from a unique national perspective.

Europeans were less pessimistic about their standing in basic science vis-à-vis the Japanese than were Americans. In Europe, 41 percent felt that Europe is *less* advanced than Japan. West Germans stood out among the European respondents: only 22 percent felt that Europe is less advanced than Japan in basic science, another 30 percent felt the two countries were at the same level, and 39 percent felt that Europe is more advanced than Japan in basic science. (See appendix table 7-22.)

The Japanese, when asked a similar question in 1987, tended to disagree with the U.S. responses and agree with the European responses (NSB 1987).[17] Only 20 percent felt that Japan was ahead of the United States in "basic science and technology," but strong majorities placed Japan ahead of West Germany, Britain, and France in these achievements.

***Military Technologies.*** Pronounced changes have occurred in Americans' assessments of the military technology of the United States and the Soviet Union. In 1985, 33 percent of U.S. respondents felt that the United States was ahead of the Soviet Union in military technology; 40 percent felt it was at the same level (NSB 1987). In 1990, those percentages had changed to 46 percent and 42 percent, respectively. (See text table 7-6.) Also in 1990, even higher percentages of highly educated respondents and of the attentive publics for nuclear power, new technologies, and space exploration placed the United States ahead of the Soviet Union in military technologies. (See appendix table 7-23.)

[16] Bauer, Durant, and Evans (1991, p. 9) make the same observation.

[17] The Japanese were asked about West Germany, Great Britain, and France, not about "Europe."

## References

Bauer, M., J. Durant, and G. Evans. 1991. "European Public Perceptions of Science: An International Comparative Study." Paper presented at the annual meeting of American Association for the Advancement of Science, Washington, DC, February 15, 1991.

Boy, D. 1991. "The Three Mainstays of the Scientific Institution." Paper presented at the annual meeting of American Association for the Advancement of Science, Washington, DC, February 15, 1991.

Commission of the European Communities (CEC). 1989. "Eurobaromètre No. 31, L'Opinion Publique dans la Communauté Europèene." Brussels: Commission of the European Communities, Directorate-General for Information, Communication, Culture.

Council for Advancement and Support of Education. 1990. *Attitudes About American Colleges 1990*. Washington, DC.

Durant, J.R., J.D. Miller, J.-F. Tchernia, and W. van Deelen. 1991. "Europeans, Science, and Technology." Paper presented at the annual meeting of American Association for the Advancement of Science, Washington, DC, February 15, 1991.

Einsiedel, E.F. 1990. *Scientific Literacy: A Survey of Adult Canadians*. Calgary, Alberta: Graduate Program in Communication Studies, University of Calgary.

———. 1991. "Attitudes Toward Science as Consequences of Scientific Literacy Among Canadian Adults." Paper presented at the annual meeting of American Association for the Advancement of Science, Washington, DC, February 15, 1991.

Hennessy, B. 1972. "A Headnote on the Existence and Study of Political Attitudes." In *Political Attitudes & Public Opinion*, edited by D.D. Nimmo and C.M. Bonjean. New York: David McKay.

Miller, J.D. 1987. "Scientific Literacy in the United States." In *Communicating Science to the Public*, edited by D. Evered and M. O'Connor. London: John Wiley and Sons.

———. 1991a. *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook.* Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences.

———. 1991b. *The Public Understanding of Science & Technology in the United States.* Report to the National Science Fou lation. DeKalb, IL: Public Opinion Laboratory, Northern Illinois University.

Miller, J.D., and K. Prewitt. 1979. *The Measurement of the Attitudes of the U.S. Public Toward Organized Science.* Chicago: National Opinion Research Center, University of Chicago.

Miller, J.D., K. Prewitt, and R. Pearson. 1980. *The Attitudes of the U.S. Public Toward Science and Technology.* Report to the National Science Foundation. Chicago: National Opinion Research Center, University of Chicago.

National Opinion Research Center (NORC). Annual series. *General Social Surveys, Cumulative Codebook.* By J.A. Davis and T.W. Smith, principal investigators. Chicago: University of Chicago.

National Science Board (NSB). 1973. *Science Indicators - 1972.* NSB 73-1. Washington, DC: GPO.

———. 1975. *Science Indicators - 1974.* NSB 75-1. Washington, DC: GPO.

———. 1977. *Science Indicators - 1976.* NSB 77-1. Washington, DC: GPO.

———. 1985. *Science Indicators/The 1985 Report.* NSB 85-1. Washington, DC: GPO.

———. 1987. *Science & Engineering Indicators - 1987.* NSB 87-1. Washington, DC: GPO.

———. 1989. *Science & Engineering Indicators - 1989.* NSB 89-1. Washington, DC: GPO.

Office of the Prime Minister of Japan, Public Relations Office. 1991. *Opinion Survey on Science, Technology, and Society.* T. Welch, translator. Washington, DC: Science Resources Studies Division, National Science Foundation.

Office of Technology Assessment (OTA). 1987. *New Developments in Biotechnology—Background Paper: Public Perceptions of Biotechnology.* Washington, DC: GPO.

Second Chamber of the States-General. 1990. *Technology Policy Survey 1990-1991.* Publication No. 21 804 (English edition). The Hague: Government Printing and Publishing Office.

Survey Research Center. 1958. *The Public Impact of Science in the Mass Media: A Report on a Nation-Wide Survey for the National Association of Science Writers.* Ann Arbor, MI: Institute for Social Research, University of Michigan.

Times Mirror Center for the People and the Press. 1989. "The People, Press, and Politics." Data diskette. Washington, DC.

Withey, S.B. 1959. "Public Opinion About Science and Scientists." *Public Opinion Quarterly* 23: 382-88.

# Appendix A
# Appendix Tables

## Chapter 1. Precollege Science and Mathematics Education



## Chapter 2. Higher Education in Science and Engineering

## Chapter 3. Science and Engineering Workforce

## Chapter 4. Financial Resources for Research and Development



## Chapter 5. Academic Research and Development: Financial Resources, Personnel, and Outputs

## Chapter 6. Technology and Global Competitiveness

## Chapter 7. Attitudes Toward Science and Technology: The United States and International Comparisons

Appendix table 1-1.
**Student achievement scores in science, by age, gender, and race/ethnicity: 1970-90 assessments**

| Gender and race/ethnicity | 1970 | 1973 | 1977 | 1982 | 1986 | 1990 |
|---|---|---|---|---|---|---|
| | | | **9-year-olds** | | | |
| Total | 224.9 | 220.3 | 219.9 | 220.9 | 224.3 | 228.7 |
| Male | 227.6 | 222.5 | 222.1 | 221.0 | 227.3 | 230.3 |
| Female | 222.7 | 218.4 | 217.7 | 220.7 | 221.3 | 227.1 |
| White | 235.9 | 231.1 | 229.6 | 229.1 | 231.9 | 237.5 |
| Black | 178.7 | 176.5 | 174.9 | 187.1 | 196.2 | 196.4 |
| Hispanic | NA | NA | 191.9 | 189.0 | 199.4 | 206.2 |
| | | | **13-year-olds** | | | |
| Total | 254.9 | 249.5 | 247.4 | 250.2 | 251.4 | 255.2 |
| Male | 256.8 | 251.7 | 251.1 | 255.7 | 256.1 | 258.5 |
| Female | 253.0 | 247.1 | 243.8 | 245.0 | 246.9 | 251.8 |
| White | 263.4 | 258.6 | 256.1 | 257.3 | 259.2 | 264.1 |
| Black | 214.9 | 205.3 | 208.1 | 217.2 | 221.6 | 225.7 |
| Hispanic | NA | NA | 213.4 | 225.5 | 226.1 | 231.6 |
| | | | **17-year-olds** | | | |
| Total | 304.8 | 295.8 | 289.6 | 283.3 | 288.5 | 290.4 |
| Male | 313.8 | 304.3 | 297.1 | 291.9 | 294.9 | 295.6 |
| Female | 296.7 | 288.3 | 282.3 | 275.2 | 282.3 | 285.4 |
| White | 311.8 | 303.9 | 297.7 | 293.2 | 297.5 | 300.9 |
| Black | 257.8 | 250.4 | 240.3 | 234.8 | 252.8 | 253.0 |
| Hispanic | NA | NA | 262.3 | 248.7 | 259.3 | 261.5 |

NA = not available

SOURCE: I.V.S. Mullis, J.A. Dossey, M.A. Foertsch, L.R. Jones, C.A. Gentile, "Trends in Academic Progress: Achievement of American Students in Science, 1970-90, Mathematics, 1973-90, Reading, 1971-90, and Writing, 1984-90," review draft (Washington, DC: National Center for Education Statistics, August 1991).

See figures 1-1, 1-2, and 1-3, and figure O-12 in Overview. *Science & Engineering Indicators – 1991*

Appendix table 1-2.
**Percentage of students achieving at or above science proficiency levels, by age: 1977-90 assessments**

| Level and description | Age | 1977 | 1982 | 1986 | 1990 |
|---|---|---|---|---|---|
| | | Percent | | | |
| **150 – Knows everyday science facts.** Students at this level know some general scientific facts of the type that could be learned from everyday experiences. They can read simple graphs, match the distinguishing characteristics of animals, and predict the operation of familiar apparatus that work according to mechanical principles. | 9. . . . . | 94 | 95 | 96 | 97 |
| | 13. . . . . | 99 | 100 | 100 | 100 |
| | 17. . . . . | 100 | 100 | 100 | 100 |
| **200 – Understands simple scientific principles.** Students at this level are developing some understanding of simple scientific principles, particularly in the life sciences. For example, they exhibit some rudimentary knowledge of the structure and function of plants and animals. | 9. . . . . | 68 | 71 | 72 | 76 |
| | 13. . . . . | 86 | 90 | 92 | 92 |
| | 17. . . . . | 97 | 96 | 97 | 97 |
| **250 – Applies basic scientific information.** Students at this level can interpret data from simple tables and make inferences about the outcomes of experimental procedures. They exhibit knowledge and understanding of the life sciences, including a familiarity with some aspects of animal behavior and of ecological relationships. These students also demonstrate some knowledge of basic information from the physical sciences. | 9. . . . . | 26 | 24 | 28 | 31 |
| | 13. . . . . | 49 | 51 | 53 | 57 |
| | 17. . . . . | 82 | 77 | 81 | 81 |
| **300 – Analyzes scientific procedures and data.** Students at this level can evaluate the appropriateness of the design of an experiment. They have more detailed scientific knowledge and the skill to apply their knowledge in interpreting information from text and graphs. These students also exhibit a growing understanding of principles from the physical sciences. | 9. . . . . | 3 | 2 | 3 | 3 |
| | 13. . . . . | 11 | 10 | 9 | 11 |
| | 17. . . . . | 42 | 37 | 41 | 43 |
| **350 – Integrates specialized scientific information.** Students at this level can infer relationships and draw conclusions using detailed scientific knowledge from the physical sciences, particularly chemistry. They also can apply basic principles of genetics and interpret the societal implications of research in this field. | 9. . . . . | 0 | 0 | 0 | 0 |
| | 13. . . . . | 1 | 0 | 0 | 0 |
| | 17. . . . . | 9 | 7 | 8 | 9 |

SOURCE: I.V.S. Mullis, J.A. Dossey, M.A. Foertsch, L.R. Jones, C.A. Gentile, "Trends in Academic Progress: Achievement of American Students in Science, 1970-90, Mathematics, 1973-90, Reading, 1971-90, and Writing, 1984-90," review draft (Washington, DC: National Center for Education Statistics, August 1991).

See text table 1-1.

*Science & Engineering Indicators – 1991*

Appendix table 1-3.
**Percentage of students achieving at or above science proficiency levels, by age and race/ethnicity: 1977 and 1990 assessments**

| | Assessment years | | | | | |
|---|---|---|---|---|---|---|
| | 1977 | | | 1990 | | |
| Proficiency level and age | White | Black | Hispanic | White | Black | Hispanic |
| | Percent | | | | | |
| **Level 150** | | | | | | |
| 9 | 98 | 72 | 85 | 99 | 88 | 94 |
| 13 | 100 | 93 | 94 | 100 | 99 | 99 |
| 17 | 100 | 99 | 100 | 100 | 99 | 100 |
| **Level 200** | | | | | | |
| 9 | 77 | 27 | 42 | 84 | 46 | 56 |
| 13 | 92 | 57 | 62 | 97 | 78 | 80 |
| 17 | 99 | 84 | 93 | 99 | 88 | 92 |
| **Level 250** | | | | | | |
| 9 | 31 | 4 | 9 | 38 | 9 | 12 |
| 13 | 57 | 15 | 18 | 67 | 24 | 30 |
| 17 | 88 | 41 | 62 | 90 | 51 | 60 |
| **Level 300** | | | | | | |
| 9 | 4 | 0 | 0 | 4 | 0 | 0 |
| 13 | 13 | 1 | 2 | 14 | 2 | 3 |
| 17 | 48 | 8 | 19 | 51 | 16 | 21 |
| **Level 350** | | | | | | |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 1 | 0 | 0 | 1 | 0 | 0 |
| 17 | 10 | 0 | 2 | 11 | 2 | 2 |

NOTE: See appendix table 1-2 for a description of the proficiency levels.

SOURCE: I.V.S. Mullis, J.A. Dossey, M.A. Foertsch, L.R. Jones, C.A. Gentile, "Trends in Academic Progress: Achievement of American Students in Science, 1970-90, Mathematics, 1973-90, Reading, 1971-90, and Writing, 1984-90," review draft (Washington, DC: National Center for Education Statistics, August 1991).

*Science & Engineering Indicators – 1991*

Appendix table 1-4.
**Student achievement scores in mathematics, by age, gender, and race/ethnicity: 1973-90 assessments**

| Gender and race/ethnicity | 1973 | 1978 | 1982 | 1986 | 1990 |
|---|---|---|---|---|---|
| | | **9-year-olds** | | | |
| Total | 219.1 | 218.6 | 219.0 | 221.7 | 229.6 |
| Male | 217.7 | 217.4 | 217.1 | 221.7 | 229.1 |
| Female | 220.4 | 219.9 | 220.8 | 221.7 | 230.2 |
| White | 224.9 | 224.1 | 224.0 | 226.9 | 235.2 |
| Black | 190.0 | 192.4 | 194.9 | 201.6 | 208.4 |
| Hispanic | 202.1 | 202.9 | 204.0 | 205.4 | 213.8 |
| | | **13-year-olds** | | | |
| Total | 266.0 | 264.[illegible] | 268.6 | 269.0 | 270.4 |
| Male | 265.1 | 263.6 | 269.2 | 270.0 | 271.2 |
| Female | 266.9 | 264.7 | 268.0 | 268.0 | 269.6 |
| White | 273.7 | 271.6 | 274.4 | 273.6 | 276.3 |
| Black | 227.7 | 229.6 | 240.4 | 249.2 | 249.1 |
| Hispanic | 238.8 | 238.0 | 252.4 | 254.3 | 254.6 |
| | | **17-year-olds** | | | |
| Total | 304.4 | 300.4 | 298.5 | 302.0 | 304.6 |
| Male | 308.5 | 303.8 | 301.5 | 304.7 | 306.3 |
| Female | 300.6 | 297.1 | 295.6 | 299.4 | 302.9 |
| White | 310.1 | 305.9 | 303.7 | 307.5 | 309.5 |
| Black | 269.8 | 268.4 | 271.8 | 278.6 | 288.5 |
| Hispanic | 277.2 | 276.3 | 276.7 | 283.1 | 283.5 |

SOURCE: I.V.S. Mullis, J.A. Dossey, M.A. Foertsch, L.R. Jones, C.A. Gentile, "Trends in Academic Progress: Achievement of American Students in Science, 1970-90, Mathematics, 1973-90, Reading, 1971-90, and Writing, 1984-90," review draft (Washington, DC: National Center for Education Statistics, August 1991).

See figures 1-4, 1-5, and 1-6, and figure O-12 in Overview. *Science & Engineering Indicators – 1991*

Appendix table 1-5.
**Percentage of students achieving at or above mathematics proficiency levels, by age: 1978-90 assessments**

| Level and description | Age | Assessment years 1978 | 1982 | 1986 | 1990 |
|---|---|---|---|---|---|
| | | Percent | | | |
| **150 – Simple arithmetic facts.** Students at this level know some basic addition and subtraction facts, and most can add two-digit numbers without regrouping. They recognize simple situations in which addition and subtraction apply. They also are developing rudimentary classification skills. | 9 | 97 | 97 | 98 | 99 |
| | 13 | 100 | 100 | 100 | 100 |
| | 17 | 100 | 100 | 100 | 100 |
| **200 – Beginning skills and understandings.** Students at this level have considerable understanding of two-digit numbers. They can add two-digit numbers, but are still developing an ability to regroup in subtraction. They know some basic multiplication and division facts, recognize relations among coins, can read information from charts and graphs, and use simple measurement instruments. They are developing some reasoning skills. | 9 | 70 | 71 | 74 | 82 |
| | 13 | 95 | 98 | 99 | 99 |
| | 17 | 100 | 100 | 100 | 100 |
| **250 – Basic operations and beginning problem-solving.** Students at this level have an initial understanding of the four basic operations. They are able to apply whole number addition and subtraction skills to one-step word problems and money situations. In multiplication, they can find the product of a two-digit and a one-digit number. They can also compare information from graphs and charts and are developing an ability to analyze simple logical relations. | 9 | 20 | 19 | 21 | 28 |
| | 13 | 65 | 71 | 73 | 75 |
| | 17 | 92 | 93 | 96 | 96 |
| **300 – Moderately complex procedures and reasoning.** Students at this level are developing an understanding of number systems. They can compute with decimals, simple fractions, and commonly encountered percents. They can identify geometric figures, measure lengths and angles, and calculate areas of rectangles. These students are also able to interpret simple inequalities, evaluate formulas, and solve simple linear equations. They can find averages, make decisions on information drawn from graphs, and use logical reasoning to solve problems. They are developing the skills to operate with signed numbers, exponents, and square roots. | 9 | 1 | 1 | 1 | 1 |
| | 13 | 18 | 17 | 16 | 17 |
| | 17 | 52 | 49 | 52 | 56 |
| **350 – Multi-step problem-solving and algebra.** Students at this level can apply a range of reasoning skills to solve multi-step problems. They can solve routine problems involving fractions and percents, recognize properties of basic geometric figures, and work with exponents and square roots. They can solve a variety of two-step problems using variables, identify equivalent algebraic expressions, and solve linear equations and inequalities. They are developing an understanding of functions and coordinate systems. | 9 | 0 | 0 | 0 | 0 |
| | 13 | 1 | 1 | 0 | 0 |
| | 17 | 7 | 6 | 7 | 7 |

SOURCE: I.V.S. Mullis, J.A. Dossey, M.A. Foertsch, L.R. Jones, C.A. Gentile, "Trends in Academic Progress: Achievement of American Students in Science, 1970-90, Mathematics, 1973-90, Reading, 1971-90, and Writing, 1984-90," review draft (Washington, DC: National Center for Education Statistics, August 1991).

See text table 1-2.

*Science & Engineering Indicators – 1991*

Appendix table 1-6.
**Percentage of students achieving at or above mathematics proficiency levels, by age and race/ethnicity: 1978 and 1990 assessments**

| | Assessment years | | | | | |
|---|---|---|---|---|---|---|
| | 1978 | | | 1990 | | |
| Proficiency level and age | White | Black | Hispanic | White | Black | Hispanic |
| | Percent | | | | | |
| **Level 150** | | | | | | |
| 9 | 98 | 88 | 93 | 100 | 97 | 98 |
| 13 | 100 | 99 | 100 | 100 | 100 | 100 |
| 17 | 100 | 100 | 100 | 100 | 100 | 100 |
| **Level 200** | | | | | | |
| 9 | 76 | 42 | 54 | 87 | 60 | 68 |
| 13 | 98 | 80 | 86 | 99 | 95 | 97 |
| 17 | 100 | 99 | 99 | 100 | 100 | 100 |
| **Level 250** | | | | | | |
| 9 | 23 | 4 | 9 | 33 | 9 | 11 |
| 13 | 73 | 29 | 36 | 82 | 49 | 57 |
| 17 | 96 | 71 | 78 | 98 | 92 | 86 |
| **Level 300** | | | | | | |
| 9 | 1 | 0 | 0 | 2 | 0 | 0 |
| 13 | 21 | 2 | 4 | 21 | 4 | 6 |
| 17 | 58 | 17 | 23 | 63 | 33 | 30 |
| **Level 350** | | | | | | |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 1 | 0 | 0 | 0 | 0 | 0 |
| 17 | 9 | 1 | 1 | 8 | 2 | 2 |

NOTE: See appendix table 1-5 for a description of the proficiency levels.

SOURCE: I.V.S. Mullis, J.A. Dossey, M.A. Foertsch, L.R. Jones, C.A. Gentile, "Trends in Academic Progress: Achievement of American Students in Science, 1970-90, Mathematics, 1973-90, Reading, 1971-90, and Writing, 1984-90," review draft (Washington, DC: National Center for Education Statistics, August 1991).

*Science & Engineering Indicators – 1991*

Appendix table 1-7.
**Mathematics proficiency of eighth grade public school students, by region and state: 1990**

| | Average proficiency | Students at or above level | | | |
|---|---|---|---|---|---|
| | | 200 | 250 | 300 | 350 |
| | | Percent | | | |
| **Nationwide** | 261 | 97 | 64 | 12 | 0 |
| **Regions** | | | | | |
| Northeast | 269 | 99 | 72 | 16 | 0 |
| Southeast | 253 | 94 | 52 | 8 | 0 |
| Central | 265 | 98 | 70 | 12 | 0 |
| West | 261 | 97 | 63 | 12 | 0 |
| **States**[1] | | | | | |
| Alabama | 252 | 96 | 52 | 7 | 0 |
| Arizona | 259 | 98 | 61 | 10 | 0 |
| Arkansas | 256 | 97 | 57 | 7 | 0 |
| California | 256 | 95 | 56 | 11 | 0 |
| Colorado | 267 | 99 | 72 | 14 | 0 |
| Connecticut | 270 | 98 | 72 | 19 | 0 |
| Delaware | 261 | 97 | 60 | 13 | 0 |
| District of Columbia | 231 | 86 | 23 | 2 | 0 |
| Florida | 255 | 96 | 54 | 10 | 0 |
| Georgia | 258 | 96 | 59 | 12 | 0 |
| Hawaii | 251 | 93 | 49 | 10 | 0 |
| Idaho | 272 | 100 | 79 | 15 | 0 |
| Illinois | 260 | 96 | 64 | 12 | 0 |
| Indiana | 267 | 99 | 71 | 14 | 0 |
| Iowa | 278 | 100 | 84 | 21 | 0 |
| Kentucky | 256 | 98 | 57 | 8 | 0 |
| Louisiana | 246 | 94 | 43 | 4 | 0 |
| Maryland | 260 | 96 | 61 | 14 | 0 |
| Michigan | 264 | 98 | 67 | 13 | 0 |
| Minnesota | 276 | 99 | 82 | 20 | 0 |
| Montana | 280 | 100 | 88 | 23 | 0 |
| Nebraska | 276 | 99 | 81 | 21 | 0 |
| New Hampshire | 273 | 100 | 79 | 17 | 0 |
| New Jersey | 269 | 99 | 72 | 19 | 0 |
| New Mexico | 256 | 98 | 56 | 8 | 0 |
| New York | 261 | 96 | 62 | 13 | 0 |
| North Carolina | 250 | 94 | 49 | 7 | 0 |
| North Dakota | 281 | 100 | 88 | 24 | 0 |
| Ohio | 264 | 98 | 67 | 12 | 0 |
| Oklahoma | 263 | 99 | 67 | 10 | 0 |
| Oregon | 271 | 99 | 76 | 18 | 0 |
| Pennsylvania | 266 | 98 | 69 | 15 | 0 |
| Rhode Island | 260 | 96 | 61 | 12 | 0 |
| Texas | 258 | 97 | 58 | 10 | 0 |
| Virginia | 264 | 98 | 64 | 15 | 1 |
| West Virginia | 256 | 98 | 56 | 7 | 0 |
| Wisconsin | 274 | 99 | 80 | 20 | 0 |
| Wyoming | 272 | 100 | 80 | 15 | 0 |
| **Territories** | | | | | |
| Guam | 231 | 81 | 28 | 3 | 0 |
| Virgin Islands | 218 | 76 | 11 | 0 | 0 |

[1]Data were reported by 38 states.

SOURCE: I.V.S. Mullis, J.A. Dossey, E.H. Own, and G.W. Phillips, *The State of Mathematics Achievement: NAEP's 1990 Assessment of the Nation and the Trial Assessment of the States* (Washington, DC: National Center for Education Statistics, 1991).

Appendix table 1-8.
**Intended majors of high school seniors scoring above the 90th percentile on the mathematics SAT: 1977-90**

| Intended major | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Percent | | | | | | | | | | | | | |
| All fields | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Total science and engineering | 40 | 44 | 46 | 46 | 47 | 50 | 49 | 46 | 46 | 44 | 48 | 47 | 46 | 46 |
| Total sciences | 27 | 28 | 28 | 27 | 27 | 29 | 28 | 26 | 26 | 23 | 25 | 26 | 26 | 26 |
| Mathematics and statistics | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Computer | 3 | 4 | 5 | 5 | 7 | 9 | 10 | 9 | 7 | 4 | 4 | 3 | 3 | 3 |
| Physical | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Life | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 6 | 6 | 6 |
| Earth and environmental | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | * | * | * | * |
| Psychology | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 |
| Social | 3 | 4 | 4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| Other | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| Total engineering | 14 | 16 | 18 | 19 | 20 | 22 | 21 | 20 | 20 | 21 | 23 | 21 | 20 | 20 |
| Total non-science/engineering | 25 | 28 | 31 | 27 | 28 | 29 | 26 | 25 | 29 | 28 | 34 | 35 | 35 | 35 |
| Humanities | 6 | 6 | 7 | 5 | 6 | 6 | 5 | 4 | 5 | 5 | 6 | 6 | 6 | 6 |
| Premedicine | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 7 | 8 | 7 | 7 | 7 |
| Pre-law | 2 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 |
| Business | 7 | 8 | 10 | 9 | 9 | 10 | 9 | 8 | 10 | 11 | 14 | 15 | 15 | 14 |
| Education | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 3 |
| Other, undecided, missing | 34 | 28 | 23 | 27 | 26 | 21 | 26 | 29 | 25 | 28 | 18 | 19 | 19 | 19 |

* less than 1 percent

SOURCE: J. Grandy, *Major Field Selections of High School Seniors Above the 90th Percentile in SAT Mathematics* (Princeton, NJ: Educational Testing Service, 1990), unpublished tabulations for the National Science Foundation

See figures 1-8 and 1-9

*Science & Engineering Indicators – 1991*

Appendix table 1-9.
**Intended majors of white male high school seniors scoring above the 90th percentile on the mathematics SAT: 1977-90**

| Intended major | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Percent | | | | | | | |
| All fields | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Total science and engineering | 52 | 60 | 59 | 60 | 59 | 63 | 60 | 59 | 58 | 55 | 59 | 56 | 57 | 56 |
| Total sciences | 30 | 33 | 31 | 30 | 29 | 30 | 30 | 29 | 28 | 25 | 26 | 26 | 26 | 27 |
| Mathematics and statistics | 6 | 6 | 5 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 3 | 3 | 3 | 3 |
| Computer | 4 | 5 | 6 | 7 | 8 | 10 | 12 | 11 | 10 | 6 | 6 | 5 | 5 | 4 |
| Physical | 5 | 6 | 6 | 6 | 5 | 5 | 4 | 4 | 5 | 5 | 5 | 5 | 4 | 4 |
| Life | 4 | 5 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 |
| Earth and environmental | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | * | * | * | * |
| Psychology | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Social | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 4 |
| Other | 5 | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 3 | 2 | 3 | 4 | 4 | 4 |
| Total engineering | 22 | 27 | 28 | 29 | 29 | 32 | 30 | 29 | 30 | 30 | 33 | 30 | 31 | 29 |
| Total non-science/engineering | 23 | 27 | 26 | 25 | 23 | 22 | 20 | 21 | 23 | 22 | 30 | 29 | 29 | 29 |
| Humanities | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 4 | 4 | 5 | 5 | 5 |
| Premedicine | 8 | 9 | 8 | 8 | 8 | 7 | 7 | 8 | 6 | 6 | 5 | 5 | 5 | 5 |
| Pre-law | 3 | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 3 | 2 | 3 | 4 | 4 | 4 |
| Business | 7 | 8 | 9 | 8 | 8 | 8 | 7 | 7 | 9 | 9 | 13 | 14 | 14 | 14 |
| Education | 1 | 1 | 1 | * | 1 | * | * | * | 1 | 1 | 1 | 2 | 1 | 2 |
| Other, undecided, missing | 25 | 14 | 15 | 16 | 19 | 15 | 20 | 21 | 19 | 23 | 14 | 15 | 15 | 15 |

* less than 1 percent

SOURCE: J. Grandy, *Major Field Selections of High School Seniors Above the 90th Percentile in SAT Mathematics* (Princeton, NJ: Educational Testing Servce, 1990), unpublished tabulations for the National Science Foundation.

*Science & Engineering Indicators – 1991*

221

222

Appendix table 1-10.
**Intended majors of white female high school seniors scoring above the 90th percentile on the mathematics SAT: 1977-90**

| Intended major | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Percent | | | | | | | | | | | | | |
| All fields | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Total science and engineering | 32 | 32 | 37 | 34 | 37 | 41 | 40 | 37 | 39 | 34 | 37 | 37 | 37 | 37 |
| Total sciences | 27 | 26 | 29 | 26 | 28 | 30 | 29 | 27 | 29 | 25 | 27 | 28 | 28 | 29 |
| Mathematics and statistics | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 |
| Computer | 2 | 3 | 4 | 4 | 6 | 8 | 8 | 6 | 4 | 2 | 2 | 2 | 1 | 1 |
| Physical | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Life | 7 | 7 | 7 | 5 | 6 | 6 | 5 | 5 | 6 | 6 | 7 | 7 | 7 | 8 |
| Earth and environmental | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | * | * | * | * |
| Psychology | 3 | 3 | 4 | 3 | 4 | 4 | 3 | 4 | 5 | 4 | 5 | 5 | 5 | 5 |
| Social | 5 | 4 | 5 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 6 | 7 | 7 | 7 |
| Other | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| Total engineering | 5 | 6 | 8 | 8 | 10 | 12 | 11 | 10 | 11 | 10 | 10 | 10 | 9 | 9 |
| Total non-science/engineering | 29 | 30 | 36 | 31 | 34 | 36 | 32 | 31 | 38 | 35 | 40 | 41 | 41 | 40 |
| Humanities | 9 | 9 | 10 | 8 | 8 | 9 | 8 | 7 | 9 | 8 | 9 | 9 | 10 | 9 |
| Premedicine | 7 | 6 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 7 | 7 | 6 | 6 | 6 |
| Pre-law | 2 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 4 | 3 | 4 | 4 | 4 | 5 |
| Business | 7 | 8 | 11 | 10 | 11 | 12 | 11 | 10 | 14 | 13 | 15 | 15 | 15 | 14 |
| Education | 5 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | * | 5 | 6 | 6 | 7 |
| Other, undecided, missing | 38 | 38 | 27 | 37 | 29 | 23 | 28 | 33 | 23 | 31 | 22 | 22 | 22 | 22 |

* less than 1 percent

SOURCE: J. Grandy, *Major Field Selections of High School Seniors Above the 90th Percentile in SAT Mathematics* (Princeton, NJ: Educational Testing Servce, 1990), unpublished tabulations for the National Science Foundation

*Science & Engineering Indicators – 1991*

Appendix table 1-11.
**Intended majors of black male high school seniors scoring above the 90th percentile on the mathematics SAT: 1977-90**

| Intended major | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Percent | | | | | | | |
| All fields | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Total science and engineering | 36 | 47 | 44 | 48 | 48 | 52 | 53 | 55 | 52 | 51 | 56 | 53 | 53 | 55 |
| Total sciences | 15 | 19 | 18 | 17 | 19 | 21 | 22 | 23 | 21 | 19 | 22 | 19 | 20 | 21 |
| Mathematics and statistics | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 2 |
| Computer | 3 | 4 | 5 | 4 | 7 | 9 | 11 | 13 | 10 | 7 | 7 | 6 | 6 | 6 |
| Physical | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2 |
| Life | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 4 | 3 | 3 | 3 |
| Earth and environmental | * | 1 | 1 | 1 | * | * | * | * | * | * | * | * | * | * |
| Psychology | * | 1 | 1 | 1 | * | * | * | * | * | * | * | * | * | * |
| Social | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| Other | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |
| Total engineering | 21 | 28 | 26 | 31 | 29 | 31 | 31 | 32 | 31 | 32 | 34 | 34 | 33 | 34 |
| Total non-science/engineering | 20 | 25 | 25 | 25 | 22 | 22 | 20 | 23 | 23 | 25 | 32 | 34 | 35 | 33 |
| Humanities | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |
| Premedicine | 8 | 8 | 7 | 8 | 7 | 8 | 7 | 8 | 7 | 6 | 8 | 6 | 7 | 7 |
| Pre-law | 2 | 3 | 4 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 4 | 5 | 5 |
| Business | 7 | 10 | 10 | 10 | 9 | 9 | 8 | 10 | 10 | 13 | 17 | 19 | 19 | 17 |
| Education | 1 | 1 | 1 | 1 | * | * | * | 1 | 1 | * | 1 | 1 | 1 | 1 |
| Other, undecided, missing | 44 | 29 | 30 | 28 | 31 | 26 | 27 | 22 | 25 | 25 | 12 | 13 | 13 | 13 |

* = less than 1 percent

SOURCE: J. Grandy, *Major Field Selections of High School Seniors Above the 90th Percentile in SAT Mathematics* (Princeton, NJ: Educational Testing Service, 1990), unpublished tabulations for the National Science Foundation.

*Science & Engineering Indicators – 1991*

Appendix table 1-12.
**Intended majors of black female high school seniors scoring above the 90th percentile on the mathematics SAT: 1977-90**

| Intended major | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Percent | | | | | | | |
| All fields | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Total science and engineering | 25 | 31 | 30 | 30 | 33 | 34 | 36 | 35 | 33 | 31 | 36 | 36 | 36 | 36 |
| Total sciences | 18 | 21 | 20 | 18 | 21 | 22 | 23 | 22 | 21 | 18 | 21 | 22 | 23 | 22 |
| Mathematics and statistics | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 |
| Computer | 2 | 4 | 4 | 4 | 7 | 9 | 11 | 9 | 7 | 5 | 4 | 4 | 4 | 3 |
| Physical | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Life | 3 | 3 | 4 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 5 | 4 | 4 |
| Earth and environmental | * | * | * | * | * | * | * | * | * | * | * | * | * | * |
| Psychology | 4 | 5 | 5 | 4 | 4 | 3 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 5 |
| Social | 4 | 5 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 5 | 5 | 5 |
| Other | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| Total engineering | 7 | 10 | 10 | 12 | 12 | 12 | 13 | 13 | 12 | 13 | 14 | 14 | 12 | 14 |
| Total non-science/engineering | 29 | 35 | 35 | 29 | 34 | 29 | 29 | 30 | 35 | 35 | 46 | 47 | 46 | 46 |
| Humanities | 5 | 6 | 6 | 4 | 5 | 4 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 |
| Premedicine | 10 | 11 | 11 | 10 | 12 | 11 | 11 | 11 | 12 | 12 | 14 | 12 | 12 | 13 |
| Pre-law | 3 | 5 | 5 | 4 | 5 | 4 | 4 | 4 | 4 | 4 | 6 | 7 | 8 | 7 |
| Business | 8 | 10 | 12 | 10 | 12 | 10 | 10 | 11 | 13 | 14 | 20 | 20 | 19 | 18 |
| Education | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 3 |
| Other, undecided, missing | 46 | 35 | 34 | 42 | 34 | 37 | 35 | 35 | 32 | 34 | 18 | 17 | 18 | 18 |

* = less than 1 percent

SOURCE: J. Grandy, *Major Field Selections of High School Seniors Above the 90th Percentile in SAT Mathematics* (Princeton, NJ: Educational Testing Servce, 1990), unpublished tabulations for the National Science Foundation

Appendix table 1-13.
**Percentage of 17-year-old students studying science subject matter for 1 year or more: 1982, 1986, and 1990**

| Subject and student characteristic | 1982 | 1986 | 1990 |
|---|---|---|---|
| | Percent | | |
| **General science** | | | |
| Total | 61 | 69 | 56 |
| Male | 63 | 71 | 60 |
| Female | 59 | 67 | 53 |
| White | 61 | 71 | 56 |
| Black | 66 | 62 | 58 |
| Hispanic | 58 | 64 | 69 |
| **Life science** | | | |
| Total | 27 | 40 | 30 |
| Male | 29 | 45 | 32 |
| Female | 26 | 34 | 28 |
| White | 27 | 40 | 28 |
| Black | 27 | 40 | 35 |
| Hispanic | 31 | 41 | 44 |
| **Physical science** | | | |
| Total | 33 | 41 | 41 |
| Male | 33 | 43 | 42 |
| Female | 33 | 40 | 40 |
| White | 32 | 41 | 39 |
| Black | 34 | 45 | 47 |
| Hispanic | 35 | 37 | 55 |
| **Earth and space sciences** | | | |
| Total | 27 | 38 | 35 |
| Male | 30 | 41 | 35 |
| Female | 25 | 34 | 34 |
| White | 28 | 38 | 34 |
| Black | 28 | 44 | 35 |
| Hispanic | 20 | 23 | 38 |
| **Biology** | | | |
| Total | 76 | 80 | 85 |
| Male | 74 | 78 | 82 |
| Female | 78 | 82 | 87 |
| White | 78 | 81 | 86 |
| Black | 66 | 77 | 79 |
| Hispanic | 62 | 70 | 78 |
| **Chemistry** | | | |
| Total | 31 | 33 | 42 |
| Male | 31 | 34 | 40 |
| Female | 30 | 31 | 45 |
| White | 33 | 35 | 44 |
| Black | 19 | 23 | 36 |
| Hispanic | 13 | 16 | 26 |
| **Physics** | | | |
| Total | 11 | 11 | 10 |
| Male | 14 | 13 | 12 |
| Female | 9 | 8 | 9 |
| White | 11 | 11 | 9 |
| Black | 12 | 9 | 13 |
| Hispanic | 9 | 7 | 11 |

NOTE: Data are based on self-reports of 17-year-olds on different subjects studied for 1 year or more.

SOURCE: I.V.S. Mullis, J.A. Dossey, M.A. Foertsch, L.R. Jones, C.A. Gentile, "Trends in Academic Progress: Achievement of American Students in Science, 1970-90, Mathematics, 1973-90, Reading, 1971-90, and Writing, 1984-90," review draft (Washington, DC: National Center for Education Statistics, August 1991).

*Science & Engineering Indicators – 1991*

Appendix table 1-14.
**Percentage of 17-year-old students by highest level of mathematics course taken: 1978 and 1990**

| Subject and student characteristic | 1978 | 1990 |
|---|---|---|
| | Percent | |
| **Pre-algebra or general mathematics** | | |
| Total | 20 | 15 |
| Male | 21 | 16 |
| Female | 20 | 14 |
| White | 18 | 15 |
| Black | 31 | 16 |
| Hispanic | 36 | 21 |
| **Algebra 1** | | |
| Total | 17 | 15 |
| Male | 15 | 16 |
| Female | 18 | 15 |
| White | 17 | 15 |
| Black | 19 | 16 |
| Hispanic | 19 | 24 |
| **Geometry** | | |
| Total | 16 | 15 |
| Male | 15 | 16 |
| Female | 18 | 14 |
| White | 17 | 15 |
| Black | 11 | 17 |
| Hispanic | 12 | 13 |
| **Algebra 2** | | |
| Total | 37 | 44 |
| Male | 38 | 42 |
| Female | 37 | 47 |
| White | 39 | 46 |
| Black | 28 | 41 |
| Hispanic | 23 | 32 |
| **Precalculus or calculus** | | |
| Total | 6 | 8 |
| Male | 7 | 8 |
| Female | 4 | 8 |
| White | 6 | 8 |
| Black | 4 | 6 |
| Hispanic | 3 | 7 |

SOURCE: I.V.S. Mullis, J.A. Dossey, M.A. Foertsch, L.R. Jones, C.A. Gentile, "Trends in Academic Progress: Achievement of American Students in Science, 1970-90, Mathematics, 1973-90, Reading, 1971-90, and Writing, 1984-90," review draft (Washington, DC: National Center for Education Statistics, August 1991).

*Science & Engineering Indicators – 1991*

Appendix table 1-15.
**Estimated proportion of public high school students taking selected science courses by graduation, by state: fall 1989**
(page 1 of 2)

| State | Biology | Chemistry | Physics |
|---|---|---|---|
| | | Percent | |
| U.S. total[1] | 95+ | 45 | 20 |
| | | | |
| Alabama | 95+ | 38 | 21 |
| Alaska | NA | NA | NA |
| Arizona | NA | NA | NA |
| Arkansas | 95+ | 33 | 13 |
| California | 91 | 33 | 16 |
| Colorado | NA | NA | NA |
| Connecticut | 95+ | 62 | 36 |
| Delaware | 95+ | 48 | 19 |
| District of Columbia | 75 | 46 | 13 |
| Florida | 95+ | 44 | 19 |
| | | | |
| Georgia | NA | NA | NA |
| Hawaii | 88 | 40 | 21 |
| Idaho | 80 | 26 | 15 |
| Illinois | 78 | 40 | 20 |
| Indiana | 95+ | 42 | 19 |
| Iowa | 95+ | 57 | 27 |
| Kansas | 95+ | 45 | 17 |
| Kentucky | 95+ | 45 | 14 |
| Louisiana | 90 | 50 | 21 |
| Maine | 94 | 58 | NA |
| | | | |
| Maryland | 95+ | 61 | 27 |
| Massachusetts | NA | NA | NA |
| Michigan | NA | NA | NA |
| Minnesota | 95+ | 44 | 23 |
| Mississippi | 95+ | 55 | 17 |
| Missouri | 86 | 41 | 16 |
| Montana | 95+ | 48 | 24 |
| Nebraska | 95+ | 46 | 21 |
| Nevada | 65 | 33 | 13 |
| New Hampshire | NA | NA | NA |
| | | | |
| New Jersey | NA | NA | NA |
| New Mexico | 95+ | 33 | 15 |
| New York | 95+ | 56 | 28 |
| North Carolina | 95+ | 47 | 15 |
| North Dakota | 95+ | 54 | 24 |
| Ohio | 95+ | 49 | 20 |
| Oklahoma | 93 | 37 | 10 |
| Oregon | NA | NA | NA |
| Pennsylvania | 95+ | 56 | 29 |
| Rhode Island | NA | NA | NA |

(continued)

Appendix table 1-15.
**Estimated proportion of public high school students taking selected science courses by graduation, by state: fall 1989**
(page 2 of 2)

| State | Biology | Chemistry | Physics |
|---|---|---|---|
| | | Percent | |
| South Carolina | 95+ | 51 | 16 |
| South Dakota | NA | NA | NA |
| Tennessee | 88 | 42 | 11 |
| Texas | 95+ | 40 | 12 |
| Utah | 80 | 37 | 20 |
| Vermont | NA | NA | NA |
| Virginia | 95+ | 57 | 23 |
| Washington | NA | NA | NA |
| West Virginia | 95+ | 40 | 11 |
| Wisconsin | 95+ | 51 | 25 |
| Wyoming | 86 | 36 | 16 |

NA = not available

NOTES: Each state proportion is a statistical estimate of coursetaking by high school students by the time they graduate. The estimate is based on the total course enrollment in grades 9-12 in fall 1989 divided by the estimated number of students in a grade cohort during 4 years of high school. The statistical estimation method is imprecise for states above 95-percent coursetaking rate.

[1]U.S. total is the proportion of public high school students estimated to take each course, including imputation for nonreporting states.

SOURCE: R.K. Blank and M. Dalkilic. *State Indicators of Science and Mathematics Education: 1990* (Washington, DC: Council of Chief State School Officers, 1991).

*Science & Engineering Indicators – 1991*

Appendix table 1-16.
**Estimated proportion of public high school students taking selected mathematics courses by graduation, by state: fall 1989**
(page 1 of 2)

| State | Algebra 1[1] | Algebra 2 | Calculus |
|---|---|---|---|
| | Percent | | |
| U.S. total[2] | 81 | 49 | 9 |
| Alabama | 70 | 46 | 6 |
| Alaska | NA | NA | NA |
| Arizona | NA | NA | NA |
| Arkansas | 88 | 48 | 5 |
| California | 92 | 44 | 9 |
| Colorado | NA | NA | NA |
| Connecticut | 74 | 61 | 14 |
| Delaware | 73 | 43 | 17 |
| District of Columbia | 65 | 39 | 3 |
| Florida | 78 | 42 | 9 |
| Georgia | NA | NA | NA |
| Hawaii | 52 | 33 | 4 |
| Idaho | 95+ | 64 | 6 |
| Illinois | 77 | 39 | 9 |
| Indiana | 60 | 45 | 8 |
| Iowa | 92 | 50 | 9 |
| Kansas | 66 | 47 | 9 |
| Kentucky | 81 | 54 | 6 |
| Louisiana | 95+ | 64 | 4 |
| Maine | 84 | 64 | NA |
| Maryland | 94 | 51 | 13 |
| Massachusetts | NA | NA | NA |
| Michigan | NA | NA | NA |
| Minnesota | 90 | 55 | 12 |
| Mississippi | 85 | 58 | 3 |
| Missouri | 95 | 58 | 8 |
| Montana | 94 | 65 | 6 |
| Nebraska | 75 | 54 | 6 |
| Nevada | 90 | 32 | 5 |
| New Hampshire | NA | NA | NA |
| New Jersey | NA | NA | NA |
| New Mexico | 95+ | 47 | 8 |
| New York | 69 | 46 | 12 |
| North Carolina | 67 | 51 | 8 |
| North Dakota | 95 | 64 | 3 |
| Ohio | 80 | 47 | 8 |
| Oklahoma | 95+ | 60 | 8 |
| Oregon | NA | NA | NA |
| Pennsylvania | 88 | 57 | 16 |
| Rhode Island | NA | NA | NA |

(continued)

Appendix table 1-16.
**Estimated proportion of public high school students taking selected mathematics courses by graduation, by state: fall 1989**
(page 2 of 2)

| State | Algebra 1[1] | Algebra 2 | Calculus |
|---|---|---|---|
| | | Percent | |
| South Carolina | 69 | 55 | 7 |
| South Dakota | NA | NA | NA |
| Tennessee | 79 | 54 | 4 |
| Texas | 82 | 54 | 5 |
| Utah | 82 | 63 | 13 |
| Vermont | NA | NA | NA |
| Virginia | 81 | 55 | 11 |
| Washington | NA | NA | NA |
| West Virginia | 73 | 42 | 2 |
| Wisconsin | 79 | 36 | 9 |
| Wyoming | 73 | 29 | 8 |

NA = not available

NOTES: Each state proportion is a statistical estimate of coursetaking by high school students by the time they graduate. The estimate is based on the total course enrollment in grades 9–12 in fall 1989 divided by the estimated number of students in a grade cohort during 4 years of high school. The statistical estimation method is imprecise for states above 95-percent coursetaking rate.

[1]Algebra 1 percentages include grade 8.

[2]U.S. total is the proportion of public high school students estimated to take each course, including imputation for nonreporting states.

SOURCE: R.K. Blank and M. Dalkilic, *State Indicators of Science and Mathematics Education: 1990* (Washington, DC: Council of Chief State School Officers, 1991).

*Science & Engineering Indicators – 1991*

Appendix table 1-17.
**Average credits earned by public high school graduates in science, by gender and race/ethnicity: 1969-87**

| Subject and student characteristic | 1969 | 1975-78 | 1979-81 | 1982 | 1987 |
|---|---|---|---|---|---|
| | Percent | | | | |
| **All science credits** | | | | | |
| Male | 2.38 | 2.40 | 2.26 | 2.23 | 2.53 |
| Female | 2.10 | 2.14 | 2.11 | 2.11 | 2.49 |
| White | 2.28 | NA | NA | 2.25 | 2.57 |
| Asian | 2.38 | NA | NA | 2.57 | 3.00 |
| Black | 2.02 | 1.96 | 1.95 | 2.04 | 2.31 |
| Hispanic | 2.01 | 1.98 | 1.81 | 1.78 | 2.20 |
| Native American | NA | NA | NA | 1.96 | 2.44 |
| **Survey courses** | | | | | |
| Male | 0.92 | 0.56 | 0.57 | 0.78 | 0.78 |
| Female | 0.74 | 0.51 | 0.48 | 0.71 | 0.73 |
| White | 0.80 | NA | NA | 0.73 | 0.74 |
| Asian | 1.08 | NA | NA | 0.51 | 0.65 |
| Black | 0.87 | 0.55 | 0.54 | 0.82 | 0.90 |
| Hispanic | 0.99 | 0.51 | 0.33 | 0.77 | 0.77 |
| Native American | NA | NA | NA | 0.72 | 0.81 |
| **Biology** | | | | | |
| Male | 0.88 | 0.97 | 0.86 | 0.89 | 1.04 |
| Female | 0.99 | 0.99 | 0.98 | 0.96 | 1.13 |
| White | 0.94 | NA | NA | 0.96 | 1.11 |
| Asian | 0.69 | NA | NA | 1.08 | 1.11 |
| Black | 0.95 | 0.84 | 0.83 | 0.88 | 1.00 |
| Hispanic | 0.89 | 0.86 | 0.84 | 0.79 | 1.05 |
| Native American | NA | NA | NA | 0.77 | 1.22 |
| **Chemistry** | | | | | |
| Male | 0.42 | 0.42 | 0.37 | 0.35 | 0.47 |
| Female | 0.32 | 0.35 | 0.33 | 0.33 | 0.47 |
| White | 0.41 | NA | NA | 0.38 | 0.50 |
| Asian | 0.47 | NA | NA | 0.60 | 0.80 |
| Black | 0.17 | 0.22 | 0.21 | 0.25 | 0.31 |
| Hispanic | 0.11 | 0.34 | 0.24 | 0.15 | 0.28 |
| Native American | NA | NA | NA | 0.35 | 0.32 |
| **Physics** | | | | | |
| Male | 0.16 | 0.45 | 0.46 | 0.21 | 0.25 |
| Female | 0.06 | 0.29 | 0.32 | 0.12 | 0.16 |
| White | 0.13 | NA | NA | 0.19 | 0.22 |
| Asian | 0.15 | NA | NA | 0.39 | 0.43 |
| Black | 0.04 | 0.37 | 0.37 | 0.09 | 0.11 |
| Hispanic | 0.03 | 0.28 | 0.33 | 0.06 | 0.09 |
| Native American | NA | NA | NA | 0.11 | 0.09 |

SOURCE: J. Tuma, A. Gifford, D. Harde, E.G. Hoachlander, and L. Horn, *Course Enrollment Patterns in Public Secondary Schools, 1969 to 1987* (Berkeley, CA: MPR Associates, Inc., 1989).

*Science & Engineering Indicators – 1991*

Appendix table 1-18.
**Average credits earned by public high school graduates in mathematics, by gender and race/ethnicity: 1969-87**

| Subject and student characteristic | 1969 | 1975-78 | 1979-81 | 1982 | 1987 |
|---|---|---|---|---|---|
| | | | Percent | | |
| **All mathematics credits** | | | | | |
| Male | 2.73 | 2.51 | 2.57 | 2.64 | 3.06 |
| Female | 2.23 | 2.21 | 2.31 | 2.47 | 2.97 |
| White | 2.52 | NA | NA | 2.60 | 3.03 |
| Asian | 3.12 | NA | NA | 3.14 | 3.70 |
| Black | 2.19 | 2.28 | 2.40 | 2.55 | 2.96 |
| Hispanic | 2.22 | 2.18 | 2.42 | 2.2 | 42.86 |
| Native American | NA | NA | NA | 2.09 | 3.06 |
| **Basic mathematics** | | | | | |
| Male | 0.33 | 0.17 | 0.10 | 0.11 | 0.14 |
| Female | 0.31 | 0.15 | 0.08 | 0.08 | 0.12 |
| White | 0.28 | NA | NA | 0.07 | 0.09 |
| Asian | 0.14 | NA | N | 0.08 | 0.09 |
| Black | 0.51 | 0.24 | 0.15 | 0.20 | 0.25 |
| Hispanic | 0.61 | 0.16 | 0.09 | 0.15 | 0.35 |
| Native American | NA | NA | NA | 0.26 | 0.10 |
| **General mathematics** | | | | | |
| Male | 0.25 | 0.45 | 0.51 | 0.50 | 0.38 |
| Female | 0.21 | 0.45 | 0.45 | 0.40 | 0.30 |
| White | 0.21 | NA | NA | 0.37 | 0.29 |
| Asian | 0.19 | NA | NA | 0.33 | 0.22 |
| Black | 0.33 | 0.74 | 0.80 | 0.72 | 0.63 |
| Hispanic | 0.33 | 0.52 | 0.52 | 0.68 | 0.44 |
| Native American | NA | NA | NA | 0.49 | 0.48 |
| **Algebra** | | | | | |
| Male | 0.85 | 0.64 | 0.65 | 0.55 | 0.66 |
| Female | 0.79 | 0.62 | 0.68 | 0.59 | 0.68 |
| White | 0.83 | NA | NA | 0.60 | 0.69 |
| Asian | 0.82 | NA | NA | 0.60 | 0.71 |
| Black | 0.77 | 0.50 | 0.57 | 0.47 | 0.59 |
| Hispanic | 0.67 | 0.66 | 0.67 | 0.45 | 0.59 |
| Native American | NA | NA | NA | 0.40 | 0.67 |
| **Geometry** | | | | | |
| Male | 0.57 | 0.50 | 0.50 | 0.45 | 0.57 |
| Female | 0.48 | 0.44 | 0.47 | 0.46 | 0.59 |
| White | 0.58 | NA | NA | 0.51 | 0.62 |
| Asian | 0.76 | NA | NA | 0.68 | 0.75 |
| Black | 0.27 | 0.26 | 0.27 | 0.30 | 0.43 |
| Hispanic | 0.27 | 0.35 | 0.40 | 0.24 | 0.40 |
| Native American | NA | NA | NA | 0.25 | 0.45 |
| **Calculus** | | | | | |
| Male | 0.01 | 0.03 | 0.03 | 0.05 | 0.07 |
| Female | * | 0.02 | 0.03 | 0.04 | 0.05 |
| White | 0.01 | NA | NA | 0.05 | 0.06 |
| Asian | 0.01 | NA | NA | 0.13 | 0.26 |
| Black | * | 0.01 | 0.01 | 0.02 | 0.03 |
| Hispanic | * | 0.01 | 0.02 | 0.02 | 0.03 |
| Native American | NA | NA | NA | 0.02 | * |

* = less than 0.01 credits; NA = not available

SOURCE: J. Tuma, A. Gifford, D. Harde, E.G. Hoachlander, and L. Horn, *Course Enrollment Patterns in Public Secondary Schools, 1969 to 1987* (Berkeley, CA: MPR Associates, Inc., 1989).

*Science & Engineering Indicators – 1991*

Appendix table 1-19.
**Trends in mathematics classroom activities at age 17: 1978 and 1990**

*In your high school mathematics courses, how often did you:*

| | 1978 | 1990 |
|---|---|---|
| | ---Percent--- | |
| **Listen to a teacher explain a mathematics lesson** | | |
| Often | 79 | 84 |
| Sometimes | 19 | 13 |
| Never | 2 | 3 |
| **Discuss mathematics in class** | | |
| Often | 51 | 63 |
| Sometimes | 43 | 31 |
| Never | 7 | 7 |
| **Watch the teacher work mathematics problems on the board** | | |
| Often | 80 | 85 |
| Sometimes | 18 | 12 |
| Never | 2 | 3 |
| **Work mathematics problems on the board** | | |
| Often | 28 | 28 |
| Sometimes | 60 | 52 |
| Never | 12 | 21 |
| **Make reports or do projects on mathematics** | | |
| Often | 2 | 5 |
| Sometimes | 23 | 23 |
| Never | 75 | 72 |
| **Take mathematics tests** | | |
| Often | 64 | 84 |
| Sometimes | 33 | 14 |
| Never | 3 | 2 |

SOURCE: I.V.S. Mullis, J.A. Dossey, M.A. Foertsch, L.R. Jones, C.A. Gentile, "Trends in Academic Progress: Achievement of American Students in Science, 1970-90, Mathematics, 1973-90, Reading, 1971-90, and Writing, 1984-90," review draft (Washington, DC: National Center for Education Statistics, August 1991).

*Science & Engineering Indicators – 1991*

Appendix table 1-20.
**Frequency of scientific experiments conducted in public school eighth grade science classes, by student background: 1988**

| Student characteristic | Number of science experiments: 0 or <1 per month | About 1 per month | About 1 per week | About 1 per day |
|---|---|---|---|---|
| | Percentage of students reporting | | | |
| Total | 20.6 | 20.4 | 46.9 | 12.1 |
| **Socioeconomic status** | | | | |
| Low | 29.2 | 21.3 | 41.0 | 8.5 |
| Middle | 20.4 | 21.7 | 46.9 | 11.0 |
| High | 11.6 | 16.2 | 53.5 | 18.7 |
| **Race/ethnicity** | | | | |
| White | 19.7 | 20.0 | 47.4 | 12.9 |
| Asian/Pacific Islander | 13.8 | 17.6 | 48.2 | 20.5 |
| Black | 23.2 | 24.1 | 43.3 | 9.5 |
| Hispanic | 24.6 | 21.8 | 22.5 | 8.4 |
| Native American/Alaskan Native | 34.5 | 16.0 | 44.3 | 5.2 |

SOURCE: A. Hafner and L. Horn, *Survey Report: A Profile of American Eighth Grade Mathematics and Science Instruction* (Washington, DC: National Center for Education Statistics, in press).

*Science & Engineering Indicators – 1991*

Appendix table 1-21.
**Elementary school class time spent on science and mathematics, by state: 1990**

| State | Science | | Mathematics | |
|---|---|---|---|---|
| | Grades 1-3 | Grades 4-6 | Grades 1-3 | Grades 4-6 |
| | Hours/week | | | |
| Median | 2.3 | 3.0 | 4.8 | 4.9 |
| Alabama | 2.8 | 3.7 | 4.8 | 4.8 |
| Alaska | 2.3 | 3.0 | 4.7 | 4.7 |
| Arizona | 2.2 | 3.2 | 5.0 | 5.3 |
| Arkansas | 2.4 | 3.4 | 5.0 | 5.0 |
| California | 2.5 | 2.7 | 4.9 | 4.7 |
| Colorado | 2.6 | 3.2 | 5.0 | 4.9 |
| Connecticut | 2.0 | 3.0 | 5.0 | 5.3 |
| Delaware | 1.8 | 2.3 | 4.7 | 4.4 |
| District of Columbia | 2.9 | 3.0 | 6.0 | 4.8 |
| Florida | 2.6 | 3.2 | 4.9 | 4.9 |
| Georgia | 2.6 | 3.3 | 4.6 | 4.9 |
| Hawaii | 2.3 | 2.8 | 4.5 | 5.5 |
| Idaho | 2.5 | 2.9 | 4.7 | 4.9 |
| Illinois | 2.2 | 3.3 | 4.6 | 4.8 |
| Indiana | 2.9 | 3.2 | 5.7 | 4.5 |
| Iowa | 2.2 | 2.7 | 4.3 | 5.0 |
| Kansas | 2.2 | 3.1 | 4.8 | 4.9 |
| Kentucky | 2.9 | 3.5 | 5.0 | 4.7 |
| Louisiana | 3.3 | 3.6 | 4.6 | 5.4 |
| Maine | 2.7 | 3.0 | 4.7 | 4.7 |
| Maryland | 2.0 | 2.9 | 5.3 | 5.0 |
| Massachusetts | 1.8 | 2.3 | 5.2 | 5.4 |
| Michigan | 2.7 | 2.8 | 4.9 | 5.0 |
| Minnesota | 2.4 | 2.3 | 4.4 | 4.7 |
| Mississippi | 2.8 | 2.4 | 5.2 | 6.0 |
| Missouri | 2.3 | 3.6 | 5.2 | 4.9 |
| Montana | 2.1 | 3.3 | 4.6 | 3.8 |
| Nebraska | 2.2 | 3.5 | 4.3 | 4.9 |
| Nevada | 1.9 | 3.2 | 4.9 | 4.8 |
| New Hampshire | 2.0 | 4.1 | 4.6 | 5.0 |
| New Jersey | 2.1 | 2.4 | 4.6 | 5.2 |
| New Mexico | 2.6 | 3.5 | 5.3 | 5.4 |
| New York | 2.2 | 3.0 | 5.0 | 4.8 |
| North Carolina | 2.9 | 3.8 | 4.8 | 5.3 |
| North Dakota | 2.3 | 3.4 | 4.7 | 4.7 |
| Ohio | 2.1 | 3.3 | 4.2 | 4.1 |
| Oklahoma | 2.3 | 3.1 | 4.6 | 4.3 |
| Oregon | 2.2 | 3.0 | 5.0 | 4.7 |
| Pennsylvania | 2.1 | 2.7 | 4.7 | 4.7 |
| Rhode Island | 1.3 | 2.4 | 4.8 | 4.8 |
| South Carolina | 2.4 | 3.4 | 5.0 | 5.1 |
| South Dakota | 2.7 | 3.5 | 5.0 | 5.1 |
| Tennessee | 2.4 | 2.8 | 4.9 | 5.5 |
| Texas | 3.5 | 4.0 | 5.1 | 5.1 |
| Utah | 2.1 | 2.2 | 4.9 | 5.0 |
| Vermont | 2.8 | 2.9 | 5.2 | 4.8 |
| Virginia | 2.4 | 3.0 | 5.2 | 5.2 |
| Washington | 1.9 | 2.6 | 4.7 | 4.5 |
| West Virginia | 1.9 | 3 0 | 4.7 | 4.6 |
| Wisconsin | 2.4 | 2.9 | 4.5 | 5.4 |
| Wyoming | 2.7 | 3.7 | 4.5 | 4.6 |

SOURCE: R.K. Blank and M. Dalkilic. *State Indicators of Science and Mathematics Education: 1990* (Washington, DC: Council of Chief State School Officers, 1991).

*Science & Engineering Indicators – 1991*

Appendix table 1-22.
**Public school eighth graders in mathematics classes with algebra or fractions taught as major topic, by student background: 1988**

| Student characteristic | Algebra | Fractions |
|---|---|---|
| | Percentage of students reporting | |
| Total | 62.0 | 64.3 |
| **Socioeconomic status** | | |
| Low | 49.3 | 79.2 |
| Middle | 59.1 | 68.1 |
| High | 74.8 | 52.4 |
| **Race/ethnicity** | | |
| White | 62.3 | 63.8 |
| Asian/Pacific Islander | 67.4 | 54.6 |
| Black | 48.5 | 80.4 |
| Hispanic | 57.5 | 80.6 |
| Native American/Alaskan Native | 48.3 | 82.9 |

SOURCE: A. Hafner and L. Horn, *Survey Report: A Profile of American Eighth Grade Mathematics and Science Instruction* (Washington, DC: National Center for Education Statistics, in press).

*Science & Engineering Indicators – 1991*

Appendix table 1-23.
**Federal FY 1992 budget, by agency and major program area**

| Agency | Total precollege | Teacher preparation & enhancement | Curriculum development[1] | Comprehensive/ organization reform | Student incentives | Other |
|---|---|---|---|---|---|---|
| | | Program areas | | | | |
| | | | Millions of dollars | | | |
| Total | 660.62 | 358.53 | 137.27 | 57.57 | 47.75 | 59.50 |
| National Science Foundation | 253.05 | 97.30 | 84.75 | 47.55 | 11.00 | 12.45 |
| Education | 313.80 | 239.00 | 34.80 | 0.00 | 0.00 | 40.00 |
| Energy | 21.65 | 6.20 | 1.90 | 6.40 | 5.75 | 1.40 |
| Defense | 4.97 | 0.63 | 0.00 | 0.00 | 4.34 | 0.00 |
| Commerce | 0.55 | 0.25 | 0.09 | 0.00 | 0.21 | 0.00 |
| National Aeronautics and Space | 14.10 | 5.57 | 5.60 | 0.28 | 0.55 | 2.10 |
| Interior | 21.96 | 2.06 | 3.60 | 0.50 | 14.32 | 1.49 |
| Health and Human Services | 21.77 | 5.15 | 4.52 | 0.60 | 10.87 | 0.62 |
| Environmental Protection | 8.07 | 2.37 | 2.01 | 2.04 | 0.21 | 1.44 |
| Agriculture | 0.70 | 0.00 | 0.00 | 0.20 | 0.50 | 0.00 |

[1]Includes program assessment and evaluation.

SOURCE: Federal Coordinative Council for Science, Engineering, and Technology, *By the Year 2000: Report of the FCCSET Committee on Education and Human Resources*, budget summary, FY 1992 (Washington, DC: Office of Science and Technology Policy, 1991).

*Science & Engineering Indicators – 1991*

Appendix table 2-1.
**Number of institutions awarding baccalaureates, by Carnegie classification: 1988**

| Carnegie category | Number of institutions: Total | Number of institutions: Total S&E | Number of institutions: Natural sciences | Number of institutions: Social sciences & psychology | Number of institutions: Engineering | Number of institutions: S&E technologies | Number of degrees: Total S&E | Number of degrees: Natural sciences | Number of degrees: Social sciences & psychology | Number of degrees: Engineering | Number of degrees: S&E technologies |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 1,739 | 1,392 | 1,331 | 1,222 | 370 | 302 | 327,999 | 123,115 | 115,239 | 70,406 | 19,239 |
| Research I | 69 | 67 | 67 | 66 | 63 | 18 | 97,541 | 33,503 | 33,429 | 28,452 | 2,157 |
| Research II | 34 | 34 | 34 | 34 | 28 | 11 | 30,841 | 10,162 | 10,948 | 8,476 | 1,255 |
| Doctorate-granting I | 48 | 47 | 46 | 47 | 31 | 19 | 25,605 | 8,843 | 9,468 | 5,826 | 1,468 |
| Doctorate-granting II | 56 | 54 | 54 | 50 | 36 | 17 | 24,662 | 8,477 | 6,904 | 7,928 | 1,353 |
| Comprehensive I | 395 | 394 | 393 | 379 | 120 | 149 | 95,257 | 39,596 | 32,884 | 14,706 | 8,071 |
| Comprehensive II | 165 | 163 | 162 | 150 | 20 | 25 | 10,574 | 5,458 | 4,013 | 623 | 480 |
| Liberal arts I | 141 | 138 | 138 | 135 | 18 | 3 | 19,856 | 7,238 | 12,027 | 588 | 3 |
| Liberal arts II | 413 | 380 | 357 | 339 | 24 | 25 | 11,409 | 5,803 | 4,987 | 351 | 268 |
| Two-year institution | 27 | 15 | 8 | 2 | 1 | 7 | 591 | 39 | 16 | 129 | 407 |
| Specialized | 333 | 83 | 60 | 14 | 20 | 24 | 8,691 | 2,995 | 100 | 2,233 | 3,363 |
| Other | 20 | 11 | 8 | 4 | 8 | 0 | 2,221 | 692 | 439 | 1,090 | 0 |
| Not classified | 38 | 6 | 4 | 2 | 1 | 4 | 751 | 309 | 24 | 4 | 414 |

NOTE: S&E = science and engineering.

SOURCE: Science Resources Studies Division, National Science Foundation, unpublished tabulations from the Completion Survey conducted by the National Center for Education Statistics.

See figure 2-1 and text table 2-1.

*Science & Engineering Indicators – 1991*

Appendix table 2-2.
**Number of institutions awarding masters degrees, by Carnegie classification: 1988**

| Carnegie category | Number of institutions | | | | | | Number of degrees | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Total S&E | Natural sciences | Social sciences & psychology | Engineering | S&E technologies | Total S&E | Natural sciences | Social sciences & psychology | Engineering | S&E technologies |
| Total | 1,172 | 645 | 529 | 476 | 242 | 56 | 64,721 | 26,809 | 14,197 | 22,891 | 824 |
| Research I | 69 | 68 | 68 | 66 | 65 | 6 | 26,094 | 10,527 | 3,805 | 11,688 | 74 |
| Research II | 34 | 34 | 34 | 34 | 28 | 3 | 7,836 | 3,356 | 1,368 | 3,044 | 68 |
| Doctorate-granting I | 49 | 48 | 46 | 48 | 25 | 7 | 6,289 | 2,690 | 1,695 | 1,758 | 146 |
| Doctorate-granting II | 57 | 57 | 53 | 45 | 31 | 7 | 6,264 | 2,723 | 1,238 | 2,215 | 88 |
| Comprehensive I | 356 | 275 | 233 | 199 | 68 | 27 | 13,532 | 6,201 | 4,239 | 2,735 | 357 |
| Comprehensive II | 111 | 43 | 23 | 26 | 4 | 3 | 870 | 163 | 625 | 72 | 10 |
| Liberal arts I | 49 | 28 | 20 | 17 | 2 | 0 | 661 | 154 | 471 | 36 | 0 |
| Liberal arts II | 131 | 26 | 9 | 21 | 1 | 0 | 339 | 69 | 269 | 1 | 0 |
| Two-year institution | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Specialized | 266 | 45 | 37 | 5 | 13 | 2 | 1,524 | 764 | 75 | 680 | 5 |
| Other | 30 | 19 | 5 | 14 | 4 | 1 | 1,292 | 157 | 406 | 653 | 76 |
| Not classified | 19 | 2 | 1 | 1 | 1 | 0 | 20 | 5 | 6 | 9 | 0 |

NOTE: S&E = science and engineering.

SOURCE: Science Resources Studies Division, National Science Foundation, unpublished tabulations from the Completion Survey conducted by the National Center for Education Statistics.

See figure 2-1 and text table 2-1.

Appendix table 2-3.
**Number of institutions awarding doctorates, by Carnegie classification: 1988**

| Carnegie category | Number of institutions: Total | Total S&E | Natural sciences | Social sciences & psychology | Engineering | S&E technologies | Number of degrees: Total S&E | Natural sciences | Social sciences & psychology | Engineering | S&E technologies |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 343 | 291 | 254 | 221 | 160 | 0 | 20,762 | 10,434 | 6,139 | 4,189 | 0 |
| Research I | 70 | 70 | 70 | 69 | 64 | 0 | 13,569 | 7,159 | 3,366 | 3,044 | 0 |
| Research II | 34 | 34 | 34 | 34 | 27 | 0 | 3,196 | 1,592 | 1,014 | 590 | 0 |
| Doctorate-granting I | 49 | 48 | 47 | 47 | 22 | 0 | 2,016 | 786 | 986 | 244 | 0 |
| Doctorate-granting II | 55 | 52 | 42 | 39 | 27 | 0 | 1,033 | 454 | 348 | 231 | 0 |
| Comprehensive I | 57 | 35 | 25 | 11 | 12 | 0 | 233 | 115 | 76 | 42 | 0 |
| Comprehensive II | 4 | 2 | 1 | 1 | 1 | 0 | 32 | 9 | 16 | 7 | 0 |
| Liberal arts I | 6 | 3 | 2 | 2 | 0 | 0 | 33 | 17 | 16 | 0 | 0 |
| Liberal arts II | 2 | 1 | 1 | 1 | 0 | 0 | 5 | 3 | 2 | 0 | 0 |
| Two-year institution | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Specialized | 53 | 33 | 29 | 7 | 4 | 0 | 343 | 278 | 51 | 14 | 0 |
| Other | 13 | 13 | 3 | 10 | 3 | 0 | 302 | 21 | 264 | 17 | 0 |
| Not classified | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

NOTE S&E = science and engineering.

SOURCE: Science Resources Studies Division, National Science Foundation, unpublished tabulations from the Completion Survey conducted by the National Center for Education Statistics.

See figure 2-1 and text table 2-1

*Science & Engineering Indicators – 1991*

215

216

Appendix table 2-4.
**Baccalaureate institutions of 1985-90 doctorate recipients, by Carnegie classification and field of doctorate**

| Field of doctorate | Total | Research universities[1] | Other doctorate-granting universities[2] | Comprehensive institutions[3] | Liberal arts colleges[4] | Specialized schools |
|---|---|---|---|---|---|---|
| | Percent | | | | | |
| Total science and engineering | 100 | 40 | 25 | 20 | 14 | 2 |
| Total sciences | 100 | 38 | 25 | 21 | 15 | 1 |
| Physical sciences | 100 | 37 | 22 | 24 | 16 | 2 |
| Mathematics | 100 | 40 | 23 | 19 | 16 | 2 |
| Computer sciences | 100 | 46 | 25 | 17 | 10 | 3 |
| Environmental sciences | 100 | 42 | 27 | 14 | 15 | 1 |
| Agricultural sciences | 100 | 47 | 29 | 17 | 7 | 0 |
| Biological sciences | 100 | 41 | 24 | 20 | 15 | 1 |
| Psychology | 100 | 32 | 26 | 25 | 16 | 1 |
| Social sciences | 100 | 36 | 25 | 21 | 17 | 1 |
| Total engineering | 100 | 53 | 28 | 11 | 4 | 4 |

[1]Includes research I and II universities.

[2]Includes doctorate-granting I and II universities.

[3]Includes comprehensive I and II institutions.

[4]Includes liberal arts I and II colleges.

SOURCE: Science Resources Studies Division, National Science Foundation, *Undergraduate Origins of Recent Science and Engineering Doctorate Recipients*, special report (Washington, DC: NSF, forthcoming).

*Science & Engineering Indicators – 1991*

Appendix table 2-5.
**Selected characteristics of American college freshmen: 1971-90**
(page 1 of 7)

| | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Freshmen planning to major in science and engineering fields** | | | | | | | | | | | | | | | | | | | |
| | Percent | | | | | | | | | | | | | | | | | | | |
| **Average grade in high school** | | | | | | | | | | | | | | | | | | | | |
| A or A+ | 11.1 | 12.3 | 15.3 | 16.1 | 16.6 | 17.9 | 16.5 | 19.6 | 18.6 | 18.8 | 18.1 | 18.5 | 18.8 | 18.3 | 20.3 | 21.9 | 21.8 | 20.8 | 20.2 | 19.8 |
| A- | 15.2 | 16.6 | 16.7 | 18.6 | 18.3 | 19.2 | 17.3 | 19.8 | 18.1 | 18.3 | 17.6 | 17.2 | 17.6 | 17.3 | 19.7 | 19.2 | 17.5 | 18.9 | 19.3 | 18.9 |
| B+ | 23.0 | 24.8 | 26.1 | 24.3 | 24.1 | 24.7 | 23.3 | 22.3 | 21.3 | 21.3 | 22.1 | 22.1 | 22.1 | 22.1 | 21.9 | 20.8 | 21.6 | 20.1 | 20.6 | 20.7 |
| B | 24.1 | 24.3 | 22.9 | 22.3 | 21.9 | 21.5 | 22.8 | 20.9 | 22.0 | 22.0 | 22.2 | 22.1 | 21.2 | 21.7 | 20.4 | 19.4 | 18.1 | 20.7 | 21.6 | 21.1 |
| B- | 13.1 | 11.1 | 10.5 | 9.4 | 10.0 | 8.7 | 10.0 | 8.9 | 9.9 | 9.5 | 10.2 | 9.9 | 9.7 | 10.0 | 8.9 | 9.4 | 11.6 | 9.7 | 9.7 | 10.1 |
| C+ | 9.0 | 7.5 | 5.5 | 6.1 | 5.7 | 5.4 | 6.6 | 5.6 | 6.8 | 6.5 | 6.4 | 6.9 | 7.1 | 6.8 | 5.4 | 6.3 | 5.2 | 6.5 | 6.0 | 6.4 |
| C | 4.2 | 3.3 | 2.9 | 3.0 | 3.3 | 2.5 | 3.3 | 2.8 | 3.2 | 3.4 | 3.2 | 3.1 | 3.4 | 3.7 | 3.2 | 3.0 | 3.9 | 3.2 | 2.5 | 3.0 |
| D | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 |
| **Father's education** | | | | | | | | | | | | | | | | | | | | |
| Grammar school or less | 6.7 | 6.5 | 4.8 | 5.2 | 4.6 | 4.7 | 5.1 | 4.1 | 4.3 | 4.2 | 3.6 | 3.5 | 3.4 | 3.2 | 2.8 | 2.5 | 2.4 | 2.6 | 2.4 | 2.8 |
| Some high school | 12.6 | 11.6 | 9.5 | 9.5 | 9.2 | 8.8 | 9.0 | 8.1 | 8.1 | 8.1 | 7.5 | 7.1 | 7.1 | 6.3 | 6.0 | 5.4 | 5.3 | 5.0 | 5.1 | 5.3 |
| High school graduate | 27.6 | 27.4 | 22.3 | 23.1 | 23.0 | 22.7 | 23.5 | 21.8 | 22.6 | 22.0 | 22.8 | 22.9 | 22.9 | 22.6 | 19.8 | 19.5 | 19.4 | 19.6 | 20.3 | 20.6 |
| Postsecondary (not college) | NA | NA | 4.7 | 4.6 | 4.3 | 4.2 | 4.4 | 4.5 | 4.3 | 4.3 | 4.3 | 4.5 | 4.8 | 5.1 | 5.0 | 4.7 | 5.0 | 5.0 | 5.2 | 5.2 |
| Some college | 17.5 | 16.9 | 15.2 | 14.2 | 14.1 | 13.6 | 13.7 | 14.0 | 14.0 | 13.7 | 13.9 | 14.1 | 14.2 | 14.2 | 13.5 | 14.5 | 13.9 | 14.7 | 14.9 | 14.9 |
| College degree | 22.4 | 19.5 | 21.0 | 21.5 | 21.9 | 22.3 | 21.9 | 22.8 | 22.1 | 22.6 | 22.7 | 22.8 | 22.5 | 22.5 | 22.7 | 23.4 | 23.3 | 23.0 | 24.0 | 23.3 |
| Some graduate school | NA | 3.3 | 3.7 | 3.6 | 3.4 | 3.8 | 3.4 | 3.8 | 3.7 | 3.5 | 3.6 | 3.5 | 3.4 | 3.8 | 4.2 | 4.2 | 4.2 | 4.0 | 3.5 | 3.6 |
| Graduate degree | 13.2 | 14.7 | 18.8 | 18.3 | 19.6 | 19.8 | 19.0 | 20.9 | 20.9 | 21.6 | 21.7 | 21.6 | 21.7 | 22.4 | 26.0 | 25.8 | 26.5 | 26.2 | 24.6 | 24.2 |
| **Mother's education** | | | | | | | | | | | | | | | | | | | | |
| Grammar school or less | 4.0 | 4.0 | 2.8 | 3.4 | 3.0 | 2.9 | 3.2 | 2.7 | 3.0 | 2.7 | 2.3 | 2.3 | 2.2 | 2.1 | 2.0 | 1.8 | 2.0 | 1.9 | 1.9 | 2.3 |
| Some high school | 10.9 | 9.6 | 7.9 | 8.2 | 7.7 | 7.5 | 7.9 | 6.9 | 7.1 | 6.7 | 6.3 | 6.0 | 5.7 | 5.4 | 4.8 | 4.3 | 3.8 | 4.0 | 3.7 | 4.1 |
| High school graduate | 42.7 | 42.2 | 36.8 | 36.7 | 36.7 | 36.2 | 36.9 | 36.0 | 35.4 | 34.4 | 34.7 | 34.0 | 34.2 | 32.8 | 29.9 | 28.1 | 27.4 | 26.8 | 27.3 | 27.2 |
| Postsecondary (not college) | NA | NA | 8.2 | 8.2 | 7.9 | 8.0 | 7.7 | 7.6 | 7.8 | 7.5 | 7.3 | 8.0 | 7.9 | 8.3 | 7.6 | 8.1 | 8.3 | 7.7 | 8.3 | 7.7 |
| Some college | 19.8 | 19.7 | 17.2 | 16.4 | 16.1 | 15.9 | 15.9 | 16.1 | 16.3 | 16.9 | 16.8 | 16.6 | 16.5 | 16.9 | 17.3 | 18.5 | 17.7 | 18.5 | 18.3 | 18.2 |
| College degree | 18.2 | 16.5 | 17.5 | 18.1 | 18.5 | 19.1 | 18.2 | 19.5 | 19.0 | 19.7 | 20.6 | 20.8 | 20.3 | 21.0 | 22.2 | 22.8 | 23.3 | 23.2 | 23.4 | 23.4 |
| Some graduate school | NA | 3.0 | 3.3 | 3.1 | 3.1 | 3.1 | 3.0 | 3.4 | 3.2 | 3.3 | 3.4 | 3.2 | 3.4 | 3.5 | 4.3 | 4.4 | 4.6 | 4.6 | 4.1 | 3.9 |
| Graduate degree | 4.4 | 5.0 | 6.3 | 6.0 | 6.9 | 7.2 | 7.1 | 7.8 | 8.2 | 8.7 | 8.7 | 9.1 | 9.6 | 10.0 | 11.9 | 12.0 | 13.0 | 13.4 | 13.1 | 13.2 |
| **Father's occupation** | | | | | | | | | | | | | | | | | | | | |
| Artist (including performer) | 0.7 | 0.8 | NA | NA | NA | 0.9 | 0.9 | 0.9 | 0.8 | 0.8 | 0.9 | 0.9 | 0.9 | 0.9 | 0.8 | 0.9 | 0.9 | 0.9 | 0.7 | 0.7 |
| Businessman | 30.5 | 31.1 | NA | NA | NA | 30.3 | 29.0 | 29.3 | 28.8 | 29.1 | 29.2 | 29.3 | 28.6 | 29.0 | 29.0 | 30.1 | 30.1 | 28.9 | 28.8 | 27.7 |
| Clergy or religious worker | 1.0 | 1.1 | NA | NA | NA | 1.3 | 1.3 | 1.1 | 1.2 | 1.3 | 1.1 | 1.2 | 1.1 | 1.0 | 1.1 | 1.2 | 1.2 | 1.1 | 1.2 | 1.2 |
| College teacher | 1.2 | 1.3 | NA | NA | NA | 1.5 | 1.5 | 1.6 | 1.6 | 1.7 | 1.5 | 1.6 | 1.5 | 1.7 | 2.0 | 1.8 | 1.7 | 1.7 | 1.5 | 1.3 |
| Doctor or dentist | 2.4 | 2.4 | NA | NA | NA | 4.0 | 3.3 | 3.3 | 3.4 | 3.5 | 3.6 | 3.6 | 3.4 | 3.4 | 3.8 | 3.5 | 3.8 | 3.6 | 3.3 | 3.3 |
| Education (secondary) | 2.3 | 2.7 | NA | NA | NA | 3.4 | 3.4 | 3.6 | 3.7 | 3.8 | 4.0 | 4.0 | 4.1 | 3.9 | 4.2 | 4.2 | 4.3 | 4.3 | 4.3 | 4.1 |
| Education (elementary) | 0.3 | 0.4 | NA | NA | NA | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.8 | 0.8 | 0.9 | 0.9 | 0.9 | 1.0 |
| Engineer | 9.6 | 10.2 | NA | NA | NA | 11.8 | 11.3 | 12.4 | 11.5 | 11.5 | 11.4 | 11.4 | 11.2 | 11.2 | 11.9 | 11.5 | 11.2 | 10.7 | 10.4 | 10.0 |
| Farmer or forester | 4.5 | 3.7 | NA | NA | NA | 3.0 | 2.3 | 2.3 | 2.1 | 2.6 | 2.6 | 2.5 | 2.3 | 2.3 | 2.3 | 2.2 | 2.2 | 2.1 | 2.4 | 2.4 |

(continued)

Appendix table 2-5.
**Selected characteristics of American college freshmen: 1971-90**
(page 2 of 7)

| | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Freshmen planning to major in science and engineering fields | | | | | | | | | | | | | | | | | | | |
| | Percent | | | | | | | | | | | | | | | | | | | |
| Health professional (non-MD) | 1.2 | 1.1 | NA | NA | NA | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.5 | 1.2 |
| Lawyer | 1.5 | 1.7 | NA | NA | NA | 2.0 | 2.1 | 2.1 | 2.2 | 2.2 | 2.2 | 2.1 | 2.2 | 2.2 | 2.5 | 2.3 | 2.4 | 2.5 | 2.2 | 2.2 |
| Military (career) | 2.7 | 2.5 | NA | NA | NA | 2.7 | 2.9 | 2.9 | 2.8 | 2.9 | 2.8 | 2.7 | 2.5 | 2.5 | 2.2 | 2.7 | 2.4 | 2.4 | 2.6 | 2.4 |
| Research scientist | 1.1 | 1.1 | NA | NA | NA | 1.3 | 1.1 | 1.2 | 1.1 | 1.2 | 1.1 | 1.0 | 1.0 | 1.1 | 1.4 | 1.2 | 1 2 | 1.1 | 1.0 | 0.9 |
| Skilled worker | 11.4 | 11.6 | NA | NA | NA | 9.6 | 10.1 | 9.7 | 9.8 | 9 5 | 10.1 | 9.7 | 9.3 | 9.6 | 8.3 | 8.3 | 8.6 | 8.9 | 9.1 | 9.0 |
| Semi-skilled worker | 7.0 | 6.5 | NA | NA | NA | 4.7 | 5.4 | 4.4 | 4.7 | 4.5 | 4.1 | 4.2 | 4.7 | 4.2 | 3.8 | 3.5 | 3.4 | 3.7 | 3.8 | 3.9 |
| Laborer (unskilled) | 3.2 | 3.4 | NA | NA | NA | 2.7 | 2.7 | 2.6 | 2.9 | 2.7 | 2.5 | 2.5 | 2.5 | 2.4 | 2.5 | 2.3 | 2.0 | 2.2 | 2.2 | 2.7 |
| Unemployed | 1.1 | 1.7 | NA | NA | NA | 1.9 | 1.9 | 1.9 | 1.8 | 2.0 | 1.5 | 1.7 | 2.6 | 2.1 | 2.2 | 2.1 | 1.7 | 1.9 | 2.1 | 2.2 |
| Other | 18.1 | 16.7 | NA | NA | NA | 17.0 | 18.9 | 18.7 | 19.5 | 18.9 | 19.4 | 19.5 | 20.1 | 20.5 | 19.7 | 20.0 | 20.5 | 21.6 | 21.9 | 23.7 |
| **Mother's occupation** | | | | | | | | | | | | | | | | | | | | |
| Artist (including performer) | 0.9 | 0.9 | NA | NA | NA | 1.4 | 1.5 | 1.4 | 1.5 | 1.4 | 1.6 | 1.6 | 1.7 | 1.7 | 1.9 | 1.9 | 1.8 | 1.9 | 1.7 | 1.7 |
| Businesswoman | 4.6 | 5.5 | NA | NA | NA | 6.3 | 6.6 | 7.6 | 7.8 | 8.7 | 9.7 | 10.1 | 10.3 | 11.3 | 12.9 | 13.6 | 14.3 | 14.5 | 14.6 | 13.9 |
| Business (clerical) | 8.7 | 11.0 | NA | NA | NA | 9.7 | 9.5 | 9.9 | 10.0 | 10.7 | 10.8 | 10.6 | 10.6 | 10.7 | 9.9 | 10.8 | 10.4 | 9.8 | 10.3 | 9.8 |
| Clergy or religious worker | 0.1 | 0.1 | NA | NA | NA | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| College teacher | 0.4 | 0.4 | NA | NA | NA | 0.6 | 0.6 | 0.5 | 0.5 | 0.5 | 0.6 | 0.5 | 0.6 | 0.6 | 0.7 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 |
| Doctor or dentist | 0.1 | 0.1 | NA | NA | NA | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.7 | 0.5 | 0.5 | 0.6 | 0.5 | 0.6 |
| Education (secondary) | 2.6 | 3.1 | NA | NA | NA | 3.5 | 3.4 | 3.5 | 3.6 | 3.9 | 4.3 | 4.4 | 4.0 | 4.2 | 4.9 | 5 0 | 5.2 | 5.3 | 5.2 | 5.2 |
| Education (elementary) | 4.9 | 5.1 | NA | NA | NA | 6.6 | 6.6 | 6.7 | 6.5 | 6.9 | 7.1 | 7.1 | 6.6 | 6.5 | 7.2 | 7.4 | 7.8 | 7.9 | 8.1 | 8.0 |
| Engineer | 0.1 | 0.0 | NA | NA | NA | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Farmer or forester | 0.1 | 0.2 | NA | NA | NA | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 |
| Health professional (non-MD) | 1.1 | 1.2 | NA | NA | NA | 1.7 | 1.7 | 1.6 | 1.8 | 1.9 | 2.0 | 1.9 | 2.1 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.3 |
| Homemaker (full-time) | 52.5 | 35.5 | NA | NA | NA | 35.2 | 32.3 | 32.0 | 29.8 | 28.0 | 23.4 | 22.8 | 25.0 | 23.6 | 21.4 | 19.9 | 17.7 | 16.7 | 15.7 | 14.4 |
| Lawyer | 0.1 | 0.1 | NA | NA | NA | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Nurse | 4.5 | 4.7 | NA | NA | NA | 6.6 | 6.7 | 6.6 | 6.9 | 6.9 | 7.6 | 8.2 | 7.5 | 7.4 | 7.6 | 7.7 | 8.0 | 7.9 | 8.0 | 7.8 |
| Research scientist | 0.1 | 0.1 | NA | NA | NA | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 | 0.3 | 0.3 | 0.2 |
| Social/welfare worker | 0.8 | 1.0 | NA | NA | NA | 1.3 | 1.4 | 1.3 | 1.6 | 1.4 | 1.4 | 1.5 | 1.4 | 1.6 | 1.5 | 1.6 | 1.6 | 1.8 | 1.6 | 1.7 |
| Skilled worker | 1.3 | 1.8 | NA | NA | NA | 1.6 | 1.7 | 1.8 | 1.7 | 1.8 | 1.8 | 1.9 | 1.7 | 2.0 | 1.9 | 1.9 | 2.2 | 2.0 | 2.2 | 2.2 |
| Semi-skilled worker | 2.8 | 3.3 | NA | NA | NA | 2.9 | 3.1 | 2.8 | 3.2 | 2.9 | 3.2 | 3.1 | 3.1 | 2.8 | 2.8 | 2.5 | 2.5 | 2.4 | 2.8 | 2.7 |
| Laborer (unskilled) | 1.4 | 1.8 | NA | NA | NA | 1.7 | 2.0 | 1.8 | 1.9 | 1.9 | 2.0 | 1.8 | 1.9 | 1.6 | 1.7 | 1.6 | 1.5 | 1.6 | 1.5 | 1.7 |
| Unemployed | 3.3 | 11.8 | NA | NA | NA | 8.0 | 8.2 | 7.8 | 7.5 | 7.4 | 7.4 | 7.0 | 6.3 | 5.9 | 5.8 | 5.5 | 5.6 | 5.3 | 4.9 | 5.2 |
| Other | 9.6 | 12.3 | NA | NA | NA | 12.1 | 13.9 | 13.7 | 14.6 | 14.6 | 16.1 | 16.2 | 15.8 | 16.3 | 15.6 | 15.9 | 16.8 | 18.0 | 18.4 | 20.4 |
| **Student's probable career** | | | | | | | | | | | | | | | | | | | | |
| Accountant or actuary | 0.5 | 0.6 | NA | NA | NA | 0.4 | 0.4 | 0.4 | 0.3 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 0.7 |
| Architect | 0.2 | 0.3 | NA | NA | NA | 0.4 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.4 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 |
| Business (management) | 1.3 | 1.2 | NA | NA | NA | 1.5 | 1.5 | 1.8 | 1.9 | 1.8 | 2.0 | 2.0 | 2.2 | 2.2 | 3.0 | 2.8 | 2.7 | 2.6 | 2.3 | 2.0 |
| Clinical psychologist | 4.8 | 4.6 | NA | NA | NA | 3.8 | 3.8 | 3.8 | 4.3 | 3.7 | 3.5 | 3.2 | 3.4 | 4.2 | 4.3 | 5.3 | 5.7 | 6.4 | 5.8 | 5.5 |
| College teacher | 1.0 | 0.9 | NA | NA | NA | 0.4 | 0.4 | 0.2 | 0.3 | 0.2 | 0.3 | 0.2 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.5 |
| Computer programmer | 2.6 | 2.6 | NA | NA | NA | 3.4 | 4.1 | 5.7 | 6.8 | 9.0 | 12.4 | 15.2 | 14.4 | 10.6 | 7.1 | 5.9 | 5.3 | 4.9 | 4.9 | 4.7 |
| Conservationist or forester | 1.1 | 1.4 | NA | NA | NA | 1.7 | 1.7 | 1.3 | 1.3 | 1.0 | 1.0 | 0.6 | 0.5 | 0.5 | 0.5 | 0.6 | 0.5 | 0.6 | 0.9 | 0.9 |

(continued)

Appendix table 2-5.
**Selected characteristics of American college freshmen: 1971-90**
(page 3 of 7)

| | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Freshmen planning to major in science and engineering fields | | | | | | | | | | | | | | | | | | | |
| | Percent | | | | | | | | | | | | | | | | | | | |
| Engineer | 16.6 | 18.0 | NA | NA | NA | 22.5 | 27.3 | 27.8 | 29.0 | 32.2 | 31.1 | 33.2 | 31.2 | 30.4 | 30.7 | 29.7 | 28.6 | 26.2 | 28.1 | 27.6 |
| Farmer or rancher | 0.2 | 0.3 | NA | NA | NA | 0.3 | 0.3 | 0.2 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 | 0.1 |
| Foreign service worker | 1.2 | 1.2 | NA | NA | NA | 1.3 | 1.4 | 1.4 | 1.4 | 1.5 | 1.3 | 1.4 | 1.6 | 2.0 | 3.1 | 2.9 | 3.1 | 3.3 | 2.7 | 2.4 |
| Lawyer | 4.2 | 5.4 | NA | NA | NA | 8.5 | 9.0 | 8.1 | 7.9 | 7.8 | 7.3 | 7.1 | 6.7 | 6.9 | 7.1 | 7.0 | 8.2 | 9.9 | 9.4 | 9.7 |
| Military service ( areer) | 3.6 | 4.3 | NA | NA | NA | 2.8 | 3.3 | 3.7 | 3.8 | 3.2 | 3.3 | 2.5 | 3.4 | 3.8 | 2.9 | 4.3 | 3.2 | 2.3 | 2.4 | 2.3 |
| Nurse | 0.1 | 0.1 | NA | NA | NA | 0.4 | 0.3 | 0.3 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 |
| Physician | 2.0 | 3.1 | NA | NA | NA | 10.7 | 5.8 | 6.1 | 6.1 | 6.1 | 6.0 | 6.5 | 7.0 | 7.0 | 8.0 | 6.8 | 7.0 | 6.8 | 5.9 | 6.7 |
| School counselor | 1.2 | 0.9 | NA | NA | NA | 0.7 | 0.7 | 0.4 | 0.6 | 0.4 | 0.5 | 0.4 | 0.5 | 0.5 | 0.5 | 0.7 | 0.7 | 0.8 | 0.7 | 0.8 |
| Scientific researcher | 9.8 | 9.4 | NA | NA | NA | 9.0 | 8.9 | 8.3 | 7.0 | 6.2 | 5.8 | 5.0 | 5.2 | 5.4 | 5.7 | 5.8 | 5.8 | 6.0 | 6.1 | 5.8 |
| Social worker | 9.8 | 8.8 | NA | NA | NA | 6.8 | 6.9 | 6.2 | 5.8 | 4.9 | 4.0 | 2.9 | 2.8 | 3.1 | 3.1 | 3.2 | 3.4 | 3.8 | 3.1 | 3.1 |
| Statistician | 0.4 | 0.4 | NA | NA | NA | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.1 | 0.2 | 0.3 | 0.2 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 |
| Therapist (e.g., physical) | 0.4 | 0.4 | NA | NA | NA | 0.4 | 0.5 | 0.4 | 0.5 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.6 | 0.7 | 0.8 | 0.8 | 0.8 |
| Teacher (elementary) | 1.8 | 1.5 | NA | NA | NA | 0.2 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 |
| Teacher (secondary) | 6.7 | 5.0 | NA | NA | NA | 1.3 | 1.0 | 0.8 | 0.7 | 0.6 | 0.6 | 0.6 | 0.8 | 1.2 | 1.4 | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 |
| Veterinarian | 0.5 | 0.6 | NA | NA | NA | 2.2 | 1.3 | 1.2 | 1.1 | 1.1 | 1.0 | 1.0 | 0.9 | 1.0 | 0.9 | 1.0 | 1.0 | 0.9 | 0.8 | 0.9 |
| Writer or journalist | 0.4 | 0.3 | NA | NA | NA | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.4 | 0.4 |
| Skilled trades | 0.5 | 0.4 | NA | NA | NA | 0.2 | 0.3 | 0.4 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 |
| Other | 7.0 | 6.7 | NA | NA | NA | 5.2 | 5.9 | 5.8 | 5.8 | 5.4 | 5.4 | 4.7 | 4.8 | 5.4 | 5.5 | 5.9 | 6.4 | 7.2 | 8.5 | 9.1 |
| Undecided | 17.6 | 16.9 | NA | NA | NA | 9.1 | 8.8 | 9.9 | 8.8 | 8.3 | 8.1 | 7.5 | 8.0 | 8.7 | 8.8 | 9.2 | 9.1 | 8.9 | 8.9 | 9.0 |
| **Student's probable major** | | | | | | | | | | | | | | | | | | | | |
| Biological sciences | 14.5 | 16.7 | 26.7 | 24.9 | 24.3 | 24.9 | 19.1 | 18.2 | 16.4 | 14.9 | 14.6 | 13.7 | 14.8 | 15.6 | 14.8 | 15.7 | 15.7 | 15.4 | 15.1 | 16.1 |
| Engineering | 21.2 | 22.3 | 17.4 | 23.1 | 25.9 | 26.3 | 31.9 | 33.0 | 34.9 | 38.0 | 36.4 | 37.7 | 35.8 | 35.3 | 35.7 | 34.8 | 33.4 | 30.4 | 32.8 | 32.3 |
| Mathematics or statistics | 12.1 | 10.0 | 6.9 | 5.9 | 4.6 | 4.3 | 3.9 | 4.0 | 3.1 | 3.0 | 3.1 | 3.0 | 3.6 | 3.7 | 3.6 | 3.3 | 3.1 | 2.7 | 2.8 | 2.8 |
| Computer sciences | 2.3 | 2.5 | 1.5 | 2.3 | 2.4 | 2.8 | 3.2 | 4.8 | 6.2 | 8.6 | 12.4 | 15.4 | 15.3 | 11.1 | 7.9 | 6.5 | 5.8 | 5.4 | 5.5 | 5.5 |
| Physical sciences | 8.8 | 8.4 | 10.4 | 10.1 | 10.5 | 10.6 | 9.7 | 9.7 | 9.0 | 7.7 | 7.9 | 6.8 | 6.8 | 6.8 | 7.1 | 6.9 | 6.5 | 6.6 | 6.6 | 6.7 |
| Social sciences | 25.9 | 25.7 | 25.1 | 22.8 | 21.7 | 21.5 | 22.4 | 20.6 | 20.2 | 18.7 | 16.8 | 14.9 | 14.8 | 16.7 | 19.0 | 19.0 | 20.5 | 23.2 | 21.5 | 21.5 |
| Psychology | 15.3 | 14.5 | 12.0 | 11.0 | 10.6 | 9.5 | 9.8 | 9.7 | 10.3 | 9.1 | 8.8 | 8.4 | 8.9 | 10.8 | 11.8 | 13.8 | 15.0 | 16.2 | 15.6 | 15.1 |
| Other technical | 2.3 | 2.5 | 1.5 | 2.3 | 2.4 | 2.8 | 3.2 | 4.8 | 6.2 | 8.6 | 12.4 | 15.4 | 15.3 | 11.1 | 7.9 | 6.5 | 5.8 | 5.4 | 5.5 | 5.5 |
| **Highest degree planned** | | | | | | | | | | | | | | | | | | | | |
| None | NA | 1.0 | NA | 1.0 | 1.1 | 1.0 | 0.8 | 0.7 | 0.5 | 0.9 | 0.7 | 0.7 | 1.2 | 0.9 | 1.1 | 1.1 | 1.1 | 0.9 | 0.6 | 0.7 |
| Associate or equivalent | NA | 0.6 | NA | 0.5 | 0.5 | 0.4 | 0.8 | 0.7 | 1.0 | 0.7 | 0.7 | 1.1 | 0.5 | 0.5 | 0.3 | 0.3 | 0.2 | 0.3 | 0.3 | 0.3 |
| Bachelors | NA | 31.3 | NA | 24.6 | 22.8 | 22.7 | 23.8 | 25.1 | 24.2 | 26.0 | 26.8 | 27.4 | 25.5 | 24.9 | 22.5 | 22.2 | 20.4 | 18.0 | 18.9 | 18.5 |
| Masters | NA | 36.9 | NA | 29.7 | 31.4 | 31.8 | 34.5 | 35.6 | 37.3 | 36.1 | 37.1 | 36.6 | 36.8 | 36.7 | 36.5 | 37.7 | 37.5 | 37.1 | 38.1 | 37.1 |
| Doctorate | NA | 19.4 | NA | 18.6 | 18.7 | 18.5 | 20.6 | 19.5 | 19.0 | 18.0 | 17.4 | 16.8 | 18.0 | 19.5 | 21.8 | 22.5 | 23.3 | 24.9 | 24.6 | 24.6 |
| Professional (e.g., MD, DDS) | NA | 4.8 | NA | 16.3 | 15.6 | 15.6 | 9.1 | 9.3 | 9.4 | 9.4 | 9.1 | 9.3 | 9.7 | 9.6 | 10.3 | 9.0 | 9.1 | 8.9 | 8.2 | 9.1 |
| Law | NA | 5.1 | NA | 8.2 | 8.5 | 8.5 | 8.8 | 7.8 | 7.5 | 7.4 | 7.0 | 6.8 | 6.4 | 6.3 | 6.7 | 6.1 | 7.4 | 8.8 | 8.4 | 8.6 |
| Divinity | NA | 0.3 | NA | 0.3 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.3 |
| Other | NA | 0.7 | NA | 0.9 | 1.0 | 1.1 | 1.2 | 1.0 | 0.9 | 1.3 | 1.0 | 0.9 | 1.5 | 1.1 | 0.7 | 0.7 | 0.7 | 0.8 | 0.8 | 0.8 |

(continued)

Appendix table 2-5.
**Selected characteristics of American college freshmen: 1971-90**
(page 4 of 7)

| | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Freshmen planning to major in non-science/engineering fields** | | | | | | | | | | | | | | | | | | | |
| | Percent | | | | | | | | | | | | | | | | | | | |
| **Average grade in high school** | | | | | | | | | | | | | | | | | | | | |
| A or A+ | 7.0 | 8.6 | 9.3 | 8.7 | 9.5 | 10.5 | 10.3 | 12.3 | 10.7 | 10.1 | 10.6 | 10.7 | 10.9 | 10.8 | 10.4 | 11.8 | 11.4 | 12.5 | 12.4 | 11.3 |
| A- | 11.5 | 14.5 | 11.8 | 13.5 | 13.7 | 14.5 | 13.4 | 15.9 | 14.1 | 14.2 | 13.4 | 13.6 | 12.4 | 12.1 | 13.2 | 13.4 | 13.1 | 13.7 | 15.2 | 14.8 |
| B+ | 20.4 | 22.2 | 23.8 | 21.9 | 22.5 | 23.9 | 23.1 | 23.1 | 20.8 | 21.8 | 21.1 | 21.8 | 21.0 | 20.0 | 21.5 | 20.2 | 21.3 | 20.8 | 20.4 | 20.6 |
| B | 25.9 | 26.9 | 28.4 | 28.3 | 26.6 | 27.2 | 27.0 | 24.9 | 26.4 | 27.1 | 26.8 | 26.6 | 25.1 | 25.5 | 25.0 | 25.5 | 23.4 | 23.5 | 25.7 | 25.3 |
| B- | 16.0 | 12.5 | 13.4 | 12.6 | 13.4 | 11.8 | 11.8 | 11.6 | 12.5 | 11.6 | 13.6 | 13.0 | 13.5 | 13.6 | 12.6 | 13.7 | 15.7 | 14.0 | 13.1 | 13.4 |
| C+ | 12.1 | 10.0 | 7.6 | 9.3 | 9.0 | 7.9 | 8.8 | 8.1 | 9.8 | 9.8 | 9.5 | 9.6 | 11.3 | 11.5 | 11.3 | 10.2 | 8.2 | 9.9 | 8.7 | 10.0 |
| C | 6.9 | 5.1 | 5.5 | 5.3 | 5.3 | 4.1 | 5.3 | 4.0 | 5.4 | 5.1 | 4.8 | 4.6 | 5.6 | 6.2 | 5.8 | 5.0 | 6.6 | 5.4 | 4.3 | 4.5 |
| D | 0.2 | 0.3 | 0.1 | 0.3 | 0.1 | 0.1 | 0.3 | 0.1 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 |
| **Father's education** | | | | | | | | | | | | | | | | | | | | |
| Grammar school or less | 7.2 | 6.3 | 5.4 | 5.9 | 5.4 | 5.7 | 5.7 | 5.0 | 4.6 | 4.9 | 4.3 | 4.4 | 4.1 | 4.6 | 3.6 | 2.9 | 2.5 | 2.8 | 2.4 | 3.5 |
| Some high school | 13.4 | 12.7 | 10.4 | 10.9 | 11.4 | 10.8 | 9.9 | 9.1 | 9.9 | 9.2 | 8.5 | 8.2 | 8.5 | 7.9 | 7.6 | 6.7 | 5.4 | 5.7 | 5.6 | 5.5 |
| High school graduate | 28.1 | 27.5 | 26.3 | 26.4 | 26.5 | 26.0 | 27.9 | 25.6 | 25.7 | 25.9 | 26.5 | 25.6 | 25.2 | 25.8 | 23.7 | 23.6 | 24.1 | 23.7 | 23.7 | 24.7 |
| Postsecondary (not college) | NA | NA | 4.8 | 4.5 | 4.6 | 4.2 | 4.1 | 4.2 | 3.7 | 4.3 | 3.6 | 4.1 | 4.1 | 4.6 | 4.4 | 4.6 | 4.5 | 4.5 | 5.0 | 4.9 |
| Some college | 17.9 | 17.4 | 15.9 | 15.5 | 13.8 | 14.1 | 14.1 | 14.9 | 14.0 | 14.0 | 14.6 | 13.7 | 15.0 | 13.9 | 14.8 | 15.3 | 14.2 | 15.3 | 14.9 | 15.7 |
| College degree | 21.2 | 19.5 | 20.4 | 20.2 | 20.4 | 21.4 | 20.6 | 22.5 | 22.9 | 21.6 | 22.3 | 22.7 | 22.0 | 22.6 | 22.5 | 22.6 | 23.6 | 23.2 | 23.9 | 23.1 |
| Some graduate school | NA | 3.1 | 2.5 | 2.4 | 2.6 | 2.8 | 2.5 | 2.6 | 2.8 | 3.1 | 2.8 | 2.6 | 2.8 | 2.5 | 3.2 | 3.1 | 3.4 | 3.2 | 3.1 | 2.6 |
| Graduate degree | 12.1 | 13.6 | 14.3 | 14.1 | 15.3 | 15.1 | 15.1 | 16.1 | 16.3 | 17.1 | 17.4 | 18.6 | 18.3 | 18.1 | 20.2 | 21.2 | 22.3 | 21.5 | 21.5 | 20.0 |
| **Mother's education** | | | | | | | | | | | | | | | | | | | | |
| Grammar school or less | 4.0 | 3.7 | 3.0 | 3.5 | 3.1 | 3.3 | 3.2 | 3.1 | 2.7 | 3.0 | 2.5 | 2.5 | 2.2 | 2.3 | 2.2 | 1.9 | 1.9 | 2.3 | 1.7 | 2.5 |
| Some high school | 11.2 | 10.4 | 8.4 | 9.2 | 8.5 | 8.8 | 8.8 | 8.2 | 8.5 | 7.1 | 6.4 | 6.7 | 6.9 | 6.1 | 6.4 | 5.0 | 4.2 | 4.3 | 4.2 | 4.2 |
| High school graduate | 43.5 | 41.9 | 39.7 | 39.1 | 40.2 | 38.9 | 40.7 | 39.5 | 38.6 | 38.9 | 39.1 | 38.2 | 36.5 | 36.6 | 33.2 | 32.0 | 31.4 | 31.1 | 30.3 | 30.9 |
| Postsecondary (not college) | NA | NA | 8.1 | 8.1 | 7.1 | 8.1 | 7.4 | 7.0 | 7.4 | 6.9 | 7.1 | 6.8 | 7.4 | 8.2 | 7.2 | 8.0 | 8.3 | 7.8 | 7.9 | 7.8 |
| Some college | 19.7 | 20.1 | 16.4 | 16.2 | 16.1 | 15.6 | 15.2 | 15.8 | 15.8 | 17.2 | 16.9 | 16.4 | 17.4 | 16.1 | 18.1 | 18.6 | 18.2 | 18.2 | 18.3 | 18.1 |
| College degree | 18.0 | 16.4 | 17.2 | 16.8 | 17.1 | 17.9 | 16.8 | 17.6 | 17.8 | 18.0 | 18.5 | 19.2 | 18.9 | 19.4 | 20.7 | 21.2 | 21.7 | 21.7 | 22.7 | 22.4 |
| Some graduate school | NA | 2.5 | 2.6 | 2.4 | 2.3 | 2.1 | 2.2 | 2.5 | 2.7 | 2.4 | 2.4 | 2.6 | 2.5 | 2.7 | 3.3 | 3.3 | 3.4 | 3.5 | 3.7 | 3.2 |
| Graduate degree | 3.6 | 4.9 | 4.5 | 4.7 | 5.5 | 5.3 | 5.6 | 6.3 | 6.5 | 6.4 | 7.1 | 7.6 | 8.1 | 8.5 | 8.9 | 10.1 | 11.0 | 11.2 | 11.2 | 11.0 |
| **Father's occupation** | | | | | | | | | | | | | | | | | | | | |
| Artist (including performer) | 0.8 | 0.8 | NA | NA | NA | 1.0 | 0.7 | 0.9 | 0.9 | 1.0 | 0.9 | 1.0 | 1.1 | 1.0 | 1.0 | 0.8 | 1.0 | 1.0 | 1.0 | 0.8 |
| Businessman | 33.0 | 33.2 | NA | NA | NA | 33.0 | 32.5 | 33.5 | 34.0 | 32.9 | 33.3 | 33.4 | 33.2 | 31.6 | 32.8 | 35.0 | 34.6 | 33.3 | 32.6 | 30.1 |
| Clergy or religious worker | 1.2 | 1.2 | NA | NA | NA | 1.5 | 1.3 | 1.5 | 1.3 | 1.4 | 1.4 | 1.1 | 1.0 | 1.0 | 1.0 | 1.3 | 0.9 | 1.0 | 1.1 | 1.4 |
| College teacher | 1.0 | 1.1 | NA | NA | NA | 1.1 | 1.2 | 1.1 | 0.9 | 1.0 | 1.2 | 1.1 | 1.1 | 1.0 | 1.3 | 1.0 | 1.2 | 1.2 | 1.0 | 0.9 |
| Doctor or dentist | 2.5 | 2.7 | NA | NA | NA | 3.1 | 2.6 | 3.1 | 2.7 | 3.0 | 2.8 | 3.2 | 3.0 | 2.8 | 2.8 | 3.2 | 3.1 | 3.1 | 3.0 | 2.8 |
| Education (secondary) | 2.7 | 2.8 | NA | NA | NA | 3.3 | 2.9 | 3.0 | 3.8 | 3.3 | 3.5 | 3.5 | 3.8 | 3.8 | 4.0 | 3.8 | 4.2 | 4.2 | 4.2 | 4.2 |
| Education (elementary) | 0.4 | 0.5 | NA | NA | NA | 0.5 | 0.6 | 0.8 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.8 | 0.7 | 0.9 | 0.8 | 1.0 | 1.0 | 1.1 |
| Engineer | 7.0 | 7.4 | NA | NA | NA | 7.9 | 8.0 | 8.6 | 8.0 | 7.7 | 8.1 | 7.4 | 7.4 | 7.9 | 8.1 | 7.4 | 7.6 | 7.2 | 7.5 | 7.1 |
| Farmer or forester | 5.7 | 5.2 | NA | NA | NA | 4.8 | 3.9 | 3.5 | 3.4 | 3.8 | 4.7 | 4.2 | 3.7 | 4.1 | 4.6 | 2.9 | 2.9 | 2.9 | 2.9 | 3.3 |
| Health professional (non-MD) | 1.5 | 1.5 | NA | NA | NA | 1.1 | 1.3 | 1.8 | 1.4 | 1.3 | 1.3 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.4 | 1.5 | 1.1 | 1.1 |

(continued)

Appendix table 2-5.
**Selected characteristics of American college freshmen: 1971-90**
(page 5 of 7)

| | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Freshmen planning to major in non-science/engineering fields** | | | | | | | | | | | | | | | | | | | | |
| Percent | | | | | | | | | | | | | | | | | | | | |
| Lawyer | 1.5 | 1.7 | NA | NA | NA | 2.0 | 1.7 | 1.8 | 1.7 | 1.9 | 2.0 | 2.2 | 2.2 | 2.0 | 2.1 | 2.3 | 2.5 | 2.3 | 2.4 | 2.1 |
| Military (career) | 1.9 | 1.8 | NA | NA | NA | 2.0 | 1.9 | 1.8 | 1.6 | 1.7 | 1.8 | 1.7 | 2.2 | 1.3 | 1.3 | 2.0 | 1.6 | 1.5 | 1.8 | 1.7 |
| Research scientist | 0.8 | 0.7 | NA | NA | NA | 0.6 | 0.6 | 0.7 | 0.7 | 0.6 | 0.7 | 0.6 | 0.7 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.5 | 0.5 |
| Skilled worker | 10.9 | 10.6 | NA | NA | NA | 8.9 | 9.6 | 8.7 | 9.4 | 9.9 | 9.0 | 9.0 | 8.8 | 9.2 | 7.6 | 7.7 | 7.9 | 9.0 | 8.7 | 9.0 |
| Semi-skilled worker | 6.6 | 5.5 | NA | NA | NA | 5.0 | 5.3 | 4.3 | 4.9 | 4.5 | 4.0 | 3.8 | 4.2 | 4.2 | 3.9 | 3.3 | 3.2 | 3.1 | 3.3 | 3.7 |
| Laborer (unskilled) | 3.1 | 3.6 | NA | NA | NA | 3.3 | 3.2 | 2.8 | 3.0 | 2.9 | 2.5 | 2.9 | 2.9 | 2.6 | 3.1 | 2.3 | 2.3 | 2.6 | 2.7 | 2.7 |
| Unemployed | 1.1 | 1.8 | NA | NA | NA | 1.9 | 2.0 | 2.1 | 1.9 | 2.2 | 1.7 | 2.0 | 2.7 | 2.3 | 2.4 | 2.3 | 1.9 | 1.9 | 2.0 | 2.3 |
| Other | 18.4 | 17.9 | NA | NA | NA | 19.1 | 20.6 | 20.3 | 20.0 | 20.3 | 20.5 | 20.9 | 20.0 | 22.6 | 21.6 | 21.9 | 22.2 | 22.3 | 23.1 | 25.3 |
| **Mother's occupation** | | | | | | | | | | | | | | | | | | | | |
| Artist (including performer) | 0.9 | 0.9 | NA | NA | NA | 1.3 | 1.3 | 1.4 | 1.3 | 1.4 | 1.6 | 1.7 | 1.8 | 1.3 | 1.8 | 1.8 | 1.8 | 2.0 | 1.8 | 1.6 |
| Businesswoman | 4.6 | 5.5 | NA | NA | NA | 6.2 | 7.4 | 7.4 | 8.1 | 8.6 | 10.5 | 9.7 | 10.7 | 11.7 | 13.5 | 14.7 | 14.8 | 14.4 | 13.9 | 14.4 |
| Business (clerical) | 9.4 | 11.0 | NA | NA | NA | 9.9 | 10.7 | 10.4 | 10.8 | 11.5 | 11.5 | 11.4 | 11.6 | 11.9 | 11.3 | 11.3 | 12.1 | 10.8 | 11.0 | 10.0 |
| Clergy or religious worker | 0.0 | 0.1 | NA | NA | NA | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 |
| College teacher | 0.5 | 0.4 | NA | NA | NA | 0.4 | 0.4 | 0.3 | 0.3 | 0.4 | 0.5 | 0.4 | 0.4 | 0.5 | 0.4 | 0.3 | 0.4 | 0.5 | 0.5 | 0.6 |
| Doctor or dentist | 0.1 | 0.2 | NA | NA | NA | 0.1 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.3 | 0.2 | 0.3 | 0.4 | 0.6 | 0.4 | 0.6 | 0.4 | 0.6 |
| Education (secondary) | 2.5 | 3.2 | NA | NA | NA | 3.0 | 2.7 | 3.0 | 3.2 | 3.1 | 3.7 | 4.1 | 3.2 | 3.8 | 3.8 | 4.3 | 4.4 | 4.5 | 4.8 | 4.6 |
| Education (elementary) | 4.8 | 5.4 | NA | NA | NA | 6.1 | 6.0 | 6.5 | 6.3 | 5.8 | 6.1 | 6.7 | 6.0 | 6.2 | 6.5 | 6.9 | 7.8 | 8.0 | 8.2 | 7.9 |
| Engineer | 0.1 | 0.0 | NA | NA | NA | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Farmer or forester | 0.1 | 0.2 | NA | NA | NA | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.2 | 0.3 | 0.4 | 0.1 | 0.3 | 0.3 | 0.3 | 0.3 |
| Health professional (non-MD) | 1.2 | 1.2 | NA | NA | NA | 1.6 | 1.5 | 1.4 | 1.5 | 1.8 | 1.6 | 1.7 | 2.2 | 1.8 | 2.0 | 1.8 | 1.7 | 2.0 | 2.4 | 2.2 |
| Homemaker (full-time) | 53.0 | 36.6 | NA | NA | NA | 36.5 | 32.7 | 33.0 | 30.0 | 28.4 | 24.6 | 23.0 | 24.9 | 24.0 | 22.0 | 19.6 | 18.0 | 17.4 | 15.9 | 15.5 |
| Lawyer | 0.0 | 0.1 | NA | NA | NA | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.4 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 |
| Nurse | 4.1 | 4.9 | NA | NA | NA | 6.2 | 6.0 | 6.4 | 6.5 | 6.7 | 7.3 | 7.1 | 7.8 | 8.1 | 7.9 | 7.0 | 6.8 | 7.2 | 7.6 | 8.0 |
| Research scientist | 0.0 | 0.0 | NA | NA | NA | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Social/welfare worker | 0.7 | 0.9 | NA | NA | NA | 0.9 | 1.2 | 1.0 | 1.2 | 1.0 | 1.4 | 1.3 | 1.1 | 1.3 | 1.3 | 1.4 | 1.5 | 1.4 | 1.4 | 1.4 |
| Skilled worker | 1.2 | 1.6 | NA | NA | NA | 1.3 | 1.5 | 1.6 | 1.6 | 1.7 | 1.5 | 1.8 | 1.9 | 1.8 | 1.6 | 1.7 | 2.1 | 1.9 | 2.2 | 1.8 |
| Semi-skilled worker | 2.4 | 2.5 | NA | NA | NA | 2.7 | 3.0 | 2.7 | 2.7 | 3.2 | 2.7 | 3.0 | 2.9 | 2.5 | 2.3 | 2.0 | 2.2 | 2.1 | 2.3 | 2.7 |
| Laborer (unskilled) | 1.5 | 1.8 | NA | NA | NA | 1.9 | 1.9 | 1.8 | 2.1 | 2.2 | 1.8 | 2.0 | 1.8 | 1.6 | 1.6 | 1.5 | 1.4 | 1.8 | 1.5 | 1.6 |
| Unemployed | 2.9 | 10.5 | NA | NA | NA | 8.5 | 7.8 | 7.8 | 8.3 | 7.7 | 7.8 | 8.0 | 6.3 | 5.9 | 5.7 | 6.2 | 5.5 | 5.3 | 5.3 | 5.2 |
| Other | 10.0 | 13.1 | NA | NA | NA | 12.8 | 15.3 | 14.6 | 15.5 | 15.8 | 16.6 | 17.0 | 16.3 | 16.4 | 16.8 | 17.8 | 18.2 | 19.2 | 19.7 | 20.8 |
| **Student's probable career** | | | | | | | | | | | | | | | | | | | | |
| Accountant or actuary | 4.1 | 3.7 | NA | NA | NA | 7.8 | 8.5 | 8.5 | 7.9 | 8.6 | 8.3 | 8.2 | 8.2 | 9.3 | 9.6 | 7.9 | 7.9 | 7.9 | 8.0 | 7.1 |
| Architect | 1.6 | 1.7 | NA | NA | NA | 1.5 | 1.6 | 1.9 | 1.6 | 1.6 | 1.0 | 1.1 | 1.0 | 1.3 | 1.2 | 1.4 | 1.3 | 1.5 | 1.8 | 1.6 |
| Business (management) | 5.7 | 5.9 | NA | NA | NA | 9.8 | 11.3 | 12.3 | 13.2 | 13.3 | 14.4 | 14.1 | 15.4 | 16.8 | 16.9 | 17.8 | 17.7 | 16.9 | 15.8 | 13.5 |
| Clinical psychologist | 0.1 | 0.1 | NA | NA | NA | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| College teacher | 0.9 | 0.8 | NA | NA | NA | 0.6 | 0.5 | 0.4 | 0.3 | 0.3 | 0.2 | 0.3 | 0.4 | 0.4 | 0.3 | 0.4 | 0.4 | 0.4 | 0.6 | 0.4 |
| Computer programmer | 0.4 | 0.4 | NA | NA | NA | 1.0 | 1.3 | 1.6 | 2.1 | 3.1 | 3.6 | 4.8 | 4.7 | 3.1 | 2.5 | 1.7 | 1.1 | 1.2 | 1.0 | 1.0 |
| Conservationist or forester | 1.8 | 1.6 | NA | NA | NA | 1.0 | 1.4 | 0.9 | 0.6 | 0.6 | 0.8 | 0.4 | 0.3 | 0.2 | 0.3 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 |
| Engineer | 0.4 | 0.2 | NA | NA | NA | 0.4 | 0.5 | 0.3 | 0.5 | 0.7 | 0.6 | 0.7 | 0.6 | 0.4 | 0.4 | 0.3 | 0.4 | 0.4 | 0.4 | 0.5 |

(continued)

Appendix table 2-5.
**Selected characteristics of American college freshmen: 1971-90**
(page 6 of 7)

| | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Freshmen planning to major in non-science/engineering fields** | | | | | | | | | | | | | | | | | | | | |
| Percent | | | | | | | | | | | | | | | | | | | | |
| Farmer or rancher | 1.0 | 0.8 | NA | NA | NA | 0.9 | 1.0 | 0.7 | 0.9 | 0.7 | 1.0 | 0.9 | 0.7 | 0.6 | 0.5 | 0.4 | 0.3 | 0.4 | 0.4 | 0.4 |
| Foreign service worker | 0.6 | 0.5 | NA | NA | NA | 0.6 | 0.4 | 0.5 | 0.5 | 0.4 | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 |
| Lawyer | 5.8 | 6.6 | NA | NA | NA | 4.6 | 4.7 | 4.1 | 4.7 | 4.6 | 4.4 | 5.1 | 4.6 | 4.4 | 3.9 | 4.1 | 4.6 | 5.2 | 5.6 | 5.0 |
| Military service (career) | 1.0 | 1.2 | NA | NA | NA | 0.5 | 0.6 | 0.7 | 0.6 | 0.5 | 0.6 | 0.6 | 0.6 | 0.7 | 0.5 | 0.8 | 0.7 | 0.6 | 0.5 | 0.4 |
| Nurse | 4.6 | 4.6 | NA | NA | NA | 5.9 | 4.8 | 5.2 | 4.7 | 5.1 | 4.7 | 5.6 | 5.5 | 4.5 | 3.7 | 3.0 | 2.3 | 2.6 | 2.4 | 3.6 |
| Physician | 6.1 | 6.8 | NA | NA | NA | 3.2 | 4.3 | 4.7 | 4.4 | 4.7 | 4.6 | 4.9 | 4.9 | 4.9 | 5.0 | 4.5 | 3.7 | 4.1 | 4.2 | 4.6 |
| School counselor | 0.1 | 0.2 | NA | NA | NA | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 |
| Scientific researcher | 0.5 | 0.5 | NA | NA | NA | 0.3 | 0.3 | 0.4 | 0.2 | 0.3 | 0.3 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Social worker | 0.7 | 0.4 | NA | NA | NA | 0.9 | 0.7 | 0.7 | 0.7 | 0.5 | 0.3 | 0.3 | 0.4 | 0.3 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 |
| Statistician | 0.0 | 0.0 | NA | NA | NA | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| Therapist (e.g., physical) | 2.6 | 3.4 | NA | NA | NA | 3.8 | 3.7 | 3.6 | 3.2 | 3.3 | 3.5 | 3.5 | 3.3 | 3.9 | 2.8 | 2.9 | 3.0 | 3.2 | 3.2 | 3.5 |
| Teacher (elementary) | 10.2 | 8.6 | NA | NA | NA | 7.8 | 6.9 | 6.1 | 6.6 | 6.1 | 6.5 | 4.6 | 5.3 | 5.4 | 5.2 | 5.9 | 6.9 | 6.4 | 6.3 | 7.9 |
| Teacher (secondary) | 10.9 | 8.3 | NA | NA | NA | 5.9 | 4.5 | 4.4 | 3.9 | 3.7 | 3.1 | 2.7 | 3.1 | 2.8 | 3.5 | 3.9 | 4.2 | 4.3 | 4.3 | 4.8 |
| Veterinarian | 1.3 | 2.1 | NA | NA | NA | 1.2 | 1.3 | 1.5 | 1.2 | 1.4 | 1.1 | 0.9 | 1.0 | 0.8 | 1.1 | 1.0 | 0.8 | 0.7 | 0.8 | 0.7 |
| Writer or journalist | 2.4 | 2.7 | NA | NA | NA | 3.4 | 3.2 | 3.4 | 4.0 | 3.6 | 4.0 | 3.7 | 3.7 | 3.6 | 4.3 | 3.9 | 3.7 | 4.0 | 4.1 | 3.8 |
| Skilled trades | 0.5 | 0.4 | NA | NA | NA | 0.3 | 1.3 | 0.6 | 0.5 | 0.6 | 0.6 | 0.4 | 0.5 | 0.3 | 0.3 | 0.3 | 0.2 | 0.6 | 0.5 | 0.4 |
| Other | 5.4 | 5.0 | NA | NA | NA | 5.4 | 5.1 | 5.4 | 6.1 | 6.0 | 5.9 | 5.2 | 5.4 | 4.8 | 4.9 | 5.3 | 5.5 | 5.4 | 6.8 | 7.9 |
| Undecided | 12.9 | 14.4 | NA | NA | NA | 11.9 | 11.7 | 12.4 | 12.4 | 12.4 | 12.1 | 13.3 | 12.8 | 13.5 | 12.9 | 14.4 | 14.2 | 13.5 | 13.8 | 13.6 |
| **Student's probable major** | | | | | | | | | | | | | | | | | | | | |
| Agriculture | 3.1 | 3.0 | 3.2 | 4.0 | 3.9 | 3.4 | 3.1 | 2.5 | 2.4 | 2.2 | 2.7 | 2.1 | 1.6 | 1.4 | 1.3 | 1.1 | 0.9 | 1.0 | 1.2 | 1.3 |
| Business | 15.9 | 14.8 | 19.9 | 21.6 | 22.2 | 24.0 | 26.6 | 29.5 | 29.8 | 30.0 | 32.2 | 31.9 | 32.2 | 36.6 | 35.9 | 36.0 | 36.3 | 34.6 | 34.1 | 30.7 |
| Education | 15.3 | 11.9 | 20.1 | 17.7 | 16.7 | 16.3 | 14.3 | 13.2 | 13.3 | 11.9 | 11.0 | 9.1 | 10.6 | 9.7 | 9.3 | 11.4 | 12.3 | 11.6 | 11.7 | 14.0 |
| English | 4.5 | 2.9 | 3.3 | 2.2 | 2.2 | 2.0 | 1.8 | 2.1 | 1.7 | 1.7 | 1.7 | 1.5 | 1.9 | 1.7 | 2.1 | 2.3 | 2.1 | 2.3 | 2.6 | 2.7 |
| Health professional | 17.8 | 19.9 | 8.7 | 10.8 | 10.2 | 10.9 | 15.1 | 15.5 | 14.3 | 15.4 | 14.4 | 15.5 | 15.4 | 15.2 | 13.8 | 12.2 | 10.6 | 11.6 | 12.4 | 13.8 |
| History or political science | 3.8 | 3.4 | 2.8 | 2.1 | 1.8 | 1.8 | 1.5 | 1.1 | 1.3 | 1.0 | 1.2 | 1.1 | 1.2 | 1.4 | 1.3 | 1.4 | 1.4 | 1.5 | 1.7 | 1.8 |
| Humanities | 5.1 | 5.6 | 4.7 | 4.8 | 3.7 | 3.6 | 2.8 | 2.5 | 2.5 | 2.2 | 2.4 | 2.3 | 2.2 | 2.2 | 2.4 | 2.5 | 2.6 | 2.7 | 2.4 | 2.6 |
| Fine arts | 11.2 | 10.8 | 10.3 | 11.0 | 10.1 | 9.5 | 9.5 | 9.4 | 8.7 | 8.8 | 8.6 | 8.0 | 7.5 | 7.1 | 7.2 | 8.0 | 8.4 | 7.3 | 8.0 | 7.3 |
| Other technical | 4.0 | 4.5 | 7.3 | 6.7 | 7.4 | 6.7 | 5.4 | 4.6 | 5.2 | 6.6 | 6.4 | 7.3 | 7.2 | 4.6 | 4.1 | 3.3 | 2.9 | 3.8 | 2.5 | 2.5 |
| Other nontechnical | 15.9 | 15.8 | 12.6 | 12.1 | 13.8 | 14.4 | 12.0 | 12.2 | 13.0 | 12.0 | 11.1 | 12.3 | 11.5 | 11.0 | 12.7 | 11.3 | 11.7 | 12.8 | 12.3 | 12.7 |
| Undecided | 3.3 | 7.4 | 7.0 | 7.0 | 8.1 | 7.5 | 8.0 | 7.3 | 8.0 | 8.1 | 8.4 | 8.8 | 8.7 | 9.1 | 10.0 | 10.6 | 10.8 | 10.7 | 11.1 | 10.6 |

(continued)

Appendix table 2-5.
**Selected characteristics of American college freshmen: 1971-90**
(page 7 of 7)

| | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Freshmen planning to major in non-science/engineering fields** | | | | | | | | | | | | | | | | | | | |
| | Percent | | | | | | | | | | | | | | | | | | | |
| **Highest degree planned** | | | | | | | | | | | | | | | | | | | | |
| None | NA | 1.5 | NA | 2.2 | 2.8 | 2.2 | 1.6 | 1.5 | 1.2 | 1.3 | 1.5 | 1.5 | 2.5 | 1.7 | 2.3 | 1.8 | 1.7 | 2.0 | 0.9 | 1.3 |
| Associate or equivalent | NA | 1.4 | NA | 2.2 | 1.6 | 1.7 | 2.2 | 1.6 | 2.1 | 2.1 | 1.9 | 2.0 | 1.3 | 1.6 | 1.0 | 0.9 | 0.8 | 1.5 | 0.9 | 0.8 |
| Bachelors | NA | 41.5 | NA | 44.0 | 41.6 | 40.4 | 39.4 | 40.0 | 39.3 | 40.7 | 40.1 | 39.5 | 37.6 | 39.5 | 38.7 | 37.7 | 37.4 | 31.8 | 32.5 | 30.4 |
| Masters | NA | 28.8 | NA | 30.9 | 32.3 | 32.9 | 33.4 | 33.9 | 34.7 | 33.0 | 35.1 | 33.6 | 35.1 | 34.5 | 36.1 | 38.4 | 39.3 | 41.2 | 41.8 | 42.1 |
| Doctorate | NA | 7.4 | NA | 7.1 | 7.3 | 8.0 | 7.7 | 7.6 | 7.1 | 7.0 | 7.6 | 7.9 | 7.6 | 8.4 | 7.5 | 8.0 | 8.6 | 10.1 | 9.8 | 10.8 |
| Professional (e.g., MD, DDS) | NA | 10.7 | NA | 6.6 | 6.0 | 6.3 | 7.8 | 8.2 | 7.7 | 8.0 | 7.4 | 7.9 | 7.5 | 7.3 | 8.1 | 7.1 | 6.0 | 6.1 | 6.6 | 7.1 |
| Law | NA | 6.6 | NA | 4.1 | 5.3 | 5.3 | 5.1 | 5.0 | 5.1 | 4.9 | 4.7 | 5.3 | 5.2 | 4.8 | 3.8 | 4.1 | 4.4 | 5.2 | 5.4 | 5.1 |
| Divinity | NA | 0.6 | NA | 0.7 | 0.5 | 0.5 | 0.6 | 0.5 | 0.6 | 0.4 | 0.3 | 0.4 | 0.5 | 0.4 | 0.5 | 0.2 | 0.3 | 0.4 | 0.4 | 0.5 |
| Other | NA | 1.5 | NA | 2.2 | 2.6 | 2.5 | 2.3 | 1.7 | 2.2 | 2.6 | 1.3 | 1.8 | 2.6 | 1.8 | 2.0 | 1.7 | 1.5 | 1.7 | 1.6 | 1.9 |

NA = data not collected

SOURCE: Higher Education Research Institute, University of California at Los Angeles, unpublished tabulations.

See figures 2-2 and 2-3.

*Science & Engineering Indicators – 1991*

Appendix table 2-6.
**Undergraduate enrollment in engineering and engineering technology programs: 1979-89**

| | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **Engineering programs** | | | | | | |
| Total enrollment | 366,299 | 397,344 | 420,402 | 435,330 | 441,205 | 429,499 | 420,864 | 407,657 | 392,198 | 385 [illegible]2 | 378,277 |
| Total full time | 340,488 | 365,117 | 387,577 | 403,390 | 406,144 | 394,635 | 384,191 | 369,520 | 356,998 | 346,169 | 338,529 |
| Freshman | 103,724 | 110,149 | 115,280 | 115,303 | 109,638 | 105,249 | 103,225 | 99,238 | 95,453 | 98,009 | 95,420 |
| Sophomore | 78,594 | 84,982 | 87,519 | 89,785 | 89,515 | 83,946 | 79,627 | 76,195 | 73,317 | 71,030 | 71,267 |
| Junior | 74,928 | 80,024 | 86,633 | 90,541 | 91,233 | 89,509 | 84,875 | 80,386 | 77,085 | 73,761 | 70,483 |
| Senior | 77,823 | 84,442 | 92,414 | 102,055 | 109,036 | 109,695 | 110,305 | 107,773 | 104,003 | 97,614 | 94,465 |
| Fifth year | 5,419 | 5,520 | 5,731 | 5,706 | 6,722 | 6,23[illegible] | 6,159 | 5,928 | 7,140 | 5,755 | 6,894 |
| Total part time | 25,811 | 32,227 | 32,825 | 31,940 | 35,061 | 34,864 | 36,673 | 38,137 | 35,200 | 39,243 | 39,748 |
| Total number of schools | 286 | 287 | 286 | 286 | 292 | 289 | 297 | 311 | 316 | 320 | 323 |
| ABET-accredited schools | 239 | 246 | 250 | 249 | 258 | 258 | 264 | 270 | 277 | 281 | 284 |
| | | | | | **Engineering technology programs** | | | | | | |
| Total enrollment | NA | NA | 191,152 | 176,133 | 163,226 | 157,897 | 123,571 | 137,390 | 128,501 | 131,704 | 127,687 |
| Total full time | NA | NA | 134,444 | 120,342 | 112,745 | 111,446 | 83,038 | 90,536 | 80,600 | 79,624 | 76,179 |
| First year | NA | NA | 65,893 | 59,339 | 53,032 | 46,806 | 34,389 | 39,177 | 32,685 | 33,477 | 32,225 |
| Second year | NA | NA | 40,774 | 36,807 | 33,799 | 31,716 | 23,293 | 25,612 | 22,906 | 21,852 | 21,627 |
| Other full-time associates | NA | NA | 872 | 797 | 925 | 1,165 | 466 | 657 | 1,404 | 1,760 | 1,810 |
| Bachelor of engineering technology third and later years | NA | NA | 26,905 | 23,399 | 24,989 | 31,759 | 24,890 | 25,090 | 23,605 | 22,535 | 20,517 |
| Total part time | NA | NA | 56,708 | 55,791 | 50,481 | 46,451 | 40,533 | 46,854 | 47,901 | 52,080 | 51,508 |
| Number of schools | NA | NA | NA | NA | NA | NA | 200 | 257 | 291 | 310 | 286 |

NA not available

Schools with at least one [illegible]ulum accredited by the Accreditation Board of Engineering and Technology (ABET).

SOURCE: Engineering Manpower Commission, American Association of Engineering Societies, *Engineering & Technology Enrollments, Fall 1989, Parts I and II* (Washington, DC: AAES, 1990).

See figure 2-4

Appendix table 2-7.
**Bachelors degree conferrals, by field and gender: 1980-89**

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **Total** | | | | | |
| Total, all baccalaureates | 940,251 | 946,877 | 964,043 | 980,679 | 986,345 | 990,880 | 1,000,352 | 1,003,532 | 1,006,033 | 1,030,171 |
| Total science and engineering | 291,983 | 294,867 | 302,118 | 307,229 | 314,666 | 321,739 | 323,950 | 318,942 | 308,760 | 307,580 |
| Total sciences | 232,743 | 230,799 | 234,327 | 234,275 | 238,135 | 243,868 | 246,889 | 244,237 | 238,354 | 240,366 |
| Physical sciences | 17,506 | 17,481 | 17,311 | 16,199 | 15,834 | 16,271 | 15,786 | 15,466 | 14,263 | 14,148 |
| Mathematics | 11,473 | 11,173 | 11,708 | 12,557 | 13,342 | 15,267 | 16,388 | 16,626 | 16,122 | 15,439 |
| Computer sciences | 11,213 | 15,233 | 20,431 | 24,682 | 32,435 | 39,121 | 42,195 | 39,927 | 34,896 | 30,963 |
| Environmental sciences | 6,155 | 6,694 | 7,061 | 7,298 | 7,925 | 7,576 | 6,076 | 4,689 | 3,554 | 3,181 |
| Life sciences | 71,617 | 68,086 | 65,041 | 63,237 | 59,613 | 57,812 | 56,465 | 56,215 | 54,280 | 52,612 |
| Psychology | 42,513 | 41,364 | 41,539 | 40,825 | 40,375 | 40,237 | 40,937 | 43,195 | 45,378 | 48,954 |
| Social sciences | 72,266 | 70,768 | 71,236 | 69,477 | 68,611 | 67,584 | 69,042 | 68,119 | 69,861 | 75,069 |
| Total engineering | 59,240 | 64,068 | 67,791 | 72,954 | 76,531 | 77,871 | 77,061 | 74,705 | 70,406 | 67,214 |
| | | | | | **Men** | | | | | |
| Total, all baccalaureates | 477,750 | 474,336 | 477,543 | 483,395 | 486,750 | 486,662 | 490,306 | 485,003 | 481,236 | 487,566 |
| Total science and engineering | 186,009 | 186,425 | 188,957 | 191,617 | 196,650 | 200,301 | 200,893 | 194,633 | 186,671 | 183,787 |
| Total sciences | 132,783 | 129,474 | 129,503 | 128,382 | 130,952 | 133,746 | 135,035 | 131,401 | 127,105 | 126,817 |
| Physical sciences | 13,317 | 13,167 | 12,779 | 11,586 | 11,177 | 11,434 | 11,090 | 10,793 | 9,677 | 9,777 |
| Mathematics | 6,625 | 6,392 | 6,650 | 7,059 | 7,428 | 8,231 | 8,772 | 8,900 | 8,662 | 8,333 |
| Computer sciences | 7,814 | 10,280 | 13,316 | 15,690 | 20,369 | 24,690 | 27,069 | 26,038 | 23,543 | 21,418 |
| Environmental sciences | 4,693 | 5,028 | 5,254 | 5,450 | 5,991 | 5,715 | 4,722 | 2,629 | 2,707 | 2,380 |
| Life sciences | 44,021 | 40,610 | 38,115 | 36,677 | 34,253 | 32,664 | 31,643 | 31,592 | 29,731 | 28,787 |
| Psychology | 15,590 | 14,447 | 13,756 | 13,228 | 12,949 | 12,815 | 12,691 | 13,399 | 13,584 | 14,291 |
| Social sciences | 40,723 | 39,550 | 39,633 | 38,692 | 38,785 | 38,197 | 39,048 | 38,050 | 39,201 | 41,831 |
| Total engineering | 53,226 | 56,951 | 59,454 | 63,235 | 65,698 | 66,555 | 65,858 | 63,232 | 59,566 | 56,970 |
| | | | | | **Women** | | | | | |
| Total, all baccalaureates | 462,501 | 472,541 | 486,500 | 497,284 | 499,595 | 504,218 | 510,046 | 518,529 | 524,797 | 542,604 |
| Total science and engineering | 105,974 | 108,442 | 113,161 | 115,612 | 118,016 | 121,438 | 123,057 | 123,309 | 122,089 | 123.793 |
| Total sciences | 99,960 | 101,325 | 104,824 | 105,893 | 107,183 | 110,122 | 111,854 | 111,836 | 111,249 | 113,549 |
| Physical sciences | 4,189 | 4,314 | 4,532 | 4,613 | 4,657 | 4,837 | 4,696 | 4,673 | 4,586 | 4,371 |
| Mathematics | 4,848 | 4,781 | 5,058 | 5,498 | 5,914 | 7,036 | 7,616 | 7,726 | 7,460 | 7,106 |
| Computer sciences | 3,399 | 4,953 | 7,115 | 8,992 | 12,066 | 14,431 | 15,126 | 13,889 | 11,353 | 9,545 |
| Environmental sciences | 1,462 | 1,666 | 1,807 | 1,848 | 1,934 | 1,861 | 1,354 | 1,060 | 847 | 801 |
| Life sciences | 27,596 | 27,476 | 26,926 | 26,560 | 25,360 | 25,148 | 24,822 | 24,623 | 24,549 | 23,825 |
| Psychology | 26,923 | 26,917 | 27,783 | 27,597 | 27,426 | 27,422 | 28,246 | 29,796 | 31,794 | 34,663 |
| Social sciences | 31,543 | 31,218 | 31,603 | 30,785 | 29,826 | 29,387 | 29,994 | 30,069 | 30,660 | 33,238 |
| Total engineering | 6,014 | 7,117 | 8,337 | 9,719 | 10,833 | 11,316 | 11,203 | 11,473 | 10,840 | 10.244 |

SOURCE: Science Resources Studies Division, National Science Foundation, *Science and Engineering Degrees. 1966-89, A Source Book.* NSF 91-314. Detailed Statistical Tables (Washington, DC: NSF, 1991).

See figure 2-5 and figure O-15 in Overview.

*Science & Engineering Indicators – 1991*

Appendix table 2-8.
**Bachelors degree conferrals, by field and racial/ethnic group: 1977-89**
(page 1 of 2)

| Field[1] | 1977 | 1979 | 1981 | 1985 | 1987 | 1989 |
|---|---|---|---|---|---|---|
| | | | **Total, U.S. citizens and permanent residents** | | | |
| Total science and engineering | 326,418 | 322,195 | 322,189 | 345,400 | 339,934 | 336,582 |
| Total sciences | 280,325 | 264,192 | 253,803 | 257,992 | 254,800 | 257,857 |
| Physical sciences[2] | 22,038 | 22,659 | 23,441 | 22,892 | 19,027 | 16,482 |
| Mathematics | 13,977 | 11,534 | 10,717 | 14,212 | 15,506 | 14,524 |
| Computer sciences | 6,161 | 8,392 | 14,455 | 36,692 | 35,943 | 27,721 |
| Life sciences[3] | 74,230 | 71,442 | 64,560 | 55,479 | 51,729 | 48,561 |
| Psychology | 47,297 | 42,561 | 40,878 | 39,406 | 41,248 | 47,396 |
| Social sciences[4] | 116,622 | 107,604 | 99,752 | 89,311 | 91,347 | 103,173 |
| Total engineering[5] | 46,093 | 58,003 | 68,386 | 87,408 | 85,134 | 78,725 |
| | | | **White, non-Hispanic** | | | |
| Total science and engineering | 290,175 | 284,852 | 281,924 | 299,662 | 289,700 | 283,260 |
| Total sciences | 248,103 | 232,201 | 221,068 | 223,357 | 217,834 | 218,035 |
| Physical sciences[2] | 20,417 | 20,958 | 21,249 | 20,541 | 16,653 | 14,238 |
| Mathematics | 12,602 | 10,229 | 9,447 | 12,163 | 13,265 | 12,287 |
| Computer sciences | 5,508 | 7,404 | 12,566 | 31,321 | 29,181 | 21,711 |
| Life sciences[3] | 67,891 | 64,445 | 57,529 | 48,248 | 44,034 | 40,594 |
| Psychology | 41,494 | 36,648 | 34,718 | 33,959 | 35,761 | 40,506 |
| Social sciences[4] | 100,191 | 92,517 | 85,559 | 77,125 | 78,940 | 88,699 |
| Total engineering[5] | 42,072 | 52,651 | 60,856 | 76,305 | 71,866 | 65,225 |
| | | | **Black, non-Hispanic** | | | |
| Total science and engineering | 19,455 | 18,743 | 18,828 | 18,075 | 18,279 | 18,405 |
| Total sciences | 18,070 | 16,968 | 16,379 | 14,933 | 14,859 | 15,251 |
| Physical sciences[2] | 692 | 704 | 911 | 830 | 823 | 697 |
| Mathematics | 712 | 652 | 585 | 770 | 834 | 792 |
| Computer sciences | 361 | 507 | 786 | 2,143 | 2,820 | 2,457 |
| Life sciences[3] | 2,724 | 2,837 | 2,650 | 2,417 | 2,185 | 2,225 |
| Psychology | 3,221 | 3,218 | 3,308 | 2,667 | 2,451 | 2,743 |
| Social sciences[4] | 10,360 | 9,050 | 8,139 | 6,106 | 5,746 | 6,337 |
| Total engineering[5] | 1,385 | 1,775 | 2,449 | 3,142 | 3,420 | 3,154 |
| | | | **Asian** | | | |
| Total science and engineering | 6,096 | 7,080 | 9,027 | 13,791 | 17,612 | 19,734 |
| Total sciences | 4,885 | 5,222 | 5,961 | 8,784 | 11,234 | 12,831 |
| Physical sciences[2] | 377 | 439 | 599 | 763 | 894 | 922 |
| Mathematics | 316 | 324 | 392 | 885 | 1,034 | 1,019 |
| Computer sciences | 163 | 263 | 669 | 2,044 | 2,455 | 2,268 |
| Life sciences[3] | 1,558 | 1,788 | 1,807 | 2,197 | 2,844 | 3,146 |
| Psychology | 807 | 781 | 843 | 845 | 1,154 | 1,575 |
| Social sciences[4] | 1,664 | 1,627 | 1,651 | 2,050 | 2,853 | 3,901 |
| Total engineering[5] | 1,211 | 1,858 | 3,066 | 5,007 | 6,378 | 6,903 |

(continued)

Appendix table 2-8.
**Bachelors degree conferrals, by field and racial/ethnic group: 1977-89**
(page 2 of 2)

| Field[1] | 1977 | 1979 | 1981 | 1985 | 1987 | 1989 |
|---|---|---|---|---|---|---|
| | | | **Native American** | | | |
| Total science & engineering | 1,155 | 1,187 | 1,202 | 1,484 | 1,350 | 1,323 |
| Total sciences | 1,020 | 1,023 | 1,007 | 1,175 | 1,067 | 1,048 |
| Physical sciences[2] | 68 | 63 | 65 | 98 | 72 | 62 |
| Mathematics | 26 | 41 | 18 | 59 | 52 | 53 |
| Computer sciences | 15 | 11 | 21 | 139 | 112 | 90 |
| Life sciences[3] | 270 | 233 | 233 | 231 | 202 | 215 |
| Psychology | 167 | 177 | 196 | 201 | 180 | 420 |
| Social sciences[4] | 474 | 498 | 474 | 447 | 449 | 208 |
| Total engineering[5] | 135 | 164 | 195 | 309 | 283 | 275 |
| | | | **Hispanic** | | | |
| Total science & engineering | 9,537 | 10,333 | 11,208 | 12,388 | 12,993 | 13,860 |
| Total sciences | 8,247 | 8,778 | 9,388 | 9,743 | 9,806 | 10,692 |
| Physical sciences[2] | 484 | 495 | 617 | 660 | 585 | 563 |
| Mathematics | 321 | 288 | 275 | 335 | 321 | 373 |
| Computer sciences | 114 | 207 | 413 | 1,045 | 1,375 | 1,195 |
| Life sciences[3] | 1,787 | 2,139 | 2,341 | 2,386 | 2,464 | 2,381 |
| Psychology | 1.608 | 1,737 | 1,813 | 1,734 | 1,702 | 2,152 |
| Social sciences[4] | 3.933 | 3,912 | 3,929 | 3.583 | 3,359 | 4,028 |
| Total engineering[5] | 1,290 | 1,555 | 1,820 | 2.645 | 3,187 | 3,168 |

NOTES: Data by racial/ethnic group are collected on a biennial schedule; data are provided by institutions; imputations are done for some nonresponse. Racial/ethnic categories are designated on the survey form. These categories include U.S. citizens and foreign citizens on permanent visas. Data are not available by racial/ethnic group for foreign citizens on temporary visas.

[1]Data on racial/ethnic groups are collected by broad fields of study only; therefore, these data cannot be adjusted to the exact field taxonomies used by the National Science Foundation.

[2]Includes environmental sciences.

[3]Excludes health sciences.

[4]For 1977 to 1981, social sciences included Afro-American black cultural studies and American Indian studies.

[5]Includes engineering technology. Racial/ethnic data for engineering and engineering technology can only be separated for 1985 and 1987.

SOURCE: Science Resources Studies Division, National Science Foundation, unpublished tabulations from the Completion Survey conducted by the National Center for Education Statistics.

