DOCUMENT RESUME

ED 309 920 SE 050 399

TITLE Science and Technology Data Book, 1989.
INSTITUTION National Science Foundation, Washington, D.C. Div. of Science Resources Studies.
REPORT NO NSF-88-332
PUB DATE 89
NOTE 59p.; For 1988 issue see ED 290 635. Contains some small type and colored graphs which may not reproduce well.
PUB TYPE Statistical Data (110)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *College Science; Doctoral Degrees; Employment Patterns; Financial Support; Global Approach; Graduate Students; Higher Education; *Human Resources; *International Trade; Minority Groups; *Research and Development; *Science and Society; Statistics; Tables (Data); *Technology

ABSTRACT

Designed to provide easy access to information pertaining to science and technology, this data book provides indicators in: (1) funding for research and development; (2) human resources utilization and supply; and (3) international science and technology indicators. Graphs and charts are used to note research and development efforts from a nationwide perspective with expenditures from federal, industrial and academic sources illustrated. Comparative graphs on human resources provide data on employed scientists and engineers, employed doctorates, women in science and technology, racial minorities, and school retention rates. In addition, assessments of the supply of professionals in science and technology are presented by type and number of degrees awarded, and full-time graduate students currently enrolled. Several international science and technology indicators are outlined, such as ratios of research and development to gross national product (by country), U.S. patents granted to U.S. and foreign inventors, data on U.S. trade balances in high technology, and U.S. scientific and technical publications as compared to world publications. Three pages list other science resources. (MVL)

science and technology

DATA BOOK

1989

National Science Foundation

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Division of Science Resources Studies
National Science Foundation
Washington, D.C. 20550

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Suggested Citation of This Publication

Science and Technology Data Book (NSF 88-332) (Washington, D.C.: 1989)

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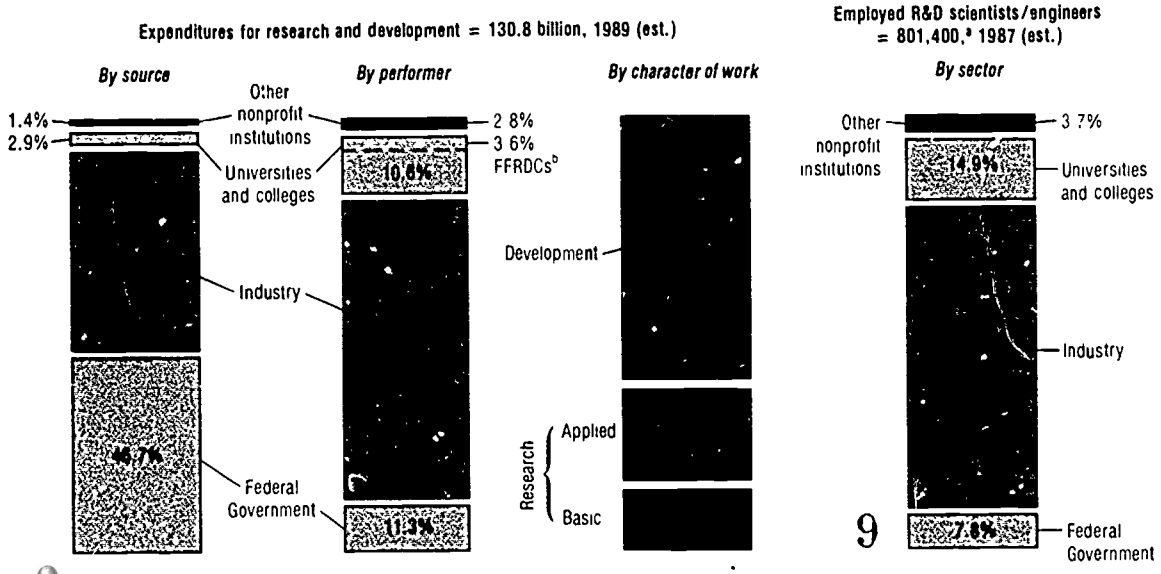
R&D FUNDING

R&D FUNDING

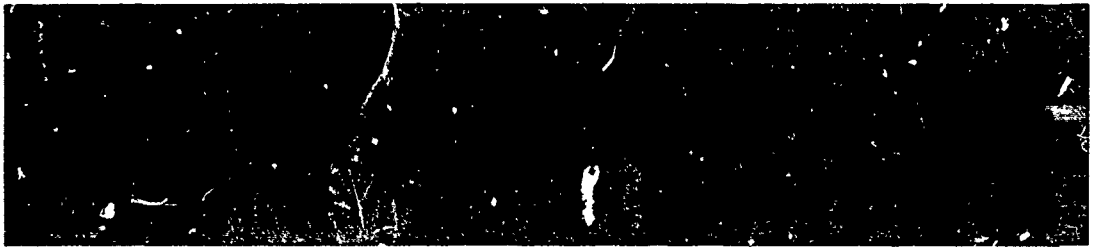
Figure 1. The national R&D effort



[a] ull time equivalents
[b] ederally funded research and development centers administered by universities and colleges
SOURCE National Science Foundation
Additional data may be obtained from John R Chrichello SRS Tel (202) 634 4625

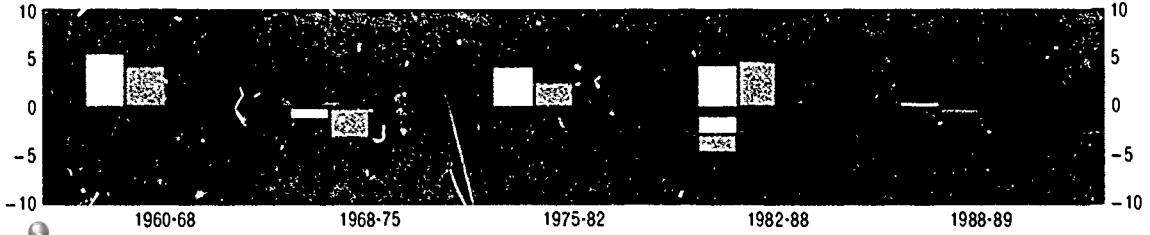
Figure 2. **National R&D funding by source**

[Dollars in millions]



Average annual rate of change

(Constant (1982) dollars)[1]



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E National Science Foundation

nal data may be obtained from John R Churchiello SRS Tel (202) 634 1625

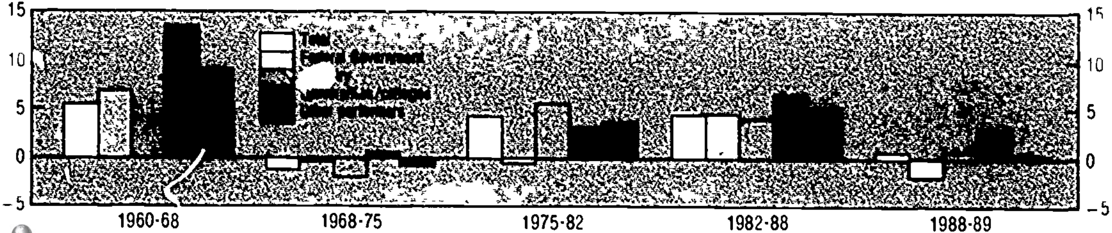
Figure 3. National R&D funding by performer

[Dollars in millions]