*Science & Engineering Indicators – 1991*

Appendix table 2-9.
**Freshman intentions as predictor of science and engineering bachelors degrees**

| | Engineering | Computer sciences | Natural sciences | Social & behavioral sciences |
|---|---|---|---|---|
| | **Freshman intentions**[1] | | | |
| | Percent | | | |
| 1977 | 9.5 | 0.9 | 11.8 | 9.5 |
| 1978 | 10.1 | 1.5 | 11.6 | 9.4 |
| 1979 | 10.5 | 1.8 | 10.1 | 9.0 |
| 1980 | 11.4 | 2.5 | 9.2 | 8.3 |
| 1981 | 11.1 | 3.8 | 9.4 | 7.7 |
| 1982 | 12.0 | 4.9 | 8.7 | 7.2 |
| 1983 | 11.5 | 4.9 | 9.1 | 7.6 |
| 1984 | 11.0 | 3.5 | 9.1 | 8.6 |
| 1985 | 10.5 | 2.5 | 8.5 | 9.0 |
| 1986 | 10.2 | 1.9 | 8.2 | 9.5 |
| 1987 | 9.5 | 1.6 | 7.7 | 10.0 |
| 1988 | 8.9 | 1.6 | 7.8 | 11.3 |
| 1989 | 9.8 | 1.6 | 8.2 | 11.0 |
| 1990 | 9.7 | 1.7 | 8.4 | 11.0 |
| | **Share of bachelors degrees**[2] | | | |
| 1980 | 6.3 | 1.2 | 11.4 | 12.2 |
| 1981 | 6.8 | 1.6 | 10.9 | 11.8 |
| 1982 | 7.0 | 2.1 | [illegible] | 11.7 |
| 1983 | 7.4 | 2.5 | [illegible] | 11.2 |
| 1984 | 7.8 | 3.3 | 9.8 | 11.0 |
| 1985 | 7.9 | 3.9 | 9.8 | 10.9 |
| 1986 | 7.7 | 4.2 | 9.5 | 11.0 |
| 1987 | 7.4 | 4.0 | 9.3 | 11.1 |
| 1988 | 7.0 | 3.5 | 8.8 | 11.5 |
| 1989 | 6.5 | 3.0 | 8.3 | 12.6 |

[1]Percentage of freshmen at 4-year colleges and universities who plan to major in a science or engineering field.

[2]Science and engineering bachelors degrees as a pecentage of all bachelors degrees.

SOURCES: Science Resources Studies Division, National Science Foundation, unpublished tabulations: and Higher Education Research Institute, University of California at Los Angeles, unpublished tabulations.

See figure 2-6. *Science & Engineering Indicators – 1991*

Appendix table 2-10.
**Science and engineering graduate students, by field and gender: 1980-90**

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | **Total** | | | | | |
| Total science & engineering | 327,533 | 334,059 | 340,707 | 349,547 | 352,027 | 360,722 | 370,487 | 375,632 | 378,274 | 386,047 | 401,569 |
| Total sciences | 252,449 | 253,580 | 256,126 | 257,610 | 258,383 | 263,771 | 267,416 | 270,988 | 274,555 | 281,232 | 292,270 |
| Physical sciences | 26,952 | 27,382 | 28,199 | 29,466 | 30,064 | 30,995 | 32,260 | 32,738 | 32,972 | 33,628 | 34,337 |
| Mathematics | 15,360 | 15,915 | 17,199 | 17,397 | 17,478 | 17,613 | 17,990 | 18,573 | 19,141 | 19,382 | 19,884 |
| Computer sciences | 13,578 | 16,437 | 19,812 | 23,616 | 25,810 | 29,844 | 31,425 | 32,137 | 32,787 | 32,846 | 34,507 |
| Environmental sciences | 14,208 | 14,422 | 15,174 | 15,544 | 15,612 | 15,545 | 15,163 | 14,522 | 14,032 | 13,848 | 14,159 |
| Life sciences | 60,144 | 59,079 | 58,624 | 58,345 | 58,233 | 57,918 | 58,545 | 58,456 | 59,316 | 60,655 | 62,104 |
| Psychology | 40,636 | 40,691 | 40,082 | 41,039 | 41,074 | 41,308 | 41,551 | 42,888 | 44,389 | 46,304 | 48,659 |
| Social sciences | 81,571 | 79,654 | 77,036 | 72,203 | 70,112 | 70,548 | 70,482 | 71,674 | 71,918 | 74,569 | 78,620 |
| Total engineering | 75,084 | 80,479 | 84,581 | 91,937 | 93,644 | 96,951 | 103,071 | 104,644 | 103,719 | 104,815 | 109,299 |
| | | | | | | **Men** | | | | | |
| Total science & engineering | 232,753 | 233,604 | 236,602 | 242,234 | 243,683 | 249,089 | 255,324 | 257,686 | 256,113 | 258,889 | 266,292 |
| Total sciences | 164,172 | 161,056 | 160,987 | 160,276 | 160,574 | 163,470 | 164,922 | 166,131 | 165,719 | 167,874 | 171,954 |
| Physical sciences | 22,352 | 22,366 | 22,776 | 23,586 | 23,904 | 24,483 | 25,395 | 25,620 | 25,473 | 25,825 | 26,223 |
| Mathematics | 11,272 | 11,419 | 12,109 | 12,184 | 12,295 | 12,227 | 12,501 | 12,944 | 13,348 | 13,359 | 13,646 |
| Computer sciences | 10,491 | 12,228 | 14,366 | 16,968 | 18,905 | 22,387 | 23,677 | 24,233 | 24,564 | 24,880 | 26,316 |
| Environmental sciences | 10,940 | 10,945 | 11,393 | 11,593 | 11,694 | 11,571 | 11,183 | 10,708 | 10,164 | 9,923 | 9,994 |
| Life sciences | 38,939 | 37,580 | 36,335 | 35,755 | 35,473 | 34,904 | 34,965 | 34,776 | 34,695 | 35,013 | 35,367 |
| Psychology | 19,036 | 17,902 | 16,977 | 16,687 | 16,216 | 15,778 | 15,459 | 15,744 | 15,643 | 15,906 | 15,963 |
| Social sciences | 51,142 | 48,616 | 47,031 | 43,503 | 42,087 | 42,120 | 41,742 | 42,106 | 41,832 | 42,968 | 44,445 |
| Total engineering | 68,581 | 72,548 | 75,615 | 81,958 | 83,109 | 85,619 | 90,402 | 91,555 | 90,394 | 91,015 | 94,338 |
| | | | | | | **Women** | | | | | |
| Total science & engineering | 94,780 | 100,455 | 104,105 | 107,313 | 108,344 | 111,633 | 115,163 | 117,946 | 122,161 | 127,158 | 135,277 |
| Total sciences | 88,277 | 92,524 | 95,139 | 97,334 | 97,809 | 100,301 | 102,494 | 104,857 | 108,836 | 113,358 | 120,316 |
| Physical sciences | 4,600 | 5,016 | 5,423 | 5,880 | 6,160 | 6,512 | 6,865 | 7,118 | 7,499 | 7,803 | 8,114 |
| Mathematics | 4,088 | 4,496 | 5,090 | 5,213 | 5,183 | 5,386 | 5,489 | 5,629 | 5,793 | 6,023 | 6,238 |
| Computer sciences | 3,087 | 4,209 | 5,446 | 6,648 | 6,905 | 7,457 | 7,748 | 7,904 | 8,223 | 7,966 | 8,191 |
| Environmental sciences | 3,268 | 3,477 | 3,781 | 3,951 | 3,918 | 3,974 | 3,980 | 3,814 | 3,868 | 3,925 | 4,165 |
| Life sciences | 21,205 | 21,499 | 22,289 | 22,590 | 22,760 | 23,014 | 23,580 | 23,680 | 24,621 | 25,642 | 26,737 |
| Psychology | 21,600 | 22,789 | 23,105 | 24,352 | 24,858 | 25,530 | 26,092 | 27,144 | 28,746 | 30,398 | 32,696 |
| Social sciences | 30,429 | 31,038 | 30,005 | 28,700 | 28,025 | 28,428 | 28,740 | 29,568 | 30,086 | 31,601 | 34,175 |
| Total engineering | 6,503 | 7,931 | 8,966 | 9,979 | 10,535 | 11,332 | 12,669 | 13,089 | 13,325 | 13,800 | 14,961 |

SOURCES: Science Resources Studies Division, National Science Foundation, *Selected Data on Graduate Students and Postdoctorates in Science and Engineering: Fall 1990*, NSF 91-320 (Washington, DC: NSF, 1991), unpublished tabulations; and annual series.

See figure 2-7.

Appendix table 2-11.
**Science and engineering graduate students, by field and racial/ethnic group: 1983-90**
(page 1 of 2)

| | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|
| | | | | **Total, U.S. citizens**[1] | | | | |
| Total science & engineering. . | 278,994 | 279,554 | 283,741 | 286,279 | 287,606 | 284,243 | 287,681 | 299,110 |
| Total sciences | 214,676 | 213,916 | 215,725 | 215,349 | 216,457 | 215,893 | 219,731 | 227,938 |
| Physical sciences | 21,805 | 22,017 | 22,054 | 22,232 | 22,110 | 21,860 | 21,820 | 21,826 |
| Mathematics | 12,442 | 12,285 | 12,262 | 12,179 | 12,443 | 12,716 | 12,711 | 13,443 |
| Computer sciences | 18,068 | 19,451 | 22,386 | 23,419 | 23,409 | 23,717 | 23,122 | 23,778 |
| Environmental sciences | 13,679 | 13,808 | 13,651 | 13,067 | 12,299 | 11,589 | 11,247 | 11,442 |
| Life sciences | 49,567 | 49,208 | 48,366 | 47,918 | 47,785 | 46,612 | 46,878 | 47,391 |
| Psychology | 39,605 | 39,685 | 39,811 | 40,047 | 41,346 | 42,726 | 44,652 | 46,819 |
| Social sciences | 59,510 | 57,462 | 57,195 | 56,487 | 57,065 | 56,673 | 59,301 | 63,239 |
| Total engineering | 64,318 | 65,638 | 68,016 | 70,930 | 71,149 | 68,350 | 67,950 | 71,172 |
| | | | | **White** | | | | |
| Total science & engineering | 226,010 | 224,118 | 224,898 | 228,655 | 230,170 | 230,855 | 232,012 | 241,210 |
| Total sciences | 176,909 | 174,289 | 174,063 | 175,249 | 175,991 | 178,030 | 180,165 | 186,869 |
| Physical sciences | 18,657 | 18,595 | 18,338 | 18,565 | 18,098 | 18,292 | 18,328 | 18,570 |
| Mathematics | 10,293 | 9,976 | 9,818 | 9,547 | 9,695 | 10,188 | 10,174 | 10,705 |
| Computer sciences | 13,482 | 13,983 | 15,569 | 16,498 | 17,149 | 17,660 | 16,665 | 17,436 |
| Environmental sciences | 12,322 | 12,021 | 11,860 | 11,654 | 11,035 | 10,531 | 10,309 | 10,476 |
| Life sciences | 43,665 | 43,725 | 42,051 | 41,767 | 40,532 | 40,454 | 40,107 | 40,343 |
| Psychology | 32,665 | 32,143 | 32,741 | 33,285 | 34,872 | 36,120 | 37,815 | 39,511 |
| Social sciences | 45,825 | 43,846 | 43,686 | 43,933 | 44,610 | 44,785 | 46,767 | 49,828 |
| Total engineering | 49,101 | 49,829 | 50,835 | 53,406 | 54,179 | 52,825 | 51,847 | 54,341 |
| | | | | **Black** | | | | |
| Total science & engineering | 11,045 | 10,781 | 10,587 | 10,580 | 10,510 | 11,246 | 11,779 | 12,891 |
| Total sciences | 9,634 | 9,306 | 9,165 | 9,071 | 9,075 | 9,713 | 10,131 | 11,081 |
| Physical sciences | 575 | 596 | 535 | 524 | 536 | 569 | 633 | 653 |
| Mathematics | 404 | 394 | 410 | 450 | 442 | 422 | 463 | 512 |
| Computer sciences | 564 | 561 | 609 | 686 | 750 | 825 | 838 | 984 |
| Environmental sciences | 111 | 108 | 122 | 98 | 95 | 108 | 96 | 125 |
| Life sciences | 1,296 | 1,295 | 1,332 | 1,238 | 1,194 | 1,304 | 1,372 | 1,441 |
| Psychology | 1,911 | 1,933 | 1,815 | 1,815 | 1,825 | 1,983 | 2,094 | 2,289 |
| Social sciences | 4,773 | 4,419 | 4,342 | 4,260 | 4,233 | 4,502 | 4,635 | 5,077 |
| Total engineering | 1,411 | 1,475 | 1,422 | 1,509 | 1,435 | 1,533 | 1,648 | 1,810 |
| | | | | **Asian** | | | | |
| Total science & engineering | 9,393 | 10,208 | 12,049 | 12,883 | 14,639 | 15,256 | 15,778 | 17,474 |
| Total sciences | 5,974 | 6,374 | 7,222 | 7,697 | 8,754 | 9,289 | 9,745 | 10,699 |
| Physical sciences | 748 | 891 | 937 | 912 | 1,047 | 1,213 | 1,141 | 1,217 |
| Mathematics | 564 | 565 | 625 | 707 | 771 | 759 | 710 | 900 |
| Computer sciences | 1,099 | 1,251 | 1,853 | 2,078 | 2,463 | 2,690 | 2,748 | 2,864 |
| Environmental sciences | 239 | 187 | 193 | 152 | 181 | 210 | 211 | 267 |
| Life sciences | 1,409 | 1,460 | 1,602 | 1,716 | 1,846 | 2,035 | 2,263 | 2,585 |
| Psychology | 532 | 545 | 559 | 619 | 728 | 752 | 821 | 964 |
| Social sciences | 1,383 | 1,475 | 1,453 | 1,513 | 1,718 | 1,630 | 1,851 | 1,902 |
| Total engineering | 3,419 | 3,834 | 4,827 | 5,186 | 5,885 | 5,967 | 6,033 | 6,775 |

(continued)

Appendix table 2-11.
**Science and engineering graduate students, by field and racial/ethnic group: 1983-90**
(page 2 of 2)

| | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|
| | | | | **Native American** | | | | |
| Total science & engineering . . | 919 | 835 | 741 | 752 | 788 | 928 | 859 | 1,048 |
| Total sciences. . . . . . . . . . . . | 738 | 643 | 619 | 620 | 664 | 784 | 734 | 891 |
| Physical sciences. . . . . . . | 45 | 77 | 35 | 48 | 46 | 52 | 44 | 63 |
| Mathematics . . . . . . . . . . | 32 | 23 | 22 | 32 | 48 | 32 | 34 | 20 |
| Computer sciences . . . . . | 22 | 48 | 56 | 20 | 27 | 40 | 41 | 42 |
| Environmental sciences . . | 27 | 23 | 23 | 21 | 19 | 29 | 27 | 30 |
| Life sciences . . . . . . . . . . | 153 | 108 | 109 | 130 | 118 | 139 | 110 | 157 |
| Psychology . . . . . . . . . . . | 136 | 116 | 136 | 135 | 153 | 179 | 181 | 236 |
| Social sciences . . . . . . . . | 323 | 248 | 238 | 234 | 253 | 313 | 297 | 343 |
| Total engineering. . . . . . . . . . | 181 | 192 | 122 | 132 | 124 | 144 | 125 | 157 |
| | | | | **Hispanic** | | | | |
| Total science & engineering . . | 8,928 | 8,715 | 8,637 | 8,713 | 8,842 | 9,132 | 9,487 | 10.502 |
| Total sciences. . . . . . . . . . . . | 7,463 | 7,193 | 7,140 | 7,071 | 7,108 | 7,401 | 7,762 | 8.547 |
| Physical sciences. . . . . . . | 563 | 535 | 599 | 629 | 591 | 624 | 680 | 641 |
| Mathematics . . . . . . . . . . | 331 | 292 | 262 | 270 | 266 | 328 | 305 | 370 |
| Computer sciences . . . . . | 282 | 292 | 481 | 445 | 544 | 517 | 546 | 566 |
| Environmental sciences . . | 226 | 263 | 241 | 239 | 228 | 211 | 213 | 241 |
| Life sciences . . . . . . . . . . | 1,138 | 1,103 | 1,263 | 1,265 | 1,262 | 1,405 | 1,510 | 1,530 |
| Psychology . . . . . . . . . . . | 1,814 | 1,903 | 1,613 | 1,709 | 1,669 | 1,728 | 1,756 | 2,159 |
| Social sciences . . . . . . . . | 3,109 | 2,805 | 2,681 | 2,514 | 2,548 | 2,588 | 2,752 | 3,040 |
| Total engineering. . . . . . . . . . | 1,465 | 1,522 | 1,497 | 1,642 | 1,734 | 1,731 | 1,725 | 1,955 |

NOTE: Data on racial/ethnic groups are only available for U.S. citizens.

[1]Total includes racial/ethnic group unknown.

SOURCES: Science Resources Studies Division, National Science Foundation, *Selected Data on Graduate Students and Postdoctorates in Science and Engineering: Fall 1990*, NSF 91-320 (Washington, DC: NSF, 1991), unpublished tabulations; and annual series.

See figure 2-8.

Appendix table 2-12.
**First year full-time science and engineering graduate enrollment, by field and gender: 1982-90**

| | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | **Total** | | | | |
| Total science & engineering | 70,351 | 72,405 | 70,829 | 71,771 | 73,618 | 71,508 | 71,484 | 75,506 | 76,934 |
| Total sciences | 51,969 | 53,140 | 51,666 | 53,335 | 53,029 | 52,006 | 52,145 | 55,566 | 56,681 |
| Physical sciences | 6,185 | 6,705 | 6,513 | 6,645 | 6,935 | 6,779 | 6,528 | 6,842 | 6,817 |
| Mathematics | 3,694 | 3,600 | 3,738 | 3,985 | 4,029 | 3,900 | 3,919 | 4,224 | 4,244 |
| Computer sciences | 3,330 | 3,898 | 4,056 | 4,774 | 5,033 | 5,135 | 5,229 | 5,707 | 5,396 |
| Environmental sciences | 3,648 | 3,775 | 3,387 | 3,275 | 3,091 | 2,609 | 2,603 | 2,672 | 2,707 |
| Life sciences | 12,540 | 12,700 | 12,528 | 12,305 | 12,172 | 12,037 | 12,011 | 12,416 | 12,770 |
| Psychology | 7,567 | 7,804 | 7,558 | 7,837 | 7,703 | 7,874 | 8,258 | 9,115 | 8,800 |
| Social sciences | 15,005 | 14,658 | 13,886 | 14,514 | 14,066 | 13,672 | 13,597 | 14,590 | 15,947 |
| Total engineering | 18,382 | 19,265 | 19,163 | 18,436 | 20,589 | 19,502 | 19,339 | 19,940 | 20,253 |
| | | | | | **Men** | | | | |
| Total science & engineering | 48,019 | 49,403 | 48,399 | 48,324 | 49,782 | 48,049 | 47,207 | 49,345 | 49,710 |
| Total sciences | 31,909 | 32,504 | 31,604 | 32,306 | 31,930 | 31,202 | 30,644 | 32,286 | 32,497 |
| Physical sciences | 4,747 | 5,144 | 5,025 | 5,099 | 5,280 | 5,145 | 4,812 | 5,039 | 5,011 |
| Mathematics | 2,582 | 2,458 | 2,622 | 2,732 | 2,777 | 2,623 | 2,637 | 2,773 | 2,821 |
| Computer sciences | 2,450 | 2,894 | 2,992 | 3,620 | 3,874 | 3,941 | 3,967 | 4,426 | 4,208 |
| Environmental sciences | 2,650 | 2,753 | 2,482 | 2,364 | 2,245 | 1,854 | 1,804 | 1,825 | 1,863 |
| Life sciences | 7,363 | 7,448 | 7,325 | 7,076 | 6,819 | 6,714 | 6,646 | 6,810 | 6,853 |
| Psychology | 2,961 | 3,001 | 2,849 | 2,899 | 2,700 | 2,858 | 2,747 | 2,965 | 2,791 |
| Social sciences | 9,156 | 8,806 | 8,309 | 8,516 | 8,235 | 8,067 | 8,031 | 8,448 | 8,950 |
| Total engineering | 16,110 | 16,899 | 16,795 | 16,018 | 17,852 | 16,847 | 16,563 | 17,059 | 17,213 |
| | | | | | **Women** | | | | |
| Total science & engineering | 22,332 | 23,002 | 22,430 | 23,447 | 23,836 | 23,459 | 24,277 | 26,161 | 27,224 |
| Total sciences | 20,060 | 20,636 | 20,062 | 21,029 | 21,099 | 20,804 | 21,501 | 23,280 | 24,184 |
| Physical sciences | 1,438 | 1,561 | 1,488 | 1,546 | 1,655 | 1,634 | 1,716 | 1,803 | 1,806 |
| Mathematics | 1,112 | 1,142 | 1,116 | 1,253 | 1,252 | 1,277 | 1,282 | 1,451 | 1,423 |
| Computer sciences | 880 | 1,004 | 1,064 | 1,154 | 1,159 | 1,194 | 1,262 | 1,281 | 1,188 |
| Environmental sciences | 998 | 1,022 | 905 | 911 | 846 | 755 | 799 | 847 | 844 |
| Life sciences | 5,177 | 5,252 | 5,203 | 5,229 | 5,353 | 5,323 | 5,365 | 5,606 | 5,917 |
| Psychology | 4,606 | 4,803 | 4,709 | 4,938 | 5,003 | 5,016 | 5,511 | 6,150 | 6,009 |
| Social sciences | 5,849 | 5,852 | 5,577 | 5,998 | 5,831 | 5,605 | 5,566 | 6,142 | 6,997 |
| Total engineering | 2,272 | 2,366 | 2,368 | 2,418 | 2,737 | 2,655 | 2,776 | 2,881 | 3,040 |

SOURCES: Science Resources Studies Division, National Science Foundation, *Selected Data on Graduate Students and Postdoctorates in Science and Engineering: Fall 1990*, NSF 91-320 (Washington, DC: NSF, 1991), unpublished tabulations; and annual series.

*Science & Engineering Indicators – 1991*

Appendix table 2-13.
**Part-time science and engineering graduate enrollment, by field and gender: 1982-90**

| | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | **Total** | | | | |
| Total science & engineering . . | 117,937 | 118,977 | 119,845 | 125,129 | 126,063 | 126,980 | 125,631 | 126,636 | 133,948 |
| Total sciences . . . . . . . . . . . . | 83,589 | 81,361 | 81,729 | 84,461 | 83,700 | 84,503 | 85,312 | 86,537 | 91,196 |
| Physical sciences . . . . . . . | 4,159 | 4,261 | 4,212 | 4,326 | 4,496 | 4,324 | 4,398 | 4,435 | 4,764 |
| Mathematics . . . . . . . . . . . | 6,376 | 6,433 | 6,159 | 5,780 | 5,592 | 5,524 | 5,618 | 5,677 | 6,014 |
| Computer sciences . . . . . . | 10,641 | 12,929 | 14,223 | 15,743 | 16,115 | 16,565 | 17,191 | 16,838 | 17,635 |
| Environmental sciences . . . | 3,738 | 3,495 | 3,793 | 4,106 | 3,840 | 3,979 | 3,736 | 3,710 | 3,864 |
| Life sciences . . . . . . . . . . | 11,744 | 11,397 | 11,003 | 11,459 | 11,138 | 10,684 | 10,558 | 10,745 | 11,458 |
| Psychology . . . . . . . . . . . | 14,270 | 14,338 | 14,966 | 15,539 | 15,030 | 15,391 | 15,909 | 16,132 | 17,667 |
| Social sciences . . . . . . . . . | 32,661 | 28,508 | 27,373 | 27,508 | 27,489 | 28,036 | 27,902 | 29,000 | 29,794 |
| Total engineering . . . . . . . . . . | 34,348 | 37,616 | 38,116 | 40,668 | 42,363 | 42,477 | 40,319 | 40,099 | 42,752 |
| | | | | | **Men** | | | | |
| Total science & engineering . . | 79,676 | 80,012 | 80,587 | 83,927 | 84,443 | 84,648 | 82,464 | 82,489 | 86,292 |
| Total sciences . . . . . . . . . . . . | 48,887 | 46,621 | 46,821 | 48,176 | 47,608 | 47,900 | 47,750 | 47,944 | 49,680 |
| Physical sciences . . . . . . . | 3,135 | 3,215 | 3,149 | 3,242 | 3,372 | 3,236 | 3,265 | 3,290 | 3,495 |
| Mathematics . . . . . . . . . . . | 4,080 | 4,140 | 3,963 | 3,612 | 3,503 | 3,453 | 3,540 | 3,590 | 3,819 |
| Computer sciences . . . . . . | 7,506 | 8,930 | 10,080 | 11,336 | 11,702 | 11,988 | 12,367 | 12,174 | 12,944 |
| Environmental sciences . . . | 2,785 | 2,555 | 2,765 | 2,997 | 2,793 | 2,882 | 2,658 | 2,576 | 2,649 |
| Life sciences . . . . . . . . . . | 6,564 | 6,196 | 6,004 | 6,141 | 5,886 | 5,711 | 5,383 | 5,431 | 5,774 |
| Psychology . . . . . . . . . . . | 5,696 | 5,282 | 5,460 | 5,422 | 5,127 | 5,260 | 5,328 | 5,237 | 5,206 |
| Social sciences . . . . . . . . . | 19,121 | 16,303 | 15,400 | 15,426 | 15,225 | 15,370 | 15,209 | 15,646 | 15,793 |
| Total engineering . . . . . . . . . . | 30,789 | 33,391 | 33,766 | 35,751 | 36,835 | 36,748 | 34,714 | 34,545 | 36,612 |
| | | | | | **Women** | | | | |
| Total science & engineering . . | 38,261 | 38,965 | 39,258 | 41,202 | 41,620 | 42,332 | 43,167 | 44,147 | 47,656 |
| Total sciences . . . . . . . . . . . . | 34,702 | 34,740 | 34,908 | 36,285 | 36,092 | 36,603 | 37,562 | 38,593 | 41,516 |
| Physical sciences . . . . . . . | 1,024 | 1,046 | 1,063 | 1,084 | 1,124 | 1,088 | 1,133 | 1,145 | 1,269 |
| Mathematics . . . . . . . . . . . | 2,296 | 2,293 | 2,196 | 2,168 | 2,089 | 2,071 | 2,078 | 2,087 | 2,195 |
| Computer sciences . . . . . . | 3,135 | 3,999 | 4,143 | 4,407 | 4,413 | 4,577 | 4,824 | 4,664 | 4,691 |
| Environmental sciences . . . | 953 | 940 | 1,028 | 1,109 | 1,047 | 1,097 | 1,078 | 1,134 | 1,215 |
| Life sciences . . . . . . . . . . | 5,180 | 5,201 | 4,999 | 5,318 | 5,252 | 4,973 | 5,175 | 5,314 | 5,684 |
| Psychology . . . . . . . . . . . | 8,574 | 9,056 | 9,506 | 10,117 | 9,903 | 10,131 | 10,581 | 10,895 | 12,461 |
| Social sciences . . . . . . . . . | 13,540 | 12,205 | 11,973 | 12,082 | 12,264 | 12,666 | 12,693 | 13,354 | 14,001 |
| Total engineering . . . . . . . . . . | 3,559 | 4,225 | 4,350 | 4,917 | 5,528 | 5,729 | 5,605 | 5,554 | 6,140 |

SOURCES: Science Resources Studies Division, National Science Foundation. *Selected Data on Graduate Students and Postdoctorates in Science and Engineering: Fall 1990.* NSF 91-320 (Washington, DC: NSF, 1991), unpublished tabulations; and annual series.

*Science & Engineering Indicators – 1991*

Appendix table 2-14.
**Masters degree conferrals, by field and gender: 1980-89**

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **Total** | | | | | |
| Total, all masters degrees | 299,095 | 296,798 | 296,580 | 290,931 | 285,462 | 287,210 | 289,823 | 290,532 | 300,091 | 311,050 |
| Total science and engineering | 54,391 | 54,811 | 57,025 | 58,868 | 59,569 | 61,278 | 62,526 | 63,018 | 63,897 | 66,026 |
| Total sciences | 37,545 | 37,438 | 38,431 | 39,147 | 39,217 | 40,072 | 41,212 | 40,737 | 41,006 | 42,098 |
| Physical sciences | 3,440 | 3,424 | 3,514 | 3,329 | 3,586 | 3,642 | 3,676 | 3,587 | 3,730 | 3,876 |
| Mathematics | 2,868 | 2,569 | 2,731 | 2,839 | 2,749 | 2,888 | 3,171 | 3,327 | 3,434 | 3,431 |
| Computer sciences | 3,647 | 4,218 | 4,935 | 5,321 | 6,190 | 7,101 | 8,070 | 8,481 | 9,166 | 9,399 |
| Environmental sciences | 1,793 | 1,876 | 2,012 | 1,959 | 1,982 | 2,160 | 2,234 | 2,051 | 1,920 | 1,819 |
| Life sciences | 10,278 | 9,731 | 9,824 | 9,720 | 9,330 | 8,757 | 8,572 | 8,831 | 8,559 | 8,430 |
| Psychology | 7,861 | 8,039 | 7,849 | 8,439 | 8,073 | 8,481 | 8,363 | 8,165 | 7,925 | 8,652 |
| Social sciences | 7,658 | 7,581 | 7,566 | 7,540 | 7,307 | 7,043 | 7,126 | 6,295 | 6,272 | 6,491 |
| Total engineering | 16,846 | 17,373 | 18,594 | 19,721 | 20,352 | 21,206 | 21,314 | 22,281 | 22,891 | 23,928 |
| | | | | | **Men** | | | | | |
| Total, all masters degrees | 151,159 | 147,431 | 145,941 | 145,114 | 143,998 | 143,717 | 143,932 | 141,655 | 145,403 | 149,399 |
| Total science and engineering | 40,008 | 39,797 | 41,049 | 41,787 | 41,894 | 42,979 | 43,344 | 43,480 | 44,416 | 45,262 |
| Total sciences | 24,352 | 23,830 | 24,139 | 23,942 | 23,701 | 24,101 | 24,501 | 24,040 | 24,379 | 24,466 |
| Physical sciences | 2,801 | 2,743 | 2,765 | 2,636 | 2,736 | 2,811 | 2,759 | 2,694 | 2,838 | 2,836 |
| Mathematics | 1,832 | 1,692 | 1,821 | 1,859 | 1,795 | 1,877 | 2,055 | 2,026 | 2,057 | 2,061 |
| Computer sciences | 2,883 | 3,247 | 3,625 | 3,813 | 4,379 | 5,064 | 5,658 | 5,985 | 6,702 | 6,773 |
| Environmental sciences | 1,457 | 1,470 | 1,560 | 1,515 | 1,517 | 1,639 | 1,717 | 1,531 | 1,433 | 1,337 |
| Life sciences | 6,952 | 6,451 | 6,315 | 6,111 | 5,728 | 5,265 | 5,022 | 5,180 | 5,011 | 4,849 |
| Psychology | 3,397 | 3,371 | 3,228 | 3,254 | 2,980 | 3,064 | 2,937 | 2,838 | 2,599 | 2,814 |
| Social sciences | 5,030 | 4,856 | 4,825 | 4,754 | 4,566 | 4,381 | 4,353 | 3,786 | 3,739 | 3,796 |
| Total engineering | 15,656 | 15,967 | 16,910 | 17,845 | 18,193 | 18,878 | 18,843 | 19,440 | 20,037 | 20,796 |
| | | | | | **Women** | | | | | |
| Total, all masters degrees | 147,936 | 149,367 | 150,639 | 145,817 | 141,464 | 143,493 | 145,891 | 148,877 | 154,688 | 161,651 |
| Total science and engineering | 14,383 | 15,014 | 15,976 | 17,081 | 17,675 | 18,299 | 19,182 | 19,538 | 19,481 | 20,764 |
| Total sciences | 13,193 | 13,608 | 14,292 | 15,205 | 15,516 | 15,971 | 16,711 | 16,697 | 16,627 | 17,632 |
| Physical sciences | 639 | 681 | 749 | 693 | 850 | 831 | 917 | 893 | 892 | 1,040 |
| Mathematics | 1,036 | 877 | 910 | 980 | 954 | 1,011 | 1,116 | 1,301 | 1,377 | 1,370 |
| Computer sciences | 764 | 971 | 1,310 | 1,508 | 1,811 | 2,037 | 2,412 | 2,496 | 2,464 | 2,626 |
| Environmental sciences | 336 | 406 | 452 | 444 | 465 | 521 | 517 | 520 | 487 | 482 |
| Life sciences | 3,326 | 3,280 | 3,509 | 3,609 | 3,602 | 3,492 | 3,550 | 3,651 | 3,548 | 3,581 |
| Psychology | 4,464 | 4,668 | 4,621 | 5,185 | 5,093 | 5,417 | 5,426 | 5,327 | 5,326 | 5,838 |
| Social sciences | 2,628 | 2,725 | 2,741 | 2,786 | 2,741 | 2,662 | 2,773 | 2,509 | 2,533 | 2,695 |
| Total engineering | 1,190 | 1,406 | 1,684 | 1,876 | 2,159 | 2,328 | 2,471 | 2,841 | 2,854 | 3,132 |

SOURCES: Science Resources Studies Division, National Science Foundation. *Selected Data on Graduate Students and Postdoctorates in Science and Engineering: Fall 1990*, NSF 91-320 (Washington, DC: NSF, 1991), unpublished tabulations; and annual series.

See figure 2-9.

Appendix table 2-15.
**Masters degree conferrals, by field and racial/ethnic group: 1977-89**
(page 1 of 2)

| Field[1] | 1977 | 1979 | 1981 | 1985 | 1987 | 1989 |
|---|---|---|---|---|---|---|
| | | | **Total, U.S. citizens and permanent residents** | | | |
| Total science & engineering | 55,054 | 50,201 | 48,711 | 50,994 | 50,720 | 51,872 |
| Total sciences | 42,359 | 38,784 | 36,909 | 36,094 | 34,773 | 35,510 |
| Physical sciences[2] | 4,689 | 4,713 | 4,457 | 4,563 | 4,271 | 4,232 |
| Mathematics | 3,328 | 2,571 | 2,103 | 2,146 | 2,331 | 2,309 |
| Computer sciences | 2,432 | 2,528 | 3,239 | 5,233 | 5,848 | 6,061 |
| Life sciences[3] | 9,748 | 9,697 | 8,954 | 7,624 | 6,963 | 6,561 |
| Psychology | 8,149 | 7,852 | 7,769 | 8,129 | 7,493 | 7,994 |
| Social sciences[4] | 14,013 | 11,423 | 10,387 | 8,399 | 7,867 | 8,353 |
| Total engineering[5] | 12.695 | 11,417 | 11,802 | 14,900 | 15,947 | 16,362 |
| | | | **White, non-Hispanic** | | | |
| Total science & engineering | 49,670 | 45,185 | 43,435 | 44,387 | 43,715 | 44,316 |
| Total sciences | 38,226 | 35,103 | 33,288 | 31,808 | 30,476 | 30,894 |
| Physical sciences[2] | 4,363 | 4,373 | 4,115 | 4,133 | 3,834 | 3,766 |
| Mathematics | 3,048 | 2,352 | 1,890 | 1,873 | 2,012 | 2,032 |
| Computer sciences | 2,208 | 2,273 | 2,818 | 4,303 | 4,717 | 4,786 |
| Life sciences[3] | 9,042 | 8,909 | 8,296 | 6,946 | 6,236 | 5,878 |
| Psychology | 7,201 | 7,078 | 7,019 | 7,220 | 6,698 | 7,075 |
| Social sciences[4] | 12,364 | 10,118 | 9,150 | 7,333 | 6,979 | 7,357 |
| Total engineering[5] | 11,444 | 10,082 | 10,147 | 12,579 | 13,239 | 13,422 |
| | | | **Black, non-Hispanic** | | | |
| Total science & engineering | 2,266 | 1,988 | 1,787 | 1,755 | 1,803 | 1,688 |
| Total sciences | 2,026 | 1,742 | 1,527 | 1,396 | 1,370 | 1,287 |
| Physical sciences[2] | 94 | 86 | 107 | 89 | 79 | 78 |
| Mathematics | 133 | 71 | 67 | 53 | 73 | 59 |
| Computer sciences | 67 | 65 | 70 | 180 | 207 | 198 |
| Life sciences[3] | 257 | 296 | 244 | 226 | 245 | 177 |
| Psychology | 506 | 476 | 424 | 426 | 376 | 395 |
| Social sciences[4] | 969 | 748 | 615 | 422 | 390 | 380 |
| Total engineering[5] | 240 | 246 | 260 | 359 | 433 | 401 |
| | | | **Asian** | | | |
| Total science & engineering | 1,693 | 1,895 | 2,132 | 3,276 | 3,475 | 4,100 |
| Total sciences | 956 | 1,045 | 1,053 | 1,703 | 1.783 | 2,073 |
| Physical sciences[2] | 142 | 160 | 153 | 213 | 227 | 278 |
| Mathematics | 90 | 104 | 97 | 164 | 183 | 178 |
| Computer sciences | 108 | 149 | 279 | 615 | 779 | 894 |
| Life sciences[3] | 246 | 309 | 212 | 254 | 247 | 276 |
| Psychology | 95 | 87 | 77 | 129 | 113 | 131 |
| Social sciences[4] | 275 | 236 | 235 | 328 | 234 | 316 |
| Total engineering[5] | 737 | 850 | 1,079 | 1,573 | 1,692 | 2,027 |

(continued)

Appendix table 2-15.
**Masters degree conferrals, by field and racial/ethnic group: 1977-89**
(page 2 of 2)

| Field[1] | 1977 | 1979 | 1981 | 1985 | 1987 | 1989 |
|---|---|---|---|---|---|---|
| | | | **Native American** | | | |
| Total science & engineering | 148 | 163 | 159 | 222 | 171 | 205 |
| Total sciences | 125 | 139 | 128 | 173 | 108 | 170 |
| Physical sciences[2] | 21 | 29 | 11 | 21 | 9 | 18 |
| Mathematics | 12 | 8 | 7 | 7 | 3 | 6 |
| Computer sciences | 3 | 16 | 12 | 41 | 22 | 39 |
| Life sciences[3] | 27 | 21 | 22 | 24 | 17 | 23 |
| Psychology | 26 | 20 | 32 | 37 | 35 | 33 |
| Social sciences[4] | 36 | 45 | 44 | 43 | 22 | 51 |
| Total engineering[5] | 2[illegible] | 24 | 31 | 49 | 63 | 35 |
| | | | **Hispanic** | | | |
| Total science & engineering | 1,277 | 970 | 1,198 | 1,354 | 1,556 | 1,563 |
| Total sciences | 1,026 | 755 | 913 | 1,014 | 1,036 | 1,086 |
| Physical sciences[2] | 69 | 65 | 71 | 107 | 122 | 92 |
| Mathematics | 45 | 36 | 42 | 49 | 60 | 34 |
| Computer sciences | 46 | 25 | 60 | 94 | 123 | 144 |
| Life sciences[3] | 176 | 162 | 180 | 174 | 218 | 207 |
| Psychology | 321 | 191 | 217 | 317 | 271 | 360 |
| Social sciences[4] | 369 | 276 | 343 | 273 | 242 | 249 |
| Total engineering[5] | 251 | 215 | 285 | 340 | 520 | 477 |

NOTES: Data by racial/ethnic group are collected on a biennial schedule; data are provided by institutions; imputations are done for some nonresponse. Racial/ethnic categories are designated on the survey form. These categories include U.S. citizens and foreign citizens on permanent visas. Data are not available by racial/ethnic group for foreign citizens on temporary visas.

[1]Data on racial/ethnic groups are collected by broad fields of study only; therefore, these data cannot be adjusted to the exact field taxonomies used by the National Science Foundation.

[2]Includes environmental sciences.

[3]Excludes health sciences.

[4]For 1977 to 1981, social sciences included Afro-American black cultural studies and American Indian studies.

[5]Includes engineering technology. Racial/ethnic data for engineering and engineering technology can only be separated for 1985 and 1987.

SOURCE: Science Resources Studies Division, National Science Foundation, unpublished tabulations from the Completion Survey conducted by the National Center for Education Statistics.

*Science & Engineering Indicators – 1991*

Appendix table 2-16.
**Doctorate conferrals, by field and gender: 1980-90**

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | | | | | | | | | | | |
| Total, all doctorates | 31,020 | 31,357 | 31,111 | 31,282 | 31,337 | 31,297 | 31,895 | 32,364 | 33,490 | 34,319 | 36,027 |
| Total science & engineering | 17,523 | 17,996 | 18,017 | 18,393 | 18,514 | 18,712 | 19,251 | 19,707 | 20,741 | 21,530 | 22,673 |
| Total sciences | 15,044 | 15,468 | 15,371 | 15,612 | 15,601 | 15,546 | 15,875 | 15,995 | 16,551 | 16,986 | 17,781 |
| Physical sciences | 2,521 | 2,627 | 2,694 | 2,802 | 2,845 | 2,916 | 3,090 | 3,212 | 3,317 | 3,244 | 3,494 |
| Mathematics | 744 | 728 | 720 | 701 | 698 | 688 | 729 | 740 | 749 | 859 | 892 |
| Computer sciences | 218 | 232 | 220 | 286 | 295 | 310 | 399 | 450 | 515 | 612 | 704 |
| Environmental sciences | 628 | 583 | 657 | 637 | 614 | 617 | 589 | 628 | 728 | 740 | 769 |
| Life sciences | 4,715 | 4,786 | 4,844 | 4,756 | 4,877 | 4,904 | 4,805 | 4,816 | 5,127 | 5,203 | 5,509 |
| Psychology | 3,098 | 3,358 | 3,159 | 3,347 | 3,257 | 3,117 | 3,124 | 3,169 | 3,064 | 3,203 | 3,267 |
| Social sciences | 3,120 | 3,154 | 3,077 | 3,083 | 3,015 | 2,994 | 3,139 | 2,980 | 3,051 | 3,125 | 3,146 |
| Total engineering | 2,479 | 2,528 | 2,646 | 2,781 | 2,913 | 3,166 | 3,376 | 3,712 | 4,190 | 4,544 | 4,892 |
| **Men** | | | | | | | | | | | |
| Total, all doctorates | 21,612 | 21,465 | 21,018 | 20,749 | 20,638 | 20,553 | 20,591 | 20,938 | 21,679 | 21,811 | 22,966 |
| Total science & engineering | 13,639 | 13,880 | 13,747 | 13,769 | 13,810 | 13,900 | 14,167 | 14,472 | 15,164 | 15,522 | 16,399 |
| Total sciences | 11,250 | 11,451 | 11,225 | 11,112 | 11,048 | 10,932 | 11,016 | 11,002 | 11,260 | 11,353 | 11,921 |
| Physical sciences | 2,199 | 2,318 | 2,337 | 2,431 | 2,446 | 2,452 | 2,585 | 2,686 | 2,760 | 2,627 | 2,843 |
| Mathematics | 649 | 616 | 624 | 588 | 583 | 582 | 608 | 615 | 628 | 704 | 734 |
| Computer sciences | 197 | 206 | 200 | 250 | 258 | 277 | 351 | 385 | 459 | 504 | 594 |
| Environmental sciences | 564 | 527 | 554 | 540 | 508 | 506 | 489 | 514 | 583 | 590 | 620 |
| Life sciences | 3,565 | 3,565 | 3,552 | 3,390 | 3,529 | 3,495 | 3,353 | 3,284 | 3,436 | 3,433 | 3,657 |
| Psychology | 1,787 | 1,885 | 1,721 | 1,750 | 1,626 | 1,576 | 1,526 | 1,474 | 1,388 | 1,406 | 1,361 |
| Social sciences | 2,289 | 2,334 | 2,237 | 2,163 | 2,098 | 2,044 | 2,104 | 2,044 | 2,006 | 2,089 | 2,112 |
| Total engineering | 2,389 | 2,429 | 2,522 | 2,657 | 2,762 | 2,968 | 3,151 | 3,470 | 3,904 | 4,169 | 4,478 |
| **Women** | | | | | | | | | | | |
| Total, all doctorates | 9,408 | 9,892 | 10,093 | 10,533 | 10,699 | 10,744 | 11,304 | 11,426 | 11,811 | 12,508 | 13,061 |
| Total science & engineering | 3,884 | 4,116 | 4,270 | 4,624 | 4,704 | 4,812 | 5,084 | 5,235 | 5,577 | 6,008 | 6,274 |
| Total sciences | 3,794 | 4,017 | 4,146 | 4,500 | 4,553 | 4,614 | 4,859 | 4,993 | 5,291 | 5,633 | 5,860 |
| Physical sciences | 322 | 309 | 357 | 371 | 399 | 464 | 505 | 526 | 557 | 617 | 651 |
| Mathematics | 95 | 112 | 96 | 113 | 115 | 106 | 121 | 125 | 121 | 155 | 158 |
| Computer sciences | 21 | 26 | 20 | 36 | 37 | 33 | 48 | 65 | 56 | 108 | 110 |
| Environmental sciences | 64 | 56 | 103 | 97 | 106 | 111 | 100 | 114 | 145 | 150 | 149 |
| Life sciences | 1,150 | 1,221 | 1,292 | 1,366 | 1,348 | 1,409 | 1,452 | 1,532 | 1,691 | 1,770 | 1,852 |
| Psychology | 1,311 | 1,473 | 1,438 | 1,597 | 1,631 | 1,541 | 1,598 | 1,695 | 1,676 | 1,797 | 1,906 |
| Social sciences | 831 | 820 | 840 | 920 | 917 | 950 | 1,035 | 936 | 1,045 | 1,036 | 1,034 |
| Total engineering | 90 | 99 | 124 | 124 | 151 | 198 | 225 | 242 | 286 | 375 | 414 |

SOURCE: Science Resources Studies Division, National Science Foundation, *Selected Data on Science and Engineering Doctorate Awards: 1990*, NSF 91-310 (Washington, DC.: NSF, 1991).

See figure 2-9.

*Science & Engineering Indicators – 1991*

Appendix table 2-17.
**Doctorate conferrals, by field and racial/ethnic group: 1980-90**
(page 1 of 2)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL, ALL DOCTORATES | 26,512 | 26,342 | 25,619 | 25,634 | 25,251 | 24,694 | 24,513 | 24,561 | 24,911 | 25,024 | 25,844 |
| White | 22,462 | 22,470 | 22,143 | 22,245 | 21,864 | 21,297 | 21,224 | 21,116 | 21,455 | 21,568 | 22,345 |
| Black | 1,105 | 1,110 | 1,143 | 1,005 | 1,055 | 1,043 | 949 | 907 | 966 | 962 | 972 |
| Asian | 1,102 | 1,073 | 1,004 | 1,043 | 1,019 | 1,069 | 1,058 | 1,167 | 1,236 | 1,260 | 1,260 |
| Native American | 75 | 85 | 77 | 82 | 74 | 96 | 99 | 115 | 94 | 94 | 93 |
| Hispanic | 485 | 526 | 614 | 608 | 607 | 634 | 678 | 709 | 696 | 694 | 813 |
| TOTAL SCIENCE AND ENGINEERING | 14,362 | 14,437 | 14,146 | 14,301 | 14,085 | 13,876 | 13,856 | 13,906 | 14,346 | 14,432 | 14,776 |
| White | 12,146 | 12,388 | 12,330 | 12,478 | 12,246 | 12,004 | 12,014 | 11,921 | 12,326 | 12,364 | 12,727 |
| Black | 319 | 332 | 336 | 322 | 357 | 357 | 318 | 308 | 346 | 352 | 340 |
| Asian | 866 | 821 | 765 | 778 | 774 | 808 | 807 | 921 | 913 | 979 | 968 |
| Native American | 27 | 26 | 38 | 28 | 31 | 41 | 52 | 52 | 41 | 52 | 40 |
| Hispanic | 213 | 238 | 269 | 282 | 295 | 290 | 342 | 354 | 394 | 379 | 451 |
| **Total sciences** | 12,808 | 12,966 | 12,681 | 12,819 | 12,572 | 12,282 | 12,130 | 11,993 | 12,198 | 12,203 | 12,473 |
| White | 11,003 | 11,295 | 11,230 | 11,350 | 11,089 | 10,816 | 10,660 | 10,463 | 10,672 | 10,638 | 10,909 |
| Black | 301 | 313 | 316 | 293 | 342 | 323 | 294 | 283 | 315 | 319 | 300 |
| Asian | 588 | 536 | 519 | 531 | 524 | 527 | 545 | 594 | 580 | 619 | 623 |
| Native American | 24 | 22 | 35 | 27 | 28 | 40 | 46 | 45 | 37 | 45 | 36 |
| Hispanic | 186 | 222 | 233 | 253 | 261 | 268 | 307 | 320 | 331 | 331 | 398 |
| Physical sciences | 2,035 | 2,103 | 2,110 | 2,184 | 2,190 | 2,178 | 2,147 | 2,227 | 2,236 | 2,119 | 2,244 |
| White | 1,661 | 1,757 | 1,859 | 1,917 | 1,888 | 1,900 | 1,858 | 1,942 | 1,927 | 1,817 | 1,929 |
| Black | 16 | 24 | 26 | 25 | 34 | 27 | 25 | 20 | 33 | 31 | 27 |
| Asian | 164 | 149 | 131 | 136 | 144 | 150 | 146 | 143 | 137 | 155 | 161 |
| Native American | 3 | 1 | 3 | 6 | 4 | 3 | 5 | 7 | 6 | 10 | 3 |
| Hispanic | 27 | 30 | 25 | 26 | 47 | 30 | 40 | 56 | 63 | 59 | 70 |
| Mathematics | 582 | 525 | 499 | 457 | 443 | 418 | 402 | 396 | 386 | 428 | 416 |
| White | 496 | 448 | 437 | 395 | 380 | 350 | 343 | 319 | 332 | 369 | 367 |
| Black | 12 | 9 | 6 | 3 | 4 | 7 | 6 | 11 | 4 | 8 | 4 |
| Asian | 42 | 40 | 32 | 34 | 30 | 33 | 28 | 41 | 33 | 24 | 25 |
| Native American | 0 | 1 | 1 | 0 | 3 | 0 | 1 | 0 | 2 | 0 | 1 |
| Hispanic | 5 | 5 | 6 | 7 | 11 | 12 | 12 | 11 | 4 | 11 | 10 |
| Computer sciences | 169 | 188 | 155 | 207 | 195 | 213 | 249 | 275 | 326 | 396 | 396 |
| White | 143 | 162 | 136 | 174 | 163 | 177 | 193 | 229 | 265 | 319 | 334 |
| Black | 0 | 2 | 1 | 3 | 3 | 3 | 1 | 2 | 2 | 1 | 1 |
| Asian | 9 | 16 | 12 | 20 | 20 | 17 | 37 | 26 | 44 | 52 | 46 |
| Native American | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 3 | 1 | 2 | 0 |
| Hispanic | 1 | 0 | 1 | 0 | 3 | 6 | 7 | 4 | 2 | 4 | 5 |
| Environmental sciences | 538 | 488 | 557 | 513 | 499 | 474 | 446 | 450 | 542 | 559 | 544 |
| White | 485 | 448 | 510 | 453 | 461 | 430 | 413 | 408 | 500 | 509 | 502 |
| Black | 1 | 4 | 3 | 1 | 3 | 4 | 1 | 2 | 3 | 4 | 2 |
| Asian | 22 | 14 | 27 | 26 | 19 | 21 | 14 | 18 | 15 | 23 | 17 |
| Native American | 2 | 0 | 0 | 2 | 0 | 1 | 2 | 0 | 2 | 6 | 1 |
| Hispanic | 4 | 6 | 7 | 11 | 2 | 6 | 5 | 5 | 8 | 9 | 13 |
| Life sciences | 4,035 | 4,050 | 4,104 | 4,009 | 4,059 | 3,982 | 3,868 | 3,774 | 3,933 | 3,951 | 3,967 |
| White | 3,511 | 3,566 | 3,678 | 3,608 | 3,646 | 3,572 | 3,445 | 3,313 | 3,484 | 3,475 | 3,505 |
| Black | 58 | 61 | 56 | 58 | 68 | 69 | 64 | 73 | 68 | 70 | 56 |
| Asian | 198 | 181 | 182 | 197 | 178 | 175 | 189 | 208 | 201 | 222 | 223 |
| Native American | 6 | 7 | 10 | 5 | 11 | 17 | 17 | 13 | 12 | 9 | 7 |
| Hispanic | 36 | 56 | 54 | 49 | 52 | 71 | 83 | 77 | 97 | 90 | 111 |

(continued)

Appendix table 2-17.
**Doctorate conferrals, by field and racial/ethnic group: 1980-90**
(page 2 of 2)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Psychology | 2,909 | 3,158 | 2,923 | 3,108 | 2,986 | 2,864 | 2,831 | 2,806 | 2,728 | 2,738 | 2,859 |
| White | 2,562 | 2,849 | 2,638 | 2,783 | 2,683 | 2,590 | 2,547 | 2,516 | 2,445 | 2,453 | 2,551 |
| Black | 119 | 113 | 115 | 112 | 121 | 105 | 109 | 93 | 103 | 97 | 110 |
| Asian | 50 | 41 | 31 | 44 | 43 | 44 | 41 | 47 | 47 | 55 | 51 |
| Native American | 6 | 9 | 16 | 9 | 6 | 10 | 9 | 16 | 7 | 11 | 18 |
| Hispanic | 54 | 66 | 74 | 94 | 84 | 69 | 89 | 95 | 93 | 93 | 103 |
| Social sciences | 2,540 | 2,454 | 2,333 | 2,341 | 2,200 | 2,153 | 2,187 | 2,065 | 2,047 | 2,012 | 2,047 |
| White | 2,145 | 2,065 | 1,972 | 2,020 | 1,868 | 1,797 | 1,861 | 1,736 | 1,719 | 1,696 | 1,721 |
| Black | 95 | 100 | 109 | 91 | 109 | 108 | 88 | 82 | 102 | 108 | 100 |
| Asian | 103 | 95 | 104 | 74 | 90 | 87 | 90 | 111 | 103 | 88 | 100 |
| Native American | 7 | 4 | 4 | 4 | 4 | 9 | 12 | 6 | 7 | 7 | 6 |
| Hispanic | 59 | 59 | 66 | 66 | 62 | 74 | 71 | 72 | 64 | 65 | 86 |
| **Total engineering** | 1,554 | 1,471 | 1,465 | 1,482 | 1,513 | 1,594 | 1,726 | 1,913 | 2,148 | 2,229 | 2,303 |
| White | 1,143 | 1,093 | 1,100 | 1,128 | 1,157 | 1,188 | 1,354 | 1,458 | 1,654 | 1,726 | 1,818 |
| Black | 18 | 19 | 20 | 29 | 15 | 34 | 24 | 25 | 31 | 33 | 40 |
| Asian | 278 | 285 | 246 | 247 | 250 | 281 | 262 | 327 | 333 | 360 | 345 |
| Native American | 3 | 4 | 3 | 1 | 3 | 1 | 6 | 7 | 4 | 7 | 4 |
| Hispanic | 27 | 16 | 36 | 29 | 34 | 22 | 35 | 34 | 63 | 48 | 53 |

NOTE: Data are for U.S. citizens and permanent residents only.

SOURCE: Science Resources Studies Division, National Science Foundation, *Selected Data on Science and Engineering Doctorate Awards: 1990*. NSF 91-310 (Washington, DC.: NSF, 1991).

*Science & Engineering Indicators – 1991*

Appendix table 2-18.
**Time to degree from U.S. baccalaureate to science and engineering doctorate: 1974-89**

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chemistry Ph.D.s | 1,451 | 1,438 | 1,307 | 1,266 | 1,219 | 1,280 | 1,192 | 1,282 | 1,337 | 1,408 | 1,372 | 1,399 | 1,378 | 1,430 | 1,455 | 1,377 |
| Total time to degree | 7.12 | 7.12 | 7.20 | 7.13 | 7.22 | 6.92 | 6.94 | 6.94 | 6.92 | 7.28 | 7.24 | 7.21 | 7.46 | 7.39 | 7.41 | 7.42 |
| Enrolled time to degree | 5.98 | 5.94 | 6.06 | 6.03 | 6.06 | 5.91 | 5.97 | 5.98 | 6.00 | 6.18 | 6.23 | 6.33 | 6.27 | 6.22 | 6.27 | 6.32 |
| Physics and astronomy Ph.D.s | 999 | 970 | 946 | 872 | 825 | 848 | 757 | 743 | 728 | 749 | 770 | 734 | 745 | 768 | 806 | 751 |
| Total time to degree | 8.16 | 8.20 | 8.19 | 8.42 | 8.31 | 7.93 | 8.32 | 8.04 | 8.33 | 8.23 | 8.18 | 8.35 | 8.52 | 8.44 | 8.31 | 8.40 |
| Enrolled time to degree | 6.93 | 7.03 | 7.01 | 7.11 | 7.17 | 6.93 | 7.16 | 7.08 | 7.28 | 7.23 | 7.16 | 7.28 | 7.20 | 7.25 | 7.24 | 7.24 |
| Math/computer science Ph.D.s | 897 | 865 | 766 | 742 | 722 | 734 | 690 | 663 | 623 | 622 | 587 | 576 | 588 | 621 | 653 | 752 |
| Total time to degree | 8.33 | 8.03 | 8.27 | 8.15 | 8.57 | 8.51 | 8.49 | 8.50 | 8.47 | 9.29 | 9.30 | 9.51 | 9.42 | 9.84 | 10.40 | 10.51 |
| Enrolled time to degree | 6.57 | 6.45 | 6.51 | 6.69 | 6.75 | 6.86 | 6.85 | 7.01 | 7.03 | 7.42 | 7.14 | 7.41 | 7.34 | 7.49 | 7.56 | 7.54 |
| Environmental science Ph.D.s | 473 | 496 | 512 | 567 | 521 | 540 | 522 | 472 | 525 | 485 | 483 | 443 | 417 | 426 | 507 | 534 |
| Total time to degree | 9.52 | 9.58 | 8.84 | 9.39 | 8.97 | 8.86 | 9.48 | 9.64 | 9.59 | 9.77 | 9.96 | 9.91 | 10.27 | 10.66 | 10.68 | 10.63 |
| Enrolled time to degree | 6.80 | 6.82 | 6.64 | 7.00 | 6.89 | 6.97 | 7.11 | 7.29 | 7.24 | 7.64 | 7.78 | 7.66 | 7.85 | 7.87 | 8.08 | 7.94 |
| Life science Ph.D.s | 3,350 | 3,568 | 3,594 | 3,531 | 3,614 | 3,768 | 3,949 | 4,011 | 4,090 | 3,928 | 4,003 | 3,919 | 3,808 | 3,683 | 3,869 | 3,847 |
| Total time to degree | 8.31 | 8.29 | 8.40 | 8.33 | 8.29 | 8.33 | 8.28 | 8.34 | 8.54 | 8.81 | 9.06 | 9.14 | 9.37 | 9.48 | 9.62 | 9.90 |
| Enrolled time to degree | 6.39 | 6.44 | 6.47 | 6.45 | 6.51 | 6.51 | 6.62 | 6.72 | 6.87 | 6.89 | 7.11 | 7.12 | 7.16 | 7.31 | 7.38 | 7.44 |
| Psychology Ph.D.s | 2,406 | 2,589 | 2,732 | 2,773 | 2,842 | 2,873 | 2,875 | 3,133 | 2,904 | 3,074 | 2,946 | 2,872 | 2,789 | 2,798 | 2,781 | 2,638 |
| Total time to degree | 8.82 | 8.86 | 8.78 | 9.03 | 9.17 | 9.49 | 9.72 | 10.11 | 10.45 | 10.62 | 11.03 | 11.24 | 11.42 | 11.72 | 12.01 | 12.17 |
| Enrolled time to degree | 6.44 | 6.48 | 6.54 | 6.62 | 6.78 | 6.96 | 7.12 | 7.24 | 7.47 | 7.58 | 7.86 | 7.93 | 7.96 | 8.10 | 8.25 | 8.44 |
| Economics Ph.D.s | 739 | 769 | 731 | 694 | 669 | 649 | 628 | 674 | 587 | 616 | 555 | 577 | 593 | 520 | 540 | 546 |
| Total time to degree | 8.78 | 8.93 | 9.22 | 9.01 | 9.31 | 9.37 | 9.44 | 9.22 | 9.38 | 9.69 | 9.72 | 10.04 | 9.95 | 10.04 | 10.01 | 10.30 |
| Enrolled time to degree | 6.40 | 6.52 | 6.47 | 6.72 | 6.66 | 6.82 | 6.88 | 7.00 | 7.08 | 7.16 | 7.35 | 7.61 | 7.37 | 7.64 | 7.56 | 7.55 |
| Political science Ph.D.s | 770 | 749 | 670 | 604 | 603 | 511 | 482 | 445 | 439 | 448 | 441 | 431 | 420 | 403 | 395 | 413 |
| Total time to degree | 10.65 | 11.14 | 10.21 | 10.83 | 10.77 | 11.06 | 10.84 | 11.15 | 11.93 | 12.07 | 11.71 | 12.51 | 12.97 | 12.86 | 13.10 | 12.34 |
| Enrolled time to degree | 6.96 | 7.22 | 7.31 | 7.65 | 7.55 | 7.80 | 7.78 | 7.89 | 8.26 | 8.34 | 8.23 | 8.84 | 9.04 | 8.64 | 8.92 | 8.83 |
| Other social science Ph.D.s | 1,309 | 1,374 | 1,418 | 1,362 | 1,278 | 1,231 | 1,231 | 1,203 | 1,152 | 1,135 | 1,061 | 1,024 | 1,028 | 965 | 955 | 864 |
| Total time to degree | 10.43 | 10.28 | 10.64 | 10.69 | 10.85 | 11.30 | 11.22 | 11.40 | 11.72 | 12.18 | 12.59 | 13.09 | 13.27 | 13.55 | 14.05 | 14.10 |
| Enrolled time to degree | 7.22 | 7.05 | 7.32 | 7.61 | 7.63 | 8.09 | 7.99 | 8.27 | 8.52 | 8.81 | 9.06 | 9.30 | 9.32 | 9.54 | 9.80 | 9.73 |

SOURCE: Policy Research and Analysis Division, National Science Foundation, unpublished tabulations from Survey of Earned Doctorates.

See figure 2-10

Appendix table 2-19.
**Ratio of doctorates to bachelors awards, lagged by time to degree**

| | Year of doctorate | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
| | Percent | | | | | | | | | | | | | | |
| Chemistry | 13.7 | 11.5 | 11.1 | 11.0 | 12.2 | 11.9 | 12.4 | 12.7 | 13.1 | 12.4 | 12.5 | 12.1 | 12.6 | 12.9 | 12.3 |
| Physics and astronomy | 16.5 | 15.4 | 13.3 | 12.5 | 12.7 | 12.1 | 12.1 | 12.2 | 13.8 | 14.4 | 13.3 | 13.3 | 13.7 | 13.7 | 12.7 |
| Math and computer sciences | 4.8 | 3.9 | 3.2 | 3.0 | 3.1 | 3.0 | 2.9 | 2.8 | 2.8 | 2.9 | 3.1 | 3.3 | 3.6 | 3.9 | 4.5 |
| Environmental sciences | NA | NA | NA | NA | 18.3 | 17.3 | 14.5 | 14.4 | 12.4 | 11.5 | 10.4 | 9.6 | 9.3 | 10.1 | 10.1 |
| Life sciences | 11.5 | 10.7 | 9.4 | 8.7 | 8.6 | 8.7 | 8.1 | 7.5 | 6.6 | 6.4 | 5.9 | 5.7 | 5.5 | 5.9 | 6.0 |
| Psychology | [illegible] | 17.6 | 15.4 | 13.1 | 12.0 | 10.8 | 11.0 | 9.3 | 9.0 | 8.1 | 7.4 | 7.1 | 7.2 | 7.3 | 7.2 |
| Economics | [illegible] | 6.0 | 4.7 | 4.2 | 3.9 | 3.9 | 4.5 | 4.0 | 4.3 | 4.0 | [illegible] | 4.1 | 3.4 | 3.4 | 3.4 |
| Political science | NA | NA | 4.5 | 3.8 | 2.9 | 2.3 | 2.0 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.6 | 1.6 | 1.8 |
| Other social sciences[1] | NA | NA | 9.5 | 7.8 | 6.7 | 5.4 | 4.6 | 4.0 | 3.7 | 3.3 | 3.1 | 3.1 | 2.9 | 2.8 | 2.8 |
| Engineering | 5.0 | 4.6 | 4.3 | 3.4 | 3.2 | 3.1 | 2.8 | 2.8 | 3.0 | 3.5 | 3.7 | 3.8 | 3.6 | 3.8 | 3.5 |

NA = data not available

NOTE: See appendix table 2-18 for average time to degree by field.

[1] Other social sciences includes anthropology, sociology, history of science, linguistics, and other social science fields.

SOURCES: Policy Research and Analysis Division, National Science Foundation, unpublished tabulations from Survey of Earned Doctorate and from Completion Survey.

See figure 2-11

*Science & Engineering Indicators – 1991*

281

282

Appendix table 2-20.
**Full-time science and engineering graduate students, by field and source of support: 1980-90**
(page 1 of 2)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL SCIENCE AND ENGINEERING | 215,354 | 219,088 | 222,770 | 230,570 | 232,182 | 235,593 | 244,424 | 248,652 | 252,643 | 259,411 | 267,621 |
| Federal | 44,590 | 43,098 | 41,139 | 42,138 | 42,018 | 42,945 | 45,387 | 47,202 | 49,279 | 51,203 | 52,875 |
| National Science Foundation | 9,278 | 9,149 | 9,253 | 9,494 | 9,812 | 10,142 | 10,793 | 11,200 | 11,587 | 11,861 | 11,961 |
| National Institutes of Health | 10,614 | 10,132 | 9,583 | 9,673 | 9,972 | 10,083 | 10,770 | 11,491 | 12,377 | 12,993 | 13,416 |
| Other Health & Human Svcs | 2,148 | 1,802 | 1,412 | 1,114 | 947 | 1,164 | 1,106 | 1,157 | 999 | 1,179 | 1,250 |
| Department of Defense | 5,086 | 5,485 | 5,749 | 6,751 | 6,873 | 7,052 | 7,713 | 8,563 | 9,276 | 8,760 | 8,357 |
| Other Federal | 17,464 | 16,530 | 15,142 | 15,106 | 14,414 | 14,504 | 15,005 | 14,791 | 15,040 | 16,410 | 17,891 |
| Non-Federal | 104,440 | 109,282 | 113,486 | 116,847 | 120,409 | 123,923 | 129,066 | 130,819 | 133,663 | 137,465 | 141,158 |
| Self-support | 66,324 | 66,708 | 68,145 | 71,585 | 69,755 | 68,725 | 69,971 | 70,631 | 69,701 | 70,743 | 73,588 |
| **Total sciences** | 172,247 | 172,831 | 172,537 | 176,249 | 176,654 | 179,310 | 183,716 | 186,485 | 189,243 | 194,695 | 201,074 |
| Federal | 33,399 | 32,124 | 30,044 | 30,153 | 30,428 | 31,678 | 33,008 | 34,082 | 35,259 | 36,858 | 37,968 |
| National Science Foundation | 6,867 | 6,781 | 6,680 | 6,813 | 7,115 | 7,455 | 7,663 | 7,720 | 7,779 | 8,085 | 8,089 |
| National Institutes of Health | 10,106 | 9,686 | 9,180 | 9,196 | 9,506 | 9,628 | 10,321 | 10,976 | 11,822 | 12,349 | 12,742 |
| Other Health & Human Svcs | 1,991 | 1,699 | 1,310 | 1,016 | 869 | 1,095 | 1,019 | 1,043 | 926 | 1,094 | 1,128 |
| Department of Defense | 2,228 | 2,325 | 2,294 | 2,737 | 3,065 | 3,278 | 3,598 | 3,978 | 4,306 | 3,952 | 3,741 |
| Other Federal | 12,207 | 11,633 | 10,580 | 10,391 | 9,873 | 10,222 | 10,407 | 10,365 | 10,426 | 11,378 | 12,268 |
| Non-Federal | 85,278 | 87,764 | 90,066 | 92,181 | 94,150 | 95,717 | 98,421 | 99,614 | 101,951 | 104,600 | 107,416 |
| Self-support | 53,570 | 52,943 | 52,427 | 53,915 | 52,076 | 51,915 | 52,287 | 52,789 | 52,033 | 53,237 | 55,690 |
| Physical sciences | 22,918 | 23,308 | 24,040 | 25,205 | 25,852 | 26,669 | 27,764 | 28,414 | 28,574 | 29,193 | 29,573 |
| Federal | 7,707 | 7,956 | 7,713 | 8,126 | 8,640 | 8,821 | 9,523 | 9,717 | 9,857 | 10,247 | 10,333 |
| National Science Foundation | 2,887 | 3,036 | 3,114 | 3,218 | 3,406 | 3,516 | 3,671 | 3,590 | 3,656 | 3,612 | 3,576 |
| National Institutes of Health | 1,556 | 1,432 | 1,435 | 1,437 | 1,506 | 1,635 | 1,847 | 1,930 | 2,002 | 1,981 | 1,972 |
| Other Health & Human Svcs | 94 | 107 | 83 | 98 | 122 | 161 | 165 | 167 | 150 | 130 | 144 |
| Department of Defense | 661 | 753 | 707 | 831 | 1,011 | 1,024 | 1,161 | 1,292 | 1,475 | 1,392 | 1,216 |
| Other Federal | 2,509 | 2,628 | 2,374 | 2,542 | 2,595 | 2,485 | 2,679 | 2,738 | 2,574 | 3,132 | 3,425 |
| Non-Federal | 13,688 | 13,803 | 14,786 | 15,306 | 15,531 | 16,053 | 16,348 | 16,694 | 16,840 | 17,157 | 17,248 |
| Self-support | 1,523 | 1,549 | 1,541 | 1,773 | 1,681 | 1,795 | 1,893 | 2,003 | 1,877 | 1,789 | 1,992 |
| Mathematics | 9,902 | 10,154 | 10,823 | 10,964 | 11,319 | 11,833 | 12,398 | 13,049 | 13,523 | 13,705 | 13,870 |
| Federal | 868 | 796 | 818 | 760 | 762 | 935 | 999 | 1,090 | 1,190 | 1,211 | 1,346 |
| National Science Foundation | 262 | 227 | 228 | 223 | 279 | 321 | 357 | 436 | 463 | 475 | 500 |
| National Institutes of Health | 34 | 24 | 25 | 28 | 22 | 18 | 19 | 24 | 25 | 28 | 39 |
| Other Health & Human Svcs | 24 | 11 | 14 | 13 | 4 | 3 | 5 | 6 | 3 | 8 | 10 |
| Department of Defense | 329 | 343 | 374 | 310 | 304 | 386 | 432 | 438 | 513 | 395 | 367 |
| Other Federal | 219 | 191 | 177 | 186 | 153 | 207 | 186 | 186 | 186 | 305 | 430 |
| Non-Federal | 7,137 | 7,262 | 7,703 | 8,004 | 8,399 | 8,660 | 9,083 | 9,384 | 9,753 | 9,994 | 10,042 |
| Self-support | 1,897 | 2,096 | 2,302 | 2,200 | 2,158 | 2,238 | 2,316 | 2,575 | 2,580 | 2,500 | 2,482 |
| Computer sciences | 6,587 | 7,445 | 9,171 | 10,687 | 11,587 | 14,101 | 15,310 | 15,572 | 15,596 | 16,008 | 16,872 |
| Federal | 953 | 1,008 | 1,075 | 1,130 | 1,269 | 1,638 | 1,892 | 2,084 | 2,226 | 2,361 | 2,444 |
| National Science Foundation | 333 | 379 | 389 | 386 | 431 | 502 | 527 | 623 | 634 | 779 | 819 |
| National Institutes of Health | 66 | 48 | 42 | 26 | 24 | 20 | 43 | 61 | 64 | 53 | 62 |
| Other Health & Human Svcs | 6 | 2 | 5 | 3 | 1 | 1 | 2 | 1 | 0 | 7 | 9 |
| Department of Defense | 298 | 394 | 387 | 475 | 630 | 860 | 1,037 | 1,137 | 1,214 | 1,164 | 1,129 |
| Other Federal | 250 | 185 | 252 | 240 | 183 | 255 | 283 | 262 | 314 | 358 | 425 |
| Non-Federal | 2,696 | 3,050 | 3,523 | 4,050 | 4,509 | 5,686 | 6,127 | 6,283 | 6,462 | 6,602 | 6,893 |
| Self-support | 2,938 | 3,387 | 4,573 | 5,507 | 5,809 | 6,777 | 7,291 | 7,205 | 6,908 | 7,045 | 7,535 |
| Environmental sciences | 10,969 | 11,038 | 11,436 | 12,049 | 11,819 | 11,439 | 11,323 | 10,543 | 10,296 | 10,138 | 10,295 |
| Federal | 3,442 | 3,010 | 2,854 | 2,874 | 2,848 | 2,960 | 3,033 | 2,868 | 2,799 | 2,863 | 2,939 |
| National Science Foundation | 1,256 | 1,206 | 1,192 | 1,325 | 1,341 | 1,374 | 1,357 | 1,261 | 1,236 | 1,253 | 1,191 |
| National Institutes of Health | 34 | 20 | 42 | 15 | 30 | 26 | 25 | 24 | 19 | 17 | 21 |
| Other Health & Human Svcs | 87 | 79 | 35 | 23 | 11 | 15 | 14 | 34 | 32 | 8 | 13 |
| Department of Defense | 296 | 310 | 300 | 365 | 372 | 418 | 453 | 499 | 461 | 435 | 409 |
| Other Federal | 1,769 | 1,395 | 1,285 | 1,146 | 1,094 | 1,127 | 1,184 | 1,050 | 1,051 | 1,150 | 1,305 |
| Non-Federal | 4,912 | 5,231 | 5,474 | 5,554 | 5,640 | 5,561 | 5,566 | 5,232 | 5,379 | 5,357 | 5,251 |
| Self-support | 2,615 | 2,797 | 3,108 | 3,621 | 3,331 | 2,918 | 2,724 | 2,443 | 2,118 | 1,918 | 2,105 |

(continued)

Appendix table 2-20.

**Full-time science and engineering graduate students, by field and source of support: 1980-90**

(page 2 of 2)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Life sciences | 47,908 | 47,658 | 46,880 | 46,948 | 47,230 | 46,459 | 47,407 | 47,772 | 48,758 | 49,910 | 50,646 |
| Federal | 12,743 | 12,489 | 11,941 | 11,914 | 11,890 | 12,324 | 12,867 | 13,658 | 14,337 | 15,162 | 15,533 |
| National Science Foundation | 1,296 | 1,226 | 1,203 | 1,132 | 1,151 | 1,171 | 1,155 | 1,200 | 1,175 | 1,306 | 1,282 |
| National Institutes of Health | 7,023 | 6,931 | 6,713 | 6,878 | 7,066 | 7,110 | 7,596 | 8,098 | 8,742 | 9,349 | 9,639 |
| Other Health & Human Svcs | 423 | 401 | 329 | 316 | 224 | 357 | 370 | 341 | 269 | 366 | 373 |
| Department of Defense | 173 | 133 | 131 | 258 | 258 | 248 | 209 | 281 | 320 | 275 | 260 |
| Other Federal | 3,828 | 3,798 | 3,565 | 3,330 | 3,191 | 3,438 | 3,537 | 3,738 | 3,831 | 3,866 | 3,979 |
| Non-Federal | 24,679 | 24,991 | 25,302 | 25,735 | 26,296 | 25,762 | 26,211 | 26,152 | 26,698 | 27,197 | 27,919 |
| Self-support | 10,486 | 10,178 | 9,637 | 9,299 | 9,044 | 8,373 | 8,329 | 7,962 | 7,723 | 7,551 | 7,194 |
| Psychology | 26,692 | 26,725 | 25,812 | 26,701 | 26,108 | 25,769 | 26,521 | 27,497 | 28,480 | 30,172 | 30,992 |
| Federal | 3,390 | 3,055 | 2,414 | 2,141 | 2,062 | 2,057 | 2,035 | 2,052 | 2,173 | 2,215 | 2,401 |
| National Science Foundation | 289 | 246 | 206 | 190 | 206 | 235 | 231 | 246 | 233 | 236 | 261 |
| National Institutes of Health | 1,043 | 926 | 716 | 600 | 647 | 622 | 589 | 630 | 763 | 720 | 799 |
| Other Health & Human Svcs | 885 | 737 | 607 | 424 | 396 | 434 | 361 | 379 | 361 | 463 | 475 |
| Department of Defense | 131 | 144 | 128 | 174 | 157 | 140 | 158 | 177 | 156 | 117 | 159 |
| Other Federal | 1,042 | 1,002 | 757 | 753 | 656 | 626 | 696 | 620 | 660 | 679 | 707 |
| Non-Federal | 10,088 | 10,960 | 10,746 | 11,178 | 11,630 | 11,893 | 12,361 | 12,190 | 12,385 | 12,945 | 13,341 |
| Self-support | 13,214 | 12,710 | 12,652 | 13,382 | 12,416 | 11,819 | 12,125 | 13,255 | 13,922 | 15,012 | 15,250 |
| Social sciences | 47,271 | 46,503 | 44,375 | 43,695 | 42,739 | 43,040 | 42,993 | 43,638 | 44,016 | 45,569 | 48,826 |
| Federal | 4,296 | 3,810 | 3,229 | 3,208 | 2,957 | 2,943 | 2,659 | 2,613 | 2,677 | 2,799 | 2,972 |
| National Science Foundation | 544 | 461 | 348 | 339 | 301 | 336 | 365 | 364 | 382 | 424 | 460 |
| National Institutes of Health | 350 | 305 | 207 | 212 | 211 | 197 | 202 | 209 | 207 | 201 | 210 |
| Other Health & Human Svcs | 472 | 362 | 237 | 139 | 111 | 124 | 102 | 115 | 111 | 112 | 104 |
| Department of Defense | 340 | 248 | 267 | 324 | 333 | 202 | 148 | 154 | 167 | 174 | 201 |
| Other Federal | 2,590 | 2,434 | 2,170 | 2,194 | 2,001 | 2,084 | 1,842 | 1,771 | 1,810 | 1,888 | 1,997 |
| Non-Federal | 22,078 | 22,467 | 22,532 | 22,354 | 22,145 | 22,102 | 22,725 | 23,679 | 24,434 | 25,348 | 26,722 |
| Self-support | 20,897 | 20,226 | 18,614 | 18,133 | 17,637 | 17,995 | 17,609 | 17,346 | 16,905 | 17,422 | 19,132 |
| **Total engineering** | 43,107 | 46,257 | 50,233 | 54,321 | 55,528 | 56,283 | 60,708 | 62,167 | 63,400 | 64,716 | 66,547 |
| Federal | 11,191 | 10,974 | 11,095 | 11,985 | 11,590 | 11,267 | 12,379 | 13,120 | 14,020 | 14,345 | 14,907 |
| National Science Foundation | 2,411 | 2,368 | 2,573 | 2,681 | 2,697 | 2,687 | 3,130 | 3,480 | 3,808 | 3,776 | 3,872 |
| National Institutes of Health | 508 | 446 | 403 | 477 | 466 | 455 | 449 | 515 | 555 | 644 | 674 |
| Other Health & Human Svcs | 157 | 103 | 102 | 98 | 78 | 69 | 87 | 114 | 73 | 85 | 122 |
| Department of Defense | 2,858 | 3,160 | 3,455 | 4,014 | 3,808 | 3,774 | 4,115 | 4,585 | 4,970 | 4,808 | 4,616 |
| Other Federal | 5,257 | 4,897 | 4,562 | 4,715 | 4,541 | 4,282 | 4,598 | 4,426 | 4,614 | 5,032 | 5,623 |
| Non-Federal | 19,162 | 21,518 | 23,420 | 24,666 | 26,259 | 28,206 | 30,645 | 31,205 | 31,712 | 32,865 | 33,742 |
| Self-support | 12,754 | 13,765 | 15,718 | 17,670 | 17,679 | 16,810 | 17,684 | 17,842 | 17,668 | 17,506 | 17,898 |

SOURCES: Science Resources Studies Division, National Science Foundation, *Selected Data on Graduate Students and Postdoctorates in Science and Engineering: Fall 1990*, NSF 91-320 (Washington DC: NSF, 1991), unpublished tabulations; and annual series.

See figure 2-12.

*Science & Engineering Indicators – 1991*

Appendix table 2-21.
**Full-time science and engineering graduate students, by field and mechanism of support: 1980-90**
(page 1 of 2)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL SCIENCE AND ENGINEERING | 215,354 | 219,088 | 222,770 | 230,570 | 232,182 | 235,593 | 244,424 | 248,652 | 252,643 | 259,411 | 267,621 |
| Fellowships | 19,455 | 19,084 | 19,592 | 20,041 | 20,284 | 21,017 | 21,571 | 20,658 | 21,285 | 22,095 | 23,830 |
| Traineeships | 10,526 | 10,093 | 9,130 | 8,753 | 8,614 | 8,620 | 8,517 | 9,142 | 9,428 | 9,712 | 10,046 |
| Research assistantships | 50,140 | 51,314 | 51,066 | 53,396 | 55,963 | 58,907 | 63,782 | 67,632 | 71,729 | 76,005 | 77,629 |
| Teaching assistantships | 51,931 | 53,769 | 56,164 | 58,027 | 59,095 | 59,741 | 60,358 | 60,709 | 61,102 | 62,181 | 62,646 |
| Other types of support | 83,302 | 84,828 | 86,818 | 90,353 | 88,226 | 87,308 | 90,196 | 90,511 | 89,099 | 89,418 | 93,470 |
| **Total sciences** | 172,247 | 172,831 | 172,537 | 176,249 | 176,654 | 179,310 | 183,716 | 186,485 | 189,243 | 194,695 | 201,074 |
| Fellowships | 15,698 | 14,907 | 14,899 | 15,194 | 15,409 | 16,206 | 16,625 | 15,983 | 16,797 | 17,383 | 18,662 |
| Traineeships | 9,590 | 9,148 | 8,322 | 7,998 | 7,876 | 7,860 | 7,681 | 8,241 | 8,506 | 8,730 | 9,030 |
| Research assistantships | 36,133 | 36,832 | 36,365 | 37,758 | 39,620 | 40,944 | 43,296 | 45,472 | 48,270 | 51,402 | 52,258 |
| Teaching assistantships | 44,529 | 45,480 | 46,958 | 47,971 | 48,535 | 48,969 | 49,234 | 49,602 | 49,926 | 51,044 | 51,638 |
| Other types of support | 66,297 | 66,464 | 65,993 | 67,328 | 65,214 | 65,331 | 66,880 | 67,187 | 65,744 | 66,136 | 69,486 |
| Physical sciences | 22,918 | 23,308 | 24,040 | 25,205 | 25,852 | 26,669 | 27,764 | 28,414 | 28,574 | 29,193 | 29,573 |
| Fellowships | 1,803 | 1,846 | 1,904 | 1,929 | 2,091 | 1,929 | 1,895 | 1,847 | 1,821 | 1,992 | 2,289 |
| Traineeships | 409 | 455 | 433 | 399 | 357 | 418 | 524 | 541 | 502 | 599 | 695 |
| Research assistantships | 8,340 | 8,607 | 8,768 | 9,145 | 9,628 | 10,284 | 10,994 | 11,558 | 12,056 | 12,426 | 12,137 |
| Teaching assistantships | 10,248 | 10,304 | 10,711 | 11,270 | 11,339 | 11,467 | 11,654 | 11,752 | 11,600 | 11,726 | 11,821 |
| Other types of support | 2,118 | 2,096 | 2,224 | 2,462 | 2,437 | 2,571 | 2,697 | 2,716 | 2,595 | 2,450 | 2,631 |
| Mathematical sciences | 9,902 | 10,154 | 10,823 | 10,964 | 11,319 | 11,833 | 12,398 | 13,049 | 13,523 | 13,705 | 13,870 |
| Fellowships | 760 | 681 | 687 | 694 | 766 | 857 | 909 | 859 | 940 | 1,001 | 1,103 |
| Traineeships | 145 | 134 | 126 | 124 | 159 | 149 | 123 | 158 | 204 | 212 | 189 |
| Research assistantships | 784 | 760 | 845 | 803 | 872 | 998 | 1,038 | 1,111 | 1,227 | 1,305 | 1,417 |
| Teaching assistantships | 5,607 | 5,748 | 6,074 | 6,445 | 6,624 | 6,814 | 7,154 | 7,461 | 7,598 | 7,845 | 7,803 |
| Other types of support | 2,606 | 2,831 | 3,091 | 2,898 | 2,898 | 3,015 | 3,169 | 3,460 | 3,554 | 3,342 | 3,358 |
| Computer sciences | 6,587 | 7,445 | 9,171 | 10,687 | 11,587 | 14,101 | 15,310 | 15,572 | 15,596 | 16,008 | 16,872 |
| Fellowships | 301 | 396 | 411 | 488 | 561 | 781 | 830 | 784 | 807 | 847 | 956 |
| Traineeships | 69 | 101 | 74 | 50 | 81 | 73 | 114 | 103 | 115 | 134 | 133 |
| Research assistantships | 1,036 | 1,098 | 1,191 | 1,403 | 1,635 | 2,076 | 2,354 | 2,837 | 3,054 | 3,340 | 3,341 |
| Teaching assistantships | 1,481 | 1,782 | 2,074 | 2,411 | 2,748 | 3,216 | 3,251 | 3,404 | 3,434 | 3,460 | 3,653 |
| Other types of support | 3,700 | 4,068 | 5,421 | 6,335 | 6,562 | 7,955 | 8,761 | 8,444 | 8,186 | 8,227 | 8,789 |
| Environmental sciences | 10,969 | 11,038 | 11,436 | 12,049 | 11,819 | 11,439 | 11,323 | 10,543 | 10,296 | 10,138 | 10,295 |
| Fellowships | 876 | 844 | 892 | 880 | 962 | 982 | 846 | 741 | 778 | 770 | 791 |
| Traineeships | 259 | 278 | 263 | 272 | 178 | 176 | 149 | 176 | 148 | 112 | 104 |
| Research assistantships | 3,770 | 3,469 | 3,339 | 3,545 | 3,574 | 3,723 | 3,834 | 3,660 | 3,891 | 4,164 | 4,171 |
| Teaching assistantships | 2,672 | 2,651 | 2,849 | 2,881 | 2,865 | 2,647 | 2,659 | 2,498 | 2,553 | 2,455 | 2,387 |
| Other types of support | 3,392 | 3,796 | 4,093 | 4,471 | 4,240 | 3,911 | 3,835 | 3,468 | 2,926 | 2,637 | 2,842 |
| Life sciences | 47,908 | 47,658 | 46,880 | 46,948 | 47,230 | 46,459 | 47,407 | 47,772 | 48,758 | 49,910 | 50,646 |
| Fellowships | 4,086 | 4,154 | 4,141 | 4,205 | 4,291 | 4,586 | 4,850 | 4,794 | 4,736 | 5,103 | 5,349 |
| Traineeships | 4,963 | 4,755 | 4,592 | 4,596 | 4,486 | 4,368 | 4,318 | 4,563 | 4,734 | 4,778 | 5,005 |
| Research assistantships | 14,334 | 14,796 | 14,631 | 14,857 | 15,715 | 15,700 | 16,846 | 17,607 | 18,712 | 20,014 | 20,600 |
| Teaching assistantships | 10,675 | 10,460 | 10,669 | 10,535 | 10,423 | 10,328 | 9,904 | 9,535 | 9,521 | 9,683 | 9,582 |
| Other types of support | 13,850 | 13,493 | 12,847 | 12,755 | 12,315 | 11,477 | 11,489 | 11,273 | 11,055 | 10,332 | 10,110 |
| Psychology | 26,692 | 26,725 | 25,812 | 26,701 | 26,108 | 25,769 | 26,521 | 27,497 | 28,480 | 30,172 | 30,992 |
| Fellowships | 1,601 | 1,304 | 1,232 | 1,270 | 1,295 | 1,277 | 1,422 | 1,433 | 1,538 | 1,506 | 1,654 |
| Traineeships | 2,008 | 1,956 | 1,794 | 1,383 | 1,477 | 1,602 | 1,328 | 1,243 | 1,243 | 1,180 | 1,139 |
| Research assistantships | 2,571 | 2,890 | 2,723 | 2,962 | 3,027 | 3,082 | 3,119 | 3,231 | 3,743 | 3,871 | 4,089 |
| Teaching assistantships | 4,779 | 5,014 | 4,922 | 5,007 | 5,048 | 5,182 | 5,365 | 5,377 | 5,518 | 5,783 | 5,808 |
| Other types of support | 15,733 | 15,561 | 15,141 | 16,079 | 15,261 | 14,626 | 15,287 | 16,213 | 16,438 | 17,832 | 18,302 |

(continued)

Appendix table 2-21.
**Full-time science and engineering graduate students, by field and mechanism of support: 1980-90**
(page 2 of 2)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Social sciences | 47,271 | 46,503 | 44,375 | 43,695 | 42,739 | 43,040 | 42,993 | 43,638 | 44,016 | 45,569 | 48,826 |
| Fellowships | 6,271 | 5,682 | 5,632 | 5,728 | 5,443 | 5,794 | 5,873 | 5,525 | 6,177 | 6,164 | 6,520 |
| Traineeships | 1,737 | 1,469 | 1,040 | 1,174 | 1,138 | 1,074 | 1,120 | 1,457 | 1,560 | 1,715 | 1,765 |
| Research assistantships | 5,298 | 5,212 | 4,868 | 5,043 | 5,169 | 5,081 | 5,111 | 5,468 | 5,587 | 6,282 | 6,503 |
| Teaching assistantships | 9,067 | 9,521 | 9,659 | 9,422 | 9,488 | 9,315 | 9,247 | 9,575 | 9,702 | 10,092 | 10,584 |
| Other types of support | 24,898 | 24,619 | 23,176 | 22,328 | 21,501 | 21,776 | 21,642 | 21,613 | 20,990 | 21,316 | 23,454 |
| **Total engineering** | 43,107 | 46,257 | 50,233 | 54,321 | 55,528 | 56,283 | 60,708 | 62,167 | 63,400 | 64,716 | 66,547 |
| Fellowships | 3,757 | 4,177 | 4,693 | 4,847 | 4,875 | 4,811 | 4,946 | 4,675 | 4,488 | 4,712 | 5,168 |
| Traineeships | 936 | 945 | 808 | 755 | 738 | 760 | 836 | 901 | 922 | 982 | 1,016 |
| Research assistantships | 14,007 | 14,482 | 14,701 | 15,638 | 16,343 | 17,963 | 20,486 | 22,160 | 23,459 | 24,603 | 25,371 |
| Teaching assistantships | 7,402 | 8,289 | 9,206 | 10,056 | 10,560 | 10,772 | 11,124 | 11,107 | 11,176 | 11,137 | 11,008 |
| Other types of support | 17,005 | 18,364 | 20,825 | 23,025 | 23,012 | 21,977 | 23,316 | 23,324 | 23,355 | 23,282 | 23,984 |

SOURCES: Science Resources Studies Division, National Science Foundation, *Selected Data on Graduate Students and Postdoctorates in Science and Engineering: Fall 1990*, NSF 91-320 (Washington DC: NSF, 1991), unpublished tabulations; and annual series.

*Science & Engineering Indicators – 1991*

Appendix table 2-22.
**Full-time science and engineering graduate students, by source and mechanism of support: 1980-89**
(page 1 of 4)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Total science and engineering** | | | | | | | | | |
| TOTAL SUPPORT | 215,354 | 219,088 | 222,844 | 230,621 | 232,230 | 235,615 | 244,526 | 248,730 | 252,749 | 259,575 |
| Fellowships | 19,455 | 19,084 | 19,640 | 20,184 | 20,448 | 21,126 | 21,997 | 20,894 | 21,506 | 22,645 |
| Traineeships | 10,526 | 10,093 | 9,122 | 8,735 | 8,615 | 8,610 | 8,503 | 9,128 | 9,425 | 9,557 |
| Research assistantships | 50,140 | 51,314 | 51,081 | 53,412 | 55,976 | 58,930 | 63,813 | 67,681 | 71,776 | 75,924 |
| Teaching assistantships | 51,931 | 53,769 | 56,161 | 58,020 | 59,091 | 59,730 | 60,360 | 60,730 | 61,120 | 62,154 |
| Mechanism unknown | 83,302 | 84,828 | 86,840 | 90,270 | 88,100 | 87,219 | 89,853 | 90,297 | 88,922 | 89,295 |
| **Total Federal support** | 44,590 | 43,098 | 41,145 | 42,145 | 42,024 | 42,950 | 45,398 | 47,242 | 49,326 | 51,171 |
| Fellowships | 4,204 | 3,790 | 3,659 | 3,765 | 3,790 | 4,025 | 4,246 | 4,086 | 4,211 | 4,866 |
| Traineeships | 6,797 | 6,105 | 5,328 | 4,939 | 4,705 | 4,502 | 4,372 | 4,590 | 4,504 | 4,618 |
| Research assistantships | 28,718 | 28,527 | 27,723 | 28,580 | 28,822 | 29,643 | 31,915 | 33,961 | 35,680 | 37,186 |
| Teaching assistantships | 542 | 506 | 345 | 405 | 271 | 477 | 423 | 341 | 435 | 447 |
| Mechanism unknown | 4,329 | 4,170 | 4,090 | 4,456 | 4,436 | 4,303 | 4,442 | 4,264 | 4,496 | 4,054 |
| National Science Foundation | 9,278 | 9,149 | 9,255 | 9,494 | 9,813 | 10,143 | 10,795 | 11,202 | 11,590 | 11,844 |
| Fellowships | 1,312 | 1,262 | 1,288 | 1,290 | 1,321 | 1,377 | 1,492 | 1,479 | 1,576 | 1,765 |
| Traineeships | 215 | 143 | 89 | 61 | 49 | 50 | 26 | 66 | 62 | 83 |
| Research assistantships | 7,615 | 7,585 | 7,738 | 8,054 | 8,268 | 8,547 | 9,075 | 9,470 | 9,800 | 9,838 |
| Teaching assistantships | 35 | 61 | 27 | 25 | 28 | 43 | 74 | 26 | 58 | 68 |
| Mechanism unknown | 101 | 98 | 113 | 64 | 147 | 126 | 128 | 161 | 94 | 90 |
| National Institutes of Health | 10,614 | 10,132 | 9,583 | 9,673 | 9,972 | 10,083 | 10,770 | 11,527 | 12,408 | 13,023 |
| Fellowships | 673 | 546 | 456 | 469 | 518 | 509 | 531 | 557 | 564 | 554 |
| Traineeships | 4,526 | 4,166 | 3,954 | 3,788 | 3,747 | 3,609 | 3,459 | 3,650 | 3,611 | 3,559 |
| Research assistantships | 5,071 | 5,144 | 4,942 | 5,106 | 5,391 | 5,682 | 6,495 | 6,977 | 7,865 | 8,545 |
| Teaching assistantships | 72 | 64 | 32 | 72 | 38 | 53 | 67 | 79 | 106 | 110 |
| Mechanism unknown | 272 | 212 | 199 | 238 | 278 | 230 | 218 | 264 | 262 | 255 |
| Other Health and Human Services | 2,148 | 1,802 | 1,412 | 1,114 | 947 | 1,164 | 1,106 | 1,140 | 1,000 | 1,132 |
| Fellowships | 337 | 210 | 161 | 132 | 123 | 132 | 100 | 93 | 69 | 97 |
| Traineeships | 1,159 | 1,021 | 727 | 434 | 303 | 312 | 341 | 279 | 272 | 265 |
| Research assistantships | 502 | 502 | 439 | 477 | 474 | 610 | 595 | 713 | 632 | 745 |
| Teaching assistantships | 22 | 6 | 30 | 12 | 3 | 7 | 2 | 12 | 3 | 6 |
| Mechanism unknown | 128 | 63 | 55 | 59 | 44 | 103 | 68 | 43 | 24 | 19 |
| Department of Defense | 5,086 | 5,485 | 5,749 | 6,751 | 6,873 | 7,052 | 7,713 | 8,565 | 9,277 | 8,886 |
| Fellowships | 196 | 161 | 182 | 245 | 207 | 237 | 275 | 346 | 332 | 495 |
| Traineeships | 65 | 67 | 27 | 27 | 36 | 36 | 72 | 113 | 121 | 96 |
| Research assistantships | 2,927 | 3,287 | 3,448 | 3,904 | 4,051 | 4,152 | 4,608 | 5,559 | 5,974 | 5,778 |
| Teaching assistantships | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mechanism unknown | 1,898 | 1,970 | 2,092 | 2,575 | 2,579 | 2,627 | 2,758 | 2,547 | 2,850 | 2,517 |
| Other Federal | 17,464 | 16,530 | 15,146 | 15,113 | 14,419 | 14,508 | 15,014 | 14,808 | 15,051 | 16,286 |
| Fellowships | 1,686 | 1,611 | 1,572 | 1,629 | 1,621 | 1,770 | 1,848 | 1,611 | 1,670 | 1,955 |
| Traineeships | 832 | 708 | 531 | 629 | 570 | 495 | 474 | 482 | 438 | 615 |
| Research assistantships | 12,603 | 12,009 | 11,156 | 11,039 | 10,638 | 10,652 | 11,142 | 11,242 | 11,409 | 12,280 |
| Teaching assistantships | 413 | 375 | 256 | 296 | 202 | 374 | 280 | 224 | 268 | 263 |
| Mechanism unknown | 1,930 | 1,827 | 1,631 | 1,520 | 1,388 | 1,217 | 1,270 | 1,249 | 1,266 | 1,173 |
| **Non-Federal support** | 104,440 | 109,282 | 113,532 | 116,884 | 120,457 | 123,958 | 129,134 | 130,848 | 133,734 | 137,258 |
| Fellowships | 15,251 | 15,294 | 15,981 | 16,419 | 16,658 | 17,101 | 17,751 | 16,808 | 17,295 | 17,779 |
| Traineeships | 3,729 | 3,988 | 3,794 | 3,796 | 3,910 | 4,108 | 4,131 | 4,538 | 4,921 | 4,939 |
| Research assistantships | 21,422 | 22,787 | 23,358 | 24,832 | 27,154 | 29,287 | 31,898 | 33,720 | 36,096 | 38,738 |
| Teaching assistantships | 51,389 | 53,263 | 55,816 | 57,615 | 58,820 | 59,253 | 59,937 | 60,389 | 60,685 | 61,707 |
| Mechanism unknown | 12,649 | 13,950 | 14,583 | 14,222 | 13,915 | 14,209 | 15,417 | 15,393 | 14,737 | 14,095 |

(continued)

Appendix table 2-22.
**Full-time science and engineering graduate students, by source and mechanism of support: 1980-89**
(page 2 of 4)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Self-support** | 66,324 | 66,708 | 68,167 | 71,592 | 69,749 | 68,707 | 69,994 | 70,640 | 69,689 | 71,146 |
| Fellowships | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Traineeships | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Research assistantships | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Teaching assistantships | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mechanism unknown | 66,324 | 66,708 | 68,167 | 71,592 | 69,749 | 68,707 | 69,994 | 70,640 | 69,689 | 71,146 |
| | | | | | **Total sciences** | | | | | |
| TOTAL SUPPORT | 172,247 | 172,831 | 172,605 | 176,294 | 176,691 | 179,322 | 183,800 | 186,501 | 189,271 | 194,995 |
| Fellowships | 15,698 | 14,907 | 14,947 | 15,337 | 15,573 | 16,315 | 17,051 | 16,204 | 17,007 | 17,864 |
| Traineeships | 9,590 | 9,148 | 8,309 | 7,980 | 7,877 | 7,850 | 7,667 | 8,227 | 8,498 | 8,575 |
| Research assistantships | 36,133 | 36,832 | 36,380 | 37,774 | 39,631 | 40,965 | 43,323 | 45,512 | 48,308 | 51,288 |
| Teaching assistantships | 44,529 | 45,480 | 46,955 | 47,961 | 48,528 | 48,958 | 49,236 | 49,605 | 49,924 | 51,014 |
| Mechanism unknown | 66,297 | 66,464 | 66,014 | 67,242 | 65,082 | 65,234 | 66,523 | 66,953 | 65,534 | 66,254 |
| **Total Federal support** | 33,399 | 32,124 | 30,050 | 30,160 | 30,434 | 31,683 | 33,019 | 34,111 | 35,295 | 36,918 |
| Fellowships | 3,557 | 3,156 | 2,948 | 2,981 | 2,981 | 3,221 | 3,416 | 3,255 | 3,334 | 3,860 |
| Traineeships | 6,387 | 5,788 | 5,061 | 4,673 | 4,492 | 4,286 | 4,165 | 4,333 | 4,288 | 4,379 |
| Research assistantships | 20,170 | 19,992 | 19,146 | 19,570 | 20,146 | 21,216 | 22,357 | 23,590 | 24,700 | 25,904 |
| Teaching assistantships | 403 | 406 | 305 | 365 | 251 | 383 | 391 | 317 | 361 | 373 |
| Mechanism unknown | 2,882 | 2,782 | 2,590 | 2,571 | 2,564 | 2,577 | 2,690 | 2,616 | 2,612 | 2,402 |
| National Science Foundation | 6,867 | 6,781 | 6,582 | 6,813 | 7,116 | 7,456 | 7,665 | 7,722 | 7,782 | 8,068 |
| Fellowships | 1,141 | 1,094 | 1,035 | 1,030 | 1,055 | 1,114 | 1,231 | 1,187 | 1,223 | 1,347 |
| Traineeships | 183 | 132 | 87 | 60 | 45 | 37 | 25 | 58 | 54 | 63 |
| Research assistantships | 5,444 | 5,449 | 5,449 | 5,642 | 5,897 | 6,192 | 6,262 | 6,345 | 6,395 | 6,539 |
| Teaching assistantships | 31 | 31 | 21 | 22 | 26 | 31 | 69 | 24 | 35 | 52 |
| Mechanism unknown | 68 | 75 | 90 | 59 | 93 | 82 | 78 | 108 | 75 | 67 |
| National Institutes of Health | 10,106 | 9,686 | 9,180 | 9,196 | 9,506 | 9,628 | 10,321 | 11,012 | 11,853 | 12,379 |
| Fellowships | 665 | 539 | 447 | 453 | 486 | 477 | 515 | 540 | 531 | 523 |
| Traineeships | 4,382 | 4,039 | 3,876 | 3,688 | 3,677 | 3,518 | 3,372 | 3,551 | 3,552 | 3,491 |
| Research assistantships | 4,738 | 4,851 | 4,631 | 4,754 | 5,037 | 5,355 | 6,160 | 6,593 | 7,406 | 8,008 |
| Teaching assistantships | 70 | 60 | 32 | 69 | 36 | 52 | 66 | 79 | 106 | 110 |
| Mechanism unknown | 251 | 197 | 194 | 232 | 270 | 226 | 208 | 249 | 258 | 247 |
| Other Health and Human Services | 1,991 | 1,699 | 1,310 | 1,016 | 869 | 1,095 | 1,019 | 1,026 | 927 | 1,058 |
| Fellowships | 278 | 185 | 139 | 102 | 93 | 112 | 71 | 81 | 64 | 89 |
| Traineeships | 1,118 | 993 | 708 | 427 | 299 | 306 | 325 | 266 | 263 | 255 |
| Research assistantships | 448 | 459 | 388 | 421 | 431 | 567 | 554 | 630 | 576 | 689 |
| Teaching assistantships | 21 | 6 | 27 | 12 | 3 | 7 | 2 | 12 | 1 | 6 |
| Mechanism unknown | 126 | 56 | 48 | 54 | 43 | 103 | 67 | 37 | 23 | 19 |
| Department of Defense | 2,228 | 2,325 | 2,294 | 2,737 | 3,065 | 3,278 | 3,598 | 3,978 | 4,305 | 4,066 |
| Fellowships | 143 | 86 | 88 | 145 | 87 | 115 | 167 | 194 | 187 | 338 |
| Traineeships | 52 | 36 | 5 | 26 | 16 | 25 | 38 | 74 | 71 | 44 |
| Research assistantships | 1,241 | 1,384 | 1,366 | 1,579 | 1,905 | 1,983 | 2,085 | 2,518 | 2,868 | 2,618 |
| Teaching assistantships | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mechanism unknown | 792 | 819 | 835 | 987 | 1,057 | 1,155 | 1,308 | 1,192 | 1,179 | 1,066 |
| Other Federal | 12,207 | 11,633 | 10,584 | 10,398 | 9,878 | 10,226 | 10,416 | 10,373 | 10,428 | 11,347 |
| Fellowships | 1,330 | 1,252 | 1,239 | 1,251 | 1,260 | 1,403 | 1,432 | 1,253 | 1,329 | 1,563 |
| Traineeships | 652 | 588 | 385 | 472 | 455 | 400 | 405 | 384 | 348 | 526 |
| Research assistantships | 8,299 | 7,849 | 7,312 | 7,174 | 6,876 | 7,119 | 7,296 | 7,504 | 7,455 | 8,050 |
| Teaching assistantships | 281 | 309 | 225 | 262 | 186 | 293 | 254 | 202 | 219 | 205 |
| Mechanism unknown | 1,645 | 1,635 | 1,423 | 1,239 | 1,101 | 1,011 | 1,029 | 1,030 | 1,077 | 1,003 |

(continued)

Appendix table 2-22.
**Full-time science and engineering graduate students, by source and mechanism of support: 1980-89**
(page 3 of 4)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Non-Federal support** | 85,278 | 87,764 | 90,107 | 92,215 | 94,192 | 95,750 | 98,483 | 99,612 | 101,986 | 104,623 |
| Fellowships | 12,141 | 11,751 | 11,999 | 12,356 | 12,592 | 13,094 | 13,635 | 12,949 | 13,673 | 14,004 |
| Traineeships | 3,203 | 3,360 | 3,248 | 3,307 | 3,385 | 3,564 | 3,502 | 3,894 | 4,210 | 4,196 |
| Research assistantships | 15,963 | 16,840 | 17,234 | 18,204 | 19,485 | 19,749 | 20,966 | 21,922 | 23,608 | 25,384 |
| Teaching assistantships | 44,126 | 45,074 | 46,650 | 47,596 | 48,277 | 48,575 | 48,845 | 49,288 | 49,563 | 50,641 |
| Mechanism unknown | 9,845 | 10,739 | 10,976 | 10,752 | 10,453 | 10,768 | 11,535 | 11,559 | 10,932 | 10,398 |
| | | | | | | | | | | |
| **Self-support** | 53,570 | 52,943 | 52,448 | 53,919 | 52,065 | 51,889 | 52,298 | 52,778 | 51,990 | 53,454 |
| Fellowships | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Traineeships | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Research assistantships | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Teaching assistantships | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mechanism unknown | 53,570 | 52,943 | 52,448 | 53,919 | 52,065 | 51,889 | 52,298 | 52,778 | 51,990 | 53,454 |
| | | | | **Total engineering** | | | | | | |
| TOTAL SUPPORT | 43,107 | 46,257 | 50,239 | 54,327 | 55,539 | 56,293 | 60,726 | 62,229 | 63,478 | 64,580 |
| Fellowships | 3,757 | 4,177 | 4,693 | 4,847 | 4,875 | 4,811 | 4,946 | 4,690 | 4,499 | 4,781 |
| Traineeships | 936 | 945 | 813 | 755 | 738 | 760 | 836 | 901 | 927 | 982 |
| Research assistantships | 14,007 | 14,482 | 14,701 | 15,638 | 16,345 | 17,965 | 20,490 | 22,169 | 23,468 | 24,636 |
| Teaching assistantships | 7,402 | 8,289 | 9,206 | 10,059 | 10,563 | 10,772 | 11,124 | 11,125 | 11,196 | 11,140 |
| Mechanism unknown | 17,005 | 18,364 | 20,826 | 23,028 | 23,018 | 21,985 | 23,330 | 23,344 | 23,388 | 23,041 |
| | | | | | | | | | | |
| **Total Federal support** | 11,191 | 10,974 | 11,095 | 11,985 | 11,590 | 11,267 | 12,379 | 13,131 | 14,031 | 14,253 |
| Fellowships | 647 | 634 | 711 | 784 | 809 | 804 | 830 | 831 | 877 | 1,006 |
| Traineeships | 410 | 317 | 267 | 266 | 213 | 216 | 207 | 257 | 216 | 239 |
| Research assistantships | 8,548 | 8,535 | 8,577 | 9,010 | 8,676 | 8,427 | 9,558 | 10,371 | 10,980 | 11,282 |
| Teaching assistantships | 139 | 100 | 40 | 40 | 20 | 94 | 32 | 24 | 74 | 74 |
| Mechanism unknown | 1,447 | 1,388 | 1,500 | 1,885 | 1,872 | 1,726 | 1,752 | 1,648 | 1,884 | 1.652 |
| | | | | | | | | | | |
| National Science Foundation | 2,411 | 2,368 | 2,573 | 2,681 | 2,697 | 2,687 | 3,130 | 3,480 | 3,808 | 3,776 |
| Fellowships | 171 | 168 | 253 | 260 | 266 | 263 | 261 | 292 | 353 | 418 |
| Traineeships | 32 | 11 | 2 | 1 | 4 | 13 | 1 | 8 | 8 | 20 |
| Research assistantships | 2,171 | 2,136 | 2,289 | 2,412 | 2,371 | 2,355 | 2,813 | 3,125 | 3,405 | 3,299 |
| Teaching assistantships | 4 | 30 | 6 | 3 | 2 | 12 | 5 | 2 | 23 | 16 |
| Mechanism unknown | 33 | 23 | 23 | 5 | 54 | 44 | 50 | 53 | 19 | 23 |
| | | | | | | | | | | |
| National Institutes of Health | 508 | 446 | 403 | 477 | 466 | 455 | 449 | 515 | 555 | 644 |
| Fellowships | 8 | 7 | 9 | 16 | 32 | 32 | 15 | 17 | 33 | 31 |
| Traineeships | 144 | 127 | 78 | 100 | 70 | 91 | 87 | 99 | 59 | 68 |
| Research assistantships | 333 | 293 | 311 | 352 | 354 | 327 | 335 | 384 | 459 | 537 |
| Teaching assistantships | 2 | 4 | 0 | 3 | 2 | 1 | 1 | 0 | 0 | 0 |
| Mechanism unknown | 21 | 15 | 5 | 6 | 8 | 4 | 10 | 15 | 4 | 8 |
| | | | | | | | | | | |
| Other Health and Human Services | 157 | 103 | 102 | 98 | 78 | 69 | 87 | 114 | 73 | 74 |
| Fellowships | 59 | 25 | 22 | 30 | 30 | 20 | 29 | 12 | 5 | 8 |
| Traineeships | 41 | 28 | 19 | 7 | 4 | 6 | 16 | 13 | 9 | 10 |
| Research assistantships | 54 | 43 | 51 | 56 | 43 | 43 | 41 | 83 | 56 | 56 |
| Teaching assistantships | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| Mechanism unknown | 2 | 7 | 7 | 5 | 1 | 0 | 1 | 6 | 1 | 0 |
| | | | | | | | | | | |
| Department of Defense | 2,858 | 3,160 | 3,455 | 4,014 | 3,808 | 3,774 | 4,115 | 4,587 | 4,972 | 4,820 |
| Fellowships | 53 | 75 | 94 | 100 | 120 | 122 | 108 | 152 | 145 | 157 |
| Traineeships | 13 | 31 | 22 | 1 | 20 | 11 | 34 | 39 | 50 | 52 |
| Research assistantships | 1,686 | 1,903 | 2,082 | 2,325 | 2,146 | 2,169 | 2,523 | 3,041 | 3,106 | 3,160 |
| Teaching assistantships | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mechanism unknown | 1,106 | 1,151 | 1,257 | 1,388 | 1,522 | 1,472 | 1,460 | 1,355 | 1,671 | 1,451 |

(continued)

Appendix table 2-22.
**Full-time science and engineering graduate students, by source and mechanism of support: 1980-89**
(page 4 of 4)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| Other Federal | 5,257 | 4,897 | 4,562 | 4,715 | 4,541 | 4,282 | 4,598 | 4,435 | 4,623 | 4,939 |
| Fellowships | 356 | 359 | 333 | 378 | 361 | 367 | 416 | 358 | 341 | 392 |
| Traineeships | 180 | 120 | 146 | 157 | 115 | 95 | 69 | 98 | 90 | 89 |
| Research assistantships | 4,304 | 4,160 | 3,844 | 3,865 | 3,762 | 3,533 | 3,846 | 3,738 | 3,954 | 4,230 |
| Teaching assistantships | 132 | 66 | 31 | 34 | 16 | 81 | 26 | 22 | 49 | 58 |
| Mechanism unknown | 285 | 192 | 208 | 281 | 287 | 206 | 241 | 219 | 189 | 170 |
| **Non-Federal support** | 19,162 | 21,518 | 23,425 | 24,669 | 26,265 | 28,208 | 30,651 | 31,236 | 31,748 | 32,635 |
| Fellowships | 3,110 | 3,543 | 3,982 | 4,063 | 4,066 | 4,007 | 4,116 | 3,859 | 3,622 | 3,775 |
| Traineeships | 526 | 628 | 546 | 489 | 525 | 544 | 629 | 644 | 711 | 743 |
| Research assistantships | 5,459 | 5,947 | 6,124 | 6,628 | 7,669 | 9,538 | 10,932 | 11,798 | 12,488 | 13,354 |
| Teaching assistantships | 7,263 | 8,189 | 9,166 | 10,019 | 10,543 | 10,678 | 11,092 | 11,101 | 11,122 | 11,066 |
| Mechanism unknown | 2,804 | 3,211 | 3,607 | 3,470 | 3,462 | 3,441 | 3,882 | 3,834 | 3,805 | 3,697 |
| **Self-support** | 12,754 | 13,765 | 15,719 | 17,673 | 17,684 | 16,818 | 17,696 | 17,862 | 17,699 | 17,692 |
| Fellowships | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Traineeships | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Research assistantships | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Teaching assistantships | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mechanism unknown | 12,754 | 13,765 | 15,719 | 17,673 | 17,684 | 16,818 | 17,696 | 17,862 | 17,699 | 17,692 |

SOURCES: Science Resources Studies Division, National Science Foundation, *Selected Data on Graduate Students and Postdoctorates in Science and Engineering: Fall 1990*, NSF 91-320 (Washington DC: NSF, 1991), unpublished tabulations; and annual series.

See figure 2-13.

*Science & Engineering Indicators – 1991*

Appendix table 2-23.
**Science and engineering graduate students, by field and citizenship: 1983-90**

| | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|
| | | | | **Total** | | | | |
| Total science & engineering . . . | 349,547 | 352,027 | 360,722 | 370,487 | 376,632 | 378,274 | 386,047 | 401,569 |
| Total sciences . . . . . . . . . . . . | 257,610 | 258,383 | 263,771 | 267,416 | 271,988 | 274,555 | 281,232 | 292,270 |
| Physical sciences. . . . . . . . | 29,466 | 30,064 | 30,995 | 32,260 | 32,738 | 32,972 | 33,628 | 34,337 |
| Mathematics . . . . . . . . . . . | 17,397 | 17,478 | 17,613 | 17,990 | 18,573 | 19,141 | 19,382 | 19,884 |
| Computer sciences . . . . . . | 23,616 | 25,810 | 29,844 | 31,425 | 32,137 | 32,787 | 32,846 | 34,507 |
| Environmental sciences . . . | 15,544 | 15,612 | 15,545 | 15,163 | 14,522 | 14,032 | 13,848 | 14,159 |
| Life sciences . . . . . . . . . . . | 58,345 | 58,233 | 57,918 | 58,545 | 59,456 | 59,316 | 60,655 | 62,104 |
| Psychology . . . . . . . . . . . . | 41,039 | 41,074 | 41,308 | 41,551 | 42,888 | 44,389 | 46,304 | 48,659 |
| Social sciences . . . . . . . . . | 72,203 | 70,112 | 70,548 | 70,482 | 71,674 | 71,918 | 74,560 | 78,620 |
| Total engineering . . . . . . . . . . | 91,937 | 93,644 | 96,951 | 103,071 | 104,644 | 103,719 | 104,815 | 109,299 |
| | | | | **U.S. citizens** | | | | |
| Total science & engineering . . . | 278,994 | 279,554 | 283,741 | 286,279 | 287,606 | 284,243 | 287,681 | 299,110 |
| Total sciences . . . . . . . . . . . . | 214,676 | 213,916 | 215,725 | 215,349 | 216,457 | 215,893 | 219,731 | 227,938 |
| Physical sciences. . . . . . . . | 21,805 | 22,017 | 22,054 | 22,232 | 22,110 | 21,860 | 21,820 | 21,826 |
| Mathematics . . . . . . . . . . . | 12,442 | 12,285 | 12,262 | 12,179 | 12,443 | 12,716 | 12,711 | 13,443 |
| Computer sciences . . . . . . | 18,068 | 19,451 | 22,386 | 23,419 | 23,409 | 23,717 | 23,122 | 23,778 |
| Environmental sciences . . . | 13,679 | 13,808 | 13,651 | 13,067 | 12,299 | 11,589 | 11,247 | 11,442 |
| Life sciences . . . . . . . . . . . | 49,567 | 49,208 | 48,366 | 47,918 | 47,785 | 46,612 | 46,878 | 47,391 |
| Psychology . . . . . . . . . . . . | 39,605 | 39,685 | 39,811 | 40,047 | 41,346 | 42,726 | 44,652 | 46,819 |
| Social sciences . . . . . . . . . | 59,510 | 57,462 | 57,195 | 56,487 | 57,065 | 56,673 | 59,301 | 63,239 |
| Total engineering . . . . . . . . . . | 64,318 | 65,638 | 68,016 | 70,930 | 71,149 | 68,350 | 67,950 | 71,172 |
| | | | | **Foreign citizens** | | | | |
| Total science & engineering . . . | 70,553 | 72,473 | 76,981 | 84,208 | 89,026 | 94,031 | 98,366 | 102,459 |
| Total sciences . . . . . . . . . . . . | 42,934 | 44,467 | 48,046 | 52,067 | 55,531 | 58,662 | 61,501 | 64,332 |
| Physical sciences. . . . . . . . | 7,661 | 8,047 | 8,941 | 10,028 | 10,628 | 11,112 | 11,808 | 12,511 |
| Mathematics . . . . . . . . . . . | 4,955 | 5,193 | 5,351 | 5,811 | 6,130 | 6,425 | 6,671 | 6,441 |
| Computer sciences . . . . . . | 5,548 | 6,359 | 7,458 | 8,006 | 8,728 | 9,070 | 9,724 | 10,729 |
| Environmental sciences . . . | 1,865 | 1,804 | 1,894 | 2,096 | 2,223 | 2,443 | 2,601 | 2,717 |
| Life sciences . . . . . . . . . . . | 8,778 | 9,025 | 9,552 | 10,627 | 11,671 | 12,704 | 13,777 | 14,713 |
| Psychology . . . . . . . . . . . . | 1,434 | 1,389 | 1,497 | 1,504 | 1,542 | 1,663 | 1,652 | 1,840 |
| Social sciences . . . . . . . . . | 12,693 | 12,650 | 13,353 | 13,995 | 14,609 | 15,245 | 15,268 | 15,381 |
| Total engineering . . . . . . . . . . | 27,619 | 28,006 | 28,935 | 32,141 | 33,495 | 35,369 | 36,865 | 38,127 |

SOURCES: Science Resources Studies Division, National Science Foundation, *Selected Data on Graduate Students and Postdoctorates in Science and Engineering: Fall 1990*, NSF 91-320 (Washington DC: NSF, 1991), unpublished tabulations; and annual series.

See figure 2-14 and figure O-17 in Overview.

Appendix table 2-24
**Science and engineering doctoral recipients, by field and citizenship: 1980-90**
(page 1 of 2)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total'** | | | | | | | | | | | |
| Total, all doctorates | 31,020 | 31,357 | 31,111 | 31,282 | 31,337 | 31,297 | 31,895 | 32,364 | 33,490 | 34,319 | 36,027 |
| Total science and engineering | 17,523 | 17,996 | 18,017 | 18,393 | 18,514 | 18,712 | 19,251 | 19,707 | 20,741 | 21,530 | 22,673 |
| Total sciences | 15,044 | 15,468 | 15,371 | 15,612 | 15,601 | 15,546 | 15,875 | 15,995 | 16,551 | 16,986 | 17,781 |
| Physical sciences | 2,521 | 2,627 | 2,694 | 2,802 | 2,845 | 2,916 | 3,090 | 3,212 | 3,317 | 3,244 | 3,494 |
| Mathematics | 744 | 728 | 720 | 701 | 698 | 688 | 729 | 740 | 749 | 859 | 892 |
| Computer sciences | 218 | 232 | 220 | 286 | 295 | 310 | 399 | 450 | 515 | 612 | 704 |
| Environmental sciences | 628 | 583 | 657 | 637 | 614 | 617 | 589 | 628 | 728 | 740 | 769 |
| Life sciences | 4,715 | 4,786 | 4,844 | 4,756 | 4,877 | 4,904 | 4,805 | 4,816 | 5,127 | 5,203 | 5,509 |
| Psychology | 3,098 | 3,358 | 3,159 | 3,347 | 3,257 | 3,117 | 3,124 | 3,169 | 3,064 | 3,203 | 3,267 |
| Social sciences | 3,120 | 3,154 | 3,077 | 3,083 | 3,015 | 2,994 | 3,139 | 2,980 | 3,051 | 3,125 | 3,146 |
| Total engineering | 2,479 | 2,528 | 2,646 | 2,781 | 2,913 | 3,166 | 3,376 | 3,712 | 4,190 | 4,544 | 4,892 |
| **U.S. citizens** | | | | | | | | | | | |
| Total, all doctorates | 25,222 | 25,061 | 24,391 | 34,259 | 34,027 | 23,370 | 23,081 | 22,983 | 23,287 | 23,398 | 24,190 |
| Total science and engineering | 13,400 | 13,544 | 13,292 | 13,413 | 13,250 | 12,947 | 12,869 | 12,820 | 12,217 | 13,311 | 13,618 |
| Total sciences | 12,145 | 12,374 | 12,123 | 12,250 | 12,011 | 11,668 | 11,486 | 11,262 | 10,436 | 11.447 | 11.691 |
| Physical sciences | 1,884 | 1,956 | 1,991 | 2,064 | 2,071 | 2,043 | 2,014 | 2,080 | 2,100 | 1,973 | 2,077 |
| Mathematics | 520 | 482 | 458 | 411 | 407 | 376 | 366 | 345 | 342 | 393 | 369 |
| Computer sciences | 156 | 168 | 143 | 180 | 178 | 189 | 202 | 243 | 284 | 338 | 343 |
| Environmental sciences | 512 | 472 | 528 | 483 | 474 | 442 | 422 | 425 | 511 | 529 | 521 |
| Life sciences | 3,849 | 3,891 | 3,964 | 3,869 | 3,910 | 3,831 | 3,703 | 3,566 | 2,670 | 3,724 | 3,726 |
| Psychology | 2,849 | 3,111 | 2,876 | 3,044 | 2,935 | 2,805 | 2,766 | 2,747 | 2,667 | 2,684 | 2,790 |
| Social sciences | 2,375 | 2,294 | 2,163 | 2,199 | 2,036 | 1,982 | 2,013 | 1,856 | 1,862 | 1,806 | 1,865 |
| Total engineering | 1,255 | 1,170 | 1,169 | 1,163 | 1,239 | 1,279 | 1,383 | 1,558 | 1.781 | 1,864 | 1.927 |
| **Permanent residents** | | | | | | | | | | | |
| Total, all doctorates | 1,290 | 1,281 | 1,228 | 1,275 | 1,224 | 1,324 | 1,432 | 1,578 | 1,624 | 1,626 | 1,654 |
| Total science and engineering | 952 | 893 | 854 | 898 | 835 | 929 | 987 | 1,086 | 1,129 | 1,121 | 1,158 |
| Total sciences | 653 | 592 | 558 | 579 | 561 | 614 | 644 | 731 | 762 | 756 | 782 |
| Physical sciences | 151 | 147 | 119 | 120 | 119 | 135 | 133 | 147 | 136 | 146 | 167 |
| Mathematics | 62 | 43 | 41 | 46 | 36 | 42 | 36 | 51 | 41 | 35 | 47 |
| Computer sciences | 13 | 20 | 12 | 27 | 17 | 24 | 47 | 32 | 42 | 58 | 53 |
| Environmental sciences | 26 | 16 | 29 | 30 | 25 | 32 | 24 | 25 | 31 | 30 | 23 |
| Life sciences | 186 | 159 | 140 | 150 | 149 | 151 | 165 | 208 | 263 | 227 | 241 |
| Psychology | 50 | 47 | 47 | 64 | 51 | 59 | 65 | 59 | 61 | 54 | 69 |
| Social sciences | 165 | 160 | 170 | 142 | 164 | 171 | 174 | 209 | 185 | 206 | 182 |
| Total engineering | 299 | 301 | 296 | 319 | 274 | 315 | 343 | 355 | 367 | 365 | 376 |

(continued)

Appendix table 2-24.
**Science and engineering doctoral recipients, by field and citizenship: 1980-90**
(page 2 of 2)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **Temporary residents** | | | | | | |
| Total, all doctorates | 3,644 | 3,940 | 4,204 | 4,499 | 4,832 | 5,228 | 5,276 | 4,610 | 6,195 | 6,648 | 7,744 |
| Total science and engineering | 2,710 | 2,962 | 3,127 | 3,400 | 3,692 | 4,028 | 4,141 | 4,450 | 4,920 | 5,378 | 6,286 |
| Total sciences | 1,859 | 2,020 | 2,097 | 2,230 | 2,423 | 2,609 | 2,769 | 2,918 | 3,198 | 3,437 | 4,095 |
| Physical sciences | 426 | 442 | 506 | 539 | 564 | 620 | 758 | 798 | 865 | 888 | 1,021 |
| Mathematics | 139 | 186 | 192 | 209 | 232 | 238 | 272 | 302 | 305 | 346 | 413 |
| Computer sciences | 43 | 40 | 59 | 72 | 89 | 89 | 123 | 143 | 176 | 178 | 263 |
| Environmental sciences | 80 | 85 | 81 | 106 | 106 | 119 | 106 | 125 | 137 | 124 | 171 |
| Life sciences | 592 | 613 | 603 | 629 | 675 | 779 | 711 | 781 | 902 | 964 | 1,245 |
| Psychology | 71 | 80 | 65 | 79 | 88 | 81 | 81 | 85 | 84 | 106 | 116 |
| Social sciences | 508 | 574 | 591 | 596 | 669 | 683 | 718 | 684 | 729 | 831 | 866 |
| Total engineering | 851 | 942 | 1,030 | 1,170 | 1,269 | 1,419 | 1,372 | 1,532 | 1,722 | 1,941 | 2,191 |

[1]Includes those who did not report their citizenship status.

SOURCE: Science Resources Studies Division, National Science Foundation, unpublished tabulations from the Survey of Earned Doctorates.

See figure 2-14 and figure O-17 in Overview.

*Science & Engineering Indicators – 1991*

Appendix table 2-25.
**Natural science and engineering bachelors degrees, by country: 1975-90**

| | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | **Natural sciences** | | | | | | | | |
| North America and USSR | | | | | | | | | | | | | | | | |
| Canada | 8,338 | 9,019 | 9,559 | 9,803 | 9,312 | 9,210 | 8,818 | 9,456 | 10,041 | 11,331 | 12,876 | 14,200 | 14,039 | 14,456 | 13,966 | NA |
| United States | 117,988 | 121,722 | 123,087 | 121,861 | 120,621 | 119,645 | 120,387 | 123,346 | 125,712 | 131,163 | 138,275 | 138,993 | 134,984 | 125,531 | 116,343 | NA |
| USSR | 98,800 | 102,171 | 105,738 | 108,981 | 111,521 | 116,700 | 119,200 | 121,000 | 121,200 | 122,800 | 122,400 | 119,228 | 106,400 | 106,700 | NA | NA |
| Europe | | | | | | | | | | | | | | | | |
| France | 6,746 | 6,821 | 7,064 | 7,316 | 7,576 | 7,846 | 8,126 | 8,415 | 8,715 | 9,406 | 10,009 | 11,391 | 12,068 | 12,391 | 13,270 | 14,320 |
| Italy | 10,915 | 11,293 | 11,372 | 11,120 | 10,267 | 10,735 | 11,268 | 11,417 | 11,062 | 11,667 | 11,971 | 12,047 | 12,765 | 13,012 | NA | NA |
| Sweden | 906 | 898 | 810 | 733 | 718 | 628 | 582 | 583 | 740 | 857 | 913 | 1,075 | 1,256 | 1,347 | NA | NA |
| United Kingdom | 17,280 | 17,280 | 17,937 | 18,287 | 18,562 | 18,850 | 21,425 | 22,107 | 19,098 | 18,634 | 18,060 | 17,471 | 16,663 | 16,434 | NA | NA |
| West Germany | 6,510 | 6,426 | 7,239 | 7,618 | 7,571 | 8,043 | 8,939 | 9,266 | 10,124 | 10,802 | 11,507 | 12,419 | 12,925 | 14,714 | NA | NA |
| Asia | | | | | | | | | | | | | | | | |
| China | NA | NA | NA | NA | NA | NA | NA | 76,842 | 40,301 | 35,481 | 36,493 | 39,773 | 42,082 | NA | NA | NA |
| India | 123,353 | 118,671 | 114,223 | 110,004 | 106,004 | 109,217 | 112,669 | 116,232 | 119,912 | 123,165 | 128,236 | 129,964 | 133,257 | 137,4[illegible]9 | NA | NA |
| Japan | 18,984 | 19,977 | 20,689 | 21,625 | 23,871 | 22,736 | 23,358 | 22,771 | 22,381 | 23,423 | 23,626 | 23,805 | 24,655 | 23,972 | 23,547 | NA |
| Singapore | 466 | 490 | 335 | 347 | 528 | 573 | 460 | 577 | 663 | 726 | 854 | 945 | 1,012 | 982 | 1,166 | 1,278 |
| South Korea | 5,657 | 5,791 | 6,175 | 6,699 | 7,279 | 7,922 | 9,006 | 10,448 | 11,394 | 12,486 | 15,068 | 15,235 | 16,626 | 21,547 | 22,550 | 23,195 |
| Taiwan | 3,700 | 4,111 | 3,946 | 4,126 | 4,151 | 4,334 | 4,341 | 4,491 | 4,674 | 4,661 | 4,987 | 5,251 | 5,472 | 5,990 | NA | NA |
| | | | | | | | | **Engineering** | | | | | | | | |
| North America and USSR | | | | | | | | | | | | | | | | |
| Canada | 4,584 | 4,842 | 5,155 | 5,923 | 6,696 | 7,228 | 7,226 | 7,348 | 7,987 | 8,328 | 8,589 | 8,403 | 8,835 | 7,887 | 7,781 | NA |
| United States | 40,065 | 39,114 | 41,581 | 47,411 | 53,720 | 59,240 | 64,068 | 67,791 | 72,954 | 76,531 | 77,871 | 77,061 | 74,705 | 70,406 | 67,214 | NA |
| USSR | 272,100 | 280,400 | 291,400 | 300,100 | 306,800 | 319,800 | 327,000 | 330,300 | 331,500 | 335,400 | 334,900 | 330,700 | 288,300 | 281,100 | NA | NA |
| Europe | | | | | | | | | | | | | | | | |
| France | 9,956 | 10,264 | 10,176 | 10,429 | 11,100 | 11,548 | 11,754 | 12,156 | 12,650 | 12,670 | 13,659 | 13,722 | 14,576 | 14,998 | 16,658 | 17,019 |
| Italy | 6,949 | 10,808 | 10,798 | 10,788 | 10,777 | 10,767 | 10,757 | 10,663 | 10,570 | 10,477 | 10,386 | 10,295 | 10,794 | 11,318 | 11,867 | NA |
| Sweden | 1,724 | 1,796 | 1,745 | 1,695 | 1,713 | 1,766 | 1,821 | 1,878 | 1,891 | 2,113 | 1,947 | 2,086 | 2,455 | 2,346 | NA | NA |
| United Kingdom | 10,087 | 10,087 | 10,930 | 11,937 | 12,575 | 13,248 | 12,299 | 11,696 | 10,600 | 10,577 | 10,438 | 10,300 | 9,618 | 9,932 | NA | NA |
| West Germany | 3,810 | 4,242 | 4,499 | 5,105 | 5,120 | 5,449 | 5,639 | 6,023 | 6,469 | 6,826 | 6,734 | 7,216 | 7,246 | 8,675 | 9,579 | NA |
| Asia | | | | | | | | | | | | | | | | |
| China | NA | NA | NA | NA | NA | NA | NA | 145,263 | 89,726 | 77,388 | 63,132 | 72,703 | 92,994 | NA | NA | NA |
| India | 14,607 | 15,217 | 15,852 | 16,514 | 17,236 | 17,921 | 18,669 | 19,448 | 20,260 | 20,707 | 21,088 | 24,096 | 27,057 | 28,500 | NA | NA |
| Japan | 66,512 | 68,126 | 70,431 | 72,466 | 75,409 | 74,737 | 76,370 | 74,774 | 70,824 | 71,640 | 72,560 | 74,516 | 77,077 | 77,503 | 77,009 | NA |
| Singapore | 236 | 241 | 290 | 240 | 272 | 288 | 323 | 349 | 585 | 585 | 769 | 924 | 907 | 1,452 | 1,129 | 1,347 |
| South Korea | 7,155 | 7,272 | 7,858 | 8,919 | 10,124 | 11,492 | 13,044 | 14,806 | 20,636 | 22,190 | 23,539 | 27,612 | 27,600 | 26,891 | 28,141 | 28,071 |
| Taiwan | 5,000 | 5,142 | 5,258 | 5,559 | 6,315 | 6,463 | 7,299 | 7,309 | 7,320 | 7,330 | 7,703 | 7,730 | 7,508 | 7,994 | NA | NA |

NA = not available

SOURCE: Science Resources Studies Division, National Science Foundation, unpublished tabulations. See chapter 2 References for country sources.

See figures 2-15, 2-16, and 2-17, and text table 2-2

Appendix table 2-26.
**Natural science and engineering degrees as a percentage of 22-year-olds, by country: 1975-90**

| | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Percent | | | | | | | | |
| Western countries and USSR | | | | | | | | | | | | | | | | |
| France | 1.97 | 2.02 | 2.03 | 2.09 | 2.21 | 2.40 | 2.46 | 2.42 | 2.46 | 2.58 | 2.75 | 2.93 | 3.12 | 3.21 | NA | NA |
| Italy | 2.34 | 2.38 | 2.34 | 2.27 | 2.13 | 2.15 | 2.15 | 2.08 | 1.96 | [illegible] | 2.13 | 2.19 | 2.47 | 2.51 | NA | NA |
| United Kingdom | NA | 3.48 | 3.62 | 3.75 | 3.82 | 3.89 | 3.97 | 3.87 | 3.31 | [illegible] | 3.00 | 2.96 | 2.83 | 2.87 | NA | NA |
| United States | 4.05 | 3.88 | 3.75 | 3.65 | 3.55 | 4.14 | 4.29 | 4.46 | 4.65 | 4.88 | 5.10 | 5.22 | 5.19 | 4.97 | 4.60 | NA |
| USSR | 8.35 | 8.44 | 8.59 | 8.67 | 8.69 | 8.89 | 9.16 | 9.34 | 9.45 | 9.65 | 9.71 | 9.81 | 8.84 | 8.93 | NA | NA |
| West Germany | 1.23 | 1.24 | 1.34 | 1.32 | 1.38 | 1.53 | 1.58 | 1.44 | 1.54 | 1.57 | 1.62 | 1.76 | 1.82 | 2.13 | NA | NA |
| Asia | | | | | | | | | | | | | | | | |
| China | NA | NA | NA | NA | NA | NA | NA | 1.18 | 0.66 | 0.55 | 0.46 | 0.50 | 0.58 | 0.56 | NA | NA |
| India | 1.29 | 1.21 | 1.14 | 1.08 | 1.02 | 1.02 | 1.03 | 1.04 | 1.05 | 1.05 | 1.06 | 1.07 | 1.08 | 1.09 | NA | NA |
| Japan | 4.67 | 4.96 | 5.28 | 5.61 | 6.10 | 6.16 | 6.26 | 6.08 | 5.77 | 5.85 | 5.88 | 5.90 | 6.00 | 5.88 | 5.72 | NA |
| Singapore | 1.40 | 1.41 | 1.17 | 1.06 | 1.40 | 1.45 | 1.33 | 1.58 | 2.15 | 2.27 | 2.83 | 3.40 | 3.63 | 4.79 | 4.70 | NA |
| South Korea | 2.07 | 2.00 | 2.03 | 2.13 | 2.24 | 2.37 | 2.66 | 3.03 | 3.80 | 4.08 | 4.51 | [illegible] | 5.17 | 5.66 | 5.92 | 5.99 |
| Taiwan | NA | 2.59 | 2.53 | 2.61 | 2.76 | 2.75 | 3.01 | 2.99 | 3.01 | 2.99 | 3.18 | 3.26 | 3.32 | 3.61 | NA | NA |

NA = not available

SOURCE: Science Resources Studies Division, National Science Foundation, unpublished tabulations.

See figure 2-18.

Appendix table 2-27.
**Population of 20- to 24-year-olds, by country: 1975-2010**

| | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2010 |
|---|---|---|---|---|---|---|---|---|
| Western countries and USSR | | | | | | | | |
| France | 4,247 | 4,228 | 4,296 | 4,247 | 4,202 | 3,696 | 3,780 | 3,860 |
| Italy | 3,819 | 4,042 | 4,617 | 4,726 | 4,415 | 3,704 | 3,050 | 3,062 |
| United Kingdom | 3,891 | 4,125 | 4,747 | 4,493 | 3,882 | 3,396 | 3,606 | 3,776 |
| United States | 19,527 | 21,584 | 21,208 | 18,788 | 17,292 | 17,010 | 18,188 | 18,396 |
| USSR | 22,199 | 24,553 | 23,555 | 20,583 | 21,431 | 23,051 | 25,017 | 25,277 |
| West Germany | 5,550 | 5,986 | 6,598 | 6,306 | 4,606 | 3,951 | 4,146 | 4,203 |
| Asia | | | | | | | | |
| China | 90,236 | 86,505 | 107,785 | 128,692 | 124,198 | 96,821 | 92,344 | 108,403 |
| India | 53,509 | 62,367 | 70,207 | 78,284 | 86,970 | 91,549 | 105,460 | 114,409 |
| Japan | 9,155 | 7,906 | 8,184 | 8,942 | 10,009 | 8,503 | 7,432 | 6,919 |
| Singapore | 296 | 296 | 287 | 234 | 223 | 193 | 209 | 215 |
| South Korea | 3,089 | 4,103 | 4,281 | 4,281 | 4,374 | 4,563 | 3,999 | 3,740 |
| Taiwan | 1,710 | 1,895 | 2,002 | 1,906 | 1,806 | 2,029 | 1,861 | 1,524 |

SOURCES: UNESCO. *Statistical Yearbooks* for appropriate years; and unpublished tabulations.

*Science & Engineering Indicators – 1991*

Appendix table 2-28.

**Natural science and engineering bachelors degrees as a percentage of total degrees, by country: 1975-90**

| | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Natural sciences** | | | | | | | | | | | | | | | | |
| Percent | | | | | | | | | | | | | | | | |
| North America and USSR | | | | | | | | | | | | | | | | |
| Canada | NA | 10 | 10 | 10 | 9 | 9 | 9 | 9 | 10 | 10 | 11 | 12 | 12 | 12 | 11 | NA |
| United States | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 13 | 12 | 11 | NA |
| USSR | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | NA | NA |
| Europe | | | | | | | | | | | | | | | | |
| France | 19 | 18 | 17 | 17 | 16 | 15 | 15 | 14 | 14 | 14 | 14 | 16 | 16 | 16 | NA | NA |
| Italy | 16 | 18 | 18 | 18 | 18 | 19 | 19 | 19 | 18 | 18 | 18 | 18 | 18 | 18 | 17 | NA |
| Sweden | 7 | 5 | 5 | 5 | 5 | 4 | 3 | 3 | 4 | 4 | 5 | 7 | 8 | 8 | NA | NA |
| United Kingdom | NA | NA | NA | NA | 15 | 15 | 17 | 17 | 14 | 13 | 12 | 12 | 11 | 10 | NA | NA |
| West Germany | 19 | 18 | 19 | 19 | 18 | 17 | 19 | 18 | 18 | 19 | 19 | 19 | 19 | 20 | 21 | NA |
| Asia | | | | | | | | | | | | | | | | |
| China | NA | NA | NA | NA | NA | NA | NA | 18 | 13 | 14 | 14 | 14 | 13 | 12 | NA | NA |
| India | NA | 25 | 24 | 22 | 24 | 25 | 30 | 29 | 28 | 27 | 27 | 26 | 26 | 26 | NA | NA |
| Japan | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | NA |
| Singapore | NA | 20 | 21 | 15 | 15 | 19 | 22 | 21 | 24 | 23 | 20 | 20 | 20 | 20 | 20 | 21 |
| South Korea | NA | 17 | 17 | 16 | 16 | 16 | 16 | 17 | 15 | 14 | 13 | 11 | 11 | 13 | 14 | 14 |
| Taiwan | NA | NA | 14 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 13 | 14 | 14 | 14 | 15 | NA |
| **Engineering** | | | | | | | | | | | | | | | | |
| North America and USSR | | | | | | | | | | | | | | | | |
| Canada | NA | 5 | 5 | 6 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 7 | 7 | 6 | 6 | NA |
| United States | 4 | 4 | 4 | 5 | 6 | 6 | 7 | 7 | 7 | 8 | 8 | 8 | 7 | 7 | 7 | NA |
| USSR | 38 | 37 | 38 | 38 | 38 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 38 | 36 | NA | NA |
| Europe | | | | | | | | | | | | | | | | |
| France | 28 | 27 | 25 | 24 | 23 | 23 | 21 | 21 | 20 | 19 | 19 | 19 | 19 | 19 | NA | NA |
| Italy | 10 | 16 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 14 | 14 | 14 | 14 | 14 | NA |
| Sweden | 13 | 10 | 11 | 11 | 11 | 11 | 10 | 10 | 10 | 10 | 11 | 13 | 15 | 14 | NA | NA |
| United Kingdom | NA | NA | NA | NA | 10 | 11 | 10 | 9 | 8 | 7 | 7 | 7 | 6 | 6 | NA | NA |
| West Germany | 11 | 12 | 12 | 13 | 12 | 12 | 12 | 12 | 12 | 12 | 11 | 11 | 10 | 12 | 12 | NA |
| Asia | | | | | | | | | | | | | | | | |
| China | NA | NA | NA | NA | NA | NA | NA | 35 | 30 | 31 | 25 | 24 | 27 | 26 | NA | NA |
| India | NA | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | NA | NA |
| Japan | 21 | 21 | 21 | 20 | 20 | 20 | 20 | 20 | 19 | 19 | 19 | 20 | 20 | 20 | 20 | NA |
| Singapore | 10 | 12 | 14 | 12 | 12 | 13 | 18 | 18 | 25 | 19 | 21 | 22 | 21 | 31 | 22 | NA |
| South Korea | NA | 21 | 21 | 22 | 22 | 23 | 23 | 24 | 27 | 24 | 20 | 20 | 18 | 17 | 17 | 17 |
| Taiwan | NA | 18 | 18 | 18 | 20 | 19 | 23 | 22 | 22 | 21 | 22 | 21 | 19 | 21 | NA | NA |

NA = not available

SOURCE: Science Resources Studies Division, National Science Foundation, unpublished tabulations.

Appendix table 3-1.
**Total and scientist and engineer employment, by industry: 1980, 1983, 1986, and 1989**
(page 1 of 4)

| Industry | 1980 | 1983 | 1986 | 1989 |
|---|---|---|---|---|
| | Number of jobs | | | |
| | Thousands | | | |
| **TOTAL PRIVATE** | | | | |
| All occupations | 66,160 | 65,556 | 73,279 | 79,501 |
| All scientists and engineers | 1,366 | 1,523 | 1,702 | 1,917 |
| Scientists | 374 | 425 | 498 | 568 |
| Life | 19 | 26 | 29 | 34 |
| Mathematical | 45 | 59 | 66 | 79 |
| Physical | 108 | 110 | 113 | 112 |
| Social | 26 | 29 | 25 | 25 |
| Computer specialists | 175 | 201 | 264 | 318 |
| Engineers | 992 | 1,098 | 1,204 | 1,349 |
| Aeronautical/astronautical | 27 | 33 | 59 | 57 |
| Chemical | 45 | 47 | 42 | 41 |
| Civil | 79 | 104 | 94 | 103 |
| Electrical/electronic | 273 | 319 | 377 | 436 |
| Industrial | 133 | 103 | 120 | 124 |
| Mechanical | 198 | 199 | 196 | 208 |
| Other[1] | 237 | 294 | 317 | 381 |
| MANUFACTURING | | | | |
| All occupations | 20,286 | 18,434 | 18,964 | 19,442 |
| All scientists and engineers | 745 | 814 | 927 | 993 |
| Scientists | 140 | 144 | 175 | 193 |
| Life | 11 | 15 | 18 | 23 |
| Mathematical | 13 | 12 | 14 | 12 |
| Physical | 64 | 57 | 57 | 55 |
| Social | 1 | 1 | 1 | 1 |
| Computer specialists | 52 | 59 | 85 | 103 |
| Engineers | 605 | 670 | 753 | 804 |
| Aeronautical/astronautical | 23 | 29 | 52 | 49 |
| Chemical | 33 | 36 | 34 | 31 |
| Civil | 7 | 8 | 8 | 8 |
| Electrical/electronic | 159 | 206 | 234 | 256 |
| Industrial | 123 | 89 | 104 | 104 |
| Mechanical | 126 | 135 | 135 | 143 |
| Other[1] | 135 | 167 | 185 | 213 |
| NONMANUFACTURING | | | | |
| All occupations | 45,874 | 47,122 | 54,315 | 60,059 |
| All scientists and engineers | 621 | 709 | 775 | 920 |
| Scientists | 234 | 281 | 323 | 375 |
| Life | 8 | 11 | 12 | 11 |
| Mathematical | 33 | 47 | 53 | 67 |
| Physical | 44 | 53 | 56 | 57 |
| Social | 25 | 28 | 24 | 24 |
| Computer specialists | 124 | 142 | 179 | 216 |
| Engineers | 387 | 428 | 452 | 545 |
| Aeronautical/astronautical | 4 | 4 | 6 | 8 |
| Chemical | 12 | 11 | 8 | 9 |
| Civil | 73 | 95 | 86 | 94 |
| Electrical/electronic | 113 | 113 | 144 | 180 |
| Industrial | 10 | 14 | 15 | 20 |
| Mechanical | 72 | 64 | 61 | 65 |
| Other[1] | 102 | 127 | 131 | 168 |

(continued)

Appendix table 3-1.
**Total and scientist and engineer employment, by industry: 1980, 1983, 1986, and 1989**
(page 2 of 4)

| Industry | Number of jobs | | | |
|---|---|---|---|---|
| | 1980 | 1983 | 1986 | 1989 |
| | Thousands | | | |
| **Mining** | | | | |
| All occupations | 1,027 | 952 | 777 | 693 |
| All scientists and engineers | 55 | 65 | 56 | 47 |
| Scientists | 26 | 30 | 26 | 21 |
| Life | 0 | 0 | 0 | 0 |
| Mathematical | 0 | 0 | 0 | 0 |
| Physical | 21 | 25 | 22 | 18 |
| Social | 0 | 0 | 0 | 0 |
| Computer specialists | 4 | 5 | 4 | 3 |
| Engineers | 29 | 35 | 30 | 26 |
| Aeronautical/astronautical | 0 | 0 | 0 | 0 |
| Chemical | 1 | 1 | 1 | 1 |
| Civil | 1 | 2 | 1 | 1 |
| Electrical/electronic | 2 | 1 | 1 | 1 |
| Industrial | 0 | 0 | 0 | 0 |
| Mechanical | 1 | 3 | 2 | 2 |
| Other[1] | 24 | 28 | 25 | 21 |
| **Construction** | | | | |
| All occupations | 4,346 | 3,948 | 4,816 | 5,187 |
| All scientists and engineers | 53 | 48 | 32 | 22 |
| Scientists | 1 | 1 | 1 | 1 |
| Life | 0 | 0 | 0 | 0 |
| Mathematical | 0 | 0 | 0 | 0 |
| Physical | 0 | 0 | 0 | 0 |
| Social | 0 | 0 | 0 | 0 |
| Computer specialists | 1 | 1 | 1 | 1 |
| Engineers | 52 | 47 | 31 | 21 |
| Aeronautical/astronautical | 0 | 0 | 0 | 0 |
| Chemical | 0 | 0 | 0 | 0 |
| Civil | 18 | 19 | 10 | 7 |
| Electrical/electronic | 7 | 6 | 5 | 3 |
| Industrial | 0 | 1 | 1 | 1 |
| Mechanical | 10 | 7 | 5 | 4 |
| Other[1] | 17 | 13 | 10 | 6 |
| **Communications/transportation/utilities** | | | | |
| All occupations | 5,146 | 4,954 | 5,255 | 5,644 |
| All scientists anu engineers | 95 | 114 | 110 | 113 |
| Scientists | 13 | 32 | 32 | 32 |
| Life | 0 | 0 | 1 | 0 |
| Mathematical | 1 | 4 | 2 | 2 |
| Physical | 0 | 0 | 2 | 2 |
| Social | 0 | 1 | 2 | 0 |
| Computer specialists | 11 | 16 | 19 | 26 |
| Engineers | 82 | 81 | 78 | 81 |
| Aeronautical/astronautical | 1 | 1 | 1 | 1 |
| Chemical | 1 | 1 | 1 | 1 |
| Civil | 5 | 7 | 8 | 7 |
| Electrical/electronic | 43 | 40 | 38 | 39 |
| Industrial | 4 | 6 | 5 | 8 |
| Mechanical | 7 | 6 | 6 | 5 |
| Other[1] | 20 | 21 | 20 | 20 |

(continued)

Appendix table 3-1.
**Total and scientist and engineer employment, by industry: 1980, 1983, 1986, and 1989**
(page 3 of 4)

| Industry | 1980 | 1983 | 1986 | 1989 |
|---|---|---|---|---|
| | Number of jobs | | | |
| | Thousands | | | |
| **Trade** | | | | |
| All occupations | 20,310 | 20,880 | 23,683 | 25,769 |
| All scientists and engineers | 66 | 66 | 72 | 97 |
| Scientists | 26 | 30 | 27 | 21 |
| Life | 0 | 1 | 1 | 0 |
| Mathematical | 0 | 2 | 0 | 0 |
| Physical | 1 | 2 | 2 | 0 |
| Social | 0 | 0 | 0 | 0 |
| Computer specialists | 25 | 26 | 24 | 21 |
| Engineers | 40 | 36 | 45 | 76 |
| Aeronautical/astronautical | 0 | 0 | 0 | 0 |
| Chemical | 3 | 0 | 0 | 0 |
| Civil | 0 | 0 | 0 | 0 |
| Electrical/electronic | 16 | 11 | 16 | 21 |
| Industrial | 0 | 0 | 0 | 0 |
| Mechanical | 18 | 9 | 7 | 6 |
| Other[1] | 3 | 15 | 23 | 49 |
| **Financial services** | | | | |
| All occupations | 5,160 | 5,468 | 6,283 | 6,695 |
| All scientists and engineers | 52 | 73 | 95 | 134 |
| Scientists | 46 | 64 | 86 | 116 |
| Life | 0 | 0 | 0 | 0 |
| Mathematical | 16 | 23 | 27 | 38 |
| Physical | 0 | 0 | 0 | 0 |
| Social | 2 | 7 | 6 | 7 |
| Computer specialists | 28 | 33 | 52 | 71 |
| Engineers | 5 | 8 | 10 | 19 |
| Aeronautical/astronautical | 0 | 0 | 0 | 0 |
| Chemical | 0 | 0 | 0 | 0 |
| Civil | 0 | 0 | 0 | 0 |
| Electrical/electronic | 0 | 0 | 0 | 0 |
| Industrial | 0 | 0 | 0 | 0 |
| Mechanical | 0 | 0 | 0 | 0 |
| Other[1] | 5 | 8 | 10 | 19 |
| **Business and related services** | | | | |
| All occupations | 9,885 | 10,920 | 13,501 | 16,071 |
| All scientists and engineers | 301 | 356 | 416 | 508 |
| Scientists | 122 | 134 | 159 | 185 |
| Life | 7 | 9 | 10 | 11 |
| Mathematical | 15 | 18 | 24 | 28 |
| Physical | 22 | 26 | 30 | 37 |
| Social | 23 | 20 | 16 | 17 |
| Computer specialists | 54 | 61 | 80 | 93 |
| Engineers | 179 | 222 | 257 | 323 |
| Aeronautical/astronautical | 3 | 3 | 6 | 7 |
| Chemical | 9 | 8 | 6 | 7 |
| Civil | 49 | 68 | 67 | 80 |
| Electrical/electronic | 46 | 55 | 84 | 116 |
| Industrial | 5 | 6 | 10 | 12 |
| Mechanical | 35 | 39 | 40 | 48 |
| Other[1] | 32 | 42 | 45 | 53 |

(continued)

Appendix table 3-1.
**Total and scientist and engineer employment, by industry: 1980, 1983, 1986, and 1989**
(page 4 of 4)

NOTES: Details may not sum to totals because of rounding. The Standard Industrial Classification numbers are:

| | |
|---|---|
| Manufacturing | 20-39 |
| Nonmanufacturing | |
| Mining | 10-14 |
| Construction | 15-17 |
| Communications/transportation/utilities | 40-49 |
| Trade | 50-59 |
| Financial services | 60-67 |
| Business and related services | 70-79,81,83,87 |

[1]The "other" engineering category includes a number of smaller fields that are combined in the interest of space. None of these fields individually accounts for more than about 5 percent of the total engineering jobs.

SOURCES: Science Resources Studies Division, National Science Foundation, unpublished tabulations; and Bureau of Labor Statistics, unpublished tabulations from the Occupation Employment Statistics Survey.

See figures 3-1, 3-2, 3-3, 3-4, and 3-5, and figures O-8, O-9, and O-10 in Overview. *Science & Engineering Indicators – 1991*

Appendix table 3-2.
**Scientists and engineers employed in R&D in manufacturing industries: 1989**

| | Scientists in R&D | | | | | Engineers in R&D | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Life | Math | Physical | Computer specialists | Total | Aeronautical/ astronautical | Chemical | Civil | Electrical/ electronic | Industrial | Mechanical | Other |
| | | | | | | Thousands | | | | | | | |
| Total manufacturing | 37.8 | 11.5 | 0.6 | 21.3 | 4.4 | 77.7 | 5.6 | 6.5 | 0.1 | 32.6 | 1.7 | 9.4 | 21.8 |
| Transportation equipment | 2.0 | 0 | 0.3 | 0 | 1.7 | 19.7 | 5.6 | 0.2 | 0 | 0.5 | 0.5 | 1.3 | 11.6 |
| Machinery, except electrical | 0.5 | 0 | 0 | 0 | 0.5 | 16.4 | 0 | 0 | 0 | 10.7 | 0.3 | 2.7 | 2.7 |
| Electrical/electronic equipment | 0.6 | 0 | 0 | 0.3 | 0.3 | 13.8 | 0 | 0.2 | 0 | 11.1 | 0.1 | 1.1 | 1.3 |
| Instruments and related products | 2.0 | 0.6 | 0 | 0.6 | 0.7 | 12.9 | 0 | 0.3 | 0 | 9.6 | 0.3 | 1.0 | 1.7 |
| Chemicals and allied products | 27.8 | 10.5 | 0.2 | 16.2 | 0.9 | 7.0 | 0 | 4.1 | 0 | 0.3 | 0.2 | 0.6 | 1.8 |
| Other | 4.9 | 0.4 | 0.1 | 4.2 | 0.3 | 7.9 | 0 | 1.7 | 0.1 | 0.4 | 0.3 | 1.9 | 3.5 |

SOURCES: Science Resources Studies Division, National Science Foundation, *Total and R&D Scientists, Engineers, and Technicians in Manufacturing Industries: 1989* (Washington, DC:NSF).

See figure 3-6.

*Science & Engineering Indicators – 1991*

Appendix table 3-3.
**Number of 1988 and 1989 science and engineering bachelors degree recipients, by field of degree and graduate school status: 1990**

| Field of degree | Total | Graduate school status | | | | |
|---|---|---|---|---|---|---|
| | | Full-time student | Part-time student | Non-student | Other | No report |
| Total science and engineering | 643,200 | 127,100 | 68,800 | 439,200 | 7,400 | 800 |
| Total sciences | 494,500 | 110,000 | 50,800 | 327,000 | 6,200 | 500 |
| Physical | 29,400 | 11,600 | 2,600 | 15,100 | 100 | * |
| Mathematics | 35,200 | 6,500 | 3,900 | 24,300 | 500 | * |
| Computer | 69,300 | 4,100 | 6,600 | 57,900 | 400 | 300 |
| Environmental | 7,300 | 2,200 | 700 | 4,400 | * | * |
| Life | 111,200 | 35,600 | 10,400 | 64,100 | 1,000 | * |
| Psychology | 85,700 | 17,900 | 12,000 | 54,300 | 1,200 | 200 |
| Social | 156,400 | 32,000 | 14,500 | 106,900 | 3,000 | * |
| Total engineering | 148,700 | 17,100 | 18,000 | 112,200 | 1,200 | 300 |
| Aeronautical/astronautical | 6,700 | 800 | 700 | 5,200 | * | * |
| Chemical | 7,700 | 1,100 | 700 | 5,700 | * | * |
| Civil | 15,200 | 1,500 | 1,200 | 12,300 | 100 | * |
| Electrical/electronic | 55,500 | 5,900 | 8,100 | 40,800 | 600 | 200 |
| Industrial | 12,300 | 600 | 1,700 | 9,900 | 100 | * |
| Materials | 1,800 | 400 | 100 | 1,200 | * | * |
| Mechanical | 30,000 | 3,200 | 3,100 | 23,300 | 300 | 100 |
| Mining | 1,100 | 300 | * | 800 | * | * |
| Nuclear | 900 | 200 | 200 | 500 | * | * |
| Petroleum | 1,200 | 200 | 100 | 900 | * | * |
| Other | 16,500 | 2,800 | 2,000 | 11,600 | 100 | 100 |

* = too few cases to report

NOTE: Details may not sum to totals because of rounding.

SOURCE: Science Resources Studies Division, National Science Foundation, *Characteristics of Recent Science and Engineering Graduates: 1990* (Washington, DC: NSF, forthcoming).

See figure 3-8.

Appendix table 3-4.
**Number of 1988 and 1989 science and engineering masters degree recipients, by field of degree and graduate school status: 1990**

| | | Graduate school status | | | | |
|---|---|---|---|---|---|---|
| Field of degree | Total | Full-time student | Part-time student | Non-student | Other | No report |
| Total science and engineering | 136,600 | 31,100 | 10,300 | 94,400 | 800 | 100 |
| Total sciences | 93,700 | 23,600 | 6,700 | 63,100 | 300 | 100 |
| Physical | 9,200 | 3,800 | 500 | 4,700 | 100 | * |
| Mathematics/statistics | 10,600 | 1,900 | 800 | 7,800 | * | * |
| Computer | 22,200 | 2,100 | 1,500 | 18,500 | * | * |
| Environmental | 5,200 | 1,100 | 300 | 3,800 | 100 | * |
| Life | 19,300 | 6,800 | 1,200 | 11,200 | 100 | * |
| Psychology | 7,300 | 2,500 | 800 | 3,900 | * | * |
| Social | 19,900 | 5,200 | 1,500 | 13,100 | 100 | * |
| Total engineering | 42,900 | 7,500 | 3,600 | 31,300 | 500 | * |
| Aeronautical/astronautical | 1,800 | 400 | 100 | 1,300 | * | * |
| Chemical | 2,100 | 600 | 100 | 1,400 | * | * |
| Civil | 4,700 | 500 | 300 | 3,900 | 100 | * |
| Electrical/electronic | 13,800 | 2,600 | 1,700 | 9,100 | 300 | * |
| Industrial | 2,600 | 200 | 100 | 2,200 | * | * |
| Materials | 1,700 | 600 | 100 | 1,000 | * | * |
| Mechanical | 8,000 | 1,200 | 800 | 6,000 | * | * |
| Mining | 500 | 100 | * | 400 | * | * |
| Nuclear | 500 | 200 | * | 200 | * | * |
| Petroleum | 400 | 100 | * | 300 | * | * |
| Other | 6,700 | 900 | 400* | 5,400 | * | * |

* = too few cases to report

NOTE: Details may not sum to totals because of rounding.

SOURCE: Science Resources Studies Division, National Science Foundation, *Characteristics of Recent Science and Engineering Graduates: 1990* (Washington, DC: NSF, forthcoming).

See figure 3-8.

*Science & Engineering Indicators – 1991*

Appendix table 3-5.
**Median annual salaries of 1988 and 1989 science and engineering (S&E) bachelors degree recipients, by field of degree, gender, and race/ethnicity: 1990**

| Field of degree | Total | Male | Female | White | Black | Asian | Native American | Hispanic[1] |
|---|---|---|---|---|---|---|---|---|
| Total science and engineering | $26,000 | $29,500 | $21,600 | $26,100 | $24,000 | $30,000 | $21,900 | $25,100 |
| Total sciences | 23,000 | 25,100 | 20,100 | 23,000 | 22,200 | 27,900 | * | 21,100 |
| Physical | 25,100 | 26,500 | 24,900 | 25,000 | * | * | * | 24,000 |
| Mathematics/statistics | 23,600 | 24,000 | 23,000 | 24,000 | * | * | * | * |
| Computer | 30,100 | 30,600 | 30,000 | 30,100 | 28,000 | 33,200 | * | 30,000 |
| Environmental | 23,700 | 24,000 | 22,900 | 23,600 | * | * | * | * |
| Life | 21,000 | 23,000 | 19,600 | 21,000 | 20,100 | * | * | * |
| Psychology | 18,600 | 21,300 | 18,000 | 18,600 | * | * | * | * |
| Social | 21,900 | 23,900 | 20,100 | 21,500 | 21,900 | * | * | * |
| Total engineering | 33,000 | 33,000 | 33,800 | 33,300 | 32,500 | 32,800 | * | 32,200 |
| Aeronautical/astronautical | 34,800 | 34,400 | * | 34,900 | * | * | * | * |
| Chemical | 35,100 | 35,100 | 35,100 | 35,200 | * | * | * | * |
| Civil | 30,100 | 30,100 | 31,100 | 30,000 | * | 33,600 | * | 32,900 |
| Electrical/electronic | 34,000 | 34,000 | 33,900 | 34,300 | 32,900 | 33,300 | * | * |
| Industrial | 31,100 | 30,600 | 32,700 | 31,500 | 27,000 | * | * | 28,000 |
| Materials | 33,200 | 33,800 | 31,600 | 32,900 | * | * | * | * |
| Mechanical | 34,000 | 33,800 | 35,000 | 34,000 | * | * | * | * |
| Mining | 30,100 | 31,000 | * | 31,000 | * | * | * | * |
| Nuclear | 33,300 | 34,000 | 31,600 | 33,000 | * | * | * | * |
| Petroleum | 36,600 | 36,500 | 38,700 | 36,600 | * | * | * | * |
| Other | 30,000 | 30,000 | 30,100 | 30,100 | * | * | * | * |

* = no median was computed for groups with fewer than 20 individuals reporting salary

NOTES: Median salaries were computed only for full-time employed civilians. Data exclude full-time graduate students.

[1]Includes members of all racial groups.

SOURCE: Science Resources Studies Division, National Science Foundation, *Characteristics of Recent Science and Engineering Graduates: 1990* (Washington, DC: NSF, forthcoming).

See text table 3-1.

*Science & Engineering Indicators – 1991*

Appendix table 3-6.
**Median annual salaries of 1988 and 1989 science and engineering (S&E) masters degree recipients, by field of degree, gender, and race/ethnicity: 1990**

| Field of degree | Total | Male | Female | White | Black | Asian | Native American | Hispanic[1] |
|---|---|---|---|---|---|---|---|---|
| Total science and engineering | $37,000 | $39,000 | $32,800 | $37,500 | $35,000 | $35,900 | * | $36,100 |
| Total sciences | 33,800 | 35,400 | 31,200 | 34,000 | 30,100 | 33,000 | * | 29,000 |
| Physical | 34,900 | 36,000 | 31,100 | 35,900 | * | 32,100 | * | * |
| Mathematics/statistics | 32,800 | 35,000 | 30,000 | 32,800 | * | * | * | * |
| Computer | 42,100 | 42,900 | 40,100 | 43,900 | * | 36,000 | * | * |
| Environmental | 33,800 | 35,000 | 31,800 | 34,300 | * | * | * | * |
| Life | 26,900 | 26,900 | 26,600 | 26,900 | * | * | * | * |
| Psychology | 32,000 | 36,900 | 32,000 | 32,100 | * | * | * | * |
| Social | 31,000 | 30,000 | 31,200 | 31,100 | * | * | * | * |
| Total engineering | 41,400 | 42,000 | 40,100 | 42,100 | 41,900 | 39,100 | * | 40,100 |
| Aeronautical/astronautical | 46,500 | 46,500 | * | 46,500 | * | * | * | * |
| Chemical | 40,200 | 40,600 | 38,100 | 41,000 | * | 39,100 | * | * |
| Civil | 35,200 | 35,200 | 35,600 | 35,900 | * | 30,800 | * | * |
| Electrical/electronic | 46,500 | 46,700 | * | 47,900 | * | 41,000 | * | * |
| Industrial | 40,300 | 40,200 | 40,400 | 42,000 | * | * | * | * |
| Materials | 41,300 | 40,400 | 42,200 | 41,400 | * | 40,100 | * | * |
| Mechanical | 42,100 | 42,100 | * | 42,100 | * | * | * | * |
| Mining | 37,300 | 37,500 | * | 37,300 | * | * | * | * |
| Nuclear | 40,200 | 40,100 | * | 40,400 | * | * | * | * |
| Petroleum | 40,800 | 41,100 | * | 40,900 | * | * | * | * |
| Other | 39,000 | 39,900 | 37,000 | 39,000 | * | 40,000 | * | * |

* = no median was computed for groups with fewer than 20 individuals reporting salary

NOTES: Median salaries were computed only for full-time employed civilians. Data exclude full-time graduate students.

[1]Includes members of all racial groups.

SOURCE: Science Resources Studies Division, National Science Foundation, *Characteristics of Recent Science and Engineering Graduates: 1990* (Washington, DC: NSF, forthcoming).

See text table 3-1.

Appendix table 3-7.
**Selected employment characteristics of 1988 and 1989 science and engineering bachelors and masters degree recipients, by field of degree and gender: 1990**
(page 1 of 2)

| Field of degree and gender | Labor force participation rate | | Unemployment rate | | In-field employment rate | | S&E employment rate | |
|---|---|---|---|---|---|---|---|---|
| | Bachelors | Masters | Bachelors | Masters | Bachelors | Masters | Bachelors | Masters |
| TOTAL SCIENCE AND ENGINEERING | 97.4 | 97.1 | 3.4 | 1.8 | 37.8 | 59.0 | 62.0 | 89.3 |
| Male | 98.2 | 98.5 | 3.5 | 1.5 | 42.7 | 57.6 | NA | NA |
| Female | 96.1 | 93.9 | 3.3 | 2.7 | 29.9 | 62.4 | NA | NA |
| **Total sciences** | 96.9 | 96.9 | 3.7 | 1.9 | 33.2 | 59.6 | 52.5 | 85.2 |
| Male | 97.7 | 98.8 | 4.0 | 1.5 | 38.0 | 57.1 | NA | NA |
| Female | 95.9 | 94.0 | 3.4 | 2.6 | 27.7 | 63.7 | NA | NA |
| Physical | 97.0 | 97.9 | 5.0 | 2.1 | 35.6 | 43.4 | 84.8 | 94.8 |
| Male | 97.3 | 98.5 | 6.0 | 2.1 | 33.9 | 41.7 | NA | NA |
| Female | 96.5 | • | 2.8 | • | 39.1 | • | NA | NA |
| Mathematics/statistics | 96.7 | 98.1 | 4.1 | 1.1 | 39.6 | 57.4 | 74.0 | 87.8 |
| Male | 98.7 | 99.6 | 3.1 | 1.5 | 31.7 | 53.3 | NA | NA |
| Female | 94.8 | 95.9 | 5.2 | 0.5 | 47.9 | 63.1 | NA | NA |
| Computer | 98.3 | 98.2 | 2.5 | 1.5 | 81.5 | 77.2 | 87.9 | 91.8 |
| Male | 98.9 | 99.3 | 2.4 | 0.8 | 79.7 | 73.0 | NA | NA |
| Female | 96.7 | 95.3 | 2.6 | 3.2 | 86.5 | 88.8 | NA | NA |
| Environmental | 97.2 | 99.8 | 4.8 | 2.7 | 56.1 | 69.4 | 84.6 | 100.0 |
| Male | 97.2 | 99.7 | 4.5 | 2.7 | 57.3 | 71.5 | NA | NA |
| Female | • | • | • | • | • | • | NA | NA |
| Life | 96.0 | 96.5 | 4.6 | 2.1 | 38.4 | 59.0 | 64.8 | 90.4 |
| Male | 97.8 | 98.0 | 4.3 | 2.1 | 40.4 | 52.5 | NA | NA |
| Female | 94.3 | 95.0 | 4.8 | 2.1 | 36.5 | 65.9 | NA | NA |
| Psychology | 96.1 | 97.6 | 2.9 | 3.6 | 9.9 | 48.1 | 29.5 | 71.9 |
| Male | 97.4 | 100.0 | 6.9 | 2.5 | 9.4 | 41.0 | NA | NA |
| Female | 95.5 | 96.3 | 1.0 | 4.2 | 10.1 | 52.3 | NA | NA |
| Social | 97.1 | 93.4 | 4.0 | 2.1 | 14.1 | 43.5 | 28.0 | 68.0 |
| Male | 96.9 | 97.5 | 3.8 | 1.2 | 16.6 | 38.9 | NA | NA |
| Female | 97.4 | 88.5 | 4.2 | 3.3 | 11.2 | 49.5 | NA | NA |
| **Total engineering** | 98.9 | 97.5 | 2.7 | 1.7 | 50.7 | 57.8 | 90.8 | 98.2 |
| Male | 99.0 | 98.1 | 2.8 | 1.5 | 50.9 | 58.2 | NA | NA |
| Female | 98.0 | 93.1 | 2.1 | 3.2 | 49.8 | 54.5 | NA | NA |
| Aeronautical/astronautical | 100.0 | • | 2.5 | • | 48.9 | • | 82.3 | 93.8 |
| Male | 100.0 | • | 2.7 | • | 46.7 | • | NA | NA |
| Female | • | • | • | • | • | • | NA | NA |
| Chemical | 95.1 | • | 2.8 | • | 49.6 | • | 98.5 | NA |
| Male | 93.2 | • | 4.0 | • | 51.8 | • | NA | NA |
| Female | 99.2 | • | 0.2 | • | 45.2 | • | NA | NA |
| Civil | 98.6 | 98.1 | 2.0 | 1.4 | 71.1 | 69.1 | 92.9 | NA |
| Male | 99.3 | 98.9 | 2.1 | 1.6 | 71.1 | 70.8 | NA | NA |
| Female | 94.8 | • | 0.9 | • | 71.3 | • | NA | NA |
| Electrical/electronic | 99.3 | 95.8 | 2.6 | 1.5 | 53.3 | 57.7 | 92.0 | NA |
| Male | 99.4 | 96.9 | 2.6 | 0.8 | 53.8 | 58.6 | NA | NA |
| Female | 98.7 | • | 3.2 | • | 49.5 | • | NA | NA |

(continued)

Appendix table 3-7.
**Selected employment characteristics of 1988 and 1989 science and engineering bachelors and masters degree recipients, by field of degree and gender: 1990**
(page 2 of 2)

| | Labor force participation rate | | Unemployment rate | | In-field employment rate | | S&E employment rate | |
|---|---|---|---|---|---|---|---|---|
| Field of degree and gender | Bachelors | Masters | Bachelors | Masters | Bachelors | Masters | Bachelors | Masters |
| Industrial | 98.9 | 99.1 | 4.5 | 5.9 | 42.2 | 26.5 | 85.2 | 79.2 |
| Male | 99.4 | 99.0 | 5.3 | 6.3 | 41.9 | 27.1 | NA | NA |
| Female | 96.9 | * | 1.5 | * | 43.5 | * | NA | NA |
| Materials | * | * | * | * | * | * | NA | NA |
| Male | * | * | * | * | * | * | NA | NA |
| Female | * | * | * | * | * | * | NA | NA |
| Mechanical | 98.7 | 99.5 | 3.0 | 0.8 | 44.3 | 60.4 | 91.5 | 94.7 |
| Male | 98.9 | 99.7 | 2.8 | 0.8 | 43.3 | 61.1 | NA | NA |
| Female | 97.1 | * | 4.4 | * | 52.2 | * | NA | * |
| Mining | * | * | * | * | * | * | NA | NA |
| Male | * | * | * | * | * | * | NA | NA |
| Female | * | * | * | * | * | * | NA | NA |
| Nuclear | * | * | * | * | * | * | NA | NA |
| Male | * | * | * | * | * | * | NA | NA |
| Female | * | * | * | * | * | * | NA | NA |
| Petroleum | * | * | * | * | * | * | NA | NA |
| Male | * | * | * | * | * | * | NA | NA |
| Female | * | * | * | * | * | * | NA | NA |
| Other | 99.0 | 97.4 | 1.4 | 1.6 | 38.6 | 53.5 | 84.1 | 98.3 |
| Male | 98.9 | 97.4 | 1.6 | 1.6 | 38.6 | 48.7 | NA | NA |
| Female | 99.4 | * | 0.6 | * | 38.7 | * | NA | NA |

* = no rate was computed for groups with fewer than 1,500 individuals in labor force; NA = not available

NOTE: Data exclude full-time graduate students.

SOURCE: Science Resources Studies Division, National Science Foundation, *Characteristics of Recent Science and Engineering Graduates: 1990* (Washington, DC: NSF, forthcoming).

See figure 3-8 and text table 3-2.

*Science & Engineering Indicators – 1991*

Appendix table 3-8.
**Number of 1988 and 1989 science and engineering bachelors degree recipients, by field of degree and primary work activity: 1990**

| | | Primary work activity | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Research and development | | | | Management/administration | | | | | | | | | |
| Field of degree | Total employed | Total | Basic research | Applied research | Devlopment | Total | Of R&D | Of non-R&D | Teaching | Prod./ inspection | Reporting/ stat. work/ computing | Sales | Professional services | Other | No report |
| Total science and engineering | 485,400 | 89,200 | 9,300 | 19,100 | 60,800 | 70,700 | 11,500 | 59,200 | 47,500 | 68,200 | 73,700 | 46,400 | 8.100 | 77,600 | 4,200 |
| Total sciences | 358,800 | 45,500 | 8,500 | 15,200 | 21,800 | 56,000 | 8,400 | 47,700 | 45,300 | 37,100 | 61,700 | 41.70 | 7,900 | 60,300 | 3,300 |
| Physical | 16.400 | 4,800 | 900 | 1,700 | 2,300 | 1.600 | 200 | 1,500 | 2,000 | 3,100 | 1,40 | 1.100 | 100 | 2,200 | 100 |
| Mathematics/statistics | 26,600 | 2.000 | 300 | 500 | 1,200 | 2,300 | 500 | 1,800 | 7,700 | 2,000 | 6.600 | 2,200 | * | 3,600 | 100 |
| Computer | 62.500 | 13,500 | 200 | 800 | 12,500 | 4,700 | 800 | 3,900 | 1,300 | 5,000 | 28,700 | 1,300 | 200 | 7,100 | 600 |
| Environmental | 4,700 | 700 | 200 | 500 | * | 400 | * | 400 | 300 | 1,100 | 500 | 200 | * | 1,400 | * |
| Life | 69,300 | 15,000 | 5.500 | 6.300 | 3,300 | 9,200 | 1,600 | 7,700 | 8,100 | 13,400 | 3,300 | 5.600 | 2.300 | 11,300 | 1,000 |
| Psychology | 63.300 | 3,600 | 1,00C | 1.900 | 800 | 11,500 | 1.200 | 10,200 | 12,900 | 3.800 | 5,300 | 8,100 | 3.600 | 13.900 | 600 |
| Social | 116,000 | 5,900 | 500 | 3,600 | 1,600 | 26,300 | 4,000 | 22.200 | 12,900 | 8.700 | 15,900 | 23,100 | 1,600 | 20,700 | 900 |
| Total engineering | 126.700 | 43.700 | 800 | 3,900 | 39.000 | 14,600 | 3,100 | 11.500 | 2,200 | 31 000 | 12,000 | 4.700 | 200 | 17.300 | 900 |
| Aeronautical/astronautical | 5.800 | 2.100 | 100 | 300 | 1,800 | 500 | 100 | 400 | 300 | 1.100 | 300 | 100 | * | 1,500 | * |
| Civil | 13,200 | 2,500 | * | 200 | 2.300 | 2.200 | 100 | 2,100 | 100 | 3.300 | 1.000 | 200 | * | 3,600 | 300 |
| Electrical/electronic | 47.900 | 18.900 | 200 | 1,700 | 17,000 | 5.300 | 1,700 | 3.500 | 500 | 11,200 | 5,700 | 1,700 | * | 4,200 | 400 |
| Industrial | 11.100 | 1.800 | * | 200 | 1.600 | 1,900 | 300 | 1.500 | 100 | 3,500 | 1,400 | 700 | 100 | 1,400 | 100 |
| Mechanical | 25.600 | 11,100 | 100 | 700 | 10,300 | 2.000 | 100 | 1.900 | 600 | 6,100 | 1.500 | 1,100 | * | 3.100 | * |
| Other | 23.100 | 7.300 | 300 | 800 | 6.000 | 2,700 | 800 | 2,100 | 600 | 5.800 | 2,100 | 900 | * | 3.500 | * |

* too few cases to report

NOTES Details may not sum to totals because of rounding. Data exclude full-time graduate students.

SOURCE: Science Resources Studies Division. National Science Foundation, *Characteristics of Recent Science and Engineering Graduates: 1990* (Washington, DC: NSF, forthcoming).

See figure 3-10.

Appendix table 3-9.
**Number of 1988 and 1989 science and engineering masters degree recipients, by field of degree and primary work activity: 1990**

| Field of degree | Total employed | Primary work activity: Research and development: Total | Basic research | Applied research | Devlopment | Management/administration: Total | Of R&D | Of non-R&D | Teaching | Prod./ inspection | Reporting/ stat. work/ computing | Sales | Professional services | Other | No report |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total science and engineering | 100,600 | 34,000 | 3,100 | 8,000 | 22,800 | 15,100 | 5,000 | 10,100 | 12,200 | 7,600 | 16,100 | 2,200 | 1,300 | 11,900 | 200 |
| Total sciences | 66,700 | 16,400 | 2,600 | 5,400 | 8,500 | 10,800 | 3,000 | 7,800 | 11,400 | 3,900 | 13,200 | 1,700 | 1,200 | 8,000 | 100 |
| Physical | 5,200 | 2,200 | 500 | 800 | 900 | 300 | 100 | 200 | 1,200 | 600 | 400 | * | * | 400 | * |
| Mathematics/statistics | 8,400 | 1,300 | 100 | 500 | 700 | 1,000 | 300 | 700 | 3,400 | 400 | 1,700 | * | * | 500 | * |
| Computer | 19,400 | 6,000 | 100 | 700 | 5,200 | 3,300 | 1,500 | 1,800 | 800 | 800 | 6,900 | 300 | * | 1,300 | * |
| Environmental | 4,000 | 1,100 | 200 | 600 | 300 | 500 | 100 | 300 | 200 | 600 | 600 | * | * | 1,000 | * |
| Life | 11,800 | 3,800 | 1,200 | 1,800 | 900 | 1,600 | 600 | 1,100 | 2,400 | 900 | 900 | 500 | 300 | 1,200 | * |
| Psychology | 4,500 | 400 | * | 100 | 300 | 900 | 100 | 800 | 1,200 | 100 | 400 | * | 800 | 800 | * |
| Social | 13,400 | 1,500 | 300 | 1,000 | 200 | 3,200 | 300 | 2,900 | 2,100 | 500 | 2,200 | 800 | * | 3,000 | * |
| Total engineering | 33,900 | 17,600 | 600 | 2,700 | 14,300 | 4,300 | 2,000 | 2,300 | 900 | 3,800 | 2,900 | 600 | * | 3,900 | 100 |
| Aeronautical/astronautical | 1,400 | 900 | * | 300 | 600 | 200 | 100 | 100 | * | * | 100 | * | * | 100 | * |
| Civil | 4,100 | 1,200 | * | 200 | 1,000 | 600 | 100 | 500 | 100 | 500 | 400 | 100 | * | 1,300 | * |
| Electrical electronic | 10,500 | 6,600 | 200 | 600 | 5,800 | 1,000 | 800 | 200 | 300 | 1,100 | 1,000 | 200 | * | 400 | * |
| Industrial | 2,200 | 500 | * | 100 | 300 | 500 | 100 | 400 | * | 500 | 200 | 100 | * | 400 | * |
| Mechanical | 6,700 | 4,500 | 100 | 500 | 3,900 | 600 | 400 | 300 | 200 | 600 | 400 | * | * | 300 | * |
| Other | 9,000 | 3,900 | 200 | 1,000 | 2,700 | 1,400 | 500 | 800 | 200 | 1,000 | 800 | 100 | * | 1,300 | * |

* too few cases to report

NOTES: Details may not sum to totals because of rounding. Data exclude full-time graduate students.

SOURCE: Science Resources Studies Division, National Science Foundation, *Characteristics of Recent Science and Engineering Graduates: 1990* (Washington, DC: NSF, forthcoming).

See figure 3-10.

Appendix table 3-10.
**Number of 1988 and 1989 science and engineering bachelors degree recipients, by field of degree, gender, and type of employer: 1990**
(page 1 of 3)

| Field of degree and gender | Total employed | Business and industry: Total | Business and industry: Industry | Business and industry: Self-employed | Educational institution: Total | Educational institution: 4-year college/ univ. | Educational institution: Other | Non-profit org. | Federal Gov't | State/ local gov't | Other | No report |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL SCIENCE & ENGINEERING | 485,400 | 313,000 | 301,600 | 11,300 | 47,300 | 15,800 | 31,600 | 24,400 | 20,300 | 26,900 | 51,400 | 2,100 |
| Male | 299,000 | 213,200 | 203,700 | 9,500 | 20,400 | 8,000 | 12,400 | 6,700 | 12,900 | 15,800 | 28,800 | 1,300 |
| Female | 186,400 | 99,800 | 98,000 | 1,900 | 26,900 | 7,700 | 19,200 | 17,700 | 7,400 | 11,100 | 22,600 | 800 |
| **Total sciences** | 358,800 | 214,000 | 204,500 | 9,600 | 44,800 | 14,100 | 30,700 | 23,300 | 12,400 | 21,100 | 41,400 | 1,700 |
| Male | 191,100 | 128,800 | 121,000 | 7,800 | 18,300 | 6,700 | 11,600 | 5,800 | 6,400 | 11,000 | 19,900 | 900 |
| Female | 167,700 | 85,200 | 83,500 | 1,700 | 26,500 | 7,300 | 19,100 | 17,400 | 6,000 | 10,100 | 21,500 | 800 |
| Physical | 16,400 | 10,100 | 10,000 | 100 | 3,100 | 800 | 2,200 | 400 | 500 | 600 | 1,700 | 100 |
| Male | 11,100 | 6,700 | 6,600 | 100 | 2,000 | 700 | 1,300 | 300 | 300 | 400 | 1,400 | 100 |
| Female | 5,300 | 3,400 | 3,400 | * | 1,100 | 200 | 900 | 100 | 200 | 200 | 300 | * |
| Mathematics/statistics | 26,600 | 14,400 | 14,200 | 200 | 7,900 | 1,100 | 6,800 | 800 | 700 | 500 | 2,300 | 100 |
| Male | 13,700 | 8,100 | 7,900 | 100 | 3,200 | 800 | 2,400 | 300 | 300 | 300 | 1,500 | * |
| Female | 12,900 | 6,300 | 6,300 | * | 4,700 | 300 | 4,400 | 600 | 400 | 100 | 800 | 100 |
| Computer | 62,500 | 50,700 | 49,700 | 1,000 | 3,900 | 2,500 | 1,400 | 700 | 1,600 | 1,700 | 3,300 | 600 |
| Male | 45,800 | 37,700 | 36,700 | 1,000 | 2,300 | 1,500 | 800 | 500 | 1,000 | 1,100 | 2,700 | 600 |
| Female | 16,700 | 13,100 | 13,000 | * | 1,600 | 1,000 | 700 | 200 | 600 | 600 | 700 | * |
| Environmental | 4,700 | 3,000 | 2,900 | 100 | 300 | 200 | 100 | * | 300 | 300 | 800 | * |
| Male | 3,400 | 2,100 | 2,100 | * | 200 | 200 | * | * | 200 | 200 | 700 | * |
| Fema | 1,300 | 900 | 800 | * | 100 | * | 100 | * | 100 | 100 | 100 | * |
| Life | 69,300 | 34,600 | 31,800 | 2,800 | 11,400 | 3,900 | 7,500 | 3,500 | 2,600 | 4,700 | 12,100 | 300 |
| Male | 34,500 | 19,400 | 17,200 | 2,200 | 5,200 | 1,900 | 3,300 | 1,300 | 1,500 | 2,200 | 5,000 | * |
| Female | 34,700 | 15,300 | 14,700 | 600 | 6,200 | 2,000 | 4,200 | 2,200 | 1,200 | 2,500 | 7,100 | 200 |
| Psychology | 63,300 | 28,800 | 27,600 | 1,200 | 7,200 | 1,900 | 5,300 | 11,900 | 1,200 | 5,100 | 8,900 | 200 |
| Male | 19,200 | 12,100 | 11,200 | 800 | 900 | 200 | 700 | 2,200 | 200 | 1,400 | 2,500 | * |
| Female | 44,000 | 16,700 | 16,400 | 400 | 6,300 | 1,700 | 4,600 | 9,700 | 1,000 | 3,700 | 6,400 | 200 |
| Social | 116,000 | 72,500 | 68,200 | 4,200 | 10,900 | 3,500 | 7,400 | 5,900 | 5,500 | 8,400 | 12,300 | 500 |
| Male | 63,300 | 42,900 | 39,300 | 3,600 | 4,500 | 1,400 | 3,100 | 1,300 | 3,000 | 5,400 | 6,100 | 200 |
| Female | 52,700 | 29,600 | 29,000 | 600 | 6,400 | 2,100 | 4,300 | 4,600 | 2,500 | 2,900 | 6,200 | 300 |

(continued)

Appendix table 3-10.
**Number of 1988 and 1989 science and engineering bachelors degree recipients, by field of degree, gender, and type of employer: 1990**
(page 2 of 3)

| Field of degree and gender | Total employed | Type of employer: Business and industry: Total | Business and industry: Industry | Business and industry: Self-employed | Educational institution: Total | Educational institution: 4-year college/ univ. | Educational institution: Other | Non-profit org. | Federal Gov't | State/ local gov't | Other | No report |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total engineering** | 126,700 | 98,900 | 97,200 | 1,800 | 2,600 | 1,700 | 800 | 1,100 | 7,900 | 5,800 | 10,000 | 400 |
| Male | 107,900 | 84,300 | 82,700 | 1,600 | 2,100 | 1,300 | 800 | 900 | 6,500 | 4,800 | 8,900 | 400 |
| Female | 18,800 | 14,600 | 14,500 | 100 | 400 | 400 | * | 300 | 1,400 | 1,000 | 1,100 | * |
| Aeronautical/astronautical | 5,800 | 3,200 | 3,200 | 100 | 100 | 100 | * | * | 800 | * | 1,600 | * |
| Male | 5,200 | 2,900 | 2,900 | 100 | 100 | 100 | * | * | 700 | * | 1,400 | * |
| Female | 600 | 300 | 300 | * | * | * | * | * | 100 | * | 200 | * |
| Chemical | 6,000 | 5,200 | 5,200 | * | 100 | 100 | * | * | 300 | 200 | 100 | * |
| Male | 4,000 | 3,500 | 3,500 | * | 100 | 100 | * | * | 200 | 100 | 100 | * |
| Female | 2,000 | 1,700 | 1,700 | * | * | * | * | * | 200 | 100 | * | * |
| Civil | 13,200 | 8,600 | 8,300 | 300 | 100 | 100 | * | 100 | 500 | 2,900 | 900 | 100 |
| Male | 11,300 | 7,300 | 7,000 | 300 | 100 | 100 | * | 100 | 400 | 2,400 | 800 | 100 |
| Female | 1,900 | 1,300 | 1,300 | * | * | * | * | * | 100 | 500 | 100 | * |
| Electrical/electronic | 47,900 | 38,600 | 37,800 | 800 | 1,300 | 900 | 300 | 700 | 3,400 | 1,300 | 2,400 | 300 |
| Male | 42,400 | 34,300 | 33,600 | 700 | 1,000 | 700 | 300 | 500 | 2,900 | 1,200 | 2,200 | 300 |
| Female | 5,500 | 4,300 | 4,200 | 100 | 200 | 200 | * | 300 | 500 | 100 | 200 | * |
| Industrial | 11,100 | 9,300 | 9,200 | 200 | 100 | 100 | * | * | 500 | 200 | 900 | * |
| Male | 8,700 | 7,300 | 7,100 | 200 | 100 | 100 | * | * | 400 | 100 | 800 | * |
| Female | 2,400 | 2,100 | 2,000 | * | * | * | * | * | 200 | * | 100 | * |
| Materials | 1,300 | 1,100 | 1,100 | * | 100 | * | * | * | 100 | * | 100 | * |
| Male | 1,000 | 800 | 800 | * | * | * | * | * | 100 | * | 100 | * |
| Female | 300 | 200 | 200 | * | * | * | * | * | * | * | * | * |
| Mechanical | 25,600 | 21,100 | 20,900 | 200 | 300 | 100 | 200 | 200 | 1,700 | 600 | 1,700 | * |
| Male | 22,600 | 18,600 | 18,300 | 200 | 300 | 100 | 200 | 200 | 1,500 | 400 | 1,600 | * |
| Female | 3,000 | 2,500 | 2,500 | * | * | * | * | * | 200 | 100 | 100 | * |
| Mining | 800 | 700 | 700 | * | * | * | * | * | * | * | * | * |
| Male | 600 | 600 | 600 | * | * | * | * | * | * | * | * | * |
| Female | 100 | 100 | 100 | * | * | * | * | * | * | * | * | * |

(continued)

Appendix table 3-10.

**Number of 1988 and 1989 science and engineering bachelors degree recipients, by field of degree, gender, and type of employer: 1990**

(page 3 of 3)

| | | Type of employer | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Business and industry | | | Educational institution | | | | | | | |
| Field of degree and gender | Total employed | Total | Industry | Self-employed | Total | 4-year college/ univ. | Other | Non-profit org. | Federal Gov't | State/ local gov't | Other | No report |
| Nuclear | 700 | 300 | 300 | * | * | * | * | * | 100 | * | 300 | * |
| Male | 500 | 300 | 300 | * | * | * | * | * | * | * | 200 | * |
| Female | 200 | * | * | * | * | * | * | * | * | * | 100 | * |
| Petroleum | 900 | 800 | 800 | * | * | * | * | * | * | * | * | * |
| Male | 800 | 700 | 700 | * | * | * | * | * | * | * | * | * |
| Female | 100 | 100 | 100 | * | * | * | * | * | * | * | * | * |
| Other | 13,400 | 10.000 | 9,800 | 200 | 500 | 300 | 200 | * | 400 | 600 | 1,900 | * |
| Male | 10.800 | 8,000 | 7,800 | 200 | 400 | 200 | 200 | * | 300 | 500 | 1,600 | * |
| Female | 2,600 | 2,000 | 2.000 | * | 100 | 100 | * | * | 100 | 100 | 300 | * |

* too few cases to report

NOTE: Details may not sum to totals because of rounding. Data exclude full-time graduate students.

SOURCE: Science Resources Studies Division, National Science Foundation, *Characteristics of Recent Science and Engineering Graduates: 1990* (Washington, DC: NSF, forthcoming).

See figure 3-8.

*Science & Engineering Indicators – 1991*

Appendix table 3-11.
**Number of 1988 and 1989 science and engineering masters degree recipients, by field of degree, gender, and type of employer: 1990**
(page 1 of 3)

| Field of degree and gender | Total employed | Type of employer: Business and industry: Total | Industry | Self-employed | Educational institution: Total | 4-year college/ univ. | Other | Non-profit org. | Federal Gov't | State/ local gov't | Other | No report |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL SCIENCE & ENGINEERING | 100,600 | 60,200 | 58,000 | 2,200 | 16,700 | 8,100 | 8,600 | 2,500 | 7,800 | 5,300 | 7,900 | 200 |
| Male | 71,000 | 46,700 | 45,500 | 1,200 | 9,200 | 5,000 | 4,200 | 1,200 | 5,100 | 3,000 | 5,700 | 100 |
| Female | 29,600 | 13,500 | 12,500 | 1,000 | 7,500 | 3,100 | 4,400 | 1,300 | 2,700 | 2,300 | 2,200 | 100 |
| **Total sciences** | 66,700 | 33,700 | 31,900 | 1,900 | 15,500 | 7,100 | 8,400 | 2,200 | 5,400 | 4,200 | 5,600 | 100 |
| Male | 41,300 | 23,200 | 22,200 | 1,000 | 8,100 | 4,100 | 4,100 | 900 | 3,200 | 2,200 | 3,600 | * |
| Female | 25,400 | 10,500 | 9,600 | 900 | 7,400 | 3,000 | 4,400 | 1,300 | 2,200 | 2,000 | 2,000 | * |
| Physical | 5,200 | 2,800 | 2,800 | * | 1,400 | 600 | 900 | 100 | 300 | 100 | 300 | * |
| Male | 3,700 | 2,000 | 2,000 | * | 900 | 500 | 500 | 100 | 300 | 100 | 300 | * |
| Female | 1,400 | 800 | 800 | * | 500 | 100 | 400 | * | 100 | * | * | * |
| Mathematics/statistics | 8,400 | 3,500 | 3,400 | * | 3,700 | 1,000 | 2,700 | 100 | 200 | 100 | 800 | * |
| Male | 5,000 | 2,300 | 2,300 | * | 1,700 | 600 | 1,000 | 100 | 100 | 100 | 700 | * |
| Female | 3,400 | 1,200 | 1,200 | * | 2,000 | 300 | 1,700 | * | 100 | * | 100 | * |
| Computer | 19,400 | 15,000 | 14,700 | 300 | 1,400 | 700 | 700 | 300 | 800 | 300 | 1,700 | * |
| Male | 14,400 | 11,000 | 10,700 | 300 | 1,000 | 500 | 500 | 100 | 600 | 200 | 1,400 | * |
| Female | 5,100 | 4,000 | 4,000 | * | 400 | 200 | 200 | 200 | 200 | 100 | 200 | * |
| Environmental | 4,000 | 2,500 | 2,300 | 100 | 400 | 300 | 100 | * | 500 | 300 | 300 | * |
| Male | 2,800 | 1,900 | 1,800 | 100 | 300 | 200 | 100 | * | 300 | 100 | 200 | * |
| Female | 1,100 | 600 | 500 | * | 100 | 100 | * | * | 200 | 200 | 100 | * |
| Life | 11,800 | 3,500 | 3,200 | 300 | 4,100 | 2,100 | 2,000 | 500 | 1,400 | 1,200 | 1,000 | * |
| Male | 34,500 | 19,400 | 17,200 | 2,200 | 5,200 | 1,900 | 3,300 | 1,300 | 1,500 | 2,200 | 5,000 | * |
| Female | 34,700 | 15,300 | 14,700 | 600 | 6,200 | 2,000 | 4,200 | 2,200 | 1,200 | 2,500 | 7,100 | 200 |
| Psychology | 4,500 | 1,400 | 1,400 | * | 1,100 | 500 | 600 | 700 | 200 | 300 | 700 | * |
| Male | 1,700 | 600 | 600 | * | 400 | 200 | 300 | 200 | 200 | 100 | 200 | * |
| Female | 2,800 | 800 | 800 | * | 700 | 300 | 300 | 500 | 100 | 200 | 500 | * |
| Social | 13,400 | 5,100 | 4,100 | 1,000 | 3,400 | 1,900 | 1,500 | 500 | 1,800 | 1,900 | 800 | * |
| Male | 7,700 | 3,000 | 2,700 | 300 | 1,900 | 1,000 | 900 | 300 | 1,200 | 800 | 400 | * |
| Female | 5,800 | 2,100 | 1,400 | 700 | 1,500 | 900 | 600 | 300 | 600 | 1,100 | 400 | * |

(continued)

Appendix table 3-11.
**Number of 1988 and 1989 science and engineering masters degree recipients, by field of degree, gender, and type of employer: 1990**
(page 2 of 3)

| Field of degree and gender | Total employed | Type of employer: Business and industry: Total | Business and industry: Industry | Business and industry: Self-employed | Educational institution: Total | Educational institution: 4-year college/univ. | Educational institution: Other | Non-profit org. | Federal Gov't | State/local gov't | Other | No report |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total engineering** | 33,900 | 26,500 | 26,200 | 300 | 1,200 | 1,000 | 200 | 300 | 2,400 | 1,100 | 2,300 | 100 |
| Male | 29,700 | 23,500 | 23,200 | 200 | 1,000 | 900 | 100 | 300 | 1,900 | 800 | 2,100 | 100 |
| Female | 4,200 | 3,000 | 2,900 | 100 | 200 | 100 | * | * | 500 | 300 | 200 | * |
| Aeronautical/astronautical | 1,400 | 1,000 | 1,000 | * | * | * | * | 100 | 200 | * | 100 | * |
| Male | 1,400 | 900 | 900 | * | * | * | * | 100 | 200 | * | 100 | * |
| Female | * | * | * | * | * | * | * | * | * | * | * | * |
| Chemical | 1,400 | 1,200 | 1,200 | * | 100 | 100 | * | * | * | * | * | * |
| Male | 1,100 | 1,000 | 1,000 | * | 100 | 100 | * | * | * | * | * | * |
| Female | 300 | 200 | 200 | * | * | * | * | * | * | * | * | * |
| Civil | 4,100 | 2,800 | 2,800 | * | 100 | 100 | * | * | 400 | 500 | 300 | * |
| Male | 3,600 | 2,600 | 2,500 | * | 100 | 100 | * | * | 200 | 400 | 300 | * |
| Female | 500 | 300 | 300 | * | * | * | * | * | 100 | 100 | * | * |
| Electrical/electronic | 10,500 | 8,700 | 8,600 | 100 | 300 | 300 | * | * | 700 | 100 | 700 | * |
| Male | 9,600 | 8,000 | 8,000 | * | 300 | 300 | * | * | 600 | * | 700 | * |
| Female | 900 | 700 | 600 | 100 | * | * | * | * | * | 100 | * | * |
| Industrial | 2,200 | 1,700 | 1,700 | * | 100 | 100 | * | * | 200 | * | 200 | * |
| Male | 1,800 | 1,400 | 1,400 | * | 100 | 100 | * | * | 100 | * | 200 | * |
| Female | 400 | 300 | 300 | * | * | * | * | * | 100 | * | * | * |
| Materials | 1,000 | 900 | 900 | * | * | * | * | * | * | * | * | * |
| Male | 700 | 600 | 600 | * | * | * | * | * | * | * | * | * |
| Female | 300 | 300 | 300 | * | * | * | * | * | * | * | * | * |
| Mechanical | 6,700 | 5,600 | 5,500 | 100 | 300 | 300 | * | 100 | 400 | 100 | 200 | * |
| Male | 6,300 | 5,400 | 5,300 | 100 | 300 | 300 | * | 100 | 300 | 100 | 200 | * |
| Female | 400 | 300 | 300 | * | * | * | * | * | 100 | * | * | * |
| Mining | 400 | 300 | 300 | * | * | * | * | * | * | * | * | * |
| Male | 300 | 200 | 200 | * | * | * | * | * | * | * | * | * |
| Female | 100 | 100 | 100 | * | * | * | * | * | * | * | * | * |

(continued)

Appendix table 3-11.
**Number of 1988 and 1989 science and engineering masters degree recipients, by field of degree, gender, and type of employer: 1990**
(page 3 of 3)

| | | Type of employer | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Business and industry | | | Educational institution | | | | | | | |
| Field of degree and gender | Total employed | Total | Industry | Self-employed | Total | 4-year college/ univ. | Other | Non-profit org. | Federal Gov't | State/ local gov't | Other | No report |
| Nuclear | 300 | 200 | 200 | * | * | * | * | * | * | * | 100 | * |
| Male | 200 | 100 | 100 | * | * | * | * | * | * | * | 100 | * |
| Female | * | * | * | * | * | * | * | * | * | * | * | * |
| Petroleum | 300 | 300 | 300 | * | * | * | * | * | * | * | * | * |
| Male | 300 | 200 | 200 | * | * | * | * | * | * | * | * | * |
| Female | * | * | * | | * | * | * | * | * | * | * | * |
| Other | 5,500 | 3,800 | 3,800 | 100 | 200 | 100 | 100 | * | 500 | 300 | 600 | * |
| Male | 4,300 | 3,000 | 2,900 | 100 | 200 | 100 | 100 | * | 300 | 300 | 600 | * |
| Female | 1,200 | 900 | 800 | * | 100 | * | * | * | 200 | 100 | * | * |

* - too few cases to report

NOTE: Details may not sum to totals because of rounding. Data exclude full-time graduate students.

SOURCE: Science Resources Studies Division, National Science Foundation, *Characteristics of Recent Science and Engineering Graduates: 1990* (Washington, DC: NSF, forthcoming).

See figure 3-8.

*Science & Engineering Indicators – 1991*

327

325

Appendix table 3-12.
**Employed doctoral scientists and engineers, by field and gender: 1977-89**
(page 1 of 2)

| Field and gender | 1977 | 1979 | 1981 | 1983 | 1985 | 1987 | 1989 |
|---|---|---|---|---|---|---|---|
| TOTAL SCIENTISTS AND ENGINEERS | 285,055 | 314,257 | 343,956 | 369,320 | 400,358 | 419,118 | 448,645 |
| Male | 257,465 | 280,857 | 302,971 | 320,494 | 341,873 | 352,386 | 371,483 |
| Female | 27,590 | 33,400 | 40,985 | 48,826 | 58,485 | 66,732 | 77,160 |
| **Total scientists** | 240,005 | 263,915 | 286,917 | 307,775 | 334,505 | 351,350 | 373,860 |
| Male | 212,696 | 231,040 | 246,685 | 260,025 | 277,508 | 286,346 | 299,015 |
| Female | 27,309 | 32,875 | 40,232 | 47,750 | 56,997 | 65,004 | 74,845 |
| Physical | 57,531 | 60,222 | 63,110 | 63,986 | 67,480 | 68,647 | 70,209 |
| Male | 54,594 | 57,086 | 59,346 | 59,811 | 62,809 | 63,163 | 64,139 |
| Female | 2,937 | 3,136 | 3,764 | 4,175 | 4,671 | 5,484 | 6,070 |
| Mathematical | 14,609 | 15,250 | 15,569 | 16,379 | 16,758 | 16,699 | 17,611 |
| Male | 13,560 | 14,104 | 14,259 | 14,964 | 15,199 | 15,074 | 15,766 |
| Female | 1,049 | 1,146 | 1,310 | 1,415 | 1,559 | 1,625 | 1,845 |
| Computer specialists | 5,767 | 6,684 | 9,064 | 12,164 | 14,964 | 18,571 | 19,797 |
| Male | 5,534 | 6,318 | 8,363 | 10,898 | 13,345 | 16,693 | 17,493 |
| Female | 233 | 366 | 701 | 1,266 | 1,619 | 1,878 | 2,304 |
| Environmental | 13,001 | 14,575 | 15,909 | 16,467 | 17,288 | 17,811 | 19,787 |
| Male | 12,560 | 13,968 | 15,054 | 15,553 | 16,199 | 16,510 | 18,123 |
| Female | 441 | 607 | 855 | 914 | 1,089 | 1,301 | 1,664 |
| Life | 70,537 | 78,857 | 84,912 | 92,802 | 101,838 | 107,378 | 115,833 |
| Male | 61,437 | 67,528 | 71,593 | 76,573 | 82,146 | 85,269 | 89,558 |
| Female | 9,100 | 11,329 | 13,319 | 16,229 | 19,692 | 22,109 | 26,275 |
| Psychologists | 33,652 | 37,848 | 42,829 | 46,645 | 52,182 | 56,378 | 60,596 |
| Male | 26,055 | 28,690 | 31,103 | 32,962 | 35,573 | 37,274 | 38,754 |
| Female | 7,597 | 9,158 | 11,726 | 13,683 | 16,609 | 19,104 | 21,842 |
| Social | 44,908 | 50,479 | 55,524 | 59,332 | 63,995 | 65,866 | 70,027 |
| Male | 38,956 | 43,346 | 46,967 | 49,264 | 52,237 | 52,363 | 55,182 |
| Female | 5,952 | 7,133 | 8,557 | 10,068 | 11,758 | 13,503 | 14,845 |
| **Total engineers** | 45,050 | 50,342 | 57,039 | 61,545 | 65,853 | 67,768 | 74,783 |
| Male | 44,769 | 49,817 | 56,286 | 60,469 | 64,365 | 66,040 | 72,468 |
| Female | 281 | 525 | 753 | 1,076 | 1,488 | 1,728 | 2,315 |
| Aeronautical/astronautical | 1,987 | 2,364 | 2,519 | 3,684 | 3,827 | 5,005 | 6,367 |
| Male | 1,967 | 2,340 | 2,480 | 3,614 | 3,732 | 4,884 | 6,156 |
| Female | 20 | 24 | 39 | 70 | 95 | 121 | 211 |
| Chemical | 5,603 | 6,166 | 7,146 | 6,992 | 7,122 | 6,923 | 7,959 |
| Male | 5,575 | 6,117 | 7,092 | 6,895 | 7,021 | 6,783 | 7,744 |
| Female | 28 | 49 | 54 | 97 | 101 | 140 | 215 |
| Civil | 4,066 | 5.157 | 6,089 | 5,317 | 6,396 | 6,479 | 6.951 |
| Male | 4,051 | 5,101 | 6,003 | 5,245 | 6,305 | 6,316 | 6,762 |
| Female | 15 | 56 | 86 | 72 | 91 | 163 | 189 |
| Electrical/electronic | 8,284 | 8,597 | 10,630 | 12,696 | 14,248 | 12,601 | 15,088 |
| Male | 8,246 | 8,528 | 10,493 | 12,460 | 13,901 | 12,236 | 14,651 |
| Female | 38 | 69 | 137 | 236 | 347 | 365 | 437 |
| Mechanical | 4,648 | 5,245 | 5,370 | 5,657 | 6,594 | 6,711 | 7,390 |
| Male | 4,629 | 5,213 | 5,330 | 5,603 | 6,536 | 6,613 | 7,287 |
| Female | 19 | 32 | 40 | 54 | 58 | 98 | 103 |

(continued)

Appendix table 3-12.
**Employed doctoral scientists and engineers, by field and gender: 1977-89**
(page 2 of 2)

| Field and gender | 1977 | 1979 | 1981 | 1983 | 1985 | 1987 | 1989 |
|---|---|---|---|---|---|---|---|
| Other | 20,462 | 22,813 | 25,285 | 27,199 | 27,666 | 30,049 | 31,028 |
| Male | 20,301 | 22,518 | 24,888 | 26,652 | 26,870 | 29,208 | 29,868 |
| Female | 161 | 295 | 397 | 547 | 796 | 841 | 1,160 |

NOTE: Details may not sum to totals because of rounding.

SOURCE: Science Resources Studies Division, National Science Foundation, *Characteristics of Doctoral Scientists and Engineers in the United States: 1989*, NSF 91-317 (Washington, DC: NSF, 1991).

See figures 3-11, 3-12, and 3-15. *Science & Engineering Indicators – 1991*

Appendix table 3-13.
**Employed doctoral scientists and engineers, by field and race/ethnicity: 1977-89**
(page 1 of 2)

| Field and racial/ethnic group | 1977 | 1979 | 1981 | 1983 | 1985 | 1987 | 1989 |
|---|---|---|---|---|---|---|---|
| TOTAL SCIENTISTS AND ENGINEERS | 285,055 | 314,257 | 343,953 | 369,320 | 400,358 | 419,118 | 448,643 |
| White | 258,255 | 284,965 | 309,123 | 328,455 | 355,125 | 372,985 | 397,169 |
| Black | 2,709 | 3,227 | 4,224 | 4,948 | 5,716 | 6,359 | 7,153 |
| Asian | 16,275 | 22,912 | 27,350 | 29,740 | 34,533 | 36,397 | 41,106 |
| Other | 7,816 | 3,153 | 3,256 | 6,177 | 4,984 | 3,377 | 3,215 |
| **Total scientists** | 240,005 | 263,915 | 286,917 | 307,775 | 334,505 | 351,350 | 373,860 |
| White | 219,636 | 243,008 | 261,912 | 278,722 | 302,526 | 319,091 | 338,040 |
| Black | 2,588 | 3,125 | 3,954 | 4,538 | 5,203 | 5,704 | 6,539 |
| Asian | 11,229 | 15,037 | 18,328 | 19,259 | 22,651 | 23,645 | 26,522 |
| Other | 6,552 | 2,745 | 2,723 | 5,256 | 4,125 | 2,910 | 2,759 |
| Physical | 57,531 | 60,222 | 63,110 | 63,986 | 67,480 | 68,647 | 70,209 |
| White | 51,963 | 54,618 | 56,245 | 56,521 | 59,598 | 60,751 | 61,594 |
| Black | 543 | 403 | 579 | 690 | 522 | 620 | 831 |
| Asian | 3,441 | 4,719 | 5,769 | 5,684 | 6,561 | 6,788 | 7,195 |
| Other | 1,584 | 482 | 517 | 1,091 | 799 | 488 | 589 |
| Mathematical | 14,609 | 15,250 | 15,569 | 16,379 | 16,758 | 16,699 | 17,611 |
| White | 13,218 | 13,729 | 13,975 | 14,531 | 14,921 | 14,940 | 15,624 |
| Black | 120 | 144 | 167 | 178 | 166 | 166 | 198 |
| Asian | 799 | 1,110 | 1,155 | 1,378 | 1,368 | 1,482 | 1,644 |
| Other | 472 | 267 | 272 | 292 | 303 | 111 | 145 |
| Computer specialists | 5,767 | 6,684 | 9,064 | 12,164 | 14,964 | 18,571 | 19,797 |
| White | 5,014 | 6,059 | 8,056 | 11,012 | 13,064 | 16,219 | 17,018 |
| Black | 15 | 4 | 27 | 43 | 85 | 200 | 190 |
| Asian | 613 | 561 | 868 | 944 | 1,634 | 1,838 | 2,423 |
| Other | 125 | 60 | 113 | 165 | 181 | 314 | 166 |
| Environmental | 13,001 | 14,575 | 15,909 | 16,467 | 17,288 | 17,811 | 19,787 |
| White | 12,125 | 13,813 | 14,996 | 15,476 | 15,774 | 16,587 | 18,165 |
| Black | 24 | 65 | 34 | 33 | 98 | 222 | 228 |
| Asian | 572 | 539 | 744 | 770 | 1,133 | 943 | 1,338 |
| Other | 280 | 158 | 135 | 188 | 283 | 59 | 56 |
| Life | 70,537 | 78,857 | 84,912 | 92,802 | 101,838 | 107,378 | 115,833 |
| White | 64,243 | 71,861 | 77,089 | 83,378 | 92,002 | 96,955 | 104,295 |
| Black | 769 | 883 | 1,013 | 1,142 | 1,419 | 1,456 | 1,633 |
| Asian | 3,980 | 5,417 | 6,257 | 6,750 | 7,412 | 8,207 | 9,276 |
| Other | 1,545 | 696 | 553 | 1,532 | 1,005 | 760 | 629 |
| Psychologists | 33,652 | 37,848 | 42,829 | 46,645 | 52,182 | 56,378 | 60,596 |
| White | 31,943 | 36,480 | 9,825 | 44,237 | 49,508 | 53,655 | 57,833 |
| Black | 467 | 594 | 809 | 983 | 1,190 | 1,266 | 1,350 |
| Asian | 313 | 412 | 583 | 640 | 756 | 858 | 934 |
| Other | 929 | 362 | 31,612 | 785 | 728 | 599 | 479 |
| Social | 44,908 | 50,479 | 55,524 | 59,332 | 63,995 | 65,866 | 70,027 |
| White | 41,130 | 46,448 | 50,542 | 53,567 | 57,659 | 59,984 | 63,511 |
| Black | 650 | 1,032 | 1,325 | 1,469 | 1,723 | 1,774 | 2,109 |
| Asian | 1,511 | 2,279 | 2,952 | 3,093 | 3,787 | 3,529 | 3,712 |
| Other | 1,617 | 720 | 705 | 1,203 | 826 | 579 | 695 |

(continued)

Appendix table 3-13.
**Employed doctoral scientists and engineers, by field and race/ethnicity: 1977-89**
(page 2 of 2)

| Field and racial/ethnic group | 1977 | 1979 | 1981 | 1983 | 1985 | 1987 | 1989 |
|---|---|---|---|---|---|---|---|
| **Total engineers** | 45,050 | 50,342 | 57,039 | 61,545 | 65,853 | 67,768 | 74,783 |
| White | 38,619 | 41,957 | 47,211 | 49,733 | 52,599 | 53,894 | 59,129 |
| Black | 121 | 102 | 270 | 410 | 513 | 655 | 614 |
| Asian | 5,046 | 7,875 | 9,022 | 10,481 | 11,882 | 12,752 | 14,584 |
| Other | 1,264 | 408 | 536 | 921 | 859 | 467 | 456 |
| Aeronautical/astronautical | 1,987 | 2,364 | 2,519 | 3,684 | 3,827 | 5,005 | 6.367 |
| White | 1,793 | 2,122 | 2,232 | 3,128 | 3,295 | 4,092 | 4,786 |
| Black | 0 | 2 | 10 | 21 | 27 | 34 | 165 |
| Asian | 138 | 232 | 269 | 482 | 503 | 869 | 1,395 |
| Other | 56 | 8 | 8 | 53 | 2 | 10 | 21 |
| Chemical | 5,603 | 6,166 | 7,146 | 6,992 | 7,122 | 6,923 | 7,959 |
| White | 4,674 | 4,953 | 5,553 | 5,384 | 5,130 | 4,988 | 6,008 |
| Black | 12 | 10 | 37 | 13 | 66 | 72 | 39 |
| Asian | 721 | 1,200 | 1,554 | 1,502 | 1,923 | 1,814 | 1,899 |
| Other | 196 | 3 | 2 | 93 | 3 | 49 | 13 |
| Civil | 4,066 | 5,157 | 6,089 | 5,317 | 6.396 | 6,479 | 6,951 |
| White | 3,255 | 3,875 | 4,785 | 4,190 | 5,063 | 5,182 | 5,554 |
| Black | 5 | 1 | 24 | 24 | 85 | 23 | 77 |
| Asian | 718 | 1,204 | 1,226 | 1,059 | 1,182 | 1,254 | 1,305 |
| Other | 88 | 77 | 54 | 44 | 66 | 20 | 15 |
| Electrical/electronic | 8.284 | 8,597 | 10,630 | 12,696 | 14,248 | 12.601 | 15,088 |
| White | 7,229 | 7,252 | 8,931 | 10,310 | 11,386 | 9,744 | 11,604 |
| Black | 45 | 15 | 40 | 75 | 90 | 209 | 118 |
| Asian | 833 | 1,272 | 1,552 | 2,093 | 2,553 | 2,525 | 3,234 |
| Other | 177 | 58 | 107 | 218 | 219 | 123 | 132 |
| Mechanical | 4 648 | 5,245 | 5.370 | 5,657 | 6,594 | 6,711 | 7,390 |
| White | 3,793 | 4,057 | 4,313 | 4,382 | 5,069 | 5,124 | 5,800 |
| Black | 5 | 22 | 10 | 91 | 81 | 127 | 14 |
| Asian | 771 | 1,165 | 1,045 | 1,157 | 1,354 | 1,412 | 1,497 |
| Other | 79 | 1 | 2 | 27 | 90 | 48 | 79 |
| Other | 20,462 | 22,813 | 25,285 | 27,199 | 27,666 | 30.049 | 31,028 |
| White | 17,875 | 19,698 | 21,397 | 22,339 | 22,656 | 24,764 | 25,377 |
| Black | 54 | 52 | 149 | 186 | 164 | 190 | 201 |
| Asian | 1,665 | 2,802 | 3,376 | 4,188 | 4,367 | 4,878 | 5,254 |
| Other | 668 | 261 | 363 | 486 | 479 | 217 | 196 |

NOTE: Details may not sum to totals because of rounding.

SOURCE: Science Resources Studies Division, National Science Foundation. *Characteristics of Doctoral Scientists and Engineers: 1989* NSF 91-317 (Washington, DC: NSF, 1991).

See figure 3-16. *Science & Engineering Indicators – 1991*

Appendix table 3-14.
**Employed doctoral scientists and engineers, by field and primary work activity: 1977-89**
(page 1 of 4)

| Field and primary work activity | 1977 | 1979 | 1981 | 1983 | 1985 | 1987 | 1989 |
|---|---|---|---|---|---|---|---|
| TOTAL SCIENTISTS AND ENGINEERS | 285,055 | 314,257 | 343,956 | 369,320 | 400,358 | 419,118 | 448,643 |
| Research | 79,995 | 84,678 | 101,691 | 104,511 | 110,539 | 135,384 | 145,559 |
| Basic research | 43,551 | 47,908 | 55,181 | 57,137 | 61,451 | 63,230 | 67,687 |
| Applied research[1] | 36,444 | 36,770 | 46,510 | 47,374 | 49,088 | 72,154 | 77,872 |
| Development | 13,188 | 15,009 | 18,361 | 20,277 | 21,976 | 18,909 | 21,042 |
| Management of R&D | 30,783 | 43,084 | 32,709 | 31,418 | 34,938 | 33,897 | 35,414 |
| Management other than R&D | 29,913 | 29,230 | 27,806 | 30,395 | 34,694 | 33,850 | 38,072 |
| Teaching | 90,830 | 92,242 | 105,150 | 108,236 | 111,717 | 109,730 | 112,715 |
| Consulting | 6,149 | 9,012 | 12,065 | 12,746 | 14,164 | 13,804 | 16,767 |
| Sales/professional services[1] | 15,233 | 21,126 | 25,757 | 29,820 | 36,496 | 32,644 | 36,599 |
| Reporting/statistical work/computing | NA | NA | NA | NA | NA | 11,891 | 25,029 |
| Other | 18,964 | 19,876 | 20,417 | 31,917 | 35,834 | 29,009 | 17,446 |
| **Total scientists** | 240,005 | 263,915 | 286,917 | 307,775 | 334,505 | 351,350 | 373,860 |
| Research | 69,683 | 74,739 | 88,180 | 89,528 | 95,556 | 115,587 | 123,312 |
| Basic research | 41,892 | 45,953 | 52,404 | 54,038 | 57,833 | 59,716 | 64,112 |
| Applied research[1] | 27,791 | 28,786 | 35,776 | 35,490 | 37,723 | 55,871 | 59,200 |
| Development | 6,349 | 7,185 | 8,487 | 10,514 | 11,185 | 9,083 | 9,348 |
| Management of R&D | 22,135 | 30,565 | 22,489 | 20,881 | 24,003 | 22,792 | 24,354 |
| Management other than R&D | 24,003 | 24,915 | 22,869 | 25,440 | 29,242 | 29,402 | 33,238 |
| Teaching | 82,029 | 82,909 | 94,416 | 96,403 | 99,237 | 97,938 | 99,972 |
| Consulting | 4,538 | 6,415 | 8,231 | 8,999 | 10,459 | 9,910 | 11,549 |
| Sales/professional services[1] | 14,568 | 20,029 | 24,271 | 28,568 | 34,252 | 32,500 | 36,467 |
| Reporting/statistical work/computing | NA | NA | NA | NA | NA | 10,527 | 20,297 |
| Other | 16,700 | 17,158 | 17,974 | 27,442 | 30,571 | 23,611 | 15,323 |
| Physical | 57,531 | 60,222 | 63,110 | 63,986 | 67,480 | 68,647 | 70,209 |
| Research | 22,271 | 21,135 | 26,515 | 25,569 | 26,253 | 30,750 | 31,846 |
| Basic research | 12,168 | 12,087 | 13,848 | 14,049 | 14,349 | 13,158 | 13,047 |
| Applied research[1] | 10,103 | 9,048 | 12,667 | 11,520 | 11,904 | 17,592 | 18,799 |
| Development | 2,543 | 2,796 | 3,075 | 3,484 | 3,647 | 3,779 | 3,831 |
| Management of R&D | 8,464 | 12,644 | 8,785 | 8,793 | 9,370 | 8,184 | 8,493 |
| Management other than R&D | 4,718 | 3,523 | 3,165 | 3,052 | 3,627 | 2,750 | 3,549 |
| Teaching | 14,724 | 14,450 | 15,570 | 14,652 | 15,170 | 15,213 | 14,492 |
| Consulting | 407 | 761 | 1,112 | 925 | 1,206 | 1,390 | 1,245 |
| Sales/professional services[1] | 1,088 | 1,205 | 1,437 | 1,641 | 2,026 | 531 | 531 |
| Reporting/statistical work/computing | NA | NA | NA | NA | NA | 959 | 3,993 |
| Other | 3,316 | 3,708 | 3,451 | 5,870 | 6,181 | 5,091 | 2,229 |
| Mathematical | 14,609 | 15,250 | 15,569 | 16,379 | 16,758 | 16,699 | 17,611 |
| Research | 2,912 | 3,138 | 2,969 | 2,913 | 3,452 | 3,838 | 4,241 |
| Basic research | 1,830 | 2,073 | 1,741 | 1,767 | 2,323 | 2,835 | 3,090 |
| Applied research[1] | 1,082 | 1,065 | 1,228 | 1,146 | 1,129 | 1,003 | 1,151 |
| Development | 408 | 492 | 395 | 490 | 573 | 161 | 200 |
| Management of R&D | 298 | 443 | 282 | 531 | 357 | 307 | 264 |
| Management other than R&D | 1,082 | 1,281 | 1,042 | 965 | 1,343 | 1,110 | 1,094 |
| Teaching | 9,088 | 8,865 | 9,596 | 9,701 | 9,445 | 9,347 | 9,758 |
| Consulting | 145 | 369 | 458 | 599 | 473 | 308 | 328 |
| Sales/professional services[1] | 78 | 249 | 300 | 261 | 213 | 22 | 46 |
| Reporting/statistical work/computing | NA | NA | NA | NA | NA | 808 | 1,213 |
| Other | 598 | 413 | 527 | 919 | 902 | 798 | 467 |

(continued)

Appendix table 3-14.
**Employed doctoral scientists and engineers, by field and primary work activity: 1977-89**
(page 2 of 4)

| Field and primary work activity | 1977 | 1979 | 1981 | 1983 | 1985 | 1987 | 1989 |
|---|---|---|---|---|---|---|---|
| Computer specialists | 5,767 | 6,684 | 9,064 | 12,164 | 14,964 | 18,571 | 19,797 |
| Research | 777 | 909 | 1,515 | 1,508 | 1,970 | 3,415 | 3,658 |
| Basic research | 283 | 435 | 620 | 615 | 1,005 | 1,391 | 1.463 |
| Applied research' | 494 | 474 | 895 | 893 | 965 | 2,024 | 2,195 |
| Development | 1,812 | 2.131 | 3,008 | 3,892 | 4,106 | 3,067 | 2,933 |
| Management of R&D | 735 | 971 | 808 | 1,114 | 1,734 | 2,292 | 2,368 |
| Management other than R&D | 667 | 681 | 890 | 938 | 1,128 | 1,348 | 1,627 |
| Teaching | 1,192 | 1,094 | 1,546 | 2,361 | 2,828 | 2,809 | 3,559 |
| Consulting | 155 | 301 | 554 | 678 | 914 | 825 | 884 |
| Sales/professional services' | 65 | 151 | 217 | 375 | 461 | 3 | 37 |
| Reporting/statistical work/computing | NA | NA | NA | NA | NA | 3,287 | 4,161 |
| Other | 364 | 446 | 526 | 1,298 | 1,823 | 1,525 | 570 |
| Environmental | 13,001 | 14,575 | 15,909 | 16,467 | 17,288 | 17,811 | 19,787 |
| Research | 4,674 | 5,242 | 6,036 | 6,399 | 6,501 | 7,567 | 8,477 |
| Basic research | 2,499 | 2,704 | 3,307 | 3,287 | 3,559 | 3,599 | 3,924 |
| Applied research' | 2,175 | 2,538 | 2,729 | 3,112 | 2,942 | 3,968 | 4,553 |
| Development | 200 | 370 | 286 | 329 | 313 | 141 | 253 |
| Management of R&D | 1,631 | 2,361 | 2,380 | 1,825 | 2,058 | 1,937 | 2,141 |
| Management other than R&D | 1,448 | 1,193 | 1,166 | 1,304 | 1,400 | 1,647 | 1,635 |
| Teaching | 3,510 | 2,975 | 3.606 | 3,435 | 3,393 | 3.418 | 3,447 |
| Consulting | 364 | 838 | 1,045 | 1,198 | 1,407 | 1,402 | 1,785 |
| Sales/professional services' | 137 | 216 | 381 | 242 | 315 | 88 | 74 |
| Reporting/statistical work/computing | NA | NA | NA | NA | NA | 630 | 1,130 |
| Other | 1,037 | 1,380 | 1,009 | 1,735 | 1,901 | 981 | 845 |
| Life | 70,537 | 78,857 | 84,912 | 92,802 | 101,838 | 107,378 | 115,833 |
| Research | 27,868 | 31.905 | 37,962 | 39,491 | 42,865 | 51,701 | 55,277 |
| Basic research | 19,954 | 23,413 | 27,223 | 28,784 | 30,990 | 31,225 | 33,640 |
| Applied research' | 7,914 | 8,492 | 10,739 | 10,707 | 11,875 | 20,476 | 21,637 |
| Development | 817 | 855 | 1,049 | 1,532 | 1,725 | 1,418 | 1,583 |
| Management of R&D | 7,340 | 9,246 | 6,711 | 6.165 | 7,328 | 7,310 | 8,036 |
| Management other than R&D | 6,206 | 6,613 | 5,416 | 6,806 | 8,335 | 8,233 | 9,405 |
| Teaching | 18.992 | 19,292 | 21,733 | 22,452 | 22,430 | 21,701 | 21,998 |
| Consulting | 1,037 | 1,441 | 1,535 | 1,981 | 2,383 | 2,258 | 2,657 |
| Sales/professional services' | 3,017 | 4,264 | 5,264 | 6,223 | 7,325 | 6,720 | 7,057 |
| Reporting/statistical work/computing | NA | NA | NA | NA | NA | 1,636 | 4,830 |
| Other | 5,260 | 5,241 | 5,242 | 8,152 | 9,447 | 6,401 | 4,990 |
| Psychologists | 33,652 | 37,848 | 42,829 | 46,645 | 52,182 | 56.378 | 60,596 |
| Research | 3,705 | 4,535 | 4,970 | 4,704 | 4.765 | 6.107 | 6.637 |
| Basic research | 1,937 | 2,546 | 2,464 | 2,344 | 2.316 | 2,884 | 3,290 |
| Applied research' | 1,768 | 1,989 | 2,506 | 2,360 | 2,449 | 3,223 | 3,347 |
| Development | 20[illegible] | 271 | 404 | 313 | 423 | 364 | 316 |
| Management of R&D | 1,609 | 1,620 | 1,060 | 903 | 1,043 | 1,030 | 898 |
| Management other than R&D | 4,297 | 5,002 | 4,745 | 4,705 | 5,152 | 5,695 | 6,106 |
| Teaching | 10,805 | 10,330 | 12,477 | 12,708 | 13,184 | 13,839 | 13,455 |
| Consulting | 1,481 | 1,499 | 2,051 | 2,084 | 2,118 | 1,576 | 2,239 |
| Sales/professional services' | 9,573 | 12,964 | 15,128 | 18,488 | 22,044 | 24,677 | 28,090 |
| Reporting/statistical work/computing | NA | NA | NA | NA | NA | 597 | 1,094 |
| Other | 1,978 | 1,627 | 1,994 | 2,740 | 3,453 | 2,493 | 1,761 |

(continued)

Appendix table 3-14.
**Employed doctoral scientists and engineers, by field and primary work activity: 1977-89**
(page 3 of 4)

| Field and primary work activity | 1977 | 1979 | 1981 | 1983 | 1985 | 1987 | 1989 |
|---|---|---|---|---|---|---|---|
| Social | 44,908 | 50,479 | 55,524 | 59,332 | 63,995 | 65,866 | 70,027 |
| Research | 7,476 | 7,875 | 8,213 | 8,944 | 9,750 | 12,2[illegible] | 13,176 |
| Basic research | 3,221 | 2,695 | 3,201 | 3,192 | 3,291 | 4,624 | 5,658 |
| Applied research' | 4,255 | 5,180 | 5,012 | 5,752 | 6,459 | 7,585 | 7,518 |
| Development | 365 | 270 | 270 | 474 | 398 | 153 | 232 |
| Management of R&D | 2,058 | 3,280 | 2,463 | 1,550 | 2,113 | 1,732 | 2,154 |
| Management other than R&D | 5,585 | 6,622 | 6,445 | 7,670 | 8,257 | 8,619 | 9,822 |
| Teaching | 23,718 | 25,903 | 29,888 | 31,094 | 32,787 | 31,611 | 33,263 |
| Consulting | 949 | 1,206 | 1,476 | 1,534 | 1,958 | 2,151 | 2,411 |
| Sales/professional services' | 610 | 980 | 1,544 | 1,338 | 1,868 | 459 | 632 |
| Reporting/statistical work/computing | NA | NA | NA | NA | NA | 2,610 | 3,876 |
| Other | 4,147 | 4,343 | 5,225 | 6,728 | 6,864 | 6,322 | 4,461 |
| **Total engineers** | 45,050 | 50,342 | 57,039 | 61,545 | 65,853 | 67,768 | 74,783 |
| Research | 10,312 | 9,939 | 13,511 | 14,983 | 14,983 | 19,797 | 22,247 |
| Basic research | 1,659 | 1,955 | 2,777 | 3,099 | 3,618 | 3,514 | 3,575 |
| Applied research' | 8,653 | 7,984 | 10,734 | 11,884 | 11,365 | 16,283 | 18,672 |
| Development | 6,839 | 7,824 | 9,874 | 9,763 | 10,791 | 9,826 | 11,694 |
| Management of R&D | 8,648 | 12,519 | 10,220 | 10,537 | 10,935 | 11,105 | 11,060 |
| Management other than R&D | 5,910 | 4,315 | 4,937 | 4,955 | 5,452 | 4,448 | 4,834 |
| Teaching | 8,801 | 9,333 | 10,734 | 11,833 | 12,480 | 11,792 | 12,743 |
| Consulting | 1,611 | 2,597 | 3,834 | 3,747 | 3,705 | 3,894 | 5,218 |
| Sales/professional services' | 665 | 1,097 | 1,486 | 1,252 | 2,244 | 144 | 132 |
| Reporting/statistical work/computing | NA | NA | NA | NA | NA | 1,364 | 4,732 |
| Other | 2,264 | 2,718 | 2,443 | 4,475 | 5,263 | 5,398 | 2,123 |
| Aeronautical/astronautical | 1,987 | 2,364 | 2,519 | 3,684 | 3,827 | 5,005 | 6,367 |
| Research | 586 | 733 | 763 | 994 | 1,045 | 1,327 | 1,847 |
| Basic research | 104 | 293 | 175 | 273 | 300 | 231 | 358 |
| Applied research' | 482 | 440 | 588 | 721 | 745 | 1,096 | 1,489 |
| Development | 324 | 521 | 314 | 806 | 805 | 1,025 | 1,382 |
| Management of R&D | 454 | 574 | 620 | 798 | 931 | 1,446 | 1,408 |
| Management other than R&D | 195 | 86 | 218 | 156 | 176 | 224 | 170 |
| Teaching | 336 | 310 | 387 | 517 | 335 | 436 | 631 |
| Consulting | 0 | 0 | 40 | 138 | 127 | 207 | 365 |
| Sales/professional services' | 25 | 61 | 84 | 79 | 125 | 51 | 0 |
| Reporting/statistical work/computing | NA | NA | NA | NA | NA | 114 | 242 |
| Other | 67 | 79 | 93 | 196 | 283 | 175 | 322 |
| Chemical | 5,603 | 6,166 | 7,146 | 6,992 | 7,122 | 6,923 | 7,959 |
| Research | 1,187 | 1,035 | 2,125 | 2,054 | 1,995 | 2,503 | 3,446 |
| Basic research | 199 | 175 | 278 | 374 | 446 | 488 | 491 |
| Applied research' | 988 | 860 | 1,847 | 1,680 | 1,549 | 2,015 | 2,955 |
| Development | 865 | 1,122 | 1,480 | 914 | 1,161 | 818 | 1,255 |
| Management of R&D | 1,301 | 1,809 | 1,192 | 1,110 | 1,214 | 968 | 894 |
| Management other than R&D | 903 | 662 | 432 | 587 | 542 | 390 | 428 |
| Teaching | 713 | 620 | 963 | 1,078 | 904 | 1,110 | 843 |
| Consulting | 182 | 217 | 387 | 227 | 225 | 195 | 375 |
| Sales/professional services' | 147 | 124 | 212 | 185 | 425 | 0 | 0 |
| Reporting/statistical work/computing | NA | NA | NA | NA | NA | 103 | 471 |
| Other | 305 | 577 | 355 | 837 | 656 | 836 | 247 |

(continued)

Appendix table 3-14.
**Employed doctoral scientists and engineers, by field and primary work activity: 1977-89**
(page 4 of 4)

| Field and primary work activity | 1977 | 1979 | 1981 | 1983 | 1985 | 1987 | 1989 |
|---|---|---|---|---|---|---|---|
| Civil | 4,066 | 5,157 | 6,089 | 5,317 | 6,396 | 6,479 | 6,951 |
| Research | 565 | 705 | 704 | 580 | 822 | 1,234 | 1,213 |
| Basic research | 55 | 36 | 134 | 189 | 298 | 276 | 300 |
| Applied research[1] | 510 | 669 | 570 | 391 | 524 | 958 | 913 |
| Development | 285 | 252 | 514 | 318 | 530 | 224 | 236 |
| Management of R&D | 377 | 432 | 443 | 180 | 470 | 228 | 231 |
| Management other than R&D | 710 | 624 | 770 | 598 | 668 | 781 | 755 |
| Teaching | 1,470 | 1,633 | 2,164 | 2,132 | 2,231 | 2,369 | 2,439 |
| Consulting | 347 | 1,073 | 983 | 934 | 788 | 871 | 1,461 |
| Sales/professional services[1] | 60 | 165 | 233 | 113 | 318 | 8 | 78 |
| Reporting/statistical work/computing | NA | NA | NA | NA | NA | 60 | 307 |
| Other | 252 | 273 | 278 | 462 | 569 | 704 | 231 |
| Electrical/electronic | 8,284 | 8,597 | 10,630 | 12,696 | 14,248 | 12,601 | 15,088 |
| Research | 1,418 | 1,327 | 1,976 | 2,455 | 2,344 | 2,737 | 3,451 |
| Basic research | 218 | 100 | 273 | 330 | 493 | 494 | 743 |
| Applied research[1] | 1,200 | 1,227 | 1,703 | 2,125 | 1,851 | 2,243 | 2,708 |
| Development | 1,832 | 1,454 | 2,429 | 2,551 | 2,943 | 2,966 | 3,285 |
| Management of R&D | 1,631 | 2,534 | 2,128 | 2,817 | 2,899 | 2,197 | 3,102 |
| Management other than R&D | 959 | 826 | 836 | 1,144 | 1,273 | 760 | 814 |
| Teaching | 1,897 | 1,842 | 2,313 | 2,447 | 3,028 | 2,153 | 2,808 |
| Consulting | 84 | 123 | 377 | 380 | 422 | 468 | 424 |
| Sales/professional services[1] | 106 | 186 | 242 | 247 | 423 | 26 | 0 |
| Reporting/statistical work/computing | NA | NA | NA | NA | NA | 224 | 886 |
| Other | 357 | 305 | 329 | 655 | 916 | 1,070 | 318 |
| Mechanical | 4,648 | 5,245 | 5,370 | 5,657 | 6,594 | 6,711 | 7,390 |
| Research | 931 | 778 | 1,219 | 836 | 1,214 | 1,850 | 1,964 |
| Basic research | 134 | 172 | 344 | 156 | 376 | 244 | 251 |
| Applied research[1] | 797 | 606 | 875 | 680 | 838 | 1,606 | 1,713 |
| Development | 598 | 853 | 1,015 | 1,055 | 1,264 | 838 | 1,199 |
| Management of R&D | 826 | 1,023 | 660 | 597 | 896 | 697 | 707 |
| Management other than R&D | 579 | 392 | 379 | 491 | 529 | 411 | 402 |
| Teaching | 1,267 | 1,582 | 1,501 | 1,867 | 2,025 | 2,109 | 2,387 |
| Consulting | 164 | 364 | 378 | 342 | 340 | 330 | 304 |
| Sales/professional services[1] | 61 | 178 | 132 | 65 | 113 | 0 | 41 |
| Reporting/statistical work/computing | NA | NA | NA | NA | NA | 88 | 224 |
| Other | 222 | 75 | 86 | 404 | 213 | 388 | 162 |
| Other engineers | 20,462 | 22,813 | 25,285 | 27,199 | 27,666 | 30,049 | 31,028 |
| Research | 5,625 | 5,361 | 6,724 | 8,064 | 7,563 | 10,146 | 10,326 |
| Basic research | 949 | 1,179 | 1,573 | 1,777 | 1,705 | 1,781 | 1,432 |
| Applied research[1] | 4,676 | 4,182 | 5,151 | 6,287 | 5,858 | 8,365 | 8,894 |
| Development | 2,935 | 3,622 | 4,122 | 4,119 | 4,088 | 3,955 | 4,337 |
| Management of R&D | 4,059 | 6,147 | 5,177 | 5,035 | 4,525 | 5,569 | 4,718 |
| Management other than R&D | 2,564 | 1,725 | 2,302 | 1,979 | 2,264 | 1,882 | 2,265 |
| Teaching | 3,118 | 3,346 | 3,406 | 3,792 | 3,957 | 3,615 | 3,635 |
| Consulting | 834 | 820 | 1,669 | 1,726 | 1,803 | 1,823 | 2,289 |
| Sales/professional services[1] | 266 | 383 | 583 | 563 | 840 | 59 | 13 |
| Reporting/statistical work/computing | NA | NA | NA | NA | NA | 775 | 2 602 |
| Other | 1,061 | 1,409 | 1,302 | 1,921 | 2,626 | 2,225 | 843 |

NA = not available

NOTE: Details may not sum to totals because of rounding.

[1]In 1987, sales/professional services was redefined to include only professional services; sales data from 1987 on are included with "other." In 1987, applied research was redefined. Data from 1987 on reflect this change.

SOURCE: Science Resources Studies Division, National Science Foundation, *Characteristics of Doctoral Scientists and Engineers in the United States: 1989*, NSF 91-317 (Washington, DC: NSF, 1991).

See figure 3-13.

*Science & Engineering Indicators – 1991*

Appendix table 3-15.
**Employed doctoral scientists and engineers, by field and type of employer: 1977-89**
(page 1 of 3)

| Field and type of employer | 1977 | 1979 | 1981 | 1983 | 1985 | 1987 | 1989 |
|---|---|---|---|---|---|---|---|
| TOTAL SCIENTISTS AND ENGINEERS | 285,055 | 314,257 | 343,956 | 369,320 | 400,358 | 419,118 | 448,643 |
| Business and industry | 71,562 | 82,858 | 99,126 | 113,463 | 125,767 | 131,699 | 145,148 |
| Educational institution | 163,768 | 174,483 | 187,011 | 196,050 | 211,611 | 218,697 | 230,932 |
| Federal Government | 21,389 | 23,946 | 25,124 | 25,793 | 26,337 | 27,532 | 29,242 |
| State and local government | 5,308 | 6,123 | 6,558 | 7,717 | 8,217 | 9,223 | 10,397 |
| Nonprofit organization | 10,195 | 12,454 | 12,601 | 11,894 | 13,617 | 15,464 | 16,150 |
| Other | 12,833 | 14,393 | 13,536 | 14,403 | 14,809 | 16,503 | 16,774 |
| **Total scientists** | 240,005 | 263,915 | 286,917 | 307,775 | 334,505 | 351,350 | 373,860 |
| Business and industry | 48,694 | 56,341 | 67,338 | 78,963 | 87,909 | 94,552 | 103,189 |
| Educational institution | 147,851 | 157,409 | 168,969 | 175,730 | 189,914 | 194,987 | 205,810 |
| Federal Government | 17,870 | 20,375 | 21,321 | 21,950 | 22,530 | 23,926 | 24,696 |
| State and local government | 4,924 | 5,882 | 6,201 | 7,334 | 7,855 | 8,697 | 9,858 |
| Nonprofit organization | 8,644 | 10,438 | 10,263 | 9,973 | 11,903 | 13,290 | 13,961 |
| Other | 12,022 | 13,470 | 12,825 | 13,825 | 14,394 | 15,898 | 16,346 |
| Physical | 57,531 | 60,222 | 63,110 | 63,986 | 67,480 | 68,647 | 70,209 |
| Business and industry | 23,006 | 24,989 | 27,409 | 28,748 | 30,281 | 30,741 | 32,042 |
| Educational institution | 27,118 | 27,300 | 28,225 | 27,931 | 29,700 | 30,310 | 30,276 |
| Federal Government | 3,945 | 4,598 | 4,342 | 4,307 | 4,044 | 4,322 | 4,602 |
| State and local government | 276 | 279 | 358 | 246 | 344 | 448 | 424 |
| Nonprofit organization | 2,042 | 1,985 | 2,093 | 1,751 | 2,286 | 2,167 | 2,095 |
| Other | 1,144 | 1,071 | 683 | 1,003 | 825 | 659 | 770 |
| Mathematical | 14,609 | 15,250 | 15,569 | 16,379 | 16,758 | 16,699 | 17,611 |
| Business and industry | 1,312 | 1,469 | 1,616 | 2,027 | 1,911 | 1,838 | 2,105 |
| Educational institution | 12,223 | 12,550 | 12,719 | 13,244 | 13,560 | 13,674 | 14,300 |
| Federal Government | 604 | 817 | 852 | 790 | 853 | 848 | 786 |
| State and local government | 51 | 51 | 2 | 21 | 34 | 26 | 63 |
| Nonprofit organization | 261 | 294 | 263 | 211 | 293 | 151 | 285 |
| Other | 158 | 69 | 117 | 86 | 107 | 162 | 72 |
| Computer specialists | 5,767 | 6,684 | 9,064 | 12,164 | 14,964 | 18,571 | 19,797 |
| Business and industry | 3,058 | 3,669 | 5,228 | 6,819 | 8,351 | 11,383 | 11,483 |
| Educational institution | 2,128 | 2,404 | 3,010 | 4,031 | 5,288 | 5,558 | 6,553 |
| Federal Government | 251 | 336 | 355 | 490 | 692 | 797 | 820 |
| State and local government | 81 | 7 | 152 | 336 | 248 | 258 | 308 |
| Nonprofit organization | 159 | 163 | 276 | 345 | 329 | 444 | 518 |
| Other | 90 | 105 | 43 | 143 | 56 | 131 | 115 |
| Environmental | 13,001 | 14,575 | 15,909 | 16,467 | 17,288 | 17,811 | 19,787 |
| Business and industry | 3,103 | 4,246 | 4,705 | 5,154 | 5,254 | 5,168 | 6,266 |
| Educational institution | 6,285 | 6,146 | 6,741 | 6,682 | 7,222 | 7,483 | 8,001 |
| Federal Government | 2,417 | 2,716 | 3,075 | 3,102 | 3,309 | 3,363 | 3,264 |
| State and local government | 506 | 655 | 604 | 819 | 666 | 913 | 1,131 |
| Nonprofit organization | 520 | 614 | 623 | 555 | 678 | 702 | 894 |
| Other | 170 | 198 | 161 | 155 | 159 | 182 | 231 |
| Life | 70,537 | 78,857 | 84,912 | 92,802 | 101,838 | 107,378 | 115,833 |
| Business and industry | 9,734 | 11,145 | 13,123 | 16,444 | 19,165 | 20,455 | 23,572 |
| Educational institution | 46,865 | 51,673 | 55,762 | 58,906 | 63,595 | 66,415 | 70,479 |
| Federal Government | 6,372 | 7,167 | 7,225 | 7,771 | 7,962 | 8,709 | 9,132 |
| State and local government | 1,452 | 1,551 | 1,670 | 1,710 | 2,166 | 1,944 | 2,743 |
| Nonprofit organization | 2,401 | 2,970 | 3,150 | 3,258 | 3,884 | 4,256 | 4,267 |
| Other | 3,713 | 4,351 | 3,982 | 4,713 | 5,066 | 5,599 | 5,640 |

(continued)

Appendix table 3-15.
**Employed doctoral scientists and engineers, by field and type of employer: 1977-89**
(page 2 of 3)

| Field and type of employer | 1977 | 1979 | 1981 | 1983 | 1985 | 1987 | 1989 |
|---|---|---|---|---|---|---|---|
| Psychologists | 33,652 | 37,848 | 42,829 | 46,645 | 52,182 | 56,378 | 60,596 |
| Business and industry | 5,528 | 7,077 | 10,122 | 13,020 | 15,530 | 17,381 | 19,899 |
| Educational institution | 18,512 | 19,846 | 21,675 | 22,182 | 24,893 | 25,369 | 26,425 |
| Federal Government | 1,220 | 1,080 | 1,211 | 1,191 | 1,049 | 1,388 | 1,426 |
| State and local government | 1,336 | 1,680 | 1,715 | 2,148 | 1,916 | 2,197 | 2,211 |
| Nonprofit organization | 1,272 | 1,725 | 1,679 | 1,773 | 2,084 | 2,501 | 2,697 |
| Other | 5,784 | 6,440 | 6,427 | 6,331 | 6,710 | 7,542 | 7,938 |
| Social | 44,908 | 50,479 | 55,524 | 59,332 | 63,995 | 65,866 | 70,027 |
| Business and industry | 2,953 | 3,746 | 5,135 | 6,751 | 7,417 | 7,586 | 7,822 |
| Educational institution | 34,720 | 37,490 | 40,837 | 42,754 | 45,656 | 46,178 | 49,776 |
| Federal Government | 3,061 | 3,661 | 4,261 | 4,299 | 4,621 | 4,499 | 4,666 |
| State and local government | 1,222 | 1,659 | 1,700 | 2,054 | 2,481 | 2,911 | 2,978 |
| Nonprofit organization | 1,989 | 2,687 | 2,179 | 2,080 | 2,349 | 3,069 | 3,205 |
| Other | 963 | 1,236 | 1,412 | 1,394 | 1,471 | 1,623 | 1,580 |
| **Total engineers** | 45,050 | 50,342 | 57,039 | 61,545 | 65,853 | 67,768 | 74,783 |
| Business and industry | 22,868 | 26,517 | 31,788 | 34,500 | 37,858 | 37,147 | 41,959 |
| Educational institution | 15,917 | 17,074 | 18,042 | 20,320 | 21,697 | 23,710 | 25,122 |
| Federal Government | 3,519 | 3,571 | 3,803 | 3,843 | 3,807 | 3,606 | 4,546 |
| State and local government | 384 | 241 | 357 | 383 | 362 | 526 | 539 |
| Nonprofit organization | 1,551 | 2,016 | 2,338 | 1,921 | 1,714 | 2,174 | 2,189 |
| Other | 811 | 923 | 711 | 578 | 415 | 605 | 428 |
| Aeronautical/astronautical | 1,987 | 2,364 | 2,519 | 3,684 | 3,827 | 5,005 | 6,367 |
| Business and industry | 799 | 907 | 1,127 | 1,928 | 2,095 | 3,177 | 4,116 |
| Educational institution | 561 | 783 | 675 | 865 | 732 | 907 | 1,258 |
| Federal Government | 381 | 407 | 425 | 511 | 627 | 550 | 715 |
| State and local government | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Nonprofit organization | 63 | 134 | 176 | 305 | 271 | 327 | 248 |
| Other | 183 | 133 | 116 | 74 | 102 | 44 | 30 |
| Chemical | 5,603 | 6,166 | 7,146 | 6,992 | 7,122 | 6,923 | 7,959 |
| Business and industry | 4,099 | 4,540 | 5,342 | 4,788 | 5,097 | 4,690 | 5,411 |
| Educational institution | 1,180 | 1,129 | 1,380 | 1,722 | 1,778 | 1,941 | 2,152 |
| Federal Government | 210 | 260 | 258 | 174 | 183 | 164 | 246 |
| State and local government | 8 | 0 | 23 | 0 | 0 | 0 | 14 |
| Nonprofit organization | 96 | 191 | 143 | 202 | 64 | 75 | 127 |
| Other | 10 | 46 | 0 | 106 | 0 | 53 | 9 |
| Civil | 4,066 | 5,157 | 6,089 | 5,317 | 6,396 | 6,479 | 6,951 |
| Business and industry | 1,199 | 1,822 | 2,555 | 1,895 | 2,426 | 1,931 | 2,426 |
| Educational institution | 2,211 | 2,722 | 2,887 | 3,138 | 3,409 | 3,802 | 3,667 |
| Federal Government | 279 | 249 | 145 | 79 | 295 | 387 | 432 |
| State and local government | 244 | 131 | 192 | 146 | 162 | 262 | 302 |
| Nonprofit organization | 13 | 0 | 69 | 16 | 14 | 49 | 73 |
| Other | 120 | 233 | 241 | 43 | 90 | 48 | 51 |
| Electrical/electronic | 8,284 | 8,597 | 10,630 | 12,696 | 14,248 | 12,601 | 15,088 |
| Business and industry | 3,915 | 4,687 | 6,187 | 7,615 | 8,566 | 7,600 | 8,780 |
| Educational institution | 3,290 | 2,930 | 3,592 | 3,960 | 4,672 | 3,979 | 4,829 |
| Federal Government | 620 | 719 | 524 | 776 | 756 | 637 | 950 |
| State and local government | 13 | 17 | 60 | 62 | 46 | 35 | 50 |
| Nonprofit organization | 320 | 184 | 264 | 218 | 186 | 254 | 377 |
| Other | 126 | 60 | 3 | 65 | 22 | 96 | 102 |

(continued)

Appendix table 3-15.
**Employed doctoral scientists and engineers, by field and type of employer: 1977-89**
(page 3 of 3)

| Field and type of employer | 1977 | 1979 | 1981 | 1983 | 1985 | 1987 | 1989 |
|---|---|---|---|---|---|---|---|
| Mechanical | 4,648 | 5,245 | 5,370 | 5,657 | 6,594 | 6,711 | 7,390 |
| Business and industry | 2,108 | 2,419 | 2,645 | 2,596 | 3,094 | 2,641 | 3,129 |
| Educational institution | 2,038 | 2,235 | 2,138 | 2,578 | 2,973 | 3,544 | 3,597 |
| Federal Government | 319 | 338 | 322 | 353 | 308 | 311 | 364 |
| State and local government | 0 | 1 | 2 | 0 | 0 | 8 | 7 |
| Nonprofit organization | 183 | 228 | 263 | 107 | 194 | 179 | 230 |
| Other | 0 | 24 | 0 | 23 | 25 | 28 | 63 |
| Other engineers | 20,462 | 22,813 | 25,285 | 27,199 | 27,666 | 30,049 | 31,028 |
| Business and industry | 10,748 | 12,142 | 13,932 | 15,678 | 16,580 | 17,108 | 18,097 |
| Educational institution | 6,637 | 7,275 | 7,370 | 8,057 | 8,133 | 9,537 | 9,619 |
| Federal Government | 1,710 | 1,598 | 2,129 | 1,950 | 1,638 | 1,557 | 1,839 |
| State and local government | 119 | 92 | 80 | 174 | 154 | 221 | 166 |
| Nonprofit organization | 876 | 1,279 | 1,423 | 1,073 | 985 | 1,290 | 1,134 |
| Other | 372 | 427 | 351 | 267 | 176 | 336 | 173 |

NOTE: Details may not sum to totals because of rounding.

SOURCE: Science Resources Studies Division, National Science Foundation, *Characteristics of Doctoral Scientists and Engineers in the United States: 1989*, NSF 91-317 (Washington, DC: NSF, 1991).

See figure 3-14 and figure O-11 in Overview. *Science & Engineering Indicators – 1991*

Appendix table 3-16.
**U.S. immigrant scientists and engineers, by country of origin: 1988**

| Country of origin | Total | Engineers | Natural scientists | Math scientists and computer specialists | Social scientists |
|---|---|---|---|---|---|
| All countries | 10,918 | 8,081 | 1,198 | 1,164 | 475 |
| Western Europe | 1,674 | 1,173 | 257 | 165 | 79 |
| France | 93 | 67 | 10 | 13 | 3 |
| Italy | 50 | 30 | 14 | 2 | 4 |
| Sweden | 66 | 52 | 5 | 6 | 3 |
| United Kingdom | 776 | 553 | 107 | 92 | 24 |
| West Germany | 157 | 86 | 43 | 10 | 18 |
| All others | 532 | 385 | 78 | 42 | 27 |
| Eastern Europe | 723 | 465 | 112 | 34 | 112 |
| Poland | 313 | 173 | 60 | 10 | 70 |
| USSR | 153 | 116 | 17 | 8 | 12 |
| Yugoslavia | 53 | 36 | 8 | 1 | 8 |
| All others | 204 | 140 | 27 | 15 | 22 |
| North and Central America | 1,142 | 790 | 131 | 132 | 89 |
| Canada | 325 | 202 | 50 | 54 | 19 |
| Mexico | 201 | 148 | 28 | 17 | 8 |
| All others | 616 | 440 | 53 | 61 | 62 |
| Near and Middle East | 1.262 | 1,045 | 93 | 95 | 29 |
| Iran | 648 | 552 | 41 | 43 | 12 |
| Israel | 134 | 86 | 22 | 22 | 4 |
| All others | 480 | 407 | 30 | 30 | 13 |
| Asia | 4,986 | 3,831 | 463 | 615 | 77 |
| Hong Kong | 432 | 330 | 28 | 70 | 4 |
| India | 1,246 | 958 | 161 | 104 | 23 |
| Japan | 102 | 70 | 11 | 17 | 4 |
| People's Republic of China | 740 | 566 | 53 | 110 | 11 |
| The Philippines | 798 | 676 | 51 | 60 | 11 |
| South Korea | 183 | 152 | 14 | 16 | 1 |
| Taiwan | 907 | 646 | 83 | 171 | 7 |
| All others | 578 | 433 | 62 | 67 | 16 |
| All other areas | 1,131 | 777 | 142 | 123 | 89 |

NOTES: Data refer to scientists and engineers from all sectors. Country identification is based on the country of birth. "Immigrant" refers to those scientists and engineers allowed to stay permanently in the United States and obtain citizenship: it includes both those who came directly from a foreign country and those who changed to immigrant status while in the United States. It does *not* include those admitted on a temporary basis unless they changed their status to become immigrants.

SOURCE: Science Resources Studies Division, National Science Foundation, *International Science and Technology Data Update: 1991*, NSF 91-309 (Washington, DC: NSF, 1991).

*Science & Engineering Indicators – 1991*

Appendix table 3-17.

**Nonacademic scientists and engineers per 10,000 labor force, by gender for selected countries: most current years**

| | France (1987) | Italy (1981) | Japan (1985) | United Kingdom[1] (1981) | United States[2] (1986) | West Germany (1985) |
|---|---|---|---|---|---|---|
| **Total numbers** | | | | | | |
| TOTAL SCIENTISTS & ENGINEERS | 473,897 | 124,290 | 1,514,200 | 585,190 | 3,919,900 | 621,500 |
| Male | 405,389 | 110,137 | 1,444,400 | 533,380 | 3,393,700 | 585,400 |
| Female | 68,508 | 14,153 | 69,800 | 51,810 | 526,200 | 36,100 |
| Scientists | 202,541 | 63,402 | 389,900 | 219,740 | 1,676,400 | 114,100 |
| Male | 141,413 | 50,093 | 338,400 | 173,880 | 1,242,800 | 95,700 |
| Female | 55,128 | 13,309 | 51,500 | 45,860 | 433,600 | 18,400 |
| Engineers | 271,356 | 60,888 | 1,124,300 | 365,450 | 2,243,500 | 507,400 |
| Male | 257,976 | 60,044 | 1,106,000 | 359,500 | 2,150,900 | 489,700 |
| Female | 13,380 | 844 | 18,300 | 5,950 | 92,600 | 17,700 |
| **Per 10,000 labor force** | | | | | | |
| TOTAL SCIENTISTS & ENGINEERS | 197 | 61 | 251 | 219 | 328 | 223 |
| Male | 168 | 54 | 240 | 199 | 284 | 210 |
| Female | 28 | 7 | 12 | 19 | 44 | 13 |
| Scientists | 84 | 31 | 65 | 82 | 140 | 41 |
| Male | 59 | 25 | 56 | 65 | 104 | 34 |
| Female | 23 | 7 | 9 | 17 | 36 | 7 |
| Engineers | 113 | 30 | 187 | 137 | 188 | 182 |
| Male | 107 | 30 | 184 | 134 | 180 | 176 |
| Female | 6 | * | 3 | 2 | 8 | 6 |
| Labor force | 24,073,000 | 20 246,000 | 60,270,700 | 26,740,000 | 119,540.000 | 27,844,000 |

* = less than 1 per 10,000

NOTES: Figures refer to scientists and engineers employed in science and engineering jobs. Details may not sum to totals because of rounding. The numbers of scientists and engineers for France, Italy, Japan, the United Kingdom, and West Germany are estimates prepared by the U.S. Bureau of the Census based on published and unpublished census and survey data for the years shown. Labor force data are from the Organisation for Economic Cooperation and Development; thus, the number of scientists and engineers per 10,000 labor force differs from data published in Census Bureau reports.

[1]Data exclude Northern Ireland.

[2]Data by gender are estimates.

SOURCE: Science Resources Studies Division, National Science Foundation, *International Science and Technology Data Update: 1991*, NSF 91-309 (Washington, DC: NSF, 1991).

See figure O-7 in Overview.

*Science & Engineering Indicators – 1991*

Appendix table 3-18.
**Nonacademic scientists and engineers, by sector of employment in selected countries: most current years**

| Sector | France (1987) | Japan (1985) | United Kingdom[1] (1981) | United States (1988) | West Germany (1985) |
|---|---|---|---|---|---|
| | | | **Scientists** | | |
| | | | Percent | | |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Agriculture | * | * | 0.5 | 1.0 | 0.2 |
| Mining[2] | 1.1 | * | 1.3 | 2.6 | NA |
| Manufacturing | 13.5 | 21.3 | 31.8 | 20.1 | 43.0 |
| Construction | 1.2 | 1.2 | 0.7 | 0.2 | 0.9 |
| Wholesale and retail trade | 5.1 | 9.2 | 4.8 | 3.7 | 2.2 |
| Transportation, communications, and public utilities | 1.5 | 2.1 | 5.5 | 2.7 | 2.9 |
| Services | 47.9 | 64.7 | 45.3 | 45.6 | 39.7 |
| Government | 29.4 | 1.0 | 10.1 | 24.0 | 7.4 |
| All other | 0.2 | NA | 0.1 | NA | 3.7 |
| | | | **Engineers** | | |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Agriculture | 0.3 | 0.5 | 0.1 | 0.1 | 0.1 |
| Mining[2] | 3.9 | 0.4 | 2.0 | 1.9 | NA |
| Manufacturing | 34.2 | 32.6 | 52.4 | 51.8 | 43.9 |
| Construction | 6.6 | 23.0 | 9.7 | 1.7 | 10.5 |
| Wholesale and retail trade | 3.0 | 1.9 | 2.4 | 2.0 | 1.9 |
| Transportation, communications, and public utilities | 2.3 | 5.9 | 10.7 | 5.7 | 10.1 |
| Services | 26.9 | 31.0 | 17.0 | 23.3 | 21.0 |
| Government | 22.4 | 4.7 | 5.7 | 13.4 | 12.0 |
| All other | 0.2 | NA | * | NA | 0.5 |

* = less than 0.05 percent; NA = not available

NOTES: Figures refer to scientists and engineers employed in science and engineering jobs. Details may not sum to 100 percent because of rounding. Figures for France, Japan, the United Kingdom, and West Germany are estimates prepared by the U.S. Bureau of the Census based on published and unpublished census and survey data for the years shown.

[1]Data exclude Northern Ireland.

[2]Mining data for West Germany are included under transportation, communications, and public utilities.

SOURCE: Science Resources Studies Division, National Science Foundation, *International Science and Technology Data Update: 1991*. NSF 91-309 (Washington, DC: NSF, 1991).

See figure 3-18.

*Science & Engineering Indicators – 1991*

Appendix table 3-19.

**Total labor force and scientists and engineers engaged in R&D per 10,000 labor force, for selected countries: 1965-87**

(page 1 of 2)

| | France | Italy | Japan | Sweden | United Kingdom | United States | West Germany |
|---|---|---|---|---|---|---|---|
| **Labor force (in thousands)** | | | | | | | |
| 1965 | 20,365 | 21,073 | 47,870 | 3,742 | 25,498 | 76,401 | 27,034 |
| 1966 | 20,534 | 20,836 | 48,910 | 3,792 | 25,632 | 77,892 | 26,962 |
| 1967 | 20,678 | 20,967 | 49,830 | 3,775 | 25,490 | 79,565 | 26,409 |
| 1968 | 20,861 | 21,039 | 50,610 | 3,822 | 25,378 | 80,990 | 26,291 |
| 1969 | 21,095 | 20,857 | 50,980 | 3,855 | 25,375 | 82,972 | 26,535 |
| 1970 | 21,415 | 20,886 | 51,530 | 3,913 | 25,308 | 84,889 | 26,817 |
| 1971 | 21,578 | 20,881 | 51,860 | 3,961 | 25,207 | 86,355 | 27,002 |
| 1972 | 21,738 | 20,713 | 52,000 | 3,970 | 25,264 | 88,847 | 26,990 |
| 1973 | 22,022 | 20,879 | 53,260 | 3,977 | 25,612 | 91,203 | 27,195 |
| 1974 | 22,260 | 21,046 | 53,100 | 4,043 | 25,659 | 93,670 | 27,147 |
| 1975 | 22,353 | 21,233 | 53,230 | 4,129 | 25,893 | 95,453 | 26,884 |
| 1976 | 22,605 | 21,553 | 53,780 | 4,155 | 26,111 | 97,826 | 26,651 |
| 1977 | 22,910 | 21,870 | 54,520 | 4,174 | 26,224 | 100,665 | 26,577 |
| 1978 | 23,062 | 21,950 | 55,320 | 4,290 | 26,357 | 103,882 | 26,692 |
| 1979 | 23,243 | 22,276 | 55,960 | 4,268 | 26,628 | 106,559 | 26,923 |
| 1980 | 23,369 | 22,553 | 56,500 | 4,318 | 26,840 | 108,544 | 27,217 |
| 1981 | 23,530 | 22,693 | 57,070 | 4,332 | 26,740 | 110,315 | 27,416 |
| 1982 | 23,743 | 22,798 | 57,740 | 4,357 | 26,677 | 111,872 | 27,542 |
| 1983 | 23,714 | 23,061 | 58,890 | 4,375 | 26,610 | 113,226 | 27,589 |
| 1984 | 23,867 | 23,323 | 59,270 | 4,332 | 27,265 | 115,241 | 27,629 |
| 1985 | 23,917 | 23,495 | 59,634 | 4,367 | 27,797 | 117,167 | 27,844 |
| 1986 | 23,993 | 23,851 | 60,200 | 4,386 | 27,984 | 119,540 | 28,024 |
| 1987 | 24,073 | 24,030 | 60,840 | 4,421 | 28,211 | 121,602 | 28,216 |
| **Scientists and engineers engaged in R&D per 10,000 labor force** | | | | | | | |
| 1965 | 21.0 | NA | 24.6 | NA | 19.6 | 64.7 | 22.6 |
| 1966 | 29.2 | NA | 26.4 | NA | NA | 66.9 | 22.3 |
| 1967 | 25.3 | NA | 27.8 | NA | NA | 67.2 | 24.4 |
| 1968 | 26.2 | NA | 31.1 | NA | 20.8 | 67.9 | 25.9 |
| 1969 | 27.1 | 12.2 | 30.8 | NA | NA | 66.6 | 28.2 |
| 1970 | 27.3 | 13.2 | 33.4 | NA | NA | 64.1 | 30.8 |
| 1971 | 27.9 | 14.8 | 37.5 | 22.9 | NA | 60.6 | 33.4 |
| 1972 | 28.2 | 15.7 | 38.1 | NA | 30.4 | 58.0 | 35.6 |
| 1973 | 28.5 | 16.0 | 42.5 | 23.2 | NA | 56.4 | 37.1 |
| 1974 | 28.8 | 16.3 | 44.9 | NA | NA | 55.6 | 37.8 |
| 1975 | 29.2 | 17.9 | 47.9 | 32.0 | 31.1 | 55.3 | 38.6 |
| 1976 | 29.6 | 17.6 | 48.4 | NA | NA | 54.7 | 39.2 |
| 1977 | 29.7 | 18.2 | 49.9 | 33.8 | NA | 55.7 | 41.8 |
| 1978 | 30.7 | 18.6 | 49.4 | NA | 33.3 | 55.5 | 42.7* |
| 1979 | 31.4 | 20.8 | 50.4 | 34.6 | NA | 57.7 | 43.4 |
| 1980 | 32.1 | 20.8 | 53.6 | NA | NA | 60.0 | 44.3* |
| 1981 | 36.3 | 22.9 | 55.6 | 35.2 | 35.8 | 61.9 | 45.5 |
| 1982 | 37.9 | 24.9 | 57.1 | NA | NA | 63.6 | 46.4* |
| 1983 | 39.1 | 27.3 | 58.1 | 39.0 | 35.4 | 66.4 | 47.4 |
| 1984 | 41.1 | 26.6 | 62.4 | NA | 35.5* | 69.2 | 49.6* |

(continued)

Appendix table 3-19.
**Total labor force and scientists and engineers engaged in R&D per 10,000 labor force, for selected countries: 1965-87**
(page 2 of 2)

| | France | Italy | Japan | Sweden | United Kingdom | United States | West Germany |
|---|---|---|---|---|---|---|---|
| 1985 | 42.8 | 27.1 | 63.9 | 44.9 | 35.5 | 72.5 | 51.6 |
| 1986 | 43.8 * | 28.4 | 67.4 | NA | 35.5 | 75.0 | 52.3 * |
| 1987 | 44.9 * | 29.4 | 68.8 | 50.2 | 35.9 | 75.9 | 53.7 * |

* = National Science Foundation estimates; NA = not available

NOTES: Table includes all scientists and engineers engaged in R&D on a full-time basis with the following exceptions. Japanese data include persons primarily employed in R&D in the natural sciences and engineering, and the United Kingdom data include only government and industry sectors. The figures for West Germany increased in 1979 because of increased coverage of small and medium enterprises not surveyed in 1977; data starting with 1979 were revised in 1988 using improved methodologies. The figures for France increased in 1981 in part because of a re-evaluation of university research methods.

SOURCE: Science Resources Studies Division, National Science Foundation, *International Science and Technology Data Update: 1991*, NSF 91-309 (Washington, DC: NSF, 1991).

See figure 3-19. *Science & Engineering Indicators – 1991*

Appendix table 3-20.
**Scientists and engineers engaged in R&D, by country: 1965-88**

| | France | Italy | Japan | Sweden | United Kingdom | United States | West Germany |
|---|---|---|---|---|---|---|---|
| | Thousands | | | | | | |
| 1965 | 42.8 | NA | 117.6 | NA | 49.9 | 494.6 | 61.0 |
| 1966 | 60.0 | NA | 128.9 | NA | NA | 521.1 | 60.0 |
| 1967 | 52.4 | NA | 138.7 | NA | NA | 534.4 | 64.5 |
| 1968 | 54.7 | NA | 157.6 | NA | 52.8 | 549.9 | 68.0 |
| 1969 | 57.2 | 25.4 | 157.1 | NA | NA | 552.7 | 74.9 |
| 1970 | 58.5 | 27.6 | 172.0 | NA | NA | 543.8 | 82.5 |
| 1971 | 60.1 | 30.9 | 194.3 | 9.1 | NA | 523.5 | 90.2 |
| 1972 | 61.2 | 32.6 | 198.1 | NA | 76.7 | 515.0 | 96.0 |
| 1973 | 62.7 | 33.3 | 226.6 | 9.2 | NA | 514.6 | 101.0 |
| 1974 | 64.1 | 34.3 | 238.2 | NA | NA | 520.6 | 102.5 |
| 1975 | 65.3 | 37.9 | 255.2 | 13.2 | 80.5 | 527.4 | 103.7 |
| 1976 | 67.0 | 37.9 | 260.2 | NA | NA | 535.2 | 104.5 |
| 1977 | 68.0 | 39.7 | 272.0 | 14.1 | NA | 560.6 | 111.0 |
| 1978 | 70.9 | 40.8 | 273.1 | NA | 87.7 | 586.6 | 113.9 |
| 1979 | 72.9 | 46.4 | 281.9 | 14.8 | NA | 614.5 | 116.9 |
| 1980 | 74.9 | 47.0 | 302.6 | NA | NA | 651.2 | 120.7 |
| 1981 | 85.5 | 52.1 | 317.5 | 15.2 | 95.7 | 683.3 | 124.7 |
| 1982 | 90.1 | 56.7 | 329.7 | NA | NA | 711.9 | 127.7 |
| 1983 | 92.7 | 63.0 | 342.2 | 17.0 | 94.1 | 751.7 | 130.8 |
| 1984 | 98.2 | 62.0 | 370.0 | NA | 96.3 | 797.8 | 137.1 |
| 1985 | 102.3 | 63.8 | 381.3 | 19.6 | 98.0 | 849.2 | 147.6 |
| 1986 | 105.0 | 67.8 | 405.6 | NA | 101.7 | 896.5 | 156.0 |
| 1987 | 109.4 | 70.6 | 418.3 | 22.2 | 101.4 | 923.3 | 165.6 |
| 1988 | NA | NA | 441.9 | NA | NA | 949.2 | NA |

NA = not available

NOTES: Table includes all scientists and engineers engaged in R&D on a full-time basis with the following exceptions. Japanese data include persons primarily employed in R&D in the natural sciences and engineering, and the United Kingdom data include only government and industry sectors. The figures for West Germany increased in 1979 because of increased coverage of small and medium enterprises not surveyed in 1977; data starting with 1979 were revised in 1988 using improved methodologies. The figures for France increased in 1981 in part because of a re-evaluation of university research efforts.

SOURCE: Science Resources Studies Division, National Science Foundation, *International Science and Technology Data Update: 1991*, NSF 91-309 (Washington, DC: NSF, 1991).

See figure 3-19. *Science & Engineering Indicators – 1991*

Appendix table 3-21.
**Scientists and engineers in manufacturing, by occupation group for selected countries: most current years**

| Occupation | France (1987) | Japan (1985) | United Kingdom[1] (1981) | United States (1988) | West Germany[2] (1985) |
|---|---|---|---|---|---|
| | | | Percent | | |
| Total scientists and engineers | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Scientists | 24.4 | 25.7 | 27.0 | 20.5 | 18.4 |
| Natural | 8.0 | 4.4 | 12.3 | 10.0 | 10.9 |
| Computer | 14.6 | 21.2 | 14.1 | 10.4 | NA |
| Social | 1.9 | 0.1 | 0.6 | 0.1 | 7.4 |
| Engineers | 75.4 | 74.3 | 73.0 | 79.5 | 81.6 |
| Civil | 5.4 | 32.1 | 1.3 | 0.8 | 25.9 |
| Electrical/electronic | 25.5 | 15.4 | 12.6 | 25.0 | 13.0 |
| Industrial/mechanical | 44.7 | 26.8 | 59.0 | 53.7 | 42.8 |

NA = not separately available

NOTES: Figures refer to scientists and engineers employed in science and engineering jobs. Details may not sum to totals because of rounding. Figures for France, Japan, the United Kingdom, and West Germany are estimates prepared by the U.S. Bureau of the Census based on published and unpublished census and survey data for the years shown.

[1]Data exclude Northern Ireland.

[2]Systems analysts are included with natural scientists; computer engineers are included with electrical/electronic engineers.

SOURCE: Science Resources Studies Division, National Science Foundation, *International Science and Technology Data Update: 1991*, NSF 91-309 (Washington, DC: NSF, 1991).

*Science & Engineering Indicators – 1991*

Appendix table 3-22.
**Nonacademic scientists and engineers, by age group in selected countries: most current years**

| Age group | France (1987) | Japan (1985) | United Kingdom[1] (1981) | United States[2] (1986) | West Germany (1985) |
|---|---|---|---|---|---|
| | | | Percent | | |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Under 35 | 28.2 | 48.5 | 38.9 | 32.9 | 30.3 |
| 35-54 | 61.7 | 44.9 | 32.1 | 49.0 | 56.0 |
| Over 55 | 10.1 | 6.7 | 29.0 | 18.1 | 13.6 |

NOTES: Figures refer to scientists and engineers employed in science and engineering jobs. Details may not sum to totals because of rounding. Figures for France, Japan, the United Kingdom, and West Germany are estimates prepared by the U.S. Bureau of the Census based on published and unpublished census and survey data for the years shown.

[1]Data exclude Northern Ireland.

[2]Data are for academic and nonacademic scientists and engineers and exclude those respondents for whom no age was reported.

SOURCE: Science Resources Studies Division, National Science Foundation, *International Science and Technology Data Update: 1991*, NSF 91-309 (Washington, DC: NSF, 1991).

See figure 3-20. *Science & Engineering Indicators – 1991*

Appendix table 3-23.
**First university degrees, by field of study for selected countries: most current years**

| Academic field | France[1] (1987) | Italy (1987) | Japan (1988) | Sweden (1987) | United Kingdom (1988) | United States (1988) | West Germany (1988) |
|---|---|---|---|---|---|---|---|
| | | | **Number of degrees** | | | | |
| All fields | 55,705 | 75,810 | 382,828 | 30,759 | 70,306 | 1,006,033 | 74,458 |
| Natural science and engineering | 26,606 | 23,423 | 102,911 | 3,796 | 25,990 | 196,934 | 26,081 |
| Natural sciences | 12,030 | 10,112 | 13,388 | 1,033 | 15,858 | 108,784 | 13,393 |
| Engineering | 14,576 | 10,295 | 76,362 | 2,236 | 8,839 | 70,406 | 10,444 |
| Agriculture | NA | 3,016 | 13,161 | 527 | 1,293 | 14,331 | 2,244 |
| All others | 29,099 | 52,387 | 279,917 | 26,963 | 44,316 | 809,099 | 48,377 |
| | | | **Percentage distribution among fields** | | | | |
| All fields | 100.0 | 100.00 | 100.0 | 100.00 | 100.0 | 100.0 | 100.0 |
| Natural science and engineering | 47.8 | 30.9 | 26.9 | 12.3 | 37.0 | 19.6 | 35.0 |
| Natural sciences | 21.6 | 13.3 | 3.5 | 3.4 | 22.6 | 10.8 | 18.0 |
| Engineering | 26.2 | 13.6 | 19.9 | 7.3 | 12.6 | 7.0 | 14.0 |
| Agriculture | NA | 4.0 | 3.4 | 1.7 | 1.8 | 1.4 | 3.0 |
| All others | 52.2 | 69.1 | 73.1 | 87.7 | 63.0 | 80.4 | 65.0 |

NA = not separately available

NOTE: The natural sciences include physical and earth sciences, biological sciences, mathematics, and computer sciences. For France only, agriculture is included under the natural sciences.

[1]Data are based on maitrise degrees and engineering degrees. French engineering degrees are equivalent to U.S. masters degrees.

SOURCE: Science Resources Studies Division, National Science Foundation, *International Science and Technology Data Update: 1991*, NSF 91-309 (Washington, DC: NSF, 1991).

See figure O-14 in Overview.

*Science & Engineering Indicators – 1991*

Appendix table 3-24.
**Doctorates granted, by field of study for selected countries: most current years**

| Academic field | France[1] (1987) | Italy (1987) | Japan[2] (1988) | Sweden (1987) | United Kingdom[3] (1988) | United States (1988) | West Germany (1988) |
|---|---|---|---|---|---|---|---|
| | | | **Number of degrees** | | | | |
| All fields | 7,965 | 2,145 | 9,156 | 956 | 7,588 | 33,456 | 17,321 |
| Natural science and engineering | 4,721 | 939 | 3,099 | 384 | 2,868 | 14,620 | 6,106 |
| Natural sciences | 4,439 | 518 | 837 | 191 | 1,312 | 9,415 | 4,275 |
| Engineering | 282 | 332 | 1,547 | 143 | 1,312 | 4,190 | 1,381 |
| Agriculture | NA | 89 | 715 | 50 | 244 | 1,015 | 450 |
| All others | 3,244 | 1,206 | 6,057 | 572 | 4,720 | 18,836 | 11,215 |
| | | | **Percentage distribution among fields** | | | | |
| All fields | 100.0 | 100.0 | 100.0 | 100 | 100.0 | 100.0 | 100.0 |
| Natural science and engineering | 59.3 | 43.8 | 33.8 | 40.2 | 37.8 | 43.7 | 35.3 |
| Natural sciences | 55.7 | 24.1 | 9.1 | 20.0 | 17.3 | 28.1 | 24.7 |
| Engineering | 3.5 | 15.5 | 16.9 | 15.0 | 17.3 | 12.5 | 8.0 |
| Agriculture | NA | 4.1 | 7.8 | 5.2 | 3.2 | 3.0 | 2.6 |
| All others | 40.7 | 56.2 | 66.2 | 59.8 | 62.2 | 56.3 | 64.7 |

NA = not separately available

NOTE: The natural sciences include physical and earth sciences, biological sciences, mathematics, and computer sciences. For France only, agriculture is included under the natural sciences.

[1]Data include the 3'eme Cycle and Docteur Ingenieur degrees, which are somewhat less than a Ph.D., and the Docteur d'etat, which is more than a Ph.D. France plans to grant a Ph.D.-level doctorate in the future.

[2]Ninety-four percent of "all other" Japanese doctorates are in health-related fields. Computer science is not a separate degree and is normally included in engineering.

[3]Data include Ph.D.-level and higher doctorates.

SOURCE: Science Resources Studies Division, National Science Foundation, *International Science and Technology Data Update: 1991*, NSF 91-309 (Washington, DC: NSF, 1991).

*Science & Engineering Indicators – 1991*

Appendix table 4-1.
**GNP and GNP implicit price deflators: 1960-92**

| | GNP implicit price deflators | | GNP | |
|---|---|---|---|---|
| | Calendar year | Fiscal year | Calendar year | Fiscal year |
| | | | Billions of dollars | |
| 1960 | 0.3095 | 0.3111 | 515.3 | 507.8 |
| 1961 | 0.3124 | 0.3144 | 533.8 | 519.0 |
| 1962 | 0.3194 | 0.3200 | 574.7 | 556.7 |
| 1963 | 0.3240 | 0.3258 | 606.9 | 588.6 |
| 1964 | 0.3293 | 0.3305 | 649.8 | 629.4 |
| 1965 | 0.3378 | 0.3375 | 705.1 | 673.6 |
| 1966 | 0.3496 | 0.3474 | 772.0 | 740.5 |
| 1967 | 0.3594 | 0.3593 | 816.4 | 793.6 |
| 1968 | 0.3773 | 0.3719 | 892.7 | 852.4 |
| 1969 | 0.3978 | 0.3920 | 964.0 | 929.5 |
| 1970 | 0.4203 | 0.4148 | 1,015.5 | 990.5 |
| 1971 | 0.4438 | 0.4366 | 1,102.7 | 1,057.1 |
| 1972 | 0.4649 | 0.4606 | 1,212.8 | 1,151.2 |
| 1973 | 0.4954 | 0.4835 | 1,359.3 | 1,285.5 |
| 1974 | 0.5396 | 0.5216 | 1,472.8 | 1,417.0 |
| 1975 | 0.5931 | 0.5752 | 1,598.4 | 1,523.5 |
| 1976 | 0.6307 | 0.6208 | 1,782.8 | 1,699.6 |
| 1977 | 0.6728 | 0.6703 | 1,990.5 | 1,935.8 |
| 1978 | 0.7222 | 0.7172 | 2,249.7 | 2,173.4 |
| 1979 | 0.7857 | 0.7790 | 2,508.2 | 2,452.2 |
| 1980 | 0.8572 | 0.8474 | 2,732.0 | 2,667.7 |
| 1981 | 0.9396 | 0.9321 | 3,052.6 | 2,986.2 |
| 1982 | 1.0000 | 1.0000 | 3,166.0 | 3,141.5 |
| 1983 | 1.0386 | 1.0423 | 3,405.7 | 3,322.4 |
| 1984 | 1.0773 | 1.0819 | 3,772.2 | 3,695.7 |
| 1985 | 1.1095 | 1.1153 | 4,014.9 | 3,950.9 |
| 1986 | 1.1382 | 1.1451 | 4,231.6 | 4,184.3 |
| 1987 | 1.1743 | 1.1803 | 4,515.6 | 4,428.1 |
| 1988 | 1.2133 | 1.2162 | 4,873.7 | 4,783.2 |
| 1989 | 1.2631 | 1.2674 | 5,200.8 | 5,130.9 |
| 1990 | 1.3161 | 1.3182 | 5,465.1 | 5,405.6 |
| 1991 | 1.3741 | 1.3766 | 5,689.4 | 5,615.8 |
| 1992 | 1.4283 | 1.4329 | 6,094.9 | 5,985.5 |

NOTES: Calendar year deflators were taken directly from sources cited below. Fiscal year deflators were calculated from quarterly data in the same sources. Data are as of February 4, 1991.

SOURCES: Science Resources Studies Division, National Science Foundation, unpublished tabulations; Bureau of Economic Analysis, *Survey of Current Business* (Washington, DC: Department of Commerce, monthly series); and Office of Management and Budget, unpublished tabulations.

*Science & Engineering Indicators – 1991*

Appendix table 4-2.
**U.S. R&D expenditures, by performing sector and source of funds: 1960-91**
(page 1 of 2)

| [Performing sector] | | Federal Gov't | Industry | | | Universities and colleges (U&C) | | | | | | U&C FFRDCs | Nonprofit institutions | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [Source of funds] | Total U.S. | Federal Gov't' | Total | Federal Gov't' | Industry | Total | Federal Gov't' | Industry | Non-Fed. gov't | U&C own | Non-profits | Federal Gov't' | Total | Federal Gov't' | Industry | Non-profits |
| | | | | | | Millions of current dollars | | | | | | | | | | |
| 1960 | 13.520 | 1,723 | 10,509 | 6,081 | 4,428 | 646 | 405 | 40 | 85 | 64 | 52 | 360 | 282 | 166 | 48 | 68 |
| 1961 | 14,320 | 1,878 | 10,908 | 6,240 | 4,668 | 763 | 500 | 40 | 95 | 70 | 58 | 410 | 361 | 226 | 49 | 86 |
| 1962 | 15,392 | 2.096 | 11,464 | 6,435 | 5,029 | 904 | 613 | 40 | 106 | 79 | 66 | 470 | 458 | 295 | 54 | 109 |
| 1963 | 17,059 | 2.279 | 12,630 | 7,270 | 5,360 | 1,081 | 760 | 41 | 118 | 89 | 73 | 530 | 539 | 365 | 55 | 119 |
| 1964 | 18,854 | 2,838 | 13,512 | 7,720 | 5,792 | 1,275 | 917 | 40 | 132 | 103 | 83 | 629 | 600 | 433 | 55 | 112 |
| 1965 | 20.044 | 3,093 | 14,185 | 7,740 | 6,445 | 1,474 | 1,073 | 41 | 143 | 124 | 93 | 629 | 663 | 477 | 62 | 124 |
| 1966 | 21,846 | 3,220 | 15.548 | 8,332 | 7,216 | 1,715 | 1,261 | 42 | 156 | 148 | 108 | 630 | 733 | 525 | 70 | 138 |
| 1967 | 23.146 | 3,396 | 16,385 | 8,365 | 8,020 | 1,921 | 1,409 | 48 | 164 | 181 | 119 | 673 | 771 | 552 | 74 | 145 |
| 1968 | 24.605 | 3.494 | 17,429 | 8,560 | 8,869 | 2,149 | 1,572 | 55 | 172 | 218 | 132 | 719 | 814 | 582 | 81 | 151 |
| 1969 | 25,629 | 3,501 | 18,308 | 8,451 | 9,857 | 2,225 | 1,600 | 60 | 197 | 223 | 145 | 725 | 870 | 616 | 93 | 161 |
| 1970 | 26.134 | 4.079 | 18,067 | 7,779 | 10,288 | 2,335 | 1,647 | 61 | 219 | 243 | 165 | 737 | 916 | 649 | 95 | 172 |
| 1971 | 26.676 | 4,228 | 18,320 | 7,666 | 10,654 | 2,500 | 1,724 | 70 | 255 | 274 | 177 | 716 | 912 | 630 | 98 | 184 |
| 1972 | 28,476 | 4,589 | 19,552 | 8,017 | 11,535 | 2,630 | 1,795 | 74 | 269 | 305 | 187 | 753 | 952 | 653 | 101 | 198 |
| 1973 | 30,718 | 4.762 | 21.249 | 8,145 | 13,104 | 2,884 | 1,985 | 84 | 295 | 318 | 202 | 817 | 1,006 | 690 | 105 | 211 |
| 1974 | 32.863 | 4,911 | 22,887 | 8,220 | 14,667 | 3,022 | 2,032 | 95 | 308 | 368 | 219 | 865 | 1,178 | 822 | 115 | 241 |
| 1975 | 35.213 | 5.354 | 24,187 | 8.605 | 15,582 | 3,409 | 2,288 | 113 | 332 | 417 | 259 | 987 | 1,276 | 875 | 125 | 276 |
| 1976 | 39.018 | 5,769 | 26,997 | 9,561 | 17,436 | 3,729 | 2,512 | 123 | 364 | 446 | 285 | 1,147 | 1,376 | 925 | 135 | 316 |
| 1977 | 42.783 | 6,012 | 29,825 | 10,485 | 19,340 | 4,067 | 2,726 | 139 | 374 | 514 | 314 | 1,384 | 1,495 | 987 | 150 | 358 |
| 1978 | 48.128 | 6,810 | 33.304 | 11,189 | 22,115 | 4,625 | 3,059 | 170 | 414 | 623 | 359 | 1,717 | 1,672 | 1,100 | 165 | 407 |
| 1979 | 54,953 | 7.418 | 38,226 | 12,518 | 25,708 | 5,380 | 3,604 | 194 | 476 | 738 | 368 | 1,935 | 1,994 | 1,350 | 180 | 464 |
| 1980 | 62.610 | 7.632 | 44.505 | 14,029 | 30,476 | 6.077 | 4.104 | 236 | 490 | 837 | 403 | 2,246 | 2,150 | 1,450 | 200 | 500 |
| 1981 | 71.868 | 8.426 | 51,810 | 16.382 | 35,428 | 6,846 | 4.565 | 291 | 546 | 1,008 | 436 | 2,486 | 2,300 | 1,550 | 225 | 525 |
| 1982 | 80.018 | 9.141 | 58.650 | 18,545 | 40,105 | 7,323 | 4,763 | 337 | 616 | 1,115 | 492 | 2.479 | 2,425 | 1,650 | 250 | 525 |
| 1983 | 89.139 | 10.582 | 65,268 | 20,680 | 44,588 | 7,877 | 4,983 | 388 | 626 | 1,303 | 577 | 2,737 | 2.675 | 1,850 | 275 | 550 |
| 1984 | 101.139 | 11.572 | 74.800 | 23,396 | 51,404 | 8,617 | 5,423 | 475 | 690 | 1,413 | 615 | 3,150 | 3,000 | 2.100 | 325 | 575 |
| 1985 | 113.818 | 12.945 | 84,239 | 27,196 | 57,043 | 9.686 | 6,056 | 559 | 754 | 1,622 | 695 | 3,523 | 3,425 | 2,400 | 375 | 650 |
| 1986 | 119.529 | 13.535 | 87.823 | 27,891 | 59,932 | 10.926 | 6,702 | 699 | 916 | 1,873 | 735 | 3,895 | 3,350 | 2.250 | 425 | 675 |
| 1987 | 125.352 | 13,413 | 92,155 | 30.752 | 61,403 | 12.153 | 7.333 | 789 | 1.024 | 2.176 | 831 | 4.206 | 3,425 | 2,200 | 450 | 775 |
| 1988 | 133.741 | 14,281 | 97.889 | 32.306 | 65,583 | 13,465 | 8.181 | 870 | 1,107 | 2,367 | 941 | 4,531 | 3.575 | 2,200 | 500 | 875 |
| 1989 | 140.486 | 15.121 | 101,599 | 31,366 | 70.233 | 14.987 | 8,972 | 984 | 1,239 | 2.710 | 1,083 | 4,729 | 4,050 | 2,500 | 550 | 1,000 |
| 1990 (prel.) | 145.450 | 16.100 | 104.200 | 31,200 | 73.000 | 16.000 | 9.250 | 1,100 | 1,350 | 3,100 | 1,200 | 4,800 | 4,350 | 2,650 | 600 | 1,100 |
| 1991 (est.) | 151.600 | 16.400 | 108.450 | 32,300 | 76,150 | 17,200 | 9.650 | 1,250 | 1,500 | 3,450 | 1,350 | 4,850 | 4,700 | 2,800 | 650 | 1,250 |

(continued)

Appendix table 4-2.

**U.S. R&D expenditures, by performing sector and source of funds: 1960-91**

(page 2 of 2)

| [Performing sector] | | Federal Gov't | Industry | | | Universities and colleges (U&C) | | | | | | U&C FFRDCs | Nonprofit institutions | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [Source of funds] | Total U.S. | Federal Gov't | Total | Federal Gov't | Industry | Total | Federal Gov't | Industry | Non-Fed. gov't | U&C own | Non-profits | Federal Gov't | Total | Federal Gov't | Industry | Non-profits |
| | | | | | | | Millions of constant 1982 dollars | | | | | | | | | |
| 1960 | 43,639 | 5,539 | 33,955 | 19,648 | 14,307 | 2,077 | 1,302 | 129 | 273 | 206 | 167 | 1,157 | 911 | 536 | 155 | 220 |
| 1961 | 45,777 | 5,973 | 34,917 | 19,974 | 14,942 | 2,427 | 1,590 | 127 | 302 | 223 | 184 | 1,304 | 1,156 | 723 | 157 | 275 |
| 1962 | 48,171 | 6,551 | 35,892 | 20,147 | 15,745 | 2,825 | 1,916 | 125 | 331 | 247 | 206 | 1,469 | 1,434 | 924 | 169 | 341 |
| 1963 | 52,583 | 6,994 | 38,981 | 22,438 | 16,543 | 3,318 | 2,332 | 126 | 362 | 273 | 224 | 1,627 | 1,664 | 1,127 | 170 | 367 |
| 1964 | 57,203 | 8,587 | 41,032 | 23,444 | 17,589 | 3,858 | 2,775 | 121 | 399 | 312 | 251 | 1,903 | 1,822 | 1,315 | 167 | 340 |
| 1965 | 59,351 | 9,165 | 41,992 | 22,913 | 19,079 | 4,368 | 3,179 | 121 | 424 | 367 | 276 | 1,864 | 1,963 | 1,412 | 184 | 367 |
| 1966 | 62,589 | 9,269 | 44,474 | 23,833 | 20,641 | 4,937 | 3,630 | 121 | 449 | 426 | 311 | 1,813 | 2,097 | 1,502 | 200 | 395 |
| 1967 | 64,409 | 9,453 | 45,590 | 23,275 | 22,315 | 5,347 | 3,922 | 134 | 457 | 504 | 331 | 1,873 | 2,145 | 1,536 | 206 | 403 |
| 1968 | 65,458 | 9,395 | 46,194 | 22,688 | 23,506 | 5,778 | 4,227 | 148 | 462 | 586 | 355 | 1,933 | 2,157 | 1,543 | 215 | 400 |
| 1969 | 64,666 | 8,932 | 46,023 | 21,244 | 24,779 | 5,677 | 4,082 | 153 | 503 | 569 | 370 | 1,850 | 2,187 | 1,549 | 234 | 405 |
| 1970 | 62,403 | 9,833 | 42,986 | 18,508 | 24,478 | 5,629 | 3,970 | 147 | 528 | 586 | 398 | 1,777 | 2,179 | 1,544 | 226 | 409 |
| 1971 | 60,384 | 9,684 | 41,280 | 17,274 | 24,006 | 5,726 | 3,949 | 160 | 584 | 628 | 405 | 1,640 | 2,055 | 1,420 | 221 | 415 |
| 1972 | 61,412 | 9,963 | 42,056 | 17,245 | 24,812 | 5,710 | 3,897 | 161 | 584 | 662 | 406 | 1,635 | 2,048 | 1,405 | 217 | 426 |
| 1973 | 62,427 | 9,849 | 42,893 | 16,441 | 26,451 | 5,965 | 4,106 | 174 | 610 | 658 | 418 | 1,690 | 2,031 | 1,393 | 212 | 426 |
| 1974 | 61,466 | 9,416 | 42,415 | 15,234 | 27,181 | 5,794 | 3,896 | 182 | 591 | 706 | 420 | 1,658 | 2,183 | 1,523 | 213 | 447 |
| 1975 | 59,882 | 9,308 | 40,781 | 14,509 | 26,272 | 5,926 | 3,978 | 196 | 577 | 725 | 450 | 1,716 | 2,151 | 1,475 | 211 | 465 |
| 1976 | 62,134 | 9,293 | 42,805 | 15,159 | 27,645 | 6,007 | 4,046 | 198 | 586 | 718 | 459 | 1,848 | 2,182 | 1,467 | 214 | 501 |
| 1977 | 63,653 | 8,969 | 44,330 | 15,584 | 28,746 | 6,067 | 4,067 | 207 | 558 | 767 | 468 | 2,065 | 2,222 | 1,467 | 223 | 532 |
| 1978 | 66,768 | 9,495 | 46,115 | 15,493 | 30,622 | 6,449 | 4,265 | 237 | 577 | 869 | 501 | 2,394 | 2,315 | 1,523 | 228 | 564 |
| 1979 | 70,104 | 9,523 | 48,652 | 15,932 | 32,720 | 6,907 | 4,627 | 249 | 611 | 947 | 472 | 2,484 | 2,538 | 1,718 | 229 | 591 |
| 1980 | 73,255 | 9,006 | 51,919 | 16,366 | 35,553 | 7,171 | 4,843 | 278 | 585 | 988 | 476 | 2,650 | 2,508 | 1,692 | 233 | 583 |
| 1981 | 76,641 | 9,040 | 55,140 | 17,435 | 37,705 | 7,345 | 4,898 | 312 | 586 | 1,081 | 468 | 2,667 | 2,448 | 1,650 | 239 | 559 |
| 1982 | 80,018 | 9,141 | 58,650 | 18,545 | 40,105 | 7,323 | 4,763 | 337 | 616 | 1,115 | 492 | 2,479 | 2,425 | 1,650 | 250 | 525 |
| 1983 | 85,753 | 10,152 | 62,842 | 19,911 | 42,931 | 7,557 | 4,781 | 372 | 601 | 1,250 | 554 | 2,626 | 2,576 | 1,781 | 265 | 530 |
| 1984 | 93,790 | 10,696 | 69,433 | 21,717 | 47,716 | 7,965 | 5,012 | 439 | 638 | 1,306 | 568 | 2,912 | 2,785 | 1,949 | 302 | 534 |
| 1985 | 102,462 | 11,606 | 75,925 | 24,512 | 51,413 | 8,684 | 5,430 | 501 | 676 | 1,454 | 623 | 3,159 | 3,087 | 2,163 | 338 | 586 |
| 1986 | 104,866 | 11,820 | 77,160 | 24,504 | 52,655 | 9,542 | 5,853 | 610 | 800 | 1,636 | 642 | 3,401 | 2,943 | 1,977 | 373 | 593 |
| 1987 | 106,616 | 11,364 | 78,477 | 26,188 | 52,289 | 10,296 | 6,213 | 668 | 868 | 1,844 | 704 | 3,563 | 2,917 | 1,873 | 383 | 660 |
| 1988 | 110,166 | 11,742 | 80,680 | 26,627 | 54,053 | 11,072 | 6,727 | 715 | 910 | 1,946 | 774 | 3,726 | 2,947 | 1,813 | 412 | 721 |
| 1989 | 111,129 | 11,931 | 80,436 | 24,833 | 55,604 | 11,825 | 7,079 | 776 | 978 | 2,138 | 854 | 3,731 | 3,206 | 1,979 | 435 | 792 |
| 1990 (prel.) | 110,470 | 12,213 | 79,173 | 23,706 | 55,467 | 12,137 | 7,017 | 834 | 1,024 | 2,352 | 910 | 3,641 | 3,305 | 2,014 | 456 | 836 |
| 1991 (est.) | 110,277 | 11,914 | 78,924 | 23,506 | 55,418 | 12,495 | 7,010 | 908 | 1,090 | 2,506 | 981 | 3,523 | 3,420 | 2,038 | 473 | 910 |

NOTES: Data are based on annual reports by performers except for the nonprofit sector, for which data are estimated. Expenditures for federally funded research and development centers (FFRDCs) administered by industry and nonprofit institutions are included in the totals of the respective sector.

Total funds used by Federal Government from Federal sources.

FFRDCs administered by individual universities and colleges and by university consortia. In 1989, 99 percent of total funds used were from Federal sources.

See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCES: Science Resources Studies Division, National Science Foundation, *National Patterns of R&D Resources: 1990, Final Report*, NSF 90-316 (Washington, DC: NSF, 1990), and unpublished tabulations

See figure 4-1 and text table 4-1 and figure O-6 in Overview.