Year	Current dollars					Constant (1982) dollars[1]				
[illegible]	Total	[illegible]	[illegible]	Universities/ colleges	Other performers	Total	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	2,140	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	7,325	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	14,590	[illegible]	13,000	8,016	102,651	11,812	[illegible]	[illegible]	[illegible]
1989 (est.)	130,800	14,750	95,800	13,900	8,350	103,480	11,671	74,509	10,909	6,618

Average annual rate of change

Constant (1982) dollars[1]



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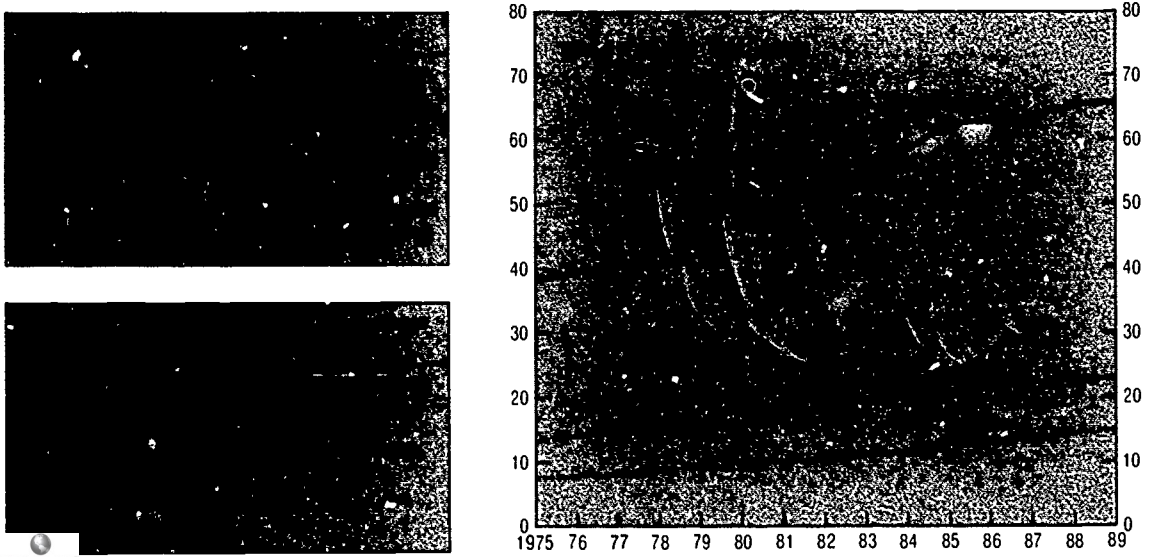
onal data may be obtained from John R Chirichiello SRS Phone (202) 634 4625

Figure 4. **National R&D spending by character of work**



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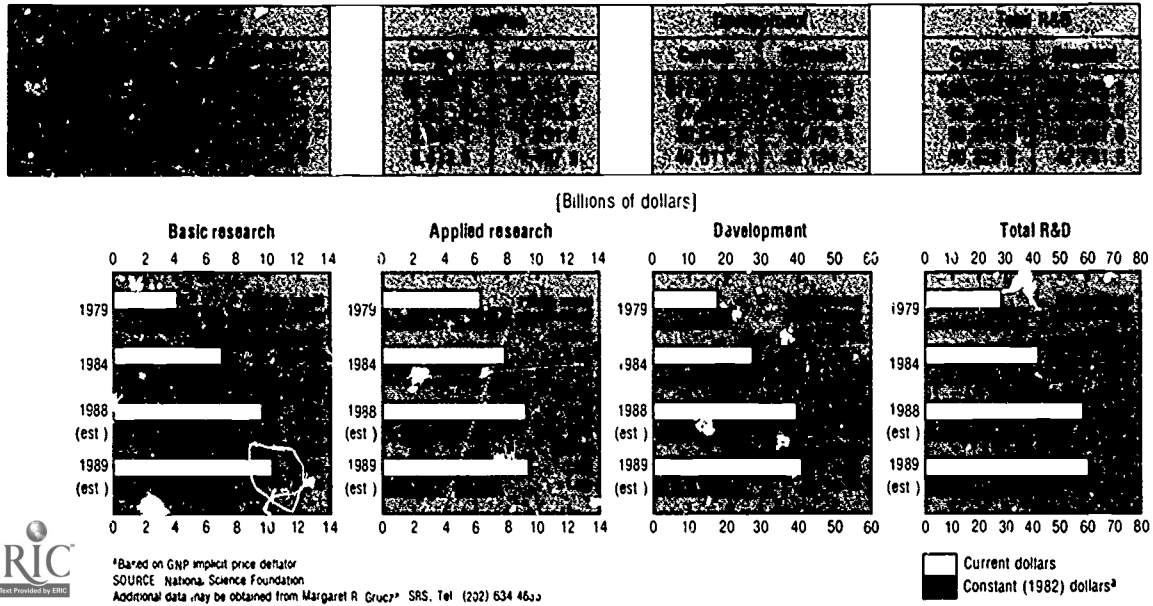
Additional data may be obtained from John R Churchelo SRS Tel (202) 634 4625

Figure 5. **Federal R&D obligations by character of work**

[Dollars in millions]

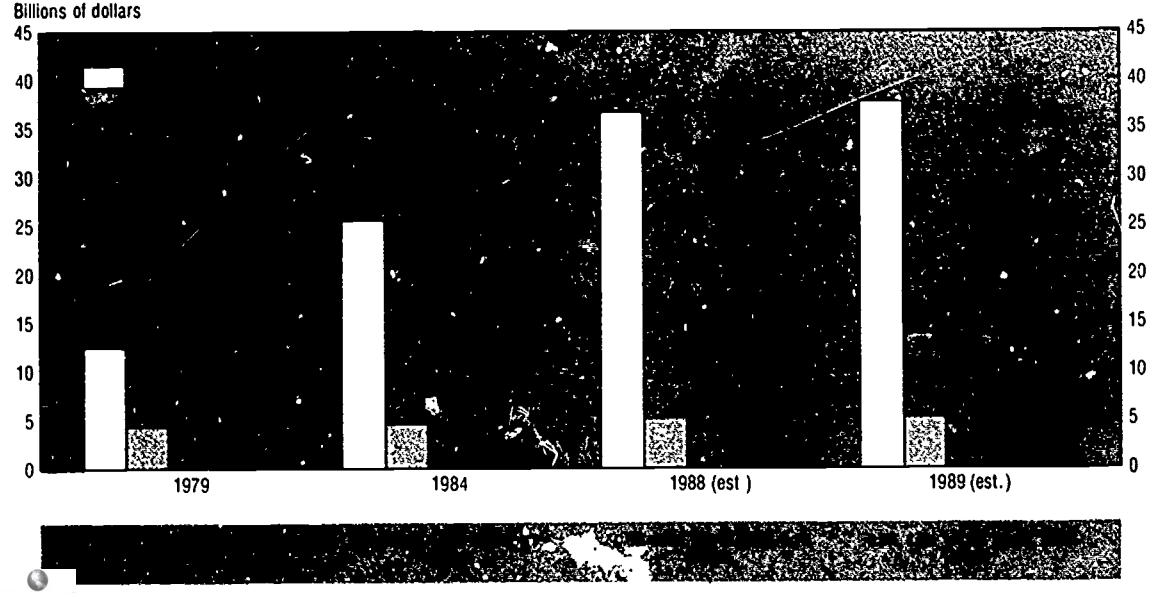


[a]Based on GNP implicit price deflator

SOURCE: National Science Foundation

Additional data may be obtained from Margaret R. Gruce, SRS, Tel. (202) 634 46..

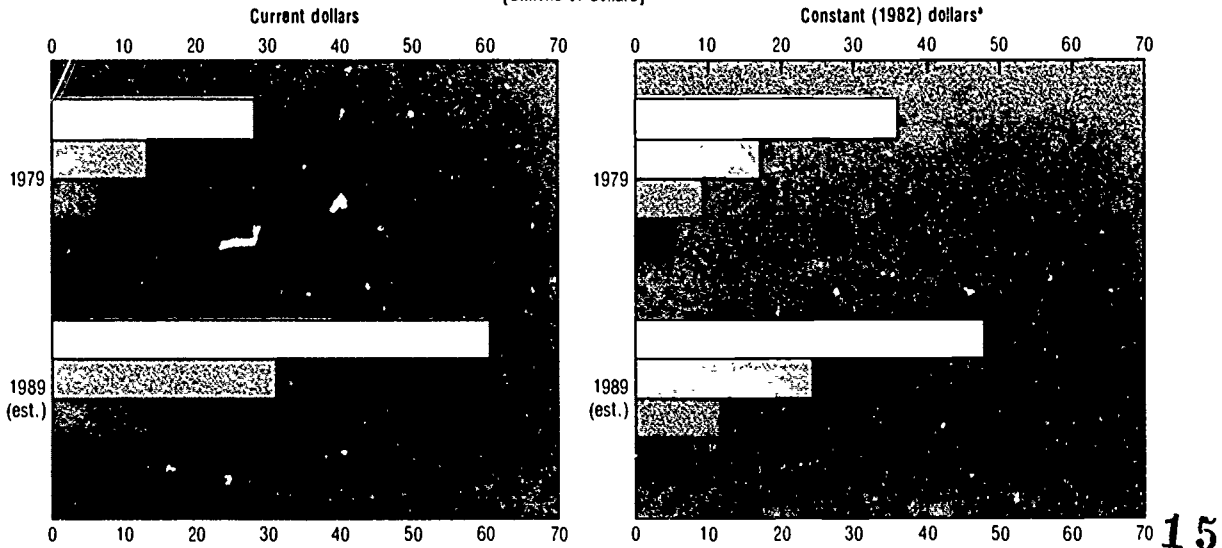
Figure 6. **Federal R&D obligations by major agency**



E National Science Foundation
Additional data may be obtained from Margaret R Grucza, SRS, Tel (202) 634 4636

Figure 7. **Federal R&D obligations by major performer**

[Billions of dollars]



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...rs feder...ly funded research and development centers

...ICE National Science Foundation

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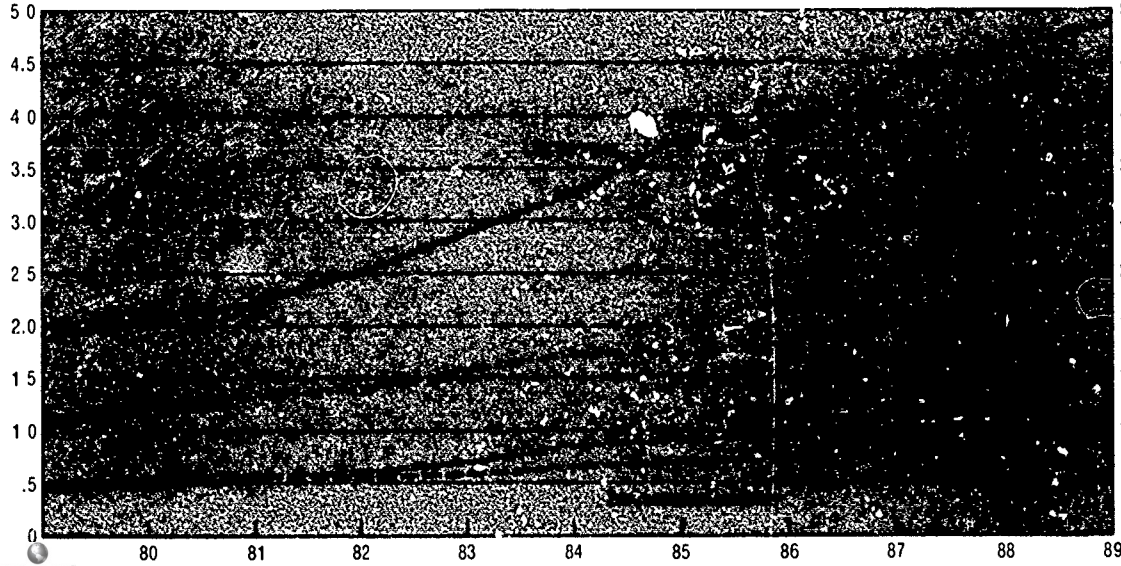
Figure 8. **Federal obligations for basic research by major field of science/engineering**



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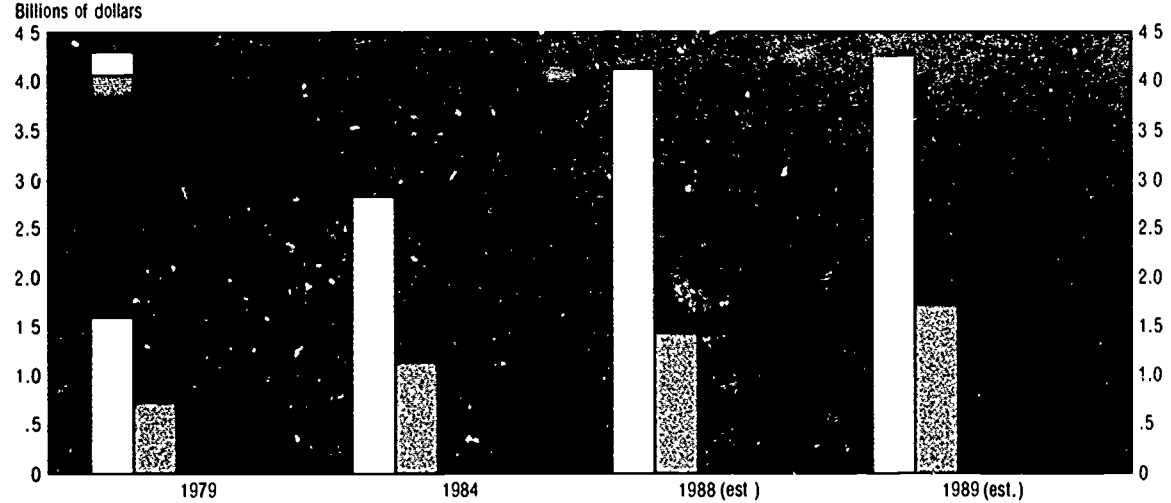
nal data may be obtained from Margaret R Grucza SRS, Tel (202) 634 4636