Appendix table 4-3.
**National expenditures for total R&D, by source of funds and performer: 1970-91**

| | Source of funds | | | | | Performer | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Federal Government | Industry | Universities & colleges[1] | Other nonprofits | Federal Government | Industry | Universities & colleges | U&C FFRDCs[2] | Other nonprofits |
| | Millions of current dollars | | | | | | | | | |
| 1970 . . . . . . . | 26,134 | 14,891 | 10,444 | 462 | 337 | 4,079 | 18,067 | 2,335 | 737 | 916 |
| 1971 . . . . . . . | 26,676 | 14,964 | 10,822 | 529 | 361 | 4,228 | 18,320 | 2,500 | 716 | 912 |
| 1972 . . . . . . . | 28,476 | 15,807 | 11,710 | 574 | 385 | 4,589 | 19,552 | 2,630 | 753 | 952 |
| 1973 . . . . . . . | 30,718 | 16,399 | 13,293 | 613 | 413 | 4,762 | 21,249 | 2,884 | 817 | 1,006 |
| 1974 . . . . . . . | 32,863 | 16,850 | 14,877 | 676 | 460 | 4,911 | 22,887 | 3,022 | 865 | 1,178 |
| 1975 . . . . . . . | 35,213 | 18,109 | 15,820 | 749 | 535 | 5,354 | 24,187 | 3,409 | 987 | 1,276 |
| 1976 . . . . . . . | 39,018 | 19,914 | 17,694 | 809 | 601 | 5,769 | 26,997 | 3,729 | 1,147 | 1,376 |
| 1977 . . . . . . . | 42,783 | 21,594 | 19,629 | 888 | 672 | 6,012 | 29,825 | 4,067 | 1,384 | 1,495 |
| 1978 . . . . . . . | 48,128 | 23,875 | 22,450 | 1,037 | 766 | 6,810 | 33,304 | 4,625 | 1,717 | 1,672 |
| 1979 . . . . . . . | 54,953 | 26,825 | 26,082 | 1,214 | 832 | 7,418 | 38,226 | 5,380 | 1,935 | 1,994 |
| 1980 . . . . . . . | 62,610 | 29,461 | 30,912 | 1,334 | 903 | 7,632 | 44,505 | 6,077 | 2,246 | 2,150 |
| 1981 . . . . . . . | 71,868 | 33,409 | 35,944 | 1,554 | 961 | 8,426 | 51,810 | 6,846 | 2,486 | 2,300 |
| 1982 . . . . . . . | 80,018 | 36,578 | 40,692 | 1,731 | 1,017 | 9,141 | 58,650 | 7,323 | 2,479 | 2,425 |
| 1983 . . . . . . . | 89,139 | 40,832 | 45,251 | 1,929 | 1,127 | 10,582 | 65,268 | 7,877 | 2,737 | 2,675 |
| 1984 . . . . . . . | 101,139 | 45,641 | 52,204 | 2,104 | 1,190 | 11,572 | 74,800 | 8,617 | 3,150 | 3,000 |
| 1985 . . . . . . . | 113,818 | 52,120 | 57,977 | 2,376 | 1,345 | 12,945 | 84,239 | 9,686 | 3,523 | 3,425 |
| 1986 . . . . . . . | 119,529 | 54,273 | 61,056 | 2,790 | 1,410 | 13,535 | 87,823 | 10,926 | 3,895 | 3,350 |
| 1987 . . . . . . . | 125,352 | 57,904 | 62,642 | 3,200 | 1,606 | 13,413 | 92,155 | 12,153 | 4,206 | 3,425 |
| 1988 . . . . . . . | 133,741 | 61,499 | 66,953 | 3,473 | 1,816 | 14,281 | 97,889 | 13,465 | 4,531 | 3,575 |
| 1989 . . . . . . . | 140,486 | 62,688 | 71,767 | 3,948 | 2,083 | 15,121 | 101,599 | 14,987 | 4,729 | 4,050 |
| 1990 (prel.) . . | 145,450 | 64,000 | 74,700 | 4,450 | 2,300 | 16,100 | 104,200 | 16,000 | 4,800 | 4,350 |
| 1991 (est.) . . . | 151,600 | 66,000 | 78,050 | 4,950 | 2,600 | 16,400 | 108,450 | 17,200 | 4,850 | 4,700 |
| | Millions of constant 1982 dollars[3] | | | | | | | | | |
| 1970 . . . . . . . | 62,403 | 35,632 | 24,851 | 1,114 | 807 | 9,833 | 42,986 | 5,629 | 1,777 | 2,179 |
| 1971 . . . . . . . | 60,384 | 33,965 | 24,387 | 1,212 | 820 | 9,684 | 41,280 | 5,726 | 1,640 | 2,055 |
| 1972 . . . . . . . | 61,412 | 34,144 | 25,190 | 1,246 | 832 | 9,963 | 42,056 | 5,710 | 1,635 | 2,048 |
| 1973 . . . . . . . | 62,427 | 33,478 | 26,837 | 1,268 | 844 | 9,849 | 42,893 | 5,965 | 1,690 | 2,031 |
| 1974 . . . . . . . | 61,466 | 31,727 | 27,577 | 1,296 | 867 | 9,416 | 42,415 | 5,794 | 1,658 | 2,183 |
| 1975 . . . . . . . | 59,882 | 30,985 | 26,679 | 1,302 | 916 | 9,308 | 40,781 | 5,926 | 1,716 | 2,151 |
| 1976 . . . . . . . | 62,134 | 31,813 | 28,058 | 1,303 | 960 | 9,293 | 42,805 | 6,007 | 1,848 | 2,182 |
| 1977 . . . . . . . | 63,653 | 32,152 | 29,176 | 1,325 | 1,001 | 8,969 | 44,330 | 6,067 | 2,065 | 2,222 |
| 1978 . . . . . . . | 66,768 | 33,171 | 31,087 | 1,446 | 1,064 | 9,495 | 46,115 | 6,449 | 2,394 | 2,315 |
| 1979 . . . . . . . | 70,104 | 34,284 | 33,198 | 1,558 | 1,063 | 9,523 | 48,652 | 6,907 | 2,484 | 2,538 |
| 1980 . . . . . . . | 73,255 | 34,557 | 36,065 | 1,574 | 1,059 | 9,006 | 51,919 | 7,171 | 2,650 | 2,508 |
| 1981 . . . . . . . | 76,641 | 35,690 | 38,257 | 1,667 | 1,027 | 9,040 | 55,140 | 7,345 | 2,667 | 2,448 |
| 1982 . . . . . . . | 80,018 | 36,578 | 40,692 | 1,731 | 1,017 | 9,141 | 58,650 | 7,323 | 2,479 | 2,425 |
| 1983 . . . . . . . | 85,753 | 39,251 | 43,568 | 1,851 | 1,083 | 10,152 | 62,842 | 7,557 | 2,626 | 2,576 |
| 1984 . . . . . . . | 93,790 | 42,286 | 48,456 | 1,945 | 1,102 | 10,696 | 69,433 | 7,965 | 2,912 | 2,785 |
| 1985 . . . . . . . | 102,462 | 46,870 | 52,252 | 2,130 | 1,209 | 11,606 | 75,925 | 8,684 | 3,159 | 3,087 |
| 1986 . . . . . . . | 104,866 | 47,555 | 53,639 | 2,436 | 1,235 | 11,820 | 77,160 | 9,542 | 3,401 | 2,943 |
| 1987 . . . . . . . | 106,616 | 49,201 | 53,341 | 2,711 | 1,364 | 11,364 | 78,477 | 10,296 | 3,563 | 2,917 |
| 1988 . . . . . . . | 110,166 | 50,635 | 55,181 | 2,856 | 1,495 | 11,742 | 80,680 | 11,072 | 3,726 | 2,947 |
| 1989 . . . . . . . | 111,129 | 49,553 | 56,815 | 3,115 | 1,646 | 11,931 | 80,436 | 11,825 | 3,731 | 3,206 |
| 1990 (prel.) . . | 110,470 | 48,591 | 56,757 | 3,376 | 1,746 | 12,213 | 79,173 | 12,137 | 3,641 | 3,305 |
| 1991 (est.) . . . | 110,277 | 47,991 | 56,799 | 3,596 | 1,890 | 11,914 | 78,924 | 12,495 | 3,523 | 3,420 |

NOTES: Data are based on annual reports by performers except for the nonprofit sector, for which data are estimated. Expenditures for federally funded research and development centers (FFRDCs) administered by industry and nonprofit institutions are included in the totals of the respective sector.

[1]Includes state and local government funds to the university and college sector.

[2]FFRDCs administered by individual universities and colleges (U&C) and by university consortia.

[3]See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCES: Science Resources Studies Division, National Science Foundation, *National Patterns of R&D Resources: 1990, Final Report*, NSF 90-316 (Washington, DC: NSF, 1990); and unpublished tabulations.

*Science & Engineering Indicators – 1991*

See figure 4-2.

Appendix table 4-4.
**National expenditures for basic research, by source of funds and performer: 1970-91**

| | Source of funds | | | | | Performer | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Federal Government | Industry[1] | Universities & colleges[2] | Other nonprofits | Federal Government | Industry | Universities & colleges | U&C FFRDCs[3] | Other nonprofits |
| | Millions of current dollars | | | | | | | | | |
| 1970 | 3,531 | 2,471 | 528 | 350 | 182 | 559 | 602 | 1,796 | 269 | 305 |
| 1971 | 3,652 | 2,509 | 547 | 400 | 196 | 566 | 590 | 1,914 | 260 | 322 |
| 1972 | 3,801 | 2,605 | 563 | 415 | 218 | 597 | 593 | 2,022 | 244 | 345 |
| 1973 | 3,945 | 2,708 | 605 | 408 | 224 | 608 | 631 | 2,053 | 296 | 357 |
| 1974 | 4,343 | 3,017 | 650 | 431 | 245 | 696 | 699 | 2,153 | 390 | 405 |
| 1975 | 4,738 | 3,269 | 705 | 478 | 286 | 734 | 730 | 2,410 | 439 | 425 |
| 1976 | 5,130 | 3,589 | 769 | 475 | 297 | 786 | 819 | 2,549 | 512 | 464 |
| 1977 | 5,735 | 4,021 | 850 | 527 | 337 | 914 | 911 | 2,800 | 600 | 510 |
| 1978 | 6,692 | 4,745 | 964 | 605 | 378 | 1,029 | 1,035 | 3,176 | 867 | 585 |
| 1979 | 7,570 | 5,350 | 1,092 | 716 | 412 | 1,089 | 1,158 | 3,628 | 1,015 | 680 |
| 1980 | 8,432 | 5,909 | 1,271 | 796 | 456 | 1,182 | 1,325 | 4,041 | 1,124 | 760 |
| 1981 | 9,598 | 6,617 | 1,589 | 911 | 481 | 1,302 | 1,614 | 4,596 | 1,261 | 825 |
| 1982 | 10,433 | 7,098 | 1,833 | 1,002 | 500 | 1,465 | 1,904 | 4,882 | 1,317 | 865 |
| 1983 | 11,634 | 7,769 | 2,121 | 1,173 | 571 | 1,690 | 2,223 | 5,304 | 1,472 | 945 |
| 1984 | 12,909 | 8,489 | 2,566 | 1,257 | 597 | 1,861 | 2,608 | 5,735 | 1,675 | 1,030 |
| 1985 | 14,198 | 9,174 | 2,885 | 1,454 | 685 | 1,923 | 2,862 | 6,559 | 1,749 | 1,105 |
| 1986 | 16,590 | 9,991 | 4,132 | 1,739 | 728 | 2,019 | 4,047 | 7,495 | 1,859 | 1,170 |
| 1987 | 17,999 | 10,867 | 4,289 | 2,011 | 832 | 2,046 | 4,323 | 8,398 | 2,012 | 1,220 |
| 1988 | 18,673 | 11,542 | 4,110 | 2,101 | 920 | 2,050 | 4,244 | 8,827 | 2,222 | 1,330 |
| 1989 | 19,885 | 12,772 | 3,737 | 2,335 | 1,041 | 2,371 | 4,000 | 9,685 | 2,329 | 1,500 |
| 1990 (prel.) | 21,920 | 13,650 | 4,530 | 2,600 | 1,140 | 2,600 | 4,750 | 10,350 | 2,500 | 1,720 |
| 1991 (est.) | 23,500 | 14,450 | 4,875 | 2,900 | 1,275 | 2,800 | 5,050 | 11,100 | 2,600 | 1,950 |
| | Millions of constant 1982 dollars[4] | | | | | | | | | |
| 1970 | 8,483 | 5,946 | 1,257 | 844 | 436 | 1,347 | 1,432 | 4,329 | 648 | 726 |
| 1971 | 8,331 | 5,734 | 1,234 | 916 | 446 | 1,296 | 1,329 | 4,384 | 595 | 726 |
| 1972 | 8,233 | 5,649 | 1,212 | 901 | 472 | 1,296 | 1,276 | 4,390 | 530 | 742 |
| 1973 | 8,110 | 5,583 | 1,224 | 844 | 459 | 1,258 | 1,274 | 4,246 | 612 | 721 |
| 1974 | 8,256 | 5,758 | 1,208 | 826 | 463 | 1,334 | 1,295 | 4,128 | 748 | 751 |
| 1975 | 8,176 | 5,662 | 1,192 | 831 | 491 | 1,276 | 1,231 | 4,190 | 763 | 717 |
| 1976 | 8,231 | 5,770 | 1,221 | 765 | 475 | 1,266 | 1,299 | 4,106 | 825 | 736 |
| 1977 | 8,548 | 5,996 | 1,264 | 786 | 502 | 1,364 | 1,354 | 4,177 | 895 | 758 |
| 1978 | 9,315 | 6,610 | 1,336 | 844 | 525 | 1,435 | 1,433 | 4,428 | 1,209 | 810 |
| 1979 | 9,698 | 6,861 | 1,391 | 919 | 527 | 1,398 | 1,474 | 4,657 | 1,303 | 865 |
| 1980 | 9,922 | 6,963 | 1,485 | 939 | 535 | 1,395 | 1,546 | 4,769 | 1,326 | 887 |
| 1981 | 10,277 | 7,092 | 1,693 | 977 | 514 | 1,397 | 1,718 | 4,931 | 1,353 | 878 |
| 1982 | 10,433 | 7,098 | 1,833 | 1,002 | 500 | 1,465 | 1,904 | 4,882 | 1,317 | 865 |
| 1983 | 11,172 | 7,457 | 2,041 | 1,125 | 549 | 1,621 | 2,140 | 5,089 | 1,412 | 910 |
| 1984 | 11,946 | 7,851 | 2,381 | 1,162 | 553 | 1,720 | 2,421 | 5,301 | 1,548 | 956 |
| 1985 | 12,749 | 8,231 | 2,599 | 1,304 | 615 | 1,724 | 2,580 | 5,881 | 1,568 | 996 |
| 1986 | 14,515 | 8,732 | 3,628 | 1,519 | 637 | 1,763 | 3,556 | 6,545 | 1,623 | 1,028 |
| 1987 | 15,273 | 9,213 | 3,650 | 1,704 | 706 | 1,733 | 3,681 | 7,115 | 1,705 | 1,039 |
| 1988 | 15,365 | 9,494 | 3,386 | 1,728 | 757 | 1,686 | 3,498 | 7,258 | 1,827 | 1,096 |
| 1989 | 15,704 | 10,082 | 2,957 | 1,842 | 822 | 1,871 | 3,167 | 7,642 | 1,838 | 1,188 |
| 1990 (prel.) | 16,636 | 10,357 | 3,441 | 1,972 | 865 | 1,972 | 3,609 | 7,851 | 1,896 | 1,307 |
| 1991 (est.) | 17,081 | 10,500 | 3,547 | 2,107 | 927 | 2,034 | 3,675 | 8,064 | 1,889 | 1,419 |

NOTES: Data are based on annual reports by performers except for the nonprofit sector, for which data are estimated. Expenditures for federally funded research and development centers (FFRDCs) administered by industry and nonprofit institutions are included in the totals of the respective sector.

[1]Imputation procedure for industry funding of industry basic research changed for 1986 and later years. These data may not be comparable to data for 1985 and earlier years.

[2]Includes state and local government funds to the university and college sector.

[3]FFRDCs administered by individual universities and colleges (U&C) and by university consortia.

[4]See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCES: Science Resources Studies Division, National Science Foundation, *National Patterns of R&D Resources: 1990, Final Report*, NSF 90-316 (Washington, DC: NSF, 1990); and unpublished tabulations.

See figures 4-2 and 4-3 and figure O-4 in Overview. *Science & Engineering Indicators – 1991*

Appendix table 4-5.
**National expenditures for applied research, by source of funds and performer: 1970-91**

| | | Source of funds | | | | Performer | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Federal Government | Industry[1] | Universities & colleges[2] | Other nonprofits | Federal Government | Industry | Universities & colleges | U&C FFRDCs[3] | Other nonprofits |
| | | | | | Millions of current dollars | | | | | |
| 1970 | 5,738 | 3,097 | 2,427 | 99 | 115 | 1,345 | 3,427 | 427 | 216 | 323 |
| 1971 | 5,759 | 3,028 | 2,494 | 115 | 122 | 1,322 | 3,415 | 474 | 210 | 338 |
| 1972 | 6,011 | 3,131 | 2,615 | 140 | 125 | 1,387 | 3,514 | 524 | 221 | 365 |
| 1973 | 6,598 | 3,395 | 2,891 | 172 | 140 | 1,480 | 3,825 | 713 | 227 | 353 |
| 1974 | 7,189 | 3,495 | 3,332 | 203 | 159 | 1,574 | 4,288 | 736 | 178 | 413 |
| 1975 | 7,812 | 3,889 | 3,517 | 224 | 182 | 1,730 | 4,570 | 851 | 213 | 448 |
| 1976 | 8,983 | 4,471 | 4,003 | 282 | 227 | 2,093 | 5,112 | 1,016 | 264 | 498 |
| 1977 | 9,651 | 4,692 | 4,410 | 303 | 246 | 2,044 | 5,636 | 1,067 | 371 | 533 |
| 1978 | 10,725 | 5,110 | 4,981 | 354 | 280 | 2,191 | 6,300 | 1,213 | 431 | 590 |
| 1979 | 12,272 | 5,768 | 5,796 | 413 | 295 | 2,392 | 7,225 | 1,477 | 468 | 710 |
| 1980 | 13,860 | 6,408 | 6,693 | 445 | 314 | 2,484 | 8,450 | 1,698 | 503 | 725 |
| 1981 | 16,605 | 7,198 | 8,534 | 534 | 339 | 2,732 | 10,699 | 1,865 | 529 | 780 |
| 1982 | 18,510 | 7,973 | 9,566 | 608 | 363 | 2,729 | 12,323 | 2,037 | 606 | 815 |
| 1983 | 20,694 | 9,181 | 10,506 | 621 | 386 | 3,020 | 13,927 | 2,146 | 726 | 875 |
| 1984 | 22,851 | 9,927 | 11,809 | 700 | 415 | 2,903 | 15,765 | 2,459 | 804 | 920 |
| 1985 | 25,831 | 11,408 | 13,216 | 756 | 451 | 3,133 | 18,255 | 2,673 | 835 | 935 |
| 1986 | 27,566 | 10,808 | 15,436 | 856 | 466 | 3,141 | 19,760 | 2,911 | 774 | 980 |
| 1987 | 28,096 | 11,059 | 15,541 | 965 | 531 | 3,392 | 19,813 | 3,168 | 693 | 1,030 |
| 1988 | 29,875 | 11,470 | 16,651 | 1,129 | 625 | 3,288 | 20,757 | 3,993 | 697 | 1,140 |
| 1989 | 33,300 | 12,453 | 18,784 | 1,337 | 726 | 3,611 | 23,086 | 4,581 | 722 | 1,300 |
| 1990 (prel.) | 33,895 | 12,675 | 18,870 | 1,530 | 820 | 3,800 | 23,050 | 4,845 | 750 | 1,450 |
| 1991 (est.) | 35,390 | 13,100 | 19,655 | 1,700 | 935 | 4,100 | 23,900 | 5,220 | 700 | 1,470 |
| | | | | | Millions of constant 1982 dollars[4] | | | | | |
| 1970 | 13,714 | 7,426 | 5,775 | 239 | 275 | 3,242 | 8,154 | 1,029 | 521 | 768 |
| 1971 | 13,051 | 6,891 | 5,620 | 263 | 277 | 3,028 | 7,695 | 1,086 | 481 | 762 |
| 1972 | 12,972 | 6,773 | 5,625 | 304 | 270 | 3,011 | 7,559 | 1,138 | 480 | 785 |
| 1973 | 13,439 | 6,961 | 5,837 | 356 | 285 | 3,061 | 7,721 | 1,475 | 469 | 713 |
| 1974 | 13,482 | 6,617 | 6,177 | 389 | 299 | 3,018 | 7,947 | 1,411 | 341 | 765 |
| 1975 | 13,318 | 6,686 | 5,932 | 389 | 311 | 3,007 | 7,705 | 1,479 | 370 | 755 |
| 1976 | 14,328 | 7,163 | 6,348 | 454 | 363 | 3,371 | 8,105 | 1,637 | 425 | 790 |
| 1977 | 14,364 | 6,991 | 6,555 | 452 | 366 | 3,049 | 8,377 | 1,592 | 553 | 792 |
| 1978 | 14,888 | 7,107 | 6,898 | 494 | 389 | 3,055 | 8,723 | 1,691 | 601 | 817 |
| 1979 | 15,667 | 7,382 | 7,378 | 530 | 377 | 3,071 | 9,196 | 1,896 | 601 | 904 |
| 1980 | 16,232 | 7,530 | 7,809 | 525 | 368 | 2,931 | 9,858 | 2,004 | 594 | 846 |
| 1981 | 17,717 | 7,698 | 9,083 | 573 | 362 | 2,931 | 11,387 | 2,001 | 568 | 830 |
| 1982 | 18,510 | 7,973 | 9,566 | 608 | 363 | 2,729 | 12,323 | 2,037 | 606 | 815 |
| 1983 | 19,905 | 8,823 | 10,115 | 596 | 371 | 2,897 | 13,409 | 2,059 | 697 | 842 |
| 1984 | 21,187 | 9,194 | 10,961 | 647 | 384 | 2,683 | 14,634 | 2,273 | 743 | 854 |
| 1985 | 23,250 | 10,256 | 11,911 | 678 | 405 | 2,809 | 16,453 | 2,397 | 749 | 843 |
| 1986 | 24,183 | 9,466 | 13,561 | 748 | 408 | 2,743 | 17,361 | 2,542 | 676 | 861 |
| 1987 | 23,894 | 9,392 | 13,233 | 818 | 451 | 2,874 | 16,872 | 2,684 | 587 | 877 |
| 1988 | 24,607 | 9,441 | 13,723 | 928 | 515 | 2,704 | 17,108 | 3,283 | 573 | 940 |
| 1989 | 26,340 | 9,841 | 14,870 | 1,055 | 574 | 2,849 | 18,277 | 3,614 | 570 | 1,029 |
| 1990 (prel.) | 25,742 | 9,622 | 14,337 | 1,161 | 623 | 2,883 | 17,514 | 3,675 | 569 | 1,102 |
| 1991 (est.) | 25,742 | 9,524 | 14,303 | 1,235 | 680 | 2,978 | 17,393 | 3,792 | 509 | 1,070 |

NOTES: Data are based on annual reports by performers except for the nonprofit sector, for which data are estimated. Since 1978 the applied research/development split for the academic sector has been estimated. Expenditures for federally funded research and development centers (FFRDCs) administered by industry and nonprofit institutions are included in the totals of the respective sector.

[1]Imputation procedure for industry funding of industry applied research changed for 1986 and later years. These data may not be comparable to data for 1985 and earlier years.

[2]Includes state and local government funds to the university and college sector.

[3]FFRDCs administered by individual universities and colleges (U&C) and by university consortia.

[4]See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCES: Science Resources Studies Division, National Science Foundation, *National Patterns of R&D Resources: 1990. Final Report.* NSF 90-316 (Washington, DC: NSF, 1990); and unpublished tabulations.

See figures 4-2 and 4-3 and figure O-4 in Overview.

Appendix table 4-6.
**National expenditures for development, by source of funds and performer: 1970-91**

| | Source of funds | | | | | Performer | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Federal Government | Industry[1] | Universities & colleges[2] | Other nonprofits | Federal Government | Industry | Universities & colleges | U&C FFRDCs[3] | Other nonprofits |
| | Millions of current dollars | | | | | | | | | |
| 1970 | 16,865 | 9,323 | 7,489 | 13 | 40 | 2,175 | 14,038 | 112 | 252 | 288 |
| 1971 | 17,265 | 9,427 | 7,781 | 14 | 43 | 2,340 | 14,315 | 112 | 246 | 252 |
| 1972 | 18,664 | 10,071 | 8,532 | 19 | 42 | 2,605 | 15,445 | 84 | 288 | 242 |
| 1973 | 20,175 | 10,296 | 9,797 | 33 | 49 | 2,674 | 16,793 | 118 | 294 | 296 |
| 1974 | 21,331 | 10,338 | 10,895 | 42 | 56 | 2,641 | 17,900 | 133 | 297 | 360 |
| 1975 | 22,663 | 10,951 | 11,598 | 47 | 67 | 2,890 | 18,887 | 148 | 335 | 403 |
| 1976 | 24,905 | 11,854 | 12,922 | 52 | 77 | 2,890 | 21,066 | 164 | 371 | 414 |
| 1977 | 27,397 | 12,881 | 14,369 | 58 | 89 | 3,054 | 23,278 | 200 | 413 | 452 |
| 1978 | 30,711 | 14,020 | 16,505 | 78 | 108 | 3,590 | 25,969 | 236 | 419 | 497 |
| 1979 | 35,111 | 15,707 | 19,194 | 85 | 125 | 3,937 | 29,843 | 275 | 452 | 604 |
| 1980 | 40,318 | 17,144 | 22,948 | 93 | 133 | 3,966 | 34,730 | 338 | 619 | 665 |
| 1981 | 45,665 | 19,594 | 25,821 | 109 | 141 | 4,392 | 39,497 | 385 | 696 | 695 |
| 1982 | 51,075 | 21,507 | 29,293 | 121 | 154 | 4,947 | 44,423 | 404 | 556 | 745 |
| 1983 | 56,811 | 23,882 | 32,624 | 135 | 170 | 5,872 | 49,118 | 427 | 539 | 855 |
| 1984 | 65,379 | 27,225 | 37,829 | 147 | 178 | 6,808 | 56,427 | 423 | 671 | 1,050 |
| 1985 | 73,789 | 31,538 | 41,876 | 166 | 209 | 7,889 | 63,122 | 454 | 939 | 1,385 |
| 1986 | 75,373 | 33,474 | 41,488 | 195 | 216 | 8,375 | 64,016 | 520 | 1,262 | 1,200 |
| 1987 | 79,257 | 35,978 | 42,812 | 224 | 243 | 7,975 | 68,019 | 587 | 1,501 | 1,175 |
| 1988 | 85,193 | 38,487 | 46,192 | 243 | 271 | 8,943 | 72,888 | 645 | 1,612 | 1,105 |
| 1989 | 87,301 | 37,463 | 49,246 | 276 | 316 | 9,139 | 74,513 | 721 | 1,678 | 1,250 |
| 1990 (prel.) | 89,635 | 37,675 | 51,300 | 320 | 340 | 9,700 | 76,400 | 805 | 1,550 | 1,180 |
| 1991 (est.) | 92,710 | 38,450 | 53,520 | 350 | 390 | 9,500 | 79,500 | 880 | 1,550 | 1,280 |
| | Millions of constant 1982 dollars[4] | | | | | | | | | |
| 1970 | 40,206 | 22,260 | 17,818 | 31 | 95 | 5,243 | 33,400 | 270 | 607 | 685 |
| 1971 | 39,003 | 21,341 | 17,533 | 32 | 97 | 5,359 | 32,256 | 257 | 563 | 568 |
| 1972 | 40,206 | 21,722 | 18,352 | 41 | 90 | 5,656 | 33,222 | 182 | 625 | 521 |
| 1973 | 40,878 | 20,934 | 19,776 | 68 | 99 | 5,531 | 33,898 | 244 | 608 | 597 |
| 1974 | 39,728 | 19,351 | 20,191 | 81 | 105 | 5,064 | 33,173 | 255 | 569 | 667 |
| 1975 | 38,388 | 18,637 | 19,555 | 82 | 114 | 5,024 | 31,845 | 257 | 582 | 679 |
| 1976 | 39,574 | 18,880 | 20,489 | 84 | 122 | 4,655 | 33,401 | 264 | 598 | 656 |
| 1977 | 40,741 | 19,165 | 21,357 | 87 | 132 | 4,556 | 34,599 | 298 | 616 | 672 |
| 1978 | 42,565 | 19,453 | 22,854 | 109 | 150 | 5,006 | 35,958 | 329 | 584 | 688 |
| 1979 | 44,739 | 20,041 | 24,429 | 109 | 159 | 5,054 | 37,983 | 353 | 580 | 769 |
| 1980 | 47,101 | 20,065 | 26,771 | 110 | 156 | 4,680 | 40,516 | 399 | 730 | 776 |
| 1981 | 48,648 | 20,899 | 27,481 | 117 | 150 | 4,712 | 42,036 | 413 | 747 | 740 |
| 1982 | 51,075 | 21,507 | 29,293 | 121 | 154 | 4,947 | 44,423 | 404 | 556 | 745 |
| 1983 | 54,676 | 22,972 | 31,411 | 130 | 164 | 5,634 | 47,293 | 410 | 517 | 823 |
| 1984 | 60,657 | 25,241 | 35,115 | 136 | 165 | 6,293 | 52,378 | 391 | 620 | 975 |
| 1985 | 66,463 | 28,383 | 37,743 | 149 | 188 | 7,073 | 56,892 | 407 | 842 | 1,248 |
| 1986 | 66,167 | 29,357 | 36,450 | 170 | 190 | 7,314 | 56,243 | 454 | 1,102 | 1,054 |
| 1987 | 67,449 | 30,595 | 36,457 | 190 | 207 | 6,757 | 57,923 | 497 | 1,272 | 1,001 |
| 1988 | 70,194 | 31,700 | 38,071 | 200 | 223 | 7,353 | 60,074 | 530 | 1,325 | 911 |
| 1989 | 69,085 | 29,630 | 38,988 | 218 | 250 | 7,211 | 58,992 | 569 | 1,324 | 990 |
| 1990 (prel.) | 68,092 | 28,612 | 38,979 | 243 | 258 | 7,358 | 58,050 | 611 | 1,176 | 897 |
| 1991 (est.) | 67,454 | 27,967 | 38,949 | 254 | 284 | 6,901 | 57,856 | 639 | 1,126 | 932 |

NOTES: Data are based on annual reports by performers except for the nonprofit sector, for which data are estimated. Since 1978, the applied research/development split for the academic sector has been estimated. Expenditures for federally funded research and development centers (FFRDCs) administered by industry and nonprofit institutions are included in the totals of the respective sector.

[1]Imputation procedure for industry funding of industry development changed for 1986 and later years. These data may not be comparable to data for 1985 and earlier years.

[2]Includes state and local government funds to the university and college sector.

[3]FFRDCs administered by individual universities and colleges (U&C) and by university consortia.

[4]See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCES: Science Resources Studies Division, National Science Foundation, *National Patterns of R&D Resources: 1990, Final Report* NSF 90-316 (Washington, DC: NSF, 1990); and unpublished tabulations.

See figures 4-2 and 4-3 and figure O-4 in Overview. *Science & Engineering Indicators – 1991*

Appendix table 4-7.
**Industrial R&D, by character of work, industry classification, and source of funds: 1989**

| Industry | Total | | | Basic | | | Applied | | | Development | | | Not distributed | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Federal | Other | Total | Federal | Other | Total | Federal | Other | Total | Federal | Other | Total | Federal | Other |
| | Millions of current dollars | | | | | | | | | | | | | | |
| Estimated total | 101.599 | 31.366 | 70.233 | 4.000 | 1,095 | 2.905 | 23.086 | 4,825 | 18,261 | 74.513 | 25.446 | 49,067 | 0 | 0 | 0 |
| Reported total | 101,599 | 31,366 | 70,233 | 2,992 | 837 | 2,155 | 17.356 | 3.665 | 13,691 | 55.555 | 17,[illegible]18 | 37,607 | 25,696 | 8,916 | 16,780 |
| Food. kindred. and tobacco products | D | D | 1,283 | 19 | 0 | 19 | D | D | 368 | D | D | 622 | 274 | 0 | 274 |
| Textiles and apparel | D | D | S | D | 0 | D | S | 0 | S | D | D | S | 54 | 0 | 54 |
| Lumber. wood products. and furniture | 170 | 0 | 170 | D | 0 | D | 39 | 0 | 39 | 68 | 0 | 68 | 46 | 0 | 46 |
| Paper and allied products | 683 | 0 | 683 | 29 | 0 | 29 | 121 | 0 | 121 | 323 | 0 | 323 | 210 | 0 | 210 |
| Chemicals and allied products | 11.537 | 87 | 11.450 | 534 | 8 | 526 | 3,350 | S | 3,333 | 4.118 | 57 | 4,061 | 3,535 | 5 | 3,530 |
| Industrial chemicals | 4,056 | 84 | 3.972 | 227 | 8 | 219 | D | D | 1,095 | 1,516 | 57 | 1,460 | 1,203 | 4 | 1,198 |
| Drugs and medicines | D | D | 5.206 | S | 0 | S | D | D | 1,378 | D | D | 1,629 | 1,926 | 1 | 1,925 |
| Other chemicals | D | D | 2.271 | 33 | 0 | 33 | D | D | 860 | D | D | 972 | 406 | 0 | 406 |
| Petroleum refining and extraction | 2.066 | S | 2,050 | D | D | 72 | 673 | 1 | 672 | 653 | 3 | 650 | 667 | 11 | 656 |
| Rubber products | D | D | 679 | 17 | 0 | 17 | D | D | 81 | D | D | 191 | 390 | 0 | 390 |
| Stone. clay. and glass products | D | D | 861 | D | D | 170 | D | D | 394 | D | D | 245 | 52 | 0 | 52 |
| Primary metals | 768 | 34 | 734 | S | 0 | S | D | D | 199 | 341 | 20 | 321 | 147 | 0 | 147 |
| Fabricated metal products | 788 | 135 | 653 | 23 | 0 | 23 | D | D | 109 | 376 | 75 | 301 | 267 | 47 | 220 |
| Machinery | D | D | 13.216 | D | D | S | D | D | 2.722 | D | D | S | 1.579 | 80 | 1,499 |
| Office computing. & acctg machines | D | D | 10.533 | D | D | S | D | D | 2.220 | D | D | S | 1,079 | 0 | 1,079 |
| Other machinery. except electrical | 2.789 | 106 | 2.683 | 50 | 0 | 50 | 509 | 7 | 502 | 1,730 | 19 | 1.711 | 500 | 80 | 420 |
| Electrical equipment | 16.768 | 5.222 | 11,546 | 378 | 10 | 368 | 2,894 | 568 | 2,326 | 10,001 | 3.442 | 6,559 | 3,495 | 1,202 | 2,293 |
| Radio and TV receiving equipment | 85 | 0 | 85 | S | 0 | S | D | 0 | D | D | 0 | D | 51 | 0 | 51 |
| Communication equipment | 10.508 | 4,666 | 5,842 | D | D | D | 1,161 | D | D | 7,341 | 3.158 | 4.183 | 1.742 | 1,055 | 687 |
| Electronic components | 4.884 | 522 | 4.362 | D | D | 39 | D | D | 1,387 | D | D | 1,720 | 1,350 | 134 | 1,216 |
| Other electrical equipment | 1.292 | 35 | 1,257 | D | 0 | D | 215 | 0 | 215 | D | D | D | 355 | 14 | 341 |
| Transportation equipment | 36.863 | 21.763 | 15.100 | 478 | 336 | 142 | 3,129 | 1.668 | 1,461 | 22.475 | 12,665 | 9.810 | 10.781 | 7.094 | 3.687 |
| Motor vehicles and other transportation equipment | 11.209 | 2.129 | 9.080 | 65 | 0 | 65 | 685 | 92 | 593 | 6.775 | 1.185 | 5.590 | 3,684 | 852 | 2,832 |
| Aircraft and missiles | 25.654 | 19,634 | 6.020 | 413 | 336 | 77 | 2,444 | 1 576 | 868 | 15,700 | 11,480 | 4.220 | 7.097 | 6.242 | 855 |
| Professional and scientific instruments | 5.763 | 125 | 5.638 | D | D | 196 | 688 | 21 | 667 | D | D | 1,991 | 2,798 | 14 | 2.784 |
| Other manufacturing industries | D | D | 402 | 28 | 0 | 28 | D | D | 51 | D | D | 249 | 74 | 0 | 74 |
| Nonmanufacturing industries | 8.273 | 2.716 | 5.557 | 720 | 466 | 254 | 1.881 | 768 | 1,113 | 4.348 | 1.022 | 3.326 | 1.324 | 460 | 864 |

D - withheld to avoid disclosing operations of individual companies
S withheld because of imputation of more than 50 percent

SOURCE: Science Resources Studies Division. National Science Foundation. unpublished tabulations.

Appendix table 4-8.
**Federal obligations for R&D and R&D plant, by agency and character of work: FYs 1980-91**
(page 1 of 4)

| Agency | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991(est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total research & development** | | | | | | | | | | | | |
| | Millions of current dollars | | | | | | | | | | | |
| Total, all agencies | 29,830 | 33,104 | 36,433 | 38,712 | 42,225 | 48,360 | 51,412 | 55,255 | 56,935 | 61,406 | 64,896 | 64,261 |
| Dept. of Agriculture | 688 | 774 | 797 | 848 | 866 | 943 | 929 | 948 | 1,017 | 1,038 | 1,112 | 1,224 |
| Dept. of Commerce | 343 | 328 | 336 | 335 | 358 | 399 | 399 | 402 | 389 | 398 | 434 | 527 |
| Dept. of Defense | 13,981 | 16,509 | 20,623 | 22,993 | 25,373 | 29,792 | 32,938 | 35,232 | 35,415 | 37,577 | 38,694 | 35,188 |
| Dept. of Education | 139 | 105 | 128 | 112 | 116 | 125 | 121 | 133 | 141 | 159 | 161 | 204 |
| Dept. of Energy | 4,754 | 4,918 | 4,708 | 4,537 | 4,674 | 4,966 | 4,688 | 4,757 | 5,036 | 5,193 | 5,545 | 6,057 |
| Dept. of Health & Human Services | 3,780 | 3,927 | 3,941 | 4,353 | 4,831 | 5,451 | 5,658 | 6,609 | 7,158 | 7,903 | 8,474 | 9,336 |
| National Institutes of Health | 3,182 | 3,333 | 3,433 | 3,789 | 4,257 | 4,828 | 5,005 | 5,853 | 6,291 | 6,778 | 7,137 | 7,714 |
| Dept. of Housing & Urban Develop | 56 | 48 | 29 | 32 | 18 | 19 | 15 | 16 | 18 | 18 | 18 | 30 |
| Dept. of the Interior | 411 | 427 | 381 | 383 | 411 | 392 | 385 | 404 | 417 | 469 | 511 | 586 |
| Dept. of Labor | 138 | 62 | 25 | 20 | 16 | 13 | 10 | 22 | 36 | 35 | 27 | 29 |
| Dept. of Transportation | 361 | 416 | 310 | 348 | 448 | 429 | 386 | 324 | 304 | 303 | 366 | 414 |
| Environmental Protection Agency | 345 | 326 | 335 | 241 | 261 | 320 | 317 | 348 | 347 | 380 | 420 | 425 |
| National Aeronautics & Space Admin | 3,234 | 3,593 | 3,078 | 2,662 | 2,822 | 3,327 | 3,420 | 3,787 | 4,330 | 5,393 | 6,535 | 7,435 |
| National Science Foundation | 882 | 962 | 975 | 1,062 | 1,203 | 1,346 | 1,353 | 1,471 | 1,533 | 1,670 | 1,669 | 1,828 |
| All other agencies | 719 | 710 | 766 | 789 | 828 | 839 | 793 | 804 | 794 | 870 | 930 | 978 |
| **Basic research** | | | | | | | | | | | | |
| Total, all agencies | 4,674 | 5,041 | 5,482 | 6,260 | 7,067 | 7,819 | 8,153 | 8,944 | 9,474 | 10,602 | 11,277 | 12,382 |
| Dept. of Agriculture | 276 | 314 | 331 | 362 | 393 | 445 | 433 | 445 | 481 | 485 | 518 | 563 |
| Dept. of Commerce | 16 | 16 | 17 | 19 | 21 | 23 | 27 | 26 | 31 | 29 | 31 | 31 |
| Dept. of Defense | 540 | 604 | 687 | 786 | 848 | 861 | 924 | 908 | 877 | 948 | 948 | 1,022 |
| Dept. of Education | 18 | 21 | 14 | 14 | 12 | 15 | 5 | 3 | 4 | 4 | 5 | 7 |
| Dept. of Energy | 523 | 586 | 642 | 768 | 830 | 943 | 960 | 1,068 | 1,185 | 1,411 | 1,501 | 1,741 |
| Dept. of Health & Human Services | 1,763 | 1,900 | 2,145 | 2,475 | 2,815 | 3,233 | 3,339 | 3,830 | 4,081 | 4,388 | 4,660 | 5,101 |
| National Institutes of Health | 1,642 | 1,767 | 2,021 | 2,313 | 2,625 | 3,018 | 3,119 | 3,577 | 3,795 | 4,053 | 4,251 | 4,634 |
| Dept. of Housing & Urban Develop | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dept. of the Interior | 72 | 81 | 77 | 103 | 126 | 138 | 133 | 135 | 126 | 189 | 207 | 231 |
| Dept. of Labor | 4 | 4 | 7 | 5 | 5 | 3 | 1 | 1 | 1 | 1 | 6 | 6 |
| Dept. of Transportation | 0 | 1 | 1 | 1 | 4 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| Environmental Protection Agency | 14 | 11 | 33 | 22 | 30 | 39 | 39 | 31 | 27 | 51 | 74 | 97 |
| National Aeronautics & Space Admin | 559 | 531 | 536 | 617 | 755 | 751 | 917 | 1,014 | 1,113 | 1,417 | 1,637 | 1,730 |
| National Science Foundation | 815 | 897 | 916 | 999 | 1,132 | 1,262 | 1,275 | 1,371 | 1,433 | 1,563 | 1,570 | 1,719 |
| All other agencies | 76 | 76 | 78 | 89 | 98 | 105 | 102 | 113 | 115 | 116 | 120 | 135 |
| **Applied research** | | | | | | | | | | | | |
| Total, all agencies | 6,923 | 7,172 | 7,541 | 7,993 | 7,911 | 8,315 | 8,349 | 8,999 | 9,176 | 10,163 | 10,427 | 11,563 |
| Dept. of Agriculture | 382 | 427 | 436 | 456 | 442 | 466 | 464 | 473 | 505 | 517 | 542 | 606 |
| Dept. of Commerce | 239 | 233 | 259 | 266 | 276 | 301 | 313 | 313 | 311 | 322 | 366 | 433 |
| Dept. of Defense | 1,721 | 1,997 | 2,266 | 2,437 | 2,201 | 2,307 | 2,303 | 2,440 | 2,362 | 2,708 | 2,590 | 2,662 |
| Dept. of Education | 70 | 33 | 56 | 62 | 69 | 77 | 91 | 104 | 107 | 118 | 120 | 150 |
| Dept. of Energy | 754 | 827 | 1,054 | 1,193 | 1,195 | 1,198 | 1,081 | 1,029 | 1,051 | 1,021 | 1,048 | 1,220 |
| Dept. of Health & Human Services | 1,570 | 1,592 | 1,461 | 1,545 | 1,652 | 1,796 | 1,851 | 2,195 | 2,416 | 2,700 | 2,901 | 3,218 |
| National Institutes of Health | 1,145 | 1,182 | 1,104 | 1,165 | 1,286 | 1,410 | 1,469 | 1,740 | 1,886 | 2,008 | 2,112 | 2,264 |
| Dept. of Housing & Urban Develop | 20 | 17 | 10 | 11 | 6 | 7 | 5 | 6 | 6 | 6 | 7 | 11 |
| Dept. of the Interior | 283 | 289 | 275 | 255 | 254 | 231 | 235 | 247 | 266 | 253 | 270 | 315 |
| Dept. of Labor | 33 | 55 | 11 | 13 | 11 | 9 | 9 | 19 | 26 | 22 | 17 | 18 |
| Dept. of Transportation | 82 | 87 | 66 | 72 | 74 | 70 | 68 | 68 | 91 | 120 | 119 | 146 |
| Environmental Protection Agency | 232 | 208 | 211 | 152 | 142 | 176 | 179 | 246 | 241 | 223 | 242 | 246 |
| National Aeronautics & Space Admin | 1,051 | 876 | 871 | 928 | 955 | 1,033 | 1,152 | 1,256 | 1,219 | 1,461 | 1,424 | 1,734 |
| National Science Foundation | 58 | 59 | 57 | 63 | 71 | 84 | 78 | 99 | 100 | 108 | 99 | 109 |
| All other agencies | 429 | 472 | 508 | 541 | 564 | 560 | 520 | 503 | 475 | 584 | 682 | 695 |

(continued)

Appendix table 4-8.
**Federal obligations for R&D and R&D plant, by agency and character of work: FYs 1980-91**
(page 2 of 4)

| Agency | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991(est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Development** | | | | | | | | | | | | |
| Millions of current dollars | | | | | | | | | | | | |
| Total, all agencies | 18,233 | 20,891 | 23,410 | 24,458 | 27,246 | 32,226 | 34,910 | 37,313 | 38,285 | 40,640 | 43,192 | 40,316 |
| Dept. of Agriculture | 30 | 33 | 31 | 30 | 31 | 32 | 32 | 29 | 31 | 36 | 52 | 55 |
| Dept. of Commerce | 88 | 79 | 60 | 50 | 62 | 75 | 60 | 64 | 47 | 47 | 37 | 62 |
| Dept. of Defense | 11,719 | 13,908 | 17,670 | 19,770 | 22,324 | 26,623 | 29,711 | 31,884 | 32,176 | 33,921 | 35,155 | 31,504 |
| Dept. of Education | 52 | 51 | 58 | 36 | 35 | 33 | 26 | 26 | 30 | 37 | 37 | 47 |
| Dept. of Energy | 3,476 | 3,505 | 3,012 | 2,576 | 2,649 | 2,825 | 2,648 | 2,659 | 2,801 | 2,761 | 2,996 | 3,096 |
| Dept. of Health & Human Services | 447 | 435 | 335 | 332 | 365 | 423 | 468 | 584 | 661 | 814 | 913 | 1,018 |
| National Institutes of Health | 394 | 385 | 309 | 311 | 347 | 400 | 418 | 536 | 610 | 717 | 773 | 817 |
| Dept. of Housing & Urban Develop | 36 | 31 | 19 | 21 | 12 | 12 | 10 | 11 | 12 | 12 | 12 | 19 |
| Dept. of the Interior | 57 | 57 | 30 | 25 | 31 | 22 | 17 | 22 | 24 | 27 | 34 | 40 |
| Dept. of Labor | 102 | 4 | 8 | 2 | 0 | 1 | 1 | 1 | 9 | 13 | 4 | 5 |
| Dept. of Transportation | 279 | 327 | 243 | 275 | 371 | 358 | 317 | 256 | 213 | 182 | 247 | 269 |
| Environmental Protection Agency | 100 | 107 | 92 | 66 | 89 | 106 | 100 | 71 | 80 | 107 | 104 | 83 |
| National Aeronautics & Space Admin | 1,624 | 2,186 | 1,671 | 1,117 | 1,113 | 1,544 | 1,351 | 1,518 | 1,999 | 2,515 | 3,474 | 3,971 |
| National Science Foundation | 8 | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All other agencies | 214 | 162 | 180 | 159 | 166 | 173 | 170 | 188 | 202 | 168 | 128 | 148 |
| **R&D plant** | | | | | | | | | | | | |
| Total, all agencies | 1,556 | 1,486 | 1,390 | 1,298 | 1,787 | 1,821 | 1,539 | 1,846 | 2,057 | 2,967 | 2,385 | 3,398 |
| Dept. of Agriculture | 57 | 21 | 21 | 34 | 39 | 41 | 79 | 112 | 135 | 124 | 96 | 151 |
| Dept. of Commerce | 5 | 1 | 1 | 1 | 9 | 4 | 9 | 5 | 11 | 16 | 15 | 19 |
| Dept. of Defense | 208 | 278 | 291 | 313 | 529 | 531 | 286 | 477 | 436 | 615 | 518 | 509 |
| Dept. of Education | 0 | 0 | 0 | 0 | 0 | 1 | 7 | 21 | 5 | 9 | 9 | 7 |
| Dept. of Energy | 1,024 | 978 | 914 | 758 | 852 | 868 | 742 | 772 | 915 | 1043 | 1,015 | 1,233 |
| Dept. of Health & Human Services | 31 | 24 | 25 | 48 | 31 | 42 | 38 | 37 | 20 | 131 | 87 | 245 |
| National Institutes of Health | 29 | 22 | 19 | 18 | 28 | 29 | 29 | 35 | 19 | 130 | 84 | 233 |
| Dept. of Housing & Urban Develop | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dept. of the Interior | 8 | 3 | 1 | 2 | 5 | 4 | 4 | 12 | 9 | 12 | 11 | 15 |
| Dept. of Labor | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dept. of Transportation | 23 | 19 | 12 | 22 | 17 | 9 | 12 | 11 | 14 | 19 | 22 | 21 |
| Environmental Protection Agency | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| National Aeronautics & Space Admin | 159 | 116 | 114 | 101 | 244 | 234 | 275 | 309 | 428 | 853 | 526 | 949 |
| National Science Foundation | 19 | 15 | 2 | 3 | 45 | 74 | 53 | 61 | 57 | 119 | 64 | 206 |
| All other agencies | 23 | 31 | 10 | 17 | 14 | 13 | 33 | 28 | 32 | 26 | 24 | 30 |
| **R&D and R&D plant** | | | | | | | | | | | | |
| Total, all agencies | 31,386 | 34,590 | 37,822 | 40,010 | 44,012 | 50,180 | 52,951 | 57,101 | 58,992 | 64,373 | 67,281 | 67,659 |
| Dept. of Agriculture | 745 | 795 | 819 | 881 | 905 | 984 | 1,008 | 1,060 | 1,152 | 1,162 | 1,208 | 1,376 |
| Dept. of Commerce | 347 | 329 | 337 | 336 | 368 | 403 | 409 | 407 | 400 | 414 | 449 | 546 |
| Dept. of Defense | 14,189 | 16,786 | 20,913 | 23,305 | 25,902 | 30,322 | 33,224 | 35,709 | 35,851 | 38,192 | 39,212 | 35,698 |
| Dept. of Education | 139 | 105 | 128 | 112 | 116 | 126 | 128 | 154 | 141 | 168 | 170 | 211 |
| Dept. of Energy | 5,778 | 5,896 | 5,622 | 5,294 | 5,526 | 5,834 | 5,431 | 5,529 | 5,951 | 6,236 | 6,560 | 7,289 |
| Dept. of Health & Human Services | 3,811 | 3,951 | 3,965 | 4,400 | 4,862 | 5,493 | 5,696 | 6,645 | 7,178 | 8,034 | 8,561 | 9,581 |
| National Institutes of Health | 3,211 | 3,356 | 3,453 | 3,807 | 4,285 | 4,857 | 5,035 | 5,889 | 6,310 | 6,908 | 7,221 | 7,947 |
| Dept. of Housing & Urban Develop | 56 | 48 | 29 | 32 | 18 | 19 | 15 | 16 | 18 | 18 | 18 | 30 |
| Dept. of the Interior | 419 | 431 | 382 | 385 | 416 | 396 | 390 | 416 | 426 | 481 | 522 | 600 |
| Dept. of Labor | 138 | 62 | 25 | 20 | 16 | 13 | 10 | 22 | 36 | 35 | 27 | 29 |
| Dept. of Transportation | 385 | 434 | 322 | 370 | 465 | 438 | 398 | 336 | 318 | 322 | 387 | 435 |
| Environmental Protection Agency | 345 | 326 | 335 | 241 | 261 | 320 | 317 | 348 | 347 | 380 | 420 | 439 |
| National Aeronautics & Space Admin | 3,393 | 3,709 | 3,192 | 2,763 | 3,066 | 3,562 | 3,695 | 4,097 | 4,758 | 6,246 | 7,060 | 8,384 |
| National Science Foundation | 901 | 976 | 977 | 1,065 | 1,248 | 1,419 | 1,407 | 1,532 | 1,590 | 1,789 | 1,733 | 2,034 |
| All other agencies | 741 | 741 | 775 | 805 | 842 | 851 | 825 | 832 | 826 | 896 | 954 | 1,008 |

(continued)

Appendix table 4-8.
**Federal obligations for R&D and R&D plant, by agency and character of work: FYs 1980-91**
(page 3 of 4)

| Agency | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total research & development** | | | | | | | | | | | | |
| Millions of constant 1982 dollars[1] | | | | | | | | | | | | |
| Total, all agencies | 35,202 | 35,517 | 36,433 | 37,140 | 39,028 | 43,359 | 44,898 | 46,813 | 46,815 | 48,450 | 47,143 | 46,682 |
| Dept. of Agriculture | 811 | 830 | 797 | 813 | 801 | 845 | 811 | 803 | 836 | 819 | 808 | 889 |
| Dept. of Commerce | 404 | 352 | 336 | 321 | 331 | 358 | 349 | 341 | 320 | 314 | 315 | 383 |
| Dept. of Defense | 16,499 | 17,712 | 20,623 | 22,059 | 23,452 | 26,711 | 28,764 | 29,849 | 29,120 | 29,649 | 28,109 | 25,562 |
| Dept. of Education | 165 | 113 | 128 | 107 | 107 | 112 | 106 | 112 | 116 | 125 | 117 | 148 |
| Dept. of Energy | 5,610 | 5,277 | 4,708 | 4,352 | 4,320 | 4,452 | 4,094 | 4,030 | 4,141 | 4,097 | 4,028 | 4,400 |
| Dept. of Health & Human Services | 4,461 | 4,213 | 3,941 | 4,176 | 4,465 | 4,887 | 4,941 | 5,599 | 5,886 | 6,236 | 6,156 | 6,782 |
| National Institutes of Health | 3,755 | 3,576 | 3,433 | 3,635 | 3,935 | 4,328 | 4,371 | 4,959 | 5,173 | 5,348 | 5,185 | 5,604 |
| Dept. of Housing & Urban Develop | 66 | 52 | 29 | 31 | 17 | 17 | 13 | 14 | 15 | 14 | 13 | 22 |
| Dept. of the Interior | 485 | 458 | 381 | 367 | 380 | 351 | 336 | 342 | 343 | 370 | 371 | 426 |
| Dept. of Labor | 163 | 67 | 25 | 19 | 15 | 12 | 9 | 18 | 30 | 28 | 20 | 21 |
| Dept. of Transportation | 426 | 446 | 310 | 334 | 414 | 385 | 337 | 275 | 250 | 239 | 266 | 301 |
| Environmental Protection Agency | 407 | 349 | 335 | 231 | 241 | 287 | 277 | 295 | 285 | 300 | 305 | 309 |
| National Aeronautics & Space Admin | 3,816 | 3,855 | 3,078 | 2,554 | 2,608 | 2,983 | 2,986 | 3,208 | 3,560 | 4,255 | 4,747 | 5,401 |
| National Science Foundation | 1,041 | 1,032 | 975 | 1,019 | 1,112 | 1,206 | 1,182 | 1,246 | 1,261 | 1,318 | 1,213 | 1,328 |
| All other agencies | 848 | 762 | 766 | 757 | 765 | 752 | 692 | 681 | 653 | 686 | 676 | 710 |
| **Basic research** | | | | | | | | | | | | |
| Total, all agencies | 5,516 | 5,409 | 5,482 | 6,006 | 6,532 | 7,010 | 7,120 | 7,578 | 7,790 | 8,365 | 8,554 | 8,995 |
| Dept. of Agriculture | 325 | 337 | 331 | 347 | 363 | 399 | 378 | 377 | 396 | 383 | 393 | 409 |
| Dept. of Commerce | 19 | 17 | 17 | 18 | 19 | 21 | 23 | 22 | 25 | 23 | 24 | 23 |
| Dept. of Defense | 638 | 648 | 687 | 754 | 784 | 772 | 807 | 769 | 721 | 748 | 719 | 743 |
| Dept. of Education | 21 | 22 | 14 | 14 | 11 | 13 | 4 | 3 | 3 | 3 | 3 | 5 |
| Dept. of Energy | 617 | 629 | 642 | 737 | 768 | 845 | 838 | 905 | 974 | 1,113 | 1,138 | 1,264 |
| Dept. of Health & Human Services | 2,080 | 2,039 | 2,145 | 2,375 | 2,601 | 2,898 | 2,916 | 3,244 | 3,356 | 3,462 | 3,535 | 3,705 |
| National Institutes of Health | 1,938 | 1,896 | 2,021 | 2,219 | 2,426 | 2,706 | 2,723 | 3,031 | 3,120 | 3,198 | 3,225 | 3,366 |
| Dept. of Housing & Urban Develop | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dept. of the Interior | 84 | 87 | 77 | 99 | 116 | 124 | 116 | 114 | 104 | 149 | 157 | 168 |
| Dept. of Labor | 5 | 4 | 7 | 5 | 5 | 3 | 1 | 1 | 1 | 1 | 5 | 4 |
| Dept. of Transportation | 0 | 1 | 1 | 1 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| Environmental Protection Agency | 16 | 11 | 33 | 21 | 27 | 35 | 34 | 26 | 22 | 40 | 56 | 70 |
| National Aeronautics & Space Admin | 660 | 570 | 536 | 592 | 697 | 673 | 801 | 859 | 915 | 1,118 | 1,242 | 1,256 |
| National Science Foundation | 962 | 962 | 916 | 959 | 1,047 | 1,131 | 1,114 | 1,162 | 1,178 | 1,233 | 1,191 | 1,249 |
| All other agencies | 89 | 81 | 78 | 85 | 91 | 94 | 89 | 95 | 95 | 92 | 91 | 98 |
| **Applied research** | | | | | | | | | | | | |
| Total, all agencies | 8,170 | 7,694 | 7,541 | 7,669 | 7,312 | 7,455 | 7,291 | 7,624 | 7,545 | 8,019 | 7,910 | 8,400 |
| Dept. of Agriculture | 451 | 458 | 436 | 437 | 409 | 417 | 405 | 401 | 415 | 408 | 411 | 441 |
| Dept. of Commerce | 281 | 250 | 259 | 255 | 255 | 270 | 273 | 265 | 256 | 254 | 278 | 315 |
| Dept. of Defense | 2,031 | 2,142 | 2,266 | 2,338 | 2,034 | 2,068 | 2,011 | 2,067 | 1,942 | 2,137 | 1,965 | 1,934 |
| Dept. of Education | 83 | 36 | 56 | 59 | 63 | 69 | 80 | 88 | 88 | 93 | 91 | 109 |
| Dept. of Energy | 890 | 888 | 1,054 | 1,145 | 1,104 | 1,074 | 944 | 872 | 864 | 806 | 795 | 886 |
| Dept. of Health & Human Services | 1,853 | 1,708 | 1,461 | 1,483 | 1,526 | 1,610 | 1,616 | 1,859 | 1,987 | 2,130 | 2,201 | 2,337 |
| National Institutes of Health | 1,351 | 1,268 | 1,104 | 1,118 | 1,188 | 1,264 | 1,283 | 1,474 | 1,551 | 1,584 | 1,602 | 1,645 |
| Dept. of Housing & Urban Develop | 23 | 18 | 10 | 11 | 6 | 6 | 5 | 5 | 5 | 5 | 5 | 8 |
| Dept. of the Interior | 334 | 310 | 275 | 244 | 235 | 207 | 205 | 210 | 219 | 200 | 205 | 229 |
| Dept. of Labor | 38 | 58 | 11 | 12 | 10 | 8 | 8 | 16 | 21 | 17 | 13 | 13 |
| Dept. of Transportation | 97 | 94 | 66 | 69 | 69 | 63 | 59 | 58 | 75 | 95 | 90 | 106 |
| Environmental Protection Agency | 273 | 223 | 211 | 146 | 132 | 158 | 157 | 208 | 198 | 176 | 183 | 179 |
| National Aeronautics & Space Admin | 1,240 | 940 | 871 | 890 | 882 | 926 | 1,006 | 1,064 | 1,002 | 1,153 | 1,080 | 1,260 |
| National Science Foundation | 69 | 63 | 57 | 60 | 65 | 75 | 68 | 84 | 82 | 85 | 75 | 79 |
| All other agencies | 507 | 506 | 508 | 519 | 521 | 502 | 454 | 426 | 391 | 461 | 518 | 505 |

(continued)

Appendix table 4-8.
**Federal obligations for R&D and R&D plant, by agency and character of work: FYs 1980-91**
(page 4 of 4)

| Agency | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991(est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Development** | | | | | | | | | | | | |
| | Millions of constant 1982 dollars' | | | | | | | | | | | |
| Total, all agencies | 21,516 | 22,414 | 23,410 | 23,465 | 25,183 | 28,894 | 30,487 | 31,612 | 31,480 | 32,065 | 32,765 | 29,288 |
| Dept. of Agriculture | 36 | 35 | 31 | 29 | 29 | 29 | 28 | 25 | 25 | 28 | 39 | 40 |
| Dept. of Commerce | 104 | 84 | 60 | 48 | 57 | 67 | 52 | 54 | 39 | 37 | 28 | 45 |
| Dept. of Defense | 13,829 | 14,922 | 17,670 | 18,967 | 20,634 | 23,870 | 25,946 | 27,013 | 26,457 | 26,764 | 26,668 | 22,886 |
| Dept. of Education | 61 | 55 | 58 | 34 | 32 | 30 | 22 | 22 | 25 | 29 | 28 | 34 |
| Dept. of Energy | 4,102 | 3,760 | 3,012 | 2,471 | 2,448 | 2,533 | 2,312 | 2,253 | 2,303 | 2,178 | 2,273 | 2,249 |
| Dept. of Health & Human Services | 528 | 467 | 335 | 318 | 337 | 379 | 409 | 495 | 544 | 642 | 692 | 740 |
| National Institutes of Health | 465 | 413 | 309 | 298 | 321 | 358 | 365 | 454 | 502 | 566 | 586 | 594 |
| Dept. of Housing & Urban Develop | 43 | 34 | 19 | 20 | 11 | 11 | 9 | 9 | 10 | 9 | 9 | 14 |
| Dept. of the Interior | 67 | 61 | 30 | 24 | 28 | 20 | 15 | 18 | 20 | 21 | 26 | 29 |
| Dept. of Labor | 120 | 4 | 8 | 2 | 0 | 1 | 1 | 1 | 7 | 10 | 3 | 3 |
| Dept. of Transportation | 329 | 351 | 243 | 264 | 343 | 321 | 277 | 217 | 175 | 144 | 187 | 195 |
| Environmental Protection Agency | 118 | 115 | 92 | 63 | 82 | 95 | 87 | 60 | 66 | 84 | 79 | 60 |
| National Aeronautics & Space Admin | 1,917 | 2,345 | 1,671 | 1,071 | 1,028 | 1,384 | 1,180 | 1,286 | 1,644 | 1,984 | 2,635 | 2,885 |
| National Science Foundation | 10 | 7 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All other agencies | 253 | 174 | 180 | 153 | 153 | 155 | 149 | 160 | 166 | 133 | 97 | 107 |
| **R&D plant** | | | | | | | | | | | | |
| Total, all agencies | 1,836 | 1,594 | 1,390 | 1,245 | 1,652 | 1,633 | 1,344 | 1,564 | 1,691 | 2,341 | 1,809 | 2,468 |
| Dept. of Agriculture | 67 | 22 | 21 | 32 | 36 | 36 | 69 | 95 | 111 | 98 | 73 | 110 |
| Dept. of Commerce | 5 | 1 | 1 | 1 | 9 | [illegible] | 8 | 4 | 9 | 13 | 11 | 14 |
| Dept. of Defense | 246 | 298 | 291 | 300 | 489 | [illegible] | 250 | 404 | 358 | 485 | 393 | 370 |
| Dept. of Education | 0 | 0 | 0 | 0 | 0 | 1 | 6 | 18 | 4 | 7 | 7 | 5 |
| Dept. of Energy | 1,208 | 1,050 | 914 | 727 | 788 | 779 | 648 | 654 | 752 | 823 | 770 | 895 |
| Dept. of Health & Human Services | 36 | 25 | 25 | 46 | 29 | 38 | 33 | 31 | 16 | 103 | 66 | 178 |
| National Institutes of Health | 35 | 24 | 19 | 17 | 26 | 26 | 26 | 30 | 16 | 103 | 64 | 169 |
| Dept. of Housing & Urban Develop | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dept. of the Interior | 9 | 4 | 1 | 2 | 5 | 4 | 4 | 10 | 8 | 9 | 9 | 11 |
| Dept. of Labor | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dept. of Transportation | 27 | 20 | 12 | 21 | 16 | 8 | 11 | 9 | 11 | 15 | 17 | 15 |
| Environmental Protection Agency | 0 | 0 | 0 | 0 | 0 | 0 | 0 | [illegible] | 0 | 0 | 0 | 10 |
| National Aeronautics & Space Admin | 188 | 124 | 114 | 97 | 226 | 210 | 240 | 262 | 352 | 673 | 399 | 690 |
| National Science Foundation | 22 | 16 | 2 | 3 | 42 | 66 | 46 | 52 | 47 | 94 | 48 | 150 |
| All other agencies | 27 | 34 | 10 | 16 | 13 | 11 | 29 | 24 | 26 | 21 | 18 | 22 |
| **R&D and R&D plant** | | | | | | | | | | | | |
| Total, all agencies | 37,038 | 37,111 | 37,822 | 38,385 | 40,680 | 44,992 | 46,242 | 48,377 | 48,506 | 50,791 | 51,038 | 49,150 |
| Dept. of Agriculture | 879 | 853 | 819 | 846 | 837 | 882 | 880 | 898 | 947 | 917 | 917 | 999 |
| Dept. of Commerce | 410 | 353 | 337 | 322 | 340 | 361 | 357 | 345 | 329 | 327 | 340 | 397 |
| Dept. of Defense | 16,744 | 18,010 | 20,913 | 22,359 | 23,941 | 27,187 | 29,014 | 30,253 | 29,478 | 30,134 | 29,745 | 25,932 |
| Dept. of Education | 165 | 113 | 128 | 107 | 107 | 113 | 112 | 130 | 116 | 133 | 129 | 153 |
| Dept. of Energy | 6,818 | 6,326 | 5,622 | 5,079 | 5,108 | 5,231 | 4,742 | 4,385 | 4,893 | 4,920 | 4,976 | 5,295 |
| Dept. of Health & Human Services | 4,497 | 4,239 | 3,965 | 4,222 | 4,494 | 4,925 | 4,974 | 5,630 | 5,902 | 6,339 | 6,494 | 6,960 |
| National Institutes of Health | 3,789 | 3,600 | 3,453 | 3,652 | 3,961 | 4,354 | 4,397 | 4,989 | 5,188 | 5,450 | 5,478 | 5,773 |
| Dept. of Housing & Urban Develop | 66 | 52 | 29 | 31 | 17 | 17 | 13 | 14 | 15 | 14 | 14 | 22 |
| Dept. of the Interior | 494 | 462 | 382 | 369 | 385 | 355 | 340 | 352 | 351 | 380 | 396 | 436 |
| Dept. of Labor | 163 | 67 | 25 | 19 | 15 | 12 | 9 | 18 | 30 | 28 | 21 | 21 |
| Dept. of Transportation | 454 | 466 | 322 | 355 | 430 | 393 | 347 | 284 | 261 | 254 | 294 | 316 |
| Environmental Protection Agency | 407 | 349 | 335 | 231 | 241 | 287 | 277 | 295 | 285 | 300 | 318 | 319 |
| National Aeronautics & Space Admin | 4,004 | 3,979 | 3,192 | 2,651 | 2,834 | 3,193 | 3,227 | 3,471 | 3,912 | 4,928 | 5,356 | 6,090 |
| National Science Foundation | 1,063 | 1,047 | 977 | 1,022 | 1,154 | 1,272 | 1,228 | 1,298 | 1,307 | 1,412 | 1,315 | 1,478 |
| All other agencies | 875 | 795 | 775 | 773 | 779 | 763 | 721 | 705 | 679 | 707 | 723 | 732 |

NOTE: Data for 1990 and 1991 are from the Administration's 1992 budget proposal. they differ from the figures in appendix tables 4-9 through 4-13.

'See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCES: Science Resources Studies Division. National Science Foundation (NSF). *Federal Funds for Research and Development. Detailed Historical Tables: Fiscal Years 1955-1990* (Washington DC: NSF. 1990); NSF. unpublished tabulations: and Office of Management and Budget. unpublished tabulations

See figures 4-4 and 4-5 and figure O-5 in Overview.

Appendix table 4-9.
**Federal obligations to intramural performers for total R&D and basic research, by selected agency: FYs 1980-91**

| | All agencies | Dept. of Defense | National Institutes of Health | National Aero & Space Admin. | National Science Foundation | Dept. of Agriculture | Dept. of Energy | Dept. of Commerce | Dept. of Interior | All other agencies |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **Total research and development** | | | | | |
| | | | | | Millions of current dollars | | | | | |
| 1980 | 7,632 | 3,796 | 587 | 965 | 75 | 457 | 474 | 226 | 242 | 810 |
| 1981 | 8,426 | 4,281 | 639 | 1,044 | 106 | 511 | 451 | 237 | 274 | 883 |
| 1982 | 9,141 | 5,139 | 709 | 1,166 | 118 | 531 | 176 | 242 | 261 | 799 |
| 1983 | 10,582 | 6,401 | 769 | 1,134 | 131 | 559 | 258 | 252 | 274 | 804 |
| 1984 | 11,572 | 7,257 | 830 | 1,043 | 136 | 589 | 216 | 256 | 334 | 911 |
| 1985 | 12,945 | 8,324 | 874 | 1,171 | 143 | 628 | 224 | 280 | 342 | 959 |
| 1986 | 13,535 | 8,881 | 958 | 1,217 | 130 | 630 | 206 | 285 | 332 | 896 |
| 1987 | 13,413 | 8,336 | 1,000 | 1,414 | 143 | 649 | 248 | 320 | 355 | 948 |
| 1988 | 14,281 | 9,046 | 1,092 | 1,335 | 162 | 694 | 245 | 316 | 353 | 1,038 |
| 1989 | 15,121 | 9,296 | 1,171 | 1,733 | 166 | 689 | 248 | 325 | 394 | 1,099 |
| 1990 (est.) | 16,094 | 9,467 | 1,339 | 2,052 | 175 | 736 | 362 | 336 | 425 | 1,202 |
| 1991 (est.) | 16,396 | 8,988 | 1,402 | 2,573 | 187 | 776 | 427 | 349 | 435 | 1,259 |
| | | | | | **Basic research** | | | | | |
| 1980 | 1,182 | 199 | 320 | 225 | 68 | 180 | 6 | 13 | 62 | 109 |
| 1981 | 1,302 | 226 | 335 | 216 | 99 | 202 | 6 | 15 | 69 | 134 |
| 1982 | 1,466 | 246 | 405 | 251 | 112 | 219 | 7 | 16 | 65 | 145 |
| 1983 | 1,690 | 276 | 449 | 305 | 126 | 239 | 18 | 18 | 84 | 175 |
| 1984 | 1,861 | 303 | 479 | 345 | 130 | 274 | 11 | 19 | 110 | 190 |
| 1985 | 1,961 | 301 | 543 | 318 | 138 | 296 | 21 | 21 | 117 | 206 |
| 1986 | 2,018 | 308 | 579 | 363 | 126 | 293 | 25 | 23 | 111 | 189 |
| 1987 | 2,046 | 283 | 568 | 379 | 138 | 302 | 35 | 22 | 119 | 199 |
| 1988 | 2,050 | 263 | 592 | 343 | 154 | 322 | 33 | 27 | 108 | 208 |
| 1989 | 2,371 | 292 | 695 | 454 | 157 | 324 | 49 | 25 | 159 | 208 |
| 1990 (est.) | 2,573 | 284 | 794 | 503 | 165 | 345 | 49 | 26 | 168 | 216 |
| 1991 (est.) | 2,782 | 310 | 851 | 559 | 176 | 365 | 46 | 29 | 174 | 239 |

NOTE: Intramural activities cover costs associated with the planning and administration of intramural and extramural R&D programs by Federal personnel as well as actual intramural R&D performance.

SOURCES: Science Resources Studies Division (SRS), National Science Foundation, *Federal Funds for Research and Development, Detailed Historical Tables: Fiscal Years 1955-1990* (Washington, DC: NSF, 1990); and SRS, *Federal Funds for Research and Development: Fiscal Years 1989, 1990, and 1991*, NSF 90-327 Final (Washington, DC: NSF, 1991).

*Science & Engineering Indicators – 1991*

Appendix table 4-10.
**Estimated Federal obligations for R&D, by selected agency, performer, and character of work: FY 1991**

| Agency | Total | Federal intramural | Industry | FFRDCs admin. by industry | Univers. and colleges | FFRDCs admin. by U&C | Other non-profits | FFRDCs admin. by nonprofits | State & local gov't | Foreign |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total research & development** | | | | | | | | | | |
| | | | | | Millions of current dollars | | | | | |
| Total, all agencies | 66,107 | 16,396 | 31,512 | 2,062 | 9,191 | 3,654 | 2,302 | 482 | 184 | 325 |
| Dept. of Agriculture | 1,158 | 776 | 6 | 0 | 364 | 0 | 6 | 0 | 2 | 3 |
| Dept. of Defense | 36,918 | 8,983 | 25,353 | 287 | 1,069 | 624 | 110 | 313 | 1 | 172 |
| Dept. of Energy | 6,006 | 428 | 964 | 1,710 | 429 | 2,164 | 165 | 142 | 1 | 4 |
| Dept. of Health & Human Services | 8,888 | 1,879 | 398 | 19 | 4,946 | 33 | 1,428 | 11 | 115 | 59 |
| Nat'l Aeronautics & Space Admin. | 8,322 | 2,573 | 4,263 | 0 | 533 | 701 | 230 | 3 | 5 | 12 |
| National Science Foundation | 1,983 | 187 | 90 | 1 | 1,478 | 111 | 115 | 0 | 2 | 0 |
| All other agencies | 2,837 | 1,565 | 437 | 45 | 372 | 21 | 248 | 14 | 58 | 75 |
| **Basic research** | | | | | | | | | | |
| Total, all agencies | 12,255 | 2,782 | 1,043 | 194 | 5,721 | 1,267 | 1,077 | 68 | 51 | 52 |
| Dept. of Agriculture | 547 | 365 | * | 0 | 176 | * | 3 | 0 | 1 | 2 |
| Dept. of Defense | 972 | 310 | 88 | 1 | 529 | 8 | 24 | * | 0 | 12 |
| Dept. of Energy | 1,677 | 46 | 42 | 180 | 307 | 899 | 141 | 61 | * | 1 |
| Dept. of Health & Human Services | 4,940 | 989 | 201 | 10 | 2,892 | 21 | 744 | 4 | 46 | 33 |
| Nat'l Aeronautics & Space Admin. | 1,803 | 559 | 593 | 0 | 367 | 227 | 50 | 2 | 1 | 4 |
| National Science Foundation | 1,853 | 176 | 76 | 1 | 1,382 | 111 | 106 | * | 2 | 0 |
| All other agencies | 463 | 337 | 43 | 2 | 68 | 1 | 9 | 1 | 1 | * |
| **Applied research** | | | | | | | | | | |
| Total, all agencies | 10,965 | 4,084 | 2,384 | 311 | 2,635 | 596 | 720 | 70 | 74 | 90 |
| Dept. of Agriculture | 570 | 373 | 6 | 0 | 186 | 0 | 3 | 0 | 1 | 1 |
| Dept. of Defense | 2,497 | 1,027 | 1,079 | 24 | 260 | 49 | 38 | 9 | 1 | 9 |
| Dept. of Energy | 1,064 | 175 | 118 | 239 | 109 | 363 | 18 | 42 | 1 | 1 |
| Dept. of Health & Human Services | 3,037 | 713 | 153 | 6 | 1,621 | 9 | 463 | 6 | 45 | 21 |
| Nat'l Aeronautics & Space Admin. | 1,970 | 831 | 811 | 0 | 109 | 157 | 56 | * | 1 | 3 |
| National Science Foundation | 130 | 11 | 14 | * | 96 | * | 9 | 0 | * | 0 |
| All other agencies | 1,697 | 954 | 203 | 42 | 254 | 18 | 133 | 13 | 25 | 55 |
| **Development** | | | | | | | | | | |
| Total, all agencies | 42,888 | 9,530 | 28,084 | 1,557 | 835 | 1,791 | 505 | 345 | 59 | 183 |
| Dept. of Agriculture | 41 | 38 | 0 | 0 | 2 | 0 | * | 0 | * | * |
| Dept. of Defense | 33,449 | 7,651 | 24,186 | 262 | 280 | 567 | 48 | 304 | * | 151 |
| Dept. of Energy | 3,265 | 207 | 804 | 1,291 | 13 | 902 | 6 | 39 | * | 2 |
| Dept. of Health & Human Services | 911 | 177 | 44 | 3 | 433 | 3 | 221 | 1 | 24 | 5 |
| Nat'l Aeronautics & Space Admin. | 4,549 | 1,183 | 2,859 | 0 | 57 | 317 | 124 | 1 | 3 | 5 |
| National Science Foundation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All other agencies | 637 | 274 | 191 | 1 | 50 | 2 | 106 | 0 | 32 | 20 |

* = less than $500,000

NOTES: These figures reflect funding levels as reported by Federal agencies in March through October 1990. They differ from the figures in appendix table 4-8, which reflect subsequent Congressional appropriation actions through January 1991. FFRDCs = federally funded research and development centers; U&C = universities and colleges.

SOURCE: Science Resources Studies Division, National Science Foundation, *Federal Funds for Research and Development: Fiscal Years 1989, 1990, and 1991.* NSF 90-327 Final (Washington, DC: NSF, 1991).

See text table 4-2.

*Science & Engineering Indicators – 1991*

Appendix table 4-11.
**Federal obligations for R&D, by character of work and performer: FYs 1980-91**
(page 1 of 2)

| Performer | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 (est.) | 1991 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Millions of current dollars | | | | | | |
| TOTAL RESEARCH AND DEVELOPMENT | 29.830 | 33,104 | 36,433 | 38,712 | 42,225 | 48,360 | 51,412 | 55,255 | 56,935 | 61,405 | 62,320 | 66.107 |
| Federal intramural | 7,632 | 8,426 | 9,141 | 10.582 | 11,572 | 12,945 | 13.535 | 13,413 | 14.281 | 15,121 | 16,094 | 16,396 |
| Industrial firms excluding FFRDCs | 12.969 | 14.868 | 17.192 | 17,148 | 18,753 | 21,969 | 24,509 | 26,752 | 26,719 | 28,548 | 28,854 | 31,512 |
| FFRDCs administered by industry | 1.408 | 1,414 | 1,506 | 1.501 | 1,608 | 1,791 | 1,697 | 1,860 | 1,911 | 1,960 | 2,054 | 2,062 |
| Universities and colleges excluding FFRDCs | 4,263 | 4,466 | 4.606 | 4,966 | 5,565 | 6,358 | 6,579 | 7,354 | 7.828 | 8,672 | 8,748 | 9,191 |
| FFRDCs administered by universities/colleges | 1.533 | 1.791 | 1.977 | 2,266 | 2,325 | 2,535 | 2,440 | 3,210 | 3,474 | 3,497 | 3,410 | 3,654 |
| Nonprofit institutions excluding FFRDCs | 1.106 | 1,069 | 1,092 | 1,242 | 1,497 | 1,699 | 1,676 | 1,711 | 1,683 | 1,999 | 2,184 | 2,302 |
| FFRDCs administered by nonprofit institutions | 442 | 525 | 521 | 581 | 597 | 689 | 553 | 511 | 506 | 521 | 445 | 482 |
| State and local governments | 266 | 222 | 184 | 186 | 131 | 129 | 128 | 148 | 142 | 168 | 175 | 184 |
| Foreign | 211 | 323 | 214 | 240 | 176 | 245 | 296 | 298 | 392 | 919 | 357 | 325 |
| Basic research | 4.674 | 5,041 | 5,482 | 6.260 | 7,067 | 7,819 | 8.153 | 8,944 | 9,623 | 10,602 | 11.348 | 12.255 |
| Federal intramural | 1,183 | 1,302 | 1,466 | 1.690 | 1,861 | 1.923 | 2,019 | 2,046 | 2.173 | 2,371 | 2,573 | 2.782 |
| Industrial firms excluding FFRDCs | 325 | 293 | 271 | 306 | 394 | 408 | 545 | 467 | 583 | 773 | 959 | 1,043 |
| FFRDCs administered by industry | 70 | 73 | 87 | 83 | 91 | 123 | 118 | 120 | 135 | 167 | 176 | 194 |
| Universities and colleges excluding FFRDCs | 2.320 | 2,503 | 2,727 | 3,112 | 3,531 | 4,039 | 4.132 | 4,666 | 4,927 | 5,221 | 5,377 | 5,721 |
| FFRDCs administered by universities colleges | 437 | 491 | 517 | 591 | 653 | 696 | 691 | 907 | 1,009 | 1,098 | 1,146 | 1,267 |
| Nonprofit institutions excluding FFRDCs | 280 | 313 | 356 | 410 | 474 | 556 | 572 | 658 | 713 | 839 | 963 | 1,077 |
| FFRDCs administered by nonprofit institutions | 8 | 9 | 9 | 8 | 8 | 12 | 13 | 13 | 14 | 42 | 55 | 68 |
| State and local governments | 24 | 27 | 25 | 32 | 28 | 31 | 31 | 38 | 40 | 44 | 48 | 51 |
| Foreign | 28 | 31 | 25 | 29 | 28 | 31 | 33 | 30 | 30 | 47 | 50 | 52 |
| Applied research | 6.923 | 7.172 | 7.541 | 7.993 | 7,911 | 8.315 | 8,349 | 8.999 | 9,241 | 10,163 | 10.335 | 10,965 |
| Federal intramural | 2.484 | 2.732 | 2.729 | 3,020 | 2.904 | 3,133 | 3,142 | 3,392 | 3.452 | 3,611 | 3.765 | 4,084 |
| Industrial firms excluding FFRDCs | 1,752 | 1,665 | 1,886 | 1,847 | 1,792 | 1,751 | 1.835 | 1,982 | 1,975 | 2,102 | 2.203 | 2,384 |
| FFRDCs administered by industry | 241 | 278 | 400 | 440 | 405 | 363 | 365 | 314 | 314 | 353 | 343 | 311 |
| Universities and colleges excluding FFRDCs | 1.379 | 1,417 | 1,318 | 1,356 | 1,499 | 1,688 | 1.751 | 1.975 | 2,124 | 2,572 | 2.496 | 2,635 |
| FFRDCs administered by universities colleges | 414 | 450 | 540 | 621 | 635 | 641 | 502 | 564 | 593 | 605 | 587 | 596 |
| Nonprofit institutions excluding FFRDCs | 399 | 392 | 388 | 427 | 449 | 489 | 490 | 550 | 576 | 681 | 722 | 720 |
| FFRDCs administered by nonprofit institutions | 64 | 59 | 95 | 77 | 79 | 85 | 76 | 77 | 71 | 67 | 66 | 70 |
| State and local governments | 127 | 103 | 101 | 105 | 60 | 59 | 60 | 53 | 53 | 78 | 79 | 74 |
| Foreign | 63 | 75 | 83 | 101 | 89 | 107 | 130 | 94 | 83 | 95 | 75 | 90 |
| Development | 18.233 | 20.891 | 23.410 | 24.458 | 27.246 | 32.226 | 34.910 | 37,313 | 39.648 | 40.640 | 40.637 | 42.888 |
| Federal intramural | 3.966 | 4.392 | 4.947 | 5.872 | 6.808 | 7.889 | 8.375 | 7.975 | 8.889 | 9,139 | 9,756 | 9.530 |
| Industrial firms excluding FFRDCs | 10.892 | 12.910 | 15.036 | 14.995 | 16.567 | 19.810 | 22.129 | 24,303 | 25.676 | 25.673 | 25.692 | 28.084 |
| FFRDCs administered by industry | 1,097 | 1.063 | 1,019 | 979 | 1.112 | 1,305 | 1,215 | 1,426 | 1,439 | 1,440 | 1,534 | 1,557 |
| Universities and colleges excluding FFRDCs | 564 | 546 | 560 | 499 | 535 | 631 | 696 | 713 | 720 | 879 | 875 | 835 |
| FFRDCs administered by universities colleges | 682 | 850 | 920 | 1,054 | 1,037 | 1.198 | 1,247 | 1,739 | 1,770 | 1,794 | 1,677 | 1,791 |
| Nonprofit institutions excluding FFRDCs | 427 | 364 | 348 | 405 | 575 | 654 | 614 | 503 | 512 | 479 | 498 | 505 |
| FFRDCs administered by nonprofit institutions | 370 | 458 | 416 | 496 | 510 | 592 | 463 | 421 | 430 | 412 | 323 | 345 |
| State and local governments | 115 | 93 | 58 | 49 | 43 | 40 | 37 | 58 | 55 | 46 | 48 | 59 |
| Foreign | 120 | 218 | 106 | 110 | 59 | 107 | 134 | 173 | 159 | 777 | 233 | 183 |

(continued)

Appendix table 4-11.
**Federal obligations for R&D, by character of work and performer: FYs 1980-91**
(page 2 of 2)

| Performer | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 (est.) | 1991 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Millions of constant 1982 dollars[2] | | | | | | | | | | | |
| TOTAL RESEARCH AND DEVELOPMENT | 35,202 | 35,517 | 36,433 | 37,140 | 39,028 | 43,359 | 44,898 | 46,813 | 46,815 | 48,450 | 47,275 | 48,023 |
| Federal intramural[1] | 9,007 | 9,040 | 9,141 | 10,152 | 10,696 | 11,607 | 11,820 | 11,364 | 11,742 | 11,931 | 12,209 | 11,911 |
| Industrial firms excluding FFRDCs | 15,304 | 15,952 | 17,192 | 16,451 | 17,333 | 19,697 | 21,403 | 22,665 | 21,970 | 22,525 | 21,888 | 22,892 |
| FFRDCs administered by industry | 1,662 | 1,517 | 1,506 | 1,440 | 1,487 | 1,606 | 1,482 | 1,576 | 1,571 | 1,546 | 1,558 | 1,498 |
| Universities and colleges excluding FFRDCs | 5,031 | 4,791 | 4,606 | 4,765 | 5,144 | 5 700 | 5,746 | 6,230 | 6,437 | 6,842 | 6,636 | 6,677 |
| FFRDCs administered by universities/colleges | 1,809 | 1,922 | 1,977 | 2,174 | 2,149 | 2,273 | 2,131 | 2,719 | 2,856 | 2,759 | 2,587 | 2,654 |
| Nonprofit institutions excluding FFRDCs | 1,305 | 1,147 | 1,092 | 1,191 | 1,384 | 1,523 | 1,463 | 1,449 | 1,384 | 1,577 | 1,657 | 1,672 |
| FFRDCs administered by nonprofit institutions | 521 | 563 | 521 | 558 | 552 | 618 | 483 | 433 | 416 | 411 | 338 | 350 |
| State and local governments | 313 | 238 | 184 | 178 | 121 | 116 | 112 | 126 | 117 | 133 | 133 | 134 |
| Foreign | 249 | 347 | 214 | 230 | 162 | 219 | 259 | 252 | 322 | 725 | 271 | 236 |
| Basic research | 5,516 | 5,409 | 5,482 | 6,006 | 6,532 | 7,010 | 7,120 | 7,579 | 7,912 | 8,365 | 8,608 | 8,903 |
| Federal intramural[1] | 1,396 | 1,397 | 1,466 | 1,621 | 1,720 | 1,725 | 1,763 | 1,734 | 1,787 | 1,871 | 1,952 | 2,021 |
| Industrial firms excluding FFRDCs | 384 | 314 | 271 | 293 | 364 | 366 | 476 | 396 | 479 | 610 | 727 | 758 |
| FFRDCs administered by industry | 83 | 79 | 87 | 80 | 84 | 110 | 103 | 102 | 111 | 132 | 134 | 141 |
| Universities and colleges excluding FFRDCs | 2,738 | 2,686 | 2,727 | 2,986 | 3,263 | 3,621 | 3,609 | 3,953 | 4,051 | 4,119 | 4,079 | 4,156 |
| FFRDCs administered by universities/colleges | 515 | 526 | 517 | 567 | 603 | 624 | 604 | 768 | 829 | 866 | 869 | 920 |
| Nonprofit institutions excluding FFRDCs | 330 | 336 | 356 | 393 | 438 | 498 | 500 | 557 | 586 | 662 | 731 | 782 |
| FFRDCs administered by nonprofit institutions | 9 | 9 | 9 | 8 | 8 | 11 | 11 | 11 | 11 | 33 | 42 | 49 |
| State and local governments | 28 | 28 | 25 | 31 | 26 | 27 | 27 | 32 | 33 | 35 | 36 | 37 |
| Foreign | 33 | 33 | 25 | 27 | 26 | 28 | 29 | 26 | 25 | 37 | 38 | 38 |
| Applied research | 8,170 | 7,694 | 7,541 | 7,669 | 7,312 | 7,455 | 7,291 | 7,624 | 7,599 | 8,019 | 7,840 | 7,965 |
| Federal intramural[1] | 2,931 | 2,932 | 2,729 | 2,898 | 2,684 | 2,809 | 2,743 | 2,873 | 2,839 | 2,849 | 2,856 | 2,967 |
| Industrial firms excluding FFRDCs | 2,068 | 1,787 | 1,886 | 1,772 | 1,656 | 1,570 | 1,602 | 1,679 | 1,624 | 1,658 | 1,671 | 1,732 |
| FFRDCs administered by industry | 284 | 298 | 400 | 422 | 375 | 326 | 318 | 266 | 258 | 279 | 260 | 226 |
| Universities and colleges excluding FFRDCs | 1,627 | 1,520 | 1,318 | 1,301 | 1,385 | 1,513 | 1,529 | 1,673 | 1,747 | 2,029 | 1,893 | 1,914 |
| FFRDCs administered by universities/colleges | 489 | 483 | 540 | 595 | 587 | 574 | 438 | 478 | 487 | 477 | 445 | 433 |
| Nonprofit institutions excluding FFRDCs | 471 | 421 | 388 | 410 | 415 | 439 | 428 | 466 | 474 | 537 | 548 | 523 |
| FFRDCs administered by nonprofit institutions | 76 | 63 | 95 | 74 | 73 | 76 | 66 | 65 | 58 | 53 | 50 | 51 |
| State and local governments | 150 | 110 | 101 | 100 | 55 | 53 | 52 | 45 | 44 | 62 | 60 | 54 |
| Foreign | 74 | 80 | 83 | 97 | 82 | 96 | 113 | 80 | 68 | 75 | 57 | 65 |
| Development | 21,516 | 22,414 | 23,410 | 23,465 | 25,183 | 28,894 | 30,487 | 31,612 | 32,601 | 32,065 | 30,827 | 31,156 |
| Federal intramural[1] | 4,680 | 4,712 | 4,947 | 5,633 | 6,292 | 7,074 | 7,313 | 6,757 | 7,309 | 7,211 | 7,401 | 6,923 |
| Industrial firms excluding FFRDCs | 12,853 | 13,851 | 15,036 | 14,386 | 15,313 | 17,761 | 19,325 | 20,590 | 21,112 | 20,256 | 19,490 | 20,401 |
| FFRDCs administered by industry | 1,295 | 1,140 | 1,019 | 939 | 1,028 | 1,170 | 1,061 | 1,208 | 1,183 | 1,136 | 1,164 | 1,131 |
| Universities and colleges excluding FFRDCs | 666 | 585 | 560 | 478 | 495 | 566 | 608 | 604 | 592 | 694 | 664 | 607 |
| FFRDCs administered by universities/colleges | 805 | 912 | 920 | 1,011 | 959 | 1,074 | 1,089 | 1,473 | 1,455 | 1,415 | 1,272 | 1,301 |
| Nonprofit institutions excluding FFRDCs | 504 | 390 | 348 | 388 | 531 | 586 | 536 | 426 | 421 | 378 | 378 | 367 |
| FFRDCs administered by nonprofit institutions | 437 | 491 | 416 | 476 | 471 | 531 | 405 | 357 | 353 | 325 | 245 | 251 |
| State and local governments | 135 | 100 | 58 | 47 | 40 | 36 | 33 | 49 | 45 | 36 | 36 | 43 |
| Foreign | 142 | 233 | 106 | 105 | 55 | 96 | 117 | 147 | 131 | 613 | 177 | 133 |

NOTE: FFRDCs - Federally funded research and development centers.

[1] Federal intramural activities cover costs associated with administering intramural and extramural programs by Federal personnel and actual intramural performance.

[2] See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCES: Science Resources Studies Division (SRS). National Science Foundation. *Federal Funds for Research and Development. Detailed Historical Tables: Fiscal Years 1955-1990* (Washington, DC: NSF, 1990); and SRS. *Federal Funds for Research and Development: Fiscal Years 1989, 1990, and 1991*, NSF 90-327 Final (Washington, DC: NSF, 1991).

Appendix table 4-12.
**Federal obligations for basic research, by science and engineering field: FYs 1980-91**
(page 1 of 3)

| Science and engineering field | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 (est.) | 1991 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Millions of current dollars | | | | | | | | | | | |
| **Total, all fields** | 4,674 | 5,041 | 5,482 | 6,260 | 7,067 | 7,819 | 8,153 | 8,944 | 9,474 | 10,602 | 11,348 | 12,255 |
| Life sciences | 2.054 | 2,224 | 2,526 | 2,891 | 3,288 | 3.787 | 3.859 | 4,364 | 4,502 | 4,916 | 5,203 | 5.589 |
| Biological & agricultural, total | 1.340 | 1,462 | 1,675 | 1,929 | 2,175 | 2,516 | 2,543 | 2,870 | 2,856 | 3.102 | 3,291 | 3,565 |
| Biological (excl. environmental) | 1,100 | 1,202 | 1,401 | 1,622 | 1,836 | 2,106 | 2,152 | 2,462 | 2,415 | 2,647 | 2,804 | 3,040 |
| Environmental biology | 86 | 83 | 83 | 93 | 121 | 126 | 126 | 141 | 147 | 157 | 168 | 178 |
| Agricultural | 154 | 177 | 190 | 214 | 218 | 284 | 266 | 268 | 294 | 298 | 319 | 347 |
| Medical sciences, total | 657 | 706 | 793 | 879 | 1,015 | 1,145 | 1,197 | 1,343 | 1,573 | 1,708 | 1,801 | 1,906 |
| Other life sciences | 58 | 55 | 58 | 84 | 98 | 126 | 119 | 151 | 73 | 104 | 111 | 119 |
| Psychology | 84 | 91 | 90 | 93 | 108 | 133 | 133 | 147 | 188 | 187 | 202 | 221 |
| Physical sciences | 1,221 | 1,325 | 1,394 | 1,587 | 1,728 | 1,815 | 1,914 | 2,096 | 2,200 | 2,506 | 2,697 | 2,966 |
| Astronomy | 279 | 274 | 271 | 355 | 380 | 401 | 453 | 505 | 459 | 525 | 556 | 577 |
| Chemistry | 257 | 298 | 312 | 362 | 403 | 425 | 433 | 445 | 471 | 505 | 532 | 545 |
| Physics | 668 | 735 | 791 | 855 | 921 | 960 | 1,003 | 1,072 | 1,206 | 1,395 | 1,520 | 1,699 |
| Other physical sciences | 16 | 17 | 20 | 15 | 24 | 30 | 25 | 74 | 65 | 82 | 87 | 146 |
| Environmental sciences | 522 | 533 | 520 | 580 | 657 | 700 | 749 | 781 | 873 | 1,017 | 1,184 | 1,328 |
| Atmospheric science | 179 | 174 | 163 | 173 | 192 | 209 | 240 | 244 | 281 | 316 | 399 | 496 |
| Geological | 198 | 194 | 178 | 178 | 198 | 250 | 266 | 266 | 267 | 335 | 371 | 383 |
| Oceanography | 131 | 143 | 155 | 196 | 220 | 219 | 224 | 250 | 269 | 294 | 317 | 373 |
| Other environmental sciences | 14 | 22 | 25 | 34 | 46 | 21 | 19 | 21 | 55 | 72 | 98 | 77 |
| Mathematics & computer sciences | 116 | 140 | 165 | 208 | 241 | 260 | 293 | 306 | 313 | 346 | 356 | 379 |
| Mathematics | 67 | 79 | 91 | 101 | 114 | 130 | 142 | 158 | 165 | 168 | 171 | 186 |
| Computer sciences | 46 | 52 | 67 | 90 | 105 | 116 | 131 | 129 | 125 | 160 | 161 | 173 |
| Other math & computer sciences | 3 | 9 | 7 | 17 | 22 | 14 | 20 | 20 | 22 | 18 | 24 | 20 |
| Social sciences | 147 | 137 | 120 | 138 | 133 | 141 | 114 | 130 | 147 | 155 | 188 | 189 |
| Anthropology | 14 | 13 | 13 | 11 | 17 | 16 | 11 | 12 | 12 | 12 | 13 | 14 |
| Economics | 40 | 34 | 39 | 41 | 30 | 34 | 26 | 29 | 35 | 38 | 46 | 44 |
| Political science | 7 | 6 | 4 | 5 | 4 | 6 | 4 | 6 | 5 | 5 | 6 | 6 |
| Sociology | 25 | 23 | 19 | 33 | 34 | 32 | 30 | 34 | 37 | 38 | 54 | 81 |
| Other social sciences | 60 | 61 | 45 | 48 | 48 | 52 | 42 | 48 | 8 | 61 | 69 | 43 |
| Other sciences | 64 | 65 | 56 | 73 | 69 | 100 | 122 | 131 | 255 | 292 | 319 | 328 |

(continued)

Appendix table 4-12.
**Federal obligations for basic research, by science and engineering field: FYs 1980-91**
(page 2 of 3)

| Science and engineering field | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 (est.) | 1991 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Millions of current dollars | | | | | | |
| Engineering | 465 | 526 | 611 | 690 | 845 | 884 | 969 | 990 | 1,006 | 1,184 | 1,199 | 1,253 |
| Aeronautical | 104 | 113 | 127 | 141 | 226 | 192 | 226 | 237 | 231 | 328 | 337 | 299 |
| Astronautical | 27 | 33 | 45 | 50 | 52 | 42 | 53 | 49 | 48 | 59 | 64 | 87 |
| Chemical | 26 | 31 | 35 | 50 | 56 | 74 | 73 | 78 | 89 | 50 | 58 | 64 |
| Civil | 22 | 23 | 32 | 32 | 42 | 44 | 45 | 46 | 46 | 52 | 50 | 55 |
| Electrical | 71 | 79 | 94 | 96 | 130 | 145 | 156 | 175 | 154 | 174 | 165 | 180 |
| Mechanical | 42 | 47 | 53 | 61 | 64 | 88 | 84 | 87 | 84 | 101 | 100 | 109 |
| Metallurgy & materials | 121 | 139 | 156 | 183 | 187 | 212 | 229 | 210 | 230 | 255 | 266 | 300 |
| Other | 52 | 61 | 69 | 76 | 88 | 88 | 103 | 108 | 124 | 166 | 158 | 159 |
| | | | | | | Millions of constant 1982 dollars[1] | | | | | | |
| **Total, all fields** | 5,516 | 5,409 | 5,482 | 6,006 | 6,532 | 7,010 | 7,120 | 7,578 | 7,790 | 8,365 | 8,608 | 8,903 |
| Life sciences | 2,424 | 2,386 | 2,526 | 2,774 | 3,039 | 3,395 | 3,370 | 3,697 | 3,702 | 3,879 | 3,947 | 4,060 |
| Biological & agricultural, total | 1,581 | 1,569 | 1,675 | 1,850 | 2,010 | 2,255 | 2,221 | 2,432 | 2,348 | 2,447 | 2,496 | 2,590 |
| Biological (excl. environmental) | 1,298 | 1,289 | 1,401 | 1,556 | 1,697 | 1,888 | 1,879 | 2,085 | 1,986 | 2,089 | 2,127 | 2,208 |
| Environmental biology | 102 | 89 | 83 | 89 | 112 | 113 | 110 | 119 | 121 | 124 | 127 | 129 |
| Agricultural | 181 | 190 | 190 | 206 | 202 | 254 | 232 | 227 | 242 | 235 | 242 | 252 |
| Medical sciences, total | 775 | 758 | 793 | 843 | 938 | 1,027 | 1,045 | 1,138 | 1,293 | 1,348 | 1,366 | 1,385 |
| Other life sciences | 68 | 59 | 58 | 80 | 90 | 113 | 104 | 128 | 60 | 82 | 84 | 86 |
| Psychology | 99 | 98 | 90 | 89 | 100 | 119 | 116 | 125 | 155 | 148 | 153 | 161 |
| Physical sciences | 1,440 | 1,421 | 1,394 | 1,523 | 1,597 | 1,628 | 1,672 | 1,776 | 1,809 | 1,977 | 2,046 | 2,155 |
| Astronomy | 330 | 294 | 271 | 340 | 351 | 359 | 396 | 427 | 377 | 414 | 422 | 419 |
| Chemistry | 303 | 320 | 312 | 347 | 373 | 381 | 378 | 377 | 387 | 398 | 404 | 396 |
| Physics | 789 | 789 | 791 | 820 | 852 | 861 | 876 | 908 | 992 | 1,101 | 1,153 | 1,234 |
| Other physical sciences | 19 | 18 | 20 | 15 | 22 | 27 | 22 | 63 | 53 | 65 | 66 | 106 |
| Environmental sciences | 616 | 572 | 520 | 557 | 607 | 627 | 654 | 662 | 718 | 802 | 898 | 965 |
| Atmospheric science | 211 | 186 | 163 | 166 | 178 | 188 | 210 | 207 | 231 | 249 | 303 | 360 |
| Geological | 234 | 208 | 178 | 171 | 183 | 224 | 232 | 226 | 220 | 264 | 281 | 278 |
| Oceanography | 154 | 154 | 155 | 188 | 203 | 197 | 196 | 212 | 221 | 232 | 240 | 271 |
| Other environmental sciences | 17 | 23 | 25 | 32 | 43 | 19 | 17 | 18 | 45 | 57 | 74 | 56 |
| Mathematics & computer sciences | 137 | 151 | 165 | 200 | 223 | 233 | 256 | 260 | 257 | 273 | 270 | 275 |
| Mathematics | 79 | 85 | 91 | 97 | 105 | 117 | 124 | 134 | 136 | 133 | 130 | 135 |
| Computer sciences | 55 | 56 | 67 | 87 | 97 | 104 | 115 | 109 | 103 | 126 | 122 | 126 |
| Other math & computer sciences | 4 | 10 | 7 | 16 | 21 | 12 | 17 | 17 | 18 | 14 | 18 | 15 |

(continued)

Appendix table 4-12.
**Federal obligations for basic research, by science and engineering field: FYs 1980-91**
(page 3 of 3)

| Science and engineering field | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 (est.) | 1991 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Millions of constant 1982 dollars[1] | | | | | | | | | | | |
| Social sciences | 174 | 147 | 120 | 132 | 123 | 126 | 99 | 110 | 121 | 122 | 143 | 137 |
| Anthropology | 17 | 14 | 13 | 11 | 16 | 14 | 10 | 10 | 10 | 9 | 10 | 10 |
| Economics | 47 | 37 | 39 | 39 | 27 | 31 | 23 | 25 | 29 | 30 | 35 | 32 |
| Political science | 9 | 7 | 4 | 4 | 4 | 5 | 4 | 5 | 4 | 4 | 5 | 4 |
| Sociology | 30 | 24 | 19 | 31 | 31 | 29 | 26 | 29 | 30 | 30 | 41 | 59 |
| Other social sciences | 71 | 65 | 45 | 46 | 44 | 47 | 37 | 41 | 48 | 48 | 52 | 31 |
| Other sciences | 75 | 70 | 56 | 70 | 64 | 89 | 107 | 111 | 210 | 230 | 242 | 238 |
| Engineering | 549 | 564 | 611 | 662 | 781 | 793 | 846 | 838 | 827 | 934 | 910 | 910 |
| Aeronautical | 123 | 122 | 127 | 135 | 208 | 172 | 198 | 201 | 190 | 259 | 256 | 217 |
| Astronautical | 32 | 36 | 45 | 48 | 48 | 37 | 46 | 41 | 39 | 47 | 49 | 63 |
| Chemical | 31 | 34 | 35 | 48 | 51 | 67 | 64 | 66 | 73 | 39 | 44 | 46 |
| Civil | 26 | 25 | 32 | 31 | 39 | 39 | 39 | 39 | 38 | 41 | 38 | 40 |
| Electrical | 83 | 84 | 94 | 92 | 121 | 130 | 136 | 149 | 127 | 137 | 125 | 131 |
| Mechanical | 50 | 51 | 53 | 58 | 59 | 79 | 73 | 74 | 69 | 80 | 76 | 79 |
| Metallurgy & materials | 143 | 149 | 156 | 175 | 173 | 190 | 200 | 178 | 189 | 201 | 202 | 218 |
| Other | 61 | 65 | 69 | 73 | 81 | 79 | 90 | 91 | 102 | 131 | 120 | 116 |

[1] See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCES: Science Resources Studies Division (SRS), National Science Foundation, *Federal Funds for Research and Development, Detailed Historical Tables: Fiscal Years 1955-1990* (Washington, DC: NSF, 1990); and SRS, *Federal Funds for Research and Development: Fiscal Years 1989, 1990, and 1991*, NSF 90-327 Final (Washington, DC: NSF, 1991).

See figure 4-6

*Science & Engineering Indicators – 1991*

Appendix table 4-13.
**Federal obligations for applied research, by science and engineering field: FYs 1980-91**
(page 1 of 3)

| Science and engineering field | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 (est.) | 1991 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Millions of current dollars | | | | | | | | | | | |
| **Total, all fields** | 6,923 | 7,172 | 7,541 | 7,993 | 7,911 | 8,315 | 8,349 | 8,999 | 9,176 | 10,163 | 10,335 | 10,965 |
| Life sciences | 2,138 | 2,212 | 2,220 | 2,287 | 2,348 | 2,576 | 2,606 | 2,980 | 3,223 | 3,579 | 3,710 | 3,818 |
| Biological & agricultural, total | 1,168 | 1,249 | 1,137 | 1,136 | 1,150 | 1,240 | 1,318 | 1,488 | 1,718 | 1,917 | 1,982 | 2,060 |
| Biological (excl. environmental) | 731 | 795 | 678 | 684 | 727 | 779 | 842 | 1,041 | 1,267 | 1,336 | 1,444 | 1,480 |
| Environmental biology | 144 | 137 | 100 | 101 | 129 | 135 | 138 | 149 | 154 | 210 | 187 | 192 |
| Agricultural | 294 | 317 | 359 | 351 | 294 | 326 | 338 | 299 | 297 | 371 | 352 | 387 |
| Medical sciences, total | 880 | 904 | 980 | 1,049 | 1,098 | 1,223 | 1,164 | 1,324 | 1,368 | 1,514 | 1,572 | 1,600 |
| Other life sciences | 90 | 59 | 103 | 102 | 100 | 113 | 123 | 168 | 137 | 148 | 156 | 158 |
| Psychology | 115 | 118 | 129 | 148 | 159 | 194 | 201 | 222 | 212 | 235 | 246 | 288 |
| Physical sciences | 780 | 896 | 1,107 | 1,304 | 1,241 | 1,231 | 1,155 | 1,157 | 1,118 | 1,199 | 1,198 | 1,225 |
| Astronomy | 6 | 7 | 5 | 3 | 3 | 14 | 15 | 18 | 12 | 17 | 25 | 23 |
| Chemistry | 198 | 189 | 169 | 158 | 203 | 225 | 229 | 235 | 232 | 278 | 307 | 288 |
| Physics | 514 | 610 | 820 | 1,000 | 915 | 856 | 803 | 781 | 770 | 795 | 767 | 780 |
| Other physical sciences | 62 | 90 | 113 | 144 | 120 | 135 | 108 | 122 | 103 | 108 | 100 | 134 |
| Environmental sciences | 739 | 588 | 628 | 671 | 619 | 704 | 733 | 731 | 734 | 756 | 920 | 1,017 |
| Atmospheric science | 231 | 200 | 263 | 288 | 242 | 277 | 281 | 309 | 307 | 272 | 339 | 416 |
| Geological | 203 | 202 | 180 | 155 | 161 | 179 | 178 | 176 | 174 | 208 | 220 | 213 |
| Oceanography | 131 | 118 | 107 | 148 | 143 | 179 | 205 | 178 | 191 | 198 | 209 | 210 |
| Other environmental sciences | 173 | 68 | 79 | 80 | 73 | 69 | 68 | 68 | 62 | 78 | 152 | 178 |
| Mathematics & computer sciences | 125 | 139 | 185 | 211 | 200 | 315 | 322 | 334 | 330 | 390 | 365 | 413 |
| Mathematics | 24 | 39 | 37 | 33 | 37 | 53 | 42 | 46 | 52 | 68 | 65 | 69 |
| Computer sciences | 82 | 69 | 104 | 124 | 110 | 164 | 171 | 169 | 167 | 205 | 178 | 214 |
| Other math & computer sciences | 18 | 31 | 44 | 55 | 53 | 97 | 109 | 119 | 110 | 116 | 122 | 131 |
| Social sciences | 377 | 361 | 266 | 298 | 304 | 319 | 302 | 351 | 339 | 396 | 433 | 457 |
| Anthropology | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 |
| Economics | 153 | 173 | 118 | 125 | 118 | 125 | 105 | 120 | 125 | 129 | 134 | 143 |
| Political science | 5 | 5 | 3 | 7 | 7 | 9 | 8 | 6 | 7 | 8 | 6 | 6 |
| Sociology | 46 | 42 | 33 | 35 | 36 | 34 | 37 | 40 | 45 | 56 | 68 | 73 |
| Other social sciences | 170 | 140 | 110 | 130 | 141 | 149 | 150 | 183 | 160 | 202 | 222 | 233 |
| Other sciences | 286 | 314 | 231 | 247 | 262 | 242 | 261 | 307 | 271 | 350 | 301 | 316 |

(continued)

Appendix table 4-13.
**Federal obligations for applied research, by science and engineering field: FYs 1980-91**
(page 2 of 3)

| Science and engineering field | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 (est.) | 1991 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Millions of current dollars | | | | | | |
| Engineering | 2,365 | 2,545 | 2,776 | 2,828 | 2,779 | 2,733 | 2,770 | 2,917 | 2,950 | 3,258 | 3,162 | 3,431 |
| Aeronautical | 604 | 596 | 615 | 680 | 635 | 547 | 549 | 573 | 571 | 659 | 727 | 777 |
| Astronautical | 275 | 271 | 246 | 271 | 344 | 383 | 474 | 576 | 527 | 619 | 548 | 716 |
| Chemical | 70 | 116 | 60 | 95 | 89 | 180 | 173 | 138 | 169 | 92 | 95 | 98 |
| Civil | 137 | 136 | 170 | 156 | 161 | 173 | 158 | 159 | 169 | 178 | 185 | 195 |
| Electrical | 447 | 478 | 519 | 519 | 500 | 482 | 518 | 611 | 577 | 669 | 535 | 536 |
| Mechanical | 166 | 157 | 148 | 206 | 126 | 179 | 153 | 146 | 157 | 157 | 163 | 179 |
| Metallurgy & materials | 115 | 118 | 153 | 150 | 154 | 227 | 217 | 152 | 227 | 266 | 254 | 299 |
| Other | 552 | 673 | 866 | 751 | 770 | 563 | 529 | 562 | 553 | 619 | 656 | 631 |
| | | | | | | Millions of constant 1982 dollars | | | | | | |
| **Total, all fields** | 8,170 | 7,694 | 7,541 | 7,669 | 7,312 | 7,455 | 7,291 | 7,624 | 7,545 | 8,019 | 7,840 | 7,965 |
| Life sciences | 2,523 | 2,373 | 2,220 | 2,194 | 2,171 | 2,310 | 2,275 | 2,525 | 2,650 | 2,824 | 2,814 | 2,774 |
| Biological & agricultural, total | 1,378 | 1,340 | 1,137 | 1,089 | 1,063 | 1,112 | 1,151 | 1,261 | 1,413 | 1,513 | 1,504 | 1,496 |
| Biological (excl. environmental) | 862 | 853 | 678 | 656 | 672 | 699 | 735 | 882 | 1,042 | 1,054 | 1,095 | 1,075 |
| Environmental biology | 169 | 147 | 100 | 97 | 119 | 121 | 121 | 126 | 127 | 166 | 142 | 139 |
| Agricultural | 347 | 341 | 359 | 337 | 272 | 292 | 295 | 253 | 244 | 293 | 267 | 281 |
| Medical sciences, total | 1,038 | 970 | 980 | 1,006 | 1,014 | 1,097 | 1,016 | 1,122 | 1,125 | 1,195 | 1,192 | 1,162 |
| Other life sciences | 106 | 63 | 103 | 98 | 93 | 101 | 108 | 142 | 113 | 117 | 118 | 115 |
| Psychology | 135 | 126 | 129 | 142 | 147 | 174 | 176 | 188 | 174 | 185 | 187 | 209 |
| Physical sciences | 920 | 961 | 1,107 | 1,251 | 1,147 | 1,104 | 1,008 | 980 | 919 | 946 | 909 | 890 |
| Astronomy | 7 | 7 | 5 | 3 | 2 | 13 | 13 | 15 | 10 | 13 | 19 | 17 |
| Chemistry | 233 | 202 | 169 | 152 | 188 | 202 | 200 | 199 | 191 | 219 | 233 | 209 |
| Physics | 607 | 655 | 820 | 959 | 846 | 768 | 701 | 662 | 633 | 627 | 582 | 567 |
| Other physical sciences | 73 | 96 | 113 | 138 | 111 | 121 | 94 | 104 | 85 | 85 | 76 | 97 |
| Environmental sciences | 872 | 631 | 628 | 644 | 572 | 631 | 640 | 619 | 604 | 596 | 698 | 739 |
| Atmospheric science | 272 | 214 | 263 | 276 | 224 | 248 | 245 | 262 | 252 | 215 | 257 | 302 |
| Geological | 240 | 217 | 180 | 149 | 149 | 160 | 156 | 149 | 143 | 164 | 167 | 155 |
| Oceanography | 155 | 127 | 107 | 142 | 133 | 161 | 179 | 150 | 157 | 156 | 159 | 153 |
| Other environmental sciences | 205 | 73 | 79 | 77 | 67 | 62 | 59 | 58 | 51 | 62 | 115 | 129 |
| Mathematics & computer sciences | 147 | 149 | 185 | 203 | 184 | 282 | 281 | 283 | 271 | 308 | 277 | 300 |
| Mathematics | 28 | 41 | 37 | 31 | 34 | 48 | 37 | 39 | 43 | 54 | 49 | 50 |
| Computer sciences | 97 | 74 | 104 | 119 | 101 | 147 | 149 | 143 | 137 | 162 | 135 | 155 |
| Other math & computer sciences | 21 | 33 | 44 | 52 | 49 | 87 | 95 | 101 | 90 | 92 | 93 | 95 |

(continued)

Appendix table 4-13.
**Federal obligations for applied research, by science and engineering field: FYs 1980-91**
(page 3 of 3)

| Science and engineering field | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 (est.) | 1991 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Millions of constant 1982 dollars[1] | | | | | | | | | | | |
| Social sciences | 444 | 387 | 266 | 285 | 281 | 286 | 264 | 297 | 279 | 312 | 328 | 332 |
| Anthropology | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| Economics | 180 | 185 | 118 | 120 | 109 | 112 | 92 | 101 | 103 | 102 | 102 | 104 |
| Political science | 6 | 5 | 3 | 6 | 6 | 8 | 7 | 5 | 6 | 6 | 5 | 4 |
| Sociology | 54 | 45 | 33 | 34 | 34 | 30 | 32 | 34 | 37 | 44 | 52 | 53 |
| Other social sciences | 201 | 150 | 110 | 125 | 131 | 134 | 131 | 155 | 132 | 159 | 168 | 169 |
| Other sciences | 337 | 336 | 231 | 237 | 242 | 217 | 228 | 260 | 223 | 276 | 228 | 230 |
| Engineering | 2,791 | 2,731 | 2,776 | 2,713 | 2,569 | 2,451 | 2,419 | 2,471 | 2,426 | 2,571 | 2,399 | 2,492 |
| Aeronautical | 713 | 640 | 615 | 652 | 587 | 490 | 480 | 485 | 470 | 520 | 551 | 564 |
| Astronautical | 325 | 291 | 246 | 260 | 318 | 344 | 414 | 488 | 433 | 488 | 416 | 520 |
| Chemical | 83 | 125 | 60 | 91 | 82 | 161 | 151 | 117 | 139 | 73 | 72 | 71 |
| Civil | 161 | 146 | 170 | 150 | 149 | 155 | 138 | 134 | 139 | 140 | 140 | 142 |
| Electrical | 527 | 513 | 519 | 498 | 462 | 432 | 452 | 518 | 474 | 528 | 406 | 389 |
| Mechanical | 196 | 169 | 148 | 197 | 117 | 160 | 134 | 124 | 129 | 124 | 124 | 130 |
| Metallurgy & materials | 135 | 126 | 153 | 144 | 142 | 204 | 189 | 129 | 187 | 210 | 193 | 217 |
| Other | 651 | 722 | 866 | 721 | 712 | 505 | 462 | 476 | 455 | 488 | 498 | 458 |

[1] See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCES: Science Resources Studies Division (SRS), National Science Foundation, *Federal Funds for Research and Development. Detailed Historical Tables: Fiscal Years 1955-1990* (Washington, DC: NSF, 1990); and SRS, *Federal Funds for Research and Development: Fiscal Years 1989, 1990, and 1991*, NSF 90-327, Final (Washington, DC: NSF, 1991).

See figure 4-6

Appendix table 4-14.
**Small Business Innovation Research (SBIR) awards, by award type and selected agency: FYs 1983-89**

| Award type and agency | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|
| | | | | Millions of current dollars | | | |
| Total[1] | 45 | 108 | 199 | 298 | 351 | 389 | 432 |
| By type | | | | | | | |
| Phase I awards | 45 | 48 | 69 | 99 | 110 | 102 | 108 |
| Phase II awards | 0 | 60 | 130 | 199 | 241 | 285 | 322 |
| By agency | | | | | | | |
| Dept. of Agriculture | 1 | 2 | 3 | 4 | 4 | 4 | 4 |
| Dept. of Commerce | 0 | 0 | 0 | 1 | 2 | 1 | 1 |
| Dept. of Defense | 20 | 45 | 78 | 151 | 194 | 208 | 233 |
| Dept. of Education | * | 1 | 1 | 2 | 2 | 2 | 2 |
| Dept. of Energy | 5 | 16 | 26 | 29 | 28 | 30 | 33 |
| Dept. of Health & Human Services | 7 | 23 | 45 | 57 | 67 | 73 | 79 |
| Dept. of the Interior | * | 1 | * | 0 | 0 | 0 | 0 |
| Dept. of Transportation | * | 2 | 3 | 4 | 3 | 3 | 4 |
| Environmental Protection Agency | * | 1 | 2 | 3 | 3 | 3 | 3 |
| Nat'l Aeronautics & Space Admin | 5 | 13 | 29 | 36 | 32 | 47 | 52 |
| National Science Foundation | 5 | 7 | 10 | 15 | 17 | 17 | 19 |
| Nuclear Regulatory Commission | * | 1 | 1 | 1 | 1 | 1 | 1 |
| | | | | Millions of constant 1982 dollars[2] | | | |
| Total[1] | 43 | 100 | 178 | 260 | 297 | 320 | 341 |
| By type | | | | | | | |
| Phase I awards | 43 | 44 | 62 | 86 | 93 | 84 | 85 |
| Phase II awards | 0 | 56 | 117 | 174 | 204 | 234 | 254 |
| By agency | | | | | | | |
| Dept. of Agriculture | 1 | 2 | 3 | 3 | 3 | 3 | 3 |
| Dept. of Commerce | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| Dept. of Defense | 19 | 41 | 70 | 132 | 164 | 171 | 184 |
| Dept. of Education | * | 1 | 1 | 1 | 1 | 1 | 2 |
| Dept. of Energy | 5 | 15 | 23 | 25 | 24 | 25 | 26 |
| Dept. of Health & Human Services | 7 | 21 | 40 | 50 | 57 | 60 | 63 |
| Dept. of the Interior | * | 1 | * | 0 | 0 | 0 | 0 |
| Dept. of Transportation | * | 2 | 3 | 3 | 2 | 3 | 3 |
| Environmental Protection Agency | * | 1 | 2 | 2 | 3 | 2 | 2 |
| Nat'l Aeronautics & Space Admin | 5 | 12 | 26 | 31 | 27 | 39 | 41 |
| National Science Foundation | 5 | 6 | 9 | 13 | 14 | 14 | 15 |
| Nuclear Regulatory Commission | * | 1 | 1 | 1 | 1 | * | 1 |

* = less than $500,000

[1]Totals are SBIR award obligations that include award modifications. The details by type of award and agency do not necessarily contain subsequent year revisions and may not sum to totals.

[2]See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCE: Office of Innovation, Research, and Technology, Small Business Administration, *Small Business Innovation Development Act* (Washington, DC: SBA, ongoing series).

See figure 4-7.

*Science & Engineering Indicators – 1991*

Appendix table 4-15.
**Small Business Innovation Research (SBIR) awards, by technology area and selected agency: FYs 1983-89 (cumulative)**

| Technology area[1] | Total | Dept. of Defense | Dept. of Energy | Dept. of Health & Human Svcs | Nat'l Aero & Space Admin. | National Science Foundation | Other[2] |
|---|---|---|---|---|---|---|---|
| | | | | Percent | | | |
| Total (1983-89) | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Computer, information, & analysis | 22 | 26 | 10 | 15 | 26 | 18 | 19 |
| Electronics | 21 | 27 | 18 | 7 | 20 | 16 | 12 |
| Materials | 16 | 18 | 25 | 6 | 15 | 24 | 14 |
| Mechanics of vehicles & facilities | 7 | 10 | 4 | 1 | 12 | 4 | 4 |
| Energy conservation and use | 12 | 10 | 28 | 3 | 15 | 10 | 6 |
| Environmental & natural resources | 7 | 5 | 10 | 4 | 7 | 13 | 20 |
| Life sciences | 16 | 4 | 4 | 64 | 4 | 15 | 25 |
| | | | | Millions of current dollars | | | |
| Total (1983-89) | 2,885 | 1,389 | 337 | 513 | 371 | 136 | 139 |

[1] Distributions are based on the cumulative 1983-89 value of awards, not on the number of awards granted. Within each of the broad technology areas listed, SBIR awards are assigned to more specific technology areas, including multiple technology areas. Therefore, the percentage distributions include overcounting of awards assigned to multiple technology areas.

[2] Includes Departments of Agriculture, Commerce, Education, and Transportation, the Environmental Protection Agency, and the Nuclear Regulatory Commission.

SOURCE: Office of Innovation, Research, and Technology, Small Business Administration, *Small Business Innovation Development Act: Seventh Year Results* (Washington, DC: SBA, 1990).

*Science & Engineering Indicators – 1991*

Appendix table 4-16.
**Annual aggregate data on independent research and development (IR&D): FYs 1976-89**

| | Independent research and development | | | | | | DOD and NASA R&D obligations | | IR&D as a percentage of | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Accepted by Government IR&D program | | | | Not accepted under IR&D program | | | DOD and NASA R&D total[2] (a) | DOD and NASA R&D performed by industry[2] (b) |
| | Incurred by industry | Total accepted | DOD share | NASA share | Not reimbursed | | Total | Total to industry[1] | | |
| | Millions of current dollars | | | | | | | | Percent | |
| 1976 | 1,388 | 1,061 | 544 | 41 | 476 | 327 | 13,102 | 8,143 | 4.5 | 7.2 |
| 1977 | 1,560 | 1,199 | 598 | 46 | 555 | 361 | 14,134 | 9,109 | 4.6 | 7.1 |
| 1978 | 1,788 | 1,365 | 643 | 49 | 673 | 423 | 14,887 | 9,458 | 4.6 | 7.3 |
| 1979 | 2,104 | 1,517 | 708 | 54 | 755 | 587 | 16,084 | 10,079 | 4.7 | 7.6 |
| 1980 | 2,373 | 1,728 | 812 | 57 | 859 | 645 | 17,215 | 11,038 | 5.0 | 7.9 |
| 1981 | 2,796 | 2,039 | 1,056 | 66 | 917 | 757 | 20,102 | 13,028 | 5.6 | 8.6 |
| 1982 | 3,654 | 2,821 | 1,338 | 67 | 1,416 | 833 | 23,701 | 15,375 | 5.9 | 9.1 |
| 1983 | 4,017 | 2,961 | 1,601 | 78 | 1,282 | 1,056 | 25,654 | 15,700 | 6.5 | 10.7 |
| 1984 | 5,173 | 3,897 | 1,884 | 86 | 1,927 | 1,276 | 28,195 | 17,340 | 7.0 | 11.4 |
| 1985 | 5,036 | 3,500 | 2,099 | 88 | 1,313 | 1,536 | 33,119 | 20,645 | 6.6 | 10.6 |
| 1986 | 5,042 | 3,537 | 2,198 | 77 | 1,262 | 1,505 | 36,358 | 23,232 | 6.3 | 9.8 |
| 1987 | 4,885 | 3,544 | 2,186 | 67 | 1,291 | 1,341 | 39,019 | 25,721 | 5.8 | 8.8 |
| 1988 | 4,825 | 3,694 | 2,181 | 89 | 1,424 | 1,131 | 39,746 | 25,572 | 5.7 | 8.9 |
| 1989 | 4,831 | 3,770 | 2,226 | 105 | 1,439 | 1,061 | 42,970 | 27,469 | 5.4 | 8.5 |
| | Millions of constant 1982 dollars[3] | | | | | | | | | |
| 1976 | 2,236 | 1,709 | 876 | 66 | 767 | 527 | 21,104 | 13,116 | | |
| 1977 | 2,327 | 1,789 | 892 | 69 | 828 | 539 | 21,086 | 13,589 | | |
| 1978 | 2,493 | 1,903 | 897 | 68 | 938 | 590 | 20,757 | 13,188 | | |
| 1979 | 2,701 | 1,947 | 909 | 69 | 969 | 754 | 20,649 | 12,939 | | |
| 1980 | 2,800 | 2,039 | 958 | 67 | 1,014 | 761 | 20,315 | 13,025 | | |
| 1981 | 3,000 | 2,188 | 1,133 | 71 | 984 | 812 | 21,567 | 13,977 | | |
| 1982 | 3,654 | 2,821 | 1,338 | 67 | 1,416 | 833 | 23,701 | 15,375 | | |
| 1983 | 3,854 | 2,841 | 1,536 | 75 | 1,230 | 1,013 | 24,613 | 15,063 | | |
| 1984 | 4,781 | 3,602 | 1,741 | 79 | 1,781 | 1,179 | 26,060 | 16,027 | | |
| 1985 | 4,515 | 3,138 | 1,882 | 79 | 1,177 | 1,377 | 29,694 | 18,510 | | |
| 1986 | 4,403 | 3,089 | 1,919 | 67 | 1,102 | 1,314 | 31,751 | 20,288 | | |
| 1987 | 4,139 | 3,003 | 1,852 | 57 | 1,094 | 1,136 | 33,057 | 21,792 | | |
| 1988 | 3,967 | 3,037 | 1,793 | 73 | 1,171 | 930 | 32,681 | 21,027 | | |
| 1989 | 3,812 | 2,975 | 1,756 | 83 | 1,135 | 837 | 33,904 | 21,673 | | |

NOTE: DOD = Department of Defense; NASA = National Aeronautics and Space Administration.

[1]Includes R&D performed by federally funded research and development centers administered by the industrial sector.

[2]Percentages calculated as follows: numerator in (a) is total DOD and NASA IR&D reimbursements, and denominator is total DOD and NASA R&D, excluding IR&D; numerator in (b) is total DOD and NASA IR&D reimbursements, and denominator is DOD and NASA R&D performed by industry, excluding IR&D.

[3]See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCES: Defense Contract Audit Agency, *Summary of Independent Research and Development and Bid and Proposal Cost Incurred by Major Defense Contractors* (Washington, DC: DCAA, ongoing series); NASA, unpublished tabulations; Science Resources Studies Division (SRS), National Science Foundation, *Federal Funds for Research and Development, Detailed Historical Tables: Fiscal Years 1955-1990* (Washington, DC: NSF, 1990); and SRS, *Selected Data on Federal Funds for Research and Development: Fiscal Years 1989, 1990, and 1991*, NSF 90-327(Washington, DC: NSF, December 1990).

See figure 4-8.

*Science & Engineering Indicators – 1991*

Appendix table 4-17.
**Federal R&D funding, by budget function: FYs 1978-92**

| Function | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 (est.) | 1992 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Millions of current dollars | | | | | | | | | | | | | | |
| **Total** | 25,976 | 28,208 | 29,739 | 33,735 | 36,115 | 38,768 | 44,214 | 49,887 | 53,249 | 57,069 | 59,106 | 62,115 | 63,781 | 64,123 | 72,057 |
| National defense | 12,899 | 13,791 | 14,946 | 18,413 | 22,070 | 24,936 | 29,287 | 33,698 | 36,926 | 39,152 | 40,099 | 40,665 | 39,925 | 37,788 | 43,247 |
| Health | 2,968 | 3,401 | 3,694 | 3,871 | 3,869 | 4,298 | 4,779 | 5,418 | 5,565 | 6,556 | 7,076 | 7,773 | 8,308 | 9,086 | 9,649 |
| Space research and technology | 2,939 | 3,136 | 2,738 | 3,111 | 2,584 | 2,134 | 2,300 | 2,725 | 2,894 | 3,398 | 3,683 | 4,555 | 5,765 | 6,428 | 7,656 |
| General science | 1,050 | 1,119 | 1,233 | 1,340 | 1,359 | 1,502 | 1,676 | 1,862 | 1,873 | 2,042 | 2,160 | 2,373 | 2,410 | 2,632 | 2,962 |
| Energy | 3,134 | 3,461 | 3,603 | 3,501 | 3,012 | 2,578 | 2,581 | 2,389 | 2,286 | 2,053 | 2,126 | 2,419 | 2,715 | 2,885 | 2,920 |
| Natural resources and environment | 904 | 1,010 | 999 | 1,061 | 965 | 952 | 963 | 1,059 | 1,062 | 1,133 | 1,160 | 1,255 | 1,386 | 1,553 | 1,602 |
| Transportation | 768 | 798 | 887 | 869 | 791 | 876 | 1,040 | 1,030 | 917 | 908 | 896 | 1,064 | 1,045 | 1,251 | 1,380 |
| Agriculture | 501 | 552 | 585 | 659 | 693 | 745 | 762 | 836 | 815 | 822 | 882 | 907 | 950 | 1,049 | 1,091 |
| Education, training, employment, and social services | 345 | 354 | 468 | 298 | 228 | 189 | 200 | 220 | 248 | 267 | 285 | 347 | 374 | 470 | 510 |
| International affairs | 57 | 117 | 125 | 160 | 165 | 177 | 192 | 210 | 211 | 223 | 224 | 279 | 375 | 385 | 413 |
| Veterans benefits and services | 111 | 123 | 126 | 143 | 139 | 157 | 218 | 193 | 183 | 215 | 195 | 212 | 216 | 219 | 219 |
| Commerce and housing credit | 77 | 93 | 101 | 106 | 104 | 107 | 110 | 114 | 111 | 110 | 122 | 128 | 140 | 175 | 200 |
| Community and regional development | 92 | 127 | 119 | 104 | 63 | 44 | 46 | 50 | 88 | 99 | 108 | 74 | 78 | 97 | 102 |
| Administration of justice | 44 | 47 | 45 | 34 | 31 | 37 | 24 | 47 | 41 | 49 | 51 | 45 | 44 | 47 | 53 |
| Income security | 67 | 57 | 47 | 43 | 32 | 32 | 26 | 21 | 14 | 25 | 23 | 27 | 33 | 40 | 35 |
| General government | 20 | 23 | 22 | 22 | 10 | 6 | 8 | 17 | 14 | 17 | 17 | 15 | 17 | 18 | 18 |
| | Millions of constant 1982 dollars[1] | | | | | | | | | | | | | | |
| **Total** | 36,219 | 36,212 | 35,094 | 36,194 | 36,115 | 37,194 | 40,866 | 44,728 | 46,502 | 48,350 | 48,600 | 49,009 | 48,383 | 46,582 | 50,289 |
| National defense | 17,985 | 17,704 | 17,637 | 19,755 | 22,070 | 23,923 | 27,070 | 30,213 | 32,247 | 33,170 | 32,971 | 32,085 | 30,286 | 27,451 | 30,182 |
| Health | 4,138 | 4,366 | 4,359 | 4,153 | 3,869 | 4,123 | 4,417 | 4,858 | 4,860 | 5,554 | 5,818 | 6,133 | 6,302 | 6,600 | 6,734 |
| Space research and technology | 4,098 | 4,026 | 3,231 | 3,338 | 2,584 | 2,047 | 2,126 | 2,443 | 2,527 | 2,879 | 3,028 | 3,594 | 4,373 | 4,670 | 5,343 |
| General science | 1,464 | 1,437 | 1,455 | 1,438 | 1,359 | 1,441 | 1,549 | 1,669 | 1,636 | 1,730 | 1,776 | 1,872 | 1,828 | 1,912 | 2,067 |
| Energy | 4,370 | 4,443 | 4,252 | 3,756 | 3,012 | 2,473 | 2,386 | 2,142 | 1,996 | 1,739 | 1,748 | 1,909 | 2,060 | 2,096 | 2,038 |
| Natural resources and environment | 1,260 | 1,297 | 1,179 | 1,138 | 965 | 913 | 890 | 949 | 927 | 960 | 954 | 990 | 1,051 | 1,128 | 1,118 |
| Transportation | 1,071 | 1,024 | 1,047 | 932 | 791 | 840 | 961 | 923 | 801 | 769 | 737 | 840 | 793 | 909 | 963 |
| Agriculture | 699 | 709 | 690 | 707 | 693 | 715 | 704 | 750 | 712 | 696 | 725 | 716 | 721 | 762 | 761 |
| Education, training, employment, and social services | 481 | 454 | 552 | 320 | 228 | 181 | 185 | 197 | 217 | 226 | 234 | 274 | 284 | 341 | 356 |
| International affairs | 79 | 150 | 148 | 172 | 165 | 170 | 177 | 188 | 184 | 189 | 184 | 220 | 284 | 280 | 288 |
| Veterans benefits and services | 155 | 158 | 149 | 153 | 139 | 151 | 201 | 173 | 160 | 182 | 160 | 167 | 164 | 159 | 153 |
| Commerce and housing credit | 107 | 119 | 119 | 114 | 104 | 103 | 102 | 102 | 97 | 93 | 100 | 101 | 106 | 127 | 140 |
| Community and regional development | 128 | 163 | 140 | 112 | 63 | 42 | 43 | 45 | 77 | 84 | 89 | 58 | 59 | 70 | 71 |
| Administration of justice | 61 | 60 | 53 | 36 | 31 | 35 | 22 | 42 | 36 | 42 | 42 | 36 | 33 | 34 | 37 |
| Income security | 93 | 73 | 55 | 46 | 32 | 31 | 24 | 19 | 12 | 21 | 19 | 21 | 25 | 29 | 24 |
| General government | 28 | 30 | 26 | 24 | 10 | 6 | 7 | 15 | 12 | 14 | 14 | 12 | 13 | 13 | 13 |

NOTES: Data for 1978-90 are actual budget authority. Data for 1991 and 1992 are estimates based on the FY 1992 budget. Budget obligations for 1955-77 are available from the source document listed below.

[1] See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCE: Science Resource Studies Division, National Science Foundation, *Selected Data on Federal R&D Funding by Budget Function: Fiscal Years 1990-92*. NSF 90-319 (Washington, DC: NSF, 1991).

See figures 4-9 and 4-10.

Appendix table 4-18.
**Federal basic research funding, by budget function: FYs 1978-92**

| Function | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 (est.) | 1992 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Millions of current dollars | | | | | | | | | | | | | | |
| **Total** | 3,665 | 4,108 | 4,716 | 5,107 | 5,305 | 6,247 | 7,072 | 7,810 | 8,193 | 9,021 | 9,553 | 10,648 | 11,288 | 12,330 | 13,294 |
| Health | 1,246 | 1,579 | 1,761 | 1,951 | 1,953 | 2,475 | 2,813 | 3,243 | 3,324 | 3,851 | 4,087 | 4,413 | 4,661 | 5,101 | 5,477 |
| General science | 962 | 1,026 | 1,152 | 1,256 | 1,296 | 1,439 | 1,606 | 1,779 | 1,795 | 1,942 | 2,061 | 2,265 | 2,306 | 2,517 | 2,826 |
| Space research and technology | 412 | 440 | 482 | 445 | 434 | 501 | 646 | 498 | 737 | 843 | 944 | 1,099 | 1,389 | 1,453 | 1,696 |
| National defense | 320 | 365 | 552 | 610 | 696 | 788 | 845 | 856 | 960 | 900 | 905 | 965 | 964 | 1,024 | 1,041 |
| Energy | 157 | 172 | 200 | 220 | 260 | 320 | 365 | 428 | 456 | 511 | 571 | 703 | 761 | 913 | 870 |
| Agriculture | 197 | 222 | 246 | 281 | 295 | 326 | 353 | 406 | 390 | 397 | 428 | 433 | 456 | 495 | 532 |
| Natural resources and environment | 207 | 131 | 136 | 131 | 139 | 156 | 192 | 206 | 204 | 206 | 210 | 331 | 336 | 392 | 386 |
| Transportation | 70 | 75 | 79 | 89 | 102 | 117 | 125 | 255 | 184 | 231 | 197 | 287 | 242 | 245 | 264 |
| Education, training, employment, and social services | 57 | 59 | 61 | 66 | 78 | 70 | 77 | 86 | 83 | 78 | 83 | 92 | 106 | 119 | 127 |
| Commerce and housing credit | 9 | 10 | 15 | 17 | 17 | 19 | 20 | 23 | 26 | 26 | 28 | 29 | 31 | 31 | 34 |
| Veterans benefits and services | 9 | 10 | 14 | 15 | 13 | 14 | 15 | 15 | 15 | 17 | 17 | 16 | 16 | 16 | 16 |
| Administration of justice | 10 | 10 | 9 | 5 | 4 | 4 | 5 | 4 | 5 | 8 | 8 | 7 | 9 | 6 | 6 |
| Community and regional development | 8 | 8 | 8 | 5 | 7 | 6 | 5 | 6 | 6 | 4 | 7 | 3 | 3 | 5 | 5 |
| General government | 0 | * | * | 3 | 2 | 3 | 3 | 4 | 5 | 4 | 5 | 3 | 3 | 4 | 4 |
| International affairs | * | 0 | 0 | 12 | 10 | 10 | 3 | 4 | 5 | 3 | 3 | 3 | 4 | 9 | 10 |
| Income security | 2 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Millions of constant 1982 dollars[1] | | | | | | | | | | | | | | |
| **Total** | 5,110 | 5,274 | 5,565 | 5,479 | 5,305 | 5,993 | 6,537 | 7,002 | 7,155 | 7,643 | 7,855 | 8,401 | 8,563 | 8,957 | 9,278 |
| Health | 1,737 | 2,027 | 2,078 | 2,093 | 1,953 | 2,374 | 2,600 | 2,908 | 2,903 | 3,263 | 3,361 | 3,482 | 3,536 | 3,706 | 3,822 |
| General science | 1,341 | 1,317 | 1,359 | 1,348 | 1,296 | 1,381 | 1,484 | 1,595 | 1,568 | 1,645 | 1,695 | 1,787 | 1,749 | 1,828 | 1,972 |
| Space research and technology | 574 | 565 | 569 | 477 | 434 | 481 | 597 | 447 | 644 | 714 | 776 | 867 | 1,054 | 1,056 | 1,184 |
| National defense | 446 | 469 | 651 | 654 | 696 | 756 | 781 | 767 | 838 | 762 | 744 | 761 | 731 | 744 | 727 |
| Energy | 219 | 221 | 236 | 236 | 260 | 307 | 337 | 384 | 398 | 433 | 470 | 555 | 577 | 663 | 607 |
| Agriculture | 275 | 285 | 290 | 301 | 295 | 313 | 326 | 364 | 341 | 336 | 352 | 342 | 346 | 360 | 371 |
| Natural resources and environment | 289 | 168 | 160 | 141 | 139 | 150 | 177 | 185 | 178 | 175 | 173 | 261 | 255 | 285 | 269 |
| Transportation | 98 | 96 | 93 | 95 | 102 | 112 | 116 | 229 | 161 | 196 | 162 | 226 | 184 | 178 | 184 |
| Education, training, employment, and social services | 79 | 76 | 72 | 71 | 78 | 67 | 71 | 77 | 72 | 66 | 68 | 73 | 80 | 86 | 89 |
| Commerce and housing credit | 13 | 13 | 18 | 18 | 17 | 18 | 18 | 21 | 23 | 22 | 23 | 23 | 24 | 23 | 24 |
| Veterans benefits and services | 13 | 13 | 17 | 16 | 13 | 13 | 14 | 13 | 13 | 14 | 14 | 13 | 12 | 12 | 11 |
| Administration of justice | 14 | 13 | 11 | 5 | 4 | 4 | 5 | 4 | 4 | 7 | 7 | 6 | 7 | 4 | 4 |
| Community and regional development | 11 | 10 | 9 | 5 | 7 | 6 | 5 | 5 | 5 | 3 | 6 | 2 | 2 | 4 | 3 |
| General government | 0 | * | * | 3 | 2 | 3 | 3 | 4 | 4 | 3 | 4 | 2 | 2 | 3 | 3 |
| International affairs | * | 0 | 0 | 13 | 10 | 10 | 3 | 4 | 4 | 3 | 2 | 2 | 3 | 7 | 7 |
| Income security | 3 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

* less than $500,000

NOTES: Data for 1978-90 are actual budget authority. Data for 1991 and 1992 are estimates based on the FY 1992 budget. Budget obligations for 1955-77 are available from the source document listed below.

[1] See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCE: Science Resource Studies Division, National Science Foundation, *Selected Data on Federal R&D Funding by Budget Function: Fiscal Years 1990-92*, NSF 90-319 (Washington, DC: NSF, 1991).

See figure 4-10.

Appendix table 4-19.
**National support for health R&D, by performer and source of funds: 1979-91**

| Sector | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 (est.) | 1991 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Millions of current dollars | | | | | | | | | | | | |
| Total | 7,150 | 7,953 | 8,723 | 9,548 | 10,753 | 12,143 | 13,512 | 14,832 | 16,868 | 18,905 | 20,900 | 22,584 | 24,542 |
| **Source of funds** | | | | | | | | | | | | | |
| Government | 4,786 | 5,203 | 5,413 | 5,612 | 6,117 | 6,886 | 7,675 | 7,930 | 9,037 | 9,721 | 10,695 | 11,373 | 12,013 |
| Federal | 4,321 | 4,723 | 4,848 | 4,970 | 5,399 | 6,087 | 6,791 | 6,895 | 7,847 | 8,425 | 9,230 | 9,856 | 10,383 |
| Nat'l Institutes of Health | 2,953 | 3,182 | 3,333 | 3,433 | 3,789 | 4,257 | 4,828 | 5,005 | 5,852 | 6,292 | 6,778 | 7,141 | 7,472 |
| State and local | 465 | 480 | 564 | 642 | 718 | 799 | 884 | 1,034 | 1,191 | 1,295 | 1,465 | 1,517 | 1,630 |
| Industry | 2,093 | 2,459 | 2,998 | 3,593 | 4,205 | 4,765 | 5,352 | 6,188 | 7,103 | 8,432 | 9,404 | 10,368 | 11,619 |
| Private nonprofit | 271 | 292 | 312 | 343 | 431 | 491 | 486 | 715 | 728 | 753 | 801 | 843 | 910 |
| Howard Hughes Med. Inst[a] | 17 | 18 | 20 | 25 | 54 | 79 | 51 | 247 | 183 | 179 | 197 | 215 | 246 |
| **Performer** | | | | | | | | | | | | | |
| Government | 1,309 | 1,487 | 1,575 | 1,668 | 1,813 | 1,996 | 2,139 | 2,153 | 2,387 | 2,588 | 2,853 | 3,016 | 3,178 |
| Federal | 1,120 | 1,284 | 1,364 | 1,448 | 1,577 | 1,741 | 1,869 | 1,847 | 2,042 | 2,213 | 2,432 | 2,574 | 2,706 |
| State and local | 189 | 203 | 211 | 221 | 236 | 255 | 270 | 306 | 346 | 375 | 421 | 442 | 472 |
| Industry[b] | 1,932 | 2,249 | 2,659 | 3,161 | 3,668 | 4,216 | 4,660 | 5,293 | 6,015 | 6,927 | 7,850 | 8,595 | 9,578 |
| Higher education[b] | 2,818 | 2,998 | 3,204 | 3,362 | 3,769 | 4,268 | 4,823 | 5,281 | 6,011 | 6,519 | 7,178 | 7,663 | 8,168 |
| Private nonprofit[b] | 688 | 720 | 744 | 767 | 874 | 968 | 1,087 | 1,130 | 1,330 | 1,431 | 1,564 | 1,672 | 1,775 |
| Foreign | 403 | 499 | 542 | 591 | 630 | 696 | 803 | 975 | 1,138 | 1,441 | 1,456 | 1,639 | 1,844 |
| **Biomedical R&D price index[c]** | 0.768 | 0.840 | 0.921 | 1.000 | 1.060 | 1.121 | 1.178 | 1.227 | 1.294 | 1.359 | 1.429 | 1.512 | 1.603 |
| | Millions of constant 1982 dollars | | | | | | | | | | | | |
| Total | 9,315 | 9,473 | 9,469 | 9,548 | 10,147 | 10,833 | 11,471 | 12,090 | 13,041 | 13,915 | 14,623 | 14,935 | 15,313 |
| **Source of funds** | | | | | | | | | | | | | |
| Government | 6,235 | 6,197 | 5,875 | 5,612 | 5,772 | 6,143 | 6,516 | 6,464 | 6,986 | 7,155 | 7,483 | 7,521 | 7,495 |
| Federal | 5,630 | 5,625 | 5,263 | 4,970 | 5,095 | 5,430 | 5,765 | 5,621 | 6,066 | 6,201 | 6,458 | 6,518 | 6,478 |
| Nat'l Institutes of Health | 3,847 | 3,790 | 3,618 | 3,433 | 3,576 | 3,798 | 4,099 | 4,080 | 4,524 | 4,631 | 4,742 | 4,722 | 4,662 |
| State and local | 605 | 572 | 612 | 642 | 678 | 713 | 750 | 843 | 921 | 953 | 1,025 | 1,003 | 1,017 |
| Industry | 2,727 | 2,928 | 3,254 | 3,593 | 3,968 | 4,251 | 4,544 | 5,044 | 5,491 | 6,206 | 6,579 | 6,856 | 7,250 |
| Private nonprofit | 354 | 347 | 339 | 343 | 407 | 438 | 412 | 583 | 563 | 554 | 560 | 557 | 568 |
| Howard Hughes Med. Inst. | 22 | 21 | 22 | 25 | 51 | 70 | 43 | 201 | 141 | 132 | 138 | 142 | 153 |
| **Performer** | | | | | | | | | | | | | |
| Government | 1,705 | 1,772 | 1,709 | 1,668 | 1,711 | 1,781 | 1,816 | 1,755 | 1,845 | 1,905 | 1,996 | 1,994 | 1,983 |
| Federal | 1,459 | 1,530 | 1,480 | 1,448 | 1,488 | 1,553 | 1,587 | 1,506 | 1,579 | 1,629 | 1,701 | 1,702 | 1,688 |
| State and local | 246 | 242 | 229 | 221 | 222 | 227 | 229 | 249 | 267 | 276 | 295 | 292 | 295 |
| Industry[b] | 2,517 | 2,679 | 2,886 | 3,161 | 3,461 | 3,761 | 3,956 | 4,314 | 4,650 | 5,099 | 5,492 | 5,684 | 5,976 |
| Higher education[b] | 3,671 | 3,57[illegible] | 3,478 | 3,362 | 3,557 | 3,808 | 4,095 | 4,305 | 4,647 | 4,798 | 5,022 | 5,067 | 5,096 |
| Private nonprofit[b] | 896 | 857 | 808 | 767 | 824 | 864 | 922 | 921 | 1,028 | 1,053 | 1,094 | 1,106 | 1,108 |
| Foreign | 525 | 594 | 588 | 591 | 595 | 621 | 682 | 795 | 880 | 1,061 | 1,019 | 1,084 | 1,151 |

[a] For Howard Hughes Medical Institute, figures are for the direct conduct of biomedical research and exclude support for scientific career development. Figures for 1985 include only 8 months of operations because of change in fiscal year.

[b] Includes expenditures for federally funded research and development centers administered by organizations in the respective sectors.

[c] The biomedical R&D price index used here differs from the GNP implicit price deflator detailed in appendix table 4-1.

SOURCE: National Institutes of Health, *NIH Data Book* (Bethesda, MD: NIH, annual series).

*Science & Engineering Indicators – 1991*

Appendix table 4-20.
**Public and private R&D expenditures for health and agriculture: selected years, 1960-89**

**National support for health-related R&D**

| | Total | Public funds | | Private funds | | Health R&D | Total | Public funds | | Private funds | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Federal | State[1] | Industry | Nonprofit | deflator[2] | | Federal | State | Industry | Nonprofit |
| | Millions of dollars | | | | | | Millions of constant 1980 dollars | | | | |
| 1960 | 886 | 448 | 46 | 253 | 139 | 0.3454 | 2,565 | 1,297 | 133 | 732 | 402 |
| 1965 | 1,890 | 1,174 | 90 | 450 | 176 | 0.3901 | 4,845 | 3,009 | 231 | 1,154 | 451 |
| 1970 | 2,847 | 1,667 | 170 | 795 | 215 | 0.4948 | 5,754 | 3,369 | 344 | 1,607 | 435 |
| 1975 | 4,701 | 2,832 | 286 | 1,319 | 264 | 0.6779 | 6,935 | 4,178 | 422 | 1,946 | 389 |
| 1980 | 7,953 | 4,723 | 480 | 2,459 | 292 | 1.0000 | 7,953 | 4,723 | 480 | 2,459 | 292 |
| 1985 | 13,513 | 6,791 | 884 | 5,352 | 486 | 1.4029 | 9,632 | 4,840 | 630 | 3,815 | 346 |
| 1989 | 20,900 | 9,230 | 1,465 | 9,404 | 801 | 1.7022 | 12,278 | 5,422 | 861 | 5,525 | 471 |

**National performance of food and agriculture R&D[3]**

| | Total | Public | Industry | | Agriculture R&D | Total | Public | Industry | |
|---|---|---|---|---|---|---|---|---|---|
| | | research[4] | Input[5] | Food | deflator[6] | | research[4] | Input | Food |
| | Millions of dollars | | | | | Millions of constant 1980 dollars | | | |
| 1960 | 435 | 217 | 126 | 92 | 0.3303 | 1,317 | 657 | 381 | 279 |
| 1965 | 669 | 346 | 192 | 131 | 0.4043 | 1,655 | 856 | 475 | 324 |
| 1970 | 997 | 505 | 286 | 206 | 0.5430 | 1,836 | 930 | 527 | 379 |
| 1975 | 1,475 | 749 | 453 | 273 | 0.7326 | 2,013 | 1,022 | 618 | 373 |
| 1980 | 2,632 | 1,186 | 938 | 508 | 1.0000 | 2,632 | 1,186 | 938 | 508 |
| 1985 | 4,029 | 1,664 | 1,370 | 995 | 1.4078 | 2,862 | 1,182 | 973 | 707 |
| 1989 | 4,836 | 2,089 | 1,625 | 1,122 | 1.5213 | 3,179 | 1,373 | 1,068 | 738 |

[1] Includes state and local government funds.

[2] Index is the National Institutes of Health biomedical research and development price index. Base year = 1980.

[3] Public sector performers, including state agricultural experiment stations (SAES) affiliated with land-grant universities, receive 95 percent of their funds from public sector sources. Private sector performers, including private research firms, receive more than 95 percent of their funds from private sector sources.