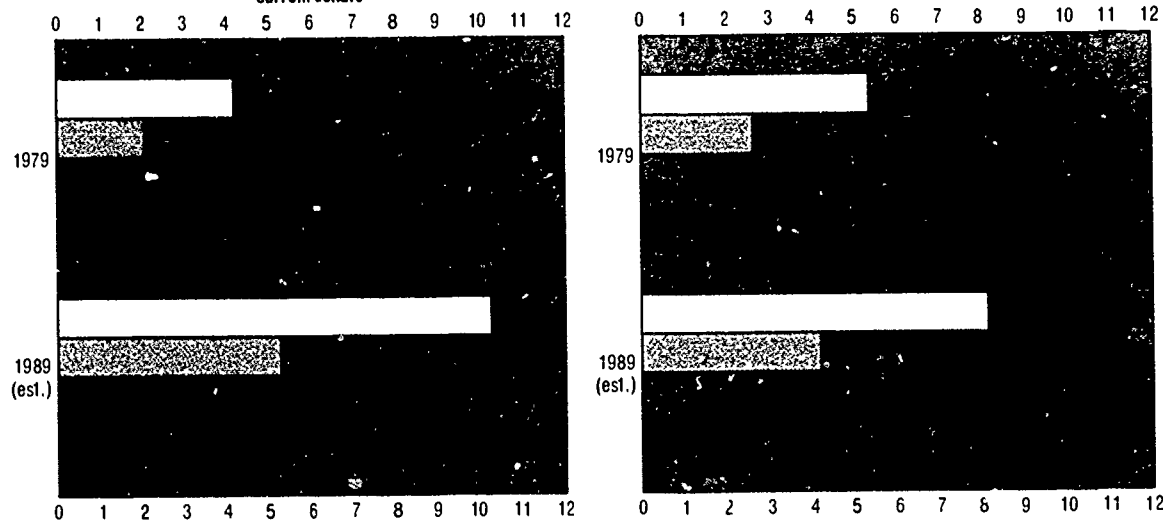
Figure 9. **Federal obligations for basic research by major agency**



National Science Foundation
Additional data may be obtained from Margaret R Grucza SRS, Phone (202) 634 4636

Figure 10. **Federal obligations for basic research by major performer**

[Billions of dollars]



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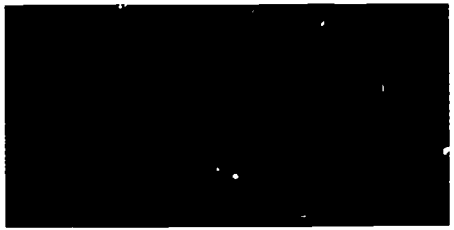
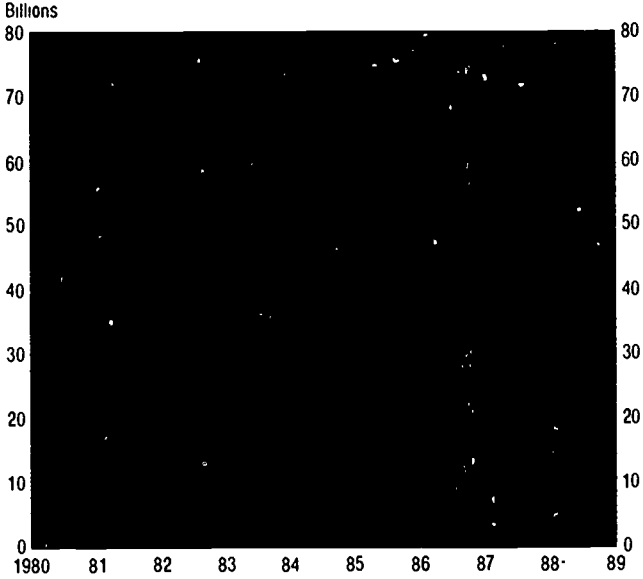
udes federally funded research and development centers

RCE National Science Foundation

Additional data may be obtained from Margaret R Grucza SRS Tel (202) 634 4636

Figure 11. **Industrial R&D expenditures by source of funds**





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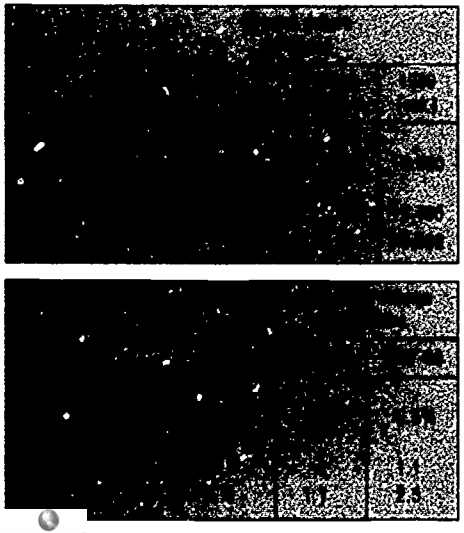
al Science Foundation
Additional data may be obtained from Thomas J Hogan SRS Tel (202) 634 4648

Figure 12. **Industrial R&D expenditures by character of work**



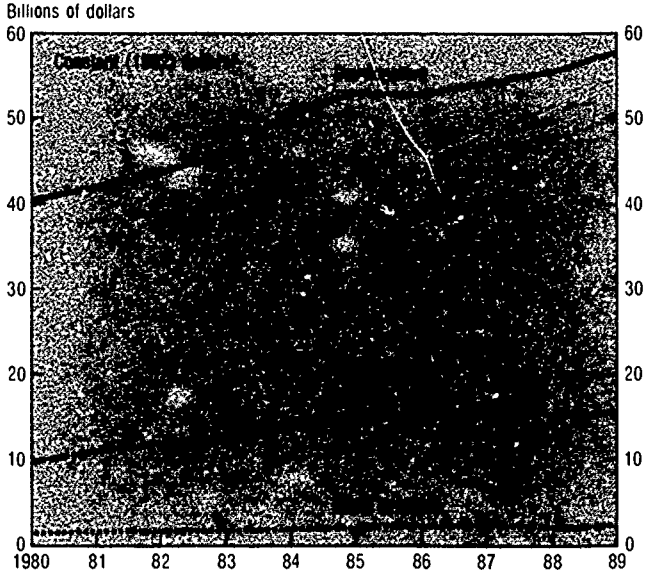


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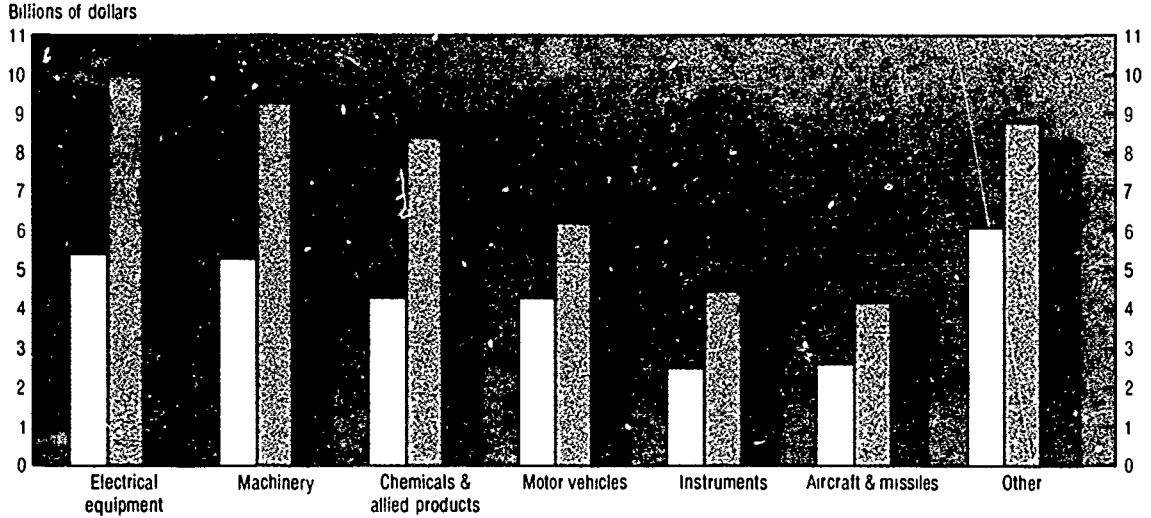
Figure 13. Company R&D expenditures and R&D/sales ratio of six leading industries



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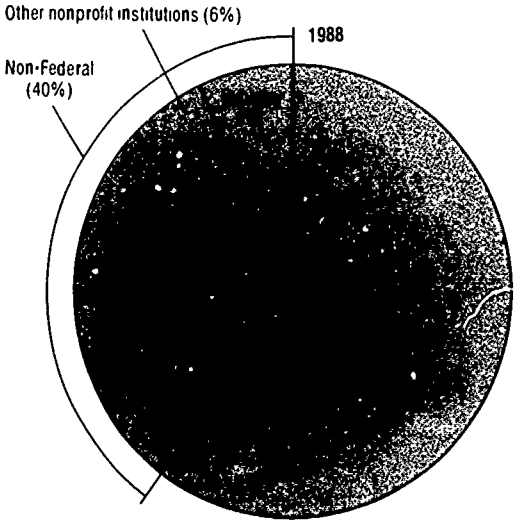
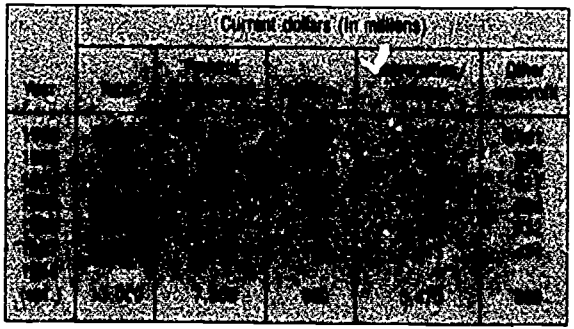
National Science Foundation
data may be obtained from Thomas J Hogan, SRS Tel (202) 634 4648

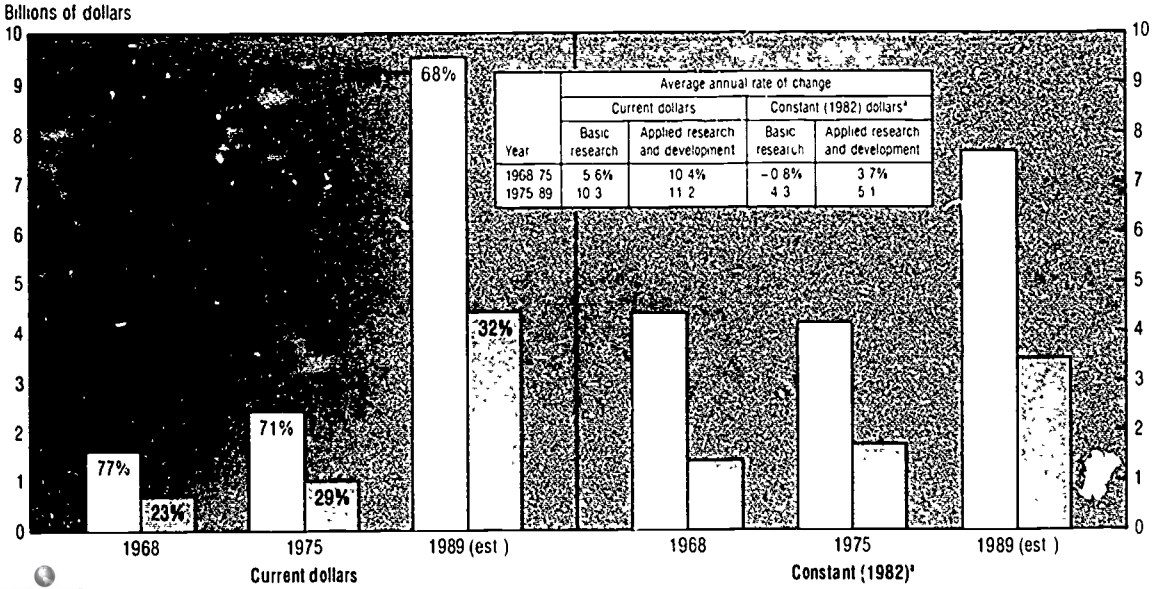
Figure 14. **Academic R&D expenditures by source**





eral portion of academic R&D has ranged between 60 percent and 69 percent during the 1970-88 period
onal Science Foundation
may be obtained from James B. Hoehn, SRS. Tel. (202) 634-4673

Figure 15. Academic R&D expenditures by character of work



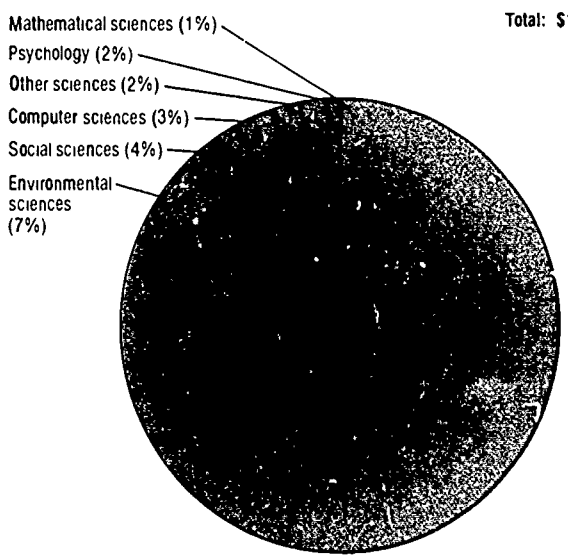
Year	Average annual rate of change			
	Current dollars		Constant (1982) dollars[a]	
	Basic research	Applied research and development	Basic research	Applied research and development
1968 75	5 6%	10 4%	−0 8%	3 7%
1975 89	10 3	11 2	4 3	5 1

[a] GNP implicit price deflator

National Science Foundation

Additional data may be obtained from James B Hoehn SRS, Tel (202) 634 4673

Figure 16. **Academic R&D expenditures by field: FY 1987**



Academic R&D expenditures by field: FYs 1982-87

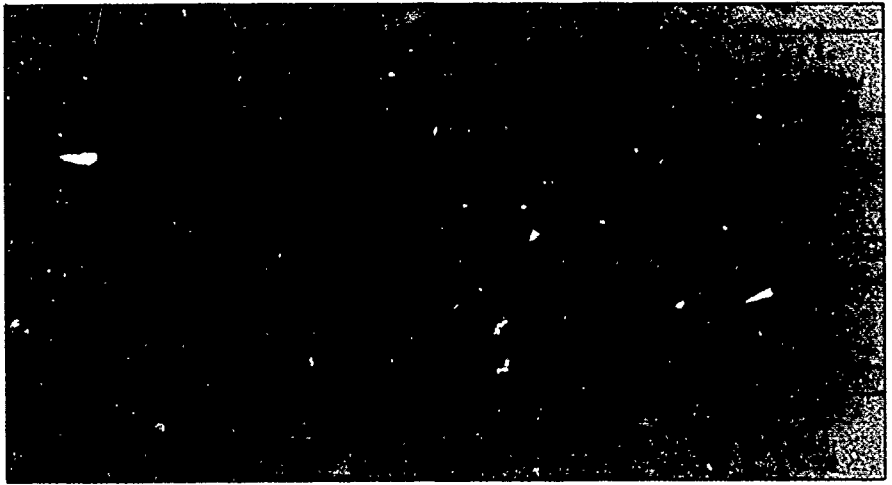
[Dollars in billions]