[4] Includes research conducted by the Department of Agriculture's (USDA's) Agricultural Research Service and Economic Research Service, and research conducted at all SAES using both Federal and non-Federal (primarily state government) funds.

[5] Includes R&D performed by agricultural input industries: agricultural chemicals, farm machinery, seeds, veterinary medicine, and agricultural biotechnology.

[6] Index for 1960-85 is an index specific to agriculture R&D developed by Pardey, Craig, and Hallaway. Index number for 1989 is based on the historical relationship between the Pardey index and the GNP implicit price deflator. Base year = 1980.

SOURCES: National Institutes of Health, *NIH Data Book* (Washington, DC: NIH, annual series); NIH unpublished tabulations; C.E. Pray and C. Neumeyer, "Trends and Composition of Private Food and Agricultural R&D Expenditure in the United States," P-02221-1-89 (New Brunswick, NJ: Rutgers College, 1989): personal communication with Dr. Pray; USDA, "Inventory of Agricultural Research: Current Research Information System" (Washington, DC: USDA, annual series); and P.G. Pardey, B. Craig, and M.L. Hallaway, "U.S. Agricultural Research Deflators: 1890-1985," *Research Policy* 18: 289-96.

See figure 4-11.

*Science & Engineering Indicators – 1991*

Appendix table 4-21.
**Budgetary impact of the Federal research and experimentation (R&E) tax credit: FYs 1981-92**

| | Cost of R&E credit[1] | | Total Federal R&D outlays | Ratio of credit outlays to R&D | Cost of R&E credit | | Total Federal R&D outlays |
|---|---|---|---|---|---|---|---|
| | Outlay equivalent (a) | Revenue loss (b) | (c) | (a)/(c) | Outlay equivalent | Revenue loss | |
| | Millions of current dollars | | | Percent | Millions of constant 1982 dollars[2] | | |
| 1981 | 205 | 15 | 32,459 | 0.63 | 220 | 16 | 34,825 |
| 1982 | 640 | 415 | 34,391 | 1.86 | 640 | 415 | 34,391 |
| 1983 | 1,010 | 615 | 36,659 | 2.76 | 969 | 590 | 35,170 |
| 1984 | 3,360 | 1,380 | 39,691 | 8.47 | 3,106 | 1,276 | 36,686 |
| 1985 | 2,430 | 1,665 | 44,171 | 5.50 | 2,179 | 1,493 | 39,604 |
| 1986 | 2,295 | 680 | 50,609 | 4.53 | 2,004 | 594 | 44,196 |
| 1987 | 2,715 | 1,865 | 51,612 | 5.26 | 2,300 | 1,580 | 43,727 |
| 1988 | 1,240 | 900 | 54,739 | 2.27 | 1,020 | 740 | 45,009 |
| 1989 | 1,590 | 1,145 | 59,450 | 2.67 | 1,255 | 903 | 46,906 |
| 1990 | 1,625 | 1,115 | 63,158 | 2.57 | 1,233 | 846 | 47,911 |
| 1991 | 1,680 | 1,155 | 63,440 | 2.65 | 1,220 | 839 | 46,086 |
| 1992 | 1,220 | 835 | 68,065 | 1.79 | 851 | 583 | 47,503 |

NOTES: Tax expenditure estimates are prepared by the Treasury Department based on income tax law enacted as of December 31st of the year for which the expenditures are reported. Expenditures for the years 1990-92 are estimated based on the assumption that the tax structure existing December 31, 1990, is unchanged.

[1]"Outlay equivalent" estimates are comparable to taxable outlay figures reported in the budget. This allows a comparison of the resource cost of the tax credit with the cost of direct Federal R&D expenditure support. The "revenue loss" estimates are net of taxes.

[2]See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCE: Office of Management and Budget, *Budget of the United States Government* (Washington, DC: OMB, annual series).

*Science & Engineering Indicators – 1991*

Appendix table 4-22.
**Geographic distribution of U.S. R&D expenditures, by performer and source of funds: 1989**
(page 1 of 2)

| Geographic area | Total all sectors | Federal intra-mural | Industry: Total | Industry: Federal Gov't | Industry: Industry | U&C: Total | U&C: Federal Gov't | U&C: Non-Fed. gov't | U&C: Industry | U&C: U&C | U&C: Other | U&C FFRDCs: Total | U&C FFRDCs: Federal Gov't | Non-profits[2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Millions of current dollars | | | | | | | | | | | | | |
| TOTAL U.S. | 139,842 | 14,651 | 101,599 | 31,366 | 70,233 | 14,701 | 8,804 | 1,201 | 9[illegible] | [illegible],369 | 1,064 | 4,729 | 4,692 | 3,876 |
| New England | 11,710 | 665 | 8,789 | 2,416 | 6,373 | 1,357 | 944 | 33 | 107 | 149 | 124 | 364 | 364 | 535 |
| Connecticut | 2,745 | 38 | 2,410 | 680 | 1,730 | 284 | 187 | 5 | 12 | 57 | 23 | 0 | 0 | 13 |
| Maine | 72 | 4 | 33 | 0 | 33 | 20 | 8 | 1 | 4 | 7 | 1 | 0 | 0 | 15 |
| Massachusetts | 7,949 | 401 | 5,825 | 1,691 | 4,134 | 868 | 622 | 19 | 79 | [illegible] | 90 | 364 | 364 | 491 |
| New Hampshire[1] | 202 | 22 | 95-140 | D | 95 | 62 | 42 | 3 | 3 | 9 | 5 | 0 | 0 | 0 |
| Rhode Island | 428 | 196 | 139 | D | D | 80 | 56 | 3 | 6 | 12 | 2 | 0 | 0 | 13 |
| Vermont[1] | 314 | 4 242 | 287 | D | D | 43 | 29 | 3 | 3 | 5 | 3 | 0 | 0 | 3 |
| Middle Atlantic | 22,918 | 793 | 19,084 | 3,988 | 15,096 | 2,376 | 1,454 | 147 | 179 | 364 | 232 | 389 | 388 | 276 |
| New Jersey | 7,229 | 430 | 6,381 | 601 | 5,780 | 283 | 118 | 45 | 17 | 83 | 20 | 113 | 112 | 22 |
| New York | 9,898 | 89 | 8,071 | 1,480 | 6,591 | 1,332 | 867 | 69 | 71 | 172 | 154 | 255 | 255 | 151 |
| Pennsylvania | 5,791 | 274 | 4,632 | 1,907 | 2,725 | 761 | 469 | 32 | 92 | 109 | 59 | 21 | 21 | 103 |
| South Atlantic | 17,779 | 6,538 | 8,100 | 2,598 | 5,502 | 2,720 | 1,673 | 262 | 178 | 499 | 109 | 32 | 31 | 389 |
| Delaware[1] | 8873 | 845 | 1,03 | D | D | 37 | 17 | 3 | 4 | 11 | 2 | 0 | 0 | 2 |
| District of Columbia[1] | 1,982 | 1,522 | 23-210 | D | 23 | 114 | 85 | 1 | 7 | 16 | 6 | 0 | 0 | 136 |
| Florida | 3,375 | 642 | 2,341 | 1,167 | 1,174 | 386 | 200 | 26 | 21 | 113 | 26 | 0 | 0 | 6 |
| Georgia | 1,302 | 158 | 719 | D | D | 417 | 205 | 40 | 35 | 125 | 12 | 0 | 0 | 8 |
| Maryland | 5,091 | 3,012 | 1,088 | 552 | 536 | 922 | 706 | 64 | 35 | 92 | 25 | 0 | 0 | 69 |
| North Carolina | 1,826 | 60 | 1,305 | 5 | 1,300 | 425 | 262 | 61 | 41 | 47 | 14 | 0 | 0 | 36 |
| South Carolina | 576 | 60 | 386 | D | D | 120 | 42 | 17 | 8 | 45 | 8 | 0 | 0 | 10 |
| Virginia | 2,536 | 1,018 | 1,126 | 687 | 439 | 259 | 139 | 49 | 22 | 34 | 14 | 13 | 12 | 120 |
| West Virginia[1] | 203 | 63 | 80-267 | D | 80 | 39 | 17 | 1 | 4 | 15 | 2 | 18 | 18 | 2 |
| Southeast | 3,132 | 864 | 1,640 | 653 | 987 | 581 | 304 | 78 | 40 | 118 | 41 | 8 | 8 | 39 |
| Alabama | 1,223 | 568 | 428 | 213 | 215 | 207 | 115 | 18 | 16 | 41 | 16 | 0 | 0 | 20 |
| Kentucky | 343 | 31 | 226 | 0 | 226 | 84 | 33 | 7 | 8 | 31 | 6 | 0 | 0 | 2 |
| Mississippi | 264 | 130 | 56 | D | D | 75 | 32 | 20 | 5 | 10 | 8 | 0 | 0 | 3 |
| Tennessee | 1,302 | 135 | 930 | D | D | 215 | 124 | 32 | 10 | 37 | 11 | 8 | 8 | 14 |
| Southwest | 7,589 | 571 | 5,580 | 1,886 | 3,694 | 1,345 | 602 | 184 | 80 | 321 | 158 | 0 | 0 | 93 |
| Arkansas | 121 | 25 | 51 | D | D | 44 | 14 | 12 | 4 | 10 | 4 | 0 | 0 | 1 |
| Louisiana | 384 | 36 | 168 | D | D | 179 | 66 | 43 | 8 | 47 | 15 | 0 | 0 | 1 |
| Oklahoma | 507 | 46 | 332 | D | D | 113 | 33 | 5 | 6 | 60 | 9 | 0 | 0 | 16 |
| Texas | 6,576 | 464 | 5,028 | 1,848 | 3,180 | 1,009 | 488 | 124 | 62 | 205 | 130 | 0 | 0 | 75 |
| Great Lakes | 23,347 | 1,288 | 19,308 | 1,267 | 18,041 | 2,072 | 1,178 | 195 | 136 | 415 | 148 | 528 | 521 | 151 |
| Illinois | 5,307 | 59 | 4,050 | D | D | 604 | 338 | 36 | 39 | 151 | 41 | 528 | 521 | 65 |
| Indiana | 2,120 | 75 | 1,815 | D | D | 227 | 136 | 19 | 18 | 44 | 10 | 0 | 0 | 3 |
| Michigan | 9,057 | 71 | 8,468 | 99 | 8,369 | 486 | 263 | 36 | 36 | 116 | 35 | 0 | 0 | 32 |
| Ohio | 5,465 | 1,056 | 3,946 | 681 | 3,265 | 417 | 242 | 49 | 26 | 62 | 38 | 0 | 0 | 46 |
| Wisconsin | 1,399 | 27 | 1,030 | 32 | 998 | 337 | 198 | 55 | 16 | 43 | 24 | 0 | 0 | 5 |

(continued)

Appendix table 4-22.
**Geographic distribution of U.S. R&D expenditures, by performer and source of funds: 1989**
(page 2 of 2)

| Geographic area | Total all sectors | Federal intra-mural | Industry | | | Universities and colleges (U&C)[a] | | | | | | U&C FFRDCs | | Non-profits[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Total | Federal Gov't | Industry | Total | Federal Gov't | Non-Fed. gov't | Industry | U&C | Other | Total | Federal Gov't | |
| | Millions of current dollars | | | | | | | | | | | | | |
| Plains | 6,530 | 166 | 5,307 | 1,770 | 3,537 | 965 | 483 | 135 | 69 | 220 | 58 | 22 | 22 | 70 |
| Iowa | 616 | 20 | 363 | D | D | 209 | 103 | 25 | 15 | 61 | 6 | 22 | 22 | 2 |
| Kansas | 523 | 9 | 404 | 94 | 310 | 108 | 44 | 24 | 5 | 30 | 4 | 0 | 0 | 2 |
| Minnesota | 2,399 | 31 | 2,066 | D | D | 259 | 133 | 43 | 12 | 44 | 27 | 0 | 0 | 43 |
| Missouri | 2,710 | 58 | 2,380 | D | D | 255 | 140 | 15 | 25 | 60 | 16 | 0 | 0 | 17 |
| Nebraska | 182 | 22 | 64 | D | D | 94 | 37 | 23 | 9 | 21 | 4 | 0 | 0 | 2 |
| North Dakota | 79 | 20 | 27 | 0 | 27 | 28 | 19 | 1 | 3 | 4 | 1 | 0 | 0 | 4 |
| South Dakota | 23 | 6 | 4 | 0 | 4 | 12 | 6 | 5 | 0 | 1 | 0 | 0 | 0 | 0 |
| Mountain | 7,109 | 1,021 | 4,095 | 1,896 | 2,199 | 874 | 514 | 70 | 62 | 182 | 46 | 993 | 978 | 126 |
| Arizona | 1,293 | 118 | 917 | 220 | 697 | 224 | 105 | 8 | 13 | 86 | 12 | 28 | 28 | 7 |
| Colorado | 1,649 | 117 | 1,162 | 251 | 911 | 226 | 167 | 11 | 14 | 18 | 17 | 63 | 61 | 80 |
| Idaho | 614 | 19 | 161-561 | D | 161 | 33 | 13 | 8 | 4 | 8 | 0 | 0 | 0 | 1 |
| Montana[d] | 59 | 21 | 5-405 | D | 5 | 32 | 12 | 8 | 3 | 10 | 0 | 0 | 0 | 1 |
| Nevada | 141 | 77 | 29 | D | D | 34 | 18 | 2 | 4 | 9 | 1 | 0 | 0 | 1 |
| New Mexico | 2,680 | 594 | 1,034 | D | D | 136 | 77 | 15 | 16 | 18 | 11 | 902 | 889 | 13 |
| Utah | 620 | 66 | 387 | D | D | 165 | 109 | 17 | 6 | 28 | 5 | 0 | 0 | 2 |
| Wyoming[e] | 53 | 9 | 0-400 | D | D | 23 | 14 | 2 | 2 | 6 | 0 | 0 | 0 | 21 |
| Pacific | 34,925 | 2,718 | 26,764 | 14,193 | 12,571 | 2,411 | 1,653 | 97 | 113 | 400 | 148 | 2,385 | 2,373 | 647 |
| Alaska | 118 | 51 | 9 | D | D | 57 | 27 | 2 | 3 | 22 | 3 | 0 | 0 | 1 |
| California | 30,881 | 2,478 | 23,675 | 12,857 | 10,818 | 1,846 | 1,281 | 43 | 83 | 322 | 116 | 2,385 | 2,373 | 497 |
| Hawaii | 123 | 36 | 9 | 2 | 7 | 71 | 41 | 25 | 1 | 4 | 1 | 0 | 0 | 7 |
| Oregon | 579 | 42 | 355 | 30 | 325 | 161 | 99 | 21 | 5 | 17 | 20 | 0 | 0 | 21 |
| Washington | 3,225 | 111 | 2,716 | D | D | 277 | 205 | 6 | 21 | 36 | 8 | 0 | 0 | 121 |
| Other unknown | 4,803 | 27 | 2,932 | 699 | 2,233 | 286 | — | — | — | — | — | 8 | 8 | 1,550 |

D = withheld to avoid disclosing operations of individual companies. — = unknown

[a] Funds distributed by state for universities and colleges are for doctorate granting institutions only. R&D performed at non-doctorate-granting institutions is included in "other unknown."

[b] For the nonprofit sector, funds distributed by state include only Federal obligations to organizations in this sector. Estimated non-Federal support to the nonprofit sector is included in "other unknown."

[c] For the industry sector, reported data fall within the range specified, but have been withheld by the Census Bureau to avoid disclosing individual company operations. Amount for state total is R&D performance of Federal Government, universities and colleges, academic federally funded research and development centers (FFRDCs), and nonprofit sector, plus the midpoint of the industry R&D performance range.

[d] For the industry sector, reported data fall within the range specified, but have been withheld by the Census Bureau to avoid disclosing individual company operations. Amount for state total is R&D performance of Federal Government, universities and colleges, academic FFRDCs, and nonprofit sector, plus the low end of the industry R&D performance range. Use of low end of range based on reported National Science Foundation (NSF) industry data for 1985 and 1987, and Federal obligation data for 1989; this implicitly assumes that there were no major shifts in industry R&D performance between 1987 and 1989.

[e] For the industry sector, reported data fall within the range specified, but have been withheld by the Census Bureau to avoid disclosing individual company operations. Amount for state total is R&D performance of Federal Government, universities and colleges, academic FFRDCs, and nonprofit sector, plus the high end of the industry R&D performance range. Use of high end of range based on reported NSF industry data for 1985 and 1987, and Federal obligation data for 1989; this implicitly assumes that there were no major shifts in industry R&D performance between 1987 and 1989.

SOURCE: Science Resources Studies Division, National Science Foundation, unpublished tabulations.

See figure 4-12 and text tables 4-5 and 4-6

Appendix table 4-23.
**States leading in R&D performance by sector and R&D as a percentage of gross state product (GSP): 1989**

| Total R&D ($ millions) | All sectors[1] | Industry | Universities & colleges[2] | Federal Government | R&D intensity of state economy | R&D/GSP | GSP[3] ($ billion) |
|---|---|---|---|---|---|---|---|
| | Largest 25 performers (ranked by size of R&D) | | | | | | |
| 30,881 | 1 California | California | California | Maryland | New Mexico | 9.8% | 27.2 |
| 9,898 | 2 New York | Michigan | New York | California | Delaware | 5.7% | 15.7 |
| 9,057 | 3 Michigan | New York | Texas | Ohio | Massachusetts | 5.5% | 145.8 |
| 7,949 | 4 Massachusetts | New Jersey | Maryland | Virginia | Maryland | 5.1% | 99.0 |
| 7,229 | 5 New Jersey | Massachusetts | Massachusetts | Florida | Michigan | 5.0% | 181.4 |
| 6,576 | 6 Texas | Texas | Pennsylvania | New Mexico | California | 4.5% | 680.7 |
| 5,791 | 7 Pennsylvania | Pennsylvania | Illinois | Alabama | Idaho | 3.8% | 16.2 |
| 5,465 | 8 Ohio | Illinois | Michigan | Texas | New Jersey | 3.7% | 197.5 |
| 5,307 | 9 Illinois | Ohio | North Carolina | New Jersey | Washington | 3.3% | 99.2 |
| 5,091 | 10 Maryland | Washington | Georgia | Massachusetts | Connecticut | 3.0% | 90.4 |
| 3,375 | 11 Florida | Connecticut | Ohio | Pennsylvania | Vermont | 2.8% | 11.2 |
| 3,225 | 12 Washington | Missouri | Florida | Rhode Island | Missouri | 2.7% | 99.9 |
| 2,745 | 13 Connecticut | Florida | Wisconsin | Georgia | Ohio | 2.6% | 211.2 |
| 2,710 | 14 Missouri | Minnesota | Connecticut | Tennessee | Minnesota | 2.5% | 94.2 |
| 2,680 | 15 New Mexico | Indiana | New Jersey | Mississippi | Pennsylvania | 2.5% | 227.6 |
| 2,536 | 16 Virginia | North Carolina | Washington | Arizona | Colorado | 2.4% | 67.9 |
| 2,399 | 17 Minnesota | Colorado | Virginia | Colorado | Rhode Island | 2.2% | 19.2 |
| 2,120 | 18 Indiana | Virginia | Minnesota | Washington | New York | 2.2% | 448.2 |
| 1,826 | 19 North Carolina | Maryland | Missouri | New York | Utah | 2.2% | 28.7 |
| 1,649 | 20 Colorado | New Mexico | Indiana | Nevada | Illinois | 2.1% | 257.7 |
| 1,399 | 21 Wisconsin | Wisconsin | Colorado | Indiana | Indiana | 2.0% | 104.6 |
| 1,302 | 22 Georgia | Tennessee | Arizona | Michigan | Arizona | 2.0% | 64.7 |
| 1,302 | 23 Tennessee | Arizona | Tennessee | Utah | Texas | 1.9% | 346.8 |
| 1,293 | 24 Arizona | Delaware | Iowa | West Virginia | Virginia | 1.9% | 133.9 |
| 1,223 | 25 Alabama | Georgia | Alabama | North Carolina | Alabama | 1.8% | 66.7 |
| Less than $1 billion | Smallest 25 performers (listed alphabetically) | | | | | 1.5% or less | |
| .. | Alaska | Alabama | Alaska | Alaska | Alaska | .. | 21.3 |
| .. | Arkansas | Alaska | Arkansas | Arkansas | Arkansas | .. | 37.5 |
| .. | Delaware | Arkansas | Delaware | Connecticut | Florida | .. | 230.4 |
| .. | Hawaii | Hawaii | Hawaii | Delaware | Georgia | .. | 127.4 |
| .. | Idaho | Idaho | Idaho | Hawaii | Hawaii | .. | 25.8 |
| .. | Iowa | Iowa | Kansas | Idaho | Iowa | .. | 54.6 |
| .. | Kansas | Kansas | Kentucky | Illinois | Kansas | .. | 49.8 |
| .. | Kentucky | Kentucky | Louisiana | Iowa | Kentucky | .. | 65.1 |
| .. | Louisiana | Louisiana | Maine | Kansas | Louisiana | .. | 81.6 |
| .. | Maine | Maine | Mississippi | Kentucky | Maine | .. | 23.0 |
| .. | Mississippi | Mississippi | Montana | Louisiana | Mississippi | .. | 38.2 |
| .. | Montana | Montana | Nebraska | Maine | Montana | .. | 13.9 |
| .. | Nebraska | Nebraska | Nevada | Minnesota | Nebraska | .. | 31.7 |
| .. | Nevada | Nevada | New Hampshire | Missouri | Nevada | .. | 27.4 |
| .. | New Hampshire | New Hampshire | New Mexico | Montana | New Hampshire | .. | 23.8 |
| .. | North Dakota | North Dakota | North Dakota | Nebraska | North Carolina | .. | 128.0 |
| .. | Oklahoma | Oklahoma | Oklahoma | New Hampshire | North Dakota | .. | 12.1 |
| .. | Oregon | Oregon | Oregon | North Dakota | Oklahoma | .. | 54.9 |
| .. | Rhode Island | Rhode Island | Rhode Island | Oklahoma | Oregon | .. | 52.6 |
| .. | South Carolina | South Carolina | South Carolina | Oregon | South Carolina | .. | 56.8 |
| .. | South Dakota | South Dakota | South Dakota | South Carolina | South Dakota | .. | 11.8 |
| .. | Utah | Utah | Utah | South Dakota | Tennessee | .. | 91.0 |
| .. | Vermont | Vermont | Vermont | Vermont | West Virginia | .. | 26.8 |
| .. | West Virginia | West Virginia | West Virginia | Wisconsin | Wisconsin | .. | 94.2 |
| .. | Wyoming | Wyoming | Wyoming | Wyoming | Wyoming | .. | 11.6 |

[1]Includes in-state R&D performance of industry, universities, associated federally funded research and development centers (FFRDCs), and Federal agencies and the federally funded R&D performance of nonprofit institutions.

[2]Excludes R&D activities of FFRDCs located within these states.

[3]Gross state product data available from the Bureau of Economic Analysis (BEA) through 1986. GSP data for 1989 estimated here based on changes in employee compensation and proprietors' income between 1986 and 1989, as reported by BEA.

SOURCE: Science Resources Studies Division, National Science Foundation, unpublished tabulations.

See text table 4-5.

Appendix table 4-24.
**Summary of state programs related to science and technology (S&T) based economic development: selected programs**
(page 1 of 2)

| | Year formed[1] | Major state administrative agencies, commissions, and boards concerned with S&T-based economic development initiatives[2] | University focus | | Industry focus | |
|---|---|---|---|---|---|---|
| | | | Grants | Centers | R&D tax incentives | Startup support |
| Alabama | 1987 | Alabama Science, Technology, & Energy Division | U | — | — | — |
| Alaska | 1988 | Alaska Science and Technology Foundation | I | — | — | — |
| Arizona | 1990 | Governor's Advisory Board on Science & High Technology | — | C | — | — |
| Arkansas | 1983 | Arkansas Science & Technology Authority | U | C | Credit | S |
| California | 1989 | California Office of Competitive Technology | UI | — | Other | — |
| Colorado | 1986 | Colorado Advanced Technology Institute | UI | C | — | — |
| Connecticut | 1972 | Connecticut Innovations Incorporated | UI | — | — | SV |
| Delaware | 1986 | Governor's High Technology Task Force | UI | — | Credit | — |
| Florida | 1983 | Florida High Technology and Industry Council | U | — | — | S |
| Georgia | 1980 | Advanced Technology Development Center | — | C | — | — |
| Hawaii | 1983 | High Technology Development Corporation | | — | — | SV |
| Idaho | 1988 | Division of Science & Technology | U | — | — | — |
| Illinois | 1981 | Office of Technology Advancement and Development | UI | — | — | SV |
| Indiana | 1982 | Business Modernization and Technology Corporation | I | C | Credit | SV |
| Iowa | 1983 | Iowa High Technology Council | UI | C | Credit | SV |
| Kansas | 1987 | Kansas Technology Enterprise Corporation | UI | C | Credit | SV |
| Kentucky | 1987 | Office of Business and Technology | I | C | — | V |
| Louisiana | 1988 | Louisiana Partnership for Technology & Innovation | — | — | — | SV |
| Maine | 1984 | Maine Science and Technology Commission | U | C | Exemption | — |
| Maryland | 1988 | Office of Technology Development | I | — | Exemption | — |
| Massachusetts | 1985 | Executive Office of Economic Affairs | I | — | Exemption | V |
| Michigan | 1985 | Michigan Strategic Fund | UI | C | — | SV |
| Minnesota | 1983 | Minnesota Technology, Inc | — | C | Credit | V |
| Mississippi | 1985 | Institute of Technology Development | — | C | Credit | — |
| Missouri | 1983 | Missouri Corporation for Science & Technology | — | C | — | S |
| Montana | 1985 | Montana Science and Technology Alliance | I | C | — | SV |
| Nebraska | 1986 | Nebraska Research and Development Authority | I | C | — | SV |
| Nevada | 1990 | Industry, Science, Engineering & Technology Task Force | — | — | — | — |
| New Hampshire | 1991 | Office of Business and Industrial Development | — | — | — | — |
| New Jersey | 1985 | New Jersey Commission on Science and Technology | U | C | Exemption | — |
| New Mexico | 1981 | Economic Development Department | UI | C | — | S |
| New York | 1982 | New York Science and Technology Foundation | I | C | — | SV |
| North Carolina | 1963 | North Carolina Board of Science and Technology | I | C | Credit | SV |
| North Dakota | 1991 | Science and Technology Corporation | U | — | — | SV |
| Ohio | 1983 | Thomas Alva Edison Program | UI | C | — | SV |
| Oklahoma | 1987 | OK Center for the Advancement of Science & Technology | I | C | — | SV |
| Oregon | 1985 | Oregon Resource and Technology Development Corporation | I | — | — | SV |
| Pennsylvania | 1982 | Ben Franklin Partnership Program | UI | — | Exemption | SV |
| Rhode Island | 1985 | Rhode Island Partnership for Science and Technology | U | — | Other | — |
| South Carolina | 1983 | South Carolina Research Authority | — | — | — | S |

(continued)

Appendix table 4-24.
**Summary of state programs related to science and technology (S&T) based economic development: selected programs**
(page 2 of 2)

| | Year formed[1] | Major state administrative agencies, commissions, and boards concerned with S&T-based economic development initiatives[2] | University focus | | Industry focus | |
|---|---|---|---|---|---|---|
| | | | Grants | Centers | R&D tax incentives | Startup support |
| South Dakota | 1988 | The Future Fund | UI | — | — | S |
| Tennessee | 1982 | Tennessee Technology Foundation | — | C | — | V |
| Texas | 1987 | Office of Advanced Technology | — | — | — | V |
| Utah | 1985 | Centers of Excellence Program | I | C | — | SV |
| Vermont | 1988 | Governor's Advisory Council on Technology | U | — | Exemption | — |
| Virginia | 1984 | Center for Innovative Technology | UI | C | Exemption | — |
| Washington | 1990 | Office of Science & Technology | — | C | Credit | V |
| West Virginia | 1977 | Office of Community & Industrial Development | — | — | Credit | V |
| Wisconsin | 1990 | Bureau of Research and Technology | U | C | Credit | — |
| Wyoming | 1989 | Science, Technology and Energy Authority | UI | — | — | — |

NOTES: University focus to foster research and technology aimed at local economic development:
U = States sponsoring university research grants (partnerships with industry)
I = States funding research grants to industry, generally with active university participation
C = States with university research centers, which generally draw on the strengths of major industries in the state

R&D tax incentives:
Exemption = R&D materials and/or equipment are exempt from sales/use taxes
Credit = State tax credit on qualified R&D expenses conducted in-state
Other = California allows R&D expenses to be deducted from state taxes and Rhode Island provides accelerated tax depreciation fo. R&D facilities

Startup support (includes programs for which the state provides ongoing support/oversight or one-time capitalization):
S = States with seed capital programs to assist companies yet to develop a marketable product
V = States with venture capital programs to assist developing companies with established business plans and commercially feasible projects

[1]Formation year can be that of a predecessor organization so long as the S&T activities of the successor organization(s) remained substantially unchanged. Date can be considered as year of state's initial involvement in S&T development.

[2]In some states there is more than one major agency responsible for S&T development.

SOURCES: Technology Administration, U.S. Department of Commerce. Clearinghouse for State and Local Initiatives in Productivity, Technology, and Innovation, unpublished tabulations (data as of August 1991); supplemental information from Paul Phelps, ADD, Inc., Alexandria, VA, personal communication.

See figure 4-13. Science & Engineering Indicators – 1991

Appendix table 4-25.
**State agency expenditures from state funds for R&D and R&D plant: 1977 and 1988**

| | R&D expenditures | | R&D plant | | R&D expenditures | | R&D plant | |
|---|---|---|---|---|---|---|---|---|
| | 1977 | 1988 | 1977 | 1988 | 1977 | 1988 | 1977 | 1988 |
| | Thousands of current dollars | | | | Thousands of constant 1982 dollars[1] | | | |
| TOTAL, ALL STATES | 197,561 | 769,264 | 8,149 | 198,681 | 293,640 | 634,026 | 12,112 | 163,753 |
| Alabama | 385 | 1,047 | 33 | 0 | 572 | 863 | 49 | 0 |
| Alaska | 3,612 | 6,927 | 175 | 256 | 5,369 | 5,709 | 260 | 211 |
| Arizona | 429 | 670 | 27 | 42 | 638 | 552 | 40 | 35 |
| Arkansas | 211 | 1,027 | 41 | 0 | 314 | 846 | 61 | 0 |
| California | 23,659 | 53,305 | 81 | 1,215 | 35,165 | 43,934 | 120 | 1,001 |
| Colorado | 1,609 | 1,416 | 5 | 0 | 2,391 | 1,167 | 7 | 0 |
| Connecticut | 2,300 | 8,358 | 321 | 1,220 | 3,419 | 6,889 | 477 | 1,006 |
| Delaware | 202 | 2,511 | 22 | 0 | 300 | 2,070 | 33 | 0 |
| Florida | 7,374 | 13,736 | 1,254 | 365 | 10,960 | 11,321 | 1,864 | 301 |
| Georgia | 1,251 | 8,992 | 0 | 0 | 1,859 | 7,411 | 0 | 0 |
| Hawaii | 2,298 | 2,994 | 497 | 6,160 | 3,416 | 2,468 | 739 | 5,077 |
| Idaho | 595 | 961 | 0 | 0 | 884 | 792 | 0 | 0 |
| Illinois | 10,563 | 42,705 | 432 | 1,533 | 15,700 | 35,197 | 642 | 1,263 |
| Indiana[2] | 2,658 | 8,050 | 12 | 0 | 3,951 | 6,635 | 18 | 0 |
| Iowa | 1,179 | 7,800 | 63 | 0 | 1,752 | 6,429 | 94 | 0 |
| Kansas | 987 | 7,621 | 0 | 56 | 1,467 | 6,281 | 0 | 46 |
| Kentucky | 5,418 | 6,733 | 1,511 | 3,405 | 8,053 | 5,549 | 2,246 | 2,806 |
| Louisiana | 4,450 | 2,799 | 478 | 267 | 6,614 | 2,307 | 710 | 220 |
| Maine | 666 | 2,556 | 4 | 404 | 990 | 2,107 | 6 | 333 |
| Maryland | 7,606 | 172,148 | 97 | 3,684 | 11,305 | 141,884 | 144 | 3,036 |
| Massachusetts | 1,839 | 6,027 | 236 | 0 | 2,733 | 4,967 | 351 | 0 |
| Michigan | 4,797 | 15,192 | 114 | 51 | 7,130 | 12,521 | 169 | 42 |
| Minnesota | 2,987 | 6,160 | 48 | 488 | 4,440 | 5,077 | 71 | 402 |
| Mississippi[2] | 909 | 2,428 | 0 | 0 | 1,351 | 2,001 | 0 | 0 |
| Missouri | 634 | 955 | 107 | 23 | 942 | 787 | 159 | 19 |
| Montana | 1,783 | 3,166 | 4 | 394 | 2,650 | 2,609 | 6 | 325 |
| Nebraska | 252 | 1,483 | 14 | 0 | 375 | 1,222 | 21 | 0 |
| Nevada[2] | 199 | 1,806 | 1 | 0 | 296 | 1,489 | 1 | 0 |
| New Hampshire | 270 | 0 | 21 | 0 | 401 | 0 | 31 | 0 |
| New Jersey | 2,060 | 21,006 | 60 | 23,020 | 3,062 | 17,313 | 89 | 18,973 |
| New Mexico | 2,380 | 34,110 | 255 | 2,790 | 3,537 | 28,113 | 379 | 2,300 |
| New York | 64,298 | 194,336 | 441 | 137,570 | 95,568 | 160,171 | 655 | 113,385 |
| North Carolina | 5,076 | 10,782 | 65 | 1,474 | 7,545 | 8,887 | 97 | 1,215 |
| North Dakota | 1,077 | 906 | 99 | 4 | 1,601 | 747 | 147 | 3 |
| Ohio | 5,302 | 29,361 | 11 | 606 | 7,880 | 24,199 | 16 | 499 |
| Oklahoma | 643 | 604 | 12 | 317 | 956 | 498 | 18 | 261 |
| Oregon | 1,750 | 1,992 | 90 | 0 | 2,601 | 1,642 | 134 | 0 |
| Pennsylvania | 5,712 | 35,592 | 4 | 3,084 | 8,490 | 29,335 | 6 | 2,542 |
| Rhode Island | 491 | 1,024 | 100 | 10 | 730 | 844 | 149 | 8 |
| South Carolina | 2,189 | 4,616 | 680 | 2,262 | 3,254 | 3,805 | 1,011 | 1,864 |
| South Dakota | 872 | 1,471 | 0 | 168 | 1,296 | 1,212 | 0 | 138 |
| Tennessee | 518 | 2,313 | 1 | 0 | 770 | 1,906 | 1 | 0 |
| Texas | 4,914 | 10,952 | 70 | 7 | 7,304 | 9,027 | 104 | 6 |
| Utah | 803 | 968 | 255 | 50 | 1,194 | 798 | 379 | 41 |
| Vermont | 100 | 300 | 0 | 0 | 149 | 247 | 0 | 0 |
| Virginia | 2,959 | 10,475 | 346 | 256 | 4,398 | 8,633 | 514 | 211 |
| Washington | 2,637 | 12,480 | 23 | 7,450 | 3,919 | 10,286 | 34 | 6,140 |
| West Virginia | 227 | 324 | 0 | 0 | 337 | 267 | 0 | 0 |
| Wisconsin | 2,251 | 5,783 | 31 | 50 | 3,346 | 4,766 | 46 | 41 |
| Wyoming | 180 | 296 | 8 | 0 | 268 | 244 | 12 | 0 |

[1]See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

[2]Expenditures only for the state's lead science and technology or research and development agency.

SOURCES: Science Resources Studies Division (SRS), National Science Foundation. *Research and Development in State and Local Governments. Fiscal Year 1977*, NSF 79-327 (Washington, DC: NSF, 1979); and SRS, *Research and Development Expenditures of State Government Agencies: Fiscal Years 1987 and 1988*, NSF 90-309 (Washington, DC: NSF, 1990).

Appendix table 4-26.
**International R&D expenditures and R&D as a percentage of GNP: 1961-89**

| | R&D expenditures[1] | | | | | | | R&D expenditures as a percentage of GNP | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | United States | Japan | West Germany | France[2] | United Kingdom | Italy | Sweden | United States | Japan | West Germany | France[2] | United Kingdom | Italy | Sweden |
| | Billions of constant 1982 dollars | | | | | | | Percent | | | | | | |
| 1961 | 45.8 | 3.9 | NA | 3.2 | 8.1 | NA | NA | 2.7 | 1.4 | NA | 1.4 | 2.5 | NA | NA |
| 1962 | 48.2 | 4.4 | 4.2 | 3.6 | NA | NA | NA | 2.7 | 1.5 | 1.2 | 1.5 | NA | NA | NA |
| 1963 | 52.6 | 4.9 | 4.9 | 4.0 | NA | 1.5 | NA | 2.8 | 1.5 | 1.4 | 1.6 | NA | 0.6 | NA |
| 1964 | 57.2 | 5.5 | 5.8 | 5.0 | 8.4 | NA | 0.7 | 2.9 | 1.5 | 1.6 | 1.8 | 2.3 | NA | 1.2 |
| 1965 | 59.4 | 6.1 | 6.7 | 5.8 | NA | 1.6 | NA | 2.8 | 1.6 | 1.7 | 2.0 | NA | 0.7 | NA |
| 1966 | 62.6 | 6.6 | 7.3 | 6.3 | 8.8 | NA | NA | 2.8 | 1.5 | 1.8 | 2.1 | 2.3 | NA | NA |
| 1967 | 64.4 | 7.6 | 7.9 | 6.8 | 8.9 | 2.0 | 0.8 | 2.8 | 1.6 | 2.0 | 2.2 | 2.3 | 0.7 | 1.3 |
| 1968 | 65.5 | 9.0 | 8.4 | 7.0 | 9.1 | 2.3 | NA | 2.8 | 1.7 | 2.0 | 2.1 | 2.2 | 0.8 | NA |
| 1969 | 64.7 | 10.5 | 8.3 | 7.1 | 9.4 | 2.6 | 0.8 | 2.7 | 1.7 | 1.8 | 2.0 | 2.3 | 0.8 | 1.3 |
| 1970 | 62.4 | 12.6 | 10.1 | 7.5 | NA | 3.0 | NA | 2.6 | 1.9 | 2.1 | 1.9 | NA | 0.9 | NA |
| 1971 | 60.4 | 13.5 | 11.0 | 7.8 | NA | 3.1 | 1.1 | 2.4 | 1.9 | 2.2 | 1.9 | NA | 0.9 | 1.5 |
| 1972 | 61.4 | 14.9 | 11.5 | 8.0 | 9.3 | 3.2 | NA | 2.4 | 1.9 | 2.2 | 1.9 | 2.1 | 0.9 | NA |
| 1973 | 62.4 | 16.3 | 11.4 | 8.0 | NA | 3.3 | 1.2 | 2.3 | 2.0 | 2.1 | 1.8 | NA | 0.8 | 1.6 |
| 1974 | 61.5 | 16.6 | 11.6 | 8.3 | NA | 3.2 | NA | 2.2 | 2.0 | 2.1 | 1.8 | NA | 0.8 | NA |
| 1975 | 59.9 | 16.8 | 12.0 | 8.3 | 10.1 | 3.5 | 1.4 | 2.2 | 2.0 | 2.2 | 1.8 | 2.1 | 0.9 | 1.7 |
| 1976 | 62.1 | 17.5 | 12.2 | 8.5 | NA | 3.4 | NA | 2.2 | 2.0 | 2.1 | 1.8 | NA | 0.9 | NA |
| 1977 | 63.7 | 18.2 | 12.5 | 8.7 | NA | 3.6 | 1.5 | 2.2 | 2.0 | 2.1 | 1.8 | NA | 0.9 | 1.8 |
| 1978 | 66.8 | 19.3 | 13.5 | 9.0 | 11.1 | 3.5 | NA | 2.1 | 2.0 | 2.2 | 1.8 | 2.2 | 0.8 | NA |
| 1979 | 70.1 | 21.2 | 15.2 | 9.6 | NA | 3.7 | 1.6 | 2.2 | 2.1 | 2.4 | 1.8 | NA | 0.8 | 1.9 |
| 1980 | 73.3 | 23.4 | 15.5 | 9.9 | NA | 3.9 | NA | 2.3 | 2.2 | 2.4 | 1.8 | NA | 0.9 | NA |
| 1981 | 76.6 | 25.8 | 16.1 | 10.9 | 12.2 | 4.6 | 2.0 | 2.4 | 2.3 | 2.5 | 2.0 | 2.4 | 1.0 | 2.4 |
| 1982 | 80.0 | 27.7 | 16.5 | 11.7 | NA | 4.8 | NA | 2.5 | 2.4 | 2.6 | 2.1 | NA | 1.1 | NA |
| 1983 | 85.8 | 30.1 | 16.0 | 12.0 | 11.9 | 5.1 | 2.3 | 2.6 | 2.6 | 2.5 | 2.1 | 2.2 | 1.1 | 2.6 |
| 1984 | 93.8 | 32.6 | 17.0 | 12.7 | NA | 5.5 | NA | 2.7 | 2.6 | 2.6 | 2.2 | NA | 1.0 | NA |
| 1985 | 102.5 | 36.1 | 18.8 | 13.1 | 12.8 | 6.3 | 2.8 | 2.8 | 2.8 | 2.8 | 2.3 | 2.3 | 1.1 | 3.0 |
| 1986 | 104.9 | 36.5 | 19.3 | 13.3 | 13.5 | 6.5 | NA | 2.8 | 2.8 | 2.8 | 2.2 | 2.4 | 1.1 | NA |
| 1987 | 106.6 | 39.1 | 20.2 | 13.8 | 13.6 | 7.1 | 3.0 | 2.8 | 2.8 | 2.9 | 2.3 | 2.3 | 1.2 | 3.0 |
| 1988 | 110.2 | 42.0 | 20.6 | 14.4 | 13.5 | 8.2 | NA | 2.7 | 2.9 | 2.9 | 2.3 | 2.2 | 1.3 | NA |
| 1989 | 111.1 | 45.9 | 21.9 | 15.0 | 13.2 | 8.2 | 2.9 | 2.7 | 3.0 | 2.9 | 2.3 | 2.0 | 1.3 | 2.8 |

NA = not available

[1]Conversions of foreign currencies to U.S. dollars are calculated with Organisation for Economic Cooperation and Development purchasing power parity exchange rates. Constant 1982 dollars are based on U.S. Department of Commerce GNP implicit price deflators.

[2]French data are based on gross domestic product (GDP): consequently, percentages may be slightly overstated compared to GNP.

SOURCE: Science Resources Studies Division, National Science Foundation, *International Science and Technology Data Update* (Washington, DC: NSF, ongoing series).

See figures O-1 and O-2 in Overview.

Appendix table 4-27.
**International nondefense R&D expenditures and nondefense R&D as a percentage of GNP: 1971-89**

| | Nondefense R&D expenditures[1] | | | | | | | Nondefense R&D expenditures as a percentage of GNP | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | United States | Japan | West Germany | France[2] | United Kingdom | Italy | Sweden | United States | Japan | West Germany | France[2] | United Kingdom | Italy | Sweden |
| | Billions of constant 1982 dollars | | | | | | | Percent | | | | | | |
| 1971 | 41.8 | 13.3 | 10.2 | 6.0 | NA | 3.1 | NA | 1.7 | 1.9 | 2.0 | 1.5 | NA | 0.9 | NA |
| 1972 | 42.1 | 14.8 | 10.8 | 6.3 | 6.9 | 3.2 | NA | 1.6 | 1.9 | 2.1 | 1.5 | 1.5 | 0.9 | NA |
| 1973 | 43.8 | 16.2 | 10.6 | 6.2 | NA | 3.2 | NA | 1.6 | 2.0 | 1.9 | 1.4 | NA | 0.8 | NA |
| 1974 | 44.2 | 16.5 | 10.9 | 6.6 | NA | 3.1 | NA | 1.6 | 2.0 | 2.0 | 1.4 | NA | 0.8 | NA |
| 1975 | 43.1 | 16.7 | 10.9 | 6.7 | 7.2 | 3.5 | 1.2 | 1.6 | 2.0 | 2.1 | 1.5 | 1.5 | 0.9 | 1.4 |
| 1976 | 45.3 | 17.4 | 11.5 | 6.9 | NA | 3.4 | NA | 1.6 | 2.0 | 2.0 | 1.4 | NA | 0.8 | NA |
| 1977 | 46.0 | 18.1 | 11.8 | 7.1 | NA | 3.5 | 1.2 | 1.6 | 2.0 | 2.0 | 1.4 | NA | 0.9 | 1.5 |
| 1978 | 48.8 | 19.1 | 12.7 | 7.2 | 8.0 | 3.4 | NA | 1.6 | 2.0 | 2.1 | 1.4 | 1.6 | 0.8 | NA |
| 1979 | 52.4 | 21.1 | 14.4 | 7.5 | NA | 3.7 | 1.4 | 1.6 | 2.1 | 2.3 | 1.4 | NA | 0.8 | 1.7 |
| 1980 | 55.6 | 23.3 | 14.7 | 7.7 | NA | 3.9 | NA | 1.7 | 2.2 | 2.3 | 1.4 | NA | 0.8 | NA |
| 1981 | 56.9 | 25.7 | 15.4 | 8.2 | 8.7 | 4.4 | 1.9 | 1.8 | 2.3 | 2.4 | 1.5 | 1.7 | 1.0 | 2.2 |
| 1982 | 57.9 | 27.5 | 15.8 | 9.1 | NA | 4.6 | NA | 1.8 | 2.4 | 2.5 | 1.6 | NA | 1.0 | NA |
| 1983 | 64.8 | 29.9 | 15.3 | 9.4 | 8.5 | 4.9 | 2.1 | 1.9 | 2.5 | 2.4 | 1.7 | 1.6 | 1.1 | 2.4 |
| 1984 | 66.7 | 32.4 | 16.2 | 9.9 | NA | NA | NA | 1.9 | 2.6 | 2.5 | 1.7 | NA | NA | NA |
| 1985 | 72.2 | 35.9 | 17.9 | 10.5 | 9.1 | 6.0 | 2.5 | 2.0 | 2.8 | 2.7 | 1.8 | 1.6 | 1.1 | 2.6 |
| 1986 | 72.5 | 36.2 | 18.3 | 10.6 | 10.1 | 6.2 | NA | 1.9 | 2.8 | 2.7 | 1.8 | 1.7 | 1.1 | NA |
| 1987 | 73.4 | 38.8 | 19.2 | 10.8 | 10.7 | 6.7 | 2.7 | 1.9 | 2.8 | 2.8 | 1.8 | 1.8 | 1.2 | 2.7 |
| 1988 | 77.1 | 41.7 | 19.7 | 11.2 | 10.9 | 7.7 | NA | 1.9 | 2.9 | 2.7 | 1.8 | 1.7 | 1.3 | NA |
| 1989 | 79.0 | 45.5 | 20.9 | 11.8 | 10.4 | 7.7 | 2.6 | 1.9 | 3.0 | 2.8 | 1.8 | 1.6 | 1.2 | 2.5 |

NA = not available

[1]Nondefense expenditures are estimated here as total R&D expenditures—generally as reported by the R&D performers (see appendix table 4-26)—minus goverment R&D funds for defense purposes (see appendix table 4-30)—generally taken from national budget documents: that is, as reported by the R&D funders. Conversions of foreign currencies to U.S. dollars are calculated with Organisation for Economic Cooperation and Development purchasing power parity exchange rates. Constant 1982 dollars are based on U.S. Department of Commerce GNP implicit price deflator.

[2]French data are based on gross domestic product (GDP): consequently, percentages may be slightly overstated compared to GNP.

SOURCE: Science Resources Studies Division, National Science Foundation, *International Science and Technology Data Update* (Washington. DC: NSF. ongoing series).

See figure 4-15 and figures O-2 and O-3 in Overview.

*Science & Engineering Indicators – 1991*

Appendix table 4-28.
**International comparison of R&D expenditures, by source of funds and sector of performance for selected countries: 1975 and 1989**

| | United States | Japan | West Germany | France | United Kingdom |
|---|---|---|---|---|---|
| **Source of funds** | | | | | |
| | Percent | | | | |
| **1975** | | | | | |
| Total | 100 | 100 | 100 | 100 | 100 |
| Government | 51 | 29 | 47 | 54 | 52 |
| Industry | 45 | 55 | 50 | 39 | 41 |
| Higher education | 2 | 15 | 0 | 1 | 1 |
| Other[1] | 2 | 1 | 2 | 6 | 7 |
| Billions of constant 1982 dollars | $59.4 | $16.7 | $11.9 | $8.1 | $10.1 |
| **1989**[2] | | | | | |
| Total | 100 | 100 | 100 | 100 | 100 |
| Government | 45 | 19 | 33 | 49 | 37 |
| Industry | 51 | 72 | 65 | 43 | 51 |
| Higher education | 3 | 8 | 0 | 0 | 1 |
| Other[1] | 1 | 1 | 2 | 7 | 11 |
| Billions of constant 1982 dollars | $111.1 | $45.9 | $21.9 | $15.0 | $13.2 |
| **Performing sector** | | | | | |
| | Percent | | | | |
| **1975** | | | | | |
| Total | 100 | 100 | 100 | 100 | 100 |
| Government | 15 | 12 | 17 | 23 | 26 |
| Industry | 69 | 57 | 63 | 60 | 62 |
| Higher education | 13 | 28 | 20 | 16 | 8 |
| Other[1] | 4 | 3 | * | 1 | 3 |
| Billions of constant 1982 dollars | $59.4 | $16.7 | $11.9 | $8.1 | $10.1 |
| **1989**[2] | | | | | |
| Total | 100 | 100 | 100 | 100 | 100 |
| Government | 11 | 8 | 13 | 24 | 15 |
| Industry | 72 | 70 | 72 | 60 | 67 |
| Higher education | 14 | 18 | 14 | 15 | 14 |
| Other[1] | 3 | 4 | * | 1 | 4 |
| Billions of constant 1982 dollars | $111.1 | $45.9 | $21.9 | $15.0 | $13.2 |

* = less than 0.5 percent

NOTE: Percentages may not sum to 100 because of rounding.

[1]Private nonprofit institutions.

[2]French data for 1989 are NSF estimates; United Kingdom data are for 1988.

SOURCE: Science Resources Studies Division, National Science Foundation, *International Science and Technology Data Update* (Washington, DC: NSF, ongoing series).

See figure 4-14.

*Science & Engineering Indicators – 1991*

Appendix table 4-29.
**Basic research expenditures as a percentage of total R&D, by country: 1975-88**

| | United States | Japan | West Germany | France | United Kingdom | Italy | Sweden |
|---|---|---|---|---|---|---|---|
| | Percent | | | | | | |
| 1975 | 13 | 12 | 26 | NA | 14 | 20 | NA |
| 1976 | 13 | 15 | 25 | NA | 13 | 20 | NA |
| 1977 | 13 | 15 | 25 | 21 | 13 | 20 | 18 |
| 1978 | 14 | 16 | 22 | NA | 13 | 19 | NA |
| 1979 | 14 | 15 | 21 | 21 | 13 | 16 | 18 |
| 1980 | 13 | 14 | 21 | 21 | 13 | 15 | NA |
| 1981 | 13 | 13 | 22 | 21 | 13 | 15 | 23 |
| 1982 | 13 | 13 | 21 | 21 | NA | 15 | NA |
| 1983 | 13 | 13 | 21 | 21 | NA | 16 | NA |
| 1984 | 13 | 13 | NA | 20 | NA | 16 | NA |
| 1985 | 12 | 12 | 18 | 20 | NA | 16 | 20 |
| 1986 | 14 | 13 | NA | 20 | NA | 17 | NA |
| 1987 | 14 | 13 | 19 | 20 | NA | NA | 23 |
| 1988 | 14 | 13 | NA | 23 | NA | NA | NA |

NA = not available

NOTES: Data for basic research are somewhat less reliable than those for total R&D expenditures. Each percentage generally relates to the total current R&D expenditures; for countries other than the United States, this may include some general university funds. Data for France and the United Kingdom are estimated for certain years.

SOURCE: Science Resources Studies Division, National Science Foundation, *International Science and Technology Data Update* (Washington, DC: NSF, ongoing series).

*Science & Engineering Indicators – 1991*

Appendix table 4-30.
**Distribution of government R&D budget appropriations, by socioeconomic objective: 1984 and 1989**

| | United States | | Japan | | West Germany | | France | | United Kingdom | |
|---|---|---|---|---|---|---|---|---|---|---|
| Objective | 1984 | 1989 | 1984 | 1989 | 1984 | 1989 | 1984 | 1989 | 1984 | 1989 |
| | Percent | | | | | | | | | |
| TOTAL | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Agriculture, forestry, and fishing | 2.2 | 1.9 | 10.9 | 3.7 | 2.4 | 2.1 | 4.7 | 4.1 | 5.0 | 4.5 |
| Industrial development | 0.2 | 0.2 | 6.1 | 4.6 | 11.6 | 12.8 | 11.7 | 13.3 | 8.5 | 8.5 |
| Energy | 5.8 | 3.9 | 14.0 | 22.2 | 15.0 | 6.4 | 7.9 | 3.5 | 5.3 | 3.3 |
| Infrastructure | 2.5 | 1.8 | 2.5 | 1.7 | 2.2 | 2.0 | 3.5 | 0.9 | 4.8 | 1.5 |
| Transportation & telecommunications | 2.4 | 1.7 | 1.4 | 1.4 | 1.1 | 0.5 | 2.2 | NA | 0.5 | 0.3 |
| Urban and rural planning | 0.1 | 0.1 | 1.1 | 0.3 | 1.1 | 1.5 | 1.3 | NA | 1.0 | 1.2 |
| Environmental protection | 0.5 | 0.5 | 1.4 | 0.4 | 2.8 | 3.4 | 0.5 | 0.7 | 1.2 | 1.3 |
| Health | 11.3 | 12.9 | 2.5 | 2.7 | 3.2 | 3.5 | 3.8 | 3.3 | 3.5 | 5.1 |
| Social development and services | 1.0 | 1.1 | 0.7 | 1.0 | 2.4 | 2.5 | 1.4 | 0.5 | 0.7 | 2.2 |
| Earth and atmosphere | 1.2 | 1.0 | 1.1 | 1.0 | 2.2 | 2.2 | 2.0 | 1.6 | 1.7 | 2.4 |
| Advancement of knowledge | 3.8 | 3.8 | 53.5 | 51.1 | 44.4 | 46.7 | 26.5 | 27.1 | 19.6 | 22.4 |
| Advancement of research | 3.8 | 3.8 | 1.7 | 7.8 | 11.4 | 13.9 | 16.2 | 15.5 | 5.1 | 4.8 |
| General university funds | — | — | 51.8 | 43.3 | 33.0 | 32.8 | 10.3 | 11.6 | 14.6 | 17.6 |
| Civil space | 5.2 | 7.3 | 4.4 | 6.3 | 3.9 | 5.7 | 5.8 | 7.7 | 2.2 | 3.1 |
| Defense | 66.2 | 65.5 | 2.8 | 5.1 | 9.8 | 12.8 | 31.3 | 37.0 | 49.4 | 45.5 |
| Not elsewhere classified | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.9 | 0.4 | 1.8 | 0.3 |

NA = not separately available but included in subtotal
— = the United States does not have an equivalent to Europe's and Japan's general university funds

NOTES: Percentages may not sum to 100 because of rounding. U.S. data are based on budget authority. Because of general university funds and slight differences in accounting practices, the distribution of government budgets among socioeconomic objectives may not completely reflect the actual distribution of government-funded research in particular fields. Japanese data are based on science and technology budget data, which include items other than R&D. Such items are a small proportion of the budget, and therefore the data may still be used as an approximate indicator of relative government emphasis on R&D by objective.

SOURCE: Science Resources Studies Division, National Science Foundation, *International Science and Technology Data Update* (Washington, DC: NSF, ongoing series).

See text table 4-7.

*Science & Engineering Indicators – 1991*

Appendix table 4-31.

**Company-financed R&D performed outside the United States by U.S. companies and their foreign subsidiaries, by industry: 1974-89**

| Industry | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Millions of current U.S. dollars | | | | | | | | | | | | | | | |
| TOTAL | 1,300 | 1,454 | 1,659 | 1,877 | 2,209 | 2,754 | 3,165 | 3,393 | 3,094 | 3,269 | 3,633 | 3,650 | 4,624 | 5,226 | 6,295 | 6,519 |
| Food, kindred, and tobacco products[1] | 27 | 23 | 29 | 32 | 43 | 51 | 54 | 62 | 64 | 63 | 70 | 75 | 69 | 37 | 27 | 34 |
| Chemicals and allied products | 208 | 269 | 312 | 332 | 395 | 500 | 603 | 715 | 682 | 729 | 786 | 843 | 1,071 | 1,243 | 1,501 | 1,287 |
| Industrial and other chemicals | 82 | 85 | 108 | 133 | 151 | 199 | 246 | 287 | 319 | 368 | 385 | 444 | 579 | 625 | 781 | 473 |
| Drugs and medicines | 126 | 184 | 204 | 199 | 244 | 301 | 357 | 428 | 363 | 361 | 401 | 399 | 492 | 618 | 720 | 814 |
| Petroleum refining and extraction | * | * | * | * | * | * | 141 | 194 | 133 | 103 | 101 | 47 | 40 | 47 | 58 | 46 |
| Stone, clay, and glass products | 7 | 7 | * | * | * | NA | 21 | 18 | 10 | 19 | 60 | D | D | D | D | D |
| Primary metals | 3 | 9 | 12 | 9 | 9 | 11 | 11 | 9 | 9 | 10 | 9 | D | D | 18 | 24 | 23 |
| Fabricated metal products | * | * | 22 | 24 | 29 | NA | NA | 30 | 25 | 23 | 21 | 21 | 26 | 40 | D | D |
| Machinery | 258 | 331 | 352 | 411 | 460 | 534 | 599 | 612 | 494 | 577 | 740 | 689 | 951 | 1,233 | 1,364 | 1,455 |
| Electrical equipment | 238 | 245 | 278 | 300 | 352 | 445 | 451 | 475 | 467 | 482 | 537 | 591 | S | 432 | 669 | 615 |
| Radio and TV receiving equipment | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | D | D | 0 | D | D |
| Communication equipment | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | D | D | D | 188 | 339 | 278 |
| Electronic components | 4 | 7 | 9 | 13 | 17 | 25 | 29 | 40 | 38 | NA | 92 | 117 | 150 | 204 | 278 | 245 |
| Other electrical equipment | NA | NA | 6 | 5 | 9 | 11 | 11 | 39 | 43 | 38 | 30 | 24 | 25 | 39 | D | D |
| Transportation equipment | 406 | 412 | 464 | 558 | 640 | 874 | 1,020 | 884 | 843 | 880 | 907 | 1,025 | D | D | 1,801 | 2,101 |
| Motor vehicles & other transportation equipment | 364 | 373 | 423 | 514 | NA | NA | NA | NA | NA | NA | D | D | D | D | 1,469 | 1,491 |
| Aircraft and missiles | 42 | 39 | 41 | 44 | NA | NA | NA | NA | NA | NA | D | D | 182 | 237 | 332 | 610 |
| Professional and scientific instruments | 39 | 49 | 69 | 81 | 121 | 156 | 186 | 230 | 237 | NA | 263 | 169 | 212 | 317 | 393 | 441 |
| Other manufacturing industries | 111 | 105 | 137 | 144 | 181 | 213 | 139 | 156 | 123 | 92 | 131 | 125 | 141 | 138 | 145 | 166 |
| Nonmanufacturing industries | 3 | 4 | 4 | 9 | 12 | 5 | 7 | 8 | 7 | 10 | 8 | 18 | 27 | 64 | 95 | 89 |
| | Millions of constant 1982 U.S. dollars[2] | | | | | | | | | | | | | | | |
| TOTAL | 2,409 | 2,452 | 2,630 | 2,790 | 3,059 | 3,505 | 3,692 | 3,611 | 3,094 | 3,148 | 3,372 | 3.290 | 4,063 | 4,450 | 5,188 | 5,161 |

D withheld to avoid disclosing operations of individual companies

S – withheld because of imputation of more than 50 percent

* included in the other manufacturing industries group

NA – not separately available, but included in totals

Until 1984, the tobacco products category, Standard Industrial Classification code 21, was included in the other manufacturing industries group.

See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCES: Science Resources Studies Division, National Science Foundation, *Research and Development in Industry* (Washington, DC: NSF, ongoing series); and unpublished tabulations.

See figure 4-16.

*Science & Engineering Indicators – 1991*

Appendix table 4-32.
**Foreign R&D expenditures in the United States, by industry and country: 1977-88**

| Industry and country | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Millions of current U.S. dollars | | | | | | | | | | | |
| TOTAL | 933 | 1,230 | 1,584 | 1,946 | 3,110 | 3,744 | 4,164 | 4,738 | 5,240 | 5,804 | 6,521 | 7,382 |
| **Expenditures by industry** | | | | | | | | | | | | |
| Manufacturing | 851 | 1,099 | 1,450 | D | 2,898 | 3,388 | 3,863 | 4,424 | 4,866 | 5,391 | 5,884 | 6,747 |
| Petroleum | 108 | 158 | 149 | D | 253 | 255 | 310 | 366 | 388 | 380 | 311 | 345 |
| Food and kindred products | 7 | 16 | 14 | 19 | 32 | 39 | 44 | 43 | 51 | 54 | 58 | 104 |
| Chemicals and allied products | 483 | 604 | 773 | 834 | 1,580 | 1,870 | 2,037 | 2,349 | 2,627 | 2,782 | 3,220 | 3,656 |
| Industrial chemicals | 181 | 234 | 308 | 454 | 1,085 | 1,329 | 1,397 | 1,620 | 1,836 | 1,657 | 1,899 | 2,087 |
| Drugs and medicines | 175 | 194 | 264 | 234 | 316 | 371 | 459 | 529 | 563 | 958 | 1,091 | 1,299 |
| Other chemicals | 127 | 176 | 201 | 146 | 179 | 170 | 181 | 200 | 228 | 167 | 230 | 270 |
| Primary metal industries | 16 | 11 | 15 | 24 | 71 | 79 | 59 | 66 | 102 | 97 | 91 | 111 |
| Fabricated metal products | 21 | 16 | 30 | 21 | 20 | 28 | 82 | 54 | 64 | 76 | 67 | 112 |
| Machinery, except electrical | 69 | 94 | 129 | 189 | 284 | 297 | 350 | 355 | 342 | 286 | 476 | 562 |
| Office and computing machines | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 370 | 401 |
| Other | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 106 | 161 |
| Electrical equipment | 98 | 131 | 229 | 318 | 385 | 505 | 613 | 799 | 977 | 1,366 | 1,105 | 1,229 |
| Transportation equipment | 4 | 4 | 26 | 101 | 136 | 150 | 92 | 95 | 83 | 124 | 76 | 88 |
| Professional and scientific instruments | 15 | 18 | 28 | 32 | 52 | 47 | 42 | 42 | 58 | 112 | 279 | 225 |
| Nonmanufacturing | 82 | 131 | 134 | D | 212 | 356 | 301 | 314 | 374 | 413 | 637 | 635 |
| Services | 19 | 20 | 14 | 37 | 43 | 41 | 51 | 60 | 54 | 77 | 243 | 274 |
| Other | 63 | 111 | 120 | D | 169 | 315 | 250 | 254 | 320 | 336 | 394 | 361 |
| **Expenditures by country** | | | | | | | | | | | | |
| Canada | 74 | 85 | 102 | 135 | 777 | 1,032 | 1,212 | 1,405 | 1,550 | 1,542 | 1,666 | D |
| Europe | 790 | 996 | 1,253 | 1,544 | 1,936 | 2,229 | 2,324 | 2,632 | 2,918 | 3,450 | 3,881 | 4,403 |
| France | 62 | 89 | 56 | 146 | 204 | 232 | 215 | 261 | 166 | 352 | 366 | 419 |
| Germany | 101 | 189 | 311 | 380 | 436 | 529 | 591 | 602 | 671 | 851 | 1,139 | 1,180 |
| The Netherlands | 190 | 215 | 244 | 299 | 373 | 397 | 387 | 432 | 514 | 517 | 542 | 597 |
| Sweden | 10 | 12 | 14 | 36 | 53 | 54 | 62 | 63 | 116 | 141 | 128 | 162 |
| Switzerland | 241 | 287 | 352 | 338 | 416 | 447 | 463 | 546 | 625 | 744 | 765 | 898 |
| United Kingdom | 155 | 176 | 252 | 312 | 405 | 520 | 559 | 664 | 748 | 764 | 833 | 1,042 |
| Other European countries | 31 | 28 | 24 | 33 | 49 | 50 | 47 | 64 | 78 | 81 | 108 | 105 |
| Japan | 23 | 54 | 77 | 88 | 142 | 141 | 171 | 210 | 267 | 292 | 307 | 515 |
| Latin America | 35 | 73 | 132 | D | D | D | 401 | 423 | 427 | 427 | 391 | 366 |
| Rest of world | 11 | 22 | 20 | D | D | D | 56 | 68 | 78 | 93 | 276 | D |
| | Millions of constant 1982 U.S. dollars[1] | | | | | | | | | | | |
| TOTAL | 1,387 | 1,703 | 2,016 | 2,270 | 3,310 | 3,744 | 4,009 | 4,398 | 4,723 | 5,099 | 5,553 | 6,084 |

D = withheld to avoid disclosing operations of individual companies
NA = not available

NOTE: Includes foreign direct investments of nonbank U.S. affiliates only.

[1]See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCE: U.S. Bureau of Economic Analysis. *Foreign Direct Investment in the United States* (Washington, DC: BEA, ongoing series).

See figure 4-16.

Appendix table 5-1.
**Expenditures for academic basic research, applied research, and development: 1960-91**

| | Total academic R&D | Basic research | Applied research | Develop-ment | Total academic R&D | Basic research | Applied research | Develop-ment | Basic research | Applied research | Develop-ment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Millions of current dollars | | | | Millions of constant 1982 dollars[1] | | | | Percentage of total | | |
| 1960 | 646 | 433 | 179 | 34 | 2,077 | 1,392 | 575 | 109 | 67.0 | 27.7 | 5.3 |
| 1961 | 763 | 536 | 192 | 35 | 2,427 | 1,705 | 611 | 111 | 70.2 | 25.2 | 4.6 |
| 1962 | 904 | 659 | 205 | 40 | 2,825 | 2,060 | 641 | 125 | 72.9 | 22.7 | 4.4 |
| 1963 | 1,081 | 814 | 227 | 40 | 3,318 | 2,498 | 697 | 123 | 75.3 | 21.0 | 3.7 |
| 1964 | 1,275 | 1,003 | 232 | 40 | 3,858 | 3,035 | 702 | 121 | 78.7 | 18.2 | 3.1 |
| 1965 | 1,474 | 1,138 | 279 | 57 | 4,368 | 3,372 | 827 | 169 | 77.2 | 18.9 | 3.9 |
| 1966 | 1,715 | 1,303 | 328 | 84 | 4,937 | 3,751 | 944 | 242 | 76.0 | 19.1 | 4.9 |
| 1967 | 1,921 | 1,457 | 374 | 90 | 5,347 | 4,056 | 1,041 | 251 | 75.8 | 19.5 | 4.7 |
| 1968 | 2,149 | 1,650 | 403 | 96 | 5,778 | 4,437 | 1,084 | 258 | 76.8 | 18.8 | 4.5 |
| 1969 | 2,225 | 1,711 | 407 | 107 | 5,677 | 4,365 | 1,038 | 273 | 76.9 | 18.3 | 4.8 |
| 1970 | 2,335 | 1,796 | 427 | 112 | 5,629 | 4,329 | 1,029 | 270 | 76.9 | 18.3 | 4.8 |
| 1971 | 2,500 | 1,914 | 474 | 112 | 5,726 | 4,384 | 1,086 | 257 | 76.6 | 19.0 | 4.5 |
| 1972 | 2,630 | 2,022 | 524 | 84 | 5,710 | 4,390 | 1,138 | 182 | 76.9 | 19.9 | 3.2 |
| 1973 | 2,884 | 2,053 | 713 | 118 | 5,965 | 4,246 | 1,475 | 244 | 71.2 | 24.7 | 4.1 |
| 1974 | 3,022 | 2,153 | 736 | 133 | 5,794 | 4,128 | 1,411 | 255 | 71.2 | 24.4 | 4.4 |
| 1975 | 3,409 | 2,410 | 851 | 148 | 5,926 | 4,190 | 1,479 | 257 | 70.7 | 25.0 | 4.3 |
| 1976 | 3,729 | 2,549 | 1,016 | 164 | 6,007 | 4,106 | 1,637 | 264 | 68.4 | 27.2 | 4.4 |
| 1977 | 4,067 | 2,800 | 1,067 | 200 | 6,067 | 4,177 | 1,592 | 298 | 68.8 | 26.2 | 4.9 |
| 1978 | 4,625 | 3,176 | 1,213 | 236 | 6,449 | 4,428 | 1,691 | 329 | 68.7 | 26.2 | 5.1 |
| 1979 | 5,380 | 3,628 | 1,477 | 275 | 6,907 | 4,657 | 1,896 | 353 | 67.4 | 27.5 | 5.1 |
| 1980 | 6,077 | 4,041 | 1,698 | 338 | 7,171 | 4,769 | 2,004 | 399 | 66.5 | 27.9 | 5.6 |
| 1981 | 6,846 | 4,596 | 1,865 | 385 | 7,345 | 4,931 | 2,001 | 413 | 67.1 | 27.2 | 5.6 |
| 1982 | 7,323 | 4,882 | 2,037 | 404 | 7,323 | 4,882 | 2,037 | 404 | 66.7 | 27.8 | 5.5 |
| 1983 | 7,877 | 5,304 | 2,146 | 427 | 7,557 | 5,089 | 2,059 | 410 | 67.3 | 27.2 | 5.4 |
| 1984 | 8,617 | 5,735 | 2,459 | 423 | 7,965 | 5,301 | 2,273 | 391 | 66.6 | 28.5 | 4.9 |
| 1985 | 9,686 | 6,559 | 2,673 | 454 | 8,684 | 5,881 | 2,397 | 407 | 67.7 | 27.6 | 4.7 |
| 1986 | 10,926 | 7,495 | 2,911 | 520 | 9,542 | 6,545 | 2,542 | 454 | 68.6 | 26.6 | 4.8 |
| 1987 | 12,153 | 8,398 | 3,168 | 587 | 10,296 | 7,115 | 2,684 | 497 | 69.1 | 26.1 | 4.8 |
| 1988 | 13,465 | 8,827 | 3,993 | 645 | 11,072 | 7,258 | 3,283 | 530 | 65.6 | 29.7 | 4.8 |
| 1989 | 14,987 | 9,685 | 4,581 | 721 | 11,825 | 7,642 | 3,614 | 569 | 64.6 | 30.6 | 4.8 |
| 1990 (est.) | 16,000 | 10,350 | 4,845 | 805 | 12,137 | 7,851 | 3,675 | 611 | 64.7 | 30.3 | 5.0 |
| 1991 (est.) | 17,200 | 11,100 | 5,220 | 880 | 12,495 | 8,064 | 3,792 | 639 | 64.5 | 30.3 | 5.1 |

[1]See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCES: Science Resources Studies Division, National Science Foundation, *National Patterns of R&D Resources: 1990*, NSF 90-316 (Washington, DC: NSF, 1990); and unpublished tabulations.

See figure 5-1.

Appendix table 5-2.
**Support for academic R&D, by sector: 1960-91**
(page 1 of 2)

| Fiscal year | Total | Federal Government | State/local government | Industry | Academic institutions | All other sources |
|---|---|---|---|---|---|---|
| | | | Millions of current dollars | | | |
| 1960 | 646 | 405 | 85 | 40 | 64 | 52 |
| 1961 | 763 | 500 | 95 | 40 | 70 | 58 |
| 1962 | 904 | 613 | 106 | 40 | 79 | 66 |
| 1963 | 1,081 | 760 | 118 | 41 | 89 | 73 |
| 1964 | 1,275 | 917 | 132 | 40 | 103 | 83 |
| 1965 | 1,474 | 1,073 | 143 | 41 | 124 | 93 |
| 1966 | 1,715 | 1,261 | 156 | 42 | 148 | 108 |
| 1967 | 1,921 | 1,409 | 164 | 48 | 181 | 119 |
| 1968 | 2,149 | 1,572 | 172 | 55 | 218 | 132 |
| 1969 | 2,225 | 1,600 | 197 | 60 | 223 | 145 |
| 1970 | 2,335 | 1,647 | 219 | 61 | 243 | 165 |
| 1971 | 2,500 | 1,724 | 255 | 70 | 274 | 177 |
| 1972 | 2,630 | 1,795 | 270 | 74 | 305 | 187 |
| 1973 | 2,884 | 1,985 | 295 | 84 | 318 | 202 |
| 1974 | 3,022 | 2,032 | 307 | 95 | 370 | 219 |
| 1975 | 3,409 | 2,288 | 332 | 113 | 417 | 259 |
| 1976 | 3,729 | 2,512 | 364 | 123 | 446 | 285 |
| 1977 | 4,067 | 2,726 | 374 | 139 | 514 | 314 |
| 1978[1] | 4,625 | 3,059 | 412 | 170 | 625 | 359 |
| 1979 | 5,380 | 3,604 | 476 | 194 | 738 | 368 |
| 1980 | 6,077 | 4,104 | 496 | 236 | 837 | 403 |
| 1981 | 6.846 | 4,565 | 546 | 291 | 1,008 | 436 |
| 1982 | 7,323 | 4,763 | 616 | 337 | 1,115 | 492 |
| 1983 | 7,877 | 4,983 | 626 | 388 | 1,303 | 577 |
| 1984 | 8,617 | 5,423 | 690 | 475 | 1,413 | 615 |
| 1985 | 9,686 | 6,056 | 754 | 559 | 1,622 | 695 |
| 1986 | 10,926 | 6,702 | 916 | 699 | 1,873 | 735 |
| 1987 | 12,153 | 7,333 | 1,024 | 789 | 2,176 | 831 |
| 1988 | 13,465 | 8,181 | 1,107 | 870 | 2,367 | 941 |
| 1989 | 14,987 | 8,972 | 1,239 | 984 | 2,710 | 1,083 |
| 1990 (est.)[1] | 16,000 | 9,250 | 1,396 | 1,100 | 3,054 | 1,200 |
| 1991 (est.)[1] | 17,200 | 9,650 | 1,553 | 1,250 | 3,397 | 1,350 |
| | | | Millions of constant 1982 dollars[2] | | | |
| 1960 | 2,077 | 1,302 | 273 | 129 | 206 | 167 |
| 1961 | 2,427 | 1,590 | 302 | 127 | 223 | 184 |
| 1962 | 2,825 | 1.916 | 331 | 125 | 247 | 206 |
| 1963 | 3,318 | 2,332 | 362 | 126 | 273 | 224 |
| 1964 | 3,858 | 2,775 | 399 | 121 | 312 | 251 |
| 1965 | 4,368 | 3,179 | 424 | 121 | 367 | 276 |
| 1966 | 4,937 | 3,630 | 449 | 121 | 426 | 311 |
| 1967 | 5,347 | 3,922 | 457 | 134 | 504 | 331 |
| 1968 | 5,778 | 4,227 | 462 | 148 | 586 | 355 |
| 1969 | 5 677 | 4,082 | 503 | 153 | 569 | 370 |
| 1970 | 5.629 | 3,970 | 528 | 147 | 586 | 398 |
| 1971 | 5.726 | 3,949 | 584 | 160 | 628 | 405 |
| 1972 | 5,710 | 3.897 | 585 | 161 | 662 | 406 |
| 1973 | 5,965 | 4,106 | 609 | 174 | 658 | 418 |
| 1974 | 5,794 | 3,896 | 588 | 182 | 709 | 420 |
| 1975 | 5,926 | 3,978 | 577 | 196 | 726 | 450 |
| 1976 | 6,007 | 4,046 | 586 | 198 | 718 | 459 |
| 1977 | 6,067 | 4,067 | 558 | 207 | 767 | 468 |
| 1978[1] | 6,449 | 4,265 | 574 | 237 | 871 | 501 |
| 1979 | 6,907 | 4,627 | 612 | 249 | 947 | 472 |

(continued)

Appendix table 5-2.
**Support for academic R&D, by sector: 1960-91**
(page 2 of 2)

| Fiscal year | Total | Federal Government | State/local government | Industry | Academic institutions | All other sources |
|---|---|---|---|---|---|---|
| | Millions of constant 1982 dollars[2] | | | | | |
| 1979 | 6,907 | 4,627 | 612 | 249 | 947 | 472 |
| 1980 | 7,171 | 4,843 | 586 | 278 | 988 | 476 |
| 1981 | 7,345 | 4,898 | 586 | 312 | 1,082 | 468 |
| 1982 | 7,323 | 4,763 | 616 | 337 | 1,115 | 492 |
| 1983 | 7,557 | 4,781 | 600 | 372 | 1,250 | 554 |
| 1984 | 7,965 | 5,012 | 638 | 439 | 1,306 | 568 |
| 1985 | 8,684 | 5,430 | 676 | 501 | 1,454 | 623 |
| 1986 | 9,542 | 5,853 | 800 | 610 | 1,636 | 642 |
| 1987 | 10,296 | 6,213 | 868 | 668 | 1,843 | 704 |
| 1988 | 11,072 | 6,727 | 910 | 715 | 1,946 | 774 |
| 1989 | 11,825 | 7,079 | 978 | 776 | 2,138 | 854 |
| 1990 (est.)[1] | 12,137 | 7,017 | 1,059 | 834 | 2,316 | 910 |
| 1991 (est.)[1] | 12,495 | 7,010 | 1,128 | 908 | 2,467 | 981 |
| | Percent | | | | | |
| 1960 | 100 | 62.7 | 13.2 | 6.2 | 9.9 | 8.0 |
| 1961 | 100 | 65.5 | 12.5 | 5.2 | 9.2 | 7.6 |
| 1962 | 100 | 67.8 | 11.7 | 4.4 | 8.7 | 7.3 |
| 1963 | 100 | 70.3 | 10.9 | 3.8 | 8.2 | 6.8 |
| 1964 | 100 | 71.9 | 10.4 | 3.1 | 8.1 | 6.5 |
| 1965 | 100 | 72.8 | 9.7 | 2.8 | 8.4 | 6.3 |
| 1966 | 100 | 73.5 | 9.1 | 2.4 | 8.6 | 6.3 |
| 1967 | 100 | 73.3 | 8.5 | 2.5 | 9.4 | 6.2 |
| 1968 | 100 | 73.2 | 8.0 | 2.6 | 10.1 | 6.1 |
| 1969 | 100 | 71.9 | 8.9 | 2.7 | 10.0 | 6.5 |
| 1970 | 100 | 70.5 | 9.4 | 2.6 | 10.4 | 7.1 |
| 1971 | 100 | 69.0 | 10.2 | 2.8 | 11.0 | 7.1 |
| 1972 | 100 | 68.3 | 10.3 | 2.8 | 11.6 | 7.1 |
| 1973 | 100 | 68.8 | 10.2 | 2.9 | 11.0 | 7.0 |
| 1974 | 100 | 67.2 | 10.2 | 3.1 | 12.2 | 7.2 |
| 1975 | 100 | 67.1 | 9.7 | 3.3 | 12.2 | 7.6 |
| 1976 | 100 | 67.4 | 9.8 | 3.3 | 11.9 | 7.6 |
| 1977 | 100 | 67.0 | 9.2 | 3.4 | 12.6 | 7.7 |
| 1978[1] | 100 | 66.1 | 8.9 | 3.7 | 13.5 | 7.8 |
| 1979 | 100 | 67.0 | 8.9 | 3.6 | 13.7 | 6.8 |
| 1980 | 100 | 67.5 | 8.2 | 3.9 | 13.8 | 6.6 |
| 1981 | 100 | 66.7 | 8.0 | 4.3 | 14.7 | 6.4 |
| 1982 | 100 | 65.0 | 8.4 | 4.6 | 15.2 | 6.7 |
| 1983 | 100 | 63.3 | 7.9 | 4.9 | 16.5 | 7.3 |
| 1984 | 100 | 62.9 | 8.0 | 5.5 | 16.4 | 7.1 |
| 1985 | 100 | 62.5 | 7.8 | 5.8 | 16.7 | 7.2 |
| 1986 | 100 | 61.3 | 8.4 | 6.4 | 17.1 | 6.7 |
| 1987 | 100 | 60.3 | 8.4 | 6.5 | 17.9 | 6.8 |
| 1988 | 100 | 60.8 | 8.2 | 6.5 | 17.6 | 7.0 |
| 1989 | 100 | 59.9 | 8.3 | 6.6 | 18.1 | 7.2 |
| 1990 (est.)[1] | 100 | 57.8 | 8.7 | 6.9 | [illegible] | 7.5 |
| 1991 (est.)[1] | 100 | 56.1 | 9.0 | 7.3 | 19.7 | 7.8 |

[1]Relative amounts of funds from state and local governments and from academic institutions are estimated from previous year's ratio.

[2]See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCES: Science Resources Studies Division, National Science Foundation. *Academic Science/Engineering: R&D Expenditures, Fiscal Year 1989.* NSF 90-321. Detailed Statistical Tables (Washington, DC: NSF, 1991); and annual series.

See figures 5-1 and 5-2 and figure O-19 in Overview. *Science & Engineering Indicators – 1991*

Appendix table 5-3.
**Sources of R&D funds at private and public institutions, by sector: 1980 and 1989**

| Type of institution | Total | Federal Government | State and local government | Industry | Academic institutions | Other sources |
|---|---|---|---|---|---|---|
| | Thousands of dollars | | | | | |
| **1980** | | | | | | |
| Private | 2,213,087 | 1,744,398 | 44,048 | 94,954 | 164,580 | 165,107 |
| Public | 3,863,626 | 2,359,777 | 452,239 | 141,399 | 672,385 | 237,826 |
| **1989** | | | | | | |
| Private | 5,164,603 | 3,787,343 | 125,730 | 358,983 | 454,901 | 437,648 |
| Public | 9,822,676 | 5,185,125 | 1,113,379 | 624,591 | 2,254,690 | 644,891 |
| | Percent | | | | | |
| **1980** | | | | | | |
| Private | 100.0 | 78.8 | 2.0 | 4.3 | 7.4 | 7.5 |
| Public | 100.0 | 61.1 | 11.7 | 3.7 | 17.4 | 6.2 |
| **1989** | | | | | | |
| Private | 100.0 | 73.3 | 2.4 | 7.0 | 8.8 | 8.5 |
| Public | 100.0 | 52.8 | 11.3 | 6.4 | 23.0 | 6.6 |

SOURCES: Science Resources Studies Division, National Science Foundation, *Academic Science/Engineering: R&D Expenditures, Fiscal Year 1989*, NSF 90-321, Detailed Statistical Tables (Washington, DC: NSF, 1991); and annual series.

*Science & Engineering Indicators – 1991*

Appendix table 5-4.
**R&D expenditures at the top 100 universities and colleges, by source of funds: 1989**
(page 1 of 3)

| Academic institutions' ranking | Institutional category | Total | Federal Gov't | State and local gov't | Industry | Academic institutions | All other sources |
|---|---|---|---|---|---|---|---|
| | | Thousands of dollars | | | | | |
| **Total, all institutions**[1] | | 14,556,179 | 8,550,551 | 1,238,860 | 983,574 | 2,700,657 | 1,082,539 |
| 1 Massachusetts Institute of Technology | Private | 287,157 | 215,140 | 3,211 | 39,650 | 6,692 | 22,464 |
| 2 Cornell University | Private | 286,733 | 157,984 | 40,405 | 16,627 | 49,157 | 22,560 |
| 3 Stanford University | Private | 285,994 | 238,650 | 392 | 13,764 | 14,261 | 18,927 |
| 4 University of Wisconsin-Madison | Public | 285,982 | 169,452 | 49,054 | 11,035 | 37,916 | 18,525 |
| 5 University of Michigan | Public | 280,905 | 174,875 | 2,533 | 22,023 | 61,626 | 19,848 |
| 6 University of Minnesota | Public | 258,614 | 132,880 | 42,542 | 12,389 | 43,713 | 27,090 |
| 7 Texas A & M University-all campuses | Public | 250,706 | 93,584 | 65,179 | 21,204 | 63,053 | 7,686 |
| 8 University of California-Los Angeles | Public | 227,828 | 159,002 | 3,479 | 7,548 | 32,975 | 24,824 |
| 9 University of Washington | Public | 221,712 | 182,453 | 3,795 | 19,135 | 13,181 | 3,148 |
| 10 Pennsylvania State University-all campuses | Public | 219,930 | 114,646 | 8,907 | 30,256 | 66,036 | 85 |
| **Total, 1st 10 institutions** | | 2,605,561 | 1,638,666 | 219,497 | 193,631 | 388,610 | 165,157 |
| 11 University of California-San Francisco | Public | 219,446 | 159,906 | 8,770 | 6,226 | 24,269 | 20,275 |
| 12 Johns Hopkins University[1] | Private | 217,295 | 168,267 | 2,087 | 11,013 | 17,577 | 18,351 |
| 13 University of California-San Diego | Public | 216,991 | 171,479 | 3,288 | 6,824 | 19,057 | 16,343 |
| 14 University of Illinois-Urbana | Public | 210,590 | 114,398 | 25,838 | 15,785 | 47,336 | 7,233 |
| 15 University of California-Berkeley | Public | 209,967 | 124,371 | 7,154 | 8,480 | 59,984 | 9,978 |
| 16 Harvard University | Private | 209,519 | 143,451 | 1,135 | 10,461 | 16,602 | 37,870 |
| 17 University of Texas-Austin | Public | 193,337 | 94,311 | 15,724 | 2,694 | 64,591 | 16,017 |
| 18 University of California-Davis | Public | 180,297 | 72,718 | 10,322 | 8,039 | 79,601 | 9,617 |
| 19 Georgia Inst. of Technology-all campuses | Public | 174,664 | 98,048 | 1,093 | 21,346 | 54,177 | 0 |
| 20 University of Arizona | Public | 174,119 | 80,533 | 7,257 | 9,729 | 66,070 | 10,530 |
| **Total, 1st 20 institutions** | | 4,611,786 | 2,866,148 | 302,165 | 294,228 | 837,874 | 311,371 |
| 21 University of Pennsylvania | Private | 173,744 | 123,810 | 2,730 | 9,582 | 8,984 | 28,638 |
| 22 Columbia University | Private | 172,145 | 146,712 | 2,461 | 5,408 | 4,189 | 13,375 |
| 23 Yale University | Private | 171,139 | 138,835 | 920 | 6,563 | 9,736 | 15,085 |
| 24 Ohio State University-all campuses | Public | 162,690 | 75,484 | 32,949 | 9,449 | 26,640 | 18,168 |
| 25 University of Southern California | Private | 162,013 | 119,005 | 2,751 | 14,716 | 25,541 | 0 |
| 26 University of Maryland-College Park | Public | 149,510 | 58,924 | 43,675 | 12,940 | 33,971 | 0 |
| 27 University of Georgia | Public | 145,953 | 42,797 | 36,081 | 4,877 | 60,675 | 1,523 |
| 28 University of Colorado | Public | 143,694 | 109,145 | 1,692 | 6,728 | 12,175 | 13,954 |
| 29 Baylor College of Medicine | Private | 134,681 | 69,336 | 5,565 | 7,263 | 15,513 | 37,004 |
| 30 Duke University | Private | 131,090 | 99,036 | 914 | 12,551 | 9,082 | 9,507 |
| **Total, 1st 30 institutions** | | 6,158,445 | 3,849,232 | 431,903 | 384,305 | 1,044,380 | 448,625 |
| 31 North Carolina State University-Raleigh | Public | 128,891 | 37,783 | 45,487 | 21,735 | 21,705 | 2,181 |
| 32 Washington University | Private | 128,419 | 96,829 | 1,532 | 13,500 | 8,114 | 8,444 |
| 33 University of Florida | Public | 125,770 | 60,731 | 10,180 | 10,579 | 38,144 | 6,136 |
| 34 University of Tennessee-System Office | Public | 124,820 | 57,763 | 24,454 | 6,636 | 29,911 | 6,056 |
| 35 Rutgers State University of New Jersey | Public | 124,574 | 35,896 | 26,369 | 6,087 | 50,305 | 5,917 |
| 36 Purdue University-all campuses | Public | 124,323 | 63,979 | 17,641 | 11,451 | 25,954 | 5,298 |
| 37 University of Rochester | Private | 123,997 | 101,049 | 6,088 | 4,913 | 2,779 | 9,168 |
| 38 Louisiana State University-all campuses | Public | 122,357 | 40,114 | 37,182 | 2,120 | 32,750 | 10,191 |
| 39 University of North Carolina-Chapel Hill | Public | 122,097 | 93,280 | 13,655 | 579 | 14,428 | 155 |
| 40 Michigan State University | Public | 121,456 | 51,741 | 22,456 | 4,068 | 33,253 | 9,938 |

(continued)

Appendix table 5-4.
**R&D expenditures at the top 100 universities and colleges, by source of funds: 1989**
(page 2 of 3)

| Academic institutions' ranking | Institutional category | Total | Federal Gov't | State and local gov't | Industry | Academic institutions | All other sources |
|---|---|---|---|---|---|---|---|
| | | Thousands of dollars | | | | | |
| **Total, 1st 40 institutions** | | 7,405,149 | 4,488,397 | 636,947 | 465,973 | 1,301,723 | 512,109 |
| 41 Northwestern University | Private | 118,991 | 57,510 | 831 | 5,289 | 45,008 | 10,353 |
| 42 University of Pittsburgh | Public | 111,265 | 81,217 | 1,190 | 9,406 | 8,148 | 11,304 |
| 43 University of Massachusetts-System Office | Public | 110,644 | 56,505 | 10,337 | 11,480 | 27,383 | 4,939 |
| 44 University of Chicago | Private | 109,429 | 90,459 | 558 | 1,520 | 9,075 | 7,817 |
| 45 University of Connecticut | Public | 109,328 | 46,184 | 4,249 | 4,996 | 46,208 | 7,691 |
| 46 University of Iowa | Public | 105,900 | 74,271 | 1,121 | 10,301 | 18,102 | 2,105 |
| 47 New York University | Private | 104,451 | 81,143 | 798 | 4,066 | 7,727 | 10,717 |
| 48 Virginia Polytechnic Inst. & State Univ. | Public | 104,266 | 38,597 | 36,412 | 9,825 | 16,841 | 2,591 |
| 49 Iowa State University of Science & Tech. | Public | 103,174 | 28,895 | 23,718 | 4,408 | 42,644 | 3,509 |
| 50 Carnegie-Mellon University | Private | 101,635 | 65,079 | 9,277 | 18,976 | 1,844 | 6,459 |
| **Total, 1st 50 institutions** | | 8,484,232 | 5,108,257 | 725,438 | 546,240 | 1,524,703 | 579,594 |
| 51 SUNY-Buffalo | Public | 100,291 | 64,453 | 2,699 | 1,759 | 16,827 | 14,553 |
| 52 California Institute of Technology | Private | 98,731 | 84,167 | 202 | 3,567 | 7,772 | 3,023 |
| 53 University of Alabama-Birmingham | Public | 98,302 | 68,204 | 2,120 | 6,602 | 8,445 | 12,931 |
| 54 Oregon State University | Public | 91,355 | 49,112 | 20,373 | 2,285 | 5,554 | 14,031 |
| 55 University of Miami (FL) | Private | 90,298 | 63,101 | 1,546 | 4,702 | 5,604 | 15,345 |
| 56 Case Western Reserve University | Private | 86,168 | 68,632 | 1,251 | 2,915 | 5,867 | 7,503 |
| 57 University of Texas-Cancer Ctr, MD Andrn | Public | 85,903 | 28,992 | 0 | 0 | 35,200 | 21,711 |
| 58 University of Illinois-Chicago | Public | 85,237 | 43,288 | 3,629 | 5,333 | 25,064 | 7,923 |
| 59 University of Utah | Public | 83,340 | 61,819 | 3,511 | 2,700 | 11,259 | 4,051 |
| 60 Princeton University | Private | 82,914 | 47,176 | 1,018 | 5,640 | 21,760 | 7,320 |
| **Total, 1st 60 institutions** | | 9,386,771 | 5,687,201 | 761,787 | 581,743 | 1,668,055 | 687,985 |
| 61 Indiana University-all campuses | Public | 81,793 | 58,334 | 833 | 2,591 | 15,120 | 4,915 |
| 62 University of Virginia | Public | 81,281 | 51,214 | 7,006 | 5,768 | 10,196 | 7,097 |
| 63 University of Texas-Health Sci Ctr Dallas | Public | 79,920 | 51,254 | 429 | 6,938 | 3,951 | 17,348 |
| 64 SUNY-Stony Brook | Public | 79,455 | 49,726 | 2,534 | 3,093 | 16,710 | 7,392 |
| 65 University of Maryland-Baltimore | Public | 75,854 | 35,970 | 14,047 | 11,183 | 9,488 | 5,166 |
| 66 Woods Hole Oceanographic Institute | Private | 74,881 | 64,333 | 341 | 916 | 1,257 | 8,034 |
| 67 Yeshiva University | Private | 74,496 | 58,224 | 0 | 0 | 8,022 | 8,250 |
| 68 University of Missouri-Columbia | Public | 74,055 | 22,312 | 11,210 | 6,434 | 29,864 | 4,235 |
| 69 Rockefeller University | Private | 73,945 | 41,192 | 297 | 3,453 | 17,442 | 11,561 |
| 70 University of Hawaii-Manoa | Public | 70,733 | 40,574 | 24,759 | 799 | 3,686 | 915 |
| **Total, 1st 70 institutions** | | 10,153,184 | 6,160,334 | 823,243 | 622,918 | 1,783,791 | 762,898 |
| 71 Utah State University | Public | 69,944 | 42,449 | 12,125 | 1,315 | 13,087 | 968 |
| 72 University of Cincinnati-all campuses | Public | 69,831 | 40,598 | 2,910 | 4,160 | 14,019 | 8,144 |
| 73 University of Kentucky | Public | 69,532 | 27,010 | 6,840 | 5,819 | 25,318 | 4,545 |
| 74 University of Nebraska-Lincoln | Public | 68,281 | 25,803 | 22,006 | 2,675 | 15,931 | 1,866 |
| 75 University of California-Irvine | Public | 66,806 | 46,492 | 1,483 | 4,582 | 7,706 | 6,543 |
| 76 Boston University | Private | 66,325 | 56,402 | 550 | 2,555 | 0 | 6,818 |
| 77 Vanderbilt University | Private | 65,218 | 56,151 | 576 | 2,759 | 2,081 | 3,651 |
| 78 Emory University | Private | 64,713 | 46,497 | 2,242 | 6,169 | 1,904 | 7,901 |
| 79 Colorado State University | Public | 64,351 | 46,572 | 7,992 | 2,432 | 4,708 | 2,647 |
| 80 University of South Florida | Public | 60,973 | 26,576 | 2,824 | 327 | 29,246 | 2,000 |

(continued)

Appendix table 5-4.
**R&D expenditures at the top 100 universities and colleges, by source of funds: 1989**
(page 3 of 3)

| Academic institutions' ranking | Institutional category | Total | Federal Gov't | State and local gov't | Industry | Academic institutions | All other sources |
|---|---|---|---|---|---|---|---|
| | | Thousands of dollars | | | | | |
| **Total, 1st 80 institutions** | | 10,819,158 | 6,574,884 | 882,791 | 655,711 | 1,897,791 | 807,981 |
| 81 New Mexico State University-all campuses | Public | 60,930 | 45,660 | 7,070 | 6,242 | 1,727 | 231 |
| 82 Wayne State University | Public | 59,521 | 28,167 | 7,042 | 3,850 | 15,507 | 4,955 |
| 83 University of Kansas | Public | 57,111 | 26,420 | 2,674 | 2,809 | 23,640 | 1,568 |
| 84 CUNY-Mount Sinai School of Medicine | Private | 56,856 | 37,233 | 957 | 3,732 | 5,767 | 9,167 |
| 85 University of Alaska-Fairbanks | Public | 56,701 | 26,659 | 2,101 | 3,039 | 21,869 | 3,033 |
| 86 Clemson University | Public | 56,699 | 12,484 | 16,245 | 3,849 | 22,486 | 1,635 |
| 87 Florida State University | Public | 55,245 | 24,897 | 1,566 | 832 | 25,449 | 2,501 |
| 88 Washington State University | Public | 55,173 | 22,697 | 2,268 | 2,258 | 22,945 | 5,005 |
| 89 University of Medicine & Dentistry of NJ | Public | 54,451 | 27,983 | 9,421 | 2,583 | 9,166 | 5,298 |
| 90 University of Oklahoma | Public | 53,956 | 17,020 | 3,052 | 1,991 | 24,226 | 7,667 |
| **Total, 1st 90 institutions** | | 11,385,801 | 6,844,104 | 935,187 | 686,896 | 2,070,573 | 849,041 |
| 91 Auburn University-all campuses | Public | 53,814 | 15,179 | 13,570 | 4,111 | 17,667 | 3,287 |
| 92 Mississippi State University | Public | 53,670 | 17,694 | 20,334 | 3,886 | 5,416 | 6,340 |
| 93 Oklahoma State University | Public | 53,655 | 14,116 | 1,853 | 1,645 | 34,613 | 1,428 |
| 94 Georgetown University | Private | 53,597 | 37,351 | 217 | 4,370 | 8,278 | 3,381 |
| 95 University of California-Riverside | Public | 53,213 | 15,584 | 2,441 | 1,094 | 31,449 | 2,645 |
| 96 University of New Mexico | Public | 52,970 | 23,934 | 5,660 | 2,496 | 11,732 | 9,148 |
| 97 Tufts University | Private | 50,424 | 40,771 | 773 | 8,010 | 847 | 23 |
| 98 University of California-Santa Barbara | Public | 50,067 | 39,227 | 1,036 | 2,645 | 4,878 | 2,281 |
| 99 Kansas State Univ. of Agric. & Applied Sci | Public | 47,302 | 15,951 | 21,133 | 1,790 | 6,384 | 2,044 |
| 100 Univ. of Texas-Health Science Ctr Houston | Public | 46,860 | 29,500 | 5,668 | 3,266 | 1,694 | 6,732 |
| **Total, 1st 100 institutions** | | 11,901,373 | 7,093,411 | 1,007,872 | 720,209 | 2,193,531 | 886,350 |

[1]These figures exclude the Applied Physics Laboratory (APL) at Johns Hopkins University, which is similar to a federally funded research and development center and dominates the R&D performed at the university.

SOURCES: Science Resources Studies Division, National Science Foundation, *Academic Science/Engineering: R&D Expenditures, Fiscal Year 1989*, NSF 90-321, Detailed Statistical Tables (Washington, DC: NSF, 1991); and unpublished tabulations.

See text table 5-1. *Science & Engineering Indicators – 1991*

Appendix table 5-5.
**Federal and non-Federal R&D expenditures at universities and colleges, by field and source of funds: 1989**

| Field | Total | | Federal | | Non-Federal[1] | |
|---|---|---|---|---|---|---|
| | Thousands of dollars | Percent | Thousands of dollars | Percent | Thousands of dollars | Percent |
| TOTAL SCIENCE AND ENGINEERING | 14,987,279 | 100.0 | 8,972,468 | 59.9 | 6,014,811 | 40.1 |
| **Total sciences** | 12,599,686 | 84.1 | 7,592,804 | 60.3 | 5,006,882 | 39.7 |
| Physical sciences | 1,643,377 | 11.0 | 1,195,155 | 72.7 | 448,222 | 27.3 |
| Astronomy | 137,114 | 0.9 | 88,011 | 64.2 | 49,103 | 35.8 |
| Chemistry | 610,395 | 4.1 | 423,711 | 69.4 | 186,684 | 30.6 |
| Physics | 772,999 | 5.2 | 597,664 | 77.3 | 175,335 | 22.7 |
| Other | 122,869 | 0.8 | 85,769 | 69.8 | 37,100 | 30.2 |
| Mathematical sciences | 214,248 | 1.4 | 155,929 | 72.8 | 58,319 | 27.2 |
| Computer sciences | 467,729 | 3.1 | 317,882 | 68.0 | 149,847 | 32.0 |
| Environmental sciences | 982.937 | 6.6 | 644,691 | 65.6 | 338,246 | 34.4 |
| Atmospheric sciences | 159,084 | 1.1 | 124,894 | 78.5 | 34,190 | 21.5 |
| Earth sciences | 322,533 | 2.2 | 186,069 | 57.7 | 136,464 | 42.3 |
| Oceanography | 357,663 | 2.4 | 265,923 | 74.4 | 91,740 | 25.6 |
| Other | 143,657 | 1.0 | 67,805 | 47.2 | 75,852 | 52.8 |
| Life sciences | 8,079,851 | 53.9 | 4,772,841 | 59.1 | 3,307,010 | 40.9 |
| Agricultural sciences | 1,289,522 | 8.6 | 345,890 | 26.8 | 943,632 | 73.2 |
| Biological sciences | 2,609,759 | 17.4 | 1,719,858 | 65.9 | 889.901 | 34.1 |
| Medical sciences | 3,836,616 | 25.6 | 2,505,391 | 65.3 | 1,331,225 | 34.7 |
| Other | 343,954 | 2.3 | 201,702 | 58.6 | 142,252 | 41.4 |
| Psychology | 237,945 | 1.6 | 156,260 | 65.7 | 81,685 | 34.3 |
| Social sciences | 636,372 | 4.2 | 211,174 | 33.2 | 425,198 | 66.8 |
| Economics | 186,376 | 1.2 | 50,477 | 27.1 | 135,899 | 72.9 |
| Political science | 108,063 | 0.7 | 29,123 | 27.0 | 78,940 | 73.0 |
| Sociology | 118,554 | 0.8 | 52,802 | 44.5 | 65,752 | 55.5 |
| Other | 223,379 | 1.5 | 78,772 | 35.3 | 144,607 | 64.7 |
| Other sciences | 337,227 | 2.3 | 138,872 | 41.2 | 198,355 | 58.8 |
| **Total engineering** | 2,387,593 | 15.9 | 1,379,664 | 57.8 | 1,007,929 | 42.2 |
| Aeronautical/astronautical | 146,548 | 1.0 | 113,109 | 77.2 | 33,439 | 22.8 |
| Chemical | 185,087 | 1.2 | 92,947 | 50.2 | 92,140 | 49.8 |
| Civil | 249,552 | 1.7 | 104,108 | 41.7 | 145,444 | 58.3 |
| Electrical/electronic | 600,016 | 4.0 | 388,700 | 64.8 | 211,316 | 35.2 |
| Mechanical | 340,280 | 2.3 | 209,711 | 61.6 | 130,569 | 38.4 |
| Other | 866,110 | 5.8 | 471,089 | 54.4 | 395,021 | 45.6 |

[1]See appendix table 5-2 for detail on non-Federal sources.

SOURCES: Science Resources Studies Division, National Science Foundation, *Academic Science/Engineering: R&D Expenditures, Fiscal Year 1989*, NSF 90-321, Detailed Statistical Tables (Washington, DC: NSF, 1991); and unpublished tabulations.

*Science & Engineering Indicators – 1991*

Appendix table 5-6.
**Expenditures for academic R&D, by field: 1979-89**
(page 1 of 3)

| Field | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Thousands of current dollars | | | | | | | | | | |
| TOTAL SCIENCE & ENGINEERING | 5,379,917 | 6,076,713 | 6,846,302 | 7,322,745 | 7,876,861 | 8,616,682 | 9,686,358 | 10,925,519 | 12,153,437 | 13,465,094 | 14,987,279 |
| **Total sciences** | 4,604,364 | 5,203,539 | 5,869,568 | 6,281,886 | 6,746,534 | 7,387,668 | 8,271,436 | 9,287,291 | 10,265,945 | 11,373,904 | 12,599,686 |
| Physical sciences | 602,106 | 677,407 | 765,358 | 823,363 | 899,695 | 999,672 | 1,147,733 | 1,285,972 | 1,390,942 | 1,547,216 | 1,643,377 |
| Astronomy | 48,492 | 58,625 | 67,259 | 73,125 | 73,442 | 80,474 | 96,083 | 101,795 | 108,429 | 124,438 | 137,114 |
| Chemistry | 206,353 | 243,943 | 284,696 | 308,058 | 334,982 | 371,484 | 421,023 | 469,275 | 513,102 | 567,822 | 610,395 |
| Physics | 292,366 | 322,760 | 357,151 | 366,833 | 417,037 | 473,591 | 550,834 | 630,244 | 666,568 | 732,486 | 772,999 |
| Other | 54,895 | 52,079 | 56,252 | 75,347 | 74,234 | 74,123 | 79,793 | 84,658 | 102,843 | 122,470 | 122,869 |
| Mathematical sciences | 77,822 | 78,108 | 87,099 | 96,459 | 106,440 | 123,261 | 128,031 | 151,904 | 176,871 | 198,833 | 214,248 |
| Computer sciences | 97,701 | 113,390 | 132,542 | 149,101 | 175,902 | 224,637 | 282,722 | 322,874 | 373,086 | 410,839 | 467,729 |
| Environmental sciences | 452,831 | 508,262 | 549,273 | 557,353 | 615,892 | 643,946 | 703,180 | 772,605 | 830,819 | 884,522 | 982,937 |
| Atmospheric sciences | NA | 75,898 | 87,357 | 86,668 | 98,636 | 102,010 | 107,696 | 120,057 | 128,345 | 133,668 | 159,084 |
| Earth sciences | NA | 188,570 | 190,238 | 195,272 | 216,245 | 227,768 | 253,931 | 274,525 | 284,091 | 294,559 | 322,533 |
| Oceanography | NA | 176,313 | 191,995 | 198,202 | 223,931 | 236,784 | 257,973 | 279,992 | 299,949 | 333,282 | 357,663 |
| Other | 452,831 | 67,481 | 79,683 | 77,211 | 77,080 | 77,384 | 83,580 | 98,031 | 118,434 | 123,013 | 143,657 |
| Life sciences | 2,847,512 | 3,230,619 | 3,698,138 | 4,016,113 | 4,303,519 | 4,712,815 | 5,282,032 | 5,892,653 | 6,532,724 | 7,257,860 | 8,079,851 |
| Agricultural sciences | 612,256 | 689,127 | 789,574 | 864,681 | 921,445 | 954,565 | 999,674 | 1,089,949 | 1,120,938 | 1,181,841 | 1,289,522 |
| Biological sciences | 912,418 | 1,027,542 | 1,185,643 | 1,282,740 | 1,414,501 | 1,567,350 | 1,774,357 | 1,937,994 | 2,132,208 | 2,372,832 | 2,609,759 |
| Medical sciences | 1,246,579 | 1,422,915 | 1,612,621 | 1,745,615 | 1,835,875 | 2,040,616 | 2,327,268 | 2,625,341 | 3,015,867 | 3,387,914 | 3,836,616 |
| Other | 76,259 | 91,035 | 110,300 | 123,077 | 131,698 | 150,284 | 180,733 | 239,369 | 263,711 | 315,273 | 343,954 |
| Psychology | 99,694 | 110,108 | 126,935 | 130,609 | 135,669 | 145,525 | 158,534 | 170,705 | 187,881 | 213,989 | 237,945 |
| Social sciences | 293,245 | 339,550 | 365,648 | 353,023 | 344,642 | 358,317 | 382,844 | 462,472 | 502,098 | 553,238 | 636,372 |
| Economics | 83,349 | 90,942 | 98,800 | 95,116 | 98,088 | 108,494 | 117,988 | 135,766 | 149,685 | 164,142 | 186,376 |
| Political science | 44,641 | 54,476 | 55,403 | 60,213 | 54,624 | 56,110 | 59,379 | 68,835 | 81,221 | 87,027 | 108,063 |
| Sociology | 74,309 | 87,699 | 93,955 | 78,805 | 77,102 | 70,319 | 75,334 | 96,608 | 96,627 | 110,580 | 118,554 |
| Other | 90,946 | 106,433 | 117,490 | 118,889 | 114,828 | 123,394 | 130,143 | 161,263 | 174,565 | 191,489 | 223,379 |
| Other sciences | 133,453 | 146,095 | 144,575 | 155,865 | 164,775 | 179,495 | 186,360 | 228,106 | 271,524 | 307,407 | 337,227 |

(continued)

Appendix table 5-6.
**Expenditures for academic R&D, by field: 1979-89**
(page 2 of 3)

| Field | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Thousands of current dollars | | | | | | |
| **Total engineering** | 775,553 | 873,174 | 976,734 | 1,040,859 | 1,130,327 | 1,229,014 | 1,414,922 | 1,638,228 | 1,887,492 | 2,091,190 | 2,387,593 |
| Aeronautical/astronautical | NA | 53,096 | 58,532 | 65,160 | 69,916 | 71,831 | 82,229 | 93,530 | 110,065 | 124,737 | 146,548 |
| Chemical | NA | 60,874 | 79,235 | 83,808 | 91,174 | 96,095 | 109,782 | 126,197 | 140,649 | 154,169 | 185,087 |
| Civil | NA | 83,231 | 108,608 | 115,800 | 126,465 | 139,609 | 153,141 | 178,745 | 192,334 | 226,832 | 249,552 |
| Electrical/electronic | NA | 193,976 | 203,569 | 224,461 | 261,809 | 294,836 | 337,479 | 394,904 | 449,770 | 507,894 | 600,016 |
| Mechanical | NA | 140,335 | 140,582 | 142,388 | 148,820 | 178,361 | 206,894 | 227,031 | 273,340 | 300,886 | 340,280 |
| Other | NA | 341,662 | 386,208 | 409,242 | 432,143 | 448,282 | 525,397 | 617,821 | 721,334 | 776,672 | 866,110 |
| | | | | | Thousands of constant 1982 dollars' | | | | | | |
| TOTAL SCIENCE & ENGINEERING | 6,906,546 | 7,170,942 | 7,345,364 | 7,322,745 | 7,557,012 | 7,964,282 | 8,684,745 | 9,541,111 | 10,296,590 | 11,071,623 | 11,825,067 |
| **Total sciences** | 5,910,919 | 6,140,537 | 6,297,431 | 6,281,886 | 6,472,583 | 6,828,321 | 7,416,133 | 8,110,468 | 8,697,476 | 9,352,150 | 9,941,240 |
| Physical sciences | 772,962 | 799,387 | 821,149 | 823,363 | 863,162 | 923,983 | 1,029,052 | 1,123,022 | 1,178,429 | 1,272,193 | 1,296,636 |
| Astronomy | 62,252 | 69,182 | 72,162 | 73,125 | 70,460 | 74,381 | 86,148 | 88,896 | 91,863 | 102,319 | 108,184 |
| Chemistry | 264,909 | 287,870 | 305,449 | 308,058 | 321,380 | 343,358 | 377,487 | 409,812 | 434,708 | 466,890 | 481,606 |
| Physics | 375,329 | 380,879 | 383,186 | 366,833 | 400,103 | 437,734 | 493,875 | 550,384 | 564,727 | 602,284 | 609,902 |
| Other | 70,472 | 61,457 | 60,352 | 75,347 | 71,220 | 68,511 | 71,542 | 73,931 | 87,130 | 100,701 | 96,944 |
| Mathematical sciences | 99,905 | 92,173 | 93,448 | 96,459 | 102,118 | 113,928 | 114,792 | 132,656 | 149,848 | 163,490 | 169,043 |
| Computer sciences | 125,425 | 133,808 | 142,204 | 149,101 | 168,759 | 207,629 | 253,487 | 281,962 | 316,085 | 337,811 | 369,041 |
| Environmental sciences | 581,328 | 599,784 | 589,312 | 557,353 | 590,883 | 595,191 | 630,468 | 674,706 | 703,883 | 727,295 | 775,544 |
| Atmospheric sciences | NA | 89,565 | 93,725 | 86,668 | 94,631 | 94,286 | 96,560 | 104,844 | 108,736 | 109,908 | 125,518 |
| Earth sciences | NA | 222,526 | 204,105 | 195,272 | 207,464 | 210,523 | 227,673 | 239,739 | 240,687 | 242,200 | 254,481 |
| Oceanography | NA | 208,062 | 205,991 | 198,202 | 214,838 | 218,856 | 231,297 | 244,513 | 254,122 | 274,040 | 282,199 |
| Other | 581,328 | 79,632 | 85,492 | 77,211 | 73,950 | 71,525 | 74,937 | 85,609 | 100,339 | 101,147 | 113,346 |
| Life sciences | 3,655,535 | 3,812,354 | 3,967,714 | 4,016,113 | 4,128,770 | 4,355,991 | 4,735,846 | 5,145,976 | 5,534,630 | 5,967,748 | 6,375,059 |
| Agricultural sciences | 785,992 | 813,218 | 847,130 | 864,681 | 884,029 | 882,291 | 896,303 | 951,838 | 949,677 | 971,764 | 1,017,442 |
| Biological sciences | 1,171,330 | 1,212,571 | 1,272,071 | 1,282,740 | 1,357,064 | 1,448,680 | 1,590,881 | 1,692,425 | 1,806,441 | 1,951,052 | 2,059,118 |
| Medical sciences | 1,600,314 | 1,679,138 | 1,730,173 | 1,745,615 | 1,761,327 | 1,886,114 | 2,086,618 | 2,292,676 | 2,555,092 | 2,785,700 | 3,027,117 |
| Other | 97,899 | 107,428 | 118,340 | 123,077 | 126,350 | 138,905 | 162,044 | 209,038 | 223,420 | 259,232 | 271,382 |
| Psychology | 127,984 | 129,935 | 136,188 | 130,609 | 130,160 | 134,507 | 142,141 | 149,074 | 159,176 | 175,952 | 187,740 |
| Social sciences | 376,458 | 400,693 | 392,302 | 353,023 | 330,647 | 331,188 | 343,256 | 403,871 | 425,386 | 454,898 | 502,102 |
| Economics | 107,000 | 107,318 | 106,002 | 95,116 | 94,105 | 100,280 | 105,788 | 118,563 | 126,816 | 134,965 | 147,052 |
| Political science | 57,309 | 64,285 | 59,442 | 60,213 | 52,406 | 51,862 | 53,239 | 60,113 | 68,812 | 71,558 | 85,262 |
| Sociology | 95,395 | 103,491 | 100,804 | 78,805 | 73,971 | 64,995 | 67,544 | 84,366 | 81,864 | 90,924 | 93,540 |
| Other | 116,753 | 125,598 | 126,054 | 118,889 | 110,165 | 114,051 | 116,686 | 140,829 | 147,894 | 157,451 | 176,248 |
| Other sciences | 171,322 | 172,402 | 155,114 | 155,865 | 158,084 | 165,905 | 167,090 | 199,202 | 230,040 | 252,764 | 266,074 |

(continued)

Appendix table 5-6.
**Expenditures for academic R&D, by field: 1979-89**
(page 3 of 3)

| Field | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Thousands of constant 1982 dollars[1] | | | | | | |
| **Total engineering** | 995,627 | 1,030,406 | 1,047,933 | 1,040,859 | 1,084,429 | 1,135,961 | 1,268,613 | 1,430,643 | 1,599,114 | 1,719,473 | 1,883,827 |
| Aeronautical/astronautical | NA | 62,657 | 62,799 | 65,160 | 67,077 | 66,392 | 73,726 | 81,679 | 93,249 | 102,565 | 115,627 |
| Chemical | NA | 71,836 | 85,011 | 83,808 | 87,472 | 88,819 | 98,430 | 110,206 | 119,160 | 126,765 | 116,035 |
| Civil | NA | 98,218 | 116,525 | 115,800 | 121,330 | 129,039 | 137,306 | 156,096 | 162,948 | 186,512 | 196,898 |
| Electrical/electronic | NA | 228,905 | 218,408 | 224,461 | 251,178 | 272,513 | 302,582 | 344,864 | 381,052 | 417,614 | 473,417 |
| Mechanical | NA | 165,605 | 150,830 | 142,388 | 142,777 | 164,857 | 185,500 | 198,263 | 231,578 | 247,402 | 268,483 |
| Other | NA | 403,185 | 414,361 | 409,242 | 414,595 | 414,341 | 471,069 | 539,535 | 611,126 | 638,616 | 683,367 |

NA = not available

[1]See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCES: Science Resources Studies Division, National Science Foundation, *Academic Science/Engineering: R&D Expenditures, Fiscal Year 1989*, NSF 90-321, Detailed Statistical Tables (Washington, DC: NSF, 1991); and annual series.

See figure 5-3.

Appendix table 5-7.
**Federal financing of academic R&D funds, by field: 1973-89**

| Field | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Percentage federally financed | | | | | | | | | | | | | | | | |
| TOTAL SCIENCE AND ENGINEERING | 68.8 | 67.2 | 67.1 | 67.4 | 67.0 | 66.2 | 67.0 | 67.5 | 66.7 | 65.0 | 63.3 | 62.9 | 62.5 | 61.3 | 60.3 | 60.8 | 59.9 |
| Physical sciences | 81.8 | 81.0 | 81.4 | 80.5 | 80.0 | 79.6 | 81.5 | 81.9 | 80.8 | 78.9 | 77.7 | 78.2 | 77.5 | 76.4 | 75.3 | 74.6 | 72.7 |
| Astronomy | 73.4 | 70.0 | 73.4 | 69.8 | 71.8 | 71.6 | 74.8 | 75.6 | 71.0 | 70.6 | 68.0 | 66.1 | 67.0 | 68.5 | 65.7 | 65.5 | 64.2 |
| Chemistry | 76.1 | 76.6 | 76.8 | 77.0 | 76.2 | 75.8 | 75.8 | 77.7 | 76.0 | 74.7 | 73.8 | 75.1 | 74.2 | 72.0 | 71.7 | 71.3 | 69.4 |
| Physics | 87.1 | 86.6 | 86.4 | 85.3 | 85.2 | 84.9 | 86.4 | 86.8 | 86.5 | 83.6 | 82.1 | 82.4 | 82.3 | 81.0 | 79.7 | 78.6 | 77.3 |
| Other | 79.7 | 74.4 | 77.7 | 77.2 | 73.7 | 72.6 | 82.7 | 78.7 | 81.1 | 81.2 | 80.4 | 80.1 | 75.0 | 75.8 | 75.1 | 74.7 | 69.8 |
| Math and computer sciences | 73.8 | 75.7 | 76.3 | 75.6 | 72.5 | 68.6 | 73.9 | 72.0 | 73.4 | 72.8 | 72.3 | 73.3 | 71.2 | 73.1 | 70.6 | 71.9 | 69.5 |
| Mathematical sciences | 77.5 | 78.4 | 78.6 | 77.4 | 77.7 | 75.7 | 77.6 | 78.4 | 77.7 | 74.4 | 71.8 | 74.9 | 75.8 | 75.3 | 74.3 | 75.0 | 72.8 |
| Computer sciences | 69.9 | 73.2 | 74.3 | 74.0 | 67.6 | 62.2 | 70.9 | 67.6 | 70.5 | 71.7 | 72.6 | 72.5 | 69.2 | 72.0 | 68.9 | 70.4 | 68.0 |
| Environmental sciences | 75.2 | 71.7 | 70.8 | 73.4 | 74.7 | 72.7 | 72.6 | 73.2 | 71.1 | 70.1 | 69.1 | 69.1 | 67.2 | 66.7 | 65.1 | 65.9 | 65.6 |
| Atmospheric sciences | NA | NA | NA | NA | NA | NA | NA | 84.2 | 77.0 | 80.0 | 78.5 | 80.8 | 79.9 | 81.3 | 82.5 | 81.7 | 78.5 |
| Earth sciences | NA | NA | NA | NA | NA | NA | NA | 69.7 | 67.2 | 65.0 | 62.4 | 61.5 | 60.7 | 58.3 | 56.2 | 59.2 | 57.7 |
| Oceanography | NA | NA | NA | NA | NA | NA | NA | 77.6 | 77.9 | 77.4 | 76.6 | 76.4 | 72.7 | 74.3 | 72.6 | 71.6 | 74.4 |
| Other | 75.2 | 71.7 | 70.8 | 73.4 | 74.7 | 72.7 | 72.6 | 58.7 | 57.7 | 53.2 | 54.0 | 53.8 | 53.6 | 50.1 | 48.7 | 49.2 | 47.2 |
| Life sciences | 66.3 | 64.5 | 65.1 | 65.7 | 65.3 | 63.9 | 64.0 | 64.8 | 63.9 | 62.3 | 60.1 | 60.0 | 60.3 | 59.2 | 58.6 | 59.5 | 59.1 |
| Agricultural sciences | 34.1 | 29.2 | 29.4 | 29.7 | 28.8 | 29.2 | 30.5 | 31.1 | 29.7 | 29.5 | 28.4 | 28.2 | 29.4 | 26.8 | 26.5 | 27.3 | 26.8 |
| Biological sciences | 71.6 | 71.7 | 72.5 | 73.5 | 74.5 | 72.8 | 72.6 | 74.0 | 73.0 | 71.4 | 69.5 | 69.5 | 67.9 | 67.4 | 66.2 | 67.0 | 65.9 |
| Medical sciences | 75.3 | 75.9 | 75.6 | 75.5 | 74.9 | 73.1 | 73.7 | 74.4 | 73.7 | 71.7 | 68.7 | 67.3 | 67.8 | 66.4 | 65.1 | 65.4 | 65.3 |
| Other | 70.3 | 72.5 | 71.8 | 72.6 | 71.7 | 70.6 | 70.1 | 67.4 | 67.6 | 63.8 | 60.8 | 62.8 | 60.0 | 61.3 | 59.7 | 60.1 | 58.6 |
| Psychology | 79.5 | 78.9 | 76.8 | 76.2 | 74.8 | 71.4 | 72.3 | 73.3 | 72.7 | 68.2 | 66.1 | 67.4 | 67.0 | 67.0 | 66.1 | 65.8 | 65.7 |
| Social sciences | 57.3 | 56.9 | 55.2 | 52.7 | 51.6 | 51.1 | 53.0 | 53.8 | 51.0 | 45.7 | 42.6 | 39.9 | 40.1 | 37.4 | 33.5 | 34.0 | 33.2 |
| Economics | 47.6 | 46.6 | 48.2 | 44.5 | 43.8 | 48.1 | 48.4 | 48.9 | 45.4 | 43.7 | 39.5 | 39.1 | 37.0 | 33.5 | 29.0 | 30.0 | 27.1 |
| Political science | 40.6 | 44.0 | 41.8 | 42.2 | 46.2 | 42.1 | 46.0 | 43.4 | 42.0 | 37.3 | 36.8 | 33.9 | 33.3 | 29.5 | 29.7 | 28.9 | 27.0 |
| Sociology | 65.8 | 65.1 | 65.5 | 62.1 | 61.1 | 61.0 | 63.7 | 65.0 | 60.7 | 58.6 | 55.6 | 54.3 | 53.3 | 51.3 | 46.6 | 44.4 | 44.5 |
| Other | 61.0 | 60.0 | 55.9 | 54.8 | 52.9 | 50.6 | 51.9 | 54.0 | 52.3 | 42.9 | 39.3 | 35.1 | 38.4 | 35.6 | 31.9 | 33.9 | 35.3 |
| Other sciences | 58.7 | 57.1 | 57.2 | 59.5 | 54.9 | 57.4 | 54.9 | 53.6 | 56.6 | 56.5 | 52.7 | 48.5 | 49.3 | 47.1 | 46.0 | 43.4 | 41.2 |
| Engineering | 71.5 | 69.0 | 68.1 | 67.3 | 67.6 | 67.9 | 68.7 | 69.0 | 68.7 | 67.6 | 65.9 | 64.0 | 61.2 | 59.6 | 58.7 | 58.6 | 57.8 |
| Aeronautical/astronautical | NA | NA | NA | NA | NA | NA | NA | 79.5 | 81.8 | 80.6 | 80.4 | 79.4 | 78.5 | 78.8 | 76.0 | 77.8 | 77.2 |
| Chemical | NA | NA | NA | NA | NA | NA | NA | 64.4 | 64.0 | 59.7 | 57.6 | 57.1 | 53.4 | 53.6 | 49.5 | 50.6 | 50.2 |
| Civil | NA | NA | NA | NA | NA | NA | NA | 64.1 | 56.8 | 51.4 | 50.4 | 51.9 | 51.6 | 49.7 | 47.1 | 46.1 | 41.7 |
| Electrical/electronic | NA | NA | NA | NA | NA | NA | NA | 77.1 | 76.6 | 77.4 | 73.8 | 71.0 | 67.7 | 65.9 | 64.7 | 64.8 | 64.8 |
| Mechanical | NA | NA | NA | NA | NA | NA | NA | 67.0 | 67.5 | 68.4 | 67.2 | 66.5 | 64.6 | 64.9 | 64.8 | 63.3 | 61.6 |
| Other | NA | NA | NA | NA | NA | NA | NA | 65.7 | 67.4 | 66.1 | 64.5 | 61.2 | 57.3 | 54.7 | 55.0 | 54.8 | 54.4 |

NA = not available

SOURCES: Science Resources Studies Division, National Science Foundation, *Academic Science/Engineering: R&D Expenditures, Fiscal Year 1989*, NSF 90-321, Detailed Statistical Tables (Washington, DC: NSF, 1991); and annual series

Appendix table 5-8.
**Federal obligations for academic R&D, by agency: 1971-91**
(page 1 of 2)

| | Total agencies | National Institutes of Health | National Science Foundation | Department of Defense | National Aero & Space Administration | Department of Energy[a] | Department of Agriculture | All other agencies |
|---|---|---|---|---|---|---|---|---|
| | | | | Millions of current dollars | | | | |
| 1971 | 1,645 | 603 | 267 | 211 | 134 | 94 | 72 | 264 |
| 1972 | 1,904 | 756 | 362 | 217 | 119 | 85 | 87 | 277 |
| 1973 | 1,917 | 761 | 374 | 204 | 111 | 83 | 94 | 289 |
| 1974 | 2,214 | 1,027 | 389 | 197 | 99 | 94 | 95 | 312 |
| 1975 | 2,411 | 1,077 | 435 | 203 | 108 | 132 | 108 | 348 |
| 1976 | 2,552 | 1,185 | 437 | 240 | 119 | 145 | 120 | 307 |
| 1977 | 2,905 | 1,311 | 511 | 273 | 118 | 188 | 140 | 364 |
| 1978 | 3,375 | 1,493 | 537 | 383 | 127 | 240 | 186 | 408 |
| 1979 | 3,889 | 1,765 | 617 | 438 | 139 | 260 | 200 | 470 |
| 1980 | 4,263 | 1,888 | 685 | 495 | 158 | 285 | 216 | 536 |
| 1981 | 4,466 | 1,984 | 702 | 573 | 171 | 300 | 243 | 492 |
| 1982 | 4,605 | 2,026 | 715 | 664 | 186 | 277 | 255 | 483 |
| 1983 | 4,966 | 2,264 | 783 | 724 | 189 | 297 | 275 | 434 |
| 1984 | 5,547 | 2,560 | 880 | 830 | 204 | 321 | 261 | 491 |
| 1985 | 6,340 | 2,974 | 1,002 | 940 | 237 | 357 | 293 | 536 |
| 1986 | 6,559 | 3,044 | 992 | 1,098 | 254 | 345 | 274 | 553 |
| 1987 | 7,337 | 3,638 | 1,096 | 1,017 | 294 | 386 | 280 | 626 |
| 1988 | 7,828 | 3,886 | 1,143 | 1,071 | 338 | 406 | 305 | 678 |
| 1989 | 8,672 | 4,157 | 1,254 | 1,189 | 434 | 454 | 328 | 858 |
| 1990 (est.) | 8,748 | 4,143 | 1,317 | 1,049 | 493 | 441 | 346 | 959 |
| 1991 (est.) | 9,191 | 4,339 | 1,478 | 1,069 | 533 | 429 | 364 | 980 |
| | | | | Millions of constant 1982 dollars[b] | | | | |
| 1971 | 3,767 | 1,382 | 611 | 483 | 307 | 215 | 165 | 604 |
| 1972 | 4,133 | 1,641 | 787 | 471 | 258 | 183 | 190 | 602 |
| 1973 | 3,964 | 1,574 | 775 | 421 | 230 | 171 | 195 | 598 |
| 1974 | 4,245 | 1,969 | 746 | 378 | 190 | 180 | 182 | 599 |
| 1975 | 4,207 | 1,878 | 759 | 355 | 188 | 230 | 189 | 608 |
| 1976 | 4,111 | 1,908 | 703 | 387 | 192 | 234 | 193 | 494 |
| 1977 | 4,335 | 1,956 | 762 | 408 | 175 | 281 | 209 | 543 |
| 1978 | 4,705 | 2,082 | 749 | 534 | 177 | 335 | 260 | 568 |
| 1979 | 4,992 | 2,266 | 792 | 562 | 178 | 334 | 256 | 604 |
| 1980 | 5,031 | 2,228 | 808 | 585 | 186 | 336 | 255 | 633 |
| 1981 | 4,791 | 2,129 | 753 | 615 | 184 | 322 | 260 | 528 |
| 1982 | 4,605 | 2,026 | 715 | 664 | 186 | 277 | 255 | 483 |
| 1983 | 4,765 | 2,172 | 751 | 695 | 182 | 285 | 264 | 416 |
| 1984 | 5,127 | 2,366 | 814 | 767 | 188 | 297 | 241 | 454 |
| 1985 | 5,684 | 2,667 | 898 | 843 | 213 | 320 | 263 | 481 |
| 1986 | 5,728 | 2,658 | 866 | 959 | 222 | 301 | 239 | 483 |
| 1987 | 6,216 | 3,083 | 929 | 862 | 249 | 327 | 237 | 530 |
| 1988 | 6,436 | 3,195 | 940 | 881 | 278 | 334 | 251 | 558 |
| 1989 | 6,842 | 3,280 | 989 | 938 | 342 | 358 | 259 | 677 |
| 1990 (est.) | 6,636 | 3,143 | 999 | 796 | 374 | 335 | 262 | 727 |
| 1991 (est.) | 6,676 | 3,152 | 1,073 | 777 | 387 | 312 | 264 | 712 |

(continued)

Appendix table 5-8.
**Federal obligations for academic R&D, by agency: 1971-91**
(page 2 of 2)

| | Total agencies | National Institutes of Health | National Science Foundation | Department of Defense | National Aero & Space Administration | Department of Energy[1] | Department of Agriculture | All other agencies |
|---|---|---|---|---|---|---|---|---|
| | Percent | | | | | | | |
| 1971 | 100 | 36.7 | 16.2 | 12.8 | 8.2 | 5.7 | 4.4 | 16.0 |
| 1972 | 100 | 39.7 | 19.0 | 11.4 | 6.3 | 4.4 | 4.6 | 14.6 |
| 1973 | 100 | 39.7 | 19.5 | 10.6 | 5.8 | 4.3 | 4.9 | 15.1 |
| 1974 | 100 | 46.4 | 17.6 | 8.9 | 4.5 | 4.2 | 4.3 | 14.1 |
| 1975 | 100 | 44.6 | 18.0 | 8.4 | 4.5 | 5.5 | 4.5 | 14.4 |
| 1976 | 100 | 46.4 | 17.1 | 9.4 | 4.7 | 5.7 | 4.7 | 12.0 |
| 1977 | 100 | 45.1 | 17.6 | 9.4 | 4.0 | 6.5 | 4.8 | 12.5 |
| 1978 | 100 | 44.2 | 15.9 | 11.4 | 3.8 | 7.1 | 5.5 | 12.1 |
| 1979 | 100 | 45.4 | 15.9 | 11.3 | 3.6 | 6.7 | 5.1 | 12.1 |
| 1980 | 100 | 44.3 | 16.1 | 11.6 | 3.7 | 6.7 | 5.1 | 12.6 |
| 1981 | 100 | 44.4 | 15.7 | 12.8 | 3.8 | 6.7 | 5.4 | 11.0 |
| 1982 | 100 | 44.0 | 15.5 | 14.4 | 4.0 | 6.0 | 5.5 | 10.5 |
| 1983 | 100 | 45.6 | 15.8 | 14.6 | 3.8 | 6.0 | 5.5 | 8.7 |
| 1984 | 100 | 46.2 | 15.9 | 15.0 | 3.7 | 5.8 | 4.7 | 8.8 |
| 1985 | 100 | 46.9 | 15.8 | 14.8 | 3.7 | 5.6 | 4.6 | 8.5 |
| 1986 | 100 | 46.4 | 15.1 | 16.7 | 3.9 | 5.3 | 4.2 | 8.4 |
| 1987 | 100 | 49.6 | 14.9 | 13.9 | 4.0 | 5.3 | 3.8 | 8.5 |
| 1988 | 100 | 49.6 | 14.6 | 13.7 | 4.3 | 5.2 | 3.9 | 8.7 |
| 1989 | 100 | 47.9 | 14.5 | 13.7 | 5.0 | 5.2 | 3.8 | 9.9 |
| 1990 (est.) | 100 | 47.4 | 15.1 | 12.0 | 5.6 | 5.0 | 3.9 | 11.0 |
| 1991 (est.) | 100 | 47.2 | 16.1 | 11.6 | 5.8 | 4.7 | 4.0 | 10.7 |

NOTE: Percentages may not total 100 because of rounding.

[1]Atomic Energy Commission, 1971-73; Energy Research and Development Administration, 1974-76; Department of Energy, 1977-91.

[2]See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCES: Science Resources Studies Division, National Science Foundation. *Federal Funds for Research and Development: Fiscal Years 1989, 1990, and 1991*, NSF 90-327 Final, Detailed Statistical Tables (Washington, DC: NSF, 1991); and annual series.

*Science & Engineering Indicators – 1991*

Appendix table 5-9.
**Federal academic R&D obligations, by lead agency and field: 1971-89**
(page 1 of 2)

| Field | Lead agency | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Percentage from lead agency | | | | | | | | | | | | | | | | | | |
| TOTAL SCIENCE AND ENGINEERING | HHS | 44.8 | 47.4 | 48.3 | 54.1 | 53.7 | 53.3 | 51.8 | 49.0 | 50.8 | 48.7 | 47.9 | 46.3 | 47.0 | 49.2 | 49.6 | 49.7 | 53.0 | 53.5 | 53.0 |
| Physical sciences | NSF | 20.4 | 27.9 | 29.0 | 31.6 | 35.9 | 36.2 | 35.2 | 34.5 | 36.6 | 35.6 | 32.9 | 37.2 | 36.6 | 39.0 | 38.8 | 37.0 | 36.9 | 36.5 | 35.8 |
| Astronomy | NASA | 74.7 | 74.5 | 73.3 | 69.8 | 67.2 | 65.1 | 59.8 | 61.3 | 66.9 | 69.9 | 74.1 | 64.3 | 66.3 | 65.1 | 61.8 | 62.8 | 64.9 | 65.8 | 68.6 |
| Chemistry | NSF | 25.2 | 32.6 | 32.0 | 30.6 | 38.9 | 37.0 | 36.5 | 35.6 | 37.7 | 37.8 | 33.8 | 36.3 | 36.9 | 38.9 | 38.9 | 37.5 | 38.7 | 38.9 | 39.8 |
| Physics | DOE | 30.0 | 30.3 | 30.0 | 34.4 | 34.8 | 33.7 | 38.3 | 39.5 | 41.8 | 42.2 | 45.8 | 44.7 | 46.7 | 46.5 | 45.7 | 44.1 | 43.6 | 43.3 | 41.3 |
| Other | NSF | 0.0 | 1.0 | 1.4 | 2.1 | 40.1 | 46.1 | 35.9 | 49.4 | 50.4 | 67.9 | 72.8 | 79.4 | 77.4 | 77.4 | 71.8 | 72.7 | 70.6 | 69.9 | 71.0 |
| Math and computer sciences | NSF | 39.5 | 43.9 | 47.3 | 45.7 | 45.4 | 40.4 | 48.9 | 50.6 | 57.6 | 50.2 | 52.4 | 50.8 | 50.9 | 53.8 | 53.4 | 53.4 | 53.1 | 50.8 | 54.0 |
| Mathematical sciences | NSF | NA | NA | NA | NA | NA | NA | 41.8 | 50.6 | 53.2 | 46.0 | 49.1 | 47.6 | 47.7 | 50.3 | 49.2 | 52.5 | 55.1 | 55.4 | 60.4 |
| Computer sciences | NSF | NA | NA | NA | NA | NA | NA | 62.0 | 52.3 | 66.2 | 58.4 | 61.3 | 56.8 | 56.4 | 59.4 | 58.4 | 56.7 | 52.6 | 45.9 | 48.5 |
| Environmental sciences | NSF | 32.5 | 41.4 | 44.2 | 48.4 | 50.1 | 48.1 | 39.1 | 39.1 | 38.9 | 37.5 | 42.1 | 43.5 | 45.5 | 44.7 | 42.0 | 41.1 | 41.0 | 41.0 | 40.2 |
| Atmospheric sciences | NSF | 31.0 | 35.4 | 41.2 | 38.0 | 46.0 | 45.2 | 29.7 | 33.4 | 32.5 | 38.6 | 34.9 | 36.9 | 38.9 | 41.1 | 35.0 | 38.0 | 41.5 | 36.4 | 37.8 |
| Earth sciences | NSF | 22.0 | 31.1 | 29.0 | 31.7 | 41.5 | 49.1 | 41.3 | 41.5 | 47.6 | 51.0 | 56.7 | 60.4 | 66.7 | 62.0 | 60.1 | 59.0 | 57.6 | 52.0 | 50.6 |
| Oceanography | NSF | 44.5 | 60.4 | 59.4 | 66.8 | 35.8 | 39.1 | 38.4 | 32.1 | 30.4 | 31.1 | 31.5 | 31.3 | 30.1 | 30.2 | 32.8 | 36.0 | 28.8 | 35.6 | 35.6 |
| Other | NSF | 27.8 | 24.8 | 30.3 | 43.4 | 74.8 | 63.1 | 51.5 | 52.7 | 42.6 | 26.9 | 46.5 | 46.7 | 54.4 | 58.1 | 43.3 | 30.5 | 38.3 | 39.2 | 35.6 |
| Life sciences | HHS | 76.4 | 79.3 | 79.6 | 82.6 | 82.3 | 81.4 | 82.1 | 80.6 | 80.6 | 81.3 | 79.9 | 77.7 | 79.6 | 80.6 | 80.5 | 81.1 | 82.8 | 83.8 | 83.6 |
| Agricultural sciences | USDA | NA | NA | NA | NA | NA | NA | NA | NA | 80.3 | 86.4 | 81.5 | 75.9 | 79.2 | 72.7 | 76.5 | 78.4 | 77.2 | 83.7 | 78.4 |
| Biological sciences | HHS | 63.4 | 61.8 | 62.5 | 66.8 | 66.3 | 67.1 | 67.8 | 71.0 | 80.0 | 82.3 | 81.3 | 81.7 | 83.4 | 80.8 | 81.5 | 81.5 | 83.4 | 83.9 | 82.8 |
| Medical sciences | HHS | 95.1 | 94.8 | 96.0 | 96.6 | 96.5 | 96.8 | 96.8 | 95.9 | 94.4 | 92.8 | 92.4 | 88.3 | 90.0 | 92.3 | 91.9 | 92.0 | 93.1 | 93.4 | 94.6 |
| Psychology | HHS | 59.2 | 60.5 | 63.6 | 65.5 | 75.0 | 75.7 | 72.1 | 68.6 | 77.2 | 74.9 | 75.6 | 77.7 | 77.9 | 78.7 | 79.2 | 80.8 | 83.3 | 84.2 | 85.6 |
| Social sciences | HHS | 37.7 | 43.8 | 41.9 | 42.7 | 54.4 | 41.6 | 43.3 | 47.9 | 58.3 | 31.5 | 29.4 | 28.4 | 27.3 | 33.6 | 33.7 | 33.6 | 42.2 | 44.6 | 49.0 |
| Economics | USDA | 43.1 | 8.1 | 9.7 | 7.2 | 4.3 | 3.0 | 4.0 | 40.8 | 41.4 | 40.2 | 45.6 | 56.3 | 59.9 | 54.6 | 46.4 | 47.8 | 44.1 | 55.0 | 50.6 |
| Political science | NSF | 46.0 | 55.2 | 59.1 | 53.6 | 44.0 | 52.3 | 59.8 | 66.7 | 51.8 | 71.8 | 60.1 | 81.3 | 61.2 | 48.2 | 60.3 | 47.4 | 54.4 | 52.3 | 45.9 |
| Sociology | HHS | 40.7 | 45.5 | 47.9 | 55.7 | 71.0 | 57.3 | 52.5 | 42.0 | 57.5 | 48.5 | 63.5 | 61.0 | 67.7 | 66.3 | 62.5 | 58.1 | 69.3 | 75.5 | 75.1 |
| Anthropology | NSF | 69.1 | 77.4 | 87.4 | 72.8 | 76.2 | 70.5 | 67.4 | 47.6 | 58.3 | 59.2 | 78.2 | 93.8 | 96.8 | 88.7 | 91.5 | 88.2 | 70.7 | 73.5 | 89.4 |
| Linguistics | NSF | 29.2 | 51.7 | 47.2 | 66.8 | 50.3 | 61.5 | 65.4 | 65.3 | 67.5 | 72.8 | 72.1 | 88.8 | 90.8 | 94.8 | 95.5 | 94.5 | 92.3 | 86.8 | 77.9 |
| History of science | NSF | 85.0 | 49.5 | 93.5 | 80.1 | 86.4 | 99.3 | 87.6 | 89.9 | 89.9 | 76.4 | 86.1 | 98.4 | 93.9 | 96.9 | 97.9 | 94.0 | 88.2 | 89.7 | 91.2 |
| Other | HHS | 54.4 | 57.5 | 55.6 | 49.7 | 68.6 | 54.5 | 54.9 | 88.4 | 92.4 | 42.5 | 32.7 | 68.1 | 41.4 | 38.8 | 39.1 | 40.3 | 57.7 | 54.9 | 56.2 |
| Other sciences | HHS | 40.3 | 49.8 | 37.2 | 43.2 | 48.9 | 58.9 | 66.6 | 58.9 | 51.1 | 45.2 | 53.5 | 43.3 | 51.6 | 44.2 | 49.9 | 40.6 | 37.8 | 30.1 | 33.1 |

(continued)

424 425

Appendix table 5-9.
**Federal academic R&D obligations, by lead agency and field: 1971-89**
(page 2 of 2)

| Field | Lead agency | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Percentage from lead agency | | | | | | | | | | | | | | | | | | |
| Engineering | DOD | 45.2 | 40.3 | 42.1 | 30.7 | 27.9 | 26.6 | 30.2 | 53.8 | 61.4 | 55.4 | 62.1 | 67.4 | 67.4 | 61.3 | 62.7 | 65.6 | 66.5 | 66.9 | 61.2 |
| Aeronautical/astronautical | DOD | 14.1 | 30.8 | 13.1 | 42.1 | 31.9 | 22.0 | 32.9 | 47.0 | 56.4 | 49.9 | 49.7 | 57.5 | 62.7 | 55.0 | 57.4 | 58.3 | 55.6 | 54.5 | 51.7 |
| Chemical | NSF | 71.1 | 51.0 | 48.2 | 62.4 | 60.7 | 40.2 | 27.4 | 22.1 | 51.9 | 53.8 | 52.6 | 50.7 | 43.8 | 44.2 | 39.1 | 55.0 | 51.7 | 41.1 | 74.2 |
| Civil | NSF | 36.5 | 37.9 | 29.1 | 38.6 | 32.5 | 44.0 | 48.1 | 42.9 | 45.5 | 40.1 | 30.5 | 53.6 | 43.1 | 49.8 | 68.9 | 68.1 | 64.6 | 63.2 | 53.5 |
| Electrical/electronic | DOD | 80.4 | 76.2 | 77.3 | 61.6 | 58.3 | 44.0 | 50.3 | 59.4 | 62.5 | 68.4 | 72.2 | 79.2 | 81.5 | 75.6 | 83.5 | 82.0 | 81.4 | 86.1 | 78.1 |
| Mechanical | NSF | 40.6 | 33.8 | 52.4 | 52.5 | 45.6 | 32.0 | 30.3 | 25.9 | 35.3 | 22.7 | 26.9 | 34.1 | 34.7 | 36.6 | 35.2 | 40.9 | 34.3 | 36.8 | 48.4 |
| Materials/metallurgy | NSF | 16.3 | 57.4 | 55.9 | 56.1 | 35.6 | 39.4 | 37.1 | 33.1 | 40.2 | 26.0 | 33.8 | 30.0 | 30.1 | 30.8 | 33.8 | 28.0 | 20.9 | 16.4 | 18.1 |
| Other | DOD | 19.3 | 25.2 | 40.2 | 17.1 | 19.3 | 20.2 | 25.8 | 71.6 | 77.5 | 75.8 | 78.4 | 80.0 | 81.3 | 79.7 | 77.9 | 80.4 | 82.6 | 80.4 | 73.4 |

NOTE: DOD = Department of Defense; DOE = Department of Energy; HHS = Department of Health and Human Services; NASA = National Aeronautics and Space Administration; NSF = National Science Foundation; USDA = Department of Agriculture.

NASA provided over 80 percent of the Federal academic R&D obligations for aerospace engineering in the 1970s; this field is now split between NASA and DOD.

SOURCES: Science Resources Studies Division, National Science Foundation, *Federal Funds for Research and Development: Fiscal Years 1989, 1990, and 1991*, NSF 90-327 Final, Detailed Statistical Tables (Washington, DC: NSF, 1991); and annual series.

See figure 5-4.

Appendix table 5-10.
**Capital funds expenditures for academic facilities and certain equipment: 1964-89**

| | Total | | Federal sources | | Non-Federal sources | |
|---|---|---|---|---|---|---|
| | Current dollars | Constant 1982 dollars[1] | Current dollars | Constant 1982 dollars[1] | Current dollars | Constant 1982 dollars[1] |
| | Thousands of dollars | | | | | |
| 1964 | 529,492 | 1,602,094 | 134,439 | 406,775 | 395,053 | 1,195,319 |
| 1965 | NA | NA | NA | NA | NA | NA |
| 1966 | 666,997 | 1,919,968 | 212,397 | 611,390 | 454,600 | 1,308,578 |
| 1967 | NA | NA | NA | NA | NA | NA |
| 1968 | 1,070,727 | 2,879,072 | 340,447 | 915,426 | 730,280 | 1,963,646 |
| 1969 | NA | NA | NA | NA | NA | NA |
| 1970 | 951,873 | 2,294,776 | 279,316 | 673,375 | 672,557 | 1,621,401 |
| 1971 | NA | NA | NA | NA | NA | NA |
| 1972 | 912,487 | 1,981,034 | 236,836 | 514,177 | 675,651 | 1,466,856 |
| 1973 | 835,862 | 1,728,790 | 224,651 | 464,639 | 611,211 | 1,264,151 |
| 1974 | 841,560 | 1,613,521 | 225,681 | 432,698 | 615,879 | 1,180,823 |
| 1975 | 1,018,773 | 1,771,062 | 270,083 | 469,519 | 748,690 | 1,301,542 |
| 1976 | 1,043,153 | 1,680,342 | 206,890 | 333,265 | 836,263 | 1,347,078 |
| 1977 | 960,014 | 1,432,190 | 195,519 | 291,684 | 764,495 | 1,140,506 |
| 1978 | NA | NA | NA | NA | NA | NA |
| 1979 | 694,583 | 891,681 | 169,419 | 217,494 | 525,164 | 674,187 |
| 1980 | 790,040 | 932,302 | 147,590 | 174,166 | 642,450 | 758,136 |
| 1981 | 953,529 | 1,023,037 | 160,557 | 172,261 | 792,972 | 850,776 |
| 1982 | 964,596 | 964,596 | 126,448 | 126,448 | 838,148 | 838,148 |
| 1983 | 1,091,753 | 1,047,421 | 135,101 | 129,615 | 956,652 | 917,806 |
| 1984 | 1,174,646 | 1,085,709 | 142,440 | 131,655 | 1,032,206 | 954,054 |
| 1985 | 1,222,698 | 1,096,266 | 106,801 | 95,757 | 1,115,897 | 1,000,508 |
| 1986 | 1,493,503 | 1,304,256 | 170,509 | 148,903 | 1,322,994 | 1,155,353 |
| 1987 | 1,737,118 | 1,471,715 | 193,246 | 163,721 | 1,543,872 | 1,307,993 |
| 1988 | 1,954,626 | 1,607,184 | 202,034 | 166,122 | 1,752,592 | 1,441,062 |
| 1989 | 2,091,399 | 1,650,365 | 205,769 | 162,353 | 1,885,930 | 1,488,012 |

NA = not available

NOTE: Data are for expenditures on facilities used for research, development, and instruction, and for expenditures on nonfixed equipment costing over $1 million.

[1]See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCES: Science Resources Studies Division, National Science Foundation. *Academic Science/Engineering: R&D Expenditures, Fiscal Year 1989*, NSF 90-321, Detailed Statistical Tables (Washington, DC: NSF, 1991); and annual series.

See figure 5-5 and figure O-20 in Overview. *Science & Engineering Indicators – 1991*

Appendix table 5-11.