NOTE Because of rounding components may not add to totals
SOURCE National Science Foundation

...bution of academic R&D expenditures in FY 1968 was essentially the same as in FY 1987
...al Science Foundation
...may be obtained from James B Hoehn SRS Tel (202) 634 4673

Figure 17. **Federal obligations to universities and colleges by type of activity[1]**

[Dollars in millions]



[1]Detail may not add to total because of rounding

[2]Total obligations for the years 1981 through 1983 have been estimated by NSF based on revised data on student aid provided by the Department of Education

[3]Academic research and development is estimated at $7.8 billion for 1988 and $8.2 billion for 1989. Separate data for the other components of academic science, engineering and non science/engineering are not available

[4]Separate data were unavailable for this component before 1966. [Its total was imbedded within the total for all other S&E activities for the years 1963 through 1965.]

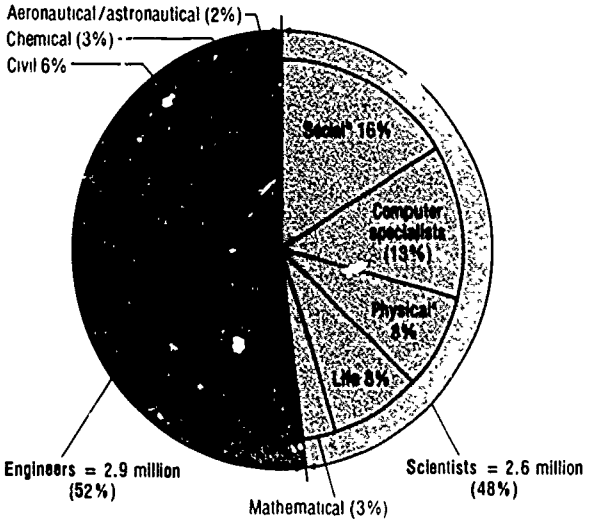
[5]Based on GNP implicit price deflator

SOURCE: National Science Foundation

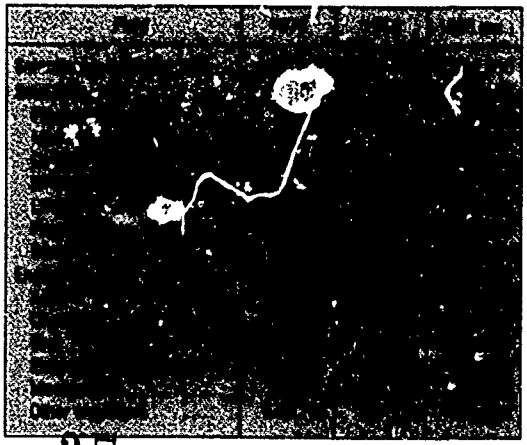
Additional data may be obtained from Margaret A. Grucza, SRS, Tel. (202) 634-4636

Figure 18. **Employed scientists/engineers by field: 1988 (est.)**

Scientists/engineers total = 5.5 million



Employed scientists and engineers by field



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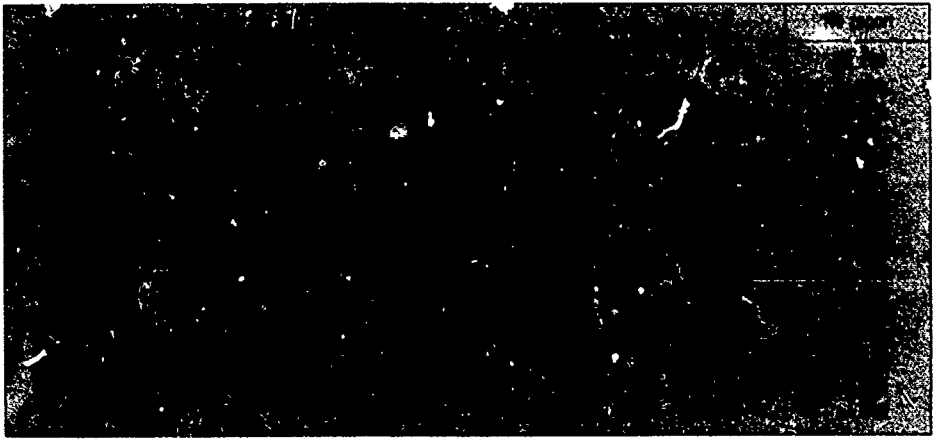
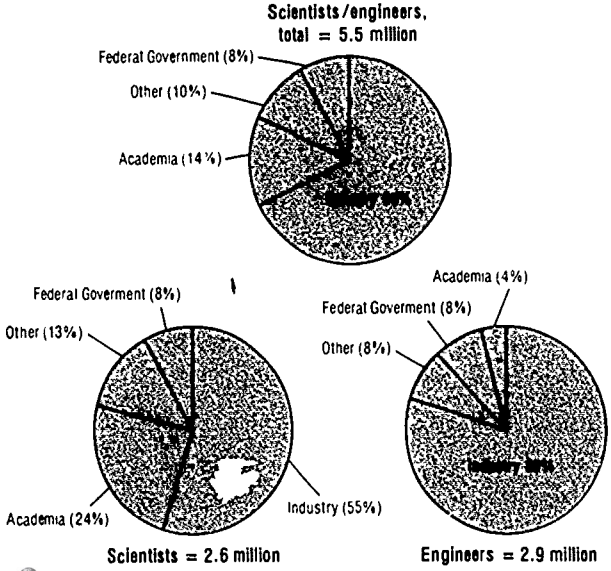
...ironmental scientists. 2 percent of total scientists and engineers
...ychologists. 6 percent of total scientists and engineers
...ational Science Foundation
...ta may be obtained from Michael F. Crowley, SRS. Tel. (202) 634-4664

Figure 19. Scientists and engineers by field and citizenship: 1986



SOURCE National Science Foundation
Additional information may be obtained from Michael F. Crowley, SRS, Tel. (202) 634-4664

Figure 20. **Employed scientists and engineers by sector: 1988 (est.)**



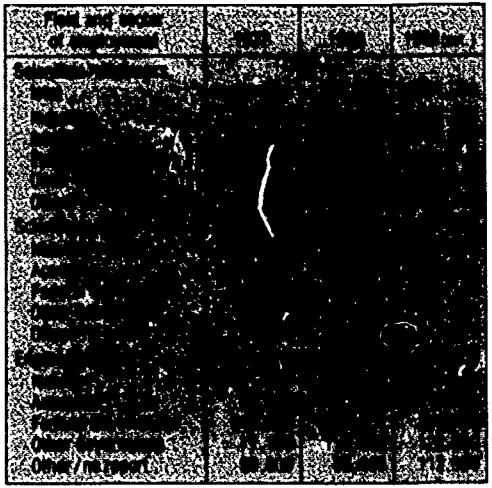


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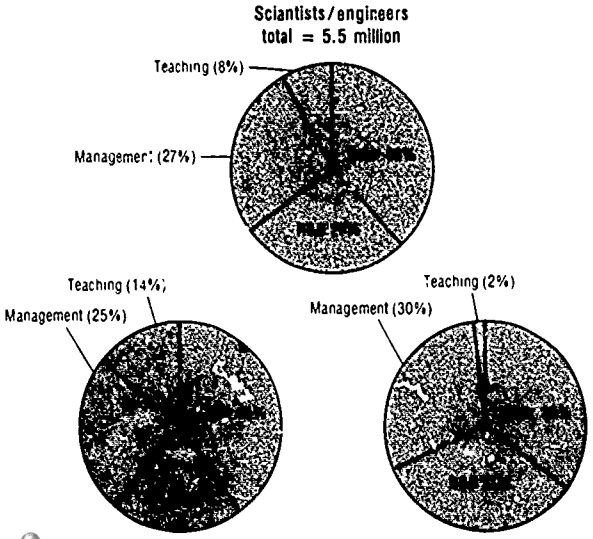
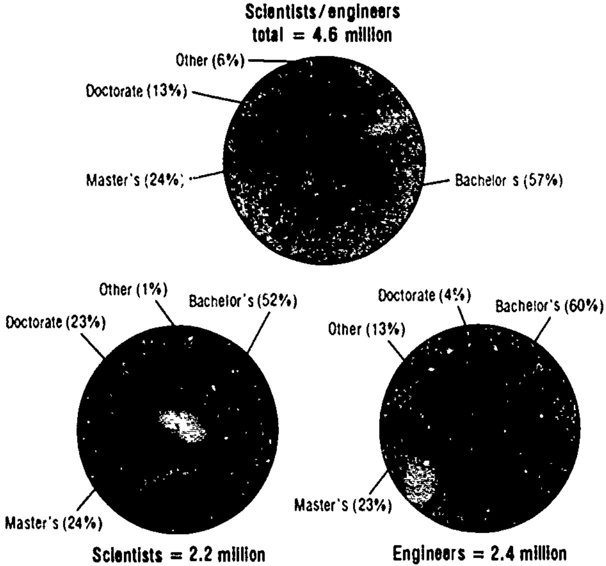
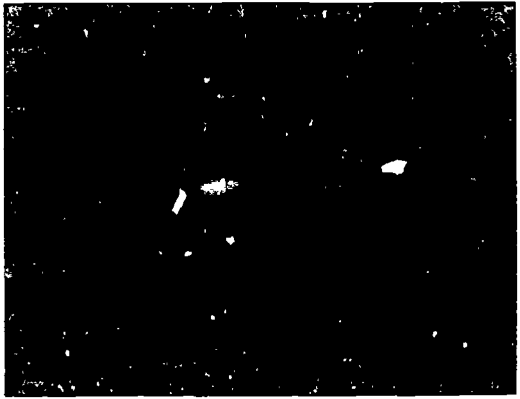
Figure 21. **Employed scientists and engineers by primary work activity: 1988 (est.)**



SOURCE National Science Foundation
Additional data may be obtained from Michael F Crowley, SRS, Tel (202) 634 4664

Figure 22. **Employed scientists and engineers by highest degree: 1986**





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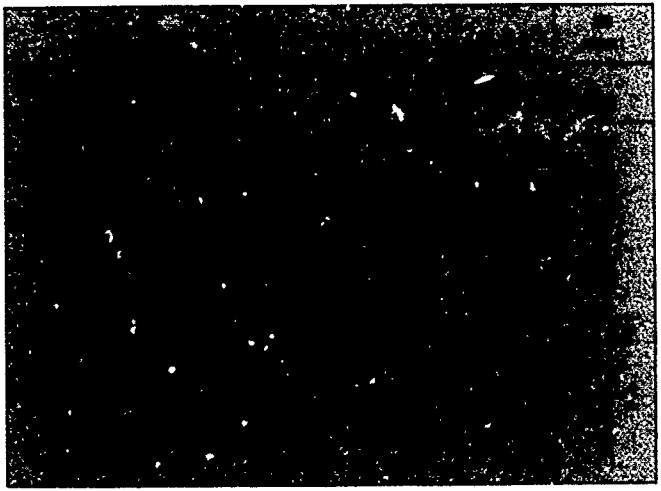
...ional Science Foundation
...a may be obtained from Michael F Crowley SRS, Tel (202) 634 4664

Figure 23. **Doctoral scientists and engineers by field and citizenship: 1985**



'Too few cases to estimate
SOURCE National Science Foundation
Additional information may be obtained from Michael F Crowley, SRS Tel (202) 634 4664

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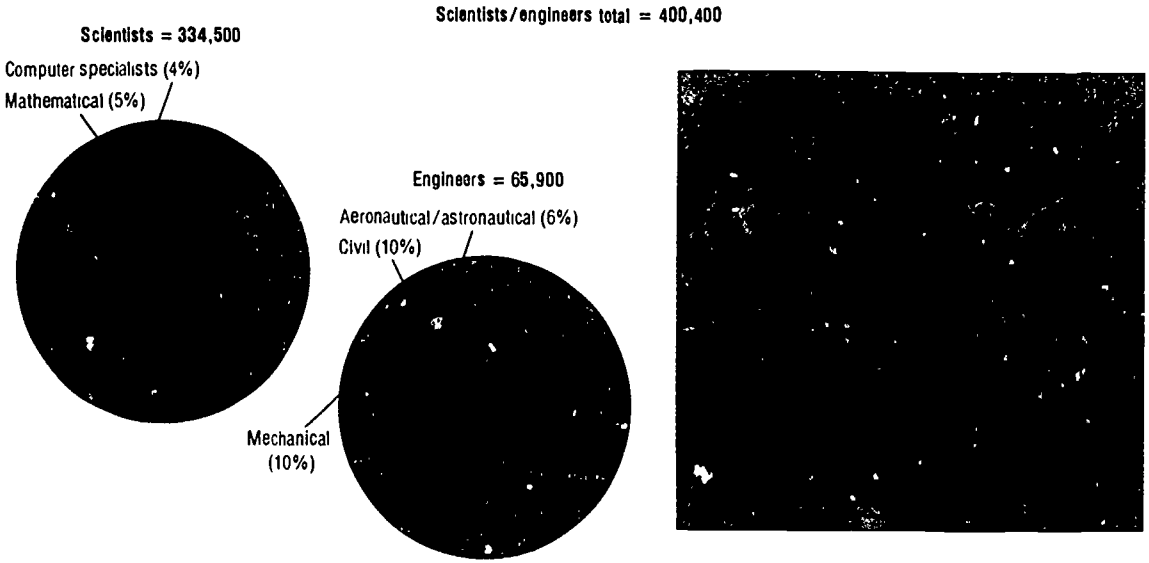
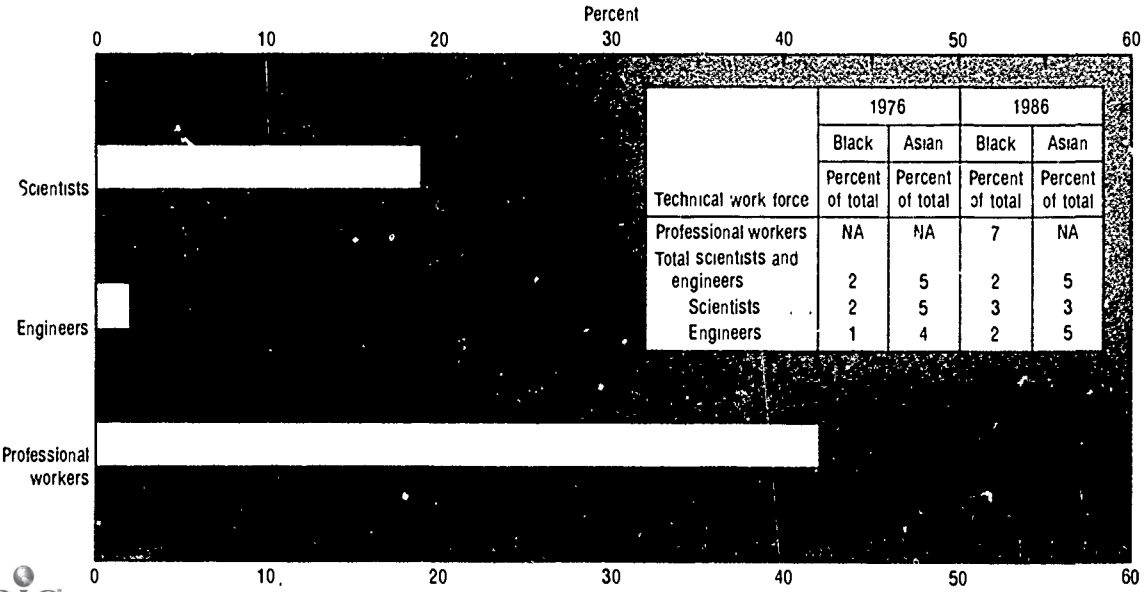
Figure 24. **Employed doctorates in science and engineering by field: 1985**