**Capital expenditures at universities and colleges, by field and source of funds: 1980-89**

(page 1 of 2)

| Field | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Thousands of current dollars | | | | | |
| TOTAL | 790,040 | 953,529 | 964,596 | 1,091,753 | 1,174,646 | 1,222,698 | 1,493,503 | 1,737,118 | 1,954,626 | 2,091,699 |
| Total sciences | 700,088 | 848,037 | 817,600 | 954,918 | 1,027,762 | 1,039,100 | 1,179,354 | 1,357,333 | 1,589,311 | 1,719,874 |
| Physical sciences | 77,567 | 88,880 | 83,296 | 97,864 | 110,134 | 115,653 | 143,667 | 156,849 | 204,919 | 237,669 |
| Math and computer sciences | 32,923 | 31,904 | 35,651 | 54,206 | 48,921 | 77,209 | 90,603 | 82,651 | 95,412 | 72,672 |
| Environmental sciences | 36,727 | 36,790 | 44,006 | 42,174 | 36,218 | 54,574 | 48,945 | 54,063 | 58,676 | 67,518 |
| Life sciences | 452,522 | 591,395 | 578,398 | 667,367 | 716,602 | 691,149 | 768,281 | 908,977 | 1,050,025 | 1,161,852 |
| Pyschology | 17,970 | 11,139 | 12,956 | 16,705 | 31,317 | 12,807 | 17,816 | 9,669 | 12,130 | 13,894 |
| Social sciences | 34,956 | 45,702 | 31,344 | 40,898 | 46,941 | 60,720 | 49,919 | 55,207 | 80,709 | 77,483 |
| Other sciences | 47,423 | 42,227 | 31,949 | 35,704 | 37,629 | 26,988 | 60,123 | 89,917 | 87,440 | 88,786 |
| Engineering | 89,952 | 105,492 | 146,996 | 136,835 | 146,884 | 183,598 | 314,149 | 379,785 | 365,315 | 371,825 |
| **Federal sources** | 147,590 | 160,557 | 126,448 | 135,101 | 142,440 | 106,801 | 170,509 | 193,246 | 202,034 | 205,769 |
| Total sciences | 126,335 | 141,436 | 105,517 | 116,711 | 111,800 | 90,008 | 132,973 | 143,902 | 155,024 | 162,429 |
| Physical sciences | 22,939 | 26,590 | 21,966 | 19,482 | 20,713 | 31,497 | 38,108 | 40,130 | 33,140 | 40,249 |
| Math and computer sciences | 6,156 | 5,649 | 5,049 | 5.516 | 8,697 | 8,918 | 17,516 | 12,228 | 19,529 | 7,335 |
| Environmental sciences | 8,513 | 8,330 | 6,006 | 4,639 | 4,828 | 4,128 | 8.168 | 15,199 | 13,455 | 18,985 |
| Life sciences | 81,732 | 90,452 | 67,319 | 79,357 | 72,685 | 40,315 | 57,823 | 57,954 | 71,203 | 77,031 |
| Pyschology | 2,037 | 1,768 | 1,205 | 1,082 | 1,035 | 871 | 1,739 | 989 | 2,184 | 1,654 |
| Social sciences | 1,616 | 7,149 | 2,213 | 5,277 | 3,209 | 2,493 | 3,618 | 4,834 | 7,985 | 8,178 |
| Other sciences | 3,342 | 1,498 | 1,759 | 1.358 | 633 | 1,786 | 6,001 | 12,568 | 7,528 | 8,997 |
| Engineering | 21,255 | 19,121 | 20,931 | 18,390 | 30,640 | 16,793 | 37,536 | 49,344 | 47,010 | 43,340 |
| **Non-Federal sources** | 642,450 | 792,972 | 838,148 | 956,652 | 1,032,206 | 1,115,897 | 1,322,994 | 1,543,872 | 1,752,592 | 1,885,930 |
| Total sciences | 573,753 | 706,601 | 712,083 | 838.207 | 915,962 | 949,092 | 1,046,381 | 1,213,431 | 1,434,287 | 1,557,445 |
| Physical sciences | 54,628 | 62,290 | 61,330 | 78,382 | 89,421 | 84.156 | 105.559 | 116,719 | 171,779 | 197,420 |
| Math and computer sciences | 26.767 | 26,255 | 30,602 | 48,690 | 40,224 | 68.291 | 73,087 | 70,423 | 75,883 | 60,183 |
| Environmental sciences | 28.214 | 28,460 | 38,000 | 37,535 | 31,390 | 50,446 | 40,777 | 38,864 | 45,221 | 53,687 |
| Life sciences | 370.790 | 500,943 | 511,079 | 588,010 | 643 917 | 650.834 | 710,458 | 851,023 | 978,822 | 1,084,821 |
| Pyschology | 15,933 | 9,371 | 11,751 | 15,623 | 30,282 | 11,936 | 16,077 | 8,680 | 9,946 | 12,240 |
| Social sciences | 33,340 | 38.553 | 29,131 | 35,621 | 43,732 | 58,227 | 46.301 | 50,373 | 72,724 | 69,305 |
| Other sciences | 44,081 | 40.729 | 30,190 | 34,346 | 36,996 | 25.202 | 54,122 | 77,349 | 79,912 | 79,789 |
| Engineering | 68,697 | 86,371 | 126,065 | 118,445 | 116,244 | 166,805 | 276,613 | 330,441 | 318,305 | 328,485 |

(continued)

Appendix table 5-11.
**Capital expenditures at universities and colleges, by field and source of funds: 1980-89**
(page 2 of 2)

| Field | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Thousands of constant 1982 dollars' | | | | | | | | | |
| TOTAL | 932,302 | 1,023,037 | 964,596 | 1,047,421 | 1,085,709 | 1,096,266 | 1,304,256 | 1,471,715 | 1,607,184 | 1,650,365 |
| Total sciences | 826,152 | 909,855 | 817,600 | 916,142 | 94[illegible],946 | 931,652 | 1,029,914 | 1,149,955 | 1,306,805 | 1,356,993 |
| Physical sciences | 91,534 | 95,359 | 83,296 | 93,890 | 101,795 | 103,694 | 125,462 | 132,885 | 168,494 | 187,522 |
| Math and computer sciences | 38,851 | 34,230 | 35,651 | 52,005 | 45,217 | 69,225 | 79,122 | 70,023 | 78,452 | 53,272 |
| Environmental sciences | 43,340 | 39,472 | 44,006 | 40,461 | 33,476 | 48,931 | 42,743 | 45,803 | 48,246 | 57,339 |
| Life sciences | 534,007 | 634,505 | 578,398 | 640,268 | 662,345 | 619,681 | 670,930 | 770,100 | 863,379 | 916,709 |
| Pyschology | 21,206 | 11,951 | 12,956 | 16,027 | 28,946 | 11,483 | 15,558 | 8,192 | 9,974 | 10,962 |
| Social sciences | 41,251 | 49,033 | 31,344 | 39,237 | 43,387 | 54,441 | 43,594 | 46,772 | 66,363 | 61,135 |
| Other sciences | 55,962 | 45,305 | 31,949 | 34,254 | 34,780 | 24,197 | 52,505 | 76,179 | 71,897 | 70,053 |
| Engineering | 106,150 | 113,182 | 146,996 | 131,279 | 135,763 | 164,613 | 274,342 | 321,760 | 300,379 | 293,373 |
| **Federal sources** | 174,166 | 172,261 | 126,448 | 129,615 | 131,655 | 95,757 | 148,903 | 163,721 | 166,122 | 162,353 |
| Total sciences | 149,084 | 151,746 | 105,517 | 111,972 | 103,335 | 80,701 | 116,124 | 121,916 | 127,468 | 128,158 |
| Physical sciences | 27,070 | 28,528 | 21,966 | 18,691 | 19,145 | 28,240 | 33,279 | 33,999 | 27,249 | 31,757 |
| Math and computer sciences | 7,265 | 6,061 | 5,049 | 5,292 | 8,039 | 7,996 | 15,296 | 10,360 | 16,058 | 5,787 |
| Environmental sciences | 10,046 | 8,937 | 6,006 | 4,451 | 4,462 | 3,701 | 7,133 | 12,877 | 11,063 | 14,979 |
| Life sciences | 96,449 | 97,046 | 67,319 | 76,135 | 67,182 | 36,146 | 50,496 | 49,100 | 58,546 | 60,778 |
| Pyschology | 2,404 | 1,897 | 1,205 | 1,038 | 957 | 781 | 1,519 | 838 | 1,796 | 1,305 |
| Social sciences | 1,907 | 7,670 | 2,213 | 5,063 | 2,966 | 2,235 | 3,160 | 4,095 | 6,566 | 6,452 |
| Other sciences | 3,944 | 1,607 | 1,759 | 1,303 | 585 | 1,601 | 5,241 | 10,648 | 6,190 | 7,099 |
| Engineering | 25,082 | 20,515 | 20,931 | 17,643 | 28,320 | 15,057 | 32,780 | 41,805 | 38,654 | 34,196 |
| **Non-Federal sources** | 758,136 | 850,776 | 838,148 | 917,806 | 954,054 | 1,000,508 | 1,155,353 | 1,307,993 | 1,441,062 | 1,488,012 |
| Total sciences | 677,068 | 758,109 | 712,083 | 804,171 | 846,611 | 850,952 | 913,791 | 1,028,038 | 1,179,337 | 1,228,835 |
| Physical sciences | 64,465 | 66,831 | 61,330 | 75,199 | 82,651 | 75,454 | 92,183 | 98,886 | 141,245 | 155,766 |
| Math and computer sciences | 31,587 | 28,169 | 30,602 | 46,713 | 37,178 | 61,229 | 63,826 | 59,664 | 62,395 | 47,485 |
| Environmental sciences | 33,294 | 30,535 | 38,000 | 36,011 | 29,013 | 45,230 | 35,610 | 32,926 | 37,183 | 42,359 |
| Life sciences | 437,558 | 537,459 | 511,079 | 564,133 | 595,164 | 583,535 | 620,434 | 721,001 | 804,833 | 855,931 |
| Pyschology | 18,802 | 10,054 | 11,751 | 14,989 | 27,989 | 10,702 | 14,040 | 7,354 | 8,178 | 9,657 |
| Social sciences | 39,344 | 41,363 | 29,131 | 34,175 | 40,421 | 52,206 | 40,434 | 42,677 | 59,797 | 54,682 |
| Other sciences | 52,019 | 43,698 | 30,190 | 32,951 | 34,195 | 22,596 | 47,264 | 65,531 | 65,707 | 62,954 |
| Engineering | 81,067 | 92,667 | 126,065 | 113,635 | 107,443 | 149,557 | 241,562 | 279,955 | 261,725 | 259,177 |

See appendix table 4-1 for GNP implicit price deflators used convert current dollars to constant 1982 dollars.

SOURCES: Science Resources Studies Division, National Science Foundation. *Academic Science/Engineering: R&D Expenditures, Fiscal Year 1989*, NSF 90-321, Detailed Statistical Tables (Washington, DC: NSF, 1991); and annual series.

*Science & Engineering Indicators – 1991*

Appendix table 5-12.
**Cost and square footage of academic R&D construction: 1986-91**

| Field | New R&D space | | | Cost[1] | | | Cost per square foot | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1986-87 actual | 1988-89 actual | 1990-91 planned | 1986-87 actual | 1988-89 actual | 1990-91 planned | 1986-87 actual | 1988-89 actual | 1990-91 planned |
| | Thousands of square feet | | | Millions of dollars | | | Dollars | | |
| Total | 9,922 | 10,647 | 11,222 | 2,051 | 2,464 | 3,495 | 207 | 231 | 311 |
| Physical sciences | 799 | 2,000 | 1,564 | 182 | 401 | 624 | 228 | 201 | 399 |
| Mathematical sciences | 9 | 25 | 45 | 2 | 8 | 11 | 222 | 320 | 244 |
| Computer sciences | 237 | 286 | 392 | 61 | 65 | 99 | 257 | 227 | 253 |
| Environmental sciences | 380 | 324 | 520 | 57 | 82 | 165 | 150 | 253 | 317 |
| Agricultural sciences | 1,513 | 1,146 | 756 | 150 | 152 | 186 | 99 | 133 | 246 |
| Biological sciences | 1,708 | 2,262 | 2,808 | 463 | 577 | 944 | 271 | 255 | 336 |
| Medical sciences | 1,948 | 2,253 | 2,723 | 505 | 647 | 877 | 259 | 287 | 322 |
| Psychology | 132 | 115 | 21 | 23 | 25 | 9 | 174 | 217 | 429 |
| Social sciences | 202 | 329 | 162 | 38 | 48 | 34 | 188 | 146 | 210 |
| Other sciences | 603 | 418 | 36 | 139 | 70 | 17 | 231 | 167 | 472 |
| Engineering | 2,390 | 1,490 | 2,196 | 430 | 388 | 529 | 180 | 260 | 241 |

NOTE: Data for 2 years are combined, e.g., 1988-89 refers to two academic years.

[1]Project cost estimates are prorated to reflect R&D component only.

SOURCE: Science Resources Studies Division, National Science Foundation, *Scientific and Engineering Research Facilities at Universities and Colleges: 1990*, NSF 90-318 (Washington, DC: NSF, 1990).

*Science & Engineering Indicators – 1991*

Appendix table 5-13.
**Current fund expenditures for research equipment at universities and colleges, by field: 1981-89**
(page 1 of 2)

| Field | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|
| **Federal and non-Federal** | | | | | | | | | |
| | Thousands of current dollars | | | | | | | | |
| Total | 418,273 | 421,400 | 455,167 | 541,596 | 680,508 | 790,166 | 847,339 | 921,099 | 997,880 |
| Physical sciences | 77,527 | 79,554 | 81,039 | 103,684 | 142,045 | 163,010 | 165,492 | 180,910 | 179,388 |
| Mathematical sciences | 2,641 | 3,568 | 3,746 | 5,326 | 6,149 | 6,854 | 9,764 | 9,601 | 10,555 |
| Computer sciences | 13,011 | 14,726 | 18,588 | 22,919 | 37,541 | 44,274 | 43,645 | 44,505 | 42,321 |
| Environmental sciences | 31,102 | 28,528 | 31,672 | 41,625 | 48,280 | 51,846 | 55,532 | 55,563 | 66,430 |
| Life sciences | 199,646 | 201,924 | 211,370 | 245,998 | 287,553 | 335,407 | 344,107 | 386,374 | 442,421 |
| Pyschology | 5,754 | 5,701 | 6,603 | 7,346 | 8,758 | 8,673 | 10,600 | 9,647 | 10,717 |
| Social sciences | 7,793 | 7,073 | 9,452 | 13,800 | 10,040 | 13,892 | 11,779 | 11,832 | 14,378 |
| Other sciences | 7,261 | 8,992 | 10,438 | 10,342 | 14,718 | 20,070 | 27,265 | 27,005 | 26,680 |
| Engineering | 73,538 | 71,334 | 82,259 | 90,556 | 125,424 | 146,140 | 179,155 | 195,662 | 204,990 |
| **Federal** | | | | | | | | | |
| Total | 262,394 | 270,433 | 281,267 | 342,321 | 433,132 | 501,902 | 527,230 | 577,412 | 594,191 |
| Physical sciences | 59,460 | 63,763 | 63,610 | 82,653 | 113,189 | 130,405 | 130,267 | 142,077 | 131,653 |
| Mathematical sciences | 1,850 | 2,559 | 2,485 | 4,082 | 4,934 | 5,172 | 7,577 | 7,516 | 6,946 |
| Computer sciences | 7,132 | 9,865 | 12,223 | 16,846 | 29,398 | 35,098 | 33,932 | 34,716 | 28,983 |
| Environmental sciences | 18,870 | 18,370 | 19,719 | 29,760 | 33,041 | 35,779 | 36,144 | 36,624 | 44,790 |
| Life sciences | 117,842 | 116,473 | 115,033 | 137,224 | 157,056 | 188,614 | 188,344 | 215,754 | 239,523 |
| Psychology | 4,166 | 4,052 | 4,596 | 4,998 | 6,228 | 5,857 | 8,105 | 6,575 | 6,892 |
| Social sciences | 3,380 | 2,748 | 3,103 | 3,905 | 4,044 | 4,179 | 3,438 | 3,296 | 4,672 |
| Other sciences | 4,061 | 5,724 | 6,245 | 5,601 | 6,792 | 11,762 | 14,085 | 13,014 | 13,410 |
| Engineering | 45,633 | 46,879 | 54,253 | 57,252 | 78,450 | 85,036 | 105,338 | 117,840 | 117,322 |
| **Non-Federal** | | | | | | | | | |
| Total | 155,879 | 150,967 | 173,900 | 199,275 | 247,376 | 288,264 | 320,109 | 343,687 | 403,689 |
| Physical sciences | 18,067 | 15,791 | 17,429 | 21,031 | 28,856 | 32,605 | 35,225 | 38,833 | 47,735 |
| Mathematical sciences | 791 | 1,009 | 1,261 | 1,244 | 1,215 | 1,682 | 2,187 | 2,085 | 3,609 |
| Computer sciences | 5,879 | 4,861 | 6,365 | 6,073 | 8,143 | 9,176 | 9,713 | 9,789 | 13,338 |
| Environmental sciences | 12,232 | 10,158 | 11,953 | 11,865 | 15,239 | 16,067 | 19,388 | 18,939 | 21,640 |
| Life sciences | 81,804 | 85,451 | 96,337 | 108,774 | 130,497 | 146,793 | 155,763 | 170,620 | 202,898 |
| Pyschology | 1,588 | 1,649 | 2,007 | 2,348 | 2,530 | 2,816 | 2,495 | 3,072 | 3,825 |
| Social sciences | 4,413 | 4,325 | 6,349 | 9,895 | 5,996 | 9,713 | 8,341 | 8,536 | 9,706 |
| Other sciences | 3,200 | 3,268 | 4,193 | 4,741 | 7,926 | 8,308 | 13,180 | 13,991 | 13,270 |
| Engineering | 27,905 | 24,455 | 28,006 | 33,304 | 46,974 | 61,104 | 73,817 | 77,822 | 87,668 |
| **Federal and non-Federal** | | | | | | | | | |
| | Thousands of constant 1982 dollars[1] | | | | | | | | |
| Total | 448,763 | 421,400 | 436,684 | 500,590 | 610,140 | 690,042 | 717,879 | 757,370 | 787,334 |
| Physical sciences | 83,178 | 79,554 | 77,748 | 95,834 | 127,357 | 142,354 | 140,208 | 148,753 | 141,538 |
| Mathematical sciences | 2,834 | 3,568 | 3,594 | 4,923 | 5,513 | 5,986 | 8,272 | 7,894 | 8,328 |
| Computer sciences | 13,959 | 14,726 | 17,833 | 21,184 | 33,659 | 38,664 | 36,977 | 36,594 | 33,392 |
| Environmental sciences | 33,369 | 28,528 | 30,386 | 38,473 | 43,288 | 45,276 | 47,048 | 45,686 | 52,414 |
| Life sciences | 214,199 | 201,924 | 202,787 | 227,373 | 257,619 | 292,906 | 291,533 | 317,695 | 349,073 |
| Pyschology | 6,173 | 5,701 | 6,335 | 6,790 | 7,852 | 7,574 | 8,980 | 7,932 | 8,456 |
| Social sciences | 8,361 | 7,073 | 9,068 | 12,755 | 9,002 | 12,132 | 9,979 | 9,729 | 11,344 |
| Other sciences | 7,790 | 8,992 | 10,014 | 9,559 | 13,196 | 17,527 | 23,099 | 22,205 | 21,051 |
| Engineering | 78,899 | 71,334 | 78,919 | 83,700 | 112,455 | 127,622 | 151,783 | 160,882 | 161,739 |

(continued)

Appendix table 5-13.
**Current fund expenditures for research equipment at universities and colleges, by field: 1981-89**
(page 2 of 2)

| Field | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | **Federal** | | | | |
| | | | | | Thousands of constant 1982 dollars' | | | | |
| Total | 281,521 | 270,433 | 269,846 | 316,403 | 388,344 | 438,304 | 446,678 | 474,775 | 468,821 |
| Physical sciences | 63,794 | 63,763 | 61,027 | 76,395 | 101,485 | 113,881 | 110,364 | 116,822 | 103,875 |
| Mathematical sciences | 1,985 | 2,559 | 2,384 | 3,773 | 4,424 | 4,517 | 6,419 | 6,180 | 5,480 |
| Computer sciences | 7,652 | 9,865 | 11,727 | 15,571 | 26,358 | 30,651 | 28,748 | 28,545 | 22,868 |
| Environmental sciences | 20,246 | 18,370 | 18,918 | 27,507 | 29,624 | 31,245 | 30,622 | 30,114 | 35,340 |
| Life sciences | 126,432 | 116,473 | 110,362 | 126,834 | 140,816 | 164,714 | 159,568 | 177,403 | 188,985 |
| Pyschology | 4,470 | 4,052 | 4,409 | 4,620 | 5,584 | 5,115 | 6,867 | 5,406 | 5,438 |
| Social sciences | 3,626 | 2,748 | 2,977 | 3,609 | 3,626 | 3,649 | 2,913 | 2,710 | 3,686 |
| Other sciences | 4,357 | 5,724 | 5,991 | 5,177 | 6,090 | 10,272 | 11,933 | 10,701 | 10,581 |
| Engineering | 48,959 | 46,879 | 52,050 | 52,917 | 70,338 | 74,261 | 89,244 | 96,894 | 92,568 |
| | | | | | **Non-Federal** | | | | |
| Total | 167,242 | 150,967 | 166,839 | 184,187 | 221,796 | 251,737 | 271,202 | 282,595 | 318,513 |
| Physical sciences | 19,384 | 15,791 | 16,721 | 19,439 | 25,872 | 28,474 | 29,843 | 31,930 | 37,663 |
| Mathematical sciences | 849 | 1,009 | 1,210 | 1,150 | 1,089 | 1,469 | 1,853 | 1,714 | 2,848 |
| Computer sciences | 6,308 | 4,861 | 6,107 | 5,613 | 7,301 | 8,013 | 8,229 | 8,049 | 10,524 |
| Environmental sciences | 13,124 | 10,158 | 11,468 | 10,967 | 13,663 | 14,031 | 16,426 | 15,573 | 17,074 |
| Life sciences | 87,767 | 85,451 | 92,425 | 100,538 | 117,003 | 128,192 | 131,965 | 140,292 | 160,088 |
| Psychology | 1,704 | 1,649 | 1,926 | 2,170 | 2,268 | 2,459 | 2,114 | 2,526 | 3,018 |
| Social sciences | 4,735 | 4,325 | 6,091 | 9,146 | 5,376 | 8,482 | 7,067 | 7,019 | 7,658 |
| Other sciences | 3,433 | 3,268 | 4,023 | 4,382 | 7,106 | 7,255 | 11,166 | 11,504 | 10,470 |
| Engineering | 29,939 | 24,455 | 26,869 | 30,782 | 42,117 | 53,361 | 62,539 | 63,989 | 69,171 |

'See appendix table 4-1 for GNP implicit price deflators used to convert current dollars into constant 1982 dollars.

SOURCES: Science Resources Studies Division, National Science Foundation, *Academic Science/Engineering: R&D Expenditures, Fiscal Year 1989*. NSF 90-321. Detailed Statistical Tables (Washington, DC: NSF, 1991); and annual series.

*Science & Engineering Indicators – 1991*

Appendix table 5-14.
**Trends in research equipment in the $10,000-$999,000 range, by system age: 1982-83, 1985-86, and 1988-89**

| | 1982-83 | | 1985-86 | | 1988-89 | |
|---|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | Number | Percent |
| Total systems | 36,300 | 100 | 53,390 | 100 | 78,950 | 100 |
| **Age (from year of purchase)** | | | | | | |
| Less than 3 years | 12,705 | 35 | 19,637 | 37 | 29,968 | 38 |
| 3-5 years | 9,801 | 27 | 13,791 | 26 | 24,312 | 31 |
| 6 or more years | 13,794 | 38 | 19,962 | 37 | 24,670 | 31 |

SOURCES: Science Resources Studies Division, National Science Foundation. *Characteristics of Science/Engineering Equipment in Academic Settings: 1989-90.* NSF 91-315 (Washington DC: NSF, 1991); and earlier reports.

*Science & Engineering Indicators – 1991*

Appendix table 5-15.
**National stock of in-use academic instrumentation, in selected fields: 1982-83, 1985-86, and 1988-89**

| Field | Instrument systems | | | Aggregate purchase price | | | Mean price per system | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1982-83 | 1985-86 | 1988-89 | 1982-83 | 1985-86 | 1988-89 | 1982-83 | 1985-86 | 1988-89 |
| | | Number | | | Millions of dollars | | | Thousands of dollars | |
| Total | 36,300 | 53,390 | 78,950 | 1,303 | 2,044 | 3,177 | 36.1 | 38.3 | 40.2 |
| Chemistry | 4,800 | 7,019 | 10,365 | 210 | 340 | 551 | 43.6 | 48.5 | 53.2 |
| Physics/astronomy | 3,900 | 5,325 | 8,131 | 180 | 248 | 357 | 45.8 | 46.6 | 44.0 |
| Computer sciences | 900 | 2,178 | 3,703 | 50 | 109 | 165 | 57.8 | 49.8 | 44.4 |
| Environmental sciences | 2,100 | 3,300 | 4,477 | 109 | 172 | 246 | 51.6 | 52.2 | 55.0 |
| Biological sciences | 15,300 | 22,301 | 29,530 | 420 | 645 | 928 | 27.4 | 28.9 | 31.4 |
| Agricultural sciences | 1,600 | 2,570 | 3,851 | 38 | 62 | 93 | 22.7 | 24.2 | 24.2 |
| Engineering | 7,600 | 10,697 | 18,894 | 296 | 467 | 837 | 38.5 | 43.7 | 44.3 |

NOTES: Details may not sum to totals because of rounding. Number of instrument systems, aggregate purchase price, and mean price per system are not adjusted for inflation.

SOURCES: Science Resources Studies Division, National Science Foundation, *Characteristics of Science/Engineering Equipment in Academic Settings: 1989-90.* NSF 91-315 (Washington, DC. NSF, 1991); and earlier reports.

*Science & Engineering Indicators – 1991*

Appendix table 5-16.
**Number and percentage of science and engineering fields in 277 universities and colleges, by total R&D volume and field: 1980-89**
(page 1 of 2)

| | Total | More than $1 million | More than $5 million | More than $10 million | Total | More than $1 million | More than $5 million | More than $10 million |
|---|---|---|---|---|---|---|---|---|
| | **Total science and engineering** | | | | | | | |
| | Number | | | | Percent | | | |
| 1980 | 3,621 | 1,162 | 382 | 188 | 52.3 | 16.8 | 5.5 | 2.7 |
| 1981 | 3,530 | 1,186 | 377 | 197 | 51.0 | 17.1 | 5.4 | 2.8 |
| 1982 | 3,539 | 1,192 | 372 | 195 | 51.1 | 17.2 | 5.4 | 2.8 |
| 1983 | 3,546 | 1,225 | 394 | 209 | 51.2 | 17.7 | 5.7 | 3.0 |
| 1984 | 3,601 | 1,231 | 402 | 222 | 52.0 | 17.8 | 5.8 | 3.2 |
| 1985 | 3,602 | 1,308 | 441 | 247 | 52.0 | 18.9 | 6.4 | 3.6 |
| 1986 | 3,691 | 1,396 | 482 | 264 | 53.3 | 20.2 | 7.0 | 3.8 |
| 1987 | 3,672 | 1,450 | 512 | 291 | 53.0 | 20.9 | 7.4 | 4.2 |
| 1988 | 3,670 | 1,526 | 543 | 301 | 53.0 | 22.0 | 7.8 | 4.3 |
| 1989 | 3,717 | 1,575 | 572 | 310 | 53.7 | 22.7 | 8.3 | 4.5 |
| | **Physical sciences** | | | | | | | |
| 1980 | 542 | 203 | 49 | 9 | 48.9 | 18.3 | 4.4 | 0.8 |
| 1981 | 531 | 207 | 47 | 8 | 47.9 | 18.7 | 4.2 | 0.7 |
| 1982 | 532 | 209 | 50 | 8 | 48.0 | 18.9 | 4.5 | 0.7 |
| 1983 | 536 | 218 | 53 | 11 | 48.4 | 19.7 | 4.8 | 1.0 |
| 1984 | 538 | 223 | 55 | 13 | 48.6 | 20.1 | 5.0 | 1.2 |
| 1985 | 541 | 236 | 70 | 16 | 48.8 | 21.3 | 6.3 | 1.4 |
| 1986 | 551 | 249 | 78 | 17 | 49.7 | 22.5 | 7.0 | 1.5 |
| 1987 | 556 | 256 | 79 | 21 | 50.2 | 23.1 | 7.1 | 1.9 |
| 1988 | 547 | 269 | 86 | 23 | 49.4 | 24.3 | 7.8 | 2.1 |
| 1989 | 558 | 274 | 90 | 25 | 50.4 | 24.7 | 8.1 | 2.3 |
| | **Mathematical and computer sciences** | | | | | | | |
| 1980 | 316 | 51 | 9 | 1 | 57.0 | 9.2 | 1.6 | 0.2 |
| 1981 | 323 | 55 | 8 | 2 | 58.3 | 9.9 | 1.4 | 0.4 |
| 1982 | 333 | 56 | 8 | 1 | 60.1 | 10.1 | 1.4 | 0.2 |
| 1983 | 335 | 67 | 9 | 2 | 60.5 | 12.1 | 1.6 | 0.4 |
| 1984 | 344 | 69 | 11 | 5 | 62.1 | 12.5 | 2.0 | 0.9 |
| 1985 | 344 | 76 | 15 | 7 | 62.1 | 13.7 | 2.7 | 1.3 |
| 1986 | 364 | 90 | 16 | 8 | 65.7 | 16.2 | 2.9 | 1.4 |
| 1987 | 365 | 101 | 17 | 9 | 65.9 | 18.2 | 3.1 | 1.6 |
| 1988 | 369 | 109 | 22 | 10 | 66.6 | 19.7 | 4.0 | 1.8 |
| 1989 | 379 | 114 | 23 | 8 | 68.4 | 20.6 | 4.2 | 1.4 |
| | **Environmental sciences** | | | | | | | |
| 1980 | 446 | 132 | 33 | 11 | 40.3 | 11.9 | 3.0 | 1.0 |
| 1981 | 395 | 142 | 31 | 11 | 35.6 | 12.8 | 2.8 | 1.0 |
| 1982 | 385 | 138 | 30 | 11 | 34.7 | 12.5 | 2.7 | 1.0 |
| 1983 | 370 | 138 | 30 | 11 | 33.4 | 12.5 | 2.7 | 1.0 |
| 1984 | 367 | 136 | 29 | [illegible] | 33.1 | 12.3 | 2.6 | 1.2 |
| 1985 | 364 | 140 | 33 | 16 | 32.9 | 12.6 | 3.0 | 1.4 |
| 1986 | 380 | 143 | 38 | 18 | 34.3 | 12.9 | 3.4 | 1.6 |
| 1987 | 380 | 149 | 38 | 20 | 34.3 | 13.4 | 3.4 | 1.8 |
| 1988 | 380 | 146 | 41 | 19 | 34.3 | 13.2 | 3.7 | 1.7 |
| 1989 | 372 | 155 | 46 | 18 | 33.6 | 14.0 | 4.2 | 1.6 |
| | **Life sciences** | | | | | | | |
| 1980 | 593 | 360 | 227 | 145 | 53.5 | 32.5 | 20.5 | 13.1 |
| 1981 | 600 | 366 | 231 | 156 | 54.2 | 33.0 | 20.8 | 14.1 |
| 1982 | 610 | 370 | 229 | 151 | 55.1 | 33.4 | 20.7 | 13.6 |
| 1983 | 628 | 379 | 242 | 165 | 56.7 | 34.2 | 21.8 | 14.9 |
| 1984 | 640 | 380 | 239 | 170 | 57.8 | 34.3 | 21.6 | 15.3 |
| 1985 | 642 | 387 | 249 | 185 | 57.9 | 34.9 | 22.5 | 16.7 |
| 1986 | 658 | 393 | 261 | 192 | 59.4 | 35.5 | 23.6 | 17.3 |
| 1987 | 657 | 404 | 268 | 201 | 59.3 | 36.5 | 24.2 | 18.1 |
| 1988 | 652 | 415 | 269 | 208 | 58.8 | 37.5 | 24.3 | 18.8 |
| 1989 | 660 | 420 | 278 | 213 | 59.6 | 37.9 | 25.1 | 19.2 |

(continued)

Appendix table 5-16.
**Number and percentage of science and engineering fields in 277 universities and colleges, by total R&D volume and field: 1980-89**
(page 2 of 2)

| | Total | More than $1 million | More than $5 million | More than $10 million | Total | More than $1 million | More than $5 million | More than $10 million |
|---|---|---|---|---|---|---|---|---|
| | | | | **Social sciences and psychology** | | | | |
| | Number | | | | Percent | | | |
| 1980 | 868 | 165 | 17 | 3 | 62.7 | 11.9 | 1.2 | 0.2 |
| 1981 | 859 | 166 | 14 | 3 | 62.0 | 12.0 | 1.0 | 0.2 |
| 1982 | 879 | 160 | 12 | 2 | 63.5 | 11.6 | 0.9 | 0.1 |
| 1983 | 871 | 151 | 13 | 1 | 62.9 | 10.9 | 0.9 | 0.1 |
| 1984 | 906 | 145 | 17 | 2 | 65.4 | 10.5 | 1.2 | 0.1 |
| 1985 | 889 | 158 | 15 | 1 | 64.2 | 11.4 | 1.1 | 0.1 |
| 1986 | 908 | 181 | 22 | 1 | 65.6 | 13.1 | 1.6 | 0.1 |
| 1987 | 890 | 184 | 23 | 4 | 64.3 | 13.3 | 1.7 | 0.3 |
| 1988 | 896 | 203 | 28 | 4 | 64.7 | 14.7 | 2.0 | 0.3 |
| 1989 | 907 | 214 | 30 | 6 | 65.5 | 15.5 | 2.2 | 0.4 |
| | | | | **Engineering** | | | | |
| 1980 | 856 | 251 | 47 | 19 | 51.5 | 15.1 | 2.8 | 1.1 |
| 1981 | 822 | 250 | 46 | 17 | 49.5 | 15.0 | 2.8 | 1.0 |
| 1982 | 800 | 259 | 43 | 22 | 48.1 | 15.6 | 2.6 | 1.3 |
| 1983 | 806 | 272 | 47 | 19 | 48.5 | 16.4 | 2.8 | 1.1 |
| 1984 | 806 | 278 | 51 | 19 | 48.5 | 16.7 | 3.1 | 1.1 |
| 1985 | 822 | 311 | 59 | 22 | 49.5 | 18.7 | 3.5 | 1.3 |
| 1986 | 830 | 340 | 67 | 28 | 49.9 | 20.5 | 4.0 | 1.7 |
| 1987 | 824 | 356 | 87 | 36 | 49.6 | 21.4 | 5.2 | 2.2 |
| 1988 | 826 | 384 | 97 | 37 | 49.7 | 23.1 | 5.8 | 2.2 |
| 1989 | 841 | 398 | 105 | 40 | 50.6 | 23.9 | 6.3 | 2.4 |

NOTES: Data represent 26 fields in 277 universities and colleges continuously surveyed by the National Science Foundation since 1973. Funding is in constant 1988 dollars.

SOURCES: Science Resources Studies Division, National Science Foundation. *Academic Science/Engineering: R&D Expenditures, Fiscal Year 1989.* NSF 90-321, Detailed Statistical Tables (Washington, DC: NSF, 1991); and unpublished tabulations.

*Science & Engineering Indicators – 1991*

Appendix table 5-17.
**Selected academic institutions by number of their science and engineering fields exceeding $1 million in total R&D expenditures: 1980-89**

| Number of fields | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 75 | 70 | 73 | 74 | 73 | 62 | 57 | 52 | 49 | 47 |
| 1 | 30 | 32 | 29 | 25 | 28 | 35 | 31 | 30 | 25 | 30 |
| 2 | 39 | 38 | 42 | 38 | 37 | 43 | 40 | 38 | 41 | 37 |
| 3 | 17 | 18 | 15 | 18 | 15 | 10 | 16 | 22 | 22 | 21 |
| 4 | 15 | 12 | 14 | 17 | 14 | 13 | 16 | 18 | 21 | 15 |
| 5 | 13 | 22 | 16 | 16 | 20 | 17 | 12 | 12 | 11 | 16 |
| 6 | 13 | 11 | 14 | 16 | 16 | 16 | 15 | 12 | 14 | 10 |
| 7 | 10 | 9 | 10 | 7 | 12 | 13 | 15 | 14 | 12 | 12 |
| 8 | 11 | 8 | 9 | 11 | 5 | 7 | 11 | 9 | 7 | 12 |
| 9 | 8 | 9 | 5 | 5 | 9 | 8 | 8 | 12 | 7 | 8 |
| 10 | 9 | 10 | 12 | 12 | 7 | 7 | 8 | 7 | 12 | 10 |
| 11 | 6 | 7 | 8 | 5 | 8 | 8 | 7 | 9 | 8 | 9 |
| 12 | 7 | 9 | 4 | 6 | 7 | 6 | 8 | 5 | 8 | 6 |
| 13 | 6 | 4 | 6 | 5 | 6 | 8 | 6 | 8 | 6 | 11 |
| 14 | 3 | 5 | 5 | 4 | 3 | 5 | 3 | 5 | 7 | 5 |
| 15 | 7 | 4 | 4 | 5 | 6 | 4 | 7 | 4 | 3 | 4 |
| 16 | 2 | 1 | 2 | 3 | 1 | 4 | 2 | 3 | 3 | 2 |
| 17 | 0 | 3 | 2 | 3 | 2 | 3 | 3 | 4 | 6 | 4 |
| 18 | 2 | 1 | 1 | 1 | 0 | 0 | 2 | 4 | 5 | 6 |
| 19 | 1 | 0 | 4 | 1 | 2 | 1 | 3 | 0 | 0 | 2 |
| 20 | 2 | 3 | 1 | 4 | 4 | 3 | 3 | 4 | 4 | 3 |
| 21 | 1 | 0 | 0 | 0 | 0 | 2 | 2 | 3 | 3 | 4 |
| 22 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| 23 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| 24 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

NOTES: Data represent 26 fields in 277 universities and colleges continuously surveyed by the National Science Foundation since 1973. Funding is in constant 1988 dollars.

SOURCES: Science Resources Studies Division, National Science Foundation, *Academic Science/Engineering: R&D Expenditures, Fiscal Year 1989*, NSF 90-321, Detailed Statistical Tables (Washington, DC: NSF, 1991); and unpublished tabulations.

See figure 5-6.

Appendix table 5-18.
**Total and Federal academic R&D funds, by geographic region and field: 1973-74, 1980-81, and 1988-89**

| Region | Total science and engineering | Physical sciences | Mathematical and computer sciences | Environ-mental sciences | Life sciences | Psychology | Social sciences | Other sciences | Engineering |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | **1973-74** | | | | |
| | | | | | Percentage of total R&D | | | | |
| East | 28.0 | 33.2 | 36.3 | 26.1 | 27.0 | 28.8 | 27.5 | 26.3 | 27.4 |
| West | 24.3 | 27.6 | 20.6 | 43.7 | 22.1 | 21.6 | 20.9 | 14.0 | 24.8 |
| North | 24.1 | 21.0 | 23.0 | 14.9 | 23.7 | 29.6 | 31.5 | 31.9 | 26.4 |
| South | 23.3 | 18.2 | 20.0 | 15.0 | 26.5 | 20.0 | 20.0 | 27.7 | 21.2 |
| | | | | | **1980-81** | | | | |
| East | 26.5 | 31.8 | 37.9 | 24.5 | 24.9 | 31.2 | 26.7 | 18.9 | 27.8 |
| West | 24.8 | 27.5 | 16.0 | 41.3 | 22.8 | 21.9 | 20.5 | 24.4 | 24.4 |
| North | 22.7 | 21.0 | 21.2 | 13.1 | 23.7 | 29.8 | 28.3 | 30.3 | 21.8 |
| South | 25.7 | 19.7 | 24.8 | 20.8 | 28.0 | 17.1 | 24.2 | 26.4 | 25.9 |
| | | | | | **1988-89** | | | | |
| East | 26.0 | 27.7 | 36.9 | 24.0 | 24.8 | 32.4 | 28.0 | 15.8 | 27.3 |
| West | 23.1 | 28.6 | 22.3 | 35.7 | 21.6 | 22.4 | 17.6 | 17.1 | 21.5 |
| North | 21.1 | 19.9 | 15.2 | 11.9 | 22.1 | 22.5 | 23.5 | 36.8 | 21.2 |
| South | 29.1 | 23.0 | 24.9 | 27.4 | 30.7 | 21.2 | 29.9 | 30.1 | 29.5 |
| | | | | | **1973-74** | | | | |
| | | | | | Percentage of Federal R&D | | | | |
| East | 29.9 | 34.2 | 41.4 | 28.4 | 29.1 | 28.4 | 26.6 | 29.6 | 28.9 |
| West | 26.7 | 29.2 | 21.8 | 48.7 | 24.0 | 23.2 | 22.5 | 13.0 | 27.9 |
| North | 22.2 | 20.9 | 21.7 | 10.4 | 21.6 | 27.8 | 33.0 | 29.8 | 25.2 |
| South | 21.0 | 15.7 | 15.1 | 12.4 | 24.9 | 20.6 | 17.9 | 27.6 | 17.9 |
| | | | | | **1980-81** | | | | |
| East | 29.2 | 32.7 | 40.6 | 27.3 | 28.1 | 30.1 | 29.5 | 18.0 | 30.2 |
| West | 26.7 | 29.4 | 19.2 | 44.2 | 23.7 | 23.7 | 21.1 | 27.1 | 28.4 |
| North | 21.0 | 21.2 | 20.9 | 10.9 | 21.5 | 30.5 | 28.5 | 26.5 | 20.7 |
| South | 22.8 | 16.6 | 19.1 | 17.4 | 26.2 | 15.7 | 20.9 | 28.4 | 20.7 |
| | | | | | **1988-89** | | | | |
| East | 28.6 | 29.6 | 40.2 | 26.7 | 28.1 | 32.5 | 27.8 | 13.0 | 28.4 |
| West | 25.7 | 30.7 | 27.5 | 38.5 | 22.7 | 25.4 | 19.1 | 22.2 | 27.1 |
| North | 19.6 | 19.8 | 13.0 | 10.1 | 20.5 | 22.3 | 26.8 | 29.7 | 19.9 |
| South | 25.5 | 19.2 | 18.7 | 23.4 | 28.1 | 18.0 | 25.7 | 34.9 | 24.1 |

SOURCES: Science Resources Studies Division, National Science Foundation, *Academic Science/Engineering: R&D Expenditures, Fiscal Year 1989*, NSF 90-321, Detailed Statistical Tables (Washington, DC: NSF, 1991); and unpublished tabulations.

See text table 5-4.

*Science & Engineering Indicators – 1991*

Appendix table 5-19.
**Total and Federal academic R&D funds, by state: 1973-74, 1980-81, and 1988-89**

| | Total R&D funds | | | Federal R&D funds | | |
|---|---|---|---|---|---|---|
| State | 1973-74 | 1980-81 | 1988-89 | 1973-74 | 1980-81 | 1988-89 |
| TOTAL U.S. | 6,957,428 | 8,516,040 | 13,534,597 | 4,734,782 | 5,640,293 | 8,013,164 |
| Alabama | 68,264 | 86,948 | 201,203 | 48,959 | 57,101 | 117,105 |
| Alaska | 41,929 | 53,634 | 52,133 | 26,634 | 31,199 | 24,511 |
| Arizona | 72,454 | 114,176 | 206,839 | 37,550 | 62,856 | 97,870 |
| Arkansas | 25,241 | 41,160 | 41,727 | 10,838 | 12,736 | 15,126 |
| California | 909,923 | 1,133,468 | 1,771,457 | 729,244 | 853,894 | 1,225,363 |
| Colorado | 149,326 | 174,311 | 211,870 | 115,011 | 130,202 | 156,176 |
| Connecticut | 127,378 | 174,674 | 265,068 | 93,220 | 136,424 | 177,226 |
| Delaware | 13,380 | 23,044 | 34,350 | 7,370 | 12,622 | 15,492 |
| District of Columbia | 71,689 | 75,789 | 106,217 | 57,006 | 54,553 | 78,285 |
| Florida | 176,897 | 204,349 | 336,286 | 98,970 | 111,109 | 172,155 |
| Georgia | 130,967 | 197,320 | 383,293 | 58,904 | 103,286 | 188,953 |
| Hawaii | 54,416 | 56,702 | 66,077 | 34,789 | 34,653 | 38,747 |
| Idaho | 22,693 | 24,255 | 31,320 | 10,178 | 11,328 | 11,636 |
| Illinois | 324,353 | 344,751 | 565,177 | 234,023 | 241,156 | 320,937 |
| Indiana | 132,574 | 151,017 | 215,068 | 94,483 | 100,698 | 130,711 |
| Iowa | 89,881 | 134,477 | 191,534 | 49,659 | 71,347 | 93,586 |
| Kansas | 76,003 | 71,067 | 101,787 | 47,837 | 37,409 | 42,500 |
| Kentucky | 40,057 | 55,594 | 88,364 | 21,194 | 25,278 | 34,187 |
| Louisiana | 83,460 | 112,037 | 173,385 | 35,619 | 44,740 | 65,951 |
| Maine | 16,253 | 22,169 | 18,436 | 10,597 | 9,295 | 7,572 |
| Maryland | 176,314 | 209,527 | 453,681 | 136,676 | 164,623 | 267,580 |
| Massachusetts | 460,890 | 563,641 | 818,277 | 378,669 | 452,787 | 594,032 |
| Michigan | 260,123 | 307,132 | 453,699 | 163,988 | 179,261 | 247,986 |
| Minnesota | 136,158 | 171,339 | 243,299 | 78,625 | 99,362 | 124,368 |
| Mississippi | 48,217 | 59,223 | 73,903 | 21,677 | 23,278 | 33,528 |
| Missouri | 156,664 | 160,898 | 241,836 | 99,653 | 100,900 | 130,888 |
| Montana | 22,865 | 26,295 | 32,148 | 9,915 | 14,136 | 12,612 |
| Nebraska | 45,867 | 61,115 | 86,742 | 17,663 | 23,262 | 35,219 |
| Nevada | 16,435 | 17,621 | 36,400 | 7,817 | 9,121 | 19,827 |
| New Hampshire | 18,998 | 31,776 | 58,659 | 15,646 | 22,865 | 39,602 |
| New Jersey | 121,951 | 123,181 | 258,633 | 68,884 | 74,978 | 110,167 |
| New Mexico | 40,846 | 85,343 | 130,054 | 32,564 | 65,279 | 73,893 |
| New York | 817,816 | 856,638 | 1,274,185 | 576,985 | 600,764 | 839,956 |
| North Carolina | 182,093 | 197,632 | 400,220 | 127,821 | 137,355 | 247,718 |
| North Dakota | 16,710 | 26,850 | 25,481 | 6,632 | 10,310 | 17,448 |
| Ohio | 187,587 | 261,372 | 392,104 | 127,200 | 170,328 | 225,555 |
| Oklahoma | 46,190 | 78,259 | 112,532 | 24,776 | 31,672 | 32,502 |
| Oregon | 84,008 | 103,193 | 152,439 | 58,250 | 63,960 | 92,996 |
| Pennsylvania | 333,071 | 405,658 | 706,119 | 229,245 | 287,630 | 440,510 |
| Rhode Island | 32,363 | 51,516 | 77,060 | 28,696 | 44,406 | 56,141 |
| South Carolina | 29,351 | 50,064 | 109,967 | 13,155 | 26,148 | 40,905 |
| South Dakota | 15,987 | 14,007 | 12,243 | 7,090 | 5,999 | 5,955 |
| Tennessee | 82,108 | 122,175 | 200,092 | 65,736 | 73,492 | 111,979 |
| Texas | 342,309 | 524,414 | 937,620 | 203,405 | 307,776 | 468,579 |
| Utah | 89,001 | 95,319 | 152,099 | 65,878 | 68,623 | 101,227 |
| Vermont | 17,827 | 23,507 | 39,202 | 11,758 | 16,970 | 26,553 |
| Virginia | 87,632 | 126,168 | 246,478 | 52,858 | 88,398 | 135,571 |
| Washington | 167,376 | 206,872 | 256,550 | 124,975 | 150,988 | 190,202 |
| West Virginia | 16,454 | 25,413 | 34,137 | 10,902 | 13,751 | 16,323 |
| Wisconsin | 232,321 | 232,185 | 333,245 | 123,646 | 145,305 | 193,489 |
| Wyoming | 16,288 | 16,577 | 21,399 | 10,792 | 8,866 | 12,191 |
| Remaining areas | 28,465 | 30,187 | 102,506 | 11,118 | 15,811 | 53,574 |

NOTE: Funding is in constant 1988 dollars.

SOURCES: Science Resources Studies Division, National Science Foundation, *Academic Science/Engineering: R&D Expenditures, Fiscal Year 1989,* NSF 90-321, Detailed Statistical Tables (Washington, DC: NSF, 1991); and unpublished tabulations.

See figure 5-7.

*Science & Engineering Indicators – 1991*

Appendix table 5-20.
**Science and engineering doctorate-holders employed by academic institutions and those active in R&D, by field: 1979 and 1989**

| Field | Total employment | | Total in R&D | | Active in R&D | |
|---|---|---|---|---|---|---|
| | 1979 | 1989 | 1979 | 1989 | 1979 | 1989 |
| | Number | | | | Percent | |
| TOTAL SCIENCE AND ENGINEERING | 153,220 | 202,089 | 100,562 | 154,860 | 65.6 | 76.6 |
| Physical sciences | 22,549 | 25,163 | 15,513 | 19,800 | 68.8 | 78.7 |
| Astronomy | 1,235 | 1,642 | 1,074 | 1,486 | 87.0 | 90.5 |
| Chemistry | 13,147 | 14,276 | 8,460 | 10,849 | 64.3 | 76.0 |
| Physics | 8,167 | 9,245 | 5,979 | 7,465 | 73.2 | 80.7 |
| Math and computer sciences | 13,504 | 19,118 | 8,235 | 13,465 | 61.0 | 70.4 |
| Mathematical sciences | 11,001 | 12,323 | 6,560 | 8,825 | 59.6 | 71.6 |
| Computer sciences | 2,192 | 6,090 | 1,491 | 4,122 | 68.0 | 67.7 |
| Other | 311 | 705 | 184 | 518 | 59.2 | 73.5 |
| Environmental sciences | 5,278 | 7,385 | 4,106 | 6,560 | 77.8 | 88.8 |
| Atmospheric sciences | 637 | 845 | 615 | 800 | 96.5 | 94.7 |
| Earth sciences | 3,454 | 4,493 | 2,554 | 3,870 | 73.9 | 86.1 |
| Oceanography | 669 | 1,328 | 645 | 1,261 | 94.9 | 95.0 |
| Other | 518 | 719 | 292 | 629 | 57.8 | 87.5 |
| Life sciences | 48,282 | 67,380 | 36,353 | 55,647 | 75.3 | 82.6 |
| Agricultural sciences | 6,567 | 8,943 | 4,993 | 7,696 | 76.0 | 86.1 |
| Biological sciences | 32,936 | 45,569 | 25,982 | 39,380 | 78.9 | 86.4 |
| Medical sciences | 7,232 | 9,202 | 4,796 | 6,452 | 66.3 | 70.1 |
| Other | 1,547 | 3,666 | 582 | 2,119 | 37.6 | 57.8 |
| Psychology | 16,616 | 21,354 | 8,112 | 12,423 | 48.8 | 58.2 |
| Social sciences | 28,165 | 37,158 | 15,021 | 27,294 | 53.3 | 73.5 |
| Anthropology | 2,044 | 2,763 | 1,070 | 2,205 | 52.3 | 79.8 |
| Economics | 7,126 | 10,497 | 4,711 | 8,052 | 66.1 | 76.7 |
| History of science | 350 | 1,077 | 172 | 576 | 57.3 | 53.5 |
| Linguistics | 969 | 1,430 | 667 | 1,194 | 68.8 | 83.5 |
| Political science | 7,842 | 9,278 | 3,064 | 6,678 | 38.8 | 72.0 |
| Sociology | 5,655 | 6,949 | 3,268 | 4,967 | 57.8 | 71.5 |
| Other | 4,179 | 5,164 | 2,069 | 3,622 | 49.5 | 70.1 |
| Other sciences | 5,052 | 3,133 | 2,628 | 1,922 | 52.0 | 61.3 |
| Engineering | 13,839 | 21,517 | 10,659 | 17,749 | 77.0 | 82.5 |
| Aeronautical/astronautical | 598 | 1,031 | 556 | 893 | 93.0 | 86.6 |
| Chemical | 1,060 | 2,051 | 777 | 1,886 | 73.3 | 92.0 |
| Civil | 2,165 | 3,278 | 1,822 | 2,529 | 84.2 | 77.2 |
| Electrical/electronic | 2,490 | 4,402 | 1,830 | 3,442 | 73.5 | 78.2 |
| Materials/metallurgy | 1,300 | 1,595 | 1,044 | 1,421 | 80.3 | 89.1 |
| Mechanical | 2,374 | 3,938 | 1,675 | 3,295 | 70.6 | 83.4 |
| Other | 3,852 | 5,222 | 2,955 | 4,283 | 76.7 | 82.2 |

NOTE: Academic institutions exclude federally funded research and development centers.

SOURCES: Science Resources Studies Division, National Science Foundation. *Characteristics of Doctoral Scientists and Engineers in the United States: 1989*, NSF 91-317, Detailed Statistical Tables (Washington, DC: NSF, 1991); and unpublished tabulations.

See figure 5-8.

*Science & Engineering Indicators – 1991*

Appendix table 5-21.
**Academic employment and R&D activity of doctoral scientists and engineers, by gender, race/ethnicity, and field: 1979 and 1989**
(page 1 of 2)

| | 1979 | | | | | 1989 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | White | Black | Asian | Native American | Hispanic | White | Black | Asian | Native American | Hispanic |
| | | | | | **Total** | | | | | |
| **Total employed** | | | | | | | | | | |
| Total science and engineering | 138,162 | 1,721 | 9,966 | 267 | 2,019 | 177,232 | 3,299 | 16,420 | 387 | 3,893 |
| Physical sciences | 20,085 | 130 | 1,801 | 43 | 349 | 21,780 | 363 | 2,188 | 70 | 526 |
| Math and computer sciences | 12,054 | 128 | 998 | * | 207 | 16,390 | 169 | 1,998 | 32 | 428 |
| Environmental sciences | 4,991 | * | 176 | * | 71 | 6,774 | 24 | 383 | * | 193 |
| Life sciences | 43,310 | 523 | 3,507 | 46 | 627 | 59,576 | 927 | 5,537 | 80 | 1,095 |
| Psychology | 15,885 | 284 | 194 | 38 | 67 | 19,920 | 531 | 418 | 44 | 258 |
| Social sciences | 25,511 | 542 | 1,479 | 90 | 312 | 32,900 | 987 | 2,147 | 143 | 837 |
| Other sciences | 4,512 | 78 | 306 | 32 | 64 | 2,477 | 141 | 359 | * | 87 |
| Engineering | 11,814 | 35 | 1,505 | * | 322 | 17,415 | 157 | 3,390 | * | 469 |
| **Active in R&D** | | | | | | | | | | |
| Total science and engineering | 89,395 | 866 | 8,173 | 206 | 1,257 | 133,976 | 2,055 | 14,627 | 302 | 3,154 |
| Physical sciences | 13,633 | 94 | 1,478 | * | 183 | 16,923 | 306 | 1,913 | 68 | 432 |
| Math and computer sciences | 7,199 | 51 | 751 | * | 131 | 11,264 | 115 | 1,636 | 28 | 321 |
| Environmental sciences | 3,856 | * | 160 | * | 56 | 6,016 | 22 | 337 | * | 174 |
| Life sciences | 32,117 | 340 | 3,151 | 46 | 520 | 48,732 | 659 | 5,042 | 66 | 1,005 |
| Psychology | 7,804 | 94 | 68 | 38 | 30 | 11,650 | 217 | 290 | 33 | 85 |
| Social sciences | 13,651 | 251 | 822 | 59 | 171 | 24,016 | 540 | 1,820 | 89 | 703 |
| Other sciences | 2,242 | 22 | 269 | 32 | 33 | 1,447 | 84 | 319 | * | 70 |
| Engineering | 8,893 | * | 1,474 | * | 133 | 13,928 | 112 | 3,270 | * | 364 |
| | | | | | **Men** | | | | | |
| **Total employed** | | | | | | | | | | |
| Total science and engineering | 121,089 | 1,296 | 8,688 | 251 | 1,739 | 145,304 | 2,228 | 13,823 | 315 | 3,066 |
| Physical sciences | 18,811 | 119 | 1,600 | 43 | 332 | 19,861 | 333 | 1,831 | 70 | 441 |
| Math and computer sciences | 11,229 | 117 | 890 | * | 201 | 14,768 | 140 | 1,755 | 30 | 397 |
| Environmental sciences | 4,711 | * | 163 | * | 66 | 6,123 | 22 | 354 | * | 180 |
| Life sciences | 36,562 | 324 | 2,810 | 35 | 530 | 45,647 | 524 | 4,175 | 47 | 805 |
| Psychology | 12,429 | 207 | 134 | 34 | * | 13,533 | 249 | 228 | 30 | 93 |
| Social sciences | 21,779 | 447 | 1,359 | 90 | 241 | 26,443 | 696 | 1,875 | 124 | 628 |
| Other sciences | 3,866 | 47 | 257 | 32 | 36 | 1,993 | 114 | 305 | * | 76 |
| Engineering | 11,702 | 34 | 1,475 | * | 322 | 16,936 | 150 | 3,300 | * | 446 |

(continued)

Appendix table 5-21.
**Academic employment and R&D activity of doctoral scientists and engineers, by gender, race/ethnicity, and field: 1979 and 1989**
(page 2 of 2)

| | 1979 | | | | | 1989 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | White | Black | Asian | Native American | Hispanic | White | Black | Asian | Native American | Hispanic |
| **Men** | | | | | | | | | | |
| **Active in R&D** | | | | | | | | | | |
| Total science and engineering | 79,634 | 654 | 7,184 | 191 | 1,101 | 110,934 | 1,413 | 12,362 | 251 | 2,496 |
| Physical sciences | 12,917 | 89 | 1,329 | * | 174 | 15,555 | 278 | 1,609 | 68 | 361 |
| Math and computer sciences | 6,782 | 50 | 691 | * | 127 | 10,259 | 99 | 1,442 | 26 | 297 |
| Environmental sciences | 3,663 | * | 147 | * | 54 | 5,426 | 22 | 308 | * | 164 |
| Life sciences | 27,367 | 225 | 2,554 | 35 | 454 | 37,720 | 404 | 3,770 | 37 | 752 |
| Psychology | 6,221 | 60 | 40 | 34 | * | 8,041 | 80 | 153 | 30 | * |
| Social sciences | 11,844 | 208 | 749 | 59 | 134 | 19,248 | 348 | 1,620 | 76 | 517 |
| Other sciences | 2,041 | * | 228 | 32 | 25 | 1,192 | 75 | 273 | * | 61 |
| Engineering | 8,799 | * | 1,446 | * | 133 | 13,493 | 107 | 3,187 | * | 344 |
| **Women** | | | | | | | | | | |
| **Total employed** | | | | | | | | | | |
| Total science and engineering | 17,073 | 425 | 1,278 | * | 280 | 31,928 | 1,071 | 2,597 | 72 | 827 |
| Physical sciences | 1,274 | * | 201 | * | 17 | 1,919 | 30 | 357 | * | 85 |
| Math and computer sciences | 825 | * | 108 | * | 6 | 1,622 | 29 | 243 | * | 31 |
| Environmental sciences | 280 | * | * | * | 5 | 651 | * | 29 | * | * |
| Life sciences | 6,748 | 199 | 697 | * | 97 | 13,929 | 403 | 1,362 | 33 | 290 |
| Psychology | 3,456 | 77 | 60 | * | 56 | 6,387 | 282 | 190 | * | 165 |
| Social sciences | 3,732 | 95 | 120 | * | 71 | 6,457 | 291 | 272 | * | 209 |
| Other sciences | 646 | 31 | 49 | * | 28 | 484 | 27 | 54 | * | * |
| Engineering | 112 | * | 30 | * | 0 | 479 | * | 90 | * | 23 |
| **Active in R&D** | | | | | | | | | | |
| Total science and engineering | 9,761 | 212 | 989 | * | 156 | 23,042 | 642 | 2,265 | 51 | 658 |
| Physical sciences | 716 | * | 149 | * | * | 1,368 | 28 | 304 | * | 71 |
| Math and computer sciences | 417 | * | 60 | * | * | 1,005 | * | 194 | * | 24 |
| Environmental sciences | 193 | * | * | * | * | 590 | * | 29 | * | * |
| Life sciences | 4,750 | 115 | 597 | * | 66 | 11,012 | 255 | 1,272 | 29 | 253 |
| Psychology | 1,583 | 34 | 28 | * | 30 | 3,609 | 137 | 137 | * | 85 |
| Social sciences | 1,807 | 43 | 73 | * | 37 | 4,768 | 192 | 200 | * | 186 |
| Other sciences | 201 | * | 41 | * | * | 255 | * | 46 | * | * |
| Engineering | 94 | * | 28 | * | * | 435 | * | 83 | * | 20 |

* = too few cases to estimate

SOURCES: Science Resources Studies Division, National Science Foundation, *Characteristics of Doctoral Scientists and Engineers in the United States: 1989*, NSF 91-317, Detailed Statistical Tables (Washington, DC: NSF, 1991), and unpublished tabulations

See figure 5-9 and text tables 5-5 and 5-6.

*Science & Engineering Indicators – 1991*

Appendix table 5-22.
**Academic doctoral scientists and engineers active in R&D, by number of years since Ph.D. award and field: 1973-89**
(page 1 of 2)

| | 1-3 years | 4-7 years | 8-10 years | 11-15 years | More than 15 years |
|---|---|---|---|---|---|
| | | | **Total science and engineering** | | |
| | | | Percent | | |
| 1973 | 20.7 | 26.0 | 13.9 | 14.2 | 25.3 |
| 1975 | 17.8 | 26.3 | 14.8 | 15.8 | 25.2 |
| 1977 | 15.4 | 23.9 | 15.7 | 17.5 | 27.6 |
| 1979 | 14.8 | 21.1 | 15.4 | 20.1 | 28.5 |
| 1981 | 14.4 | 19.7 | 13.9 | 20.6 | 31.4 |
| 1983 | 13.3 | 17.7 | 12.0 | 22.3 | 34.7 |
| 1985 | 12.8 | 16.9 | 11.8 | 19.4 | 39.1 |
| 1987 | 11.6 | 16.2 | 10.8 | 17.9 | 43.5 |
| 1989 | 12.3 | 15.7 | 10.4 | 16.6 | 45.0 |
| | | | **Physical sciences** | | |
| 1973 | 18.2 | 25.5 | 14.8 | 16.0 | 25.4 |
| 1975 | 13.4 | 23.5 | 16.4 | 18.5 | 28.2 |
| 1977 | 13.7 | 19.6 | 16.1 | 18.7 | 31.9 |
| 1979 | 12.8 | 15.6 | 14.0 | 23.9 | 33.6 |
| 1981 | 13.8 | 14.9 | 10.7 | 22.0 | 38.6 |
| 1983 | 10.5 | 11.9 | 9.3 | 21.4 | 46.8 |
| 1985 | 11.8 | 12.2 | 8.5 | 14.4 | 53.0 |
| 1987 | 11.1 | 11.3 | 7.2 | 13.9 | 56.5 |
| 1989 | 13.8 | 12.5 | 7.3 | 11.1 | 55.3 |
| | | | **Mathematical and computer sciences** | | |
| 1973 | 22.9 | 30.9 | 15.3 | 12.2 | 18.7 |
| 1975 | 17.5 | 30.8 | 15.8 | 16.3 | 19.6 |
| 1977 | 15.4 | 24.5 | 19.1 | 17.6 | 23.5 |
| 1979 | 13.3 | 18.9 | 18.7 | 24.4 | 24.6 |
| 1981 | 13.8 | 18.6 | 13.8 | 24.7 | 29.2 |
| 1983 | 12.6 | 18.7 | 10.3 | 23.0 | 35.5 |
| 1985 | 12.7 | 17.3 | 8.8 | 20.3 | 40.9 |
| 1987 | 11.0 | 17.3 | 9.3 | 17.0 | 45.3 |
| 1989 | 12.0 | 16.5 | 9.8 | 14.6 | 47.2 |
| | | | **Environmental sciences** | | |
| 1973 | 21.4 | 25.0 | 14.3 | 15.0 | 24.3 |
| 1975 | 21.3 | 24.1 | 16.0 | 15.8 | 22.8 |
| 1977 | 16.5 | 25.5 | 13.4 | 17.5 | 27.0 |
| 1979 | 15.8 | 18.9 | 15.4 | 21.9 | 28.0 |
| 1981 | 17.6 | 17.4 | 14.8 | 19.1 | 31.1 |
| 1983 | 14.9 | 19.7 | 14.0 | 17.8 | 33.6 |
| 1985 | 11.0 | 17.4 | 12.1 | 20.1 | 39.3 |
| 1987 | 12.7 | 17.2 | 7.5 | 21.7 | 40.9 |
| 1989 | 10.3 | 17.1 | 10.0 | 17.7 | 45.0 |
| | | | **Life sciences** | | |
| 1973 | 19.6 | 23.8 | 12.5 | 13.7 | 30.4 |
| 1975 | 17.8 | 25.8 | 13.1 | 15.1 | 28.3 |
| 1977 | 15.6 | 24.3 | 15.0 | 16.2 | 28.9 |
| 1979 | 15.4 | 23.0 | 15.2 | 17.4 | 29.1 |
| 1981 | 15.9 | 20.7 | 13.7 | 19.6 | 30.2 |
| 1983 | 14.5 | 18.0 | 12.4 | 22.5 | 32.7 |
| 1985 | 13.6 | 18.2 | 11.8 | 20.8 | 35.6 |
| 1987 | 12.4 | 17.4 | 12.1 | 18.6 | 39.4 |
| 1989 | 13.7 | 17.0 | 11.5 | 16.9 | 40.9 |

(continued)

Appendix table 5-22.
**Academic doctoral scientists and engineers active in R&D, by number of years since Ph.D. award and field: 1973-89**
(page 2 of 2)

| | 1-3 years | 4-7 years | 8-10 years | 11-15 years | More than 15 years |
|---|---|---|---|---|---|
| | **Social sciences and psychology** | | | | |
| | Percent | | | | |
| 1973 | 24.6 | 25.7 | 12.8 | 13.6 | 23.2 |
| 1975 | 22.3 | 28.4 | 13.4 | 13.4 | 22.6 |
| 1977 | 17.4 | 28.1 | 14.8 | 15.1 | 24.7 |
| 1979 | 18.1 | 24.8 | 16.8 | 17.2 | 23.2 |
| 1981 | 14.5 | 24.1 | 15.4 | 19.9 | 26.0 |
| 1983 | 13.2 | 21.1 | 15.3 | 21.0 | 29.4 |
| 1985 | 11.8 | 18.1 | 15.8 | 21.2 | 33.1 |
| 1987 | 10.5 | 16.3 | 13.1 | 20.7 | 39.4 |
| 1989 | 9.7 | 15.4 | 11.3 | 20.3 | 43.3 |
| | **Engineering** | | | | |
| 1973 | 17.7 | 30.4 | 17.3 | 15.3 | 19.4 |
| 1975 | 13.2 | 24.7 | 20.1 | 19.6 | 22.4 |
| 1977 | 12.8 | 18.2 | 17.6 | 25.6 | 25.8 |
| 1979 | 11.4 | 18.6 | 11.6 | 25.8 | 32.5 |
| 1981 | 11.7 | 16.2 | 14.3 | 20.3 | 37.5 |
| 1983 | 14.1 | 16.0 | 7.9 | 26.2 | 35.8 |
| 1985 | 14.5 | 15.9 | 9.9 | 16.1 | 43.6 |
| 1987 | 12.3 | 16.9 | 8.4 | 14.0 | 48.4 |
| 1989 | 13.5 | 15.4 | 9.5 | 14.3 | 47.2 |

NOTE: "Active in R&D" is defined as those individuals who report R&D as either their primary or secondary activity.

SOURCES: Science Resources Studies Division, National Science Foundation, *Characteristics of Doctoral Scientists and Engineers in the United States: 1989*, NSF 91-317, Detailed Statistical Tables (Washington, DC: NSF, 1991); and unpublished tabulations.

See figure 5-10. *Science & Engineering Indicators – 1991*

Appendix table 5-23.
**Participation of academic doctoral scientists and engineers in R&D, by number of years since Ph.D. award and field: 1973-89**
(page 1 of 2)

| | Total | 1-3 years | 4-7 years | 8-10 years | 11-15 years | More than 15 years |
|---|---|---|---|---|---|---|
| **Total science and engineering** | | | | | | |
| | Percent | | | | | |
| 1973...... | 77.9 | 80.9 | 79.7 | 79.1 | 76.0 | 74.2 |
| 1975...... | 73.2 | 80.2 | 75.3 | 73.8 | 71.1 | 68.0 |
| 1977...... | 68.2 | 73.2 | 68.3 | 69.0 | 66.1 | 66.5 |
| 1979...... | 66.5 | 76.3 | 68.7 | 64.9 | 64.8 | 62.8 |
| 1981...... | 64.6 | 80.3 | 70.6 | 63.4 | 60.0 | 59.7 |
| 1983...... | 63.1 | 77.7 | 72.1 | 64.0 | 59.8 | 57.2 |
| 1985...... | 64.3 | 77.8 | 71.5 | 67.7 | 59.8 | 59.6 |
| 1987...... | 76.5 | 87.2 | 83.2 | 80.0 | 75.3 | 71.6 |
| 1989...... | 77.7 | 88.6 | 87.2 | 80.4 | 77.4 | 72.0 |
| **Physical sciences** | | | | | | |
| 1973...... | 80.7 | 84.6 | 81.7 | 83.9 | 82.2 | 74.7 |
| 1975...... | 77.4 | 85.3 | 79.7 | 80.3 | 76.3 | 71.9 |
| 1977...... | 74.1 | 87.8 | 73.2 | 73.3 | 70.5 | 72.4 |
| 1979...... | 69.1 | 89.1 | 75.4 | 66.5 | 67.4 | 63.5 |
| 1981...... | 68.7 | 92.0 | 83.5 | 70.6 | 62.0 | 62.2 |
| 1983...... | 69.7 | 89.1 | 81.6 | 74.8 | 66.3 | 64.7 |
| 1985...... | 69.3 | 90.9 | 84.7 | 78.5 | 60.2 | 64.6 |
| 1987...... | 78.6 | 94.8 | 89.2 | 87.6 | 79.0 | 73.4 |
| 1989...... | 79.5 | 96.4 | 94.5 | 89.6 | 78.8 | 72.7 |
| **Mathematical and computer sciences** | | | | | | |
| 1973...... | 73.6 | 75.6 | 75.8 | 79.0 | 72.5 | 65.1 |
| 1975...... | 69.5 | 75.2 | 69.6 | 69.4 | 73.2 | 62.5 |
| 1977...... | 63.7 | 71.9 | 61.8 | 64.5 | 59.6 | 63.6 |
| 1979...... | 61.1 | 81.6 | 58.2 | 58.0 | 60.5 | 58.4 |
| 1981...... | 58.2 | 79.1 | 65.7 | 52.6 | 52.8 | 54.7 |
| 1983...... | 59.9 | 75.3 | 71.4 | 53.7 | 53.6 | 57.2 |
| 1985...... | 56.7 | 73.4 | 71.2 | 53.8 | 48.7 | 53.3 |
| 1987...... | 70.4 | 89.6 | 84.7 | 71.9 | 65.5 | 64.4 |
| 1989...... | 72.0 | 89.0 | 88.4 | 81.3 | 68.1 | 64.4 |
| **Environmental sciences** | | | | | | |
| 1973...... | 82.3 | 89.6 | 80.1 | 84.6 | 85.6 | 76.0 |
| 1975...... | 80.5 | 94.7 | 85.3 | 79.0 | 74.4 | 71.3 |
| 1977...... | 80.6 | 93.4 | 84.5 | 76.7 | 72.9 | 78.0 |
| 1979...... | 78.4 | 88.8 | 81.8 | 75.5 | 77.6 | 73.5 |
| 1981...... | 75.5 | 97.8 | 85.1 | 69.0 | 69.1 | 69.2 |
| 1983...... | 76.7 | 89.3 | 87.4 | 85.9 | 68.6 | 68.6 |
| 1985...... | 77.5 | 87.0 | 84.9 | 85.8 | 75.3 | 71.5 |
| 1987...... | 89.6 | 91.1 | 98.0 | 82.5 | 91.7 | 86.5 |
| 1989...... | 89.7 | 96.4 | 95.5 | 91.9 | 92.0 | 85.1 |
| **Life sciences** | | | | | | |
| 1973...... | 84.5 | 84.8 | 87.6 | 84.5 | 82.5 | 82.9 |
| 1975...... | 80.0 | 83.9 | 81.8 | 81.9 | 79.3 | 75.8 |
| 1977...... | 77.5 | 79.8 | 78.6 | 79.1 | 76.8 | 75.2 |
| 1979...... | 76.4 | 84.6 | 78.5 | 76.1 | 74.7 | 72.3 |
| 1981...... | 75.8 | 89.2 | 81.2 | 74.3 | 73.8 | 69.1 |
| 1983...... | 75.1 | 86.2 | 80.8 | 77.4 | 73.1 | 68.9 |
| 1985...... | 74.1 | 87.6 | 81.1 | 74.3 | 72.7 | 67.8 |
| 1987...... | 83.1 | 90.4 | 86.9 | 88.0 | 82.8 | 78.4 |
| 1989...... | 83.3 | 89.7 | 89.6 | 84.0 | 84.2 | 78.6 |

(continued)

Appendix table 5-23.
**Participation of academic doctoral scientists and engineers in R&D, by number of years since Ph.D. award and field: 1973-89**
(page 2 of 2)

| | Total | 1-3 years | 4-7 years | 8-10 years | 11-15 years | More than 15 years |
|---|---|---|---|---|---|---|
| | | | **Social sciences and psychology** | | | |
| | | | Percent | | | |
| 1973...... | 68.2 | 74.9 | 69.4 | 66.9 | 62.1 | 65.1 |
| 1975...... | 63.9 | 74.4 | 66.9 | 62.6 | 57.3 | 57.3 |
| 1977...... | 53.6 | 57.3 | 55.5 | 55.5 | 49.6 | 50.8 |
| 1979...... | 52.4 | 60.9 | 56.2 | 55.3 | 47.9 | 45.7 |
| 1981...... | 53.0 | 62.8 | 58.3 | 52.9 | 48.6 | 48.1 |
| 1983...... | 51.1 | 62.5 | 60.4 | 56.0 | 46.0 | 44.2 |
| 1985...... | 50.9 | 57.6 | 55.0 | 59.1 | 48.4 | 45.8 |
| 1987...... | 67.5 | 75.3 | 73.5 | 70.9 | 67.3 | 62.7 |
| 1989...... | 68.9 | 77.8 | 77.9 | 71.8 | 69.2 | 63.9 |
| | | | **Engineering** | | | |
| 1973...... | 84.5 | 86.5 | 88.2 | 84.0 | 86.9 | 76.5 |
| 1975...... | 76.5 | 82.9 | 80.7 | 77.1 | 74.3 | 70.5 |
| 1977...... | 75.2 | 82.5 | 77.2 | 73.0 | 75.2 | 72.4 |
| 1979...... | 77.8 | 90.5 | 86.4 | 67.0 | 76.6 | 75.1 |
| 1981...... | 63.9 | 87.1 | 74.3 | 68.7 | 54.7 | 59.1 |
| 1983...... | 69.7 | 83.0 | 80.2 | 66.5 | 73.1 | 60.9 |
| 1985...... | 68.2 | 87.5 | 75.2 | 71.5 | 60.0 | 63.8 |
| 1987...... | 84.0 | 94.4 | 88.1 | 91.3 | 81.2 | 80.1 |
| 1989...... | 83.5 | 94.3 | 95.6 | 85.2 | 85.3 | 77.1 |

NOTE: "Active in R&D" is defined as those individuals who report R&D as either their primary or secondary activity.

SOURCES: Science Resources Studies Division, National Science Foundation, *Characteristics of Doctoral Scientists and Engineers in the United States: 1989*, NSF 91-317, Detailed Statistical Tables (Washington, DC: NSF, 1991); and unpublished tabulations.

See figure 5-11.

*Science & Engineering Indicators – 1991*

Appendix table 5-24.
**Science and engineering doctorate-holders active in academic R&D reporting U.S. Government support, by field and years since Ph.D. award: 1973-89**
(page 1 of 2)

| | Total | 1-3 years | 4-7 years | 8-10 years | 11-15 years | More than 15 years |
|---|---|---|---|---|---|---|
| | | | **Physical sciences** | | | |
| | | | Percent | | | |
| 1973...... | 54.7 | 67.1 | 50.0 | 51.3 | 54.2 | 52.8 |
| 1975...... | 53.1 | 67.3 | 50.3 | 50.3 | 49.5 | 52.6 |
| 1977...... | 54.4 | 68.5 | 56.5 | 48.4 | 53.9 | 50.3 |
| 1979...... | 56.7 | 70.7 | 53.8 | 51.7 | 56.8 | 54.7 |
| 1981...... | 59.0 | 76.1 | 61.1 | 65.0 | 52.0 | 54.4 |
| 1983...... | 63.9 | 76.5 | 74.2 | 72.0 | 57.6 | 59.6 |
| 1985...... | * | * | * | * | * | * |
| 1987...... | 65.6 | 79.8 | 68.4 | 72.9 | 70.6 | 60.1 |
| 1989...... | 68.9 | 78.1 | 72.7 | 73.9 | 66.6 | 65.6 |
| | | | **Mathematical and computer sciences** | | | |
| 1973...... | 34.7 | 25.3 | 35.0 | 29.6 | 45.9 | 42.7 |
| 1975...... | 24.6 | 15.1 | 23.1 | 31.5 | 26.0 | 29.0 |
| 1977...... | 25.5 | 23.7 | 24.7 | 27.0 | 23.9 | 27.7 |
| 1979...... | 28.2 | 24.9 | 44.7 | 26.7 | 16.9 | 29.7 |
| 1981...... | 27.5 | 24.2 | 35.0 | 31.0 | 31.3 | 19.4 |
| 1983...... | 41.1 | 42.4 | 46.3 | 49.7 | 40.3 | 35.7 |
| 1985...... | * | * | * | * | * | * |
| 1987...... | 38.7 | 30.9 | 43.8 | 49.9 | 38.1 | 36.6 |
| 1989...... | 41.5 | 34.1 | 51.6 | 51.8 | 48.4 | 35.6 |
| | | | **Environmental sciences** | | | |
| 1973...... | 61.8 | 63.5 | 68.9 | 57.1 | 64.2 | 54.0 |
| 1975...... | 60.8 | 60.8 | 66.9 | 61.8 | 61.1 | 53.4 |
| 1977...... | 57.6 | 48.0 | 63.8 | 64.5 | 55.2 | 55.7 |
| 1979...... | 63.9 | 84.5 | 64.1 | 62.9 | 61.1 | 54.8 |
| 1981...... | 58.0 | 63.6 | 71.3 | 55.8 | 48.1 | 54.5 |
| 1983...... | 68.3 | 72.6 | 70.6 | 79.9 | 63.3 | 63.0 |
| 1985...... | * | * | * | * | * | * |
| 1987...... | 68.4 | 67.2 | 69.8 | 80.9 | 75.6 | 62.0 |
| 1989...... | 72.3 | 64.4 | 78.1 | 85.1 | 82.6 | 65.1 |
| | | | **Life sciences** | | | |
| 1973...... | 67.7 | 67.9 | 67.3 | 68.7 | 67.0 | 67.6 |
| 1975...... | 65.8 | 67.2 | 64.9 | 67.4 | 66.3 | 64.6 |
| 1977...... | 67.5 | 69.7 | 68.1 | 70.2 | 67.1 | 64.5 |
| 1979...... | 66.1 | 68.1 | 65.4 | 66.1 | 66.9 | 65.1 |
| 1981...... | 63.8 | 73.3 | 67.4 | 62.0 | 62.3 | 58.2 |
| 1983...... | 70.4 | 72.1 | 74.5 | 74.5 | 70.7 | 65.7 |
| 1985...... | * | * | * | * | * | * |
| 1987...... | 73.0 | 72.8 | 75.6 | 79.8 | 76.1 | 68.3 |
| 1989...... | 74.0 | 79.0 | 75.9 | 77.6 | 79.2 | 68.3 |
| | | | **Social sciences and psychology** | | | |
| 1973...... | 35.0 | 30.7 | 37.3 | 36.0 | 35.2 | 36.2 |
| 1975...... | 31.4 | 25.5 | 32.7 | 35.0 | 31.1 | 33.6 |
| 1977...... | 32.8 | 28.5 | 32.4 | 32.0 | 37.6 | 33.9 |
| 1979...... | 33.2 | 33.5 | 31.9 | 34.3 | 34.7 | 32.5 |
| 1981...... | 30.9 | 35.7 | 32.0 | 27.3 | 30.0 | 30.0 |
| 1933...... | 34.7 | 38.9 | 37.1 | 31.4 | 37.0 | 31.1 |
| 1985...... | * | * | * | * | * | * |
| 1987 ..... | 32.6 | 31.2 | 37.2 | 31.6 | 33.5 | 30.8 |
| 1989...... | 34.7 | 35.9 | 37.3 | 38.2 | 37.0 | 31.6 |

(continued)

Appendix table 5-24.
**Science and engineering doctorate-holders active in academic R&D reporting U.S. Government support, by field and years since Ph.D. award: 1973-89**
(page 2 of 2)

| | Total | 1-3 years | 4-7 years | 8-10 years | 11-15 years | More than 15 years |
|---|---|---|---|---|---|---|
| | | | **Engineering** | | | |
| | | | Percent | | | |
| 1973...... | 60.9 | 54.2 | 58.5 | 59.6 | 71.0 | 63.9 |
| 1975...... | 59.0 | 62.3 | 61.4 | 54.7 | 59.8 | 57.5 |
| 1977...... | 60.6 | 64.1 | 61.1 | 59.9 | 58.4 | 61.3 |
| 1979...... | 60.7 | 56.5 | 69.5 | 61.7 | 57.2 | 59.6 |
| 1981...... | 59.9 | 51.2 | 75.3 | 63.8 | 61.6 | 53.5 |
| 1983...... | 64.3 | 47.4 | 68.4 | 78.2 | 63.8 | 66.4 |
| 1985...... | * | * | * | * | * | * |
| 1987...... | 66.6 | 53.5 | 76.4 | 69.0 | 71.4 | 64.8 |
| 1989...... | 65.4 | 54.3 | 76.6 | 63.5 | 76.7 | 62.0 |

* = results for 1985 are discontinuous with other years because of substantial changes in questionnaire item content

SOURCES: Science Resources Studies Division, National Science Foundation, *Characteristics of Doctoral Scientists and Engineers in the United States: 1989*, NSF 91-317. Detailed Statistical Tables (Washington, DC: NSF, 1991); and unpublished tabulations.

See figure 5-12. *Science & Engineering Indicators – 1991*

Appendix table 5-25.
**Full-time graduate students in science and engineering supported by research assistantships (RA), by source and field: 1972-89**
(page 1 of 4)

| | Total | Federal support | RA | Federal RA support | Non-Federal RA support | Total RA support | Federal RA support | Non-Federal RA support |
|---|---|---|---|---|---|---|---|---|
| | | | | **Total science and engineering** | | | | |
| | | | Number | | | | Percent | |
| 1972 | 159,520 | 46,913 | 34,297 | 20,666 | 13,631 | 21.5 | 13.0 | 8.5 |
| 1973 | 161,902 | 42,745 | 35,944 | 20,589 | 15,355 | 22.2 | 12.7 | 9.5 |
| 1974 | 191,471 | 46,848 | 39,507 | 22,266 | 17,241 | 20.6 | 11.6 | 9.0 |
| 1975 | 220,489 | 47,182 | 40,006 | 23,045 | 16,961 | 18.1 | 10.5 | 7.7 |
| 1976 | 224,115 | 49,116 | 42,592 | 24,352 | 18,240 | 19.0 | 10.9 | 8.1 |
| 1977 | 227,862 | 50,958 | 43,743 | 25,125 | 18,618 | 19.2 | 11.0 | 8.2 |
| 1978 | 209,572 | 50,038 | NA | NA | NA | NA | NA | NA |
| 1979 | 233,089 | 52,880 | 49,118 | 28,045 | 21,073 | 21.1 | 12.0 | 9.0 |
| 1980 | 239,855 | 53,164 | 51,716 | 29,352 | 22,364 | 21.6 | 12.2 | 9.3 |
| 1981 | 243,671 | 51,085 | 52,880 | 29,176 | 23,704 | 21.7 | 12.0 | 9.7 |
| 1982 | 246,218 | 47,593 | 52,701 | 28,320 | 24,381 | 21.4 | 11.5 | 9.9 |
| 1983 | 253,735 | 47,909 | 55,069 | 29,173 | 25,896 | 21.7 | 11.5 | 10.2 |
| 1984 | 255,597 | 47,921 | 57,863 | 29,467 | 28,396 | 22.6 | 11.5 | 11.1 |
| 1985 | 259,467 | 49,230 | 61,162 | 30,442 | 30,720 | 23.6 | 11.7 | 11.8 |
| 1986 | 268,404 | 51,545 | 66,224 | 32,761 | 33,463 | 24.7 | 12.2 | 12.5 |
| 1987 | 273,434 | 53,780 | 70,384 | 35,013 | 35,371 | 25.7 | 12.8 | 12.9 |
| 1988 | 278,167 | 55,768 | 74,727 | 36,781 | 37,946 | 26.9 | 13.2 | 13.6 |
| 1989 | 286,619 | 57,921 | 79,151 | 38,314 | 40,837 | 27.6 | 13.4 | 14.2 |
| | | | | **Physical sciences** | | | | |
| 1972 | 22,253 | 7,617 | 6,651 | 5,559 | 1,092 | 29.9 | 25.0 | 4.9 |
| 1973 | 21,060 | 6,346 | 6,305 | 5,079 | 1,226 | 29.9 | 24.1 | 5.8 |
| 1974 | 21,267 | 6,157 | 6,395 | 5,299 | 1,096 | 30.1 | 24.9 | 5.2 |
| 1975 | 21,916 | 6,210 | 6,441 | 5,487 | 954 | 29.4 | 25.0 | 4.4 |
| 1976 | 22,252 | 6,400 | 6,789 | 5,686 | 1,103 | 30.5 | 25.6 | 5.0 |
| 1977 | 22,505 | 6,628 | 6,810 | 5,770 | 1,040 | 30.3 | 25.6 | 4.6 |
| 1978 | 21,516 | 6,943 | NA | NA | NA | NA | NA | NA |
| 1979 | 22,535 | 7,496 | 7,806 | 6,512 | 1,294 | 34.6 | 28.9 | 5.7 |
| 1980 | 22,918 | 7,707 | 8,340 | 6,980 | 1,360 | 36.4 | 30.5 | 5.9 |
| 1981 | 23,308 | 7,956 | 8,607 | 7,271 | 1,336 | 36.9 | 31.2 | 5.7 |
| 1982 | 24,040 | 7,713 | 8,768 | 7,095 | 1,673 | 36.5 | 29.5 | 7.0 |
| 1983 | 25,205 | 8,126 | 9,145 | 7,471 | 1,674 | 36.3 | 29.6 | 6.6 |
| 1984 | 25,852 | 8,640 | 9,628 | 7,807 | 1,821 | 37.2 | 30.2 | 7.0 |
| 1985 | 26,669 | 8,821 | 10,284 | 8,065 | 2,219 | 38.6 | 30.2 | 8.3 |
| 1986 | 27,764 | 9,523 | 10,994 | 8,665 | 2,329 | 39.6 | 31.2 | 8.4 |
| 1987 | 28,414 | 9,717 | 11,558 | 8,873 | 2,685 | 40.7 | 31.2 | 9.4 |
| 1988 | 28,574 | 9,857 | 12,056 | 8,968 | 3,088 | 42.2 | 31.4 | 10.8 |
| 1989 | 29,164 | 10,276 | 12,413 | 9,160 | 3,253 | 42.6 | 31.4 | 11.2 |
| | | | | **Mathematical and computer sciences** | | | | |
| 1972 | 13,273 | 2,072 | 1,344 | 847 | 497 | 10.1 | 6.4 | 3.7 |
| 1973 | 13,277 | 1,957 | 1,321 | 824 | 497 | 9.9 | 6.2 | 3.7 |
| 1974 | 13,755 | 1,581 | 1,414 | 828 | 586 | 10.3 | 6.0 | 4.3 |
| 1975 | 15,168 | 1,436 | 1,375 | 752 | 623 | 9.1 | 5.0 | 4.1 |
| 1976 | 15,700 | 1,481 | 1,528 | 795 | 733 | 9.7 | 5.1 | 4.7 |
| 1977 | 14,969 | 1,490 | 1,508 | 877 | 631 | 10.1 | 5.9 | 4.2 |
| 1978 | 13,733 | 1,471 | NA | NA | NA | NA | NA | NA |
| 1979 | 15,521 | 1,654 | 1,642 | 1,005 | 637 | 10.6 | 6.5 | 4.1 |

(continued)

Appendix table 5-25.
**Full-time graduate students in science and engineering supported by research assistantships (RA), by source and field: 1972-89**
(page 2 of 4)

| | Total | Federal support | RA | Federal RA support | Non-Federal RA support | Total RA support | Federal RA support | Non-Federal RA support |
|---|---|---|---|---|---|---|---|---|
| | **Mathematical and computer sciences** | | | | | | | |
| | Number | | | | | Percent | | |
| 1980 | 16,489 | 1,821 | 1,820 | 1,099 | 721 | 11.0 | 6.7 | 4.4 |
| 1981 | 17,599 | 1,804 | 1,858 | 1,055 | 803 | 10.6 | 6.0 | 4.6 |
| 1982 | 19,994 | 1,893 | 2,036 | 1,140 | 896 | 10.2 | 5.7 | 4.5 |
| 1983 | 21,651 | 1,890 | 2,206 | 1,193 | 1,013 | 10.2 | 5.5 | 4.7 |
| 1984 | 22,906 | 2,031 | 2,507 | 1,382 | 1,125 | 10.9 | 6.0 | 4.9 |
| 1985 | 25,934 | 2,573 | 3,074 | 1,551 | 1,523 | 11.9 | 6.0 | 5.9 |
| 1986 | 27,708 | 2,891 | 3,392 | 1,686 | 1,706 | 12.2 | 6.1 | 6.2 |
| 1987 | 28,640 | 3,175 | 3,948 | 2,142 | 1,806 | 13.8 | 7.5 | 6.3 |
| 1988 | 29,150 | 3,416 | 4,281 | 2,312 | 1,969 | 14.7 | 7.9 | 6.8 |
| 1989 | 29,818 | 3,614 | 4,506 | 2,330 | 2,176 | 15.1 | 7.8 | 7.3 |
| | **Mathematical sciences** | | | | | | | |
| 1972 | 10,372 | 1,393 | 706 | 442 | 264 | 6.8 | 4.3 | 2.5 |
| 1973 | 10,339 | 1,222 | 668 | 373 | 295 | 6.5 | 3.6 | 2.9 |
| 1974 | 10,009 | 860 | 667 | 351 | 316 | 6.7 | 3.5 | 3.2 |
| 1975 | 10,695 | 693 | 629 | 300 | 329 | 5.9 | 2.8 | 3.1 |
| 1976 | 10,952 | 784 | 797 | 409 | 388 | 7.3 | 3.7 | 3.5 |
| 1977 | 10,365 | 786 | 784 | 403 | 381 | 7.6 | 3.9 | 3.7 |
| 1978 | 9,307 | 772 | NA | NA | NA | NA | NA | NA |
| 1979 | 9,668 | 864 | 825 | 424 | 401 | 8.5 | 4.4 | 4.1 |
| 1980 | 9,902 | 868 | 784 | 421 | 363 | 7.9 | 4.3 | 3.7 |
| 1981 | 10,154 | 796 | 760 | 340 | 420 | 7.5 | 3.3 | 4.1 |
| 1982 | 10,823 | 818 | 845 | 377 | 468 | 7.8 | 3.5 | 4.3 |
| 1983 | 10,964 | 760 | 803 | 350 | 453 | 7.3 | 3.2 | 4.1 |
| 1984 | 11,319 | 762 | 872 | 411 | 461 | 7.7 | 3.6 | 4.1 |
| 1985 | 11,833 | 935 | 998 | 478 | 520 | 8.4 | 4.0 | 4.4 |
| 1986 | 12,398 | 999 | 1,038 | 538 | 500 | 8.4 | 4.3 | 4.0 |
| 1987 | 13,068 | 1,091 | 1,111 | 635 | 476 | 8.5 | 4.9 | 3.6 |
| 1988 | 13,554 | 1,190 | 1,227 | 666 | 561 | 9.1 | 4.9 | 4.1 |
| 1989 | 13,792 | 1,267 | 1,304 | 662 | 642 | 9.5 | 4.8 | 4.7 |
| | **Computer sciences** | | | | | | | |
| 1972 | 2,901 | 679 | 638 | 405 | 233 | 22.0 | 14.0 | 8.0 |
| 1973 | 2,938 | 735 | 653 | 451 | 202 | 22.2 | 15.4 | 6.9 |
| 1974 | 3,746 | 721 | 747 | 477 | 270 | 19.9 | 12.7 | 7.2 |
| 1975 | 4,473 | 743 | 746 | 452 | 294 | 16.7 | 10.1 | 6.6 |
| 1976 | 4,748 | 697 | 731 | 386 | 345 | 15.4 | 8.1 | 7.3 |
| 1977 | 4,604 | 704 | 724 | 474 | 250 | 15.7 | 10.3 | 5.4 |
| 1978 | 4,426 | 699 | NA | NA | NA | NA | NA | NA |
| 1979 | 5,853 | 790 | 817 | 581 | 236 | 14.0 | 9.9 | 4.0 |
| 1980 | 6,587 | 953 | 1,036 | 678 | 358 | 15.7 | 10.3 | 5.4 |
| 1981 | 7,445 | 1,008 | 1,098 | 715 | 383 | 14.7 | 9.6 | 5.1 |
| 1982 | 9,171 | 1,075 | 1,191 | 763 | 428 | 13.0 | 8.3 | 4.7 |
| 1983 | 10,687 | 1,130 | 1,403 | 843 | 560 | 13.1 | 7.9 | 5.2 |
| 1984 | 11,587 | 1,269 | 1,635 | 971 | 664 | 14.1 | 8.4 | 5.7 |
| 1985 | 14,101 | 1,638 | 2,076 | 1,073 | 1,003 | 14.7 | 7.6 | 7.1 |
| 1986 | 15,310 | 1,892 | 2,354 | 1,148 | 1,206 | 15.4 | 7.5 | 7.9 |
| 1987 | 15,572 | 2,084 | 2,837 | 1,507 | 1,330 | 18.2 | 9.7 | 8.5 |
| 1988 | 15,596 | 2,226 | 3,054 | 1,646 | 1,408 | 19.6 | 10.6 | 9.0 |
| 1989 | 16,026 | 2,347 | 3,202 | 1,668 | 1,534 | 20.0 | 10.4 | 9.6 |

(continued)

Appendix table 5-25.
**Full-time graduate students in science and engineering supported by research assistantships (RA), by source and field: 1972-89**
(page 3 of 4)

| | Total | Federal support | RA | Federal RA support | Non-Federal RA support | Total RA support | Federal RA support | Non-Federal RA support |
|---|---|---|---|---|---|---|---|---|
| **Environmental sciences** | | | | | | | | |
| | Number | | | | | Percent | | |
| 1972 | 7,210 | 2,619 | 2,398 | 1,666 | 732 | 33.3 | 23.1 | 10.2 |
| 1973 | 7,767 | 2,480 | 2,551 | 1,780 | 771 | 32.8 | 22.9 | 9.9 |
| 1974 | 8,335 | 2,561 | 2,665 | 1,941 | 724 | 32.0 | 23.3 | 8.7 |
| 1975 | 9,677 | 2,693 | 2,838 | 2,089 | 749 | 29.3 | 21.6 | 7.7 |
| 1976 | 10,219 | 2,964 | 3,196 | 2,287 | 909 | 31.3 | 22.4 | 8.9 |
| 1977 | 10,556 | 3,117 | 3,234 | 2,318 | 916 | 30.6 | 22.0 | 8.7 |
| 1978 | 10,012 | 3,169 | NA | NA | NA | NA | NA | NA |
| 1979 | 10,724 | 3,523 | 3,587 | 2,706 | 881 | 33.4 | 25.2 | 8.2 |
| 1980 | 10,969 | 3,442 | 3,770 | 2,702 | 1,068 | 34.4 | 24.6 | 9.7 |
| 1981 | 11,038 | 3,010 | 3,469 | 2,402 | 1,067 | 31.4 | 21.8 | 9.7 |
| 1982 | 11,436 | 2,854 | 3,339 | 2,323 | 1,016 | 29.2 | 20.3 | 8.9 |
| 1983 | 12,049 | 2,874 | 3,545 | 2,348 | 1,197 | 29.4 | 19.5 | 9.9 |
| 1984 | 11,819 | 2,848 | 3,574 | 2,324 | 1,250 | 30.2 | 19.7 | 10.6 |
| 1985 | 11,439 | 2,960 | 3,723 | 2,410 | 1,313 | 32.5 | 21.1 | 11.5 |
| 1986 | 11,323 | 3,033 | 3,834 | 2,372 | 1,462 | 33.9 | 20.9 | 12.9 |
| 1987 | 10,543 | 2,868 | 3,660 | 2,251 | 1,409 | 34.7 | 21.4 | 13.4 |
| 1988 | 10,296 | 2,799 | 3,891 | 2,317 | 1,574 | 37.8 | 22.5 | 15.3 |
| 1989 | 10,088 | 2,842 | 4,124 | 2,394 | 1,730 | 40.9 | 23.7 | 17.1 |
| **Life sciences** | | | | | | | | |
| 1972 | 36,751 | 12,868 | 8,742 | 4,023 | 4,719 | 23.8 | 10.9 | 12.8 |
| 1973 | 40,830 | 12,563 | 9,461 | 4,292 | 5.169 | 23.2 | 10.5 | 12.7 |
| 1974 | 55,048 | 16,802 | 10,851 | 5,025 | 5,826 | 19.7 | 9.1 | 10.6 |
| 1975 | 63,513 | 17,594 | 11,322 | 5,373 | 5,949 | 17.8 | 8.5 | 9.4 |
| 1976 | 66,235 | 18,237 | 12,593 | 6,045 | 6,548 | 19.0 | 9.1 | 9.9 |
| 1977 | 68,828 | 19,465 | 13,077 | 6,172 | 6,905 | 19.0 | 9.0 | 10.0 |
| 1978 | 65,257 | 19,634 | NA | NA | NA | NA | NA | NA |
| 1979 | 71,150 | 21,240 | 15,421 | 7,230 | 8,191 | 21.7 | 10.2 | 11.5 |
| 1980 | 72,409 | 21,317 | 15,910 | 7,634 | 8.276 | 22.0 | 10.5 | 11.4 |
| 1981 | 72,241 | 20,476 | 16,362 | 7,606 | 8,756 | 22.6 | 10.5 | 12.1 |
| 1982 | 70,254 | 18,389 | 16,251 | 7,287 | 8,964 | 23.1 | 10.4 | 12.8 |
| 1983 | 70,062 | 17,678 | 16,514 | 7,272 | 9,242 | 23.6 | 10.4 | 13.2 |
| 1984 | 70,597 | 17,787 | 17,602 | 7,400 | 10,202 | 24.9 | 10.5 | 14.5 |
| 1985 | 70,311 | 18,604 | 17,932 | 7,996 | 9,936 | 25.5 | 11.4 | 14.1 |
| 1986 | 71,285 | 19,014 | 19,257 | 8,571 | 10.686 | 27.0 | 12.0 | 15.0 |
| 1987 | 72,463 | 20,213 | 20,301 | 9,377 | 10,924 | 28.0 | 12.9 | 15.1 |
| 1988 | 74,168 | 20,807 | 21,654 | 10,069 | 11,585 | 29.2 | 13.6 | 15.6 |
| 1989 | 77,001 | 21,931 | 23,264 | 10,872 | 12,392 | 30.2 | 14.1 | 16.1 |
| **Psychology** | | | | | | | | |
| 1972 | 15,308 | 4,708 | 1,777 | 1,006 | 771 | 11.6 | 6.6 | 5.0 |
| 1973 | 15,191 | 4,166 | 1,930 | 913 | 1,017 | 12.7 | 6.0 | 6.7 |
| 1974 | 19,044 | 4,425 | 2,291 | 1,042 | 1,249 | 12.0 | 5.5 | 6.6 |
| 1975 | 24,109 | 4,330 | 2,213 | 1,006 | 1,207 | 9.2 | 4.2 | 5.0 |
| 1976 | 25,649 | 4,311 | 2,261 | 977 | 1,284 | 8.8 | 3.8 | 5.0 |
| 1977 | 25,710 | 4,261 | 2,312 | 1,039 | 1,273 | 9.0 | 4.0 | 5.0 |
| 1978 | 20.740 | 3,937 | NA | NA | NA | NA | NA | NA |
| 1979 | 25,865 | 3,603 | 2,528 | 1,170 | 1.358 | 9.8 | 4.5 | 5.38 |

(continued)

Appendix table 5-25.
**Full-time graduate students in science and engineering supported by research assistantships (RA), by source and field: 1972-89**
(page 4 of 4)

| | Total | Federal support | RA | Federal RA support | Non-Federal RA support | Total RA support | Federal RA support | Non-Federal RA support |
|---|---|---|---|---|---|---|---|---|
| | | | | **Psychology** | | | | |
| | Number | | | | | Percent | | |
| 1980 | 26,692 | 3,390 | 2,571 | 942 | 1,629 | 9.6 | 3.5 | 6.1 |
| 1981 | 26,725 | 3,055 | 2,890 | 1,036 | 1,854 | 10.8 | 3.9 | 6.9 |
| 1982 | 25,818 | 2,414 | 2,723 | 927 | 1,796 | 10.5 | 3.6 | 7.0 |
| 1983 | 26,701 | 2,141 | 2,962 | 944 | 2,018 | 11.1 | 3.5 | 7.6 |
| 1984 | 26,108 | 2,062 | 3,027 | 962 | 2,065 | 11.6 | 3.7 | 7.9 |
| 1985 | 25,769 | 2,057 | 3,082 | 1,017 | 2,065 | 12.0 | 3.9 | 8.0 |
| 1986 | 26,521 | 2,035 | 3,119 | 1,021 | 2,098 | 11.8 | 3.8 | 7.9 |
| 1987 | 27,426 | 2,052 | 3,231 | 1,078 | 2,153 | 11.8 | 3.9 | 7.9 |
| 1988 | 28,412 | 2,167 | 3,743 | 1,210 | 2,533 | 13.2 | 4.3 | 8.9 |
| 1989 | 30,221 | 2,208 | 3,900 | 1,271 | 2,629 | 12.9 | 4.2 | 8.7 |
| | | | | **Social sciences** | | | | |
| 1972 | 32,534 | 5,553 | 3,654 | 1,149 | 2,505 | 11.2 | 3.5 | 7.7 |
| 1973 | 32,551 | 4,765 | 3,996 | 1,147 | 2,849 | 12.3 | 3.5 | 8.8 |
| 1974 | 40,285 | 5,133 | 4,788 | 1,350 | 3,438 | 11.9 | 3.4 | 8.5 |
| 1975 | 48,293 | 4,656 | 4,830 | 1,403 | 3,427 | 10.0 | 2.9 | 7.1 |
| 1976 | 47,096 | 5,148 | 4,897 | 1,349 | 3,548 | 10.4 | 2.9 | 7.5 |
| 1977 | 47,729 | 5,360 | 4,925 | 1,399 | 3,526 | 10.3 | 2.9 | 7.4 |
| 1978 | 41,257 | 4,433 | NA | NA | NA | NA | NA | NA |
| 1979 | 46,901 | 4,553 | 5,223 | 1,408 | 3,815 | 11.1 | 3.0 | 8.1 |
| 1980 | 47,271 | 4,296 | 5,298 | 1,447 | 3,851 | 11.2 | 3.1 | 8.1 |
| 1981 | 46,503 | 3,810 | 5,212 | 1,271 | 3,941 | 11.2 | 2.7 | 8.5 |
| 1982 | 44,437 | 3,235 | 4,883 | 971 | 3,912 | 11.0 | 2.2 | 8.8 |
| 1983 | 43,740 | 3,215 | 5,059 | 935 | 4,124 | 11.6 | 2.1 | 9.4 |
| 1984 | 42,776 | 2,963 | 5,180 | 916 | 4,264 | 12.1 | 2.1 | 10.0 |
| 1985 | 43,052 | 2,948 | 5,102 | 976 | 4,126 | 11.9 | 2.3 | 9.6 |
| 1986 | 43,077 | 2,670 | 5,138 | 888 | 4,250 | 11.9 | 2.1 | 9.9 |
| 1987 | 43,719 | 2,624 | 5,517 | 921 | 4,596 | 12.6 | 2.1 | 10.5 |
| 1988 | 44,089 | 2,691 | 5,634 | 925 | 4,709 | 12.8 | 2.1 | 10.7 |
| 1989 | 45,747 | 2,797 | 6,308 | 1,005 | 5,303 | 13.8 | 2.2 | 11.6 |
| | | | | **Engineering** | | | | |
| 1972 | 32,191 | 11,476 | 9,731 | 6,416 | 3,315 | 30.2 | 19.9 | 10.3 |
| 1973 | 31,226 | 10,468 | 10,380 | 6,554 | 3,826 | 33.2 | 21.0 | 12.3 |
| 1974 | 33,737 | 10,189 | 11,103 | 6,781 | 4,322 | 32.9 | 20.1 | 12.8 |
| 1975 | 37,813 | 10,263 | 10,987 | 6,935 | 4,052 | 29.1 | 18.3 | 10.7 |
| 1976 | 36,964 | 10,575 | 11,328 | 7,213 | 4,115 | 30.6 | 19.5 | 11.1 |
| 1977 | 37,565 | 10,637 | 11,877 | 7,550 | 4,327 | 31.6 | 20.1 | 11.5 |
| 1978 | 37,057 | 10,451 | NA | NA | NA | NA | NA | NA |
| 1979 | 40,393 | 10,811 | 12,911 | 8,014 | 4,897 | 32.0 | 19.8 | 12.1 |
| 1980 | 43,107 | 11,191 | 14,007 | 8,548 | 5,459 | 32.5 | 19.8 | 12.7 |
| 1981 | 46,257 | 10,974 | 14,482 | 8,535 | 5,947 | 31.3 | 18.5 | 12.9 |
| 1982 | 50,239 | 11,095 | 14,701 | 8,577 | 6,124 | 29.3 | 17.1 | 12.2 |
| 1983 | 54,327 | 11,985 | 15,638 | 9,010 | 6,628 | 28.8 | 16.6 | 12.2 |
| 1984 | 55,539 | 11,590 | 16,345 | 8,676 | 7,669 | 29.4 | 15.6 | 13.8 |
| 1985 | 56,293 | 11,267 | 17,965 | 8,427 | 9,538 | 31.9 | 15.0 | 16.9 |
| 1986 | 60,726 | 12,379 | 20,490 | 9,558 | 10,932 | 33.7 | 15.7 | 18.0 |
| 1987 | 62,229 | 13,131 | 22,169 | 10,371 | 11,798 | 35.6 | 16.7 | 19.0 |
| 1988 | 63,478 | 14,031 | 23,468 | 10,980 | 12,488 | 37.0 | 17.3 | 19.7 |
| 1989 | 64,580 | 14,253 | 24,636 | 11,282 | 13,354 | 38.1 | 17.5 | 20.7 |

NA = not available

SOURCE: Science Resources Studies Division, National Science Foundation, *Academic Science and Engineering: Graduate Enrollment and Support, Fall 1989*. Detailed Statistical Tables, NSF 90-324 Final (Washington, DC: NSF, 1991).

See figure 5-13.

Science & Engineering Indicators – 1991

Appendix table 5-26.
**U.S. and world scientific and technical articles, by field: 1973-87**

| Field | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **U.S. articles as percentage of all articles** | | | | | | | | | | | | | | | |
| Total | 38.2 | 37.7 | 37.3 | 37.4 | 37.1 | 36.7 | 37.1 | 36.5 | 35.9 | 35.9 | 35.4 | 35.4 | 35.3 | 35.6 | 35.6 |
| Clinical medicine | 42.8 | 42.5 | 42.6 | 43.0 | 43.2 | 43.1 | 43.1 | 43.0 | 41.3 | 41.1 | 40.3 | 40.9 | 40.3 | 40.0 | 39.9 |
| Biomedical research | 39.2 | 38.4 | 38.6 | 38.8 | 39.1 | 38.7 | 40.5 | 39.7 | 39.5 | 39.7 | 39.3 | 39.5 | 37.8 | 38.4 | 38.2 |
| Biology | 46.4 | 45.7 | 44.7 | 44.2 | 41.7 | 41.7 | 42.7 | 42.0 | 37.6 | 38.4 | 37.6 | 37.2 | 37.5 | 38.1 | 37.3 |
| Chemistry | 23.3 | 22.2 | 21.7 | 21.8 | 21.7 | 21.1 | 21.2 | 20.8 | 20.0 | 21.2 | 20.3 | 20.6 | 21.0 | 22.2 | 22.2 |
| Physics | 32.7 | 33.5 | 32.4 | 31.2 | 30.5 | 30.8 | 30.0 | 30.1 | 28.6 | 28.1 | 27.8 | 27.3 | 29.4 | 30.3 | 30.1 |
| Earth and space sciences | 46.7 | 46.8 | 43.8 | 46.1 | 45.1 | 44.9 | 44.6 | 42.4 | 42.7 | 42.4 | 41.6 | 41.3 | 43.0 | 42.6 | 42.6 |
| Engineering and technology | 41.8 | 41.7 | 40.6 | 41.1 | 40.2 | 39.4 | 40.7 | 39.4 | 40.7 | 40.6 | 40.9 | 39.5 | 38.6 | 37.3 | 37.9 |
| Mathematics | 47.9 | 46.0 | 44.0 | 42.9 | 41.1 | 40.4 | 40.5 | 39.7 | 38.2 | 39.0 | 38.5 | 37.2 | 38.3 | 40.3 | 40.7 |
| **Number of U.S. articles** | | | | | | | | | | | | | | | |
| Total | 103,778 | 100,066 | 97,278 | 99,970 | 97,854 | 99,207 | 99,377 | 98,394 | 132,278 | 133,622 | 132,413 | 131,111 | 137,771 | 137,770 | 134,497 |
| Clinical medicine | 32,638 | 31,691 | 31,334 | 32,920 | 33,516 | 34,966 | 33,975 | 34,612 | 48,072 | 48,530 | 48,055 | 48,735 | 50,595 | 50,637 | 49,904 |
| Biomedical research | 16,115 | 15,607 | 15,901 | 16,271 | 16,197 | 16,611 | 17,649 | 17,582 | 21,847 | 22,732 | 22,496 | 22,196 | 24,461 | 24,765 | 24,542 |
| Biology | 11.150 | 10,700 | 10,400 | 10,573 | 9,904 | 9,663 | 10,553 | 9,594 | 14,740 | 14,974 | 14,216 | 14,166 | 13,083 | 13,000 | 12,231 |
| Chemistry | 10,474 | 9,867 | 9,222 | 9,337 | 8,852 | 9,266 | 9,182 | 9,250 | 10,880 | 11,758 | 11,010 | 11,137 | 11,585 | 12,313 | 11,827 |
| Physics | 11,721 | 11,945 | 11,363 | 11,502 | 10.995 | 11,015 | 10,995 | 11,415 | 13,053 | 13,255 | 13,021 | 12,691 | 15,903 | 16,360 | 16,078 |
| Earth and space sciences | 5.591 | 5,371 | 4,975 | 5,537 | 5,197 | 5,043 | 5,167 | 4,832 | 7,257 | 7,057 | 6,862 | 6,748 | 7,663 | 7,811 | 7,797 |
| Engineering and technology | 11.955 | 11,088 | 10,431 | 10,346 | 10.081 | 9,694 | 9,018 | 8,461 | 12,486 | 11,619 | 13,105 | 11,976 | 10,822 | 9,775 | 9,225 |
| Mathematics | 4,134 | 3,797 | 3,652 | 3,484 | 3,112 | 2,949 | 2,838 | 2,648 | 3,943 | 3,697 | 3,648 | 3,462 | 3,659 | 3,109 | 2,893 |
| **Total number of articles** | | | | | | | | | | | | | | | |
| Total | 271,512 | 265,130 | 260,908 | 267,354 | 263,700 | 270,126 | 267,954 | 269,557 | 368,934 | 371,760 | 373,549 | 369,930 | 389,846 | 387,028 | 378,313 |
| Clinical medicine | 76.209 | 74,509 | 73,485 | 76,599 | 77,597 | 81,207 | 78,827 | 80,533 | 116,371 | 118,186 | 119,325 | 119,094 | 125,532 | 126,463 | 124,975 |
| Biomedical research | 41.155 | 40,632 | 41,244 | 41,891 | 41,388 | 42,968 | 43,631 | 44,267 | 55,303 | 57,203 | 57,289 | 56,223 | 64,717 | 64,550 | 64,216 |
| Biology | 24.047 | 23,414 | 23,260 | 23,905 | 23,757 | 23,176 | 24,734 | 22,838 | 39,232 | 39,025 | 37,788 | 38,093 | 34,896 | 34,127 | 32,775 |
| Chemistry | 45.004 | 44.529 | 42.502 | 42,773 | 40,734 | 43,850 | 43,273 | 44,448 | 54,432 | 55,381 | 54,186 | 54,117 | 55,268 | 55,558 | 53,236 |
| Physics | 35,864 | 35,708 | 35,104 | 36,902 | 36,057 | 35,815 | 36,700 | 37,944 | 45,561 | 47,229 | 46,902 | 46,450 | 54,044 | 54,056 | 53,377 |
| Earth and space sciences | 11.977 | 11,479 | 11,356 | 12,011 | 11,531 | 11,224 | 11,596 | 11,395 | 16,991 | 16,660 | 16,508 | 16,334 | 17,834 | 18,351 | 18,285 |
| Engineering and technology | 28,617 | 26,600 | 25,664 | 25,146 | 25,063 | 24,588 | 22,182 | 21,459 | 30,710 | 28,602 | 32,073 | 30,310 | 28,004 | 26,201 | 24,344 |
| Mathematics | 8.639 | 8,259 | 8,293 | 8,127 | 7,573 | 7,298 | 7,011 | 6,673 | 10,334 | 9.474 | 9,478 | 9,309 | 9,551 | 7,722 | 7,105 |

NOTES: Articles written by researchers from more than one country are prorated according to the number of author institutions in each country. For example, a paper authored by two U.S. scientists and one French scientist would be counted as two-thirds of a U.S. article and one-third of a French article. Data are based on more than 3,200 U.S. and foreign journals on the 1981 Science Citation Index Corporate Tapes.

SOURCE: CHI Research, Inc., *Science & Engineering Indicators* Literature Data Base, 1989, special tabulations.

Appendix table 5-27.
**Contribution of selected countries to world literature, by field: 1981 and 1987**

| Field | Total articles | United States | Total European Community countries | United Kingdom | West Germany | France | USSR | Japan | Canada |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **1981** | | | | | |
| | | | | Percent | | | | | |
| Total | 368,934 | 35.9 | 26.3 | 8.3 | 7.3 | 5.0 | 8.0 | 6.8 | 3.9 |
| Clinical medicine | 116,371 | 41.3 | 28.9 | 9.8 | 7.0 | 5.2 | 3.3 | 5.1 | 3.4 |
| Biomedical research | 55,303 | 39.5 | 26.9 | 8.5 | 7.1 | 5.2 | 5.7 | 6.2 | 4.1 |
| Biology | 39,232 | 37.6 | 22.4 | 9.0 | 6.0 | 3.5 | 2.8 | 6.1 | 6.3 |
| Chemistry | 54,432 | 20.0 | 26.2 | 6.6 | 8.4 | 5.9 | 16.7 | 10.9 | 3.1 |
| Physics | 45,561 | 28.6 | 25.8 | 6.4 | 7.7 | 5.9 | 16.8 | 8.2 | 2.9 |
| Earth and space sciences | 16,991 | 42.7 | 22.8 | 8.5 | 4.9 | 4.6 | 10.0 | 2.3 | 5.2 |
| Engineering and technology | 30,710 | 40.7 | 22.9 | 8.5 | 7.6 | 3.3 | 7.6 | 9.2 | 4.2 |
| Mathematics | 10,334 | 38.2 | 26.2 | 6.1 | 11.0 | 5.6 | 7.6 | 4.3 | 5.1 |
| | | | **1987** | | | | | | |
| Total | 378,313 | 35.6 | 26.5 | 8.0 | 6.8 | 4.8 | 7.3 | 7.6 | 4.4 |
| Clinical medicine | 124,975 | 39.9 | 28.9 | 10.0 | 6.2 | 4.5 | 2.8 | 6.7 | 4.1 |
| Biomedical research | 64,216 | 38.2 | 25.5 | 7.6 | 6.4 | 5.0 | 8.0 | 7.1 | 4.3 |
| Biology | 32,775 | 37.3 | 22.4 | 8.8 | 5.6 | 3.2 | 2.3 | 6.9 | 8.6 |
| Chemistry | 53,236 | 22.2 | 27.5 | 6.0 | 8.8 | 5.9 | 13.9 | 10.8 | 3.2 |
| Physics | 53,377 | 30.1 | 26.2 | 5.6 | 8.1 | 6.0 | 14.3 | 8.5 | 2.8 |
| Earth and space sciences | 18,285 | 42.6 | 22.6 | 7.3 | 4.6 | 4.8 | 7.1 | 3.5 | 6.8 |
| Engineering and technology | 24,344 | 37.9 | 22.5 | 7.5 | 7.6 | 3.4 | 5.6 | 10.1 | 5.1 |
| Mathematics | 7,105 | 40.7 | 28.6 | 8.6 | 6.7 | 5.0 | 4.8 | 3.6 | 4.5 |

NOTES: Articles written by researchers from more than one country are prorated according to the number of author institutions in each country. For example, a paper authored by two U.S. scientists and one French scientist would be counted as two-thirds of a U.S. article and one-third of a French article. Data are based on more than 3,200 U.S. and foreign journals on the 1981 Science Citation Index Corporate Tapes.

SOURCE: CHI Research, Inc., *Science & Engineering Indicators* Literature Data Base, 1989, special tabulations.

See figure O-18 in Overview.

*Science & Engineering Indicators – 1991*

Appendix table 5-28.
**Patents awarded to U.S. universities, by technology class: 1969-90**
(page 1 of 7)

| Technology class | 1969-75 | 1976-80 | 1981-85 | 1986-90 |
|---|---|---|---|---|
| Total | 1,694 | 1,739 | 2,462 | 4,664 |
| 1 Unclassified | 5 | 1 | 1 | 30 |
| 2 Apparel | 0 | 1 | 4 | 3 |
| 4 Baths, closets, sinks, spittoons | 0 | 1 | 0 | 0 |
| 5 Beds | 1 | 1 | 0 | 2 |
| 8 Bleaching & dying; fluid treatment & chemical modification of textiles & fibers | 1 | 3 | 3 | 2 |
| 15 Brushing, scrubbing & general cleaning | 5 | 1 | 1 | 0 |
| 17 Butchering | 0 | 0 | 0 | 0 |
| 19 Textiles, fiber preparation | 0 | 1 | 0 | 0 |
| 23 Chemistry, physical processes | 1 | 0 | 2 | 0 |
| 24 Buckles, buttons, clasps | 0 | 0 | 0 | 2 |
| 27 Undertaking | 0 | 0 | 0 | 1 |
| 29 Metal working | 7 | 1 | 1 | 10 |
| 33 Geometrical instruments | 0 | 2 | 2 | 2 |
| 34 Drying & gas or vapor contact with solids | 2 | 4 | 3 | 1 |
| 37 Excavating | 1 | 1 | 1 | 0 |
| 40 Card, picture & sign exhibiting | 0 | 1 | 0 | 1 |
| 43 Fishing, trapping & vermin destroying | 1 | 1 | 1 | 2 |
| 44 Fuel & related compositions | 0 | 2 | 17 | 12 |
| 47 Plant husbandry | 5 | 10 | 14 | 9 |
| 48 Gas, heating & illuminating | 3 | 5 | 4 | 1 |
| 51 Abrading | 4 | 4 | 0 | 3 |
| 52 Static structures, buildings | 4 | 2 | 8 | 5 |
| 53 Package making | 2 | 1 | 0 | 0 |
| 54 Harness | 0 | 0 | 0 | 1 |
| 55 Gas separation | 13 | 8 | 13 | 20 |
| 56 Harvesters | 34 | 9 | 7 | 4 |
| 60 Power plants | 6 | 6 | 8 | 7 |
| 62 Refrigeration | 7 | 10 | 15 | 19 |
| 65 Glass manufacturing | 6 | 2 | 1 | 12 |
| 70 Locks | 0 | 0 | 1 | 1 |
| 71 Chemistry, fertilizers | 5 | 8 | 8 | 26 |
| 72 Metal deforming | 6 | 1 | 1 | 0 |
| 73 Measuring and testing | 69 | 59 | 71 | 105 |
| 74 Machine elements & mechanisms | 6 | 7 | 5 | 8 |
| 75 Metallurgy | 8 | 9 | 10 | 14 |
| 76 Metal tools & implements - making | 0 | 0 | 1 | 0 |
| 81 Tools | 0 | 0 | 0 | 2 |
| 82 Turning | 0 | 1 | 0 | 0 |
| 83 Cutting | 4 | 0 | 1 | 1 |
| 84 Music | 3 | 4 | 3 | 3 |
| 87 Textiles, braiding, netting, lace making | 0 | 0 | 0 | 1 |
| 89 Ordnance | 0 | 0 | 0 | 7 |
| 91 Motors, expansible chamber type | 1 | 0 | 0 | 1 |
| 92 Expansible chamber devices | 0 | 0 | 2 | 2 |
| 98 Ventilation | 2 | 0 | 0 | 0 |
| 99 Foods & beverages - apparatus | 1 | 2 | 3 | 1 |
| 100 Presses | 2 | 1 | 1 | 1 |
| 101 Printing | 2 | 0 | 0 | 0 |
| 102 Ammunition & explosives | 0 | 1 | 0 | 1 |
| 104 Railways | 10 | 1 | 2 | 6 |

(continued)

Appendix table 5-28.
**Patents awarded to U.S. universities, by technology class: 1969-90**
(page 2 of 7)

| Technology class | 1969-75 | 1976-80 | 1981-85 | 1986-90 |
|---|---|---|---|---|
| 106 Compositions, coating or plastic | 6 | 6 | 6 | 6 |
| 108 Horizontally supported planar surfaces | 1 | 1 | 4 | 0 |
| 110 Furnaces | 1 | 0 | 10 | 3 |
| 111 Planting | 4 | 0 | 7 | 8 |
| 112 Sewing | 0 | 0 | 0 | 1 |
| 114 Ships | 1 | 1 | 1 | 0 |
| 116 Signals & indicators | 1 | 0 | 0 | 1 |
| 118 Coating apparatus | 5 | 3 | 4 | 5 |
| 119 Animal husbandry | 5 | 6 | 7 | 19 |
| 122 Liquid heaters & vaporizers | 1 | 0 | 1 | 4 |
| 123 Internal combustion engines | 5 | 9 | 5 | 15 |
| 124 Mechanical guns & projectors | 0 | 1 | 0 | 0 |
| 125 Stone working | 0 | 0 | 0 | 1 |
| 126 Stoves & furnaces | 2 | 16 | 13 | 3 |
| 127 Sugar, starch & carbohydrates | 0 | 3 | 11 | 1 |
| 128 Surgery | 68 | 67 | 110 | 224 |
| 131 Tobacco | 4 | 2 | 0 | 4 |
| 132 Toilet | 1 | 0 | 0 | 0 |
| 134 Cleaning & liquid contact with solids | 0 | 4 | 7 | 4 |
| 135 Tents canopies umbrellas & canes | 1 | 0 | 0 | 1 |
| 136 Batteries, thermoelectric & photoelectric | 2 | 15 | 28 | 4 |
| 137 Fluid handling | 13 | 7 | 3 | 5 |
| 138 Pipes & tubular conduits | 0 | 0 | 1 | 1 |
| 139 Textiles, weaving | 0 | 0 | 1 | 0 |
| 141 Fluent materials handling with receiver or receiver coating means | 1 | 4 | 1 | 1 |
| 144 Woodworking | 2 | 0 | 2 | 0 |
| 148 Metal treatment | 2 | 11 | 11 | 15 |
| 149 Explosives & thermic compositions & charges | 1 | 0 | 0 | 0 |
| 156 Adhesive bonding & misc. chemical manufacture | 5 | 6 | 19 | 48 |
| 159 Concentrating evaporators | 0 | 0 | 1 | 1 |
| 160 Closures, partitions & panels, flexible & portable | 0 | 0 | 1 | 0 |
| 162 Paper making & fiber liberation | 0 | 1 | 3 | 4 |
| 164 Metal founding | 3 | 3 | 5 | 4 |
| 165 Heat exchange | 2 | 3 | 5 | 12 |
| 166 Wells | 2 | 3 | 9 | 5 |
| 169 Fire extinguishers | 0 | 0 | 1 | 0 |
| 171 Unearthing plants or buried objects | 5 | 3 | 0 | 1 |
| 172 Earth working | 0 | 7 | 1 | 0 |
| 173 Tool driving & impacting | 1 | 0 | 1 | 2 |
| 174 Electricity conductors & insulators | 2 | 3 | 0 | 3 |
| 175 Boring & penetrating earth | 1 | 3 | 5 | 1 |
| 177 Weighing scales | 1 | 0 | 0 | 2 |
| 178 Telegraphy | 5 | 1 | 1 | 1 |
| 180 Motor vehicles | 0 | 1 | 1 | 3 |
| 181 Acoustics | 0 | 1 | 5 | 1 |
| 185 Motors, springs, weight & animal powered | 1 | 0 | 0 | 0 |
| 188 Brakes | 3 | 2 | 1 | 0 |
| 194 Check actuated control mechanisms | 1 | 0 | 0 | 1 |
| 198 Conveyors power driven | 6 | 1 | 7 | 0 |
| 200 Electricity, circuit makers & breakers | 1 | 0 | 0 | 5 |

(continued)

Appendix table 5-28.
**Patents awarded to U.S. universities, by technology class: 1969-90**
(page 3 of 7)

| Technology class | 1969-75 | 1976-80 | 1981-85 | 1986-90 |
|---|---|---|---|---|
| 201 Distillation processes thermolytic | 0 | 2 | 0 | 0 |
| 202 Distillation apparatus | 1 | 0 | 0 | 1 |
| 203 Distillation processes separatory | 0 | 2 | 3 | 5 |
| 204 Chemistry: electrical and wave energy | 41 | 36 | 65 | 92 |
| 206 Receptacle or package, special | 1 | 0 | 0 | 8 |
| 208 Mineral oils, processes & products | 2 | 3 | 9 | 5 |
| 209 Classifying, separating & assorting solids | 19 | 9 | 12 | 19 |
| 210 Liquid purification or separation | 27 | 32 | 34 | 59 |
| 211 Supports, racks | 1 | 0 | 2 | 0 |
| 215 Bottles & jars | 2 | 0 | 0 | 0 |
| 219 Electric heating | 6 | 8 | 9 | 15 |
| 220 Receptacles | 1 | 0 | 1 | 2 |
| 221 Dispensing, article | 1 | 1 | 1 | 1 |
| 222 Dispensing | 2 | 4 | 3 | 2 |
| 225 Severing by tearing, breaking | 1 | 0 | 0 | 0 |
| 226 Advancing material of indeterminate length | 0 | 0 | 0 | 1 |
| 228 Metal fusion bonding | 1 | 1 | 0 | 4 |
| 235 Registers | 1 | 1 | 0 | 1 |
| 236 Automatic temperature & humidity regulation | 0 | 0 | 0 | 1 |
| 238 Railways surface track | 0 | 0 | 2 | 0 |
| 239 Fluid sprinkling, spraying, diffusing | 3 | 1 | 4 | 7 |
| 241 Solid material comminution, disintegration | 7 | 1 | 2 | 5 |
| 242 Winding & reeling | 2 | 1 | 0 | 3 |
| 244 Aeronautics | 8 | 3 | 2 | 4 |
| 248 Supports | 2 | 0 | 0 | 3 |
| 249 Molds, static | 1 | 0 | 0 | 0 |
| 250 Radiant energy | 38 | 54 | 46 | 117 |
| 251 Valves, valve actuation | 2 | 1 | 0 | 5 |
| 252 Compositions | 10 | 15 | 20 | 26 |
| 254 Apparatus, implements for applying pushing, pulling force | 1 | 1 | 0 | 0 |
| 256 Fences | 0 | 0 | 0 | 1 |
| 260 Chemistry, carbon compounds | 5 | 6 | 5 | 7 |
| 261 Gas, liquid contact apparatus | 1 | 0 | 2 | 0 |
| 264 Plastic & nonmetallic article shaping and treating processes | 9 | 18 | 19 | 31 |
| 266 Metallurgical apparatus | 0 | 0 | 0 | 1 |
| 267 Device, spring | 1 | 1 | 0 | 0 |
| 269 Work holders | 0 | 1 | 1 | 1 |
| 272 Devices, amusement & exercising | 1 | 0 | 3 | 12 |
| 273 Devices, amusement-games | 1 | 5 | 0 | 3 |
| 277 Joint packing | 0 | 0 | 0 | 5 |
| 279 Chucks, sockets | 0 | 0 | 1 | 0 |
| 280 Vehicles, land | 2 | 0 | 15 | 4 |
| 283 Printed matter | 1 | 0 | 0 | 0 |
| 285 Pipe joints, couplings | 1 | 0 | 0 | 0 |
| 289 Knots, knot tying | 1 | 0 | 0 | 0 |
| 290 Dynamo plants, prime mover | 1 | 2 | 2 | 0 |
| 292 Fasteners, closure | 0 | 0 | 1 | 0 |
| 293 Vehicle fenders | 1 | 0 | 0 | 0 |
| 294 Implements, handling-hand & hoist line | 0 | 1 | 1 | 5 |
| 296 Vehicles, land-bodies & tops | 0 | 2 | 1 | 0 |

(continued)

Appendix table 5-28.
**Patents awarded to U.S. universities, by technology class: 1969-90**
(page 4 of 7)

| Technology class | 1969-75 | 1976-80 | 1981-85 | 1986-90 |
|---|---|---|---|---|
| 297 Chairs, seats | 1 | 0 | 0 | 1 |
| 299 Mining, in situ disintegration of hard material | 2 | 1 | 1 | 2 |
| 307 Electrical transmission or interconnection systems | 30 | 13 | 8 | 13 |
| 310 Electrical generator or motor structure | 28 | 8 | 10 | 18 |
| 312 Supports, cabinet structures | 2 | 1 | 1 | 0 |
| 313 Electric lamp & discharge devices | 4 | 6 | 1 | 3 |
| 315 Electric lamp & discharge devices, systems | 11 | 7 | 7 | 9 |
| 318 Electricity, motive power systems | 9 | 5 | 5 | 4 |
| 320 Electricity, battery & condenser charging & discharging | 1 | 0 | 1 | 1 |
| 322 Electricity, single generator systems | 0 | 1 | 2 | 2 |
| 323 Electricity, power supply or regulation systems | 3 | 1 | 1 | 2 |
| 324 Electricity: measuring and testing | 30 | 16 | 37 | 129 |
| 328 Electricity, misc. electron space discharge device systems | 3 | 2 | 4 | 5 |
| 329 Electr - demodulators & detectors | 3 | 0 | 0 | 0 |
| 330 Amplifiers | 13 | 6 | 5 | 13 |
| 331 Electr - amplifiers | 8 | 4 | 2 | 6 |
| 332 Electr - oscillators | 3 | 0 | 1 | 1 |
| 333 Wave transmission lines & networks | 12 | 14 | 9 | 10 |
| 335 Electr - modulators | 3 | 1 | 0 | 5 |
| 336 Electr - wave transmission lines & networks | 2 | 0 | 0 | 0 |
| 338 Electr - tuners | 6 | 2 | 1 | 5 |
| 340 Communications, electrical | 18 | 8 | 7 | 18 |
| 341 Electr - magnetically operated switches magnets & electromagnets | 5 | 2 | 1 | 13 |
| 342 Electr - inductor devices | 12 | 7 | 3 | 8 |
| 343 Communications, radio wave antennas | 18 | 5 | 5 | 3 |
| 346 Electr - switches electrothermically or thermically actuated | 3 | 1 | 0 | 1 |
| 350 Optics, systems and elements | 20 | 24 | 42 | 119 |
| 351 Electr - resistors | 4 | 2 | 2 | 17 |
| 352 Electr - communications | 1 | 0 | 0 | 2 |
| 353 Optics, image projectors | 1 | 0 | 0 | 0 |
| 354 Photography | 1 | 1 | 3 | 0 |
| 355 Photocopying | 1 | 0 | 0 | 0 |
| 356 Optics, measuring and testing | 19 | 24 | 31 | 86 |
| 357 Active solid state devices eg transistors, solid state diodes | 10 | 17 | 19 | 60 |
| 358 Pictorial communication; television | 14 | 14 | 12 | 39 |
| 360 Info tech - dynamic magnetic info storage & retrieval | 10 | 5 | 1 | 3 |
| 361 Electr - electrical systems & devices | 8 | 4 | 1 | 7 |
| 362 Electr - illumination | 3 | 0 | 0 | 2 |
| 363 Electr - power conversion systems | 3 | 8 | 7 | 12 |
| 364 Electrical computers and data processing systems | 32 | 26 | 36 | 137 |

(continued)

Appendix table 5-28.
**Patents awarded to U.S. universities, by technology class: 1969-90**
(page 5 of 7)

| Technology class | 1969-75 | 1976-80 | 1981-85 | 1986-90 |
|---|---|---|---|---|
| 365 Static information storage & retrieval | 24 | 7 | 7 | 23 |
| 366 Agitating | 1 | 4 | 2 | 2 |
| 367 Electr - communications-acoustic wave systems & devices | 11 | 6 | 0 | 9 |
| 368 Measuring: horology-time meas sys & devices | 4 | 1 | 0 | 1 |
| 369 Info tech - dynamic info storage & retrieval | 0 | 0 | 1 | 2 |
| 370 Electr - communications multiplex | 3 | 2 | 2 | 13 |
| 371 Electr - error detection/correct and fault detect/recovery | 2 | 1 | 4 | 7 |
| 372 Coherent light generators | 15 | 14 | 27 | 74 |
| 373 Heating - industrial electric furnaces | 2 | 0 | 0 | 1 |
| 374 Measuring - thermal meas & testing | 1 | 6 | 9 | 14 |
| 375 Electr - communications, pulse or digital | 5 | 2 | 2 | 9 |
| 376 Nuclear - induced reactions systems & elements | 1 | 4 | 5 | 6 |
| 377 Electr - pulse counters, dividers; shift registers-circuits & systems | 4 | 0 | 1 | 3 |
| 378 X-ray or gamma-ray systems or devices | 17 | 25 | 17 | 33 |
| 379 Nuclear - x-ray gamma ray sys, devices | 1 | 0 | 1 | 8 |
| 380 Cryptography | 0 | 3 | 6 | 2 |
| 381 Electrical audio signal processing and systems and devices | 6 | 7 | 12 | 18 |
| 382 Image analysis | 1 | 1 | 5 | 14 |
| 384 Bearings | 3 | 0 | 0 | 3 |
| 400 Typewriting machines | 0 | 0 | 1 | 1 |
| 403 Joints & connections | 0 | 2 | 0 | 1 |
| 404 Road structure process, apparatus | 0 | 0 | 0 | 2 |
| 405 Earth, hydraulic engineering | 6 | 2 | 6 | 6 |
| 406 Conveyors, fluid current | 3 | 5 | 3 | 1 |
| 407 Cutters for shaping | 0 | 0 | 0 | 2 |
| 409 Gear cutting, milling, planing | 1 | 1 | 1 | 0 |
| 414 Handling, material/article | 5 | 5 | 4 | 10 |
| 415 Motors, pumps-rotary kinetic fluid | 0 | 2 | 1 | 0 |
| 416 Fluid reaction surfaces-impellers | 0 | 1 | 1 | 0 |
| 417 Pumps | 2 | 10 | 4 | 7 |
| 418 Expansible chamber devices-rotary | 5 | 0 | 0 | 0 |
| 419 Powder metallurgy-processes | 1 | 0 | 2 | 5 |
| 420 Compositions-alloys or metallic compositions | 6 | 1 | 5 | 5 |
| 422 Process disinfecting, deodorizing, preserving or sterilizing & chemical apparatus | 9 | 12 | 14 | 39 |
| 423 Chemistry, inorganic | 37 | 30 | 26 | 31 |
| 424 Drug, bio-affecting and body treating compositions | 52 | 69 | 137 | 261 |
| 425 Plastic or earthenware article shaping, treating apparatus | 1 | 1 | 4 | 4 |
| 426 Food or edible material: processes, compositions and products | 31 | 31 | 38 | 35 |
| 427 Coating processes | 8 | 10 | 15 | 62 |
| 428 Stock material or miscellaneous articles | 13 | 14 | 31 | 48 |
| 429 Chemistry, electrical current producing apparatus, product & process | 5 | 12 | 22 | 17 |
| 430 Radiation imagery chemistry-process, composition or product | 3 | 4 | 9 | 20 |

(continued)

Appendix table 5-28.
**Patents awarded to U.S. universities, by technology class: 1969-90**
(page 6 of 7)

| Technology class | 1969-75 | 1976-80 | 1981-85 | 1986-90 |
|---|---|---|---|---|
| 431 Combustion | 2 | 1 | 1 | 3 |
| 432 Heating | 0 | 1 | 3 | 0 |
| 433 Dentistry | 4 | 10 | 3 | 17 |
| 434 Education & demonstration | 21 | 4 | 4 | 8 |
| 435 Chemistry: molecular biology and microbiology | 58 | 84 | 192 | 446 |
| 436 Chemistry: analytical and immunological testing | 23 | 56 | 72 | 65 |
| 437 Semiconductor device manufacturing, process | 5 | 14 | 26 | 50 |
| 439 Electr - connectors | 0 | 0 | 1 | 4 |
| 440 Propulsion-marine | 0 | 0 | 0 | 1 |
| 445 Electrical lamp etc | 1 | 0 | 1 | 0 |
| 449 Bee culture | 0 | 0 | 1 | 0 |
| 452 Butchering | 4 | 1 | 2 | 0 |
| 455 Telecommunications | 10 | 4 | 6 | 5 |
| 460 Crop threshing, separating | 7 | 2 | 1 | 0 |
| 474 Rotary shafts etc. & flecible couplings for | 0 | 0 | 0 | 3 |
| 494 Imperforate bowl, centrifugal separators | 0 | 0 | 1 | 0 |
| 501 Compositions-ceramic | 0 | 5 | 6 | 21 |
| 502 Catalyst, solid sorbent, or support therefor, product or process of making | 2 | 8 | 11 | 22 |
| 503 Record receiver with plural leaves or colorless color former | 1 | 0 | 0 | 0 |
| 505 Superconductor technology-apparat;mat; process | 0 | 0 | 0 | 25 |
| 514 Drug, bio-affecting and body treating compositions | 46 | 119 | 225 | 464 |
| 518 Chemistry- F/T processes; puri/recov of products | 0 | 0 | 1 | 1 |
| 521 Synthetic resins or nat rubbers- cf class 520 series | 10 | 8 | 5 | 5 |
| 522 Synthetic resins or nat rubbers- cf class 520 series | 1 | 3 | 1 | 4 |
| 523 Synthetic resins or nat rubbers- cf class 520 series | 3 | 3 | 6 | 6 |
| 524 Synthetic resins or nat rubbers- cf class 520 series | 7 | 4 | 3 | 8 |
| 525 Synthetic resins or natural rubber- part of class 520 series | 4 | 21 | 24 | 38 |
| 526 Synthetic resins or nat rubbers- cf class 520 series | 4 | 5 | 3 | 19 |
| 527 Synthetic resins or nat rubbers- cf class 520 series | 1 | 0 | 2 | 1 |
| 528 Synthetic resins or natural rubber- part of class 520 series | 20 | 13 | 6 | 30 |
| 530 Chemistry: peptides or proteins; lignins or reaction products thereof | 9 | 14 | 79 | 117 |
| 534 Organic compounds - cf class 532-570 series | 4 | 5 | 2 | 9 |
| 536 Organic compounds - part of class 532-570 series | 19 | 23 | 35 | 65 |
| 540 Organic compounds-part of class 532-570 series | 8 | 13 | 11 | 36 |
| 544 Organic compounds - cf class 532-570 series | 5 | 4 | 9 | 20 |

(continued)

Appendix table 5-28.
**Patents awarded to U.S. universities, by technology class: 1969-90**
(page 7 of 7)

| Technology class | 1969-75 | 1976-80 | 1981-85 | 1986-90 |
|---|---|---|---|---|
| 546 Organic compounds-part of class 532-570 series | 15 | 23 | 9 | 29 |
| 548 Organic compounds-part of class 532-570 series | 4 | 14 | 10 | 24 |
| 549 Organic compounds-part of class 532-570 series | 8 | 28 | 37 | 40 |
| 552 Organic compounds - cf class 532-570 series | 25 | 25 | 31 | 15 |
| 556 Organic compounds-part of class 532-570 series | 10 | 7 | 13 | 26 |
| 558 Organic compounds-part of class 532-570 series | 6 | 5 | 8 | 12 |
| 560 Organic compounds-part of class 532-570 series | 12 | 20 | 16 | 13 |
| 562 Organic compounds-part of class 532-570 series | 10 | 8 | 5 | 9 |
| 564 Organic compounds - cf class 532-570 series | 7 | 7 | 5 | 10 |
| 568 Organic compounds-part of class 532-570 series | 19 | 23 | 14 | 15 |
| 570 Organic compounds - cf class 532-570 series | 2 | 0 | 1 | 3 |
| 585 Chemistry-hydrocarbons | 4 | 6 | 6 | 14 |
| 600 Surgery | 5 | 5 | 11 | 13 |
| 604 Surgery | 7 | 11 | 36 | 78 |
| 606 Surgery | 14 | 8 | 21 | 54 |
| 623 Prosthesis, parts thereof or aids and accessories therefor | 21 | 14 | 22 | 54 |
| 800 Multicellular living organisms or parts | 1 | 1 | 3 | 2 |

SOURCE: TAF Report, U.S. Universities, U.S. Patent and Trademark Office. July 1991.

See figure 5-14. *Science & Engineering Indicators – 1991*

Appendix table 5-29.
**Patents awarded to the 100 academic institutions with the greatest R&D volume: 1969-90**
(page 1 of 3)

| | Total 1969-90 | 1969-71 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALL ACADEMIC PATENTS | 10,559 | 630 | 237 | 258 | 249 | 320 | 357 | 363 | 367 | 262 | 390 | 436 | 457 | 433 | 551 | 585 | 670 | 817 | 805 | 1,217 | 1,155 |
| **Patents to top 100 R&D performers** | 8,399 | 476 | 181 | 189 | 180 | 242 | 281 | 285 | 289 | 199 | 290 | 335 | 360 | 343 | 416 | 453 | 521 | 682 | 671 | 1,022 | 984 |
| Massachusetts Institute of Technology | 1,109 | 94 | 28 | 40 | 37 | 44 | 59 | 39 | 53 | 43 | 44 | 66 | 51 | 47 | 47 | 35 | 45 | 63 | 63 | 101 | 110 |
| University of California | 752 | 59 | 16 | 25 | 22 | 17 | 22 | 25 | 23 | 1 | 2 | 38 | 42 | 48 | 46 | 42 | 54 | 67 | 60 | 81 | 62 |
| California Institute of Technology | 428 | 29 | 17 | 14 | 15 | 27 | 18 | 16 | 18 | 12 | 26 | 16 | 19 | 16 | 15 | 16 | 23 | 27 | 18 | 56 | 30 |
| Stanford University | 415 | 3 | 3 | 6 | 7 | 16 | 19 | 18 | 10 | 4 | 11 | 10 | 4 | 16 | 36 | 38 | 33 | 48 | 54 | 43 | 36 |
| University of Wisconsin | 338 | 15 | 12 | 13 | 8 | 17 | 20 | 25 | 13 | 7 | 28 | 26 | 17 | 13 | 16 | 17 | 17 | 11 | 20 | 27 | 16 |
| Iowa State University | 332 | 42 | 11 | 14 | 20 | 15 | 14 | 15 | 12 | 8 | 12 | 12 | 15 | 10 | 14 | 21 | 9 | 15 | 15 | 28 | 30 |
| University of Minnesota | 258 | 15 | 9 | 6 | 4 | 5 | 3 | 5 | 6 | 7 | 6 | 12 | 10 | 5 | 6 | 11 | 16 | 28 | 26 | 40 | 38 |
| Cornell University | 243 | 11 | 1 | 2 | 3 | 5 | 10 | 10 | 10 | 7 | 11 | 8 | 6 | 10 | 14 | 20 | 13 | 30 | 16 | 22 | 34 |
| University of Texas | 222 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 1 | 6 | 7 | 5 | 8 | 20 | 25 | 21 | 21 | 51 | 54 |
| Johns Hopkins University | 214 | 9 | 7 | 5 | 4 | 10 | 3 | 9 | 10 | 4 | 6 | 9 | 8 | 6 | 10 | 15 | 18 | 18 | 21 | 27 | 15 |
| Purdue University | 204 | 16 | 10 | 4 | 1 | 13 | 15 | 12 | 6 | 4 | 13 | 15 | 11 | 11 | 14 | 18 | 9 | 4 | 2 | 11 | 15 |
| University of Utah | 198 | 15 | 8 | 3 | 2 | 5 | 7 | 6 | 12 | 17 | 12 | 7 | 14 | 15 | 9 | 11 | 7 | 12 | 9 | 13 | 14 |
| University of Illinois | 189 | 17 | 7 | 8 | 9 | 9 | 14 | 11 | 11 | 6 | 10 | 8 | 7 | 8 | 8 | 10 | 12 | 4 | 9 | 15 | 6 |
| Ohio State University | 176 | 38 | 12 | 8 | 3 | 4 | 7 | 9 | 8 | 0 | 3 | 4 | 5 | 8 | 3 | 10 | 5 | 12 | 14 | 13 | 10 |
| University of Florida | 153 | 0 | 0 | 1 | 1 | 2 | 2 | 0 | 1 | 3 | 7 | 4 | 0 | 6 | 10 | 7 | 10 | 13 | 21 | 33 | 32 |
| State University of New York | 112 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 8 | 2 | 11 | 5 | 11 | 18 | 10 | 25 | 19 |
| Georgia Institute of Technology | 112 | 6 | 0 | 3 | 5 | 1 | 1 | 2 | 2 | 5 | 3 | 7 | 8 | 3 | 6 | 11 | 9 | 9 | 7 | 8 | 16 |
| University of Michigan | 109 | 0 | 0 | 0 | 4 | 0 | 2 | 8 | 2 | 4 | 4 | 1 | 2 | 2 | 1 | 1 | 10 | 6 | 14 | 23 | 25 |
| Harvard University | 105 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 4 | 3 | 11 | 10 | 7 | 1 | 2 | 9 | 17 | 15 | 23 |
| University of Rochester | 100 | 0 | 0 | 0 | 0 | 0 | 4 | 2 | 4 | 0 | 6 | 7 | 8 | 9 | 6 | 2 | 8 | 9 | 11 | 11 | 13 |
| University of Southern California | 98 | 0 | 0 | 2 | 3 | 4 | 5 | 6 | 15 | 6 | 7 | 2 | 5 | 1 | 7 | 5 | 5 | 4 | 7 | 8 | 6 |
| Northwestern University | 91 | 12 | 0 | 2 | 1 | 0 | 0 | 2 | 7 | 5 | 7 | 1 | 7 | 3 | 2 | 2 | 8 | 10 | 10 | 7 | 5 |
| University of Kentucky | 86 | 8 | 2 | 3 | 6 | 0 | 0 | 1 | 3 | 2 | 5 | 4 | 6 | 6 | 7 | 5 | 7 | 4 | 7 | 6 | 4 |
| University of Iowa | 78 | 2 | 0 | 0 | 0 | 0 | 3 | 3 | 2 | 5 | 4 | 4 | 5 | 3 | 4 | 1 | 8 | 8 | 6 | 8 | 12 |
| University of Virginia | 78 | 0 | 0 | 1 | 3 | 0 | 3 | 7 | 8 | 6 | 1 | 3 | 8 | 4 | 2 | 1 | 4 | 3 | 4 | 8 | 12 |
| University of Pittsburgh | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 6 | 3 | 2 | 5 | 8 | 3 | 8 | 10 | 6 | 11 | 11 |
| Indiana University | 72 | 24 | 5 | 2 | 0 | 1 | 4 | 4 | 7 | 2 | 2 | 1 | 0 | 3 | 2 | 4 | 0 | 3 | 1 | 6 | 1 |
| Columbia University | 72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 4 | 7 | 6 | 15 | 19 | 16 |
| University of Missouri | 72 | 0 | 0 | 0 | 2 | 3 | 5 | 0 | 6 | 4 | 1 | 2 | 9 | 5 | 4 | 0 | 3 | 8 | 9 | 5 | 6 |
| University of Pennsylvania | 71 | 4 | 1 | 2 | 2 | 1 | 2 | 5 | 5 | 3 | 1 | 1 | 1 | 2 | 4 | 5 | 1 | 2 | 1 | 9 | 19 |

(continued)

Appendix table 5-29.
**Patents awarded to the 100 academic institutions with the greatest R&D volume: 1969-90**
(page 2 of 3)

| | Total 1969-90 | 1969-71 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New York University | 70 | 4 | 2 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 3 | 1 | 7 | 3 | 4 | 5 | 3 | 5 | 4 | 10 | 14 |
| University of Tennessee | 68 | 8 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 5 | 8 | 8 | 8 | 12 | 14 |
| Duke University | 62 | 2 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 1 | 3 | 3 | 6 | 4 | 6 | 4 | 9 | 11 | 7 |
| Boston University | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 3 | 2 | 1 | 2 | 2 | 3 | 6 | 9 | 9 | 9 | 11 |
| Kansas State University | 58 | 2 | 4 | 3 | 3 | 5 | 3 | 2 | 1 | 3 | 3 | 2 | 2 | 4 | 3 | 2 | 4 | 4 | 3 | 4 | 1 |
| Michigan State University | 56 | 0 | 2 | 1 | 0 | 0 | 4 | 0 | 2 | 1 | 2 | 1 | 1 | 3 | 3 | 3 | 10 | 6 | 8 | 2 | 7 |
| Texas A&M University | 55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 3 | 2 | 3 | 8 | 3 | 6 | 9 | 8 | 9 |
| Rockefeller University | 55 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 3 | 3 | 1 | 3 | 5 | 4 | 9 | 11 | 6 | 8 |
| Baylor University | 52 | 0 | 0 | 0 | 0 | 1 | 3 | 4 | 1 | 1 | 1 | 3 | 3 | 2 | 2 | 3 | 2 | 7 | 3 | 8 | 8 |
| Yale University | 52 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 5 | 3 | 12 | 6 | 11 | 10 |
| Oregon State University | 50 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 1 | 2 | 0 | 4 | 1 | 3 | 4 | 4 | 4 | 6 | 3 | 11 | 3 |
| North Carolina State University | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 1 | 0 | 2 | 3 | 4 | 6 | 5 | 10 | 14 |
| Washington University | 49 | 2 | 0 | 0 | 1 | 2 | 1 | 1 | 0 | 0 | 3 | 1 | 0 | 1 | 1 | 3 | 1 | 7 | 6 | 12 | 7 |
| University of Alabama | 48 | 1 | 0 | 1 | 0 | 0 | 1 | 4 | 4 | 2 | 3 | 2 | 3 | 1 | 1 | 5 | 3 | 5 | 3 | 3 | 6 |
| University of Miami | 48 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 1 | 0 | 2 | 2 | 2 | 0 | 4 | 4 | 3 | 15 | 5 | 5 | 1 |
| Wayne State University | 47 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 5 | 6 | 7 | 16 | 9 |
| University of Washington | 40 | 0 | 0 | 1 | 0 | 2 | 2 | 1 | 2 | 2 | 0 | 0 | 7 | 2 | 3 | 1 | 2 | 1 | 5 | 3 | 6 |
| Oklahoma State University | 40 | 10 | 3 | 3 | 1 | 2 | 2 | 2 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 2 | 2 | 0 | 2 | 3 | 4 |
| Case Western Reserve University | 38 | 6 | 2 | 2 | 3 | 0 | 4 | 3 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 6 | 3 | 1 | 1 | 2 |
| City University of New York | 37 | 3 | 1 | 2 | 1 | 1 | 0 | 2 | 1 | 0 | 1 | 5 | 4 | 3 | 2 | 1 | 2 | 1 | 3 | 2 | 2 |
| University of Georgia | 37 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 7 | 7 | 5 | 6 | 3 | 0 | 3 | 5 |
| University of Arizona | 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 0 | 8 | 10 |
| University of Cincinnati | 35 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 1 | 8 | 3 | 8 | 9 |
| University of Nebraska | 35 | 0 | 1 | 0 | 2 | 5 | 0 | 1 | 1 | 0 | 1 | 5 | 4 | 0 | 5 | 1 | 1 | 1 | 4 | 0 | 3 |
| Louisiana State University | 34 | 1 | 0 | 1 | 0 | 0 | 0 | 3 | 2 | 0 | 1 | 2 | 0 | 1 | 1 | 1 | 1 | 3 | 4 | 9 | 4 |
| Yeshiva University | 34 | 2 | 1 | 1 | 0 | 3 | 2 | 0 | 0 | 1 | 2 | 0 | 3 | 0 | 1 | 4 | 1 | 6 | 1 | 5 | 1 |
| Vanderbilt University | 31 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 0 | 1 | 1 | 2 | 1 | 0 | 0 | 5 | 4 | 4 | 4 | 5 |
| Clemson University | 31 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 1 | 0 | 0 | 0 | 2 | 2 | 1 | 3 | 3 | 6 | 6 |
| Georgetown University | 31 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 1 | 4 | 5 | 1 | 0 | 4 | 3 | 1 | 5 |
| Carnegie-Mellon University | 31 | 1 | 0 | 0 | 1 | 1 | 2 | 1 | 4 | 1 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 1 | 2 | 5 | 3 |

(continued)

Appendix table 5-29.

**Patents awarded to the 100 academic institutions with the greatest R&D volume: 1969-90**

(page 3 of 3)

| | Total 1969-90 | 1969-71 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| University of Chicago | 29 | 0 | 0 | 0 | 0 | 2 | 0 | 3 | 1 | 2 | 1 | 0 | 2 | 0 | 2 | 0 | 0 | 1 | 6 | 7 | 2 |
| Washington State University | 28 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 1 | 3 | 2 | 0 | 2 | 2 | 2 | 1 | 5 | 3 |
| University of New Mexico | 27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 1 | 3 | 9 | 9 |
| University of Medicine and Dentistry of NJ | 27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 4 | 7 | 2 | 4 | 7 |
| University of North Carolina | 26 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 3 | 2 | 2 | 6 | 8 |
| University of Oklahoma | 25 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 6 | 2 | 4 |
| University of Kansas | 24 | 3 | 1 | 2 | 0 | 2 | 2 | 0 | 0 | 0 | 2 | 1 | 0 | 2 | 2 | 1 | 0 | 2 | 0 | 1 | 3 |
| University of Hawaii | 22 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 2 | 0 | 1 | 1 | 0 | 2 | 0 | 1 | 3 | 2 | 6 |
| Princeton University | 21 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 12 | 4 |
| University of Connecticut | 20 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 2 | 1 | 2 | 8 |
| Rutgers, The State University | 19 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 2 | 7 | 2 |
| Utah State University | 19 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 1 | 3 | 2 | 2 | 1 | 1 | 2 |
| Colorado State University | 18 | 1 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 3 | 4 | 2 | 0 | 2 |
| University of Colorado | 18 | 1 | 0 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 9 |
| Tulane University of Louisiana | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 1 | 3 | 4 | 4 |
| Virginia Polytechnic Institute | 16 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 7 | 4 |
| University of Maryland | 15 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 2 | 2 | 1 | 4 |
| Tufts University | 14 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 7 | 1 |
| Brown University | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 1 | 3 | 3 |
| Emory University | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 7 | 3 |
| University of Massachusetts | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 1 | 3 | 3 |
| Auburn University | 10 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| Florida State University | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 2 | 1 | 1 | 1 |
| Pennsylvania State University | 8 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 3 |
| New Mexico State University | 6 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 2 | 0 | 0 | 0 |
| Woods Hole Oceanographic Institute | 6 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Mississippi State University | 4 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Arizona State University | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 2 |
| Virginia Commonwealth University | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

NOTES: Based on 1987 R&D expenditures; not all 100 institutions could be located in the TAF data base.

Includes the Applied Physics Laboratory

SOURCE: TAF Report, U.S. Universities, U.S. Patent and Trademark Office, July 1991.

See figure 5-15

Appendix table 6-1.
**Real gross domestic product per capita, for selected countries: 1950, 1955, and 1960-90**

| | Canada | France | Italy | Japan | South Korea | Sweden | United Kingdom | West Germany |
|---|---|---|---|---|---|---|---|---|
| 1950 . . . | 69.5 | 44.4 | 32.0 | 16.7 | NA | 59.5 | 61.1 | 35.8 |
| 1955 . . . | 68.7 | 46.8 | 36.3 | 21.1 | 9.8 | 59.5 | 61.6 | 47.2 |
| 1960 . . . | 72.1 | 54.5 | 45.3 | 29.8 | 9.7 | 67.1 | 66.7 | 61.5 |
| 1961 . . . | 72.2 | 56.4 | 46.3 | 33.6 | 9.9 | 69.9 | 67.7 | 62.9 |
| 1962 . . . | 73.2 | 57.0 | 49.2 | 34.3 | 9.5 | 69.9 | 65.4 | 62.7 |
| 1963 . . . | 73.7 | 57.5 | 50.3 | 36.6 | 9.8 | 71.4 | 66.0 | 62.3 |
| 1964 . . . | 74.3 | 58.4 | 49.4 | 39.5 | 10.1 | 72.9 | 66.4 | 63.3 |
| 1965 . . . | 74.4 | 58.0 | 48.4 | 39.3 | 10.0 | 71.7 | 64.6 | 63.1 |
| 1966 . . . | 74.5 | 57.8 | 48.7 | 41.2 | 10.4 | 69.3 | 62.6 | 61.4 |
| 1967 . . . | 74.0 | 59.0 | 51.0 | 44.4 | 10.6 | 69.9 | 62.9 | 60.1 |
| 1968 . . . | 74.5 | 59.3 | 52.4 | 48.0 | 11.2 | 69.9 | 63.3 | 61.3 |
| 1969 . . . | 76.2 | 62.0 | 54.4 | 52.4 | 12.3 | 71.8 | 62.9 | 64.3 |
| 1970 . . . | 78.2 | 65.9 | 57.8 | 57.6 | 13.2 | 76.8 | 65.2 | 67.9 |
| 1971 . . . | 80.5 | 67.5 | 57.5 | 58.6 | 14.1 | 76.0 | 65.7 | 68.2 |
| 1972 . . . | 81.2 | 67.3 | 56.5 | 60.3 | 14.0 | 74.6 | 64.7 | 68.1 |
| 1973 . . . | 83.2 | 67.7 | 57.8 | 61.1 | 15.2 | 74.5 | 67.0 | 68.4 |
| 1974 . . . | 87.0 | 70.5 | 61.6 | 60.8 | 16.5 | 77.9 | 67.4 | 69.6 |
| 1975 . . . | 89.8 | 71.4 | 60.8 | 63.1 | 17.8 | 81.2 | 68.4 | 70.3 |
| 1976 . . . | 90.6 | 71.4 | 62.1 | 62.6 | 19.1 | 78.8 | 68.3 | 71.7 |
| 1977 . . . | 89.6 | 70.9 | 62.0 | 62.7 | 20.1 | 74.6 | 66.7 | 71.4 |
| 1978 . . . | 89.1 | 70.1 | 61.3 | 62.6 | 21.1 | 72.7 | 66.4 | 70.7 |
| 1979 . . . | 90.8 | 71.4 | 64.2 | 64.9 | 22.1 | 74.7 | 67.2 | 72.9 |
| 1980 . . . | 92.2 | 73.2 | 67.7 | 67.6 | 21.4 | 76.8 | 66.7 | 74.4 |
| 1981 . . . | 93.6 | 72.9 | 67.3 | 68.9 | 22.4 | 76.0 | 65.4 | 73.7 |
| 1982 . . . | 92.9 | 77.1 | 69.7 | 73.2 | 24.2 | 79.6 | 68.7 | 75.7 |
| 1983 . . . | 92.5 | 75.2 | 68.3 | 72.6 | 25.7 | 78.8 | 69.4 | 75.1 |
| 1984 . . . | 92.1 | 71.6 | 66.0 | 71.0 | 26.2 | 77.3 | 66.4 | 73.1 |
| 1985 . . . | 93.3 | 70.8 | 65.8 | 72.2 | 27.0 | 76.8 | 66.9 | 72.8 |
| 1986 . . . | 93.9 | 70.9 | 66.3 | 72.2 | 29.5 | 76.9 | 68.1 | 72.9 |
| 1987 . . . | 94.2 | 70.3 | 66.6 | 72.9 | 32.0 | 76.8 | 69.2 | 72.1 |
| 1988 . . . | 94.0 | 70.5 | 66.9 | 74.6 | 34.1 | 75.6 | 69.4 | 71.8 |
| 1989 . . . | 94.2 | 71.9 | 67.8 | 76.6 | 35.4 | 75.6 | 69.4 | 72.3 |
| 1990 . . . | 93.9 | 73.7 | 69.0 | 80.7 | 38.1 | 75.3 | 69.8 | 74.5 |

NA = not available

NOTES: Output based on Organisation for Economic Cooperation and Development price weights to enable cross-country comparisons. Index: United States = 100.0.

SOURCE: Bureau of Labor Statistics, unpublished tabulations.

See figure 6-1. *Science & Engineering Indicators – 1991*

Appendix table 6-2.
**Global production of manufactured products, by selected countries: 1980-90**

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 (est.) | 1989 (est.) | 1990 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Millions of constant 1980 dollars | | | | | | | | | | |
| **Total manufactures** | | | | | | | | | | | |
| United States | 1,430,747 | 1,435,326 | 1,344,149 | 1,399,916 | 1,542,762 | 1,547,177 | 1,561,688 | 1,685,110 | 1,769,769 | 1,809,062 | 1,815,580 |
| Japan | 796,676 | 814,486 | 843,104 | 895,261 | 957,703 | 1,043,767 | 1,018,609 | 1,065,679 | 1,105,732 | 1,224,983 | 1,279,649 |
| West Germany | 516,797 | 515,167 | 520,975 | 537,401 | 581,057 | 636,783 | 637,013 | 629,509 | 651,060 | 684,896 | 714,699 |
| France | 322,494 | 313,581 | 323,348 | 328,541 | 342,960 | 377,864 | 377,704 | 379,183 | 397,797 | 417,814 | 424,220 |
| United Kingdom | 311,322 | 284,324 | 289,596 | 303,221 | 331,034 | 351,554 | 349,332 | 371,496 | 406,626 | 425,265 | 430,881 |
| Italy | 201,452 | 202,271 | 198,030 | 209,718 | 227,159 | 230,267 | 239,853 | 247,278 | 252,985 | 259,487 | 263,150 |
| EC-12 | 1,611,308 | 1,571,914 | 1,595,714 | 1,688,731 | 1,807,951 | 1,941,680 | 1,943,146 | 1,973,268 | 2,065,127 | 2,209,208 | 2,246,410 |
| Europe | 1,842,598 | 1,805,957 | 1,833,324 | 1,934,293 | 2,067,593 | 2,219,306 | 2,232,253 | 2,261,077 | 2,354,217 | 2,501,518 | 2,531,327 |
| OECD | 4,265,013 | 4,257,110 | 4,209,318 | 4,432,237 | 4,786,448 | 5,054,011 | 5,063,814 | 5,264,009 | 5,487,951 | 5,808,597 | 5,922,903 |
| **High-tech manufactures** | | | | | | | | | | | |
| United States | 286,239 | 296,433 | 301,567 | 320,752 | 378,567 | 395,288 | 421,981 | 469,626 | 507,279 | 534,818 | 552,231 |
| Japan | 130,154 | 147,610 | 158,132 | 183,491 | 232,905 | 257,099 | 268,419 | 313,916 | 363,772 | 422,216 | 449,442 |
| West Germany | 83,262 | 88,174 | 91,754 | 100,589 | 113,293 | 130,157 | 132,259 | 131,740 | 138,656 | 140,793 | 145,143 |
| France | 43,971 | 45,723 | 47,452 | 49,060 | 52,945 | 59,272 | 59,915 | 61,061 | 64,448 | 69,693 | 71,607 |
| United Kingdom | 57,388 | 60,779 | 63,409 | 68,332 | 79,017 | 89,242 | 92,206 | 102,634 | 112,624 | 125,326 | 130,753 |
| Italy | 27,798 | 27,796 | 26,231 | 28,017 | 31,589 | 31,461 | 36,170 | 38,771 | 43,067 | 43,116 | 42,776 |
| EC-12 | 249,036 | 261,304 | 268,113 | 294,528 | 333,749 | 373,748 | 385,980 | 401,511 | 431,516 | 445,066 | 449,214 |
| Europe | 272,458 | 285,925 | 294,932 | 322,743 | 364,216 | 408,749 | 424,339 | 440,300 | 471,545 | 481,179 | 483,123 |
| OECD | 708,162 | 750,462 | 775,515 | 849,263 | 999,522 | 1,088,661 | 1,145,111 | 1,252,843 | 1,371,023 | 1,484,959 | 1,537,395 |
| **Other manufactures** | | | | | | | | | | | |
| United States | 1,144,508 | 1,138,893 | 1,042,582 | 1,079,164 | 1,164,194 | 1,151,889 | 1,139,707 | 1,215,484 | 1,262,490 | 1,274,245 | 1,263,349 |
| Japan | 666,521 | 666,876 | 684,972 | 711,770 | 724,798 | 786,669 | 750,190 | 751,762 | 741,960 | 802,767 | 830,208 |
| West Germany | 433,535 | 426,993 | 429,222 | 436,811 | 467,764 | 506,626 | 504,754 | 497,769 | 512,404 | 544,103 | 569,556 |
| France | 278,524 | 267,858 | 275,896 | 279,481 | 290,015 | 318,592 | 317,789 | 318,122 | 333,349 | 348,121 | 352,612 |
| United Kingdom | 253,934 | 223,545 | 226,187 | 234,889 | 252,017 | 262,312 | 257,127 | 268,862 | 294,001 | 299,938 | 300,128 |
| Italy | 173,654 | 174,475 | 171,799 | 181,701 | 195,570 | 198,807 | 20[illegible],683 | 208,507 | 209,918 | 216,370 | 220,374 |
| EC-12 | 1,362,272 | 1,310,610 | 1,327,601 | 1,394,203 | 1,474,201 | 1,567,932 | 1,557,166 | 1,571,757 | 1,633,611 | 1,764,142 | 1,797,196 |
| Europe | 1,570,140 | 1,520,032 | 1,538,392 | 1,611,549 | 1,703,376 | 1,810,557 | 1,807,913 | 1,820,777 | 1,882,672 | 2,020,338 | 2,048,203 |
| OECD | 3,556,850 | 3,506,648 | 3,433,803 | 3,582,974 | 3,786,926 | 3,965,350 | 3,918,703 | 4,011,166 | 4,116,928 | 4,323,637 | 4,385,509 |

NOTE: Europe includes the 12 countries of the European Community (EC-12) plus Austria, Finland, Norway, Sweden, and Switzerland.

SOURCE: Special tabulations developed by Data Resources, Inc./McGraw-Hill from the Organisation for Economic Cooperation and Development's (OECD's) Industrial Structure Statistics and Series C Trade Data.

*Science & Engineering Indicators – 1991*

Appendix table 6-3.
**Country share of global market for high-tech manufactures, by industry: 1980-90**
(page 1 of 3)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 (est.) | 1989 (est.) | 1990 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Percent | | | | | |
| HIGH-TECH MANUFACTURES | | | | | | | | | | | |
| United States | 40.4 | 39.5 | 38.9 | 37.8 | 37.9 | 36.3 | 36.9 | 37.5 | 37.0 | 36.0 | 35.9 |
| Japan | 18.4 | 19.7 | 20.4 | 21.6 | 23.3 | 23.6 | 23.4 | 25.1 | 26.5 | 28.4 | 29.2 |
| West Germany | 11.8 | 11.7 | 11.8 | 11.8 | 11.3 | 12.0 | 11.5 | 10.5 | 10.1 | 9.5 | 9.4 |
| France | 6.2 | 6.1 | 6.1 | 5.8 | 5.3 | 5.4 | 5.2 | 4.9 | 4.7 | 4.7 | 4.7 |
| United Kingdom | 8.1 | 8.1 | 8.2 | 8.0 | 7.9 | 8.2 | 8.1 | 8.2 | 8.2 | 8.4 | 8.5 |
| Italy | 3.9 | 3.7 | 3.4 | 3.3 | 3.2 | 2.9 | 3.2 | 3.1 | 3.1 | 2.9 | 2.8 |
| EC-12 | 35.2 | 34.8 | 34.6 | 34.7 | 33.4 | 34.3 | 33.7 | 32.0 | 31.5 | 30.0 | 29.2 |
| Europe | 38.5 | 38.1 | 38.0 | 38.0 | 36.4 | 37.5 | 37.1 | 35.1 | 34.4 | 32.4 | 31.4 |
| **Industrial chemicals** | | | | | | | | | | | |
| United States | 32.7 | 33.1 | 29.8 | 29.2 | 28.0 | 25.8 | 28.5 | 31.4 | 31.2 | 32.2 | 32.5 |
| Japan | 16.1 | 14.4 | 15.3 | 14.0 | 14.1 | 13.4 | 12.1 | 13.1 | 12.7 | 13.4 | 14.1 |
| West Germany | 16.2 | 16.9 | 17.9 | 19.1 | 19.5 | 20.4 | 20.4 | 18.5 | 18.7 | 18.8 | 18.4 |
| France | 5.0 | 5.2 | 5.8 | 5.5 | 5.1 | 5.3 | 5.3 | 4.9 | 5.0 | 5.1 | 4.8 |
| United Kingdom | 8.8 | 8.4 | 9.0 | 9.4 | 9.7 | 10.1 | 9.5 | 9.2 | 9.2 | 9.3 | 9.1 |
| Italy | 5.1 | 5.2 | 4.4 | 4.4 | 4.9 | 4.9 | 4.3 | 4.3 | 4.3 | 4.3 | 4.0 |
| EC-12 | 43.0 | 44.3 | 45.8 | 48.1 | 49.6 | 52.0 | 49.9 | 46.5 | 47.2 | 45.9 | 44.3 |
| Europe | 47.9 | 49.1 | 51.2 | 53.3 | 54.8 | 57.6 | 56.0 | 52.2 | 52.8 | 51.3 | 50.4 |
| **Drugs and medicines** | | | | | | | | | | | |
| United States | 29.6 | 29.6 | 30.3 | 30.3 | 30.4 | 30.0 | 30.4 | 31.4 | 31.4 | 30.8 | 29.2 |
| Japan | 21.2 | 21.7 | 22.1 | 22.0 | 21.2 | 20.7 | 20.4 | 19.9 | 20.1 | 20.1 | 20.3 |
| West Germany | 13.1 | 13.1 | 12.5 | 12.5 | 12.7 | 12.3 | 12.1 | 11.4 | 11.5 | 11.4 | 10.9 |
| France | 5.6 | 5.3 | 4.7 | 4.4 | 4.3 | 4.0 | 3.8 | 3.6 | 3.8 | 4.0 | 3.9 |
| United Kingdom | 9.3 | 8.8 | 9.1 | 8.8 | 9.1 | 9.0 | 9.2 | 9.4 | 9.6 | 10.0 | 9.9 |
| Italy | 5.5 | 5.4 | 5.6 | 5.4 | 6.1 | 6.5 | 5.8 | 5.7 | 6.2 | 6.3 | 6.2 |
| EC-12 | 40.7 | 40.3 | 39.1 | 38.9 | 39.8 | 39.8 | 38.6 | 38.1 | 39.0 | 39.5 | 39.0 |
| Europe | 46.0 | 45.6 | 44.6 | 44.6 | 45.4 | 45.9 | 45.7 | 45.0 | 45.7 | 46.3 | 47.5 |
| **Engines and turbines** | | | | | | | | | | | |
| United States | 44.2 | 37.9 | 35.0 | 33.0 | 35.4 | 34.8 | 35.4 | 35.4 | 35.8 | 35.2 | 34.9 |
| Japan | 18.4 | 16.1 | 17.9 | 18.8 | 18.0 | 17.0 | 14.9 | 15.7 | 15.5 | 15.8 | 15.3 |
| West Germany | 11.3 | 9.9 | 9.0 | 9.4 | 10.3 | 11.2 | 10.9 | 11.2 | 10.7 | 10.8 | 11.6 |
| France | 6.8 | 6.1 | 5.6 | 5.7 | 5.9 | 5.3 | 4.9 | 5.1 | 4.9 | 4.7 | 4.9 |
| United Kingdom | 6.8 | 18.3 | 20.5 | 18.3 | 17.1 | 19.7 | 21.9 | 20.9 | 21.4 | 22.6 | 22.3 |
| Italy | 4.2 | 3.7 | 3.1 | 4.9 | 5.5 | 3.4 | 3.2 | 3.1 | 3.0 | 2.9 | 3.0 |
| EC-12 | 32.7 | 40.8 | 41.3 | 41.3 | 41.6 | 42.7 | 44.3 | 43.6 | 43.3 | 43.8 | 44.3 |
| Europe | 37.2 | 45.9 | 47.0 | 48.1 | 46.5 | 48.1 | 49.6 | 48.8 | 48.5 | 48.9 | 49.6 |

(continued)

Appendix table 6-3.
**Country share of global market for high-tech manufactures, by industry: 1980-90**
(page 2 of 3)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 (est.) | 1989 (est.) | 1990 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Percent | | | | | | | | | | |
| **Office and computing machinery** | | | | | | | | | | | |
| United States | 50.0 | 49.0 | 49.1 | 45.2 | 44.0 | 39.6 | 37.8 | 38.1 | 37.3 | 35.6 | 34.8 |
| Japan | 22.0 | 23.0 | 24.0 | 27.2 | 27.5 | 30.2 | 30.8 | 31.8 | 33.3 | 34.6 | 37.5 |
| West Germany | 6.5 | 7.4 | 7.0 | 7.0 | 7.4 | 8.3 | 8.0 | 7.1 | 6.6 | 5.5 | 5.4 |
| France | 3.9 | 4.6 | 4.4 | 4.2 | 4.3 | 3.9 | 3.6 | 3.2 | 2.9 | 2.7 | 2.6 |
| United Kingdom | 6.0 | 4.7 | 4.9 | 5.3 | 5.8 | 6.9 | 6.5 | 7.4 | 8.1 | 8.1 | 8.1 |
| Italy | 2.1 | 1.9 | 1.6 | 1.8 | 1.7 | 1.3 | 3.2 | 2.9 | 3.1 | 2.4 | 2.3 |
| EC-12 | 21.9 | 22.0 | 21.2 | 22.6 | 24.0 | 25.2 | 26.5 | 26.0 | 25.6 | 23.3 | 21.3 |
| Europe | 23.9 | 24.0 | 23.1 | 24.4 | 25.7 | 27.2 | 28.6 | 27.9 | 27.4 | 24.5 | 21.8 |
| **Radio, TV, & communication equipment** | | | | | | | | | | | |
| United States | 36.6 | 34.8 | 35.0 | 34.0 | 33.8 | 32.9 | 32.8 | 32.3 | 31.5 | 29.9 | 30.6 |
| Japan | 26.4 | 30.5 | 30.7 | 32.2 | 35.5 | 34.0 | 33.0 | 36.5 | 39.3 | 42.9 | 42.0 |
| West Germany | 12.0 | 11.4 | 11.4 | 11.1 | 9.8 | 11.3 | 11.6 | 10.3 | 9.6 | 9.5 | 10.0 |
| France | 5.4 | 5.1 | 5.2 | 4.7 | 4.2 | 5.1 | 5.1 | 4.5 | 4.1 | 4.1 | 4.4 |
| United Kingdom | 7.1 | 6.5 | 6.5 | 6.6 | 6.5 | 6.4 | 6.4 | 6.2 | 6.0 | 5.9 | 6.2 |
| Italy | 2.2 | 1.9 | 1.9 | 1.9 | 1.5 | 1.4 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 |
| EC-12 | 32.2 | 29.9 | 29.6 | 29.4 | 26.7 | 29.0 | 29.7 | 26.8 | 25.4 | 24.1 | 25.2 |
| Europe | 35.1 | 32.7 | 32.5 | 31.9 | 29.0 | 31.4 | 32.3 | 29.2 | 27.7 | 25.6 | 25.9 |
| **Aircraft** | | | | | | | | | | | |
| United States | 57.6 | 56.4 | 56.6 | 55.8 | 58.7 | 57.9 | 59.5 | 58.7 | 59.2 | 56.4 | 55.9 |
| Japan | 2.2 | 2.4 | 2.3 | 2.4 | 2.5 | 2.9 | 2.5 | 2.8 | 3.2 | 3.6 | 3.6 |
| West Germany | 4.8 | 5.3 | 6.0 | 5.4 | 5.0 | 5.0 | 4.4 | 4.6 | 4.7 | 4.6 | 4.8 |
| France | 13.9 | 13.9 | 14.2 | 15.1 | 13.7 | 13.0 | 11.9 | 12.0 | 12.9 | 13.9 | 13.7 |
| United Kingdom | 12.0 | 12.5 | 11.7 | 12.5 | 11.7 | 11.8 | 12.7 | 13.1 | 11.2 | 13.2 | 13.5 |
| Italy | 3.9 | 3.5 | 3.6 | 3.1 | 2.9 | 3.4 | 2.8 | 3.0 | 3.0 | 3.0 | 3.0 |
| EC-12 | 36.0 | 36.9 | 37.2 | 37.8 | 34.7 | 34.8 | 33.3 | 34.3 | 33.6 | 36.1 | 36.1 |
| Europe | 37.1 | 38.1 | 38.5 | 39.1 | 36.2 | 36.5 | 35.0 | 35.9 | 35.1 | 37.6 | 37.7 |

(continued)

Appendix table 6-3.
**Country share of global market for high-tech manufactures, by industry: 1980-90**
(page 3 of 3)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 (est.) | 1989 (est.) | 1990 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Percent | | | | | |
| **Scientific instruments** | | | | | | | | | | | |
| United States | 49.1 | 49.0 | 50.5 | 50.0 | 50.4 | 48.4 | 48.4 | 50.8 | 51.5 | 52.7 | 53.4 |
| Japan | 17.6 | 19.2 | 18.1 | 19.0 | 19.0 | 19.7 | 18.9 | 18.1 | 16.2 | 16.1 | 15.4 |
| West Germany | 11.4 | 10.8 | 10.2 | 9.8 | 9.8 | 10.8 | 11.1 | 11.1 | 11.4 | 10.8 | 11.1 |
| France | 4.4 | 4.1 | 4.2 | 4.4 | 4.4 | 5.4 | 5.5 | 5.6 | 5.8 | 5.9 | 6.1 |
| United Kingdom | 5.4 | 4.7 | 5.3 | 4.9 | 4.8 | 5.1 | 5.3 | 5.6 | 5.9 | 5.8 | 5.9 |
| Italy | 5.5 | 5.5 | 5.2 | 5.1 | 4.9 | 4.1 | 4.1 | 4.4 | 4.8 | 4.5 | 4.1 |
| EC-12 | 28.9 | 27.4 | 27.1 | 26.9 | 26.6 | 27.5 | 28.2 | 28.4 | 29.7 | 28.6 | 28.6 |
| Europe | 30.8 | 29.3 | 29.0 | 28.8 | 28.7 | 29.9 | 30.6 | 30.4 | 31.6 | 30.5 | 30.5 |

NOTES Total shipments by OECD countries are used as a proxy for global output. Shares represent each country's shipments as a percentage of OECD shipments. Europe includes the 12 countries of the European Community (EC-12) plus Austria, Finland, Norway, Sweden, and Switzerland.

SOURCE Special tabulations developed by Data Resources, Inc./McGraw-Hill from the Organisation for Economic Cooperation and Development's (OECD's) Industrial Structure Statistics and Series C Trade Data.

See figures 6-2 and 6-3 and figure O-22 in Overview.

*Science & Engineering Indicators -- 1991*

Appendix table 6-4.
**High-tech manufactures' share of total manufacturing output, by country: 1980-90**

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 (est.) | 1989 (est.) | 1990 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Percent | | | | | |
| United States | 20.0 | 20.7 | 22.4 | 22.9 | 24.5 | 25.5 | 27.0 | 27.9 | 28.7 | 29.6 | 30.4 |
| Japan | 16.3 | 18.1 | 18.8 | 20.5 | 24.3 | 24.6 | 26.4 | 29.5 | 32.9 | 34.5 | 35.1 |
| West Germany | 16.1 | 17.1 | 17.6 | 18.7 | 19.5 | 20.4 | 20.8 | 20.9 | 21.3 | 20.6 | 20.3 |
| France | 13.6 | 14.6 | 14.7 | 14.9 | 15.4 | 15.7 | 15.9 | 16.1 | 16.2 | 16.7 | 16.9 |
| United Kingdom | 18.4 | 21.4 | 21.9 | 22.5 | 23.9 | 25.4 | 26.4 | 27.6 | 27.7 | 29.5 | 30.3 |
| Italy | 13.8 | 13.7 | 13.2 | 13.4 | 13.9 | 13.7 | 15.1 | 15.7 | 17.0 | 16.6 | 16.3 |
| EC-12 | 15.5 | 16.6 | 16.8 | 17.4 | 18.5 | 19.2 | 19.9 | 20.3 | 20.9 | 20.1 | 20.0 |
| OECD | 16.6 | 17.6 | 18.4 | 19.2 | 20.9 | 21.5 | 22.6 | 23.8 | 25.0 | 25.6 | 26.0 |

NOTE EC-12 = 12 countries of the European Community.

SOURCE Special tabulations developed by Data Resources, Inc./McGraw-Hill from Organisation for Economic Cooperation and Development's (OECD's) Industrial Structure Statistics and Series C Trade Data

*Science & Engineering Indicators -- 1991*

Appendix table 6-5.
**Import share of domestic market, by industry: 1980-90**

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 (est.) | 1989 (est.) | 1990 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Percent | | | | | |
| HIGH-TECH MANUFACTURES | | | | | | | | | | | |
| United States | 8.0 | 8.2 | 8.0 | 8.9 | 10.4 | 10.8 | 12.1 | 13.2 | 15.1 | 13.5 | 13.8 |
| Japan | 6.6 | 6.3 | 6.3 | 6.9 | 6.5 | 6.5 | 8.4 | 8.3 | 8.8 | 8.6 | 9.2 |
| West Germany | 25.1 | 26.7 | 28 1 | 27.9 | 28.4 | 28.8 | 31.2 | 33.9 | 35.2 | 37.6 | 41.2 |
| France | 33.2 | 33.3 | 34.1 | 36.6 | 38.7 | 40.3 | 45.1 | 50.6 | 53.9 | 53.5 | 55.2 |
| United Kingdom | 29.1 | 25.1 | 27.5 | 29.4 | 32.2 | 33.6 | 38.8 | 37.0 | 39.2 | 38.5 | 42.1 |
| Italy | 29.3 | 30.8 | 34.7 | 36.9 | 37.1 | 44.0 | 44.5 | 46.3 | 47.5 | 40.5 | 43.6 |
| **Industrial chemicals** | | | | | | | | | | | |
| United States | 8.0 | 7.6 | 8.6 | 9.4 | 11.2 | 12.3 | 11.7 | 9.8 | 9.9 | 10.8 | 10.6 |
| Japan | 8.6 | 9.8 | 11.4 | 14.3 | 16.4 | 17.6 | 25.7 | 25.0 | 26.4 | 24.5 | 22.1 |
| **Drugs and medicines** | | | | | | | | | | | |
| United States | 4.8 | 4.9 | 4.2 | 4.9 | 5.8 | 6.2 | 6.9 | 7.2 | 8.2 | 4.9 | 5.3 |
| Japan | 7.8 | 7.8 | 8.1 | 8.3 | 8.8 | 9.2 | 12.9 | 13.9 | 14.7 | 13.6 | 12.0 |
| **Office and computing machinery** | | | | | | | | | | | |
| United States | 3.8 | 4.4 | 5.2 | 8.0 | 9.8 | 10.4 | 13.6 | 16.8 | 20.3 | 15.5 | 16.4 |
| Japan | 1.9 | 2.0 | 2.0 | 1 6 | 1.8 | 2.0 | 2.3 | 3.0 | 3.9 | 5.3 | 6.2 |
| **Radio, TV, & communication equipment** | | | | | | | | | | | |
| United States | 5.0 | 5.0 | 5.2 | 5.7 | 7.1 | 5.3 | 5.5 | 6.5 | 8.2 | 9.1 | 8.8 |
| Japan | 1.4 | 1.3 | 1.2 | 1.4 | 1.6 | 1.3 | 1.9 | 1.9 | 2.3 | 2.4 | 2.7 |
| **Aircraft** | | | | | | | | | | | |
| United States | 5.6 | υ 6 | 5.6 | 4.6 | 5.3 | 6.1 | 6.7 | 6.4 | 6.7 | 7.1 | 7.7 |
| Japan | 34.4 | 39.7 | 30.8 | 47.1 | 34.2 | 40.8 | 49.9 | 43.7 | 41.4 | 32.1 | 42.2 |
| **Scientific instruments** | | | | | | | | | | | |
| United States | 13.1 | 13.6 | 12.0 | 13.0 | 14.9 | 15.9 | 18.4 | 18.6 | 19.0 | 18.7 | 17.5 |
| Japan | 19.9 | 18.1 | 19.8 | 23.1 | 27.0 | 27.0 | 36.9 | 44.0 | 62.4 | 69.0 | 73.8 |

SOURCE: Special tabulations developed by Data Resources, Inc./McGraw-Hill from Organisation for Economic Cooperation and Development's Industrial Structure Statistics and Series C Trade Data.

See figures 6-4 and 6-5.

*Science & Engineering Indicators – 1991*

482

483

Appendix table 6-6.
**U.S. share of foreign markets for high-tech manufactures: 1980-90**

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 (est.) | 1989 (est.) | 1990 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Percent | | | | | |
| **High-tech manufactures** | 10.0 | 9.6 | 8.7 | 8.1 | 7.8 | 7.6 | 8.1 | 8.9 | 9.9 | 9.2 | 9.7 |
| Industrial chemicals | 5.9 | 5.7 | 5.2 | 4.7 | 4.9 | 4.5 | 5.2 | 5.6 | 5.8 | 6.7 | 6.2 |
| Drugs and medicines | 4.6 | 4.6 | 4.3 | 4.3 | 4.3 | 4.1 | 4.4 | 4.2 | 4.6 | 3.6 | 3.5 |
| Engines and turbines | 39.6 | 32.3 | 31.8 | 30.9 | 31.0 | 33.7 | 37.4 | 40.0 | 44.1 | 39.7 | 41.0 |
| Office and computing machinery | 10.8 | 10.8 | 10.1 | 9.7 | 9.7 | 8.9 | 9.0 | 10.6 | 12.3 | 9.4 | 9.5 |
| Radio, TV, & comm. equipment | 1.7 | 1.4 | 2.6 | 2.6 | 2.6 | 2.0 | 2.3 | 2.5 | 2.9 | 3.0 | 3.4 |
| Aircraft | 26.3 | 27.2 | 22.0 | 22.4 | 20.4 | 23.1 | 23.6 | 24.6 | 25.7 | 25.0 | 28.9 |
| Scientific instruments | 18.5 | 18.6 | 17.7 | 16.7 | 16.7 | 15.1 | 16.0 | 17.8 | 19.8 | 22.4 | 23.1 |
| **Other manufactures** | 4.8 | 4.9 | 4.2 | 3.7 | 3.7 | 3.3 | 3.3 | 3.7 | 4.6 | 4.7 | 5.1 |

NOTES: Foreign market size is calculated by subtracting U.S. apparent consumption of high-tech products from total Organisation for Economic Cooperation and Development shipments of same. The concept of foreign market share differs from export market share by adding the home market shipments of non-U.S. producers to the denominator. Foreign market share provides a measure of U.S. competitiveness against foreign producers in their home markets and export markets.

SOURCE: Data Resources, Inc./McGraw-Hill, special tabulations.

See figure 6-6.

Appendix table 6-7.
**Export market shares, by industry and country: 1980-88**
(page 1 of 2)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|
| | Percent | | | | | | | | |
| ALL MANUFACTURING INDUSTRIES | | | | | | | | | |
| United States | 16.2 | 15.7 | 13.6 | 12.2 | 11.6 | 10.6 | 10.2 | 11.2 | 13.1 |
| Japan | 10.8 | 11.7 | 11.4 | 12.1 | 13.1 | 12.9 | 12.7 | 12.4 | 12.5 |
| West Germany | 17.3 | 17.8 | 18.5 | 17.9 | 17.9 | 18.4 | 17.8 | 17.2 | 16.8 |
| France | 10.2 | 10.2 | 10.1 | 10.2 | 10.0 | 9.8 | 9.3 | 9.3 | 9.4 |
| United Kingdom | 8.7 | 7.5 | 7.9 | 7.7 | 7.8 | 8.1 | 9.0 | 9.2 | 8.8 |
| Italy | 7.0 | 7.3 | 7.6 | 7.6 | 7.4 | 7.7 | 7.6 | 7.5 | 7.6 |
| EC-12 | 59.0 | 58.4 | 60.3 | 60.4 | 59.8 | 60.8 | 61.3 | 60.8 | 60.1 |
| **High-tech manufactures** | | | | | | | | | |
| United States | 26.9 | 25.9 | 23.3 | 22.0 | 20.9 | 20.1 | 20.1 | 21.8 | 23.4 |
| Japan | 9.7 | 10.1 | 9.9 | 11.0 | 12.1 | 11.6 | 12.5 | 13.7 | 15.2 |
| West Germany | 16.1 | 17.0 | 18.1 | 17.3 | 17.5 | 17.1 | 15.5 | 14.4 | 13.5 |
| France | 9.3 | 9.6 | 9.9 | 9.8 | 10.2 | 10.3 | 9.3 | 9.6 | 9.2 |
| United Kingdom | 12.6 | 10.9 | 11.7 | 11.4 | 12.0 | 13.3 | 14.6 | 13.5 | 12.0 |
| Italy | 3.6 | 4.3 | 4.6 | 5.0 | 4.6 | 4.7 | 4.4 | 4.4 | 4.2 |
| EC-12 | 52.3 | 52.4 | 55.6 | 55.5 | 56.1 | 57.3 | 56.4 | 54.0 | 52.2 |
| Industrial chemicals | | | | | | | | | |
| United States | 18.0 | 16.9 | 15.4 | 13.1 | 13.1 | 11.8 | 12.0 | 13.1 | 13.4 |
| Japan | 6.7 | 6.0 | 6.2 | 6.0 | 5.7 | 5.9 | 6.3 | 7.2 | 6.8 |
| West Germany | 19.1 | 20.1 | 20.9 | 20.6 | 21.4 | 21.1 | 19.3 | 18.7 | 17.5 |
| France | 11.9 | 12.0 | 9.8 | 12.0 | 12.3 | 13.4 | 13.0 | 13.3 | 12.3 |
| United Kingdom | 10.2 | 9.6 | 10.6 | 10.3 | 10.6 | 11.3 | 13.0 | 13.0 | 12.0 |
| Italy | 3.6 | 4.5 | 5.6 | 6.5 | 5.6 | 5.6 | 4.2 | 4.6 | 5.0 |
| EC-12 | 63.4 | 64.7 | 66.1 | 69.0 | 69.5 | 70.1 | 69.2 | 67.1 | 68.3 |
| Drugs and medicines | | | | | | | | | |
| United States | 15.6 | 14.9 | 12.9 | 14.0 | 13.4 | 12.3 | 12.6 | 12.2 | 13.5 |
| Japan | 2.3 | 2.3 | 2.0 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.4 |
| West Germany | 17.5 | 18.0 | 16.2 | 17.4 | 18.1 | 18.3 | 17.4 | 17.2 | 17.0 |
| France | 11.6 | 11.5 | 19.8 | 11.8 | 11.6 | 11.6 | 11.0 | 10.9 | 10.8 |
| United Kingdom | 13.4 | 12.9 | 12.6 | 13.2 | 13.4 | 13.7 | 14.9 | 14.5 | 13.8 |
| Italy | 5.3 | 5.6 | 5.1 | 5.6 | 5.9 | 6.2 | 5.6 | 5.3 | 5.5 |
| EC-12 | 63.4 | 63.2 | 68.0 | 64.3 | 65.8 | 66.5 | 66.1 | 66.3 | 65.8 |
| Engines and turbines | | | | | | | | | |
| United States | 26.7 | 25.2 | 23.3 | 21.0 | 19.9 | 19.0 | 17.6 | 18.2 | 20.1 |
| Japan | 10.9 | 12.2 | 11.3 | 12.3 | 14.2 | 13.5 | 13.9 | 14.2 | 13.7 |
| West Germany | 16.6 | 15.8 | 17.3 | 17.6 | 17.7 | 17.9 | 17.6 | 17.3 | 16.2 |
| France | 8.5 | 8.6 | 8.4 | 8.7 | 8.8 | 9.3 | 9.0 | 9.3 | 9.4 |
| United Kingdom | 16.3 | 15.9 | 16.0 | 13.4 | 12.8 | 13.5 | 15.2 | 14.0 | 14.9 |
| Italy | 4.6 | 4.9 | 4.9 | 5.8 | 5.0 | 4.2 | 5.0 | 5.0 | 4.2 |
| EC-12 | 51.7 | 51.3 | 53.4 | 52.1 | 50.7 | 52.5 | 53.2 | 51.9 | 50.9 |

(continued)

Appendix table 6-7.
**Export market shares, by industry and country: 1980-88**
(page 2 of 2)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Percent | | | | |
| Office and computing machinery | | | | | | | | | |
| United States | 42.3 | 41.4 | 38.1 | 35.7 | 33.6 | 28.8 | 27.1 | 28.5 | 31.8 |
| Japan | 6.3 | 7.8 | 9.2 | 10.7 | 10.8 | 11.2 | 13.5 | 15.8 | 20.0 |
| West Germany | 12.1 | 13.4 | 13.4 | 12.3 | 11.3 | 11.5 | 11.1 | 9.0 | 7.6 |
| France | 9.9 | 10.6 | 8.2 | 8.4 | 9.2 | 9.0 | 7.9 | 8.0 | 7.2 |
| United Kingdom | 12.9 | 10.0 | 11.8 | 12.9 | 15.6 | 18.2 | 17.5 | 16.9 | 12.0 |
| Italy | 2.8 | 3.0 | 3.6 | 3.4 | 3.2 | 4.5 | 4.6 | 4.0 | 4.0 |
| EC-12 | 46.7 | 46.7 | 48.8 | 49.7 | 52.1 | 56.4 | 55.7 | 52.5 | 45.7 |
| Radio, TV, ar communication equipment | | | | | | | | | |
| United States | 24.3 | 22.5 | 33.5 | 30.5 | 25.6 | 21.7 | 23.1 | 23.7 | 23.6 |
| Japan | 26.8 | 29.6 | 25.8 | 30.0 | 33.4 | 29.9 | 31.0 | 32.0 | 34.4 |
| West Germany | 14.1 | 14.2 | 11.5 | 11.2 | 11.2 | 11.9 | 10.3 | 9.6 | 10.8 |
| France | 8.7 | 9.4 | 7.2 | 6.8 | 6.6 | 8.0 | 7.5 | 8.1 | 7.7 |
| United Kingdom | 7.9 | 6.7 | 7.3 | 6.8 | 7.7 | 10.2 | 10.1 | 9.0 | 8.8 |
| Italy | 3.8 | 4.1 | 3.7 | 3.6 | 3.4 | 4.1 | 3.8 | 4.3 | 3.2 |
| EC-12 | 44.1 | 42.1 | 36.7 | 35.3 | 35.8 | 41.6 | 39.4 | 37.5 | 36.4 |
| Aircraft | | | | | | | | | |
| United States | 53.0 | 51.0 | 38.7 | 41.1 | 34.6 | 40.8 | 43.3 | 50.0 | 44.8 |
| Japan | 0.4 | 0.4 | 0.6 | 0.6 | 0.5 | 0.5 | 0.5 | 0.7 | 0.7 |
| West Germany | 10.7 | 15.0 | 21.1 | 17.3 | 20.5 | 16.8 | 11.0 | 11.8 | 13.2 |
| France | 6.7 | 8.7 | 12.0 | 11.7 | 15.0 | 11.9 | 9.2 | 11.0 | 12.9 |
| United Kingdom | 18.3 | 10.5 | 12.8 | 14.7 | 15.0 | 15.1 | 19.7 | 9.7 | 10.7 |
| Italy | 1.8 | 4.5 | 4.7 | 4.7 | 5.4 | 5.0 | 4.1 | 4.0 | 4.3 |
| EC-12 | 42.0 | 43.3 | 55.1 | 53.0 | 59.1 | 51.7 | 47.0 | 40.3 | 47.6 |
| Scientific instruments | | | | | | | | | |
| United States | 21.4 | 20.6 | 19.3 | 17.0 | 15.8 | 13.9 | 13.5 | 13.8 | 14.9 |
| Japan | 17.7 | 18.5 | 17.8 | 19.3 | 20.0 | 19.9 | 20.0 | 19.8 | 20.0 |
| West Germany | 16.4 | 16.9 | 17.7 | 17.1 | 17.6 | 18.6 | 18.1 | 17.7 | 17.6 |
| France | 7.6 | 7.4 | 7.5 | 7.7 | 7.9 | 8.0 | 7.0 | 7.3 | 7.4 |
| United Kingdom | 9.3 | 8.8 | 9.7 | 9.8 | 10.2 | 10.7 | 11.8 | 11.7 | 11.6 |
| Italy | 3.3 | 3.3 | 3.3 | 3.5 | 3.6 | 3.8 | 3.9 | 4.0 | 3.9 |
| EC-12 | 45.6 | 45.6 | 48.0 | 48.4 | 49.5 | 51.2 | 51.6 | 51.4 | 51.5 |
| **Other manufactures** | | | | | | | | | |
| United States | 14.1 | 13.6 | 11.5 | 10.0 | 9.4 | 8.3 | 7.6 | 8.3 | 10.0 |
| Japan | 11.0 | 12.0 | 11.7 | 12.3 | 13.3 | 13.2 | 12.7 | 12.1 | 11.7 |
| West Germany | 17.5 | 17.9 | 18.6 | 18.0 | 17.9 | 18.8 | 18.4 | 18.0 | 17.8 |
| France | 10.4 | 10.3 | 10.2 | 10.2 | 9.9 | 9.7 | 9.3 | 9.2 | 9.4 |
| United Kingdom | 7.9 | 6.8 | 7.0 | 6.9 | 6.8 | 6.8 | 7.5 | 8.0 | 7.9 |
| Italy | 7.7 | 8.0 | 8.2 | 8.2 | 8.1 | 8.4 | 8.4 | 8.3 | 8.6 |
| EC-12 | 60.3 | 59.6 | 61.3 | 61.5 | 60.6 | 61.7 | 62.5 | 62.7 | 62.4 |

NOTE: EC-12 = 12 countries of the European Community

SOURCE: Special tabulations developed by Data Resources, Inc./McGraw-Hill from Organisation for Economic Cooperation and Development's Industrial Structure Statistics and Series C Trade Data.

See figure 6-7.

Appendix table 6-8.
**Trade balances for high-tech industries, by country: 1980-88**
(page 1 of 2)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|
| | Millions of constant 1980 dollars | | | | | | | | |
| **High-tech manufactures** | | | | | | | | | |
| United States | 23,698 | 23,643 | 20,640 | 17,512 | 10,881 | 12,210 | 9,187 | 10.392 | 11.855 |
| Japan | 8,022 | 9,267 | 8,943 | 10,378 | 14,193 | 15,127 | 15.622 | 20,114 | 26,627 |
| West Germany | 7,941 | 8,914 | 10,663 | 9,462 | 12,670 | 11,244 | 6,002 | 3,151 | 1.807 |
| France | 1,213 | 2,690 | 3,191 | 2,893 | 5,817 | 5.862 | 563 | 357 | - 1,298 |
| United Kingdom | 6,092 | 5,377 | 5,949 | 4,328 | 4,093 | 8,078 | 11,692 | 9,371 | 588 |
| Italy | - 3,059 | - 1,422 | - 1,018 | - 389 | - 1,418 | - 2,398 | - 5,695 | - 7,088 | - 2,369 |
| Industrial chemicals | | | | | | | | | |
| United States | 3,073 | 2,926 | 2,420 | 1,459 | 1,080 | 485 | 1.005 | 2,041 | 2,572 |
| Japan | 267 | - 90 | - 557 | - 1,141 | - 2,092 | - 1,921 | - 3,303 | - 3,516 | - 4,205 |
| West Germany | 2.933 | 3,243 | 3,468 | 4,129 | 5,072 | 4,617 | 3,219 | 2,812 | 2,976 |
| France | - 436 | 454 | - 280 | 1,210 | 1,495 | 2,018 | 1,024 | 1,073 | 944 |
| United Kingdom | 1,372 | 1,022 | 1,204 | 1,218 | 1,224 | 1,788 | 2,379 | 2,223 | 2.108 |
| Italy | - 1,460 | - 883 | - 583 | - 232 | - 624 | - 1,046 | - 2,856 | - 2,710 | - 3,122 |
| Drugs and medicines | | | | | | | | | |
| United States | 1,217 | 1,217 | 1,221 | 1.110 | 914 | 740 | 806 | 570 | 567 |
| Japan | - 779 | - 803 | - 914 | - 929 | - 986 | - 1,002 | - 1,730 | - 1,954 | - 2,240 |
| West Germany | 981 | 1,188 | 1,180 | 1,161 | 1,265 | 1,289 | 1,170 | 1,115 | 1,165 |
| France | 796 | 821 | 2,257 | 857 | 886 | 895 | 816 | 739 | 575 |
| United Kingdom | 1,217 | 1,123 | 1,185 | 1,065 | 1,125 | 1,247 | 1,550 | 1,410 | 1,304 |
| Italy | 36 | 92 | 82 | - 16 | - 15 | - 75 | - 450 | - 513 | 746 |
| Engines and turbines | | | | | | | | | |
| United States | 4.566 | 4,256 | 4.102 | 2,717 | 1,401 | 288 | - 557 | - 590 | 94 |
| Japan | 2,824 | 3,463 | 3,086 | 3,268 | 3,928 | 3,880 | 4.084 | 4.318 | 4.533 |
| West Germany | 3,391 | 3,256 | 3,722 | 3,418 | 3,769 | 3,680 | 3,266 | 3,151 | 2,917 |
| France | 475 | 456 | - 2 | 71 | 358 | 378 | - 126 | - 355 | 548 |
| United Kingdom | 2,959 | 2,613 | 2,517 | 1,567 | 1,547 | 1,754 | 2.015 | 1,436 | 1,614 |
| Italy | 153 | 356 | 399 | 737 | 461 | 126 | 301 | 318 | 234 |
| Office and computing machinery | | | | | | | | | |
| United States | 2,517 | 2,864 | 2,701 | 2,847 | 2,867 | 4,084 | 1,952 | 935 | 819 |
| Japan | 279 | 487 | 742 | 1,675 | 2,722 | 4,233 | 7,012 | 10,697 | 16,263 |
| West Germany | - 78 | 9 | 0 | - 382 | - 470 | - 1,137 | - 1,954 | - 3,631 | - 5,402 |
| France | 139 | 172 | - 315 | - 470 | 422 | 300 | - 988 | - 996 | - 2,559 |
| United Kingdom | 138 | - 85 | - 121 | - 206 | 104 | 2,864 | 3,056 | 3,669 | - 4,105 |
| Italy | - 263 | - 211 | - 223 | - 217 | - 202 | - 121 | - 249 | - 908 | - 1,458 |
| Radio. TV, & comm. equipment | | | | | | | | | |
| United States | - 1,554 | - 1,835 | - 386 | - 646 | - 2,240 | - 1,411 | - 1,004 | - 1,383 | - 2,420 |
| Japan | 1.594 | 1,843 | 2.084 | 3,058 | 4,973 | 4,170 | 4,459 | 5,522 | 7,599 |
| West Germany | - 596 | - 468 | - 406 | - 450 | - 612 | - 880 | - 1,225 | - 1,147 | - 947 |
| France | - 192 | - 36 | - 122 | - 93 | - 145 | - 104 | - 204 | - 224 | - 601 |
| United Kingdom | - 177 | - 321 | - 346 | - 603 | - 864 | - 699 | - 538 | - 925 | - 1.163 |
| Italy | - 408 | - 216 | - 273 | - 245 | - 512 | - 532 | - 801 | - 1,058 | - 509 |
| Aircraft | | | | | | | | | |
| United States | 10.518 | 10,943 | 7.463 | 7,892 | 5,923 | [illegible] | 7.841 | 9,785 | 10,570 |
| Japan | - 913 | - 1,204 | - 662 | - 1,402 | - 874 | [illegible] | - 2,214 | - 1,987 | - 2,144 |
| West Germany | - 476 | - 777 | - 69 | - 1,040 | 439 | - 156 | - 1,467 | - 1,586 | - 1,501 |
| France | 763 | 1,042 | 2,067 | 1,664 | 2.817 | 2,365 | 1,248 | 1,634 | 1,424 |
| United Kingdom | 422 | 1,218 | 1,609 | 1,664 | 1,430 | 1,236 | 3,083 | 1,471 | 843 |
| Italy | - 224 | 237 | 452 | 394 | 273 | 148 | - 96 | - 97 | 9 |

(continued)

Appendix table 6-8.
**Trade balances for high-tech industries, by country: 1980-88**
(page 2 of 2)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|
| | Millions of constant 1980 dollars | | | | | | | | |
| Scientific instruments | | | | | | | | | |
| United States | 3,362 | 3,272 | 3,119 | 2,135 | 933 | 138 | - 857 | - 966 | - 347 |
| Japan | 4,750 | 5,572 | 5,163 | 5,848 | 6,523 | 7,348 | 7,313 | 7,035 | 6,824 |
| West Germany | 1,785 | 2,465 | 2,770 | 2,626 | 3,208 | 3,831 | 2,992 | 2,437 | 2,600 |
| France | - 333 | - 218 | - 416 | - 348 | - 14 | 9 | - 1,205 | - 1,516 | - 1,628 |
| United Kingdom | 162 | - 193 | - 100 | - 379 | - 473 | - 112 | 147 | 87 | - 10 |
| Italy | - 891 | - 796 | - 871 | - 809 | - 801 | - 895 | - 1,544 | - 2,119 | - 625 |
| **Other manufactures** | | | | | | | | | |
| United States | - 12,734 | - 14,989 | - 26,275 | - 50,788 | - 90,043 | - 113,885 | - 138,294 | - 140,655 | - 125,126 |
| Japan | 53,923 | 65,121 | 60,801 | 66,550 | 79,944 | 84,706 | 65,097 | 45,136 | 25,811 |
| West Germany | 33,511 | 49,165 | 53,673 | 40,922 | 48,348 | 56,764 | 37,002 | 30,691 | 33,553 |
| France | 10,343 | 16,749 | 7,916 | 8,629 | 12,069 | 7,008 | - 14,145 | - 23,823 | - 25,183 |
| United Kingdom | - 4,667 | - 12,189 | - 16,247 | - 25,911 | - 31,699 | - 32,064 | - 34,316 | - 36,171 | - 47,151 |
| Italy | 13,830 | 25,277 | 24,776 | 25,140 | 24,194 | 24,969 | 16,802 | 7,299 | 9,401 |

SOURCE: Special tabulations developed by Data Resources, Inc./McGraw-Hill from Organisation for Economic Cooperation and Development's Industrial Structure Statistics and Series C Trade Data.

See figure 6-8 and figure O-23 in Overview.

Appendix table 6-9.
**U.S. receipts and payments of royalties and license fees generated from the exchange and use of industrial processes with unaffiliated foreign residents: 1987-89**

| | Receipts | | | Payments | | | Balance | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1987 | 1988 | 1989 | 1987 | 1988 | 1989 | 1987 | 1988 | 1989 |
| | Millions of dollars | | | | | | | | |
| ALL COUNTRIES | 1,592 | 1,871 | 1,902 | 436 | 449 | 597 | 1,156 | 1,422 | 1,305 |
| Canada | 87 | 61 | 56 | 9 | 11 | 13 | 78 | 50 | 43 |
| Europe | 446 | 524 | 523 | 320 | 330 | 449 | 126 | 194 | 74 |
| Western Europe | 439 | 492 | 512 | 320 | 330 | 448 | 119 | 162 | 64 |
| European Community | 353 | 416 | 372 | 248 | 277 | 392 | 105 | 139 | -20 |
| France | 73 | 81 | 51 | 33 | 37 | 50 | 40 | 44 | 1 |
| West Germany | 79 | 74 | 76 | 100 | 112 | 135 | -21 | -38 | -59 |
| Italy | 57 | 74 | 67 | 25 | 20 | 32 | 32 | 54 | 35 |
| United Kingdom | 60 | 68 | 74 | 72 | 80 | 61 | -12 | -12 | 13 |
| Other | 84 | 119 | 104 | 18 | 28 | 114 | 66 | 91 | -10 |
| Other Western Europe | 86 | 76 | 140 | 72 | 53 | 56 | 14 | 23 | 84 |
| Eastern Europe | 7 | 32 | 11 | * | * | 1 | 7 | 32 | 10 |
| South and Central America | 63 | 48 | 49 | 5 | * | * | 58 | 48 | 49 |
| Brazil | 19 | 7 | 11 | * | * | * | 19 | 7 | 11 |
| Mexico | 14 | 13 | 17 | 3 | * | * | 11 | 13 | 17 |
| All other | 30 | 28 | 21 | 2 | NA | NA | 28 | 28 | 21 |
| Africa | D | 23 | 24 | * | 4 | * | 0 | 19 | 24 |
| Middle East | D | 18 | 18 | 2 | 3 | 4 | -2 | 15 | 14 |
| Asia and Pacific | 936 | 1,184 | 1,221 | 95 | 98 | 128 | 841 | 1,086 | 1,093 |
| Hong Kong | 4 | 6 | 8 | 1 | * | * | 3 | 6 | 8 |
| India | 18 | 40 | 26 | * | * | * | 18 | 40 | 26 |
| Indonesia | 5 | 4 | 8 | 0 | * | 0 | 5 | 4 | 8 |
| Japan | 723 | 884 | 889 | 88 | 95 | 113 | 635 | 789 | 776 |
| South Korea | 34 | 104 | 166 | * | * | 1 | 34 | 104 | 165 |
| The Philippines | 3 | 4 | 3 | 0 | * | 1 | 3 | 4 | 2 |
| Singapore | 30 | 13 | 3 | * | 0 | 0 | 30 | 13 | 3 |
| Taiwan | 21 | 46 | 22 | * | * | 4 | 21 | 46 | 18 |
| All other | 98 | 83 | 96 | 6 | 3 | 9 | 92 | 80 | 87 |
| All other | 60 | 13 | 11 | 5 | 3 | 3 | 55 | 10 | 8 |

NA = not available

* = less than $500,000

D = withheld to avoid disclosing operations of individual companies

NOTE: Industrial processes include patents and other proprietary inventions and technology.

SOURCE: Bureau of Economic Analysis, *Survey of Current Business*, Vol. 70, No. 9 (September 1990): pp. 45-47.

See figure 6-9.

*Science & Engineering Indicators – 1991*

Appendix table 6-10.
**U.S. receipts and payments of royalties and fees associated with unaffiliated foreign residents: 1972-89**
(page 1 of 2)

| | All countries | Canada | France | Japan | United Kingdom | West Germany | Other countries |
|---|---|---|---|---|---|---|---|
| | Millions of current dollars | | | | | | |
| **Receipts** | | | | | | | |
| 1972 | 655 | 38 | 42 | 240 | 63 | 56 | 216 |
| 1973 | 712 | 32 | 43 | 273 | 75 | 63 | 226 |
| 1974 | 751 | 38 | 46 | 249 | 71 | 78 | 269 |
| 1975 | 757 | 38 | 47 | 219 | 79 | 81 | 293 |
| 1976 | 822 | 45 | 57 | 246 | 72 | 83 | 319 |
| 1977 | 1,037 | 42 | 48 | 275 | 82 | 92 | 498 |
| 1978 | 1,180 | 61 | 47 | 343 | 93 | 119 | 517 |
| 1979 | 1,204 | 43 | 54 | 343 | 102 | 109 | 553 |
| 1980 | 1,305 | 68 | 144 | 403 | 113 | 145 | 432 |
| 1981 | 1,490 | 69 | 133 | 423 | 119 | 101 | 645 |
| 1982 | 1,669 | 71 | 119 | 502 | 122 | 105 | 750 |
| 1983 | 1,679 | 79 | 136 | 523 | 134 | 136 | 671 |
| 1984 | 1,709 | 84 | 105 | 549 | 133 | 127 | 711 |
| 1985 | 1,899 | 101 | 122 | 606 | 126 | 112 | 832 |
| 1986 | 1,842 | 145 | 105 | 632 | 113 | 117 | 730 |
| 1987 | 2,171 | 155 | 95 | 854 | 111 | 135 | 821 |
| 1988 | 2,522 | 107 | 96 | 1,016 | 127 | 126 | 1,050 |
| 1989 | 2,639 | 127 | 79 | 1,026 | 147 | 144 | 1,116 |
| **Payments** | | | | | | | |
| 1972 | 139 | 6 | 13 | 6 | 44 | 29 | 41 |
| 1973 | 176 | 6 | 16 | 13 | 53 | 37 | 51 |
| 1974 | 186 | 7 | 14 | 12 | 67 | 34 | 52 |
| 1975 | 186 | 9 | 15 | 9 | 76 | 32 | 45 |
| 1976 | 189 | 9 | 14 | 13 | 77 | 34 | 42 |
| 1977 | 262 | 8 | 14 | 16 | 72 | 31 | 121 |
| 1978 | 277 | 10 | 16 | 15 | 84 | 27 | 125 |
| 1979 | 309 | 16 | 17 | 15 | 93 | 40 | 128 |
| 1980 | 297 | 18 | 31 | 20 | 96 | 61 | 71 |
| 1981 | 289 | 13 | 30 | 37 | 99 | 43 | 67 |
| 1982 | 292 | 10 | 22 | 31 | 94 | 35 | 100 |
| 1983 | 318 | 10 | 29 | 53 | 90 | 35 | 101 |
| 1984 | 359 | 11 | 32 | 63 | 85 | 59 | 109 |
| 1985 | 425 | 10 | 25 | 66 | 123 | 47 | 154 |
| 1986 | 460 | 10 | 31 | 114 | 76 | 93 | 136 |
| 1987 | 520 | 18 | 38 | 104 | 96 | 109 | 155 |
| 1988 | 1,036 | 225 | 51 | 110 | 145 | 125 | 430 |
| 1989 | 871 | 118 | 55 | 126 | 190 | 153 | 229 |
| **Balance** | | | | | | | |
| 1972 | 516 | 32 | 29 | 234 | 19 | 27 | 175 |
| 1973 | 536 | 26 | 27 | 260 | 22 | 26 | 175 |
| 1974 | 565 | 31 | 32 | 237 | 4 | 44 | 217 |
| 1975 | 571 | 29 | 32 | 210 | 3 | 49 | 248 |
| 1976 | 633 | 36 | 43 | 233 | -5 | 49 | 272 |
| 1977 | 775 | 34 | 34 | 259 | 10 | 61 | 377 |
| 1978 | 903 | 51 | 31 | 328 | 9 | 92 | 392 |
| 1979 | 895 | 27 | 37 | 328 | 9 | 69 | 425 |

(continued)

Appendix table 6-10.
**U.S. receipts and payments of royalties and fees associated with unaffiliated foreign residents: 1972-89**
(page 2 of 2)

| | All countries | Canada | France | Japan | United Kingdom | West Germany | Other countries |
|---|---|---|---|---|---|---|---|
| | Millions of current dollars | | | | | | |
| 1980 | 1,008 | 50 | 113 | 383 | 17 | 84 | 361 |
| 1981 | 1,201 | 56 | 103 | 386 | 20 | 58 | 578 |
| 1982 | 1,377 | 61 | 97 | 471 | 28 | 70 | 650 |
| 1983 | 1,361 | 69 | 107 | 470 | 44 | 101 | 570 |
| 1984 | 1,350 | 73 | 73 | 486 | 48 | 68 | 602 |
| 1985 | 1,474 | 91 | 97 | 540 | 3 | 65 | 678 |
| 1986 | 1,382 | 134 | 74 | 519 | 36 | 27 | 592 |
| 1987 | 1,648 | 137 | 57 | 750 | 14 | 27 | 663 |
| 1988 | 1,436 | -118 | 45 | 906 | -18 | 1 | 484 |
| 1989 | 1,768 | 9 | 24 | 900 | -43 | -9 | 835 |

NOTE: Data do not include transactions involving services.

SOURCE: Bureau of Economic Analysis, unpublished tabulations.

*Science & Engineering Indicators – 1991*

Appendix table 6-11.
**Japanese purchases of technological know-how through new sales agreements with selected major countries: 1984-88**

| | United States | Canada | United Kingdom | West Germany | France | Total |
|---|---|---|---|---|---|---|
| | | | Number of agreements | | | |
| 1984 | 591 | 42 | 48 | 130 | 52 | 863 |
| 1985 | 716 | 23 | 134 | 102 | 38 | 1,013 |
| 1986 | 771 | 11 | 50 | 148 | 42 | 1,022 |
| 1987 | 483 | 11 | 55 | 101 | 34 | 684 |
| 1988 | 1,011 | 27 | 57 | 91 | 57 | 1,243 |
| | | | Value of agreements (million yen) | | | |
| 1984 | 23,660 | 295 | 2,123 | 1,631 | 603 | 28,312 |
| 1985 | 23,837 | 456 | 2,149 | 1,856 | 858 | 29,156 |
| 1986 | 24,210 | 161 | 1,283 | 2,955 | 1,125 | 29,734 |
| 1987 | 29,049 | 285 | 1,527 | 1,911 | 15,132 | 47,904 |
| 1988 | 32,893 | 756 | 1,101 | 1,866 | 7,046 | 43,662 |

SOURCES: Management and Coordination Agency, Statistics Bureau, Government of Japan, unpublished statistics; updates provided by Division of International Programs, Tokyo Office, National Science Foundation.

*Science & Engineering Indicators – 1991*

Appendix table 6-12.
**Japanese sales of technological know-how through new sales agreements with selected major countries: 1984-88**

| | United States | Canada | United Kingdom | West Germany | France | Total |
|---|---|---|---|---|---|---|
| | | | Number of agreements | | | |
| 1984 | 197 | 41 | 47 | 37 | 39 | 361 |
| 1985 | 261 | 10 | 42 | 61 | 41 | 415 |
| 1986 | 238 | 20 | 45 | 45 | 48 | 396 |
| 1987 | 244 | 7 | 50 | 60 | 53 | 414 |
| 1988 | 301 | 18 | 51 | 59 | 24 | 453 |
| | | | Value of agreements (million yen) | | | |
| 1984 | 12,092 | 646 | 1,971 | 467 | 1,681 | 16,857 |
| 1985 | 7,235 | 176 | 1,767 | 6,693 | 1,346 | 17,217 |
| 1986 | 8,018 | 311 | 1,667 | 2,175 | 1,126 | 13,297 |
| 1987 | 10,237 | 123 | 2,366 | 1,834 | 1,671 | 16,231 |
| 1988 | 5,500 | 325 | 1,510 | 1,877 | 530 | 9,742 |

SOURCES: Management and Coordination Agency, Statistics Bureau, Government of Japan, unpublished statistics; updates provided by Division of International Programs, Tokyo Office, National Science Foundation.

*Science & Engineering Indicators – 1991*

Appendix table 6-13.
**National R&D expenditures, by sector of performance and source of funds: 1975 and 1988**

| | France | West Germany | Japan | United Kingdom | Sweden | Italy | United States |
|---|---|---|---|---|---|---|---|
| | Percentage distribution | | | | | | |
| SECTOR OF PERFORMANCE | | | | | | | |
| **1975** | | | | | | | |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Government | 23 | 17 | 12 | 26 | 8 | 22 | 15 |
| Industry | 60 | 63 | 57 | 62 | 69 | 56 | 69 |
| Higher education | 16 | 20 | 28 | 8 | 23 | 22 | 13 |
| Other[1] | 1 | * | 3 | 3 | NA | NA | 4 |
| **1988**[2] | | | | | | | |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Government | 24 | 13 | 9 | 15 | 4 | 22 | 14 |
| Industry | 60 | 72 | 68 | 67 | 67 | 58 | 73 |
| Higher education | 15 | 14 | 19 | 14 | 29 | 20 | 10 |
| Other[1] | 1 | NA | 4 | 4 | * | NA | 3 |
| | Percentage change | | | | | | |
| Government | +1 | -4 | -3 | -11 | -4 | 0 | -1 |
| Industry | 0 | +9 | +11 | +5 | -2 | +2 | +4 |
| Higher education | -1 | -6 | -9 | -6 | +6 | -2 | -3 |
| Other[1] | 0 | * | +1 | +1 | * | NA | -1 |
| | Percentage distribution | | | | | | |
| SOURCE OF FUNDS | | | | | | | |
| **1975** | | | | | | | |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Government | 54 | 47 | 29 | 52 | 39 | 43 | 51 |
| Industry | 39 | 50 | 55 | 41 | 57 | 51 | 45 |
| Higher education | 1 | NA | 15 | 1 | 1 | 1 | 2 |
| Other[3] | 6 | 2 | 1 | 7 | 3 | 5 | 2 |
| **1988**[4] | | | | | | | |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Government | 51 | 36 | 20 | 39 | 38 | 54 | 46 |
| Industry | 43 | 63 | 70 | 50 | 60 | 42 | 50 |
| Higher education | NA | NA | 9 | * | * | NA | 3 |
| Other[3] | 6 | 1 | 1 | 11 | 1 | 4 | 1 |
| | Percentage change | | | | | | |
| Government | -3 | -11 | -9 | -13 | -1 | +11 | -5 |
| Industry | +4 | +13 | +15 | +9 | +3 | -9 | +5 |
| Higher education | -1 | — | -6 | -1 | -1 | -1 | +1 |
| Other[3] | 0 | -1 | 0 | +4 | -2 | -1 | -1 |

* = less than 0.5 percent; NA = not available; — = unknown

NOTE: Percentages may not total 100 because of rounding.

[1]Private nonprofit institutions.

[2]French and Japanese figures for 1988 are National Science Foundation (NSF) estimates; United Kingdom and Swedish data are for 1987. Italian figures are for 1986.

[3]Private nonprofit institutions and funds from abroad.

[4]French and Japanese figures for 1988 are NSF estimates; United Kingdom, Swedish, and Italian data are for 1987.

SOURCES: NSF; Organisation for Economic Cooperation and Development; and national sources

See figures 6-10 and 6-11.

*Science & Engineering Indicators – 1991*

Appendix table 6-14.
**Percentage of national R&D financed by industry, by country: 1970-88**

| | France | West Germany | Japan | United Kingdom | Sweden | Italy | United States |
|---|---|---|---|---|---|---|---|
| 1970 | 37 | 53 | 55 | NA | NA | 51 | 40 |
| 1971 | 37 | 52 | 55 | NA | 56 | 52 | 41 |
| 1972 | 37 | 49 | 55 | 44 | NA | 52 | 41 |
| 1973 | 38 | 49 | 55 | NA | 54 | 49 | 43 |
| 1974 | 38 | 48 | 55 | NA | NA | 51 | 45 |
| 1975 | 39 | 50 | 55 | 41 | 57 | 51 | 45 |
| 1976 | 42 | 51 | 55 | NA | NA | 50 | 45 |
| 1977 | 41 | 53 | 56 | NA | 59 | 47 | 46 |
| 1978 | 42 | 52 | 58 | 44 | NA | 50 | 47 |
| 1979 | 43 | 55 | 59 | NA | 60 | 55 | 47 |
| 1980 | 44 | 56 | 61 | NA | NA | 52 | 49 |
| 1981 | 41 | 56 | 62 | 41 | 57 | 50 | 50 |
| 1982 | 42 | 57 | 64 | NA | NA | 49 | 51 |
| 1983 | 42 | 59 | 65 | 42 | 59 | 45 | 50 |
| 1984 | 41 | 59 | 67 | NA | NA | 44 | 50 |
| 1985 | 42 | 60 | 69 | 47 | 61 | 45 | 49 |
| 1986 | 41 | 61 | 69 | 50 | NA | 40 | 48 |
| 1987 | 42 | 63 | 69 | 50 | 60 | 42 | 48 |
| 1988 | 43 | 63 | 70 | NA | NA | 41 | 50 |

NA = not available

NOTES: Data for 1988 are national estimates; 1988 figure for France is a National Science Foundation (NSF) estimate.

SOURCES: NSF; Organisation for Economic Cooperation and Development; and national sources.

*Science & Engineering Indicators – 1991*

Appendix table 6-15.
**Industrial R&D expenditures, by source of funds: 1953-91**

| | Total R&D | | Federal | | Company[1] | |
|---|---|---|---|---|---|---|
| | Current dollars | Constant 1982 dollars[2] | Current dollars | Constant 1982 dollars[2] | Current dollars | Constant 1982 dollars[2] |
| | Millions of dollars | | | | | |
| 1953 | 3,630 | 14,021 | 1,430 | 5,523 | 2,200 | 8,497 |
| 1954 | 4,070 | 15,475 | 1,750 | 6,654 | 2,320 | 8,821 |
| 1955 | 4,640 | 17,090 | 2,180 | 8,029 | 2,460 | 9,061 |
| 1956 | 6,605 | 23,530 | 3,328 | 11,856 | 3,277 | 11,674 |
| 1957 | 7,731 | 26,585 | 4,335 | 14,907 | 3,396 | 11,678 |
| 1958 | 8,389 | 28,274 | 4,759 | 16,040 | 3,630 | 12,235 |
| 1959 | 9,618 | 31,597 | 5,635 | 18,512 | 3,983 | 13,085 |
| 1960 | 10,509 | 33,955 | 6,081 | 19,648 | 4,428 | 14,307 |
| 1961 | 10,908 | 34,917 | 6,240 | 19,974 | 4,668 | 14,942 |
| 1962 | 11,464 | 35,892 | 6,434 | 20,144 | 5,029 | 15,745 |
| 1963 | 12,630 | 38,981 | 7,270 | 22,438 | 5,360 | 16,543 |
| 1964 | 13,512 | 41,032 | 7,720 | 23,444 | 5,792 | 17,589 |
| 1965 | 14,185 | 41,992 | 7,740 | 22,913 | 6,445 | 19,079 |
| 1966 | 15,548 | 44,474 | 8,332 | 23,833 | 7,216 | 20,641 |
| 1967 | 16,385 | 45,590 | 8,365 | 23,275 | 8,020 | 22,315 |
| 1968 | 17,429 | 46,194 | 8,560 | 22,688 | 8,869 | 23,506 |
| 1969 | 18,308 | 46,023 | 8,451 | 21,244 | 9,857 | 24,779 |
| 1970 | 18,067 | 42,986 | 7,779 | 18,508 | 10,288 | 24,478 |
| 1971 | 18,320 | 41,280 | 7,666 | 17,274 | 10,654 | 24,006 |
| 1972 | 19,552 | 42,056 | 8,017 | 17,245 | 11,535 | 24,812 |
| 1973 | 21,249 | 42,893 | 8,145 | 16,441 | 13,104 | 26,451 |
| 1974 | 22,887 | 42,415 | 8,220 | 15,234 | 14,667 | 27,181 |
| 1975 | 24,187 | 40,781 | 8,605 | 14,509 | 15,582 | 26,272 |
| 1976 | 26,997 | 42,805 | 9,561 | 15,159 | 17,436 | 27,645 |
| 1977 | 29,825 | 44,330 | 10,485 | 15,584 | 19,340 | 28,746 |
| 1978 | 33,304 | 46,115 | 11,189 | 15,493 | 22,115 | 30,622 |
| 1979 | 38,226 | 48,652 | 12,518 | 15,932 | 25,708 | 32,720 |
| 1980 | 44,505 | 51,919 | 14,029 | 16,366 | 30,476 | 35,553 |
| 1981 | 51,810 | 55,140 | 16,382 | 17,435 | 35,428 | 37,705 |
| 1982 | 58,650 | 58,650 | 18,545 | 18,545 | 40,105 | 40,105 |
| 1983 | 65,268 | 62,842 | 20,680 | 19,911 | 44,588 | 42,931 |
| 1984 | 74,800 | 69,433 | 23,396 | 21,717 | 51,404 | 47,716 |
| 1985 | 84,239 | 75,925 | 27,196 | 24,512 | 57,043 | 51,413 |
| 1986 | 87,823 | 77,160 | 27,891 | 24,504 | 59,932 | 52,655 |
| 1987 | 92,155 | 78,477 | 30,752 | 26,188 | 61,403 | 52,289 |
| 1988 | 97,889 | 80,680 | 32,306 | 26,627 | 65,583 | 54,053 |
| 1989 | 101,599 | 80,436 | 31,366 | 24,833 | 70,233 | 55,604 |
| 1990 (est.) | 104,800 | 79,629 | 31,800 | 24,162 | 73,000 | 55,467 |
| 1991 (est.) | 109,150 | 79,434 | 33,000 | 24,016 | 76,150 | 55,418 |

[1]Company funds include funds for industrial R&D work performed within company facilities from all sources except the Federal Government. The sources of funds may comprise those from outside organizations such as research institutions, universities and colleges, other nonprofit organizations, other companies, and state governments, as well as companies' own. Company-financed R&D not performed within the company is excluded.

[2]See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCE: Science Resources Studies Division, National Science Foundation, *Selected Data on Research and Development in Industry: 1989*, NSF 91-302 (Washington, DC: NSF, 1991).

See figure 6-12. *Science & Engineering Indicators -- 1991*

Appendix table 6-16.
**Total expenditures for industrial R&D (financed by company, Federal, and other funds), by industry and size of company: 1979-89**
(page 1 of 3)

| Industry and company size | SIC code | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1967 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Millions of current dollars | | | | | | | | | | |
| TOTAL | All | 38,226 | 44,505 | 51,810 | 58,650 | 65,268 | 74,800 | 84,239 | 87,823 | 92,155 | 97,889 | 101,599 |
| High-technology manufacturing industries | 28,36,372,376,38 | 22,408 | 26,038 | 31,536 | 35,908 | 39,538 | 45,165 | 50,216 | 49,976 | 55,163 | 58,340 | 59,722 |
| Other manufacturing industries | Other mfg SICs | 14,278 | 16,652 | 18,368 | 20,270 | 22,393 | 24,730 | 27,309 | 30,401 | 29,148 | 31,436 | 33,604 |
| Nonmanufacturing industries | 10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87 | 1,540 | 1,815 | 1,906 | 2,472 | 3,337 | 4,905 | 6,714 | 7,446 | 7,844 | 8,113 | 8,273 |
| **Distribution by manufacturing industry** | | | | | | | | | | | | |
| Chemicals and allied products | 28 | 4,038 | 4,636 | 5,625 | 6,604 | 7,185 | 7,927 | 8,540 | 8,843 | 9,635 | 10,772 | 11,537 |
| Industrial chemicals | 281-82,286 | 1,962 | 2,197 | 2,802 | 3,206 | 3,214 | 3,240 | 3,498 | 3,552 | 3,716 | 3,959 | 4,056 |
| Drugs and medicines | 283 | 1,517 | 1,777 | D | D | D | D | D | 3,658 | D | 4,746 | D |
| Other chemicals | 284-85,287-89 | 559 | 662 | D | D | D | D | D | 1,633 | D | 2,067 | D |
| Petroleum refining and extraction | 13,29 | 1,262 | 1,552 | D | D | D | D | D | D | 1,897 | 1,944 | 2,066 |
| Rubber products | 30 | 577 | 656 | D | D | D | D | D | D | D | D | D |
| Stone, clay, and glass products | 32 | 356 | 406 | D | D | D | D | D | 950 | 995 | D | D |
| Primary metals | 33 | 634 | 728 | 878 | 987 | 1,085 | D | D | D | 730 | 663 | 768 |
| Fabricated metal products | 34 | 455 | 550 | 624 | 625 | 701 | 842 | 829 | 895 | 783 | 829 | 788 |
| Machinery | 35 | 4,825 | 5,901 | 6,818 | 8,078 | 9,027 | 10,504 | 12,216 | D | D | D | D |
| Office, computing, and accounting machines | 357 | 3,214 | 3,962 | D | D | D | D | D | D | D | D | D |
| Other machinery, except electrical | 351-56,358-59 | 1,611 | 1,939 | D | D | D | D | D | 2,396 | 2,428 | 2,719 | 2,789 |
| Electrical equipment | 36 | 7,824 | 9,175 | 10,329 | 10,923 | 12,681 | 13,778 | 14,432 | 14,980 | 15,848 | 16,242 | 16,768 |
| Radio and TV receiving equipment | 365 | 245 | 556 | D | D | D | D | D | 133 | 139 | 139 | 85 |
| Communication equipment | 366 | 3,635 | 4,024 | 4,758 | 5,839 | 7,298 | 8,685 | 9,397 | 9,669 | 10,184 | 10,296 | 10,508 |
| Electronic components | 367 | 1,169 | 1,547 | 1,573 | 1,740 | 2,169 | 2,831 | 3,385 | D | 4,286 | 4,607 | 4,884 |
| Other electrical equipment | 361-64,369 | 2,775 | 3,048 | D | D | D | D | D | D | 1,239 | 1,200 | 1,291 |
| Transportation equipment | 37 | 12,709 | 14,315 | D | D | D | D | D | 31,275 | 34,246 | 36,338 | 36,863 |
| Motor vehicles and motor vehicles equipment | 371 | 4,509 | 4,955 | 4,806 | 4,797 | 5,318 | 6,057 | 6,984 | D | D | D | D |
| Other transportation equipment | 373-75,379 | 159 | 162 | D | D | D | D | D | D | D | D | D |
| Aircraft and missiles | 372,376 | 8,041 | 9,198 | 11,968 | 14,451 | 15,406 | 18,858 | 22,231 | 21,050 | 24,458 | 25,900 | 25,654 |
| Professional and scientific instruments | 38 | 2,505 | 3,029 | 3,614 | 3,930 | 4,266 | 4,602 | 5,013 | 5,103 | 5,222 | 5,426 | 5,763 |
| Scientific and mechanical measuring instruments | 381-82 | 950 | 1,352 | D | D | D | D | D | D | D | 1,734 | 1,868 |
| Optical, surgical, photographic, and other instruments | 383-87 | 1,555 | 1,677 | D | D | D | D | D | D | D | 3,692 | 3,895 |
| **Distribution by size of company**[1] | | | | | | | | | | | | |
| Less than 500 | | 1,764 | 2,065 | 2,305 | 2,934 | 4,422 | 4,402 | 5,866 | 7,071 | 7,163 | S | 7,446 |
| 500 - 999 | | | | | | | 1,439 | 1,648 | 1,902 | 1,725 | 1,656 | 1,718 |
| 1,000 - 4,999 | | 2,483 | 2,701 | 3,148 | 3,864 | 4,178 | 5,520 | 6,240 | 7,472 | 7,262 | 7,598 | 7,843 |
| 5,000 - 9,999 | | 1,691 | 2,028 | 2,988 | 2,751 | 2,798 | 3,251 | 4,022 | 4,251 | 4,501 | 5,236 | 5,475 |
| 10,000 - 24,999 | | 5,191 | 6,017 | 6,762 | 7,943 | 9,499 | 11,351 | 11,109 | 10,493 | 12,043 | 11,473 | 10,432 |
| 25,000 or more | | 27,097 | 31,693 | 36,607 | 41,156 | 44,372 | 48,837 | 55,354 | 56,991 | 59,461 | 64,678 | 68,685 |

(continued)

Appendix table 6-16.
**Total expenditures for industrial R&D (financed by company, Federal, and other funds), by industry and size of company: 1979-89**
(page 2 of 3)

| Industry and company size | SIC code | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Millions of constant 1982 dollars | | | | | | | | | | |
| TOTAL | All | 48,652 | 51,919 | 55,140 | 58,650 | 62,842 | 69,433 | 75,925 | 77,160 | 78,477 | 80,680 | 80,436 |
| High-technology manufacturing industries | 28,36,372,376,38 | 28,520 | 30,376 | 33,563 | 35,908 | 38,069 | 41,924 | 45,260 | 43,908 | 46,975 | 48,084 | 47,282 |
| Other manufacturing industries | Other mfg SICs | 18,172 | 19,426 | 19,549 | 20,270 | 21,561 | 22,956 | 24,614 | 26,710 | 24,822 | 25,910 | 26,604 |
| Nonmanufacturing industries | 10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87 | 1,960 | 2,117 | 2,029 | 2,472 | 3,213 | 4,553 | 6,051 | 6,542 | 6,680 | 6,687 | 6,550 |
| **Distribution by manufacturing industry** | | | | | | | | | | | | |
| Chemicals and allied products | 28 | 5,139 | 5,408 | 5,987 | 6,604 | 6,918 | 7,358 | 7,697 | 7,769 | 8,205 | 8,878 | 9,134 |
| Industrial chemicals | 281-82,286 | 2,497 | 2,563 | 2,982 | 3,206 | 3,095 | 3,008 | 3,153 | 3,121 | 3,164 | 3,263 | 3,211 |
| Drugs and medicines | 283 | 1,931 | 2,073 | D | D | D | D | D | 3,214 | D | 3,912 | D |
| Other chemicals | 284-85,287-89 | 711 | 772 | D | D | D | D | D | 1,435 | D | 1,704 | D |
| Petroleum refining and extraction | 13,29 | 1,606 | 1,811 | D | D | D | D | D | D | 1,615 | 1,602 | 1,636 |
| Rubber products | 30 | 734 | 765 | D | D | D | D | D | D | D | D | D |
| Stone, clay, and glass products | 32 | 453 | 474 | D | D | D | D | D | 835 | 847 | D | D |
| Primary metals | 33 | 807 | 849 | 934 | 987 | 1,045 | D | D | D | 622 | 546 | 608 |
| Fabricated metal products | 34 | 579 | 642 | 664 | 625 | 675 | 782 | 747 | 786 | 667 | 683 | 624 |
| Machinery | 35 | 6,141 | 6,884 | 7,256 | 8,078 | 8,692 | 9,750 | 11,010 | D | D | D | D |
| Office, computing, and accounting machines | 357 | 4,091 | 4,622 | D | D | D | D | D | D | D | D | D |
| Other machinery, except electrical | 351-56,358-59 | 2,050 | 2,262 | D | D | D | D | D | 2,105 | 2,068 | 2,241 | 2,208 |
| Electrical equipment | 36 | 9,958 | 10,703 | 10,993 | 10,923 | 12,210 | 12,789 | 13,008 | 13,161 | 13,496 | 13,387 | 13,275 |
| Radio and TV receiving equipment | 365 | 312 | 649 | D | D | D | D | D | 117 | 118 | 115 | 67 |
| Communication equipment | 366 | 4,626 | 4,694 | 5,064 | 5,839 | 7,027 | 8,062 | 8,470 | 8,495 | 8,672 | 8,486 | 8,319 |
| Electronic components | 367 | 1,488 | 1,805 | 1,674 | 1,740 | 2,088 | 2,628 | 3,051 | D | 3,650 | 3,797 | 3,867 |
| Other electrical equipment | 361-64,369 | 3,532 | 3,556 | D | D | D | D | D | D | 1,055 | 989 | 1,022 |
| Transportation equipment | 37 | 16,175 | 16,700 | D | D | D | D | D | 27,478 | 29,163 | 29,950 | 29,185 |
| Motor vehicles and motor vehicles equipment | 371 | 5,739 | 5,780 | 5,115 | 4,797 | 5,120 | 5,622 | 6,295 | D | D | D | D |
| Other transportation equipment | 373-75,379 | 202 | 189 | D | D | D | D | D | D | D | D | D |
| Aircraft and missiles | 372,376 | 10,234 | 10,730 | 12,737 | 14,451 | 14,833 | 17,505 | 20,037 | 18,494 | 20,828 | 21,347 | 20,310 |
| Professional and scientific instruments | 38 | 3,188 | 3,534 | 3,846 | 3,930 | 4,107 | 4,272 | 4,518 | 4,483 | 4,447 | 4,472 | 4,563 |
| Scientific and mechanical measuring instruments | 381-82 | 1,209 | 1,577 | D | D | D | D | D | D | D | 1,429 | 1,479 |
| Optical, surgical, photographic, and other instruments | 383-87 | 1,979 | 1,956 | D | D | D | D | D | D | D | 3,043 | 3,084 |
| **Distribution by size of company** | | | | | | | | | | | | |
| Less than 500 | | 2,245 | 2,409 | 2,453 | 2,934 | 4,258 | 4,086 | 5,287 | 6,212 | 6,100 | D | 5,895 |
| 500 - 999 | | | | | | | | | | | | |
| 1,000 - 4,999 | | 3,160 | 3,151 | 3,350 | 3,864 | 4,023 | 5,124 | 5,624 | 6,565 | 6,184 | 6,262 | 6,209 |
| 5,000 - 9,999 | | 2,152 | 2,366 | 3,180 | 2,751 | 2,694 | 3,018 | 3,625 | 3,735 | 3,833 | 4,316 | 4,335 |

(continued)

Appendix table 6-16.
**Total expenditures for industrial R&D (financed by company, Federal, and other funds), by industry and size of company: 1979-89**
(page 3 of 3)

| Industry and company size | SIC code | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Millions of constant 1982 dollars | | | | | | | | | | |
| 10,000 - 24,999 | | 6,607 | 7,019 | 7,197 | 7,943 | 9,146 | 10,537 | 10,013 | 9,219 | 10,255 | 9,456 | 8,259 |
| 25,000 or more | | 34,488 | 36,973 | 38,960 | 41,156 | 42,723 | 45,333 | 49,891 | 50,071 | 50,635 | 53,308 | 54,378 |

D = withheld to avoid disclosing operations of individual companies

S = withheld because of imputation of more than 50 percent

Distribution is based on number of employees.

See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCE: Science Resources Studies Division, National Science Foundation, *Selected Data on Research and Development in Industry: 1989*, NSF 91-302 (Washington, DC: NSF, 1991).

See figure 6-13.





5· 1

5: .

Appendix table 6-17.
**Federal funds for industrial R&D performance, by industry and size of company: 1979-89**
(page 1 of 3)

| Industry and company size | SIC code | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Millions of current dollars | | | | | | | | | | |
| TOTAL | All | 12,518 | 14,029 | 16,382 | 18,545 | 20,680 | 23,396 | 27,196 | 27,891 | 30,752 | 32,306 | 31,366 |
| High-technology manufacturing industries | 28,36,372,276,38 | 9,988 | 11,317 | 13,506 | 15,436 | 16,762 | 19,417 | 22,364 | 20,727 | 24,380 | 25,566 | 25.069 |
| Other manufacturing industries | Other mfg SICs | 1,849 | 1,933 | 2,018 | 2,109 | 2,665 | 2,326 | 2,519 | 4,458 | 3,672 | 3,987 | 3,581 |
| Nonmanufacturing industries | 10-11,14-17,40 42,44-51,53-54, 56,60,62-63,72-73,78,806-07,87 | 681 | 779 | 858 | 1,000 | 1,253 | 1,653 | 2,313 | 2,706 | 2,700 | 2,753 | 2,716 |
| **Distribution by manufacturing industry** | | | | | | | | | | | | |
| Chemicals and allied products | 28 | 346 | 372 | 421 | 407 | 393 | 191 | 230 | 179 | 190 | 199 | 88 |
| Industrial chemicals | 281-82,286 | 345 | 341 | 409 | 396 | 386 | 183 | 217 | 178 | 185 | 196 | 84 |
| Drugs and medicines | 283 | D | D | D | D | D | D | D | 1 | D | 3 | D |
| Other chemicals | 284-85,287-89 | D | D | D | D | D | D | D | 0 | D | 0 | D |
| Petroleum refining and extraction | 13,29 | 153 | 151 | D | D | D | D | D | D | 14 | 21 | S |
| Rubber products | 30 | D | D | D | D | D | D | D | D | D | D | D |
| Stone, clay, and glass products | 32 | D | D | D | D | D | D | D | 9 | 10 | D | D |
| Primary metals | 33 | 95 | 135 | 176 | 276 | 384 | D | D | D | 19 | 21 | 34 |
| Fabricated metal products | 34 | 41 | 49 | 80 | 60 | 67 | 69 | 49 | 95 | 150 | 142 | 135 |
| Machinery | 35 | 335 | 647 | 694 | 851 | 1,116 | 1,192 | 1,495 | D | D | D | D |
| Office, computing, & accounting machines | 357 | 256 | D | D | D | D | D | D | D | D | D | D |
| Other machinery, except electrical | 351-56,358-59 | 79 | D | D | D | D | D | D | 75 | 44 | 98 | 106 |
| Electrical equipment | 36 | 3,309 | 3,744 | 3,920 | 4,241 | 4,523 | 4,741 | 5,161 | 5,213 | 5,399 | 5,370 | 5,222 |
| Radio and TV receiving equipment | 365 | 53 | 210 | D | D | D | D | D | 0 | 0 | 0 | 0 |
| Communication equipment | 366 | 1,586 | 1,657 | 1,783 | 2,284 | 2,798 | 3,538 | 4,223 | 4,552 | 4,729 | 4,621 | 4,666 |
| Electronic components | 367 | D | 382 | 361 | 398 | 359 | 477 | 559 | D | 656 | 728 | 522 |
| Other electrical equipment | 361-64,369 | D | 1,495 | D | D | D | D | D | D | 14 | 21 | 34 |
| Transportation equipment | 37 | D | D | D | D | D | D | D | 17,708 | 20,784 | 22,176 | 21,763 |
| Motor vehicles and motor vehicles equipment | 371 | 729 | 655 | 587 | 476 | 564 | 673 | 820 | D | D | D | D |
| Other transportation equipment | 373-75,379 | D | D | D | D | D | D | D | D | D | D | D |
| Aircraft and missiles | 372,376 | 5,840 | 6,628 | 8,528 | 10,265 | 11,396 | 14,094 | 16,582 | 14,984 | 18,519 | 19,877 | 19,634 |
| Professional and scientific instruments | 38 | 493 | 573 | 637 | 523 | 450 | 391 | 391 | 351 | 272 | 120 | 125 |
| Scientific & mechanical measuring instruments | 381-82 | 203 | 350 | D | D | D | D | D | D | D | S | S |
| Optical, surgical, photographic, and other instruments | 383-87 | 290 | 223 | D | D | D | D | D | D | D | 96 | 115 |
| **Distribution by size of company** | | | | | | | | | | | | |
| Less than 500 | | 389 | 354 | 424 | 523 | 641 | 621 | 739 | 868 | 963 | 864 | 940 |
| 500 - 999 | | D | D | D | D | D | 98 | 117 | 137 | 115 | 139 | 105 |
| 1,000 - 4,999 | | 590 | 444 | 562 | 623 | 740 | 902 | 991 | 1,229 | 981 | 1,157 | 1,113 |
| 5,000 - 9,999 | | 228 | 432 | 619 | 527 | 718 | 487 | 672 | 796 | 748 | 914 | 813 |
| 10,000 - 24,999 | | 1,179 | 1,150 | 1,225 | 1,495 | 2,271 | 2,805 | 2,743 | 2,004 | 2,362 | 1,805 | 1,245 |
| 25,000 or more | | 10,132 | 11,648 | 13,551 | 15,377 | 16,311 | 18,483 | 21,933 | 23,213 | 25,583 | 27,428 | 27.150 |

(continued)

Appendix table 6-17.
**Federal funds for industrial R&D performance, by industry and size of company: 1979-89**
(page 2 of 3)




| Industry and company size | SIC code | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Millions of constant 1982 dollars[2] | | | | | | | | | | |
| TOTAL | All | 15,932 | 16,366 | 17,435 | 18,545 | 19,911 | 21,717 | 24,512 | 24,504 | 26,188 | 26,627 | 24,833 |
| High-technology manufacturing industries | 28,36,372,276,38 | 12,712 | 13,202 | 14,374 | 15,436 | 16,139 | 18,024 | 20,157 | 18,210 | 20,761 | 21,071 | 19,847 |
| Other manufacturing industries | Other mfg SICs | 2,353 | 2,255 | 2,148 | 2,109 | 2,566 | 2,159 | 2,270 | 3,917 | 3,127 | 3,286 | 2,835 |
| Nonmanufacturing industries | 10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87 | 867 | 909 | 913 | 1,000 | 1,206 | 1,534 | 2,085 | 2,377 | 2,299 | 2,269 | 2,150 |
| **Distribution by manufacturing industry** | | | | | | | | | | | | |
| Chemicals and allied products | 28 | 440 | 434 | 448 | 407 | 378 | 177 | 207 | 157 | 162 | 164 | 70 |
| Industrial chemicals | 281-82,286 | 439 | 398 | 435 | 396 | 372 | 170 | 196 | 156 | 158 | 162 | 67 |
| Drugs and medicines | 283 | D | D | D | D | D | D | D | 1 | D | 2 | D |
| Other chemicals | 284-85,287-89 | D | D | D | D | D | D | D | D | D | D | D |
| Petroleum refining and extraction | 13,29 | 195 | 176 | D | D | D | D | D | D | 12 | 17 | D |
| Rubber products | 30 | D | D | D | D | D | D | D | D | D | D | D |
| Stone, clay, and glass products | 32 | D | D | D | D | D | D | D | 8 | 9 | D | D |
| Primary metals | 33 | 121 | 157 | 187 | 276 | 370 | D | D | D | 16 | 17 | 27 |
| Fabricated metal products | 34 | 52 | 57 | 85 | 60 | 65 | 64 | 44 | 83 | 128 | 117 | 107 |
| Machinery | 35 | 426 | 755 | 739 | 851 | 1,075 | 1,106 | 1,347 | D | D | D | D |
| Office, computing, and accounting machines | 357 | 326 | D | D | D | D | D | D | D | D | D | D |
| Other machinery, except electrical | 351-56,358-59 | 101 | D | D | D | D | D | D | 66 | 37 | 81 | 84 |
| Electrical equipment | 36 | 4,212 | 4,368 | 4,172 | 4,241 | 4,355 | 4,401 | 4,652 | 4,580 | 4,598 | 4,426 | 4,134 |
| Radio and TV receiving equipment | 365 | 67 | 245 | D | D | D | D | D | D | D | D | D |
| Communication equipment | 366 | 2,019 | 1,933 | 1,898 | 2,284 | 2,694 | 3,284 | 3,806 | 3,999 | 4,027 | 3,809 | 3,694 |
| Electronic components | 367 | D | 446 | 384 | 398 | 346 | 443 | 504 | D | 559 | 600 | 413 |
| Other electrical equipment | 361-64,369 | D | 1,744 | D | D | D | D | D | D | 12 | 17 | 27 |
| Transportation equipment | 37 | D | D | D | D | D | D | D | 15,558 | 17,699 | 18,277 | 17,230 |
| Motor vehicles and motor vehicles equipment | 371 | 928 | 764 | 625 | 476 | 543 | 625 | 739 | D | D | D | D |
| Other transportation equipment | 373-75,379 | D | D | D | D | D | D | D | D | D | D | D |
| Aircraft and missiles | 372,376 | 7,433 | 7,732 | 9,076 | 10,265 | 10,972 | 13,083 | 14,945 | 13,165 | 15,770 | 16,383 | 15,544 |
| Professional and scientific instruments | 38 | 627 | 668 | 678 | 523 | 433 | 363 | 352 | 308 | 232 | 99 | 99 |
| Scientific and mechanical measuring instruments | 381-82 | 258 | 408 | D | D | D | D | D | D | D | D | D |
| Optical, surgical, photographic, and other instruments | 383-87 | 369 | 260 | D | D | D | D | D | D | D | 79 | 91 |
| **Distribution by size of company[1]** | | | | | | | | | | | | |
| Less than 500 | | 495 | 413 | 451 | 523 | 617 | 576 | 666 | 763 | 820 | 712 | 744 |
| 500 - 999 | | D | D | D | D | D | 91 | 105 | 120 | 98 | 115 | 83 |
| 1,000 - 4,999 | | 751 | 518 | 598 | 623 | 712 | 837 | 893 | 1,080 | 835 | 954 | 881 |
| 5,000 - 9,999 | | 290 | 504 | 659 | 527 | 691 | 452 | 606 | 699 | 637 | 753 | 644 |

(continued)

Appendix table 6-17.

**Federal funds for industrial R&D performance, by industry and size of company: 1979-89**

(page 3 of 3)

| Industry and company size | SIC code | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Millions of constant 1982 dollars[2] | | | | | | | | | | |
| 10,000 - 24,999 | | 1,501 | 1,342 | 1,304 | 1,495 | 2,187 | 2,604 | 2,472 | 1,761 | 2,011 | 1,488 | 986 |
| 25,000 or more | | 12,896 | 13,588 | 14,422 | 15,377 | 15,705 | 17,157 | 19,768 | 20,394 | 21,786 | 22,606 | 21,495 |

D = withheld to avoid disclosing operations of individual companies

S = withheld because of imputation of more than 50 percent

[1]Distribution is based on number of employees.

[2]See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCE: Science Resources Studies Division, National Science Foundation, *Selected Data on Research and Development in Industry*: 1989, NSF 91-302 (Washington, DC : NSF, 1991).

See figure 6-14.

*Science & Engineering Indicators – 1991*

Appendix table 6-18.
**Company and other (except Federal) funds for industrial R&D performance, by industry and size of company: 1979-89**
(page 1 of 3)



| Industry and company size | SIC code | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Millions of current dollars | | | | | | | | | | |
| TOTAL | All | 25,708 | 30,476 | 35,428 | 40,105 | 44,588 | 51,404 | 57,043 | 59,932 | 61,403 | 65,583 | 70,233 |
| High-technology manufacturing industries | 28,36,372,376,38 | 8,728 | 10,457 | 12,827 | 14,275 | 15,984 | 18,012 | 19,542 | 20,585 | 21,338 | 22,201 | 23,204 |
| Other manufacturing industries | Other mfg SICs | 16,121 | 18,982 | 21,553 | 24,358 | 26,520 | 30,140 | 33,100 | 34,607 | 34,921 | 38,022 | 41,472 |
| Nonmanufacturing industries | 10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87 | 859 | 1,037 | 1,048 | 1,472 | 2,084 | 3,252 | 4,401 | 4,740 | 5,144 | 5,360 | 5,557 |
| **Distribution by manufacturing industry** | | | | | | | | | | | | |
| Chemicals and allied products | 28 | 3,692 | 4,264 | 5,205 | 6,197 | 6,792 | 7.736 | 8,310 | 8,664 | 9,445 | 10,573 | 11,449 |
| Industrial chemicals | 281-82,286 | 1,617 | 1,856 | 2.393 | 2,810 | 2,828 | 3,057 | 3,281 | 3,374 | 3,531 | 3,763 | 3,972 |
| Drugs and medicines | 283 | D | D | 2,064 | 2,473 | 2.896 | 3,310 | 3,481 | 3,657 | 4,095 | 4,743 | 5,206 |
| Other chemicals | 284-85,287-89 | D | 653 | 747 | 914 | 1,068 | 1,369 | 1,548 | 1,633 | 1,819 | 2,067 | 2,271 |
| Petroleum refining and extraction | 13,29 | 1,109 | 1,401 | 1,780 | 2,003 | 2,074 | 2,245 | 2,194 | 1,971 | 1,883 | 1,923 | 2,050 |
| Rubber products | 30 | D | D | 598 | 617 | 638 | 671 | 659 | 655 | 596 | 635 | 679 |
| Stone, clay, and glass products | 32 | D | D | 411 | 472 | 586 | 705 | 825 | 941 | 985 | 826 | 861 |
| Primary metals | 33 | 539 | 594 | 702 | 711 | 701 | 683 | 730 | 786 | 711 | 642 | 734 |
| Fabricated metal products | 34 | 414 | 501 | 545 | 565 | 634 | 773 | 780 | 800 | 633 | 687 | 653 |
| Machinery | 35 | 4,490 | 5,254 | 6.124 | 7.227 | 7,911 | 9,312 | 10,721 | 10,701 | 10,577 | 11,992 | 13,216 |
| Office, computing, and accounting machines | 357 | 2.958 | D | 3.847 | 4,944 | 5,634 | 7.011 | 8,418 | 8.380 | 8,193 | 9,371 | 10,533 |
| Other machinery, except electrical | 351-56,358-59 | 1,532 | D | 2,277 | 2.283 | 2,277 | 2,301 | 2,303 | 2,321 | 2.384 | 2,621 | 2,683 |
| Electrical equipment | 36 | 4,515 | 5,431 | 6,409 | 6,682 | 8,158 | 9,037 | 9,271 | 9,767 | 10,449 | 10,872 | 11,546 |
| Radio and TV receiving equipment | 365 | 192 | 346 | 358 | 364 | 324 | 362 | 350 | 133 | 139 | 139 | 85 |
| Communication equipment | 366 | 2,049 | 2,367 | 2,975 | 3.555 | 4,500 | 5,147 | 5.174 | 5.117 | 5.455 | 5,675 | 5,842 |
| Electronic components | 367 | D | 1.165 | 1,212 | 1,342 | 1.810 | 2,354 | 2,826 | 3.357 | 3,630 | 3,879 | 4.362 |
| Other electrical equipment | 361-64,369 | D | 1,553 | 1,864 | 1,421 | 1,524 | 1,174 | 921 | 1,160 | 1,225 | 1,179 | 1,257 |
| Transportation equipment | 37 | D | 6.958 | 7.739 | 8.621 | 8.991 | 10,406 | 12,092 | 13,567 | 13,462 | 14,162 | 15,100 |
| Motor vehicles and motor vehicles equipment | 371 | 3,780 | 4.300 | 4,219 | 4,321 | 4,754 | 5,384 | 6.164 | 7,171 | 7,167 | 7,769 | 8.726 |
| Other transportation equipment | 373-75,379 | D | D | 80 | 114 | 227 | 258 | 279 | 330 | 356 | 370 | 354 |
| Aircraft and missiles | 372,376 | 2,201 | 2,570 | 3,440 | 4,186 | 4,010 | 4,764 | 5,649 | 6,066 | 5.939 | 6,023 | 6,020 |
| Professional and scientific instruments | 38 | 2,012 | 2.456 | 2.978 | 3.407 | 3.816 | 4.211 | 4,622 | 4,752 | 4.950 | 5.306 | 5.638 |
| Scientific and mechanical measuring instruments | 381-82 | 747 | 1,001 | 1.235 | 1.363 | 1,605 | 1.671 | 1.596 | 1,521 | 1,598 | 1,710 | 1,858 |
| Optical, surgical, photographic, and other instruments | 383-87 | 1,265 | 1,454 | 1.743 | 2.044 | 2.211 | 2,540 | 3.026 | 3,231 | 3,352 | 3.596 | 3,780 |
| **Distribution by size of company**' | | | | | | | | | | | | |
| Less than 500 | | 1,375 | 1,711 | 1.880 | 2,411 | 3.781 | 3,781 | 5.127 | 6,203 | 6.200 | S | S |
| 500 - 999 | | D | D | D | D | D | 1.341 | 1.531 | 1.765 | 1.610 | 1,517 | 1.613 |
| 1,000 - 4,999 | | 1.893 | 2.257 | 2.596 | 3.241 | 3.438 | 4.618 | 5,249 | 6.243 | 6.281 | 6.441 | 6.730 |
| 5,000 - 9,999 | | 1,463 | 1.596 | 2.369 | 2,224 | 2,080 | 2.764 | 3.350 | 3.455 | 3.753 | 4.322 | 4.662 |
| 10,000 - 24,999 | | 4.012 | 4.867 | 5,537 | 6.448 | 7.228 | 8.546 | 8.366 | 8,489 | 9.681 | 9,668 | 9.187 |
| 25,000 or more | | 16,965 | 20.045 | 23.056 | 25,781 | 28,061 | 30,354 | 33.421 | 33.778 | 33,878 | 37,249 | 41.535 |

(continued)

Appendix table 6-18.
**Company and other (except Federal) funds for industrial R&D performance, by industry and size of company: 1979-89**
(page 2 of 3)

| Industry and company size | SIC code | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|
| | | Millions of constant 1982 dollars | | | | |
| TOTAL | All | 32,720 | 35,553 | 37,705 | 40,105 | 42,931 |
| High-technology manufacturing industries | 28,36,372,376,38 | 11,109 | 12,199 | 13,652 | 14,275 | 15,390 |
| Other manufacturing industries | Other mfg SICs | 20,518 | 22,144 | 22,938 | 24,358 | 25,534 |
| Nonmanufacturing industries | 10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87 | 1,093 | 1,210 | 1,115 | 1,472 | 2,007 |
| **Distribution by manufacturing industry** | | | | | | |
| Chemicals and allied products | 28 | 4,699 | 4,974 | 5,540 | 6,197 | 6,540 |
| Industrial chemicals | 281-82,286 | 2,058 | 2,165 | 2,547 | 2,810 | 2,723 |
| Drugs and medicines | 283 | D | D | 2,197 | 2,473 | 2,788 |
| Other chemicals | 284-85,287-89 | D | 762 | 795 | 914 | 1,028 |
| Petroleum refining and extraction | 13,29 | 1,411 | 1,634 | 1,894 | 2,003 | 1,997 |
| Rubber products | 30 | D | D | 636 | 617 | 614 |
| Stone, clay, and glass products | 32 | D | D | 437 | 472 | 564 |
| Primary metals | 33 | 686 | 693 | 747 | 711 | 675 |
| Fabricated metal products | 34 | 527 | 584 | 580 | 565 | 610 |
| Machinery | 35 | 5,715 | 6,129 | 6,518 | 7,227 | 7,617 |
| Office, computing, and accounting machines | 357 | 3,765 | D | 4,094 | 4,944 | 5,425 |
| Other machinery, except electrical | 351-56,358-59 | 1,950 | D | 2,423 | 2,283 | 2,192 |
| Electrical equipment | 36 | 5,746 | 6,336 | 6,821 | 6,682 | 7,855 |
| Radio and TV receiving equipment | 365 | 244 | 404 | 381 | 364 | 312 |
| Communication equipment | 366 | 2,608 | 2,761 | 3,166 | 3,555 | 4,333 |
| Electronic components | 367 | D | 1,359 | 1,290 | 1,342 | 1,743 |
| Other electrical equipment | 361-64,369 | D | 1,812 | 1,984 | 1,421 | 1,467 |
| Transportation equipment | 37 | D | 8,117 | 8,236 | 8,621 | 8,657 |
| Motor vehicles and motor vehicles equipment | 371 | 4,811 | 5,016 | 4,490 | 4,321 | 4,577 |
| Other transportation equipment | 373-75,379 | D | D | 85 | 114 | 219 |
| Aircraft and missiles | 372,376 | 2,801 | 2,998 | 3,661 | 4,186 | 3,861 |
| Professional and scientific instruments | 38 | 2,561 | 2,865 | 3,169 | 3,407 | 3,674 |
| Scientific and mechanical measuring instruments | 381-82 | 951 | 1,168 | 1,314 | 1,363 | 1,545 |
| Optical, surgical, photographic, and other instruments | 383-87 | 1,610 | 1,696 | 1,855 | 2,044 | 2,129 |
| **Distribution by size of company** | | | | | | |
| Less than 500 | | 1,750 | 1,996 | 2,001 | 2,411 | 3,640 |
| 500 - 999 | | D | D | D | D | D |
| 1,000 - 4,999 | | 2,409 | 2,633 | 2,752 | 3,241 | 3,310 |
| 5,000 - 9,999 | | 1,862 | 1,862 | 2,521 | 2,224 | 2,003 |

| Industry and company size | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|
| | Millions of constant 1982 dollars | | | | | |
| TOTAL | 47,716 | 51,413 | 52,655 | 52,289 | 54,053 | 55,604 |
| High-technology manufacturing industries | 16,720 | 17,613 | 18,086 | 18,171 | 18,298 | 18,371 |
| Other manufacturing industries | 27,977 | 29,833 | 30,405 | 29,738 | 31,338 | 32,834 |
| Nonmanufacturing industries | 3,019 | 3,967 | 4,164 | 4,380 | 4,418 | 4,399 |
| **Distribution by manufacturing industry** | | | | | | |
| Chemicals and allied products | 7,181 | 7,490 | 7,612 | 8,043 | 8,714 | 9,064 |
| Industrial chemicals | 2,838 | 2,957 | 2,964 | 3,007 | 3,101 | 3,145 |
| Drugs and medicines | 3,072 | 3,137 | 3,213 | 3,487 | 3,909 | 4,122 |
| Other chemicals | 1,271 | 1,395 | 1,435 | 1,549 | 1,704 | 1,798 |
| Petroleum refining and extraction | 2,084 | 1,977 | 1,732 | 1,604 | 1,585 | 1,623 |
| Rubber products | 623 | 594 | 575 | 508 | 523 | 538 |
| Stone, clay, and glass products | 654 | 744 | 827 | 839 | 681 | 682 |
| Primary metals | 634 | 658 | 691 | 605 | 529 | 581 |
| Fabricated metal products | 718 | 703 | 703 | 539 | 566 | 517 |
| Machinery | 8,644 | 9,663 | 9,402 | 9,007 | 9,884 | 10,463 |
| Office, computing, and accounting machines | 6,508 | 7,587 | 7,363 | 6,977 | 7,724 | 8,339 |
| Other machinery, except electrical | 2,136 | 2,076 | 2,039 | 2,030 | 2,160 | 2,124 |
| Electrical equipment | 8,389 | 8,356 | 8,581 | 8,898 | 8,961 | 9,141 |
| Radio and TV receiving equipment | 336 | 315 | 117 | 118 | 115 | 67 |
| Communication equipment | 4,778 | 4,663 | 4,496 | 4,645 | 4,677 | 4,625 |
| Electronic components | 2,185 | 2,547 | 2,949 | 3,091 | 3,197 | 3,453 |
| Other electrical equipment | 1,090 | 830 | 1,019 | 1,043 | 972 | 995 |
| Transportation equipment | 9,659 | 10,899 | 11,920 | 11,464 | 11,672 | 11,955 |
| Motor vehicles and motor vehicles equipment | 4,998 | 5,556 | 6,300 | 6,103 | 6,403 | 6,908 |
| Other transportation equipment | 239 | 251 | 290 | 303 | 305 | 280 |
| Aircraft and missiles | 4,422 | 5,091 | 5,329 | 5,057 | 4,964 | 4,766 |
| Professional and scientific instruments | 3,909 | 4,166 | 4,175 | 4,215 | 4,373 | 4,464 |
| Scientific and mechanical measuring instruments | 1,551 | 1,438 | 1,336 | 1,361 | 1,409 | 1,471 |
| Optical, surgical, photographic, and other instruments | 2,358 | 2,727 | 2,839 | 2,854 | 2,964 | 2,993 |
| **Distribution by size of company** | | | | | | |
| Less than 500 | 3,510 | 4,621 | 5,450 | 5,280 | S | S |
| 500 - 999 | 1,245 | 1,380 | 1,551 | 1,371 | 1,250 | 1,277 |
| 1,000 - 4,999 | 4,287 | 4,731 | 5,485 | 5,349 | 5,309 | 5,328 |
| 5,000 - 9,999 | 2,566 | 3,019 | 3,035 | 3,196 | 3,562 | 3,691 |

(continued)

Appendix table 6-18.

**Company and other (except Federal) funds for industrial R&D performance, by industry and size of company: 1979-89**

(page 3 of 3)

| Industry and company size | SIC code | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10,000 - 24,999 | | 5 106 | 5,678 | 5,893 | 6,448 | 6,959 | 7,933 | 7,540 | 7,458 | 8,244 | 7,968 | 7,273 |
| 25,000 or more | | 21,592 | 23,384 | 24,538 | 25,781 | 27,018 | 28,176 | 30,123 | 29,677 | 28,850 | 30,701 | 32,883 |

D = withheld to avoid disclosing operations of individual companies

S = withheld because of imputation of more than 50 percent

NOTE: Company funds include all funds for industrial R&D work performed within company facilities from all sources except the Federal Government. The sources of funds may comprise those from outside organizations such as research institutions, universities and colleges, other nonprofit organizations, other companies, and state governments, as well as companies' own. Company-financed R&D not performed within the company is excluded

[1] Distribution is based on number of employees.

[2] See appendix table 4-1 for GNP implicit price deflators used to convert current dollars to constant 1982 dollars.

SOURCE: Science Resources Studies Division, National Science Foundation, *Selected Data on Research and Development in Industry: 1989*, NSF 91-302(Washington, DC: NSF, 1991).

See figure 6-14.

*Science & Engineering Indicators – 1991*

Appendix table 6-19.
**Share of R&D funding provided by the Federal Government in selected industries: 1979-89**
(page 1 of 2)

| Industry and company size | SIC code | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Percent | | | | | | | | | | |
| TOTAL | All | 32.7 | 31.5 | 31.6 | 31.6 | 31.7 | 31.3 | 32.3 | 31.8 | 33.4 | 33.0 | 30.9 |
| High-technology manufacturing industries | 28,36,372,276,38 | 44.6 | 43.5 | 42.8 | 43.0 | 42.4 | 43.0 | 44.5 | 41.5 | 44.2 | 43.8 | 42.0 |
| Other manufacturing industries | Other mfg SICs | 12.9 | 11.6 | 11.0 | 10.4 | 11.9 | 9.4 | 9.2 | 14.7 | 12.6 | 12.7 | 10.7 |
| Nonmanufacturing industries | 10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87 | 44.2 | 42.9 | 45.0 | 40.5 | 37.5 | 33.7 | 34.5 | 36.3 | 34.4 | 33.9 | 32.8 |
| **Distribution by manufacturing industry** | | | | | | | | | | | | |
| Chemicals and allied products | 28 | 8.6 | 8.0 | 7.5 | 6.2 | 5.5 | 2.4 | 2.7 | 2.0 | 2.0 | 1.8 | 0.8 |
| Industrial chemicals | 281-82,286 | 17.6 | 15.5 | 14.6 | 12.4 | 12.0 | 5.6 | 6.2 | 5.0 | 5.0 | 5.0 | 2.1 |
| Drugs and medicines | 283 | D | D | D | D | D | D | D | 0.0 | D | 0.1 | D |
| Other chemicals | 284-85,287-89 | D | D | D | D | D | D | D | D | D | D | D |
| Petroleum refining and extraction | 13,29 | 12.1 | 9.7 | D | D | D | D | D | D | 0.7 | 1.1 | D |
| Rubber products | 30 | D | D | D | D | D | D | D | D | D | D | D |
| Stone, clay, and glass products | 32 | D | D | D | D | D | D | D | 0.9 | 1.0 | D | D |
| Primary metals | 33 | 15.0 | 18.5 | 20.0 | 28.0 | 35.4 | D | D | D | 2.6 | 3.2 | 4.4 |
| Fabricated metal products | 34 | 9.0 | 8.9 | 12.8 | 9.6 | 9.6 | 8.2 | 5.9 | 10.6 | 19.2 | 17.1 | 17.1 |
| Machinery | 35 | 6.9 | 11.0 | 10.2 | 10.5 | 12.4 | 11.3 | 12.2 | D | D | D | D |
| Office, computing, and accounting machines | 357 | 8.0 | D | D | D | D | D | D | D | D | D | D |
| Other machinery, except electrical | 351-56,358-59 | 4.9 | D | D | D | D | D | D | 3.1 | 1.8 | 3.6 | 3.8 |
| Electrical equipment | 36 | 42.3 | 40.8 | 38.0 | 38.8 | 35.7 | 34.4 | 35.8 | 34.8 | 34.1 | 33.1 | 31.1 |
| Radio and TV receiving equipment | 365 | 21.6 | 37.8 | D | D | D | D | D | D | D | D | D |
| Communication equipment | 366 | 43.6 | 41.2 | 37.5 | 39.1 | 38.3 | 40.7 | 44.9 | 47.1 | 46.4 | 44.9 | 44.4 |
| Electronic components | 367 | D | 24.7 | 22.9 | 22.9 | 16.6 | 16.8 | 16.5 | D | 15.3 | 15.8 | 10.7 |
| Other electrical equipment | 361-64,369 | D | 49.0 | D | D | D | D | D | D | 1.1 | 1.8 | 2.6 |
| Transportation equipment | 37 | D | D | D | D | D | D | D | 56.6 | 60.7 | 61.0 | 59.0 |
| Motor vehicles and motor vehicles equipment | 371 | 16.2 | 13.2 | 12.2 | 9.9 | 10.6 | 11.1 | 11.7 | D | D | D | D |
| Other transportation equipment | 373-75,379 | D | D | D | D | D | D | D | D | D | D | D |
| Aircraft and missiles | 372,376 | 72.6 | 72.1 | 71.3 | 71.0 | 74.0 | 74.7 | 74.6 | 71.2 | 75.7 | 76.7 | 76.5 |
| Professional and scientific instruments | 38 | 19.7 | 18.9 | 17.6 | 13.3 | 10.5 | 8.5 | 7.8 | 6.9 | 5.2 | 2.2 | 2.2 |
| Scientific & mechanical measuring instruments | 381-82 | 21.4 | 25.9 | D | D | D | D | D | D | D | D | D |
| Optical, surgical, photographic, and other instruments | 383-87 | 18.6 | 13.3 | D | D | D | D | D | D | D | 2.6 | 3.0 |

(continued)

Appendix table 6-19.
**Share of R&D funding provided by the Federal Government in selected industries: 1979-89**
(page 2 of 2)

| Industry and company size | SIC code | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Percent | | | | | |
| **Distribution by size of company**[1] | | | | | | | | | | | | |
| Less than 500 | | 22.1 | 17.1 | 18.4 | 17.8 | 14.5 | 14.1 | 12.6 | 12.3 | 13.4 | D | 12.6 |
| 500 - 999 | | D | D | D | D | D | 6.8 | 7.1 | 7.2 | 6.7 | 8.4 | 6.1 |
| 1,000 - 4,999 | | 23.8 | 16.4 | 17.9 | 16.1 | 17.7 | 16.3 | 15.9 | 16.4 | 13.5 | 15.2 | 14.2 |
| 5,000 - 9,999 | | 13.5 | 21.3 | 20.7 | 19.2 | 25.7 | 15.0 | 16.7 | 18.7 | 16.6 | 17.5 | 14.8 |
| 10,000 - 24,999 | | 22.7 | 19.1 | 18.1 | 18.8 | 23.9 | 24.7 | 24.7 | 19.1 | 19.6 | 15.7 | 11.9 |
| 25,000 or more | | 37.4 | 36.8 | 37.0 | 37.4 | 36.8 | 37.8 | 39.6 | 40.7 | 43.0 | 42.4 | 39.5 |

D = withheld to avoid disclosing operations of individual companies

[1] Distribution is based on number of employees.

SOURCE: Science Resources Studies Division, National Science Foundation, *Selected Data on Research and Developme... in Industry: 1989*, NSF 91-302 (Washington, DC: NSF, 1991).

See figure 6-15.

Appendix table 6-20.
**Company-financed R&D performed outside the United States by U.S. domestic companies and their foreign subsidiaries: 1979-89**

| | SIC code | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Percent | | | | | | |
| ALL INDUSTRIES | All | 9.7 | 9.4 | 8.7 | 7.2 | 6.8 | 6.6 | 6.0 | 7.2 | 7.8 | 8.8 | 8.5 |
| Chemicals and allied products | 28 | 11.9 | 12.4 | 12.1 | 9.9 | 9.7 | 9.2 | 9.2 | 11.0 | 11.6 | 12.4 | 10.1 |
| Drugs and medicines | 283 | D | D | 17.2 | 12.8 | 11.1 | 10.8 | 10.3 | 11.9 | 13.1 | 13.2 | 13.5 |
| Stone, clay, and glass products | 32 | D | D | 4.2 | 2.1 | 3.1 | 7.8 | D | D | D | D | D |
| Primary metals | 33 | 2.0 | 1.8 | 1.3 | 1.3 | 1.4 | 1.3 | D | D | 2.5 | 3.6 | 3.0 |
| Fabricated metal products | 34 | D | D | 5.2 | 4.2 | 3.5 | 2.6 | 2.6 | 3.1 | 5.9 | D | D |
| Machinery | 35 | 10.6 | 10.2 | 9.1 | 6.4 | 6.8 | 7.4 | 6.0 | 8.2 | 10.4 | 10.2 | 9.9 |
| Electrical equipment | 36 | 9.0 | 7.7 | 6.9 | 6.5 | 5.6 | 5.6 | 6.0 | S | 4.0 | 5.8 | 5.1 |
| Communication equipment | 366 | D | D | D | D | D | D | D | D | 3.3 | 5.6 | 4.5 |
| Electronic components | 367 | D | 2.4 | 3.2 | 2.8 | 0.0 | 3.8 | 4.0 | 4.3 | 5.3 | 6.7 | 5.3 |
| Transportation equipment | 37 | D | 12.8 | 10.3 | 8.9 | 8.9 | 8.0 | 7.8 | D | D | 11.3 | 12.2 |
| Aircraft and missiles | 372,376 | D | D | D | D | D | D | D | 2.9 | 3.8 | 5.2 | 9.2 |
| Professional and scientific instruments | 38 | 7.2 | 7.0 | 7.2 | 6.5 | D | 5.9 | 3.5 | 4.3 | 6.0 | 6.9 | 7.3 |
| Nonmanufacturing | 10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87 | 0.6 | 0.7 | 0.8 | 0.5 | 0.5 | 0.2 | 0.4 | 0.6 | 1.2 | 1.7 | 1.6 |

D = withheld to avoid disclosing operations of individual companies

S = withheld because of imputation of more than 50 percent

SOURCE: Science Resources Sciences Division, National Science Foundation, *Selected Data on Research and Development in Industry: 1989*, NSF 91-302 (Washington, DC: NSF, 1991).

See figure 6-16.

Appendix table 6-21.
**U.S. patents granted, by nationality of inventor and year of grant: 1963-90**

| | Total | 1963-76 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL | 1,902,916 | 924,876 | 65,263 | 66,098 | 48,850 | 61,810 | 65,766 | 57,882 | 56,855 | 67,186 | 71,649 | 70,778 | 82,860 | 77,799 | 95,262 | 89,982 |
| U.S. origin | 1,227,516 | 674,289 | 41,480 | 41,251 | 30,076 | 37,351 | 39,221 | 33,891 | 32,867 | 38,354 | 39,549 | 38,078 | 43,462 | 40,416 | 50,036 | 47,195 |
| U.S. corporations owned | 882,489 | 486,886 | 29,561 | 29,418 | 21,143 | 25,963 | 27,621 | 24,081 | 24,037 | 27,997 | 28,943 | 27,305 | 31,267 | 29,267 | 35,717 | 33,283 |
| U.S. Government owned | 38,244 | 23,268 | 1,484 | 1,233 | 961 | 1,232 | 1,116 | 1,003 | 1,044 | 1,229 | 1,125 | 1,013 | 973 | 728 | 865 | 970 |
| U.S. individuals owned | 300,270 | 161,580 | 10,249 | 10,399 | 7,803 | 9,939 | 10,240 | 8,538 | 7,558 | 8,881 | 9,245 | 9,453 | 10,853 | 10,066 | 12,989 | 12,477 |
| Foreign owned | 6,513 | 2,555 | 186 | 201 | 169 | 217 | 244 | 269 | 228 | 247 | 236 | 307 | 369 | 355 | 465 | 465 |
| Foreign origin | 675,400 | 250,587 | 23,783 | 24,847 | 18,774 | 24,459 | 26,545 | 23,991 | 23,988 | 28,832 | 32,100 | 32,700 | 39,398 | 37,383 | 45,226 | 42,787 |
| U.S. owned | 53,798 | 25,013 | 1,968 | 1,962 | 1,364 | 1,694 | 1,839 | 1,715 | 1,658 | 2,029 | 2,268 | 2,166 | 2,442 | 2,146 | 2,848 | 2,686 |
| Foreign owned | 621,602 | 225,574 | 21,815 | 22,885 | 17,410 | 22,765 | 24,706 | 22,276 | 22,330 | 26,803 | 29,832 | 30,534 | 36,956 | 35,237 | 42,378 | 40,101 |
| Foreign corporations | 512,515 | 175,152 | 17,880 | 18,873 | 14,446 | 18,662 | 20,546 | 18,587 | 19,020 | 22,988 | 25,716 | 26,223 | 31,977 | 30,575 | 36,937 | 34,933 |
| Foreign governments | 7,667 | 2,553 | 215 | 249 | 186 | 253 | 249 | 369 | 336 | 438 | 482 | 477 | 551 | 453 | 443 | 413 |
| Foreign individuals | 101,420 | 47,869 | 3,720 | 3,763 | 2,778 | 3,850 | 3,911 | 3,320 | 2,974 | 3,377 | 3,634 | 3,834 | 4,428 | 4,209 | 4,998 | 4,755 |
| Foreign origin | 675,400 | 250,587 | 23,783 | 24,847 | 18,774 | 24,459 | 26,545 | 23,991 | 23,988 | 28,832 | 32,100 | 32,700 | 39,398 | 37,383 | 45,226 | 42,787 |
| European Community | 337,183 | 149,763 | 12,316 | 12,646 | 9,538 | 12,198 | 12,934 | 11,346 | 10,937 | 12,729 | 13,826 | 13,877 | 16,246 | 15,080 | 17,684 | 16,063 |
| Japan | 203,580 | 43,481 | 6,217 | 6,910 | 5,250 | 7,124 | 8,387 | 8,149 | 8,792 | 11,109 | 12,743 | 13,198 | 16,539 | 16,137 | 20,100 | 19,444 |
| West Germany | 152,706 | 63,310 | 5,537 | 5,850 | 4,527 | 5,745 | 6,250 | 5,408 | 5,423 | 6,254 | 6,665 | 6,795 | 7,815 | 7,300 | 8,286 | 7,541 |
| United Kingdom | 73,534 | 38,901 | 2,654 | 2,722 | 1,910 | 2,406 | 2,475 | 2,134 | 1,931 | 2,271 | 2,495 | 2,408 | 2,777 | 2,581 | 3,091 | 2,778 |
| France | 57,500 | 25,094 | 2,108 | 2,119 | 1,604 | 2,088 | 2,181 | 1,975 | 1,895 | 2,162 | 2,398 | 2,365 | 2,868 | 2,655 | 3,134 | 2,854 |
| Switzerland | 32,935 | 14,679 | 1,219 | 1,226 | 862 | 1,081 | 1,135 | 990 | 1,000 | 1,206 | 1,340 | 1,311 | 1,593 | 1,488 | 1,957 | 1,848 |
| Canada | 32,628 | 15,388 | 1,346 | 1,330 | 1,025 | 1,265 | 1,239 | 1,147 | 1,017 | 1,174 | 1,233 | 1,208 | 1,373 | 1,244 | 1,358 | 1,281 |
| Sweden | 20,835 | 8,179 | 756 | 725 | 596 | 805 | 883 | 752 | 625 | 794 | 919 | 995 | 1,183 | 1,075 | 1,291 | 1,257 |
| Italy | 20,422 | 9,500 | 862 | 826 | 573 | 822 | 766 | 685 | 623 | 701 | 857 | 883 | 948 | 776 | 834 | 766 |
| The Netherlands | 18,283 | 7,902 | 708 | 659 | 525 | 654 | 641 | 618 | 626 | 726 | 766 | 721 | 921 | 805 | 1,060 | 951 |
| Belgium | 6,869 | 3,242 | 255 | 264 | 185 | 244 | 263 | 224 | 205 | 240 | 240 | 242 | 294 | 302 | 357 | 312 |
| USSR | 6,580 | 3,128 | 394 | 412 | 354 | 460 | 373 | 209 | 222 | 214 | 147 | 116 | 121 | 96 | 160 | 174 |
| Hungary | 1,909 | 505 | 80 | 66 | 63 | 87 | 98 | 112 | 106 | 111 | 108 | 131 | 127 | 94 | 129 | 92 |
| East Germany | 690 | 53 | 26 | 24 | 19 | 35 | 52 | 59 | 54 | 68 | 53 | 53 | 64 | 46 | 50 | 34 |
| Taiwan | 3,072 | 52 | 52 | 29 | 38 | 65 | 80 | 88 | 65 | 98 | 174 | 208 | 343 | 457 | 592 | 731 |
| South Korea | 807 | 51 | 5 | 12 | 4 | 8 | 15 | 14 | 26 | 29 | 38 | 45 | 84 | 95 | 157 | 224 |
| Hong Kong | 527 | 139 | 9 | 21 | 13 | 27 | 33 | 18 | 14 | 24 | 25 | 30 | 34 | 41 | 47 | 52 |

SOURCE: Patent and Trademark Office. *Patenting Trends in the United States. 1963-1989* (Washington, DC: August 1990).

See figures 6-17, 6-18, and 6-19, and figure O-21 in Overview.

Appendix table 6-22.
**U.S. patents granted, by nationality of inventor and year of application: 1963-90**

| | Total | 1963-75 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 (est.) | 1988 (est.) | 1989 (est.) | 1990 (est.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL | 1,938,213 | 970,998 | 65,770 | 65,938 | 65,567 | 65,658 | 66,410 | 63,755 | 64,787 | 61,164 | 66,254 | 69,796 | 71,859 | 75,825 | 80,009 | 84,424 | 89,083 |
| **U.S. origin** | 1,235,891 | 702,113 | 41,615 | 40,811 | 39,618 | 38,951 | 38,887 | 36,720 | 36,434 | 34,252 | 35,778 | 36,719 | 37,017 | 37,987 | 38,983 | 40,005 | 41,054 |
| U.S. corporations owned | 889,561 | 507,214 | 29,130 | 28,504 | 27,721 | 27,320 | 27,624 | 26,740 | 27,018 | 25,336 | 26,155 | 26,806 | 26,754 | 27,244 | 27,743 | 28,251 | 28,769 |
| U.S. Government owned | 37,849 | 24,520 | 1,347 | 1,181 | 1,203 | 1,089 | 1,140 | 1,173 | 1,203 | 986 | 913 | 833 | 676 | 596 | 526 | 463 | 409 |
| U.S. individuals owned | 302,391 | 167,706 | 10,943 | 10,901 | 10,464 | 10,281 | 9,845 | 8,553 | 7,962 | 7,680 | 8,418 | 8,780 | 9,273 | 9,874 | 10,515 | 11,196 | 11,922 |
| Foreign owned | 6,622 | 2,673 | 195 | 225 | 230 | 261 | 278 | 254 | 251 | 250 | 292 | 300 | 314 | 339 | 366 | 394 | 426 |
| **Foreign origin** | 702,323 | 268,885 | 24,155 | 25,127 | 25,949 | 26,707 | 27,523 | 27,035 | 28,353 | 26,912 | 30,476 | 33,077 | 34,842 | 37,837 | 41,026 | 44,419 | 48,029 |
| U.S. owned | 54,409 | 26,461 | 1,830 | 1,862 | 1,847 | 1,861 | 1,986 | 1,878 | 2,013 | 1,953 | 2,067 | 2,050 | 2,082 | 2,127 | 2,173 | 2,220 | 2,267 |
| Foreign owned | 649,291 | 242,424 | 22,325 | 23,265 | 24,102 | 24,846 | 25,537 | 25,157 | 26,340 | 24,959 | 28,409 | 31,027 | 32,760 | 35,869 | 39,272 | 42,999 | 47,080 |
| Foreign corporations | 536,895 | 189,140 | 18,232 | 19,135 | 19,801 | 20,468 | 21,447 | 21,424 | 22,845 | 21,564 | 24,448 | 27,023 | 28,444 | 31,194 | 34,211 | 37,519 | 41,147 |
| Foreign governments | 8,070 | 2,728 | 238 | 265 | 283 | 270 | 411 | 384 | 428 | 407 | 456 | 425 | 431 | 439 | 448 | 456 | 465 |
| Foreign individuals | 104,374 | 50,556 | 3,855 | 3,865 | 4,018 | 4,108 | 3,679 | 3,349 | 3,067 | 2,988 | 3,505 | 3,579 | 3,885 | 4,240 | 4,628 | 5,051 | 5,513 |
| **Foreign origin** | 702,323 | 268,885 | 24,155 | 25,127 | 25,949 | 26,707 | 27,523 | 27,035 | 28,353 | 26,912 | 30,476 | 33,077 | 34,842 | 37,837 | 41,026 | 44,419 | 48,029 |
| European Community | 349,096 | 159,469 | 12,242 | 12,685 | 13,041 | 12,922 | 12,933 | 12,195 | 12,295 | 11,551 | 12,982 | 13,611 | 14,201 | 15,213 | 16,297 | 17,459 | 18,703 |
| Japan | 216,252 | 48,271 | 6,576 | 7,078 | 7,475 | 8,414 | 9,557 | 10,009 | 11,300 | 10,734 | 12,316 | 14,099 | 14,856 | 16,556 | 18,450 | 20,561 | 22,913 |
| West Germany | 159,135 | 67,655 | 5,572 | 5,969 | 6,190 | 6,135 | 6,176 | 6,050 | 5,983 | 5,473 | 6,208 | 6,694 | 6,889 | 7,438 | 8,031 | 8,671 | 9,363 |
| United Kingdom | 74,767 | 41,056 | 2,620 | 2,636 | 2,524 | 2,497 | 2,371 | 2,197 | 2,203 | 2,143 | 2,336 | 2,354 | 2,347 | 2,419 | 2,494 | 2,570 | 2,650 |
| France | 59,450 | 26,726 | 2,128 | 2,099 | 2,272 | 2,223 | 2,301 | 2,072 | 2,125 | 2,068 | 2,224 | 2,317 | 2,481 | 2,636 | 2,801 | 2,976 | 3,163 |
| Switzerland | 33,678 | 16,460 | 1,321 | 1,319 | 1,358 | 1,236 | 1,261 | 1,131 | 1,121 | 1,040 | 1,131 | 1,130 | 1,201 | 1,260 | 1,322 | 1,387 | 1,455 |
| Canada | 33,285 | 15,387 | 1,206 | 1,228 | 1,172 | 1,210 | 1,124 | 1,157 | 1,107 | 1,088 | 1,284 | 1,281 | 1,351 | 1,452 | 1,561 | 1,678 | 1,803 |
| Sweden | 20,858 | 10,133 | 856 | 843 | 805 | 824 | 748 | 689 | 671 | 739 | 804 | 778 | 741 | 742 | 742 | 743 | 744 |
| Italy | 22,196 | 8,736 | 747 | 766 | 808 | 918 | 856 | 715 | 798 | 722 | 939 | 932 | 1,069 | 1,218 | 1,389 | 1,583 | 1,804 |
| The Netherlands | 18,635 | 8,444 | 655 | 704 | 709 | 649 | 717 | 670 | 702 | 642 | 715 | 747 | 755 | 797 | 841 | 888 | 937 |
| Belgium | 7,268 | 3,479 | 241 | 230 | 267 | 239 | 246 | 231 | 213 | 214 | 238 | 253 | 298 | 333 | 372 | 415 | 463 |
| USSR | 6,521 | 3,427 | 427 | 449 | 466 | 367 | 246 | 251 | 182 | 115 | 95 | 94 | 105 | 102 | 99 | 96 | 93 |
| Hungary | 1,969 | 576 | 77 | 84 | 74 | 103 | 123 | 122 | 112 | 105 | 116 | 104 | 97 | 94 | 92 | 90 | 87 |
| East Germany | 784 | 77 | 19 | 33 | 30 | 60 | 63 | 67 | 62 | 38 | 56 | 48 | 50 | 55 | 60 | 66 | 72 |
| Taiwan | 3,750 | 81 | 44 | 36 | 68 | 85 | 99 | 65 | 118 | 116 | 158 | 250 | 349 | 504 | 727 | 1,050 | 1,516 |
| South Korea | 801 | 56 | 8 | 8 | 8 | 17 | 17 | 22 | 36 | 37 | 33 | 69 | 80 | 103 | 134 | 173 | 224 |
| Hong Kong | 574 | 147 | 13 | 28 | 27 | 21 | 28 | 14 | 24 | 22 | 22 | 24 | 38 | 46 | 55 | 66 | 79 |

SOURCE: Patent and Trademark Office *Patenting Trends in the United States, 1963-1989* (Washington, DC: August 1990).

See figures 6-17 and 6-19



523

524

Appendix table 6-23.
**Patent classes most and least emphasized by U.S. corporations patenting in the United States: 1980 and 1989**

| Patent class | Class number | Activity index 1980 | Activity index 1989 |
|---|---|---|---|
| **Most emphasized classes** | | | |
| Mineral oils: processes and products | 208 | 1.775 | 1.919 |
| Chemistry, hydrocarbons | 585 | 1.748 | 1.896 |
| Wells | 166 | 1.692 | 1.857 |
| Chemistry, lignins or reaction products thereof | 530 | 1.181 | 1.604 |
| Catalyst, solid sorbent, or support therefor, product | 502 | 1.520 | 1.539 |
| Communications, electrical: Acoustic wave system and devices | 367 | 0.911 | 1.485 |
| Communication, directive radio wave systems & devices | 342 | 0.991 | 1.482 |
| Chemistry: Analytical and immunological testing | 436 | 1.432 | 1.469 |
| Part of the class 520 series—synth. resins or natural rubber | 525 | 1.364 | 1.468 |
| Electrical connectors | 439 | 1.623 | 1.455 |
| Chemistry: Molecular biology and microbiology | 435 | 1.090 | 1.438 |
| Induced nuclear reaction, systems and elements | 376 | 0.910 | 1.374 |
| Chemistry, electrical current producing apparatus, prod. & proc. | 429 | 1.300 | 1.372 |
| Semiconductor device manufacturing: Process | 437 | 1.554 | 1.342 |
| Electricity, conductors and insulators | 174 | 1.295 | 1.335 |
| Error detection/correction and fault detection/recovery | 371 | 1.318 | 1.326 |
| Drug, bio-affecting and body treating compositions | 424 | 0.920 | 1.324 |
| Part of the class 520 series—synth. resins or natural rubber. | 521 | 1.217 | 1.322 |
| Amplifiers | 330 | 1.231 | 1.321 |
| Part of the class 520 series—synth. resins or natural rubber. | 524 | 1.291 | 1.293 |
| **Least emphasized classes** | | | |
| Fishing, trapping and vermin destroying | 43 | 0.328 | 0.360 |
| Dynamic information storage or retrieval | 369 | 0.760 | 0.368 |
| Baths, closets, sinks and spittoons | 4 | 0.617 | 0.467 |
| Fluid: Pressure brake and analogous systems | 303 | 0.619 | 0.481 |
| Photography | 354 | 0.526 | 0.484 |
| Photocopying | 355 | 0.932 | 0.487 |
| Ships | 114 | 0.514 | 0.497 |
| Land vehicles | 280 | 0.555 | 0.508 |
| Amusement devices, games | 273 | 0.436 | 0.509 |
| Motor vehicles | 180 | 0.794 | 0.515 |
| Internal-combustion engines | 123 | 0.491 | 0.555 |
| Amusement and exercising devices | 272 | 0.312 | 0.568 |
| Package and article carriers | 224 | 0.333 | 0.583 |
| Optics, eye examining, vision testing and correcting | 351 | 0.952 | 0.606 |
| Beds | 5 | 0.631 | 0.611 |
| Animal husbandry | 119 | 0.582 | 0.614 |
| Pictorial communication; television | 358 | 0.962 | 0.619 |
| Endless belt power transmission systems and components | 474 | 0.766 | 0.625 |
| Typewriting machines | 400 | 1.145 | 0.626 |
| Bleaching and dyeing; Fluid treatment and chem. modification | 8 | 0.612 | 0.629 |

NOTES: The activity index is the percentage of the patents in a class that are granted to U.S. inventors, divided by the percentage of all patents that have U.S. inventors in that year. Listing is limited to U.S. Patent Office classes that received at least 200 patents from all countries in 1989.

SOURCE: Office of Information Systems, TAF Program, Patent and Trademark Office, "Country Activity Index Report, Corporate Patenting 1989," report prepared for the National Science Foundation (Washington, DC: October 1990).

*Science & Engineering Indicators – 1991*

Appendix table 6-24.
**Patent classes most and least emphasized by Japanese inventors patenting in the United States: 1980 and 1989**

| Patent class | Class number | Activity index 1980 | Activity index 1989 |
|---|---|---|---|
| **Most emphasized classes** | | | |
| Photocopying | 355 | 2.776 | 3.581 |
| Photography | 354 | 4.606 | 3.324 |
| Dynamic information storage or retrieval | 369 | 3.372 | 3.320 |
| Dynamic magnetic information storage or retrieval | 360 | 3.235 | 2.966 |
| Radiation imagery chemistry—process, composition or products | 430 | 3.332 | 2.760 |
| Pictoral communication; television | 358 | 2.587 | 2.744 |
| Typewriting machines | 400 | 1.388 | 2.622 |
| Static information storage and retrieval | 365 | 1.236 | 2.458 |
| Recorders | 346 | 2.170 | 2.406 |
| Motor vehicles | 180 | 1.091 | 2.246 |
| Image analysis | 382 | 2.082 | 2.059 |
| Internal-combustion engines | 123 | 3.106 | 1.941 |
| Active solid state devices, e.g., transistors, solid st. diodes | 357 | 2.061 | 1.939 |
| Registers | 235 | 1.122 | 1.749 |
| Coherent light generators | 372 | 0.349 | 1.737 |
| Compositions: Ceramic | 501 | 2.297 | 1.698 |
| Metal treatment | 148 | 2.568 | 1.690 |
| Electricity, motive power systems | 318 | 1.746 | 1.675 |
| Clutches and power-stop control | 192 | 1.614 | 1.671 |
| Endless belt power transmission systems and components | 474 | 2.255 | 1.645 |
| **Least emphasized classes** | | | |
| Wells | 166 | 0.000 | 0.000 |
| Boring or penetrating the earth | 175 | 0.064 | 0.000 |
| Apparel | 2 | 0.062 | 0.035 |
| Aeronautics | 244 | 0.096 | 0.035 |
| Amusement and exercising devices | 272 | 0.193 | 0.087 |
| Ammunition and explosives | 102 | 0.063 | 0.088 |
| Animal husbandry | 119 | 0.228 | 0.093 |
| Locks | 70 | 0.146 | 0.112 |
| Ships | 114 | 0.382 | 0.118 |
| Baths, closets, sinks and spittoons | 4 | 0.053 | 0.137 |
| Card, picture and sign exhibiting | 40 | 0.230 | 0.141 |
| Package and article carriers | 224 | 0.000 | 0.144 |
| Tools | 81 | 0.238 | 0.147 |
| Beds | 5 | 0.115 | 0.165 |
| Static structures, e.g., buildings | 52 | 0.091 | 0.169 |
| Bottles and jars | 215 | 0.378 | 0.169 |
| Fishing, trapping and vermin destroying | 43 | 0.347 | 0.191 |
| Prothesis (i.e., artificial body members), parts or aids | 623 | 0.446 | 0.206 |
| Mineral oils: Processes and products | 208 | 0.505 | 0.249 |
| Chemistry: Analytical and immunological testing | 436 | 0.587 | 0.250 |

NOTES: The activity index is the percentage of the patents in a class that are granted to Japanese inventors, divided by the percentage of all patents that have Japanese inventors in that year. Listing is limited to U.S. Patent Office classes that received at least 200 patents from all countries in 1989.

SOURCE: Office of Information Systems, TAF Program, Patent and Trademark Office, "Country Activity Index Report, Corporate Patenting 1989," report prepared for the National Science Foundation (Washington, DC: October 1990).

*Science & Engineering Indicators – 1991*

Appendix table 6-25.
**Patent classes most and least emphasized by West German inventors patenting in the United States: 1980 and 1989**

| Patent class | Class number | Activity index | |
|---|---|---|---|
| | | 1980 | 1989 |
| **Most emphasized classes** | | | |
| Fluid-pressure brake and analogous systems | 303 | 2.329 | 4.655 |
| Bleaching and dyeing; Fluid treatment and chem. modification | 8 | 3.510 | 2.919 |
| Ammunition and explosives | 102 | 1.248 | 2.895 |
| Part of the class 532-570 series—organic compounds | 544 | 1.455 | 2.802 |
| Printing | 101 | 2.068 | 2.660 |
| Part of the class 532-570 series—organic compounds | 560 | 1.485 | 2.582 |
| Bearing or guides | 384 | 2.648 | 2.507 |
| X-ray or gamma ray systems or devices | 378 | 2.783 | 2.391 |
| Solid material comminution or disintegration | 241 | 1.460 | 2.248 |
| Part of the class 532-570 series—organic compounds | 568 | 1.877 | 2.222 |
| Spring devices | 267 | 1.254 | 2.183 |
| Chemistry, fertilizers | 71 | 1.156 | 2.176 |
| Part of the class 520 series—synth. resins or natural rubber | 526 | 1.269 | 2.144 |
| Glass manufacturing | 65 | 0.793 | 2.105 |
| Part of the class 520 series—synth. resins or natural rubber | 528 | 2.043 | 2.030 |
| Part of the class 532-570 series—organic compounds | 548 | 1.202 | 2.019 |
| Metal deforming | 72 | 1.391 | 1.908 |
| Part of the class 532-570 series—organic compounds | 546 | 1.919 | 1.879 |
| Part of the class 520 series—synth. resins or natural rubber | 521 | 2.263 | 1.836 |
| Induced nuclear reaction, systems and elements | 376 | 1.902 | 1.817 |
| **Least emphasized classes** | | | |
| Amusement devices, games | 273 | 0.150 | 0.018 |
| Fishing, trapping and vermin destroying | 43 | 0.000 | 0.032 |
| Beds | 5 | 0.076 | 0.054 |
| Wells | 166 | 0.096 | 0.089 |
| Amusement and exercising devices | 272 | 0.170 | 0.115 |
| Photocopying | 355 | 1.126 | 0.116 |
| Amusement devices, toys | 446 | 0.208 | 0.120 |
| Animal husbandry | 119 | 0.181 | 0.123 |
| Package and article carriers | 224 | 0.575 | 0.127 |
| Apparel | 2 | 0.328 | 0.231 |
| Image analysis | 382 | 0.499 | 0.239 |
| Communications, directive radio wave systems and devices | 342 | 0.546 | 0.263 |
| Ships | 114 | 0.360 | 0.266 |
| Recorders | 346 | 0.911 | 0.284 |
| Mineral oils: Processes and products | 208 | 0.374 | 0.288 |
| Surgery | 604 | 0.348 | 0.312 |
| Card, picture and sign exhibiting | 40 | 0.189 | 0.319 |
| Dynamic magnetic information storage or retrieval | 360 | 0.660 | 0.319 |
| Coded data generation or conversion | 341 | 0.793 | 0.324 |
| Stoves and furnaces | 126 | 0.343 | 0.327 |

NOTES: The activity index is the percentage of the patents in a class that are granted to West German inventors, divided by the percentage of all patents that have West German inventors in that year. Listing is limited to U.S. Patent Office classes that received at least 200 patents from all countries in 1989.

SOURCE: Office of Information Systems, TAF Program, Patent and Trademark Office, "Country Activity Index Report, Corporate Patenting 1989," report prepared for the National Science Foundation (Washington, DC: October 1990).

*Science & Engineering Indicators – 1991*

Appendix table 6-26.
**Patent classes most and least emphasized by French inventors patenting in the United States: 1980 and 1989**

| Patent class | Class number | Activity index 1980 | Activity index 1989 |
|---|---|---|---|
| **Most emphasized classes** | | | |
| Bleaching and dyeing: Fluid treatment and chem. modification | 8 | 2.195 | 4.794 |
| Induced nuclear reaction, systems and elements | 376 | 1.621 | 3.239 |
| Spring devices | 267 | 0.935 | 3.122 |
| Boring or penetrating the earth | 175 | 1.520 | 3.107 |
| Communication, electrical: Acoustic wave systems and devices | 367 | 1.389 | 2.914 |
| Glass manufacturing | 65 | 1.520 | 2.479 |
| Part of the class 532-570 series—organic compounds | 568 | 1.264 | 2.469 |
| Land vehicles | 280 | 1.159 | 2.413 |
| Brakes | 188 | 2.379 | 2.304 |
| Part of the class 520 series--synth. resins or natural rubber | 526 | 1.548 | 2.284 |
| Part of the class 532-570 series—organic compounds | 562 | 1.242 | 2.281 |
| Multiplex communication | 370 | 1.949 | 2.273 |
| Pipe joints or couplings | 285 | 1.243 | 2.200 |
| Electricity, circuit makers and breakers | 200 | 0.646 | 2.049 |
| Metal founding | 164 | 2.473 | 2.026 |
| Package making | 53 | 1.242 | 2.012 |
| Expanded, threaded, headed, and driven fasteners-locked | 411 | 1.338 | 1.958 |
| Clutches and power-stop control | 192 | 2.279 | 1.943 |
| Registers | 235 | 4.118 | 1.943 |
| Part of the class 532-570 series—organic compounds | 560 | 0.591 | 1.901 |
| Drug, bio-affecting and body treating compositions | 424 | 1.753 | 1.896 |
| **Least emphasized classes** | | | |
| Photography | 354 | 0.000 | 0.000 |
| Package and article carriers | 224 | 0.000 | 0.000 |
| Fishing, trapping and vermin destroying | 43 | 0.390 | 0.000 |
| Baths, closets, sinks and spittoons | 4 | 0.207 | 0.000 |
| Amusement and exercising devices | 272 | 0.000 | 0.112 |
| Photocopying | 355 | 0.240 | 0.113 |
| Land vehicles, bodies and tops | 296 | 0.644 | 0.117 |
| Dynamic magnetic information storage or retrieval | 360 | 0.918 | 0.123 |
| Radiation imagery chemistry—process, composition or product | 430 | 0.317 | 0.135 |
| Coherent light generators | 372 | 0.548 | 0.154 |
| Stoves and furnaces | 126 | 0.472 | 0.160 |
| Tools | 81 | 0.623 | 0.164 |
| Solid material comminution or disintegration | 241 | 1.089 | 0.170 |
| Amusement devices, toys | 446 | 0.000 | 0.177 |
| Animal husbandry | 119 | 0.180 | 0.181 |
| Amusement devices, games | 273 | 0.224 | 0.210 |
| Cutlery | 30 | 0.183 | 0.259 |
| Apparel | 2 | 0.000 | 0.272 |
| Electricity, conductors and insulators | 174 | 0.784 | 0.284 |
| Printing | 101 | 1.410 | 0.285 |
| Dentistry | 433 | 1.013 | 0.296 |

NOTES: The activity index is the percentage of the patents in a class that are granted to French inventors, divided by the percentage of all patents that have French inventors in that year. Listing is limited to U.S. Patent Office classes that received at least 200 patents from all countries in 1989.

SOURCE: Office of Information Systems, TAF Program, Patent and Trademark Office, "Country Activity Index Report, Corporate Patenting 1989," report prepared for the National Science Foundation (Washington, DC: October 1990).

*Science & Engineering Indicators – 1991*

Appendix table 6-27.
**Patent classes most and least emphasized by British inventors patenting in the United States: 1980 and 1989**

| Patent class | Class number | Activity index 1980 | Activity index 1989 |
|---|---|---|---|
| **Most emphasized classes** | | | |
| Drug, bio-affecting and body treating compositions | 514 | 2.756 | 2.890 |
| Aeronautics | 244 | 0.775 | 2.749 |
| Communications, directive radio wave systems and devices | 342 | 1.342 | 2.301 |
| Sheet feeding or delivering | 271 | 0.829 | 2.279 |
| Brakes | 188 | 2.288 | 2.254 |
| Compositions, coating or plastic | 106 | 2.148 | 2.139 |
| Closure fasteners | 292 | 0.401 | 2.073 |
| Dispensing | 222 | 0.852 | 1.995 |
| Coded data generation or conversion | 341 | 0.835 | 1.917 |
| Telecommunications | 455 | 0.881 | 1.912 |
| Classifying, separating and assorting solids | 209 | 1.490 | 1.905 |
| Spring devices | 267 | 0.000 | 1.873 |
| Multiplex communications | 370 | 1.148 | 1.820 |
| Part of the class 532-570 series—organic compounds | 546 | 0.404 | 1.820 |
| Power plants | 60 | 2.192 | 1.801 |
| Optics, systems and elements | 350 | 1.660 | 1.792 |
| Glass manufacturing | 65 | 2.506 | 1.788 |
| Communications, radio wave antennas | 343 | 0.409 | 1.762 |
| Chemistry, fertilizers | 71 | 1.539 | 1.752 |
| Drug, bio-affecting and body treating compositions | 424 | 2.674 | 1.725 |
| **Least emphasized classes** | | | |
| Amusement devices, toys | 446 | 0.256 | 0.000 |
| Dentistry | 433 | 0.278 | 0.000 |
| Cleaning and liquid contact with solids | 134 | 0.481 | 0.000 |
| Baths, closets, sinks and spittoons | 4 | 0.513 | 0.000 |
| Fishing, trapping and vermin destroying | 43 | 0.000 | 0.086 |
| Electric power conversion systems | 363 | 1.583 | 0.128 |
| Error detection/correction and fault detection/recovery | 371 | 1.398 | 0.136 |
| Amusement devices, games | 273 | 0.308 | 0.146 |
| Beds | 5 | 0.560 | 0.149 |
| Tools | 81 | 0.257 | 0.152 |
| Dynamic information storage or retrieval | 369 | 1.262 | 0.159 |
| Photography | 354 | 0.258 | 0.168 |
| Endless belt power transmission systems and components | 474 | 0.000 | 0.174 |
| Amusement and exercising devices | 272 | 0.000 | 0.209 |
| Winding and reeling | 242 | 0.250 | 0.238 |
| Part of the class 520 series—synth. resins or natural rubber | 525 | 0.526 | 0.260 |
| Dynamic magnetic information storage or retrieval | 360 | 0.216 | 0.265 |
| Static information storage and retrieval | 365 | 1.002 | 0.286 |
| Chairs and seats | 297 | 1.032 | 0.303 |
| Supports | 248 | 0.545 | 0.315 |

NOTES: The activity index is the percentage of the patents in a class that are granted to British inventors, divided by the percentage of all patents that have British inventors in that year. Listing is limited to U.S. Patent Office classes that received at least 200 patents from all countries in 1989.

SOURCE: Office of Information Systems, TAF Program, Patent and Trademark Office, "Country Activity Index Report, Corporate Patenting 1989," report prepared for the National Science Foundation (Washington, DC: October 1990).

*Science & Engineering Indicators – 1991*

Appendix table 6-28.
**Patent classes most emphasized by inventors from Taiwan patenting in the United States: 1980 and 1989**

| Patent class | Class number | Activity index 1980 | Activity index 1989 |
|---|---|---|---|
| Locks | 70 | 0.000 | 14.442 |
| Telephonic communications | 379 | 0.000 | 14.118 |
| Cutlery | 30 | 0.000 | 12.870 |
| Image analysis | 382 | 0.000 | 8.759 |
| Valves and valve actuation | 251 | 0.000 | 8.016 |
| Semiconductor device manufacturing process | 437 | 0.000 | 6.793 |
| Illumination | 362 | 0.000 | 6.320 |
| Part of the class 532-570 series—organic compounds | 568 | 0.000 | 6.142 |
| Chairs and seats | 297 | 0.000 | 5.421 |
| Closure fasteners | 292 | 0.000 | 4.637 |
| Part of the class 532-570 series—organic compounds | 546 | 69.304 | 4.441 |
| Baths, closets, sinks and spittoons | 4 | 0.000 | 4.420 |
| Amusement devices, toys | 446 | 131.530 | 4.400 |
| Internal-combustion engines | 123 | 0.000 | 4.359 |
| Optics, eye examining, vision testing and correcting | 351 | 0.000 | 4.359 |
| Miscellaneous hardware | 16 | 0.000 | 4.319 |
| Tools | 81 | 0.000 | 4.077 |
| Receptacles | 220 | 0.000 | 3.941 |
| Bearing or guides | 384 | 0.000 | 3.909 |
| Cutting | 83 | 0.000 | 3.893 |
| Electricity, conductors and insulators | 174 | 0.000 | 3.530 |
| Electric lamp and discharge devices, systems | 315 | 0.000 | 3.465 |
| Ships | 114 | 0.000 | 3.251 |
| Registers | 235 | 0.000 | 3.022 |
| Abrading | 51 | 0.000 | 2.841 |
| Amusement and exercising devices | 272 | 0.000 | 2.799 |
| Metal treatment | 148 | 0.000 | 2.726 |
| Pulse or digital communications | 375 | 0.000 | 2.695 |
| Package making | 53 | 0.000 | 2.635 |
| Amusement devices, games | 273 | 0.000 | 2.613 |
| Brushing, scrubbing and general cleaning | 15 | 0.000 | 2.606 |
| Special receptacle or package | 206 | 0.000 | 2.553 |
| Fishing, trapping and vermin destroying | 43 | 0.000 | 2.313 |
| Catalyst, solid sorbent, or support therefor, prod. or proc | 502 | 0.000 | 2.296 |
| Photography | 354 | 0.000 | 2.258 |
| Electric heating | 219 | 0.000 | 2.157 |
| Dynamic information storage or retrieval | 369 | 0.000 | 2.135 |
| Dynamic magnetic information storage or retrieval | 360 | 0.000 | 2.032 |
| Coherent light generators | 372 | 0.000 | 1.911 |
| Metal working | 29 | 0.000 | 1.698 |
| Measuring and testing | 73 | 0.000 | 1.490 |
| Land vehicles | 280 | 0.000 | 1.334 |
| Liquid purification or separation | 210 | 0.000 | 0.871 |
| Drug, bio-affecting and body treating compositions | 424 | 0.000 | 0.858 |
| Radiation imagery chemistry—process, composition or product | 430 | 0.000 | 0.839 |
| Drug, bio-affecting and body treating compositions | 514 | 0.000 | 0.384 |
| Electrical computers and data processing systems | 364 | 0.000 | 0.334 |

NOTES. The activity index is the percentage of the patents in a class that are granted to inventors from Taiwan, divided by the percentage of all patents that have inventors from Taiwan in that year. Listing is limited to U.S. Patent Office classes that received at least 200 patents from all countries in 1989

SOURCE: Office of Information Systems, TAF Program, Patent and Trademark Office, "Country Activity Index Report, Corporate Patenting 1989," report prepared for the National Science Foundation (Washington, DC: October 1990).

Appendix table 6-29.
**Patent classes most emphasized by South Korean inventors patenting in the United States: 1980 and 1989**

| Patent class | Class number | Activity index 1980 | Activity index 1989 |
|---|---|---|---|
| Static information storage and retrieval | 365 | 0.000 | 9.056 |
| Closure fasteners | 292 | 0.000 | 8.754 |
| Dynamic magnetic information storage or retrieval | 360 | 0.000 | 8.632 |
| Miscellaneous hardware | 16 | 0.000 | 8.154 |
| Pictorial communication; television | 358 | 0.000 | 7.855 |
| Electric lamp and discharge devices, systems | 315 | 0.000 | 6.541 |
| Electrical transmission or interconnection systems | 307 | 0.000 | 5.890 |
| Receptacles | 220 | 0.000 | 5.581 |
| Chairs and seats | 297 | 0.000 | 5.117 |
| Electric heating | 219 | 0.000 | 5.091 |
| Electric lamp and discharge devices | 313 | 0.000 | 4.699 |
| Part of the class 520 series—synth. resins or natural rubber | 521 | 0.000 | 4.232 |
| Amusement devices, toys | 446 | 0.000 | 4.153 |
| Winding and reeling | 242 | 0.000 | 4.013 |
| Sheet feeding or delivering | 271 | 0.000 | 3.849 |
| Electrical generator or motor structure | 310 | 0.000 | 3.615 |
| Communications, radio wave antennas | 343 | 0.000 | 3.434 |
| Part of the class 532-570 series—organic compounds | 560 | 250.279 | 3.434 |
| Electricity, conductors and insulators | 174 | 0.000 | 3.332 |
| Electric power conversion systems | 363 | 0.000 | 3.235 |
| Semiconductor device manufacturing process | 437 | 0.000 | 3.206 |
| Part of the class 532-570 series—organic compounds | 568 | 0.000 | 2.899 |
| Electricity, circuit makers and breakers | 200 | 0.000 | 2.673 |
| Electrical audio signal processing and systems | 381 | 0.000 | 2.558 |
| Brushing, scrubbing and general cleaning | 15 | 0.000 | 2.460 |
| Electricity, electrical systems and devices | 361 | 0.000 | 2.403 |
| Plastic and nonmetallic article shaping or treating: Process | 264 | 0.000 | 2.227 |
| Catalyst, solid sorbent, or support therefor, prod. or proc. | 502 | 0.000 | 2.167 |
| Dynamic information storage or retrieval | 369 | 0.000 | 2.016 |
| Recorders | 346 | 0.000 | 1.962 |
| Adhesive bonding and misc. chemical manufacture | 156 | 0.000 | 1.685 |
| Telephonic communications | 379 | 0.000 | 1.666 |
| Supports | 248 | 0.000 | 1.597 |
| Chemistry, inorganic | 423 | 0.000 | 1.569 |
| Communication, electrical | 340 | 0.000 | 1.526 |
| Part of the class 520 series—synth. resins or natural rubber | 528 | 0.000 | 1.526 |
| Part of the class 520 series—synth. resins or natural rubber | 524 | 0.000 | 1.389 |
| Coating processes | 427 | 0.000 | 1.294 |
| Special receptacle or package | 206 | 0.000 | 1.205 |
| Food or edible material: Processes, compositions and products | 426 | 0.000 | 1.143 |
| Part of the class 520 series—synth. resins or natural rubber | 525 | 0.000 | 1.100 |
| Chemistry, electrical and wave energy | 204 | 0.000 | 1.077 |
| Compositions | 252 | 0.000 | 0.842 |
| Measuring and testing | 73 | 0.000 | 0.703 |
| Optics, systems and elements | 350 | 0.000 | 0.561 |
| Drug, bio-affecting and body treating compositions | 514 | 0.000 | 0.363 |

NOTES: The activity index is the percentage of the patents in a class that are granted to South Korean inventors, divided by the percentage of all patents that have South Korean inventors in that year. Listing is limited to U.S. Patent Office classes that received at least 200 patents from all countries in 1989.

SOURCE: Office of Information Systems, TAF Program, Patent and Trademark Office, "Country Activity Index Report, Corporate Patenting 1989," report prepared for the National Science Foundation (Washington, DC: October 1990).

*Science & Engineering Indicators – 1991*

Appendix table 6-30.
**Nation shares of patents granted in the United States, by country of residence of inventor, product field, and year of grant: 1980 and 1989**

| Product field and SIC code | All countries | United States | Japan | West Germany | France | United Kingdom | Canada | Switzerland | USSR | Taiwan | South Korea | Other countries |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1980 | | | | | | |
| | | | | | | Percent | | | | | | |
| ALL PRODUCT FIELDS | 61,807 | 60.4 | 11.5 | 9.3 | 3.4 | 3.9 | 1.7 | 2.0 | 0.7 | 0.1 | 0.0 | 6.8 |
| Industrial inorganic chemicals (SIC 281) | 1,093 | 59.6 | 11.3 | 8.9 | 4.0 | 5.3 | 1.9 | 1.1 | 0.9 | 0.0 | 0.0 | 7.0 |
| Plastics materials and synthetic resins (SIC 282) | 965 | 56.6 | 15.1 | 13.4 | 2.9 | 2.0 | 0.8 | 2.3 | 1.1 | 0.0 | 0.1 | 5.7 |
| Drugs and medicines (SIC 283) | 1,378 | 49.5 | 12.3 | 11.6 | 5.3 | 8.0 | 0.9 | 4.1 | 0.5 | 0.1 | 0.0 | 7.8 |
| Engines and turbines (SIC 351) | 635 | 51.3 | 19.8 | 10.9 | 3.8 | 6.0 | 1.1 | 1.1 | 0.3 | 0.3 | 0.0 | 5.4 |
| Office computing and accounting machines (SIC 357) | 1,464 | 61.1 | 17.3 | 6.9 | 3.4 | 3.0 | 0.6 | 1.7 | 0.4 | 0.1 | 0.0 | 5.5 |
| Radio and TV receiving equipment (SIC 365) | 629 | 47.1 | 34.5 | 5.2 | 2.4 | 3.5 | 0.8 | 1.3 | 0.2 | 0.2 | 0.0 | 4.9 |
| Communication equip. & elect. comp. (SIC 366-367) | 5,684 | 63.9 | 14.8 | 5.9 | 3.9 | 3.5 | 1.4 | 1.1 | 0.5 | 0.1 | 0.0 | 4.9 |
| Motor vehicles and equipment (SIC 371) | 1,255 | 52.7 | 16.4 | 13.7 | 4.6 | 4.7 | 1.8 | 1.4 | 0.2 | 0.1 | 0.0 | 4.4 |
| Aircraft and parts (SIC 372) | 679 | 50.7 | 19.3 | 11.5 | 5.0 | 6.5 | 1.2 | 0.9 | 0.1 | 0.1 | 0.0 | 4.7 |
| Professional & scientific instruments (SIC 38-3825) | 7,618 | 58.3 | 16.7 | 9.0 | 2.8 | 3.2 | 1.4 | 2.2 | 0.7 | 0.1 | 0.0 | 5.6 |
| | | | | | | 1989 | | | | | | |
| ALL PRODUCT FIELDS | 94,936 | 52.5 | 21.1 | 8.7 | 3.3 | 3.2 | 2.1 | 1.4 | 0.2 | 0.6 | 0.2 | 7.6 |
| Industrial inorganic chemicals (SIC 281) | 1.253 | 55.1 | 14.0 | 11.6 | 4.6 | 4.6 | 2.4 | 1.0 | 0.4 | 0.0 | 0.2 | 6.5 |
| Plastics materials and synthetic resins (SIC 282) | 1.373 | 50.0 | 21.6 | 13.2 | 3.4 | 3.4 | 1.0 | 1.7 | 0.1 | 0.0 | 0.1 | 5.6 |
| Drugs and medicines (SIC 283) | 2.352 | 51.7 | 14.3 | 9.9 | 3.8 | 3.8 | 1.7 | 2.3 | 0.2 | 0.0 | 0.0 | 12.5 |
| Engines and turbines (SIC 351) | 827 | 44.9 | 27.4 | 12.0 | 2.4 | 2.4 | 1.0 | 1.3 | 0.2 | 0.7 | 0.2 | 8.6 |
| Office computing and accounting machines (SIC 357) | 3.791 | 44.2 | 40.0 | 4.8 | 2.5 | 2.5 | 0.9 | 0.7 | 0.0 | 0.2 | 0.2 | 4.4 |
| Radio and TV receiving equipment (SIC 365) | 1,065 | 35.0 | 45.3 | 5.9 | 3.2 | 3.2 | 0.8 | 0.2 | 0.0 | 0.4 | 0.9 | 6.4 |
| Communication equip. & elect. comp. (SIC 366-367) | 12.399 | 48.8 | 31.1 | 5.5 | 3.5 | 3.5 | 1.6 | 0.7 | 0.1 | 0.5 | 0.3 | 5.3 |
| Motor vehicles and equipment (SIC 371) | 2.002 | 40.9 | 31.9 | 12.9 | 2.9 | 2.9 | 1.9 | 0.7 | 0.0 | 0.5 | 0.1 | 5.8 |
| Aircraft and parts (SIC 372) | 1.015 | 44.0 | 27.4 | 12.4 | 3.6 | 3.6 | 1.0 | 0.9 | 0.1 | 0.7 | 0.0 | 7.0 |
| Professional & scientific instruments (SIC 38-3825) | 13.279 | 52.0 | 26.7 | 6.8 | 2.9 | 2.9 | 1.3 | 1.3 | 0.2 | 0.4 | 0.0 | 6.0 |

NOTE: Table profiles patent activity in SIC-based product fields. The Patent Office's Concordance computer program assigns patent subclasses to all product fields to which they are pertinent; fractional counts are used to eliminate multiple counts among product field categories

SOURCE: Patent and Trademark Office, *Patenting Trends in the United States, 1963-1989* (Washington, DC: August 1990).

*Science & Engineering Indicators – 1991*

Appendix table 6-31.
**Patents granted in selected countries by residence of inventor: 1985-89**
(page 1 of 2)

| Granting country | Total patents | Patents to non-residents as percent of total | Residence of inventor: United States | Japan | West Germany | France | United Kingdom | Italy | Sweden | India | Soviet Union | Other nonresidents |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1985** | | | | | | | | | | | | |
| | | | Percentage of nonresident patents | | | | | | | | | |
| Japan | 50,100 | 15.5 | 46.4 | 0.0 | 19.6 | 6.4 | 5.4 | 1.5 | 2.3 | 0.0 | 1.4 | 17.0 |
| West Germany | 33,377 | 60.4 | 29.2 | 23.9 | 0.0 | 12.4 | 6.7 | 2.8 | 2.8 | 0.0 | 1.7 | 20.5 |
| France | 37,530 | 73.8 | 27.4 | 15.8 | 25.9 | 0.0 | 5.9 | 4.1 | 2.4 | 0.0 | 1.3 | 17.0 |
| United Kingdom | 34,480 | 82.3 | 28.6 | 20.8 | 20.9 | 8.4 | 0.0 | 2.9 | 2.2 | 0.0 | 0.6 | 15.6 |
| Italy | 47,924 | 79.0 | 6.1 | 2.3 | 8.0 | 4.2 | 2.0 | 0.0 | 0.4 | 0.0 | 0.0 | 77.0 |
| Canada | 18,697 | 92.8 | 54.8 | 11.7 | 8.8 | 5.6 | 5.3 | 1.5 | 1.8 | 0.0 | 0.4 | 10.0 |
| Mexico | 1,374 | 93.4 | 56.3 | 6.6 | 7.6 | 7.0 | 4.0 | 2.6 | 1.5 | 0.0 | 0.5 | 14.0 |
| Brazil | 3,934 | 84.6 | 37.0 | 7.3 | 20.7 | 9.9 | 4.0 | 4.6 | 2.8 | 0.0 | 0.4 | 13.3 |
| South Korea | 2,268 | 84.6 | 30.4 | 42.3 | 6.2 | 5.4 | 3.5 | 1.8 | 1.4 | 0.0 | 0.0 | 9.1 |
| Soviet Union | 74,745 | 2.0 | 13.7 | 8.4 | 16.9 | 8.2 | 3.1 | 3.9 | 2.7 | 0.0 | 0.0 | 42.9 |
| India | 1,814 | 76.2 | 33.5 | 6.4 | 11.2 | 8.1 | 10.1 | 3.4 | 1.3 | 0.0 | 3.0 | 23.0 |
| **1986** | | | | | | | | | | | | |
| Japan | 59,900 | 14.4 | 46.1 | 0.0 | 20.0 | 6.7 | 5.3 | 2.0 | 2.2 | 0.0 | 1.4 | 16.3 |
| West Germany | 38,995 | 60.6 | 30.6 | 24.1 | 0.0 | 11.6 | 6.8 | 2.8 | 2.9 | 0.0 | 1.1 | 20.1 |
| France | 35,549 | 73.7 | 27.8 | 17.1 | 25.4 | 0.0 | 6.2 | 3.8 | 2.3 | 0.0 | 0.7 | 16.7 |
| United Kingdom | 32,929 | 83.6 | 28.7 | 19.9 | 21.6 | 8.3 | 0.0 | 2.8 | 2.2 | 0.0 | 0.4 | 16.1 |
| Italy | 52,493 | 23.9 | 24.9 | 8.2 | 28.4 | 13.8 | 7.4 | 0.0 | 1.5 | 0.0 | 0.0 | 15.8 |
| Canada | 17,550 | 92.2 | 56.0 | 12.2 | 7.9 | 5.2 | 5.3 | 1.8 | 1.8 | 0.0 | 0.2 | 9.6 |
| Mexico | 1,222 | 96.2 | 61.3 | 5.6 | 7.6 | 6.6 | 3.2 | 2.5 | 1.3 | 0.1 | 0.3 | 11.5 |
| Brazil | 2,935 | 84.9 | 38.2 | 9.6 | 18.8 | 7.2 | 3.5 | 4.3 | 2.7 | 0.0 | 0.2 | 15.4 |
| South Korea | 1,894 | 75.8 | 25.4 | 58.6 | 0.0 | 3.1 | 2.2 | 1.7 | 0.8 | 0.1 | 0.0 | 8.1 |
| Soviet Union | 79,367 | 1.6 | 14.4 | 7.3 | 17.4 | 9.6 | 5.0 | 3.4 | 3.8 | 0.0 | 0.0 | 39.1 |
| India | 1,994 | 75.2 | 32.3 | 7.6 | 6.3 | 6.5 | 14.7 | 4.5 | 1.8 | 0.0 | 2.8 | 23.5 |
| **1987** | | | | | | | | | | | | |
| Japan | 62,400 | 13.3 | 38.8 | 0.0 | 19.3 | 6.5 | 4.5 | 2.0 | 1.8 | 0.0 | 1.3 | 14.6 |
| West Germany | 39,897 | 59.4 | 27.3 | 25.4 | 0.0 | 11.8 | 6.7 | 3.1 | 2.7 | 0.0 | 0.9 | 19.9 |
| France | 30,413 | 72.0 | 26.4 | 18.2 | 29.1 | 0.0 | 6.4 | 4.2 | 2.4 | 0.0 | 0.7 | 18.3 |
| United Kingdom | 28,659 | 83.9 | 26.6 | 20.9 | 24.1 | 10.1 | 0.0 | 3.1 | 2.2 | 0.0 | 0.3 | 17.0 |
| Italy | 11,550 | 99.0 | 25.1 | 10.3 | 34.6 | 16.9 | 8.1 | 0.0 | 2.2 | 0.0 | 0.0 | 98.6 |
| Canada | 14,649 | 92.6 | 63.3 | 14.8 | 9.9 | 5.4 | 5.9 | 1.8 | 2.2 | 0.0 | 0.2 | 11.6 |
| Mexico | 1,406 | 94.6 | 136.7 | 14.9 | 18.3 | 16.6 | 7.0 | 7.6 | 4.8 | 0.1 | 0.5 | 29.4 |
| Brazil | 2,184 | 86.8 | 55.6 | 8.7 | 21.7 | 11.8 | 10.4 | 6.2 | 3.0 | 0.0 | 0.5 | 16.8 |
| South Korea | 2,330 | 74.4 | 26.8 | 44.0 | 5.5 | 3.3 | 3.0 | 1.7 | 0.8 | 0.0 | 0.0 | 7.2 |
| Soviet Union | 85,018 | 1.6 | 13.0 | 9.3 | 22.6 | 6.5 | 4.3 | 3.3 | 3.2 | 0.2 | 0.0 | 39.4 |
| India | 2,027 | 73.1 | 62.9 | 10.6 | 19.8 | 15.9 | 20.2 | 3.8 | 3.7 | 0.0 | 5.0 | 33.2 |
| **1988** | | | | | | | | | | | | |
| Japan | 55,300 | 13.4 | 43.7 | 0.0 | 21.8 | 7.3 | 5.0 | 2.2 | 2.0 | 0.0 | 1.5 | 16.5 |
| West Germany | 38,890 | 59.6 | 27.9 | 26.0 | 0.0 | 12.0 | 6.8 | 3.2 | 2.8 | 0.0 | 0.9 | 20.3 |
| France | 31,956 | 72.4 | 25.0 | 17.2 | 27.5 | 0.0 | 6.0 | 4.0 | 2.2 | 0.0 | 0.7 | 17.3 |
| United Kingdom | 29,564 | 85.0 | 25.5 | 20.0 | 23.0 | 9.7 | 0.0 | 3.0 | 2.1 | 0.0 | 0.3 | 16.3 |
| Italy | 25,195 | 88.9 | 12.8 | 5.3 | 17.6 | 8.6 | 4.2 | 0.0 | 1.1 | 0.0 | 0.0 | 50.3 |
| Canada | 16,813 | 93.0 | 55.0 | 12.8 | 8.6 | 4.7 | 5.1 | 1.6 | 1.9 | 0.0 | 0.2 | 10.1 |
| Mexico | 3,411 | 92.0 | 58.0 | 6.3 | 7.7 | 7.0 | 3.0 | 3.2 | 2.0 | 0.0 | 0.2 | 12.5 |
| Brazil | 3,040 | 84.0 | 41.2 | 6.5 | 16.1 | 8.8 | 7.7 | 4.6 | 2.2 | 0.0 | 0.4 | 12.5 |
| South Korea | 2,174 | 73.6 | 29.0 | 47.7 | 6.0 | 3.6 | 3.3 | 1.8 | 0.9 | 0.0 | 0.0 | 7.8 |
| Soviet Union | 83,983 | 1.6 | 12.7 | 9.2 | 22.2 | 6.4 | 4.3 | 3.2 | 3.2 | 0.2 | 0.0 | 38.6 |
| India | 3,454 | 75.1 | 35.9 | 6.1 | 11.3 | 9.1 | 11.5 | 2.2 | 2.1 | 0.0 | 2.9 | 18.9 |

(continued)

Appendix table 6-31.
**Patents granted in selected countries by residence of inventor: 1985-89**
(page 2 of 2)

| Granting country | Total patents | Patents to non-residents as percent of total | United States | Japan | West Germany | France | United Kingdom | Italy | Sweden | India | Soviet Union | Other nonresidents |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1989** | | | | | | | | | | | | |
| | | | Percentage of nonresident patents | | | | | | | | | |
| Japan | 63,301 | 13.5 | 44.4 | 0.0 | 21.2 | 7.6 | 5.0 | 2.2 | 2.3 | 0.0 | 1.3 | 16.0 |
| West Germany | 42,233 | 60.0 | 28.2 | 27.2 | 0.0 | 10.9 | 6.5 | 3.5 | 2.8 | 0.0 | 0.9 | 20.0 |
| France | 32,879 | 74.8 | 24.9 | 17.5 | 27.8 | 0.0 | 6.0 | 4.4 | 2.2 | 0.0 | 0.5 | 16.7 |
| United Kingdom | 30,897 | 86.3 | 25.7 | 20.4 | 23.2 | 9.1 | 0.0 | 3.2 | 2.1 | 0.0 | 0.3 | 16.0 |
| Italy | 15,832 | 98.7 | 22.8 | 9.1 | 29.4 | 12.9 | 6.7 | 0.0 | 2.4 | 0.0 | 0.0 | 16.7 |
| Canada | 16,299 | 93.4 | 52.9 | 13.7 | 8.6 | 6.1 | 5.7 | 1.8 | 1.7 | 0.0 | 0.2 | 9.4 |
| Mexico | 2,268 | 91.0 | 63.1 | 4.5 | 7.8 | 6.0 | 2.8 | 3.5 | 1.4 | 0.0 | 0.7 | 10.3 |
| Brazil | 3,510 | 86.5 | 41.2 | 5.2 | 16.2 | 9.1 | 10.0 | 4.3 | 2.2 | 0.0 | 0.6 | 11.1 |
| South Korea | 3,972 | 70.3 | 30.7 | 50.6 | 5.1 | 3.0 | 3.0 | 0.9 | 0.8 | 0.0 | 0.0 | 6.0 |
| Soviet Union | 84,577 | 1.5 | 13.6 | 8.3 | 19.5 | 7.0 | 4.1 | 4.8 | 1.9 | 0.0 | 0.0 | 40.8 |
| India | 1,986 | 78.0 | 35.4 | 6.8 | 14.0 | 7.2 | 7.3 | 2.8 | 1.7 | 0.0 | 5.0 | 19.6 |

SOURCE: World Intellectual Property Organization. "Industrial Property Statistics" (Geneva, Switzerland).

See figure 6-20.

Appendix table 6-32.
**Citations per patent for selected countries, by year patent was granted in the United States: 1980, 1985, and 1987**

| Industry | United States | West Germany | Japan | United Kingdom | France | Non-U.S. | World |
|---|---|---|---|---|---|---|---|
| | **1980** | | | | | | |
| ALL INDUSTRIES | 3.58 | 2.86 | 3.79 | 3.12 | 2.82 | 3.09 | 3.39 |
| Industrial inorganic chemicals | 3.98 | 3.32 | 3.75 | 4.13 | 2.94 | 3.46 | 3.77 |
| Plastic materials and synthetic resins | 3.94 | 3.24 | 4.61 | 3.36 | 2.36 | 3.78 | 3.87 |
| Drugs and medicines | 3.46 | 2.37 | 2.45 | 2.75 | 1.94 | 2.32 | 2.88 |
| Engines and turbines | 3.23 | 3.22 | 4.35 | 2.41 | 2.70 | 3.37 | 3.30 |
| Office computing and accounting machines | 6.80 | 4.89 | 6.37 | 6.09 | 5.61 | 5.63 | 6.34 |
| General industry machines and equipment | 3.11 | 2.46 | 3.77 | 2.30 | 2.45 | 2.71 | 2.94 |
| Electrical equipment except communication equipment | 3.77 | 3.10 | 3.71 | 3.43 | 2.80 | 3.15 | 3.52 |
| Communication equipment and electrical components | 4.95 | 3.24 | 4.43 | 4.37 | 3.65 | 4.01 | 4.60 |
| Radio and TV equipment except communication types | 4.60 | 3.80 | 3.93 | 4.64 | 4.42 | 4.05 | 4.30 |
| Electrical components & access & communication equip | 4.98 | 3.18 | 4.56 | 4.34 | 3.60 | 4.01 | 4.63 |
| Transportation equipment | 2.82 | 3.07 | 4.24 | 2.28 | 2.50 | 3.13 | 2.95 |
| Motor vehicles and motor vehicle equipment | 3.14 | 3.17 | 4.33 | 2.37 | 2.72 | 3.30 | 3.22 |
| Guided missiles and space vehicles and parts | 2.00 | 2.07 | 0.00 | 0.85 | 1.80 | 2.00 | 2.00 |
| Ordnance, except missiles | 2.01 | 1.82 | 2.17 | 1.14 | 2.70 | 2.04 | 2.01 |
| Aircraft and parts | 3.39 | 3.78 | 4.41 | 2.45 | 2.87 | 3.56 | 3.48 |
| Professional and scientific instruments | 4.25 | 3.52 | 3.93 | 4.68 | 3.71 | 3.69 | 4.02 |
| | **1985** | | | | | | |
| ALL INDUSTRIES | 2.07 | 1.69 | 2.66 | 1.79 | 1.61 | 2.04 | 2.06 |
| Industrial inorganic chemicals | 2.12 | 1.34 | 2.36 | 1.83 | 1.44 | 1.74 | 1.96 |
| Plastic materials and synthetic resins | 2.03 | 1.68 | 2.06 | 1.34 | 1.67 | 1.88 | 1.97 |
| Drugs and medicines | 1.77 | 1.60 | 1.39 | 1.53 | 1.01 | 1.32 | 1.54 |
| Engines and turbines | 1.37 | 1.58 | 2.84 | 1.27 | 1.61 | 2.17 | 1.85 |
| Office computing and accounting machines | 3.50 | 2.62 | 3.68 | 2.97 | 3.44 | 3.39 | 3.44 |
| General industry machines and equipment | 1.74 | 1.49 | 2.14 | 1.58 | 1.58 | 1.72 | 1.73 |
| Electrical equipment except communication equipment | 2.21 | 1.96 | 2.55 | 2.00 | 1.65 | 2.12 | 2.17 |
| Communication equipment and electrical components | 3.08 | 2.36 | 3.47 | 2.46 | 2.39 | 2.99 | 3.04 |
| Radio and TV equipment except communication types | 3.03 | 3.24 | 3.20 | 2.73 | 2.46 | 2.99 | 3.01 |
| Electrical components & access & communication equip | 3.08 | 2.27 | 3.51 | 2.44 | 2.38 | 2.99 | 3.04 |
| Transportation equipment | 1.60 | 1.95 | 3.53 | 1.40 | 2.02 | 2.50 | 2.08 |
| Motor vehicles and motor vehicle equipment | 1.80 | 1.97 | 3.57 | 1.53 | 2.21 | 2.70 | 2.32 |
| Guided missiles and space vehicles and parts | 1.23 | 1.20 | 0.00 | 0.88 | 0.84 | 0.86 | 1.10 |
| Ordnance, except missiles | 1.37 | 1.39 | 2.00 | 1.24 | 1.52 | 1.34 | 1.36 |
| Aircraft and parts | 1.51 | 2.14 | 3.36 | 1.47 | 1.94 | 2.62 | 2.14 |
| Professional and scientific instruments | 2.46 | 1.91 | 2.87 | 2.10 | 1.64 | 2.35 | 2.41 |
| | **1987** | | | | | | |
| ALL INDUSTRIES | 1.01 | 0.75 | 1.30 | 0.82 | 0.77 | 0.97 | 0.99 |
| Industrial inorganic chemicals | 0.94 | 0.54 | 0.91 | 1.11 | 0.60 | 0.71 | 0.84 |
| Plastic materials and synthetic resins | 0.97 | 0.53 | 0.89 | 0.84 | 0.68 | 0.75 | 0.87 |
| Drugs and medicines | 0.88 | 0.75 | 0.69 | 0.71 | 0.50 | 0.67 | 0.78 |
| Engines and turbines | 0.73 | 0.86 | 1.38 | 0.61 | 0.62 | 1.03 | 0.91 |
| Office computing and accounting machines | 1.63 | 0.98 | 1.53 | 1.50 | 1.24 | 1.43 | 1.51 |
| General industry machines and equipment | 0.78 | 0.68 | 1.07 | 0.71 | 0.90 | 0.82 | 0.80 |
| Electrical equipment except communication equipment | 1.09 | 0.76 | 1.17 | 0.82 | 0.88 | 0.95 | 1.02 |
| Communication equipment and electrical components | 1.45 | 0.94 | 1.71 | 1.14 | 0.95 | 1.42 | 1.43 |
| Radio and TV equipment except communication types | 1.60 | 1.09 | 1.91 | 1.28 | 1.52 | 1.68 | 1.65 |
| Electrical components & access & communication equip | 1.44 | 0.93 | 1.68 | 1.13 | 0.92 | 1.38 | 1.41 |
| Transportation equipment | 0.77 | 1.01 | 1.71 | 0.80 | 0.82 | 1.21 | 1.02 |
| Motor vehicles and motor vehicle equipment | 0.85 | 1.03 | 1.70 | 0.82 | 0.97 | 1.32 | 1.15 |
| Guided missiles and space vehicles and parts | 0.49 | 0.45 | 1.00 | 1.42 | 0.38 | 0.70 | 0.57 |
| Ordnance, except missiles | 0.61 | 0.46 | 1.04 | 0.70 | 0.80 | 0.53 | 0.57 |
| Aircraft and parts | 0.78 | 1.04 | 1.64 | 0.77 | 0.86 | 1.24 | 1.05 |
| Professional and scientific instruments | 1.20 | 0.94 | 1.48 | 1.01 | 0.97 | 1.19 | 1.20 |

NOTE: Citation rates generally increase as a patent ages. Consequently, citation rates for patents granted in 1987 are noticeably lower than those granted in 1980.

SOURCE: Computer Horizons, Inc., special report to Science Resources Studies Division, National Science Foundation, 1990

Appendix table 6-33.
**Output per worker-hour in manufacturing: 1960-89**

| | France | West Germany | Japan | United Kingdom | Italy | Sweden | United States |
|---|---|---|---|---|---|---|---|
| 1960 | 36.7 | 45.8 | 20.2 | 57.5 | 34.1 | 47.0 | 59.8 |
| 1961 | 39.0 | 47.0 | 22.4 | 56.8 | 36.4 | 48.8 | 61.6 |
| 1962 | 41.3 | 48.9 | 22.8 | 57.5 | 39.1 | 52.0 | 64.8 |
| 1963 | 43.4 | 50.1 | 24.5 | 60.5 | 40 3 | 54.4 | 69.4 |
| 1964 | 46.3 | 54.3 | 27.5 | 65.0 | 40.7 | 58.4 | 73.3 |
| 1965 | 49.0 | 57.4 | 28.2 | 66.0 | 43.9 | 62.1 | 76.1 |
| 1966 | 53.1 | 59.1 | 31.2 | 66.9 | 48.2 | 64.6 | 77.2 |
| 1967 | 55.8 | 61.3 | 35.8 | 69.6 | 51.3 | 68.9 | 76.0 |
| 1968 | 59.8 | 67.1 | 40.2 | 75.2 | 55.3 | 73.6 | 78.6 |
| 1969 | 64.9 | 71.7 | 45.8 | 77.0 | 57.0 | 77.8 | 79.3 |
| 1970 | 67.7 | 73.4 | 50.9 | 77.4 | 59.5 | 79.4 | 77.9 |
| 1971 | 70.9 | 74.4 | 53.0 | 79.2 | 58.9 | 82.5 | 82.5 |
| 1972 | 73.2 | 78.3 | 57.9 | 82.9 | 63.5 | 84.3 | 87.3 |
| 1973 | 77.0 | 82.6 | 63.4 | 90.1 | 69.5 | 88.9 | 91.9 |
| 1974 | 77.5 | 83.9 | 63.0 | 88.6 | 71.8 | 91.5 | 87.8 |
| 1975 | 78.0 | 85.3 | 62.3 | 86.4 | 68.1 | 91.0 | 88.9 |
| 1976 | 83.5 | 93.8 | 69.1 | 90.9 | 77.3 | 91.2 | 94.0 |
| 1977 | 87.6 | 95.2 | 73.5 | 92.4 | 78.6 | 89.1 | 97.4 |
| 1978 | 90.9 | 97.0 | 79.9 | 93.3 | 83.6 | 89.1 | 99.0 |
| 1979 | 95.2 | 100.2 | 85.8 | 93.9 | 90.7 | 84.6 | 98.4 |
| 1980 | 95.9 | 99.2 | 91.7 | 90.4 | 95.3 | 95.1 | 97.3 |
| 1981 | 97.6 | 99.4 | 94.5 | 93.6 | 97.9 | 95.5 | 99.4 |
| **1982** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| 1983 | 102.0 | 104.7 | 106.0 | 108.8 | 105.3 | 105.5 | 108.3 |
| 1984 | 104.0 | 108.1 | 115.0 | 115.7 | 115.8 | 112.6 | 115.8 |
| 1985 | 107.7 | 110.2 | 120.9 | 119.7 | 121.0 | 112.1 | 121.1 |
| 1986 | 109.9 | 108.4 | 121.9 | 124.0 | 125.2 | 112.4 | 125.6 |
| 1987 | 113.5 | 105.9 | 132.0 | 132.5 | 130.9 | 113.0 | 130.7 |
| 1988 | 119.6 | 110.4 | 139.5 | 140.2 | 139.3 | 115.2 | 135.4 |
| 1989 | 124.5 | 114.2 | 146.1 | 145.9 | 143.0 | 116.0 | 137.8 |

NOTE: Index: 1982 = 100.

SOURCE: Bureau of Labor Statistics, unpublished tabulations.

See figure 6-21.

*Science & Engineering Indicators – 1991*

Appendix table 6-34.
**Manufacturers' use and planned use of certain advanced technologies in the United States, Canada, and Australia**

| Technology | United States | | Canada | | Australia | |
|---|---|---|---|---|---|---|
| | In use | Plan to use within 5 years | In use | Plan to use within 5 years | In use | Plan to use within 5 years |
| | Percentage of establishments | | | | | |
| At least one of the 17 advanced technologies | 68.4 | 59.7 | 43.0 | NA | 33.0 | NA |
| **Design and engineering** | | | | | | |
| Computer-aided design (CAD) or computer-aided engineering | 39.0 | 19.6 | 17.0 | 12.0 | 10.0 | 11.0 |
| CAD output used to control manufacturing machines | 16.9 | 21.1 | 7.0 | 10.0 | 4.0 | 7.0 |
| Digital representation of CAD output used in procurement | 9.9 | 17.5 | 4.0 | 8.0 | 4.0 | 6.0 |
| **Fabrication/machining and assembly** | | | | | | |
| Flexible manufacturing cells or systems | 10.7 | 11.5 | 7.0 | 3.0 | 1.0 | 3.0 |
| Numerically controlled or computer numerically controlled machines | 41.4 | 7.9 | 14.0 | 4.0 | 13.0 | 5.0 |
| Materials working lasers | 4.3 | 9.1 | 2.0 | 4.0 | 1.0 | 3.0 |
| Pick and place robots | 7.7 | 12.2 | 3.0 | 4.0 | 2.0 | 4.0 |
| Other robots | 5.7 | 11.2 | 3.0 | 5.0 | 3.0 | 2.0 |
| **Automated material handling** | | | | | | |
| Automatic storage and retrieval systems | 3.2 | 5.8 | 4.0 | 4.0 | 2.0 | 3.0 |
| Automatic guided vehicle systems | 1.5 | 3.8 | 2.0 | 3.0 | 1.0 | 2.0 |
| **Automated sensor-based inspection or testing** | | | | | | |
| Performed on incoming or in-process materials | 10.0 | 11.9 | 9.0 | 7.0 | 3.0 | 3.0 |
| Performed on final product | 12.5 | 12.4 | 8.0 | 6.0 | 4.0 | 3.0 |
| **Communication and control** | | | | | | |
| Local area network (LAN) for technical data | 18.9 | 17.2 | 11.0 | 12.0 | 3.0 | 5.0 |
| LAN for factory use | 16.2 | 19.1 | 9.0 | 12.0 | 5.0 | 7.0 |
| Intercompany computer network linking plant to subcontractors, subcontractors, suppliers, or customers | 14.8 | 20.3 | 10.0 | 11.0 | 3.0 | 5.0 |
| Programmable controllers | 32.1 | 10.7 | 18.0 | 6.0 | 14.0 | 4.0 |
| Computers used for control on factory floor | 27.3 | 22.0 | 12.0 | 13.0 | 7.0 | 8.0 |

NOTES: "Nonuse" is defined as "do not currently use or plan to use in the next 5 years." The U.S. survey included establishments with 20 or more employees selected to represent a universe of almost 40,000 manufacturing establishments classified in Standard Industrial Classification codes 34-38; the Canadian survey covered the use of 22 advanced technologies (the first 17 of which are identical to those included in the U.S. survey) by all manufacturing plants in Canada with 20 or more employees; the Australian survey questioned manufacturers' use of 19 advanced technologies (17 of which are comparable).

SOURCE: Bureau of the Census, *Manufacturing Technology 1988*, SMT(88)-1 (Washington, DC: GPO, 1989); Organisation for Economic Cooperation and Development (OECD), "Survey of Manufacturing Technology in Canada - March 1989," Room Document 6, dist. Nov. 8, 1989; and OECD, "Survey of Manufacturing Technology in Australia," Room Document 15, dist. Nov. 27,1989.

See figure 6-22.

*Science & Engineering Indicators – 1991*

Appendix table 6-35.
**Reasons for manufacturers' nonuse of certain advanced technologies in the United States and Canada**

| Technology | United States | | Canada | |
|---|---|---|---|---|
| | Not applicable | Not cost effective | Not applicable | Not cost effective |
| | Percentage of establishments | | | |
| **Design and engineering** | | | | |
| Computer-aided design (CAD) or computer-aided engineering | 21.6 | 7.7 | 59.0 | 8.0 |
| CAD output used to control manufacturing machines | 34.0 | 13.6 | 70.0 | 9.0 |
| Digital representation of CAD output used in procurement | 40.9 | 14.1 | 73.0 | 9.0 |
| **Fabrication/machining and assembly** | | | | |
| Flexible manufacturing cells or systems | 46.0 | 15.0 | 73.0 | 10.0 |
| Numerically controlled or computer numerically controlled machines | 29.8 | 8.7 | 68.0 | 9.0 |
| Materials working lasers | 53.6 | 16.7 | 79.0 | 10.0 |
| Pick and place robots | 44.4 | 20.6 | 75.0 | 12.0 |
| Other robots | 45.4 | 21.0 | 74.0 | 11.0 |
| **Automated material handling** | | | | |
| Automatic storage and retrieval systems | 46.0 | 30.0 | 72.0 | 15.0 |
| Automatic guided vehicle systems | 51.2 | 28.2 | 74.0 | 15.0 |
| **Automated sensor-based inspection or testing** | | | | |
| Performed on incoming or in-process materials | 41.9 | 21.0 | 67.0 | 10.0 |
| Performed on final product | 40.9 | 19.4 | 68.0 | 10.0 |
| **Communication and control** | | | | |
| Local area network (LAN) for technical data | 36.7 | 10.6 | 64.0 | 6.0 |
| LAN for factory use | 36.9 | 11.3 | 64.0 | 8.0 |
| Intercompany computer network linking plant to subcontractors, subcontractors, suppliers, or customers | 34.0 | 13.9 | 60.0 | 10.0 |
| Programmable controllers | 32.4 | 9.9 | 61.0 | 8.0 |
| Computers used for control on factory floor | 26.1 | 10.9 | 61.0 | 9.0 |

NOTE: "Nonuse" is defined as "do not currently use or plan to use in the next 5 years."

SOURCE: Bureau of the Census, *Manufacturing Technology 1988*, SMT(88)-1 (Washington, DC: GPO, 1989).

*Science & Engineering Indicators – 1991*

Appendix table 6-36.
**Formation of companies in the United States active in certain high-tech fields: 1970-89**

| Period formed | All high-tech fields | Automation | Bio-technology | Computer hardware | Advanced materials | Photonics & optics | Software | Tele-communi-cations |
|---|---|---|---|---|---|---|---|---|
| | | | | Number of companies | | | | |
| Total | 19,097 | 1,754 | 722 | 3,633 | 947 | 1,025 | 6,238 | 1,620 |
| 1970-74 | 3,174 | 366 | 81 | 525 | 208 | 221 | 758 | 281 |
| 1975-79 | 4,984 | 517 | 138 | 969 | 213 | 292 | 1,871 | 411 |
| 1980-84 | 7,217 | 615 | 295 | 1,457 | 309 | 334 | 2,666 | 616 |
| 1985-89 | 3,722 | 256 | 208 | 682 | 217 | 178 | 943 | 312 |
| | | | Percentage of all high-tech companies formed during each period | | | | | |
| 1970-74 | 100.0 | 11.5 | 2.6 | 16.5 | 6.6 | 7.0 | 23.9 | 8.9 |
| 1975-79 | 100.0 | 10.4 | 2.8 | 19.4 | 4.3 | 5.9 | 37.5 | 8.2 |
| 1980-84 | 100.0 | 8.5 | 4.1 | 20.2 | 4.3 | 4.6 | 36.9 | 8.5 |
| 1985-89 | 100.0 | 6.9 | 5.6 | 18.3 | 5.8 | 4.8 | 25.3 | 8.4 |
| | | | Percentage of all high-tech companies formed during 1970-89, by field | | | | | |
| 1970-74 | 16.6 | 20.9 | 11.2 | 14.5 | 22.0 | 21.6 | 12.2 | 17.3 |
| 1975-79 | 26.1 | 29.5 | 19.1 | 26.7 | 22.5 | 28.5 | 30.0 | 25.4 |
| 1980-84 | 37.8 | 35.1 | 40.9 | 40.1 | 32.6 | 32.6 | 42.7 | 38.0 |
| 1985-89 | 19.5 | 14.6 | 28.8 | 18.8 | 22.9 | 17.4 | 15.1 | 19.3 |

NOTE: Beside those fields indicated, other high-tech fields included in the data base are chemicals, defense-related, energy, environmental, manufacturing equipment, medical, pharmaceuticals, subassemblies and components, test and measurement, and transportation.

SOURCE: Derived from the CorpTech data base, Corporate Technology Information Services, Inc., Wellesley Hills, MA (Rev 6.0. 1991).

See figure 6-23.

*Science & Engineering Indicators – 1991*

Appendix table 6-37.
**Companies active in high-tech fields, by state**

| State | All fields | Automation | Bio-technology | Computer hardware | Software | Advanced materials | Photonics & optics | Tele-communi-cations |
|---|---|---|---|---|---|---|---|---|
| | | | | Number of companies | | | | |
| TOTAL | 29,761 | 3,413 | 974 | 4,541 | 7,095 | 2,302 | 1,673 | 2,424 |
| California | 5,453 | 526 | 157 | 1,131 | 1,414 | 211 | 398 | 633 |
| Massachusetts | 2,275 | 256 | 92 | 381 | 576 | 150 | 215 | 220 |
| New York | 2,023 | 241 | 54 | 290 | 474 | 159 | 182 | 196 |
| Pennsylvania | 1,730 | 220 | 55 | 275 | 417 | 213 | 56 | 84 |
| New Jersey | 1,626 | 157 | 81 | 219 | 296 | 198 | 121 | 143 |
| Texas | 1,430 | 91 | 31 | 189 | 387 | 107 | 49 | 117 |
| Connecticut | 1,346 | 182 | 25 | 176 | 261 | 111 | 72 | 90 |
| Illinois | 1,261 | 206 | 32 | 142 | 281 | 111 | 64 | 78 |
| Ohio | 1,188 | 209 | 23 | 125 | 204 | 193 | 47 | 41 |
| Maryland | 1,157 | 93 | 107 | 244 | 292 | 51 | 52 | 118 |
| Kentucky | 910 | 172 | 9 | 49 | 71 | 97 | 11 | 20 |
| Minnesota | 858 | 109 | 27 | 135 | 166 | 66 | 38 | 46 |
| Michigan | 837 | 188 | 20 | 71 | 185 | 95 | 37 | 26 |
| Florida | 722 | 50 | 23 | 109 | 209 | 30 | 51 | 81 |
| Virginia | 695 | 44 | 15 | 156 | 223 | 39 | 28 | 112 |
| All other states | 6,250 | 669 | 223 | 849 | 1,639 | 471 | 252 | 419 |
| | | | | Percent | | | | |
| TOTAL | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| California | 18.3 | 15.4 | 16.1 | 24.9 | 19.9 | 9.2 | 23.8 | 26.1 |
| Massachusetts | 7.6 | 7.5 | 9.4 | 8.4 | 8.1 | 6.5 | 12.9 | 9.1 |
| New York | 6.8 | 7.1 | 5.5 | 6.4 | 6.7 | 6.9 | 10.9 | 8.1 |
| Pennsylvania | 5.8 | 6.4 | 5.6 | 6.1 | 5.9 | 9.3 | 3.3 | 3.5 |
| New Jersey | 5.5 | 4.6 | 8.3 | 4.8 | 4.2 | 8.6 | 7.2 | 5.9 |
| Texas | 4.8 | 2.7 | 3.2 | 4.2 | 5.5 | 4.6 | 2.9 | 4.8 |
| Connecticut | 4.5 | 5.3 | 2.6 | 3.9 | 3.7 | 4.8 | 4.3 | 3.7 |
| Illinois | 4.2 | 6.0 | 3.3 | 3.1 | 4.0 | 4.8 | 3.8 | 3.2 |
| Ohio | 4.0 | 6.1 | 2.4 | 2.8 | 2.9 | 8.4 | 2.8 | 1.7 |
| Maryland | 3.9 | 2.7 | 11.0 | 5.4 | 4.1 | 2.2 | 3.1 | 4.9 |
| Kentucky | 3.1 | 5.0 | 0.9 | 1.1 | 1.0 | 4.2 | 0.7 | 0.8 |
| Minnesota | 2.9 | 3.2 | 2.8 | 3.0 | 2.3 | 2.9 | 2.3 | 1.9 |
| Michigan | 2.8 | 5.5 | 2.1 | 1.6 | 2.6 | 4.1 | 2.2 | 1.1 |
| Florida | 2.4 | 1.5 | 2.4 | 2.4 | 2.9 | 1.3 | 3.0 | 3.3 |
| Virginia | 2.3 | 1.3 | 1.5 | 3.4 | 3.1 | 1.7 | 1.7 | 4.6 |
| All other states | 21.0 | 19.6 | 22.9 | 18.7 | 23.1 | 20.5 | 15.1 | 17.3 |

NOTE: Beside those fields indicated, other high-tech fields included in the data base are chemicals, defense-related, energy, environmental, manufacturing equipment, medical, pharmaceuticals, subassemblies and components, test and measurement, and transportation.

SOURCE: Derived from the CorpTech data base, Corporate Technology Services, Inc., Wellesley Hills, MA (Rev 6.0, 1991).

See figure 6-24. Science & Engineering Indicators – 1991

Appendix table 6-38.
**Ownership of companies active in high-tech fields operating in the United States, by country of ownership: March 1991**

| Country | All fields | Automation | Bio-technology | Computer hardware | Advanced materials | Photonics & optics | Software | Tele-communi-cations |
|---|---|---|---|---|---|---|---|---|
| | | | | Number of companies | | | | |
| Total | 30,919 | 3,413 | 974 | 4,541 | 2,302 | 1,673 | 7,095 | 2,424 |
| United States | 27,412 | 3,066 | 868 | 4,212 | 1,957 | 1,471 | 6,887 | 2,182 |
| Foreign owned | 3,507 | 347 | 106 | 329 | 345 | 202 | 208 | 242 |
| United Kingdom | 813 | 70 | 17 | 56 | 85 | 53 | 73 | 53 |
| Japan | 600 | 66 | 15 | 101 | 42 | 51 | 16 | 66 |
| West Germany | 560 | 79 | 20 | 34 | 82 | 36 | 15 | 17 |
| France | 269 | 26 | 6 | 23 | 40 | 12 | 23 | 24 |
| Switzerland | 242 | 28 | 8 | 17 | 23 | 13 | 16 | 6 |
| Canada | 246 | 20 | 4 | 16 | 18 | 9 | 22 | 27 |
| The Netherlands | 144 | 5 | 8 | 17 | 23 | 11 | 10 | 12 |
| Sweden | 170 | 21 | 8 | 12 | 10 | 5 | 8 | 6 |
| Taiwan | 35 | 0 | 0 | 10 | 0 | 2 | 1 | 6 |
| South Korea | 22 | 1 | 1 | 6 | 1 | 0 | 1 | 3 |
| | | | | Percent | | | | |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| United States | 88.7 | 89.8 | 89.1 | 92.8 | 85.0 | 87.9 | 97.1 | 90.0 |
| Foreign owned | 11.3 | 10.2 | 10.9 | 7.2 | 15.0 | 12.1 | 2.9 | 10.0 |
| United Kingdom | 2.6 | 2.1 | 1.7 | 1.2 | 3.7 | 3.2 | 1.0 | 2.2 |
| Japan | 1.9 | 1.9 | 1.5 | 2.2 | 1.8 | 3.0 | 0.2 | 2.7 |
| West Germany | 1.8 | 2.3 | 2.1 | 0.7 | 3.6 | 2.2 | 0.2 | 0.7 |
| France | 0.9 | 0.8 | 0.6 | 0.5 | 1.7 | 0.7 | 0.3 | 1.0 |
| Switzerland | 0.8 | 0.8 | 0.8 | 0.4 | 1.0 | 0.8 | 0.2 | 0.2 |
| Canada | 0.8 | 0.6 | 0.4 | 0.4 | 0.8 | 0.5 | 0.3 | 1.1 |
| The Netherlands | 0.5 | 0.1 | 0.8 | 0.4 | 1.0 | 0.7 | 0.1 | 0.5 |
| Sweden | 0.5 | 0.6 | 0.8 | 0.3 | 0.4 | 0.3 | 0.1 | 0.2 |
| Taiwan | 0.1 | * | * | 0.2 | * | 0.1 | * | 0.2 |
| South Korea | 0.1 | * | 0.1 | 0.1 | * | * | * | 0.1 |

* = less than 0.05 percent

SOURCE: Derived from the CorpTech data base, Corporate Technology Information Services, Inc., Wellesley Hills, MA (Rev 6.0, March 1991).

*Science & Engineering Indicators – 1991*

Appendix table 6-39.
**Source of capital for newly formed high-tech companies**

| Technology field | Corporate investment only | Private investment only | Venture capital only | Corporate & private investment | Corporate investment & venture capital | Private investment & venture capital | Corporate, private, & venture capital |
|---|---|---|---|---|---|---|---|
| | | | | Percentage of companies receiving source of capital | | | |
| Automation | 2.5 | 77.5 | 2.5 | 2.5 | 0.6 | 10.0 | 4.4 |
| Biotechnology | 2.7 | 63.7 | 3.5 | 10.6 | 0.9 | 9.7 | 8.8 |
| Computer hardware | 2.4 | 73.7 | 6.8 | 4.6 | 2.4 | 6.8 | 3.2 |
| Computer software | 3.0 | 76.9 | 5.2 | 2.6 | 1.1 | 7.7 | 3.4 |
| Advanced materials | 1.2 | 78.8 | 4.7 | 1.2 | 2.4 | 9.4 | 2.4 |
| Photonics & optics | 3.1 | 73.5 | 5.1 | 5.1 | 1.0 | 10.2 | 2.0 |
| Telecommunications | 3.2 | 59.7 | 8.1 | 2.2 | 1.6 | 19.9 | 5.4 |
| Weighted average | 2.8 | 74.1 | 5.9 | 4.8 | 1.7 | 10.8 | 4.4 |

NOTE: Private companies formed during 1980-89.

SOURCE: Derived from the CorpTech data base, Corporate Technology Information Services, Inc., Wellesley Hills, MA (Rev 6.0, 1991).

See figure 6-25.

*Science & Engineering Indicators – 1991*

Appendix table 7-1.
**Interest in selected issues**

| Issue area | Degree of interest | 1979 | 1981 | 1983 | 1985 | 1988 | 1990 |
|---|---|---|---|---|---|---|---|
| | | | | Percent | | | |
| **International and foreign policy** | Very | 24 | 35 | 30 | 33 | 33 | 48 |
| | Moderately | 53 | 47 | 47 | 51 | 51 | 40 |
| | Not at all | 22 | 18 | 22 | 16 | 16 | 13 |
| **New scientific discoveries** | Very | 36 | 37 | 48 | 44 | 43 | 39 |
| | Moderately | 49 | 45 | 41 | 44 | 46 | 49 |
| | Not at all | 15 | 17 | 11 | 13 | 12 | 12 |
| **Economic issues and business conditions** | Very | 35 | 52 | 57 | 48 | 48 | 51 |
| | Moderately | 48 | 37 | 33 | 41 | 42 | 40 |
| | Not at all | 17 | 10 | 10 | 11 | 10 | 10 |
| **Use of new inventions and technologies** | Very | 33 | 33 | 42 | 39 | 40 | 39 |
| | Moderately | 51 | 51 | 45 | 49 | 49 | 49 |
| | Not at all | 15 | 16 | 12 | 12 | 12 | 12 |
| **Space exploration** | Very | NA | 25 | 27 | 29 | 34 | 26 |
| | Moderately | NA | 44 | 45 | 46 | 47 | 48 |
| | Not at all | NA | 31 | 28 | 25 | 22 | 26 |
| **New medical discoveries** | Very | NA | NA | NA | 68 | 72 | 68 |
| | Moderately | NA | NA | NA | 29 | 25 | 29 |
| | Not at all | NA | NA | NA | 3 | 3 | 3 |
| **Military and defense policy** | Very | NA | NA | 43 | 47 | 47 | 55 |
| | Moderately | NA | NA | 42 | 42 | 42 | 35 |
| | Not at all | NA | NA | 15 | 11 | 11 | 10 |
| **Nuclear power issues** | Very | NA | NA | NA | NA | NA | 42 |
| | Moderately | NA | NA | NA | NA | NA | 46 |
| | Not at all | NA | NA | NA | NA | NA | 14 |
| **Environmental pollution** | Very | NA | NA | NA | NA | NA | 64 |
| | Moderately | NA | NA | NA | NA | NA | 31 |
| | Not at all | NA | NA | NA | NA | NA | 5 |

*"There are a lot of issues in the news and it is hard to keep up with every area. I'm going to read you a short list of issues and for each one—as I read it—I would like you to tell me if you are very interested, moderately interested, or not at all interested.*

*"Now, I'd like to go through this list with you again and for each issue I'd like you to tell me if you are very well-informed, moderately well-informed, or poorly informed."*

NA = not asked

NOTE: Percentages may not total 100 because of rounding.

SOURCE: J.D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991).

See figures 7-1 and 7-18. *Science & Engineering Indicators – 1991*

Appendix table 7-2.
**Knowledge about selected issues**

| Issue area | Degree of knowledge | 1979 | 1981 | 1983 | 1985 | 1988 | 1990 |
|---|---|---|---|---|---|---|---|
| | | Percent | | | | | |
| | Very well-informed | 9 | 17 | 14 | 15 | 14 | 22 |
| **International and foreign policy** | Moderately well-informed | 54 | 55 | 51 | 53 | 55 | 57 |
| | Not at all informed | 37 | 28 | 35 | 32 | 31 | 22 |
| | Very well-informed | 10 | 13 | 13 | 13 | 14 | 14 |
| **New scientific discoveries** | Moderately well-informed | 52 | 49 | 53 | 59 | 55 | 55 |
| | Not at all informed | 37 | 38 | 34 | 27 | 31 | 31 |
| | Very well-informed | 14 | 29 | 27 | 23 | 23 | 25 |
| **Economic issues and business** | Moderately well-informed | 55 | 51 | 52 | 51 | 55 | 54 |
| **conditions** | Not at all informed | 31 | 20 | 20 | 26 | 22 | 20 |
| | Very well-informed | 10 | 11 | 14 | 13 | 13 | 11 |
| **Use of new inventions and** | Moderately well-informed | 50 | 48 | 55 | 54 | 51 | 53 |
| **technologies** | Not at all informed | 40 | 40 | 32 | 34 | 36 | 35 |
| | Very well-informed | NA | 14 | 13 | 16 | 13 | 11 |
| **Space exploration** | Moderately well-informed | NA | 46 | 53 | 52 | 53 | 51 |
| | Not at all informed | NA | 40 | 34 | 32 | 34 | 38 |
| | Very well-informed | NA | NA | NA | 25 | 22 | 24 |
| **New medical discoveries** | Moderately well-informed | NA | NA | NA | 57 | 59 | 57 |
| | Not at all informed | NA | NA | NA | 18 | 19 | 20 |
| | Very well-informed | NA | NA | 21 | 21 | 17 | 26 |
| **Military and defense policy** | Moderately well-informed | NA | NA | 50 | 48 | 51 | 51 |
| | Not at all informed | NA | NA | 29 | 31 | 32 | 23 |
| | Very well-informed | NA | NA | NA | NA | NA | 12 |
| **Nuclear power issues** | Moderately well-informed | NA | NA | NA | NA | NA | 50 |
| | Not at all informed | NA | NA | NA | NA | NA | 38 |
| | Very well-informed | NA | NA | NA | NA | NA | 32 |
| **Environmental pollution** | Moderately well-informed | NA | NA | NA | NA | NA | 55 |
| | Not at all informed | NA | NA | NA | NA | NA | 13 |

*"There are a lot of issues in the news and it is hard to keep up with every area. I'm going to read you a short list of issues and for each one—as I read it—I would like you to tell me if you are very interested, moderately interested, or not at all interested.*

*"Now, I'd like to go through this list with you again and for each issue I'd like you to tell me if you are very well-informed, moderately well-informed or poorly informed."*

NA = not asked

NOTE: Percentages may not total 100 because of rounding.

SOURCE: J.D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991).

See figures 7-1 and 7-18.

Appendix table 7-3.
**Media use: 1990**

| | TV news viewership[a] | | | Newspaper readership[b] | | | | Newsmagazine readership[c] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Regularly | Occasionally | Not at all | Every day | A few times a week | Once a week | Less than once a week | Regularly | Occasionally | Never | N |
| | | | | | Percent | | | | | | |
| Total public | 75 | 22 | 4 | 57 | 24 | 8 | 10 | 23 | 13 | 64 | 2,033 |
| **Gender** | | | | | | | | | | | |
| Male | 76 | 21 | 4 | 63 | 22 | 6 | 9 | 25 | 16 | 60 | 964 |
| Female | 74 | 23 | 3 | 52 | 26 | 10 | 11 | 21 | 12 | 68 | 1,070 |
| **Degree level** | | | | | | | | | | | |
| No high school degree | 77 | 19 | 4 | 53 | 20 | 10 | 17 | 10 | 9 | 81 | 495 |
| High school graduate[d] | 73 | 24 | 3 | 55 | 27 | 8 | 9 | 24 | 14 | 63 | 1,179 |
| College graduate | 75 | 20 | 5 | 70 | 19 | 7 | 4 | 38 | 17 | 45 | 359 |
| **Science & math education**[e] | | | | | | | | | | | |
| Low | 73 | 23 | 3 | 54 | 23 | 10 | 13 | 16 | 11 | 74 | 1,263 |
| Medium | 76 | 20 | 3 | 59 | 29 | 6 | 7 | 32 | 15 | 53 | 523 |
| High | 76 | 19 | 5 | 70 | 22 | 5 | 4 | 40 | 25 | 36 | 248 |
| **Age** | | | | | | | | | | | |
| 18-24 | 64 | 34 | 2 | 32 | 43 | 11 | 15 | 20 | 16 | 63 | 322 |
| 25-34 | 67 | 29 | 4 | 44 | 29 | 16 | 11 | 20 | 16 | 64 | 497 |
| 35-44 | 73 | 23 | 4 | 60 | 26 | 5 | 10 | 26 | 15 | 59 | 366 |
| 45-64 | 81 | 15 | 4 | 71 | 16 | 4 | 9 | 28 | 11 | 61 | 533 |
| 65 and older | 87 | 10 | 3 | 78 | 10 | 4 | 8 | 19 | 7 | 74 | 315 |
| **Residence** | | | | | | | | | | | |
| Incorporated city | 75 | 22 | 3 | 59 | 24 | 8 | 9 | 23 | 15 | 63 | 1,640 |
| Unincorporated area | 73 | 22 | 5 | 51 | 24 | 10 | 15 | 23 | 8 | 69 | 392 |

[a] *Now, I'd like to read you a short list of television shows and ask you to tell me whether you watch each show regularly—that is, most of the time— occasionally, or not at all. A morning television news show? An evening television news show? A late night television news show?*

[b] *How often do you read a newspaper: every day, a few times a week, once a week, or less than once a week?*

[c] *Are there any magazines that you read regularly, that is, most of the time? Are there any other magazines that you read occasionally?"*

NOTE: Percentages may not total 100 because of rounding.

[d] Includes respondents with associate degrees.

[e] For an explanation of the education index, see chapter 7, "The Science and Mathematics Education Index," p. 172.

SOURCE: J.D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991).

See figures 7-2 and 7-3.

*Science & Engineering Indicators – 1991*

Appendix table 7-4.
**Informal science education: 1990**

| | Science television viewership | | | Science magazine readership | | | Annual science museum visits | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Regularly | Occasionally | Not at all | Regularly | Occasionally | Not at all | Two or more | One | None | *N* |
| | | | | | Percent | | | | | |
| Total public | 22 | 58 | 21 | 11 | 15 | 74 | 42 | 17 | 41 | 2,033 |
| **Gender** | | | | | | | | | | |
| Male | 24 | 58 | 18 | 13 | 21 | 66 | 43 | 16 | 41 | 964 |
| Female | 20 | 57 | 23 | 9 | 10 | 81 | 42 | 18 | 40 | 1,070 |
| **Degree level** | | | | | | | | | | |
| No high school degree | 20 | 54 | 26 | 6 | 7 | 87 | 20 | 11 | 70 | 495 |
| High school graduate' | 24 | 57 | 19 | 10 | 18 | 72 | 45 | 21 | 34 | 1,179 |
| College graduate | 19 | 63 | 18 | 18 | 20 | 62 | 64 | 14 | 22 | 359 |
| **Science & math education** | | | | | | | | | | |
| Low | 21 | 57 | 22 | 7 | 12 | 81 | 32 | 17 | 51 | 1,263 |
| Medium | 22 | 60 | 19 | 16 | 19 | 65 | 56 | 18 | 26 | 523 |
| High | 26 | 57 | 17 | 20 | 25 | 56 | 67 | 15 | 19 | 248 |
| **Age** | | | | | | | | | | |
| 18-24 | 15 | 61 | 24 | 9 | 19 | 73 | 56 | 24 | 20 | 322 |
| 25-34 | 20 | 56 | 24 | 11 | 16 | 73 | 53 | 17 | 29 | 497 |
| 35-44 | 22 | 62 | 16 | 11 | 20 | 70 | 50 | 18 | 33 | 366 |
| 45-64 | 25 | 59 | 15 | 13 | 13 | 74 | 32 | 17 | 51 | 533 |
| 65 and older | 26 | 49 | 26 | 9 | 9 | 81 | 19 | 10 | 71 | 315 |
| **Residence** | | | | | | | | | | |
| Incorporated city | 22 | 58 | 20 | 11 | 17 | 73 | 45 | 17 | 38 | 1,640 |
| Unincorporated area | 21 | 55 | 25 | 10 | 11 | 79 | 32 | 18 | 50 | 392 |

*I'd like to read you a short list of television shows and ask you to tell me whether you watch each show regularly—that is, most of the time—occasionally, or not at all. Nova? National Geographic specials?*

*Are there any magazines that you read regularly, that is, most of the time? Are there any other magazines that you read occasionally?*

*"Let me ask you about your use of museums, zoos, and similar institutions. I am going to read you a short list of places and ask you to tell me how many times you visited each type of place during the last year, that is, the last 12 months. A science or technology museum? A zoo or aquarium? A natural history museum?"*

NOTE: Percentages may not total 100 because of rounding.

Includes respondents with associate degrees.

For an explanation of the education index, see chapter 7, "The Science and Mathematics Education Index," p. 172.

SOURCE: J.D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991) and unpublished tabulations.

See figures 7-2 and 7-3.

Appendix table 7-5.
**Understanding of scientific concepts: 1990**

| | Scientific study | Probability | Controlled study | N |
|---|---|---|---|---|
| | | Percent | | |
| Total public | 18 | 70 | 72 | 2,033 |
| **Gender** | | | | |
| Male | 19 | 69 | 74 | 964 |
| Female | 17 | 71 | 70 | 1,070 |
| **Degree level** | | | | |
| No high school degree | 5 | 55 | 51 | 495 |
| High school graduate[1] | 16 | 72 | 75 | 1,179 |
| College graduate | 43 | 82 | 88 | 359 |
| **Science & math education**[2] | | | | |
| Low | 9 | 63 | 66 | 1,263 |
| Medium | 26 | 79 | 79 | 523 |
| High | 44 | 83 | 85 | 248 |
| **Age** | | | | |
| 18-24 | 22 | 79 | 64 | 322 |
| 25-34 | 21 | 77 | 73 | 497 |
| 35-44 | 24 | 76 | 79 | 366 |
| 45-64 | 15 | 67 | 77 | 533 |
| 65 and older | 7 | 45 | 62 | 315 |
| **Attentive publics** | | | | |
| New scientific discoveries | 25 | 78 | 75 | 168 |
| New technologies | 22 | 81 | 77 | 148 |
| Nuclear energy | 19 | 70 | 72 | 157 |
| Medical discoveries | 15 | 70 | 72 | 323 |
| Space exploration | 28 | 81 | 82 | 123 |
| Environmental pollution | 22 | 74 | 76 | 412 |

"*In your own words, could you tell me what it means to study something scientifically?*

"*Now, think about this situation. A doctor tells a couple that their genetic makeup means that they've got one in four chances of having a child with an inherited illness. Does this mean that if their first three children are healthy, the fourth will have the illness? Does this mean that if their first child has the illness, the next three will not? Does this mean that each of the couple's children will have the same risk of suffering from the illness? Does this mean that if they have only three children, none will have the illness?*

"*Now, think about this problem. Suppose a drug used to treat high blood pressure is suspected of having no effect. There are three different ways scientists might use to investigate this problem. First, they could talk to those patients who have used the drug to get their opinion. Second, they could use their own knowledge of medicine to decide how good the drug is. Third, they could give the drug to some patients but not to others, then compare the results for each group. Which of these three ways do you think that scientists would be most likely to use?*"

[1] Includes respondents with associate degrees.

[2] For an explanation of the education index, see chapter 7, "The Science and Mathematics Education Index," p. 172.

SOURCES: J.D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991); and unpublished tabulations.

*Science & Engineering Indicators – 1991*

Appendix table 7-6.
**Understanding of environmental concepts: 1990**

| | Acid rain | | | Ozone hole | | | |
|---|---|---|---|---|---|---|---|
| | Understand term | Know cause/ source | Identify with pollution | Understand term | Identify with pollution | Know location | *N* |
| | Percent | | | | | | |
| Total public | 6 | 10 | 31 | 25 | 18 | 11 | 2,033 |
| **Gender** | | | | | | | |
| Male | 9 | 15 | 33 | 32 | 18 | 17 | 964 |
| Female | 3 | 5 | 29 | 19 | 17 | 5 | 1,070 |
| **Degree level** | | | | | | | |
| No high school degree | * | 7 | 20 | 8 | 10 | 3 | 495 |
| High school graduate[1] | 6 | 9 | 33 | 27 | 19 | 10 | 1,179 |
| College graduate | 13 | 16 | 38 | 39 | 24 | 22 | 359 |
| **Science & math education**[2] | | | | | | | |
| Low | 3 | 7 | 27 | 17 | 15 | 6 | 1,263 |
| Medium | 8 | 13 | 36 | 33 | 21 | 13 | 523 |
| High | 16 | 18 | 41 | 46 | 25 | 29 | 243 |
| **Age** | | | | | | | |
| 18-24 | 4 | 5 | 38 | 31 | 21 | 11 | 322 |
| 25-34 | 5 | 7 | 29 | 29 | 17 | 13 | 497 |
| 35-44 | 8 | 11 | 34 | 30 | 20 | 13 | 366 |
| 45-64 | 2 | 12 | 28 | 22 | 18 | 9 | 533 |
| 65 and older | 3 | 11 | 25 | 10 | 11 | 8 | 315 |
| **Attentive publics** | | | | | | | |
| New scientific discoveries | 11 | 18 | 34 | 37 | 30 | 24 | 168 |
| New technologies | 11 | 19 | 33 | 41 | 23 | 26 | 148 |
| Nuclear energy | 13 | 20 | 32 | 37 | 20 | 14 | 157 |
| Medical discoveries | 7 | 11 | 33 | 27 | 22 | 10 | 323 |
| Space exploration | 15 | 21 | 31 | 49 | 23 | 30 | 123 |
| Environmental pollution | 10 | 13 | 36 | 33 | 22 | 17 | 412 |

*"When you read or hear the term 'acid rain,' do you have a clear understanding of what it means, a general sense of what it means, or little understanding of what it means? What is the primary cause of acid rain?*

*"Recently, there have been news reports that scientists have discovered a hole in the ozone layer. Have you personally read or heard about the hole in the ozone layer? In regard to the issue about the hole in the ozone layer, would you say that you have a clear understanding of the issue, a general sense of it, or little understanding of it? Please tell me, in your own words, why is there a hole in the ozone layer? Do you know where the hole is located? Where is it located?"*

* = less than 0.5 percent

[1]Includes respondents with associate degrees.

[2]For an explanation of the education index, see chapter 7, "The Science and Mathematics Education Index," p. 172.

SOURCES: J.D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990. Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991); and unpublished tabulations.

*Science & Engineering Indicators – 1991*

Appendix table 7-7.
**Public attitudes toward science and technology**
(page 1 of 2)

| | | 1957 | 1979 | 1983 | 1985 | 1988 | 1990 |
|---|---|---|---|---|---|---|---|
| | | Percent | | | | | |
| A. "Science and technology are making our lives healthier, easier, and more comfortable."[1] | Agree | 94 | 81 | 85 | 86 | 85 | 84 |
| | Disagree | 3 | 16 | 12 | 11 | 13 | 13 |
| | Don't know/no answer | 3 | 3 | 3 | 2 | 2 | 3 |
| B. "The quality of science and mathematics education in American schools is inadequate." | Agree | NA | NA | NA | 63 | 67 | 72 |
| | Disagree | NA | NA | NA | 29 | 25 | 24 |
| | Don't know/no answer | NA | NA | NA | 8 | 7 | 4 |
| C. "On balance, computers and factory automation will create more jobs than they will eliminate." | Agree | NA | NA | 39 | 48 | 40 | 39 |
| | Disagree | NA | NA | 55 | 44 | 52 | 53 |
| | Don't know/no answer | NA | NA | 6 | 8 | 8 | 8 |
| D. "If scientific knowledge is explained clearly, most people will be able to understand it." | Agree | NA | NA | NA | 65 | 72 | 73 |
| | Disagree | NA | NA | NA | 33 | 27 | 25 |
| | Don't know/no answer | NA | NA | NA | 2 | 1 | 2 |
| E. "We depend too much on science and not enough on faith."[2] | Agree | 50 | NA | 51 | 57 | 51 | 51 |
| | Disagree | 21 | NA | 46 | 39 | 43 | 44 |
| | Neither | 13 | NA | NA | NA | NA | NA |
| | Don't know/no answer | 16 | NA | 4 | 5 | 6 | 5 |
| F. "Even if it brings no immediate benefits, scientific research which advances the frontiers of knowledge is necessary and should be supported by the Federal Government." | Agree | NA | NA | NA | 79 | 81 | 80 |
| | Disagree | NA | NA | NA | 16 | 15 | 16 |
| | Don't know/no answer | NA | NA | NA | 5 | 4 | 4 |
| G. "One of the bad effects of science is that it breaks down people's ideas of right and wrong."[3] | Agree | 23 | 37 | 30 | 37 | 33 | 34 |
| | Disagree | 67 | 56 | 63 | 57 | 61 | 59 |
| | Don't know/no answer | 10 | 7 | 7 | 7 | 6 | 7 |
| H. "Scientists should be allowed to do research that causes pain and injury to animals like dogs and chimpanzees if it produces new information about human health problems."[4] | Agree | NA | NA | NA | 63 | 53 | 50 |
| | Disagree | NA | NA | NA | 30 | 42 | 44 |
| | Don't know/no answer | NA | NA | NA | 7 | 5 | 6 |
| I. "It is not important for me to know about science in my daily life." | Agree | NA | NA | NA | NA | 14 | 14 |
| | Disagree | NA | NA | NA | NA | 84 | 86 |
| | Don't know/no answer | NA | NA | NA | NA | 1 | 1 |
| J. "Some numbers are especially lucky for some people." | Agree | NA | NA | NA | 43 | 37 | 36 |
| | Disagree | NA | NA | NA | 53 | 59 | 60 |
| | Don't know/no answer | NA | NA | NA | 4 | 5 | 4 |
| K. "Science makes our way of life change too fast."[5] | Agree | 43 | 44 | 46 | 44 | 40 | 37 |
| | Disagree | 51 | 53 | 52 | 53 | 59 | 60 |
| | Don't know/no answer | 6 | 3 | 2 | 3 | 2 | 3 |
| L. "Most scientists want to work on things that will make life better for the average person." | Agree | 90 | NA | NA | 80 | 80 | 80 |
| | Disagree | 5 | NA | NA | 16 | 17 | 16 |
| | Don't know/no answer | 5 | NA | NA | 4 | 3 | 4 |
| M. "Rocket launchings and other space activities have caused changes in our weather." | Agree | NA | NA | NA | 44 | NA | 39 |
| | Disagree | NA | NA | NA | 44 | NA | 47 |
| | Don't know/no answer | NA | NA | NA | 12 | NA | 14 |
| N. "It is not wise to plan ahead because many things turn out to be a matter of good or bad luck anyway." | Agree | NA | NA | NA | 24 | NA | 19 |
| | Disagree | NA | NA | NA | 74 | NA | 80 |
| | Don't know/no answer | NA | NA | NA | 2 | NA | 1 |

(continued)

Appendix table 7-7.
**Public attitudes toward science and technology**
(page 2 of 2)

| | | 1957 | 1979 | 1983 | 1985 | 1988 | 1990 |
|---|---|---|---|---|---|---|---|
| | | Percent | | | | | |
| O. "New inventions will always be found to counteract any harmful consequences of technological development." | Agree | NA | NA | NA | 47 | NA | 37 |
| | Disagree | NA | NA | NA | 45 | NA | 56 |
| | Don't know/no answer | NA | NA | NA | 8 | NA | 7 |
| P. "Every high school student in the United States should be required to take a science course every year." | Agree | NA | NA | NA | 69 | NA | 73 |
| | Disagree | NA | NA | NA | 28 | NA | 25 |
| | Don't know/no answer | NA | NA | NA | 3 | NA | 2 |
| Q. "Every high school student in the United States should be required to take a math course every year." | Agree | NA | NA | NA | 87 | NA | 87 |
| | Disagree | NA | NA | NA | 12 | NA | 12 |
| | Don't know/no answer | NA | NA | NA | 1 | NA | * |
| | N = | 1,919 | 1,635 | 1,631 | 2,005 | 2,041 | 2,033 |

NA = not asked; * = less than 0.5 percent

NOTE: Percentages may not total 100 because of rounding.

[1]1957 and 1983 wording: *"Science is making . . ."*; 1979 wording: *"Scientific discoveries are making . . ."*

[2]1957 wording: *"It has been said that we depend too much on science and not enough on faith. How do you personally feel about that statement?"* This was an open-ended question, coded by the interviewing organization. Those who responded that we should rely more on faith were coded as agreeing; those who said we should rely more on science were coded as disagreeing; those who thought we should rely on both or who saw no conflict were listed as "neither."

[3]1979 wording: *"Scientific discoveries tend to break down people's ideas of right and wrong."*

[4]1985 wording: *"Studies (should be permitted) that cause pain and injury to animals like dogs and chimpanzees, but which produce new information about human disease or health problems."*

[5]1957, 1983, and 1985 wording: *"One trouble with science is that it . . ."*; *1979 wording: "Scientific discoveries make our lives change too fast."*

SOURCES: Survey Research Center, *The Public Impact of Science in the Mass Media: A Report on ation-Wide Survey for the National Association of Science Writers* (Ann Arbor, MI: Institute for Social Research, University of Michigan, 1958); and J Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991).

See figures 7-5, 7-14, 7-15, 7-16, and 7-17, and figures O-24 and O-25 in Overview. *Science & Engineering Indicators – 1991*

Appendix table 7-8.
**Public assessments of scientific research**

| | | Beneficial | | | Harmful | | | |
|---|---|---|---|---|---|---|---|---|
| | | Strongly | Only slightly | About equal' | Only slightly | Strongly | Don't know/ no answer | *N* |
| | | | | Percent | | | | |
| **Total public** | 1979 | 46 | 23 | 13 | 6 | 4 | 8 | 1,635 |
| | 1981 | 42 | 28 | 12 | 12 | 5 | 1 | 1,536 |
| | 1985 | 44 | 24 | 4 | 13 | 6 | 9 | 2,005 |
| | 1988 | 53 | 22 | 5 | 8 | 4 | 8 | 1,042 |
| | 1990 | 47 | 23 | 7 | 10 | 3 | 10 | 2,033 |
| **Male** | 1979 | 51 | 22 | 10 | 6 | 3 | 7 | 773 |
| | 1981 | 48 | 27 | 10 | 10 | 5 | 1 | 724 |
| | 1985 | 48 | 22 | 4 | 13 | 6 | 7 | 950 |
| | 1988 | 56 | 22 | 5 | 7 | 4 | 6 | 498 |
| | 1990 | 54 | 23 | 5 | 9 | 4 | 5 | 964 |
| **Female** | 1979 | 42 | 24 | 17 | 6 | 4 | 8 | 862 |
| | 1981 | 37 | 28 | 14 | 14 | 5 | 2 | 812 |
| | 1985 | 40 | 25 | 5 | 14 | 6 | 10 | 1,054 |
| | 1988 | 51 | 21 | 5 | 9 | 4 | 10 | 544 |
| | 1990 | 40 | 23 | 9 | 11 | 3 | 14 | 1,070 |
| **Less than high school graduate** | 1979 | 26 | 23 | 17 | 10 | 6 | 19 | 465 |
| | 1981 | 26 | 23 | 23 | 18 | 9 | 2 | 385 |
| | 1985 | 20 | 21 | 8 | 19 | 13 | 19 | 507 |
| | 1988 | 33 | 24 | 8 | 15 | 6 | 14 | 293 |
| | 1990 | 24 | 23 | 11 | 16 | 4 | 22 | 495 |
| **High school graduate or some college** | 1979 | 50 | 25 | 12 | 5 | 3 | 3 | 932 |
| | 1981 | 43 | 31 | 9 | 12 | 4 | 1 | 886 |
| | 1985 | 47 | 25 | 4 | 13 | 4 | 7 | 1,143 |
| | 1988 | 56 | 23 | 4 | 6 | 4 | 7 | 574 |
| | 1990 | 49 | 25 | 6 | 10 | 3 | 7 | 1,179 |
| **College graduate** | 1979 | 69 | 17 | 8 | 2 | 3 | 1 | 238 |
| | 1981 | 64 | 22 | 7 | 4 | 2 | * | 264 |
| | 1985 | 67 | 22 | 2 | 6 | 2 | 1 | 349 |
| | 1988 | 79 | 14 | 1 | 2 | 1 | 3 | 175 |
| | 1990 | 70 | 18 | 3 | 3 | 1 | 5 | 359 |
| **Attentive public for new scientific discoveries** | 1988 | 60 | 26 | 4 | 5 | 3 | * | 81 |
| | 1990 | 61 | 19 | 1 | 5 | 3 | 11 | 168 |

*"People have frequently noted that scientific research has produced both beneficial and harmful consequences. Would you say that, on balance, the benefits of scientific research have outweighed the harmful results, or have the harmful results of scientific research been greater than its benefits?*

*"Would you say that the balance has been strongly in favor of beneficial results, or only slightly? Would you say that the balance has been strongly in favor of harmful results, or only slightly?"*

* = less than 0.5 percent

' Offered as a response category for the first time in 1990; in prior years, volunteered by respondent.

SOURCES: J.D Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991) ; and unpublished tabulations.

See figure 7-6 and text table 7-3.

Appendix table 7-9.
**Public confidence in people running various institutions: 1973-90**

| Institution | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1980 | 1982 | 1983 | 1984 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Percent | | | | | | | |
| Medicine | 54 | 60 | 50 | 54 | 51 | 46 | 52 | 45 | 51 | 50 | 46 | 52 | 51 | 46 | 46 |
| Scientific community | 37 | 45 | 38 | 43 | 41 | 36 | 41 | 38 | 41 | 44 | 39 | 45 | 39 | 40 | 37 |
| U.S. Supreme Court | 31 | 33 | 31 | 35 | 35 | 28 | 25 | 30 | 28 | 33 | 30 | 36 | 35 | 34 | 35 |
| Military | 32 | 40 | 35 | 39 | 36 | 29 | 28 | 31 | 29 | 36 | 31 | 34 | 34 | 32 | 33 |
| Education | 37 | 49 | 31 | 37 | 41 | 28 | 30 | 33 | 29 | 28 | 28 | 35 | 29 | 30 | 27 |
| Major companies | 29 | 31 | 19 | 22 | 27 | 22 | 27 | 23 | 24 | 30 | 24 | 30 | 25 | 24 | 25 |
| Organized religion | 35 | 44 | 24 | 30 | 40 | 31 | 35 | 32 | 28 | 31 | 25 | 29 | 20 | 22 | 23 |
| Press | 23 | 26 | 24 | 28 | 25 | 20 | 22 | 18 | 13 | 17 | 18 | 18 | 18 | 17 | 15 |
| Average | 35 | 41 | 31 | 36 | 37 | 30 | 33 | 31 | 30 | 34 | 30 | 35 | 31 | 31 | 30 |
| *N* = | 1,504 | 1,484 | 1,490 | 1,499 | 1,530 | 1,532 | 1,468 | 1,506 | 1,599 | 989 | 1,470 | 1,466 | 997 | 1.035 | 899 |

*"I am going to name some institutions in this country. As far as the people running these institutions are concerned, would you say you have a great deal of confidence, only some confidence, or hardly any confidence at all in them?"*

NOTE: Survey was not conducted in 1979 and 1981, and question was not asked in 1985.

SOURCE: National Opinion Research Center, *General Social Surveys, Cumulative Codebook*. J.A. Davis and T.W. Smith, principal investigators (Chicago: University of Chicago, annual series).

See figure 7-7.

*Science & Engineering Indicators – 1991*

Appendix table 7-10.
**Assessments of genetic engineering research: 1985 and 1990**

| | | Benefits exceed risks | | | Risks exceed benefits | | | |
|---|---|---|---|---|---|---|---|---|
| | | Substantially | Only slightly | About equal[1] | Substantially | Only slightly | Don't know/ refused to answer | *N* |
| | | Percent | | | | | | |
| **Total public** | 1985 . . . | 23 | 26 | 2 | 14 | 25 | 12 | 2,005 |
| | 1990 . . . | 20 | 26 | 5 | 18 | 18 | 13 | 2,033 |
| **Male** | 1985 . . . | 26 | 27 | 2 | 12 | 22 | 11 | 950 |
| | 1990 . . . | 21 | 30 | 6 | 16 | 16 | 11 | 964 |
| **Female** | 1985 . . . | 19 | 24 | 2 | 14 | 27 | 15 | 1,054 |
| | 1990 . . . | 19 | 22 | 4 | 20 | 20 | 14 | 1,070 |
| **Less than high school graduate** | 1985 . . . | 19 | 28 | 1 | 12 | 23 | 17 | 507 |
| | 1990 . . . | 16 | 26 | 7 | 16 | 15 | 20 | 495 |
| **High school graduate or some college** | 1985 . . . | 21 | 23 | 2 | 14 | 27 | 13 | 1,143 |
| | 1990 . . . | 19 | 26 | 4 | 20 | 21 | 10 | 1,179 |
| **College graduate** | 1985 . . . | 32 | 29 | 2 | 12 | 18 | 8 | 349 |
| | 1990 . . . | 29 | 25 | 5 | 15 | 14 | 12 | 359 |
| **Attentive public for new scientific discoveries** | 1990 . . . | 35 | 28 | 5 | 12 | 13 | 7 | 168 |
| **Attentive public for medical discoveries** | 1990 . . . | 31 | 25 | 3 | 16 | 13 | 12 | 323 |

*"Some persons have argued that the creation of new life forms through genetic engineering research constitutes a serious risk, while other persons have argued that this research may yield major benefits for society. In your opinion, are the risks of genetic engineering research greater than the benefits, or are the benefits greater than the risks? Would you say that the benefits have substantially exceeded the risks, or only slightly exceeded the risks? Would you say that the risks have substantially exceeded the benefits, or only slightly exceeded the benefits?"*

NOTE: Percentages may not total 100 because of rounding.

[1]Offered as a response category for the first time in 1990; in prior years, volunteered by respondent.

SOURCES: J.D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991); and unpublished tabulations.

See figure 7-8.

*Science & Engineering Indicators – 1991*

Appendix table 7-11.
**Assessments of nuclear power: 1985, 1988, and 1990**

| | | Benefits exceed risks | | | Risks exceed benefits | | | |
|---|---|---|---|---|---|---|---|---|
| | | Substantially | Slightly | About equal[b] | Slightly | Substantially | Don't know/ refused to answer | N |
| | | | | Percent | | | | |
| **Total public** | 1985 | 28 | 21 | 1 | 13 | 31 | 6 | 2,005 |
| | 1988 | 18 | 23 | 3 | 17 | 30 | 9 | 2,041 |
| | 1990 | 24 | 22 | 5 | 13 | 28 | 8 | 2,033 |
| **Male** | 1985 | 37 | 21 | 1 | 9 | 26 | 6 | 950 |
| | 1988 | 23 | 26 | 2 | 15 | 25 | 9 | 958 |
| | 1990 | 31 | 24 | 5 | 11 | 26 | 3 | 964 |
| **Female** | 1985 | 18 | 21 | 2 | 13 | 35 | 8 | 1,054 |
| | 1988 | 14 | 20 | 3 | 18 | 32 | 12 | 1,083 |
| | 1990 | 17 | 21 | 4 | 15 | 30 | 13 | 1,070 |
| **Less than high school graduate** | 1985 | 28 | 21 | 1 | 14 | 26 | 11 | 507 |
| | 1988 | 15 | 25 | 4 | 18 | 25 | 14 | 530 |
| | 1990 | 21 | 20 | 6 | 13 | 23 | 18 | 495 |
| **High school graduate or some college** | 1985 | 27 | 21 | 2 | 12 | 32 | 6 | 1,143 |
| | 1988 | 18 | 22 | 3 | 17 | 33 | 9 | 1,155 |
| | 1990 | 23 | 23 | 4 | 13 | 32 | 6 | 1,179 |
| **College graduate** | 1985 | 28 | 21 | 1 | 12 | 34 | 4 | 349 |
| | 1988 | 22 | 23 | 2 | 14 | 32 | 8 | 356 |
| | 1990 | 31 | 23 | 4 | 13 | 25 | 4 | 359 |
| **Attentive public for new scientific discoveries** | 1988 | 26 | 34 | 4 | 16 | 25 | 4 | 174 |
| | 1990 | 28 | 31 | 2 | 10 | 24 | 5 | 168 |
| **Attentive public for nuclear energy** | 1988 | 30 | 17 | 4 | 12 | 30 | 5 | 161 |
| | 1990 | 45 | 13 | 3 | 7 | 31 | 1 | 157 |
| **Attentive public for new technologies** | 1988 | 31 | 23 | 6 | 14 | 23 | 4 | 144 |
| | 1990 | 35 | 21 | 4 | 7 | 31 | 2 | 148 |
| **Attentive public for environmental issues** | 1990 | 23 | 20 | 6 | 11 | 34 | 6 | 412 |

[a]*In the current debate over the use of nuclear reactors to generate electricity, there is broad agreement that there are some risks and some benefits associated with nuclear power. In your opinion, are the risks associated with nuclear power greater than the benefits, or are the benefits associated with nuclear power greater than the risks? Would you say that the benefits have substantially exceeded the risks, or only slightly exceeded the risks? Would you say that the risks substantially exceed the benefits, or only slightly exceed the benefits?"*

NOTE: Percentages may not total 100 because of rounding.

[b]Offered as a response category for the first time in 1990; in prior years, volunteered by respondent.

SOURCES: J.D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991); and unpublished tabulations.

See figure 7-8.

*Science & Engineering Indicators – 1991*

Appendix table 7-12.
**Assessments of the space program: 1985, 1988, and 1990**

| | | Benefits exceed costs | | | Costs exceed benefits | | Don't know/ refused to answer | N |
|---|---|---|---|---|---|---|---|---|
| | | Substantially | Slightly | About equal[1] | Slightly | Substantially | | |
| | | Percent | | | | | | |
| **Total public** | 1985 | 27 | 26 | 2 | 14 | 24 | 7 | 2,005 |
| | 1988 | 22 | 24 | 3 | 18 | 26 | 9 | 2,041 |
| | 1990 | 18 | 24 | 5 | 16 | 31 | 6 | 2,033 |
| **Male** | 1985 | 34 | 29 | 2 | 12 | 18 | 5 | 950 |
| | 1988 | 28 | 26 | 4 | 13 | 22 | 7 | 958 |
| | 1990 | 23 | 25 | 5 | 15 | 27 | 5 | 964 |
| **Female** | 1985 | 21 | 23 | 3 | 16 | 30 | 7 | 1,054 |
| | 1988 | 16 | 22 | 3 | 22 | 29 | 8 | 1,083 |
| | 1990 | 14 | 22 | 4 | 16 | 35 | 9 | 1,070 |
| **Less than high school graduate** | 1985 | 22 | 22 | 3 | 16 | 26 | 11 | 507 |
| | 1988 | 15 | 25 | 3 | 20 | 29 | 8 | 530 |
| | 1990 | 15 | 20 | 7 | 15 | 32 | 11 | 495 |
| **High school graduate or some college** | 1985 | 26 | 27 | 2 | 14 | 26 | 5 | 1,143 |
| | 1988 | 21 | 23 | 3 | 17 | 27 | 9 | 1,155 |
| | 1990 | 17 | 25 | 3 | 16 | 33 | 6 | 1,179 |
| **College graduate** | 1985 | 36 | 27 | 2 | 12 | 17 | 6 | 349 |
| | 1988 | 33 | 23 | 3 | 15 | 16 | 10 | 356 |
| | 1990 | 26 | 26 | 5 | 15 | 24 | 4 | 359 |
| **Attentive public for new scientific discoveries** | 1988 | 35 | 24 | 2 | 11 | 22 | 5 | 174 |
| | 1990 | 26 | 35 | 5 | 14 | 18 | 2 | 168 |
| **Attentive public for new technologies** | 1988 | 33 | 28 | 1 | 9 | 23 | 5 | 144 |
| | 1990 | 27 | 31 | 2 | 12 | 26 | 2 | 148 |
| **Attentive public for space exploration** | 1988 | 46 | 28 | 2 | 7 | 13 | 2 | 164 |
| | 1990 | 35 | 34 | 3 | 11 | 15 | 2 | 123 |

*"Many current issues in science and technology may be viewed as a judgment of relative risks and benefits, or costs and benefits. Thinking first about the space program, some persons have argued that the costs of the space program have exceeded its benefits, while other people have argued that the benefits of space exploration have exceeded its costs. In your opinion, have the costs of space exploration exceeded its benefits, or have the benefits of space exploration exceeded its costs? Would you say that the benefits have substantially exceeded the costs, or only slightly exceeded the costs? Would you say that the costs have substantially exceeded the benefits, or only slightly exceeded the benefits?"*

NOTE: Percentages may not total 100 because of rounding.

[1]Offered as a response category for the first time in 1990; in prior years, volunteered by respondent.

SOURCES: J.D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991); and unpublished tabulations.

See figure 7-9.

*Science & Engineering Indicators – 1991*

Appendix table 7-13.
**Assessments of U.S. strength in education, innovation, and science: 1987 and 1989**

| | | Very strong | Strong | Weak | Very weak | Don't know | N |
|---|---|---|---|---|---|---|---|
| | | | | Percent | | | |
| **Our system of public education** | 1987 | 10 | 38 | 40 | 7 | 5 | 4.244 |
| | 1989 | 12 | 36 | 41 | 9 | 2 | 2.048 |
| **Technical and engineering innovation** | 1987 | 19 | 51 | 21 | 2 | 7 | 4.244 |
| | 1989 | 17 | 52 | 24 | 3 | 4 | 2.048 |
| **Scientific research** | 1989 | 23 | 56 | 14 | 2 | 5 | 2.048 |

*"Would you say today that the United States is very strong, strong, weak, or very weak compared to other countries in the following areas?*

SOURCE: Times Mirror Center for the People and the Press, "The People, Press, and Politics," data diskette (Washington, DC 1989)

See figure 7-12. *Science & Engineering Indicators 1991*

Appendix table 7-14.
**Public preferences for spending in the United States: 1973-90**

| | | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1980 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Percent | | | | | | | | |
| Space exploration program | Too little | 7 | 8 | 7 | 9 | 10 | 12 | 18 | 12 | 14 | 12 | 11 | 11 | 16 | 18 | 15 | 11 |
| | About right | 29 | 27 | 30 | 28 | 34 | 35 | 34 | 41 | 40 | 43 | 44 | 43 | 38 | 42 | 44 | 44 |
| | Too much | 58 | 61 | 58 | 60 | 50 | 47 | 39 | 40 | 40 | 39 | 40 | 41 | 40 | 34 | 35 | 39 |
| | Don't know/no answer | 5 | 4 | 4 | 3 | 6 | 6 | 8 | 6 | 6 | 6 | 4 | 5 | 6 | 6 | 7 | 6 |
| Improving and protecting the environment | Too little | 61 | 59 | 53 | 55 | 47 | 52 | 48 | 50 | 54 | 58 | 56 | 59 | 65 | 65 | 71 | 71 |
| | About right | 26 | 26 | 31 | 31 | 34 | 33 | 31 | 32 | 31 | 32 | 31 | 29 | 25 | 26 | 20 | 19 |
| | Too much | 7 | 8 | 10 | 9 | 11 | 10 | 15 | 11 | 8 | 4 | 8 | 5 | 5 | 5 | 4 | 5 |
| | Don't know/no answer | 6 | 7 | 6 | 5 | 8 | 5 | 6 | 7 | 7 | 5 | 5 | 7 | 6 | 5 | 5 | 6 |
| Improving and protecting the Nation's health | Too little | 61 | 64 | 62 | 60 | 56 | 55 | 55 | 56 | 57 | 57 | 58 | 58 | 67 | 66 | 68 | 72 |
| | About right | 31 | 28 | 28 | 31 | 32 | 34 | 34 | 32 | 34 | 31 | 33 | 34 | 26 | 28 | 25 | 22 |
| | Too much | 5 | 5 | 5 | 5 | 7 | 7 | 8 | 6 | 5 | 7 | 6 | 4 | 4 | 3 | 3 | 3 |
| | Don't know/no answer | 4 | 4 | 4 | 4 | 5 | 4 | 4 | 5 | 4 | 5 | 3 | 4 | 3 | 4 | 4 | 3 |
| Dealing with drug addiction | Too little | 65 | 60 | 55 | 58 | 54 | 55 | 59 | 57 | 59 | 62 | 62 | 58 | 65 | 68 | 70 | 64 |
| | About right | 22 | 28 | 29 | 27 | 29 | 31 | 25 | 27 | 30 | 27 | 28 | 31 | 28 | 24 | 19 | 26 |
| | Too much | 6 | 6 | 8 | 8 | 8 | 9 | 8 | 8 | 5 | 6 | 5 | 6 | 4 | 4 | 6 | 7 |
| | Don't know/no answer | 8 | 6 | 8 | 7 | 8 | 5 | 8 | 8 | 6 | 5 | 5 | 5 | 3 | 4 | 4 | 4 |
| Improving the Nation's education system | Too little | 49 | 50 | 49 | 50 | 48 | 52 | 53 | 56 | 60 | 63 | 60 | 60 | 61 | 63 | 67 | 71 |
| | About right | 38 | 37 | 35 | 37 | 39 | 34 | 33 | 32 | 31 | 31 | 31 | 32 | 30 | 29 | 27 | 23 |
| | Too much | 9 | 8 | 11 | 9 | 10 | 11 | 10 | 8 | 6 | 3 | 5 | 4 | 6 | 4 | 3 | 3 |
| | Don't know/no answer | 4 | 4 | 4 | 4 | 5 | 4 | 4 | 5 | 3 | 3 | 4 | 3 | 3 | 4 | 4 | 4 |
| Military, armaments, and defense | Too little | 11 | 17 | 17 | 24 | 24 | 27 | 56 | 29 | 24 | 17 | 14 | 16 | 15 | 16 | 14 | 10 |
| | About right | 45 | 45 | 46 | 42 | 45 | 43 | 26 | 36 | 38 | 41 | 42 | 38 | 40 | 40 | 40 | 42 |
| | Too much | 38 | 31 | 31 | 27 | 23 | 22 | 11 | 30 | 32 | 38 | 40 | 40 | 40 | 38 | 39 | 42 |
| | Don't know/no answer | 6 | 7 | 7 | 7 | 8 | 8 | 7 | 5 | 6 | 4 | 4 | 5 | 5 | 6 | 6 | 6 |
| | N = | 1,504 | 1,484 | 1,490 | 1,499 | 1,530 | 1,532 | 1,468 | 1,506 | 1,599 | 490 | 751 | 730 | 485 | 718 | 768 | 674 |

*"We are faced with many problems in this country, none of which can be solved easily or inexpensively. I'm going to name some of these problems, and for each one I'd like you to tell me whether you think we're spending too much money on it, too little money, or about the right amount."*

NOTES: Survey was not conducted in 1979 and 1981. Percentages may not total 100 because of rounding.

SOURCE: National Opinion Research Center, *General Social Surveys, Cumulative Codebook*, J.A. Davis and T.W. Smith, principal investigators (Chicago: University of Chicago, annual series).

See figure 7-13 and figure O-25 in Overview.

*Science & Engineering Indicators – 1991*

Appendix table 7-15.
**International comparisons of public attitudes toward science and technology**

| | A | B | C | D | E | F | G | H | N |
|---|---|---|---|---|---|---|---|---|---|
| | Percentage who agree | | | | | | | | |
| Canada | 80 | 52 | 45 | NA | 46 | 22 | NA | NA | 1,000 |
| Europe[1] | 73 | 27 | 46 | 74 | 59 | 37 | 34 | 46 | 11,677 |
| Belgium | 68 | 28 | 35 | 70 | 53 | 41 | 39 | 42 | 1,000 |
| Denmark | 68 | 29 | 38 | 72 | 58 | 34 | 16 | 40 | 1,013 |
| France | 76 | 19 | 45 | 91 | 58 | 36 | 44 | 58 | 1,004 |
| Great Britain | 76 | 27 | 44 | 83 | 51 | 29 | 24 | 42 | 976 |
| Greece | 84 | 36 | 52 | 73 | 76 | 45 | 57 | 57 | 1,000 |
| Ireland | 70 | 20 | 45 | 74 | 54 | 35 | 28 | 48 | 1,006 |
| Italy | 71 | 23 | 55 | 77 | 65 | 37 | 40 | 49 | 1,022 |
| Luxembourg | 76 | 23 | 46 | 78 | 62 | 27 | 30 | 41 | 303 |
| The Netherlands | 75 | 26 | 42 | 78 | 60 | 39 | 23 | 28 | 1,025 |
| Portugal | 60 | 26 | 39 | 49 | 51 | 33 | 39 | 43 | 1,000 |
| Spain | 67 | 19 | 57 | 72 | 70 | 46 | 38 | 57 | 1,001 |
| West Germany | 74 | 24 | 38 | 53 | 53 | 36 | 29 | 35 | 1,024 |
| United States | 83 | 39 | 51 | 80 | 37 | 14 | NA | NA | 2,033 |

A *"Science and technology are making our lives healthier, easier, and more comfortable."*
B *"On balance, computers and factory automation will create more jobs than they will eliminate." Canadian wording: "On balance, more jobs will be created than lost as a result of computers and factory automation."*
C *"We depend too much on science and not enough on faith."*
D *"Even if it brings no immediate benefits, scientific research which advances the frontiers of knowledge should be supported by the government."*
E *"Science makes our way of life change too fast."*
F *"It is not important for me to know about science in my daily life."*
G *"Scientists can be trusted to make the right decisions."*
H *"The benefits of science are greater than any harmful effects."*

NA = not asked

[1]"Europe" includes 300 respondents from Northern Ireland not otherwise broken out here.

SOURCES: J.D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991); E.F. Einsiedel, Scientific Literacy: A Survey of Adult Canadians (Calgary, Alberta: Graduate Program in Communication Studies, University of Calgary, 1990); and Commission of the European Communities, unpublished tabulations.

See figure 7-16. *Science & Engineering Indicators – 1991*

Appendix table 7-16.
**Japanese public attitudes toward science and technology: 1990**

| | Strongly agree | Agree | Disagree | Strongly disagree | Not sure/ don't know |
|---|---|---|---|---|---|
| | | | Percent | | |
| 1. "Science and technology are making our lives healthier, easier, and more comfortable." | 14 | 40 | 26 | 6 | 13 |
| 2. "Science and technology are making our jobs more interesting." | 10 | 32 | 31 | 5 | 22 |
| 3. "The widespread use of robots and computers is decreasing the number of jobs." | 12 | 44 | 28 | 5 | 13 |
| 4. "Science and technology will solve most of the economic and social problems we face today." | 4 | 20 | 44 | 14 | 17 |
| 5. "The study of science and mathematics in school is helpful in developing students' ability to think logically and systematically." | 7 | 41 | 27 | 6 | 18 |
| 6. "In comparison to other countries, Japan doesn't have a good environment in which the individual creative scientist can work and develop." | 14 | 44 | 19 | 3 | 20 |

| | Improved | Not changed | Worsened | Don't know |
|---|---|---|---|---|
| 7. "Do you think science and technology have improved, worsened, or not changed the following?" | | | | |
| Our standard of living | 76 | 15 | 3 | 6 |
| Working conditions | 48 | 24 | 14 | 14 |
| Morality | 8 | 35 | 38 | 20 |

| | Positive | About the same | Negative | Don't know |
|---|---|---|---|---|
| 8. "Science and technology have both positive and negative effects. Which do you think has been greater—the positive effects or the negative effects?" | 53 | 31 | 7 | 10 |

*N* = 2,239

NOTE: Percentages may not total 100 because of rounding.

SOURCE: Office of the Prime Minister of Japan, Public Relations Office. *Opinion Survey on Science, Technology, and Society*. T. Welch, translator (Washington, DC: Science Resources Studies Division, National Science Foundation, 1991).

See figure 7-17. *Science & Engineering Indicators – 1991*

Appendix table 7-17.
**Interest in and knowledge about science and technology issues**

| | Percentage very interested in . . . | | | Percentage very well-informed about . . . | | | |
|---|---|---|---|---|---|---|---|
| | New scientific discoveries | New inventions and technology | New medical discoveries | New scientific discoveries | New inventions and technology | New medical discoveries | *N* |
| Canada[1] | 45 | 38 | 59 | 16 | 12 | 29 | 1,000 |
| Europe[2] | 34 | 32 | 41 | 12 | 12 | 14 | 11,677 |
| Belgium | 28 | 28 | 35 | 12 | 12 | 13 | 1,000 |
| Denmark | 28 | 28 | 30 | 9 | 11 | 11 | 1,013 |
| France | 52 | 48 | 61 | 18 | 17 | 22 | 1,004 |
| Great Britain | 36 | 37 | 43 | 10 | 11 | 11 | 976 |
| Greece | 23 | 20 | 27 | 5 | 5 | 6 | 1,000 |
| Ireland | 28 | 30 | 32 | 9 | 10 | 9 | 1,006 |
| Italy | 39 | 34 | 46 | 18 | 16 | 23 | 1,022 |
| Luxembourg | 42 | 37 | 41 | 11 | 12 | 13 | 303 |
| The Netherlands | 45 | 46 | 59 | 13 | 16 | 20 | 1,025 |
| Portugal | 21 | 20 | 25 | 5 | 5 | 6 | 1,000 |
| Spain | 22 | 22 | 20 | 7 | 7 | 6 | 1,001 |
| West Germany | 24 | 19 | 32 | 9 | 10 | 10 | 1,024 |
| United States | 39 | 39 | 68 | 14 | 11 | 24 | 2,033 |

[1]The Canadian questionnaire asked about interest in "stories about medicine and health."

[2]"Europe" includes 300 respondents from Northern Ireland not otherwise broken out here.

SOURCES: J.D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991); E.F. Einsiedel, *Scientific Literacy: A Survey of Adult Canadians* (Calgary, Alberta: Graduate Program in Communication Studies, University of Calgary, 1990); and Commission of the European Communities, unpublished tabulations.

See figure 7-18.

*Science & Engineering Indicators – 1991*

Appendix table 7-18.
**Canadian, European, and U.S. perceptions of astrology**

| | Very scientific | Sort of scientific | Not at all scientific | Don't know | N |
|---|---|---|---|---|---|
| | | | Percent | | |
| Canada | 10 | 35 | 49 | 7 | 1,000 |
| Europe[1] | 14 | 41 | 32 | 13 | 11,677 |
| Belgium | 13 | 38 | 35 | 15 | 1,000 |
| Denmark | 13 | 48 | 24 | 15 | 1,013 |
| France | 11 | 50 | 31 | 8 | 1,004 |
| Great Britain | 16 | 38 | 40 | 7 | 976 |
| Greece | 18 | 35 | 25 | 22 | 1,000 |
| Ireland | 18 | 34 | 27 | 21 | 1,006 |
| Italy | 12 | 34 | 40 | 15 | 1,022 |
| Luxembourg | 12 | 50 | 34 | 6 | 303 |
| The Netherlands | 11 | 46 | 31 | 12 | 1,025 |
| Portugal | 19 | 29 | 15 | 27 | 1,000 |
| Spain | 30 | 34 | 16 | 21 | 1,001 |
| West Germany | 8 | 46 | 32 | 14 | 1,024 |
| United States | 6 | 29 | 60 | 5 | 2,033 |

NOTE: Percentages may not total 100 because of rounding.

[1]"Europe" includes 300 respondents from Northern Ireland not otherwise broken out here.

SOURCES: J.D. Miller. *Public Attitudes Toward Science and Technology, 1979-1990. Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991); E.F. Einsiedel, *Scientific Literacy: A Survey of Adult Canadians* (Calgary, Alberta: Graduate Program in Communication Studies, University of Calgary, 1990); and Commission of the European Communities, unpublished tabulations.

See figure 7-19. *Science & Engineering Indicators – 1991*

Appendix table 7-19.
**Canadian and U.S. knowledge of science and technology**

| | Respondents answering correctly | |
|---|---|---|
| | Canada | United States |
| | Percent | |
| A. "The center of the earth is very hot." | 85 | 79 |
| B. "The oxygen we breathe comes from plants." | 80 | 85 |
| C. "Electrons are smaller than atoms." | 47 | 41 |
| D. "Hot air rises." | 96 | 95 |
| E. "The continents are moving slowly about on the surface of the earth."[1] | 75 | 77 |
| F. "Human beings, as we know them today, developed from earlier groups of animals."[2] | 58 | 45 |
| G. "The earliest humans lived at the same time as the dinosaurs." | 46 | 47 |
| H. "Which travels faster: light or sound?" | 74 | 75 |
| I. "Lasers work by focusing sound waves." | 38 | 37 |
| J. "Does the earth go around the sun, or does the sun go around the earth?" | 78 | 73 |
| K. "How long does it take for the earth to go around the sun?"[3] | 51 | 48 |
| | $N$ = 2,000 | 2,033 |
| Number of questions answered correctly | | |
| 0 | 0.3 | 0.3 |
| 1 | 0.5 | 0.7 |
| 2 | 1.7 | 1.9 |
| 3 | 3.8 | 5.2 |
| 4 | 6.1 | 7.7 |
| 5 | 10.0 | 11.3 |
| 6 | 14.2 | 13.6 |
| 7 | 16.3 | 15.2 |
| 8 | 14.4 | 15.3 |
| 9 | 13.7 | 12.3 |
| 10 | 10.5 | 9.7 |
| 11 | 8.8 | 6.7 |
| Mean | 7.28 | 7.00 |
| Alpha | 0.67 | 0.68 |
| Standard deviation | 2.31 | 2.37 |

[1]Canadian wording. U.S. wording was as follows: *"The continents on which we live have been moving their location for millions of years and will continue to move in the future."*

[2]Canadian wording. U.S. wording was as follows: *"Human beings, as we know them today, developed from earlier species of animals."*

[3]Question K was asked if J was answered correctly.

SOURCES: E.F. Einsiedel, *Scientific Literacy: A Survey of Adult Canadians* (Calgary, Alberta: Graduate Program in Communication Studies, University of Calgary, 1990), unpublished tabulations; J.D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991).

See figure 7-20. *Science & Engineering Indicators - 1991*

Appendix table 7-20.
## U.S. and European knowledge of science and technology

| | A | B | C | D | E | F | G | H | I | J | N |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Percentage answering correctly | | | | | | | | | | |
| Europe[a] | 85 | 81 | 41 | 69 | 47 | 24 | 37 | 57 | 83 | 52 | 11,677 |
| Belgium | 85 | 66 | 44 | 65 | 36 | 17 | 31 | 51 | 78 | 50 | 1,000 |
| Denmark | 91 | 85 | 35 | 65 | 54 | 50 | 40 | 70 | 81 | 53 | 1,013 |
| France | 87 | 82 | 46 | 84 | 49 | 21 | 33 | 69 | 84 | 56 | 1,004 |
| Great Britain | 88 | 76 | 38 | 76 | 56 | 40 | 51 | 73 | 75 | 45 | 976 |
| Greece | 78 | 73 | 45 | 51 | 24 | 15 | 17 | 31 | 81 | 55 | 1,000 |
| Ireland | 84 | 67 | 34 | 58 | 42 | 29 | 29 | 54 | 73 | 50 | 1,006 |
| Italy | 80 | 89 | 44 | 72 | 35 | 11 | 32 | 54 | 91 | 58 | 1,022 |
| Luxembourg | 85 | 86 | 48 | 76 | 59 | 12 | 41 | 67 | 86 | 57 | 303 |
| The Netherlands | 87 | 86 | 43 | 75 | 56 | 21 | 50 | 69 | 77 | 42 | 1,025 |
| Portugal | 68 | 73 | 33 | 40 | 26 | 6 | 18 | 25 | 80 | 42 | 1,000 |
| Spain | 73 | 71 | 36 | 60 | 35 | 24 | 25 | 44 | 80 | 55 | 1,001 |
| West Germany | 95 | 89 | 39 | 59 | 59 | 30 | 43 | 49 | 86 | 51 | 1,024 |
| United States | 79 | 85 | 41 | 77 | 47 | 30 | 37 | 63 | 73 | 48 | 2,033 |

| | Number of questions answered correctly[b] | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Mean | Alpha | SD[c] | N |
| | Percentage of respondents | | | | | | | | | | | | | | |
| Denmark | 1.4 | 2.1 | 3.3 | 7.1 | 9.3 | 12.9 | 15.4 | 15.2 | 14.3 | 12.3 | 6.8 | 6.23 | 0.71 | 2.357 | 1,013 |
| Great Britain | 0.9 | 2.4 | 4.4 | 9.7 | 9.8 | 9.6 | 14.5 | 15.0 | 14.3 | 10.6 | 8.7 | 6.17 | 0.73 | 2.458 | 976 |
| Luxembourg | 0.3 | 3.0 | 4.6 | 5.3 | 9.6 | 12.9 | 15.5 | 16.5 | 17.8 | 10.6 | 4.0 | 6.17 | 0.70 | 2.245 | 303 |
| France | 0.4 | 1.4 | 3.6 | 7.0 | 10.6 | 14.2 | 17.4 | 17.1 | 13.8 | 11.3 | 3.2 | 6.11 | 0.65 | 2.125 | 1,004 |
| The Netherlands | 0.7 | 2.2 | 3.4 | 6.8 | 12.9 | 13.5 | 14.9 | 16.0 | 14.9 | 11.0 | 3.7 | 6.05 | 0.67 | 2.226 | 1,025 |
| West Germany | 0.1 | 0.9 | 3.0 | 9.5 | 13.1 | 16.9 | 17.0 | 13.6 | 11.6 | 8.3 | 6.1 | 5.97 | 0.64 | 2.145 | 1,024 |
| United States | 0.6 | 2.6 | 5.4 | 9.2 | 13.0 | 14.5 | 16.0 | 13.0 | 10.5 | 9.0 | 6.1 | 5.79 | 0.69 | 2.350 | 2,033 |
| EUROPE | 1.5 | 2.6 | 5.2 | 9.3 | 11.9 | 14.1 | 15.3 | 14.2 | 12.1 | 9.1 | 4.6 | 5.75 | 0.71 | 2.368 | 11,677 |
| Italy | 0.8 | 2.5 | 6.4 | 9.7 | 12.4 | 15.1 | 14.1 | 15.0 | 12.2 | 8.8 | 3.0 | 5.66 | 0.73 | 2.294 | 1,022 |
| Belgium | 2.7 | 3.3 | 6.8 | 11.5 | 14.1 | 14.8 | 15.7 | 12.8 | 9.2 | 6.6 | 2.5 | 5.24 | 0.69 | 2.355 | 1,000 |
| Ireland | 3.5 | 4.6 | 7.2 | 10.0 | 13.8 | 14.8 | 14.5 | 12.2 | 9.6 | 6.4 | 3.4 | 5.19 | 0.72 | 2.474 | 1,006 |
| Spain | 4.8 | 5.3 | 8.6 | 10.7 | 12.6 | 14.5 | 12.7 | 10.5 | 9.3 | 8.3 | 2.7 | 5.03 | 0.76 | 2.603 | 1,001 |
| Greece | 5.1 | 5.8 | 8.6 | 11.6 | 13.9 | 14.4 | 17.4 | 11.8 | 5.7 | 4.0 | 1.7 | 4.71 | 0.73 | 2.393 | 1,000 |
| Portugal | 8.0 | 9.3 | 13.2 | 12.2 | 12.7 | 14.7 | 11.0 | 8.3 | 7.2 | 2.9 | 0.5 | 4.09 | 0.77 | 2.481 | 1,000 |

A *"The center of the earth is very hot."*
B *"The oxygen we breathe comes from plants."*
C *"Electrons are smaller than atoms."*
D *European wording: "The continents are moving slowly about on the surface of the earth." U.S. wording: "The continents on which we live have been moving their location for millions of years and will continue to move in the future."*
E *"The earliest humans lived at the same time as the dinosaurs."*
F *"Antibiotics kill viruses as well as bacteria."*
G *"Lasers work by focusing sound waves."*
H *European wording: "All radioactivity is manmade." U.S. wording: "Is all radioactivity manmade, or does some radioactivity occur naturally?"*
I *"Does the earth go around the sun, or does the sun go around the earth?"*
J *(Asked if Question I was answered correctly) "How long does it take for the earth to go around the sun?"*

[a] "Europe" includes 300 respondents from Northern Ireland not otherwise broken out here.

[b] Ranked on mean number of questions answered correctly.

[c] SD = standard deviation.

SOURCES: J.D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991); unpublished tabulations; and Commission of the European Communities, unpublished tabulations.

See figure 7-21 and figure O-26 in Overview.

Appendix table 7-21.
**U.S. public assessments of U.S. international position in basic scientific achievements: 1990**

| | Europe | | | | Japan | | | | Soviet Union | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | U.S. is ahead | About the same | U.S. is behind | Don't know | U.S. is ahead | About the same | U.S. is behind | Don't know | U.S. is ahead | About the same | U.S. is behind | Don't know | *N* |
| | | | | | | Percent | | | | | | | |
| Total public | 46 | 36 | 14 | 4 | 23 | 25 | 50 | 3 | 61 | 28 | 7 | 3 | 2,033 |
| **Gender** | | | | | | | | | | | | | |
| Male | 55 | 30 | 13 | 2 | 29 | 25 | 45 | 1 | 71 | 22 | 4 | 2 | 964 |
| Female | 38 | 41 | 15 | 6 | 18 | 24 | 54 | 4 | 52 | 34 | 10 | 4 | 1,070 |
| **Degree level** | | | | | | | | | | | | | |
| No high school degree | 38 | 36 | 15 | 10 | 27 | 24 | 43 | 6 | 46 | 39 | 8 | 7 | 495 |
| High school graduate' | 47 | 36 | 15 | 2 | 20 | 25 | 55 | 1 | 62 | 28 | 8 | 2 | 1,179 |
| College graduate | 53 | 35 | 10 | 2 | 31 | 25 | 43 | 2 | 79 | 15 | 4 | 2 | 359 |
| **Science & math education** | | | | | | | | | | | | | |
| Low | 44 | 36 | 14 | 6 | 23 | 26 | 48 | 3 | 55 | 33 | 9 | 4 | 1,263 |
| Medium | 50 | 34 | 15 | 2 | 22 | 21 | 56 | 1 | 67 | 25 | 6 | 2 | 523 |
| High | 49 | 38 | 11 | 2 | 28 | 26 | 45 | 2 | 82 | 14 | 4 | 1 | 248 |
| **Age** | | | | | | | | | | | | | |
| 18-24 | 43 | 38 | 17 | 3 | 11 | 22 | 65 | 1 | 54 | 35 | 11 | 1 | 322 |
| 25-34 | 45 | 39 | 12 | 4 | 20 | 25 | 51 | 3 | 60 | 31 | 7 | 2 | 497 |
| 35-44 | 53 | 30 | 15 | 3 | 24 | 24 | 51 | 1 | 68 | 22 | 8 | 2 | 366 |
| 45-64 | 47 | 35 | 14 | 4 | 32 | 23 | 44 | 1 | 63 | 26 | 8 | 3 | 533 |
| 65 and older | 42 | 37 | 14 | 6 | 25 | 29 | 39 | 7 | 59 | 28 | 4 | 8 | 315 |
| **Attentive publics** | | | | | | | | | | | | | |
| New scientific discoveries | 55 | 29 | 16 | * | 34 | 23 | 42 | * | 74 | 20 | 6 | * | 168 |
| New technologies | 61 | 27 | 12 | * | 33 | 23 | 44 | * | 78 | 19 | 3 | * | 148 |
| Nuclear policy | 56 | 27 | 17 | * | 26 | 27 | 46 | * | 76 | 22 | 2 | * | 157 |
| Medical discoveries | 50 | 33 | 17 | * | 26 | 24 | 50 | * | 64 | 28 | 8 | * | 323 |
| Space exploration | 60 | 34 | 6 | * | 38 | 25 | 38 | * | 77 | 20 | 2 | * | 123 |
| Environmental pollution | [illegible] | 34 | 17 | * | 27 | 21 | 52 | * | 69 | 27 | 4 | * | 412 |

*"Now let me ask you to think about the relative position of the United States in the world in regard to science and technology. In terms of basic scientific achievements, would you say that the United States is ahead of Europe [Japan, Soviet Union], behind Europe [Japan, Soviet Union], or at about the same level?"*

* Less than 0.5 percent

NOTE: Percentages may not total 100 because of rounding.

Includes respondents with associate degrees

For an explanation of the education index, see chapter 7, "The Science and Mathematics Education Index," p. 172.

SOURCE: J.D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991), unpublished tabulations.

See text table 7-6

Appendix table 7-22.
**European assessments of international positions in science and technology: 1989**

| | United States | | | Japan | | | |
|---|---|---|---|---|---|---|---|
| | Europe is more advanced | Europe is less advanced | At the same level | Europe is more advanced | Europe is less advanced | At the same level | N |
| **Scientific discoveries** | | | | | | | |
| | Percent | | | | | | |
| Europe' | 13 | 46 | 29 | 27 | 41 | 18 | 11,677 |
| Belgium | 14 | 46 | 26 | 20 | 44 | 18 | 1,000 |
| Denmark | 7 | 45 | 35 | 15 | 54 | 17 | 1,013 |
| France | 19 | 34 | 38 | 28 | 41 | 21 | 1,004 |
| Great Britain | 18 | 40 | 32 | 30 | 41 | 18 | 976 |
| Greece | 12 | 61 | 12 | 14 | 57 | 11 | 1,000 |
| Ireland | 10 | 53 | 23 | 20 | 47 | 14 | 1,006 |
| Italy | 8 | 58 | 22 | 22 | 48 | 14 | 1,022 |
| Luxembourg | 8 | 44 | 27 | 22 | 40 | 15 | 303 |
| The Netherlands | 14 | 42 | 33 | 30 | 41 | 18 | 1,025 |
| Portugal | 10 | 42 | 18 | 15 | 39 | 15 | 1,000 |
| Spain | 7 | 66 | 12 | 14 | 60 | 7 | 1,001 |
| West Germany | 15 | 38 | 40 | 39 | 22 | 30 | 1,024 |
| **Technology and industry** | | | | | | | |
| Europe' | 15 | 42 | 29 | 13 | 61 | 14 | 11,677 |
| Belgium | 12 | 44 | 26 | 11 | 55 | 17 | 1,000 |
| Denmark | 9 | 44 | 32 | 7 | 74 | 8 | 1,013 |
| France | 14 | 39 | 34 | 14 | 62 | 14 | 1,004 |
| Great Britain | 21 | 37 | 31 | 12 | 67 | 13 | 976 |
| Greece | 12 | 59 | 12 | 10 | 62 | 10 | 1,000 |
| Ireland | 14 | 47 | 24 | 11 | 61 | 11 | 1,006 |
| Italy | 11 | 49 | 24 | 10 | 66 | 10 | 1,022 |
| Luxembourg | 14 | 38 | 25 | 10 | 55 | 13 | 303 |
| The Netherlands | 18 | 34 | 34 | 11 | 64 | 15 | 1,025 |
| Portugal | 8 | 42 | 20 | 9 | 47 | 14 | 1,000 |
| Spain | 5 | 65 | 13 | 8 | 68 | 6 | 1,001 |
| West Germany | 23 | 30 | 38 | 20 | 49 | 23 | 1,024 |
| **Technological advances applied in everyday life** | | | | | | | |
| Europe' | 13 | 47 | 27 | 19 | 48 | 19 | 11,677 |
| Belgium | 10 | 49 | 25 | 14 | 46 | 21 | 1,000 |
| Denmark | 10 | 43 | 29 | 15 | 52 | 16 | 1,013 |
| France | 15 | 40 | 32 | 18 | 49 | 19 | 1,004 |
| Great Britain | 15 | 49 | 25 | 20 | 51 | 17 | 976 |
| Greece | 12 | 57 | 12 | 11 | 59 | 10 | 1,000 |
| Ireland | 9 | 51 | 23 | 16 | 49 | 16 | 1,006 |
| Italy | 8 | 58 | 20 | 14 | 58 | 11 | 1,022 |
| Luxembourg | 14 | 44 | 22 | 15 | 46 | 18 | 303 |
| The Netherlands | 14 | 43 | 29 | 23 | 42 | 21 | 1,025 |
| Portugal | 7 | 42 | 20 | 9 | 45 | 16 | 1,000 |
| Spain | 6 | 61 | 13 | 9 | 60 | 10 | 1,001 |
| West Germany | 18 | 33 | 39 | 31 | 26 | 32 | 1,024 |

*"For each of the following fields, could you tell me whether you think Europe is ahead or behind or at the same level as the United States [Japan]?"*

NOTE: Nonresponses and "don't know" are omitted.

'"Europe" includes 300 respondents from Northern Ireland not otherwise broken out here.

SOURCE: Commision of the European Communities, unpublished tabulations.

*Science & Engineering Indicators – 1991*

Appendix table 7-23.
**U.S. public assessments of U.S. international position in military technology: 1990**

| | Europe | | | | Japan | | | | Soviet Union | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | U.S. is ahead | About the same | U.S. is behind | Don't know | U.S. is ahead | About the same | U.S. is behind | Don't know | U.S. is ahead | About the same | U.S. is behind | Don't know | N |
| | | | | | | Percent | | | | | | | |
| Total public | 69 | 26 | 3 | 2 | 71 | 18 | 7 | 4 | 46 | 42 | 9 | 3 | 2,033 |
| **Gender** | | | | | | | | | | | | | |
| Male | 78 | 19 | 2 | 1 | 84 | 11 | 4 | 1 | 54 | 37 | 8 | 1 | 964 |
| Female | 61 | 31 | 4 | 4 | 59 | 25 | 10 | 6 | 39 | 46 | 11 | 4 | 1,070 |
| **Degree level** | | | | | | | | | | | | | |
| No high school degree | 55 | 37 | 4 | 4 | 62 | 22 | 8 | 8 | 41 | 43 | 10 | 7 | 495 |
| High school graduate[a] | 71 | 24 | 3 | 2 | 71 | 19 | 8 | 2 | 45 | 44 | 10 | 1 | 1,179 |
| College graduate | 82 | 15 | 2 | 2 | 84 | 9 | 4 | 3 | 60 | 33 | 5 | 2 | 359 |
| **Science & math education** | | | | | | | | | | | | | |
| Low | 64 | 30 | 4 | 3 | 65 | 21 | 9 | 5 | 43 | 44 | 9 | 4 | 1,263 |
| Medium | 75 | 21 | 3 | 2 | 77 | 15 | 6 | 2 | 48 | 41 | 10 | 1 | 523 |
| High | 86 | 12 | 1 | 1 | 87 | 10 | 3 | 1 | 61 | 32 | 6 | 1 | 248 |
| **Age** | | | | | | | | | | | | | |
| 18-24 | 68 | 25 | 5 | 2 | 67 | 20 | 11 | 2 | 28 | 58 | 14 | 1 | 322 |
| 25-34 | 70 | 25 | 3 | 2 | 71 | 18 | 8 | 3 | 45 | 44 | 10 | 1 | 497 |
| 35-44 | 75 | 22 | 3 | 1 | 74 | 18 | 5 | 3 | 49 | 40 | 9 | 1 | 366 |
| 45-64 | 70 | 25 | 3 | 2 | 78 | 14 | 5 | 2 | 56 | 34 | 7 | 3 | 533 |
| 65 and older | 61 | 32 | 2 | 5 | 59 | 24 | 7 | 10 | 48 | 37 | 6 | 9 | 315 |
| **Attentive publics** | | | | | | | | | | | | | |
| New scientific discoveries | 77 | 23 | 1 | * | 80 | 15 | 6 | * | 54 | 36 | 10 | * | 168 |
| New technologies | 74 | 24 | 1 | * | 83 | 10 | 7 | * | 59 | 35 | 6 | * | 148 |
| Nuclear policy | 85 | 15 | * | * | 80 | 16 | 4 | * | 66 | 28 | 6 | * | 157 |
| Medical discoveries | 77 | 22 | 2 | * | 73 | 21 | 6 | * | 52 | 39 | 10 | * | 323 |
| Space exploration | 79 | 21 | 1 | * | 87 | 11 | 3 | * | 58 | 35 | 7 | * | 123 |
| Environmental pollution | 80 | 19 | 2 | * | 79 | 17 | 5 | * | 55 | 38 | 7 | * | 412 |

"In terms of military technology, would you say that the United States is ahead of Europe [Japan, Soviet Union], behind Europe [Japan, Soviet Union], or at about the same level?"

* less than 0.5 percent

NOTE: Percentages may not total 100 because of rounding.

[a] Includes respondents with associate degrees.

For an explanation of the education index, see chapter 7, "The Science and Mathematics Education Index," p. 172.

SOURCE: J.D. Miller, *Public Attitudes Toward Science and Technology, 1979-1990, Integrated Codebook* (Chicago: International Center for the Advancement of Scientific Literacy, Chicago Academy of Sciences, 1991) unpublished tabulations.

See text table 7-6.

# Appendix B
# Contributors and Reviewers

*The following persons contributed to the report by reviewing chapters or sections, providing data, or otherwise assisting in its preparation. Their help is greatly appreciated.*

Catherine P. Ailes, SRI International
Alexander W. Astin, University of California, Los Angeles

Harley Balzer, Georgetown University
Martin Bauer, Science Museum, London
Rolf Blank, Council of Chief State School Officers
Carol Bowman, Times Mirror Center for the People and the Press
Sarah Bray, Council for Advancement and Support of Education
Paul T. Brinkman, University of Utah
Morton Brown, UNESCO
Donald Buzzelli, National Science Foundation

Geneviève Canceill, Ministry of Education, France
David Chananie, National Institutes of Health
Brad Chaney, Westat
Marianne K. Clarke, National Governors Association
Porter Coggeshall, National Research Council

Melanie Dalkilio, Council of Chief State School Officers
Robert C. Dauffenbach, University of Oklahoma
Lester A. Davis, Department of Commerce
Louis Marc Ducharme, Statistics Canada
John Durant, Science Museum, London

David Edson, Mathematica Policy Research
Edna Einsiedel, University of Calgary
Martha Firestine, Walcoff & Associates
Pamela Ebert Flattau, National Research Council
Foxon-Maddocks Associates
Susan Fuhrman, Rutgers University

Joseph Gannon, National Science Foundation
Mary Golladay, National Science Foundation
S. Gopinathan, Institute of Education, Singapore
Jerilee Grandy, Educational Testing Service
Kenneth C. Green, University of Southern California
Margaret Grucza, Industrial Research Institute

Anne Hafner, Southwest Regional Laboratory
Ray Hannapel, National Science Foundation
John R. Heizer, Department of Commerce
Susan Hill, National Science Foundation
Jim Hirabayashi, U.S. Patent and Trademark Office

Myung Kon Kim, Embassy of the Republic of Korea
Daniel Koretz, RAND Corporation
William C. Korn, University of California, Los Angeles

Eric Leber, American Chemical Society
Len Lederman, National Science Foundation
Albert N. Link, University of North Carolina, Greensboro
Betty Lipscomb, Northern Illinois University
Linda Lubrano, The American University

Shirley Malcom, American Association for the Advancement of Science

Patricia E. McKinley, National Institutes of Health
Margaret Meredith, American Association for the Advancement of Science
Jon Miller, Chicago Academy of Sciences
William Miller, SRI International
Susan Mitchell, National Research Council
Richard H. Mullins, Department of Commerce
Ina Mullis, Educational Testing Service
Richard Murnane, Harvard University
Jane S. Myers, U.S. Patent and Trademark Office

Hajime Nagahama, National Institute of Science and Technology Policy, Tokyo
Maresi Nerad, University of California, Berkeley
Jeannie Oakes, University of California, Los Angeles

Steven Parker, Corporate Technology Information Services, Inc.
C.T. Peng, Coordination Council for North American Affairs (Taiwan)
Paul B. Phelps, Advanced Development Distribution, Inc.
Don I. Phillips, Government-University-Industry Research Roundtable
Linda Pifer, Northern Illinois University
Andrew Porter, University of Wisconsin
Carl E. Pray, Rutgers University

Senta Raizen, The Network, Inc.
A.R. Rajeswari, Department of Science and Technology, Delhi
Robert A. Rivers, IEEE Manpower Committee
Elizabeth M. Robertson, Department of Commerce
Andy Rose, American Institute for Research
Neil Rosenthal, Bureau of Labor Statistics
Jim Rutherford, American Association for the Advancement of Science

F.O. Schulz, Jr., Proctor and Gamble
Merril Shanks, University of California, Berkeley
Carl Shepherd, Department of Commerce
Carolyn Shettle, National Science Foundation
R.H.M. Smulders, Central Bureau of Statistics, The Netherlands
Robert Suchner, Northern Illinois University

Albert H. Teich, American Association for the Advancement of Science
Roland Tibbetts, National Science Foundation

Wim Van Deelen, Commission of the European Communities

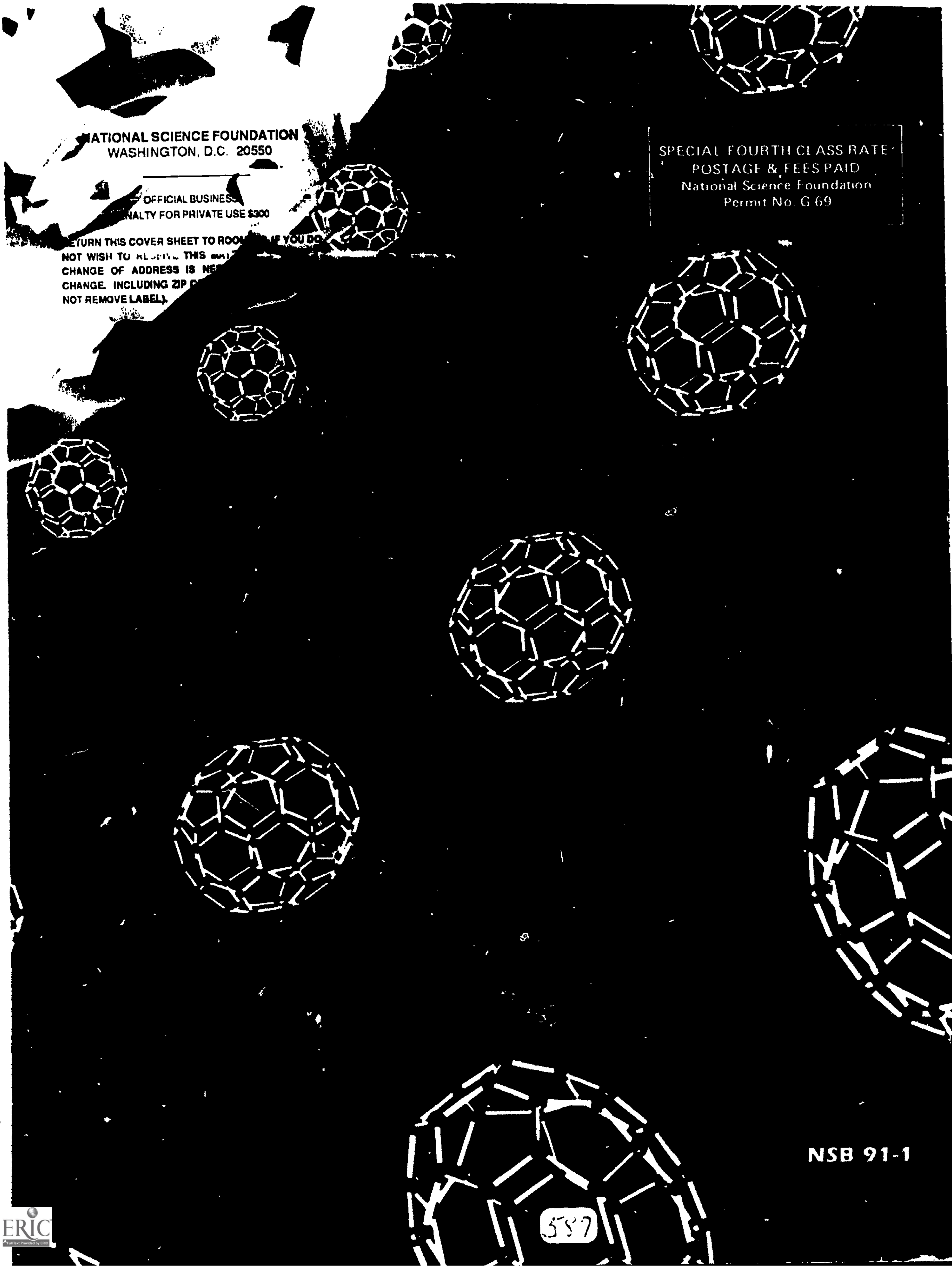
Allan T. Walters, Temple University
Iris Weiss, Horizon Research, Inc.
Wordscape
Tetsuo Yamane, Ministry of Education, Japan
John Ziman, Science Policy Support Group, London

# Appendix C
# Abbreviations

| | |
|---|---|
| AAAS | American Association for the Advancement of Science |
| APL | Applied Physics Laboratory |
| CAD/CAE | computer-aided design and engineering |
| CCSSO | Council of Chief State School Officers |
| CEHR | Committee on Education and Human Resources |
| CFCs | chlorofluorocarbons |
| CPRE | Center for Policy Research in Education |
| CRADA | cooperative research and development agreement |
| DCAA | Defense Contract Audit Agency |
| DOC | Department of Commerce |
| DOD | Department of Defense |
| DOE | Department of Energy |
| EC | European Community |
| FFRDC | federally funded research and development center |
| FTTA | Federal Technology Transfer Act |
| FY | fiscal year |
| GNP | gross national product |
| GSP | gross state product |
| GSS | General Social Survey |
| GUF | general university funds |
| HDTV | high-definition television |
| HHS | Department of Health and Human Services |
| IR&D | independent research and development |
| ISIC | International Standard Industrial Classification |
| JRV | joint research and development venture |
| LSAY | Longitudinal Study of American Youth |
| NAEP | National Assessment of Educational Progress |
| NAS/NRC | National Academy of Science/National Research Council |
| NASA | National Aeronautics and Space Administration |
| NCRA | National Cooperative Research Act of 1984 |
| NCTM | National Council of Teachers of Mathematics |
| NELS:88 | National Education Longitudinal Study of 1988 |
| NIH | National Institutes of Health |
| NORC | National Opinion Research Center |
| NS&E | natural science and engineering |
| NSF | National Science Foundation |
| OECD | Organisation for Economic Cooperation and Development |
| OES | Occupational Employment Statistics |
| OMB | Office of Management and Budget |
| R&D | research and development |
| R&E | research and experimentation |
| RDT&E | research, development, test, and evaluation |
| S&T | science and technology |
| SASS | Schools and Staffing Survey |
| SAT | Scholastic Aptitude Test |
| SBA | Small Business Administration |
| SBIR | Small Business Innovation Research |
| SES | socioeconomic status |
| SIC | Standard Industrial Classification |
| SIR | statutory invention registration |
| SME | science, mathematics, and engineering |
| SS&C | Scope, Sequence, and Coordination project |
| USDA | Department of Agriculture |

# Appendix D
# Index

*Page numbers in* **boldface** *indicate appendix tables.*



NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

RETURN THIS COVER SHEET TO ROOM ... IF YOU DO NOT WISH TO RECEIVE THIS MAT... CHANGE OF ADDRESS IS NE... CHANGE INCLUDING ZIP C... NOT REMOVE LABEL).

SPECIAL FOURTH CLASS RATE
POSTAGE & FEES PAID
National Science Foundation
Permit No. G 69

NSB 91-1