...vironmental scientists 5 percent of total scientists
...ychologists 16 percent of total ...cientists
...use of rounding components may not add to totals
...ational Science Foundation
...ta may be obtained from Michael F Crowley, SRS, Tel (202) 634 4664

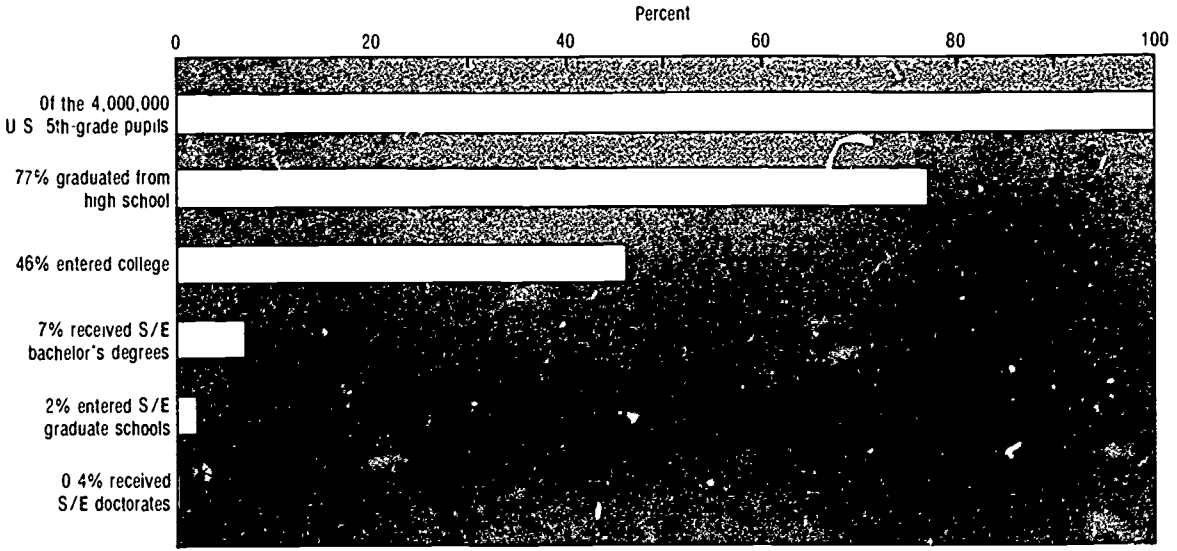
Figure 25. **Women and racial minorities as a proportion of all employed scientists, engineers, and professional workers**



Technical work force	1976		1986	
	Black	Asian	Black	Asian
	Percent of total	Percent of total	Percent of total	Percent of total
Professional workers	NA	NA	7	NA
Total scientists and engineers	2	5	2	5
Scientists	2	5	3	3
Engineers	1	4	2	5

NOTE NA not available
SOURCES National Science Foundation, SRS, and Department of Labor
Additional data may be obtained from Michael F Crowley, SRS, Tel (202) 634-4664

Figure 26. **Retention rates for U.S. citizens, fifth grade through receipt of science/engineering (S/E) doctorate: 1966-87**



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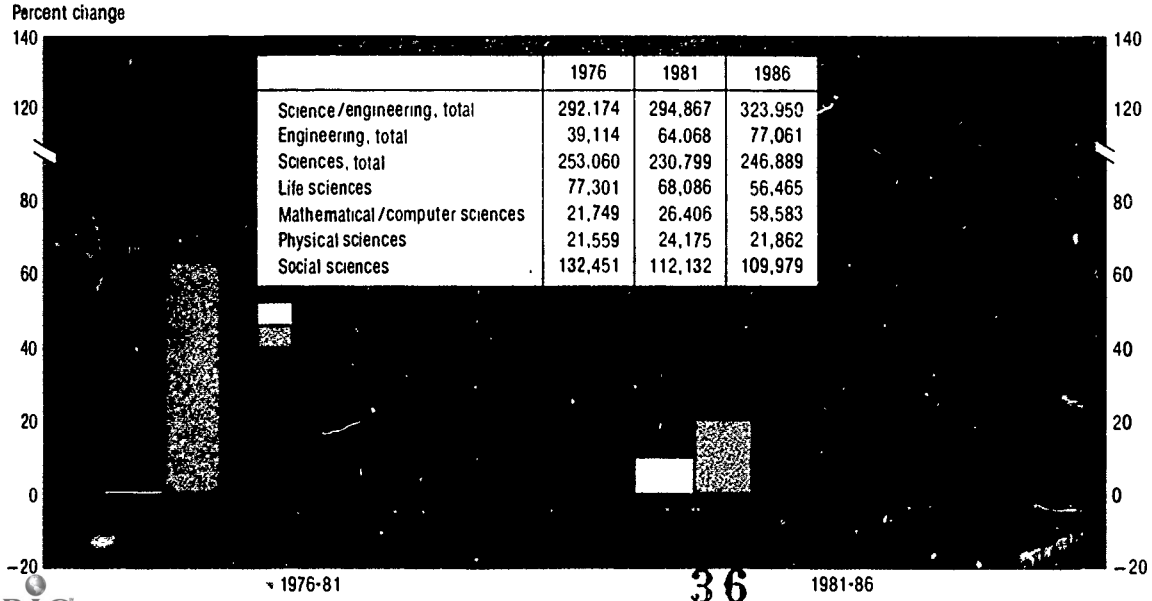
NOTE Calculations are based on comparisons of estimates for enrollment and degree awards to U S citizens only .
SOURCES Center for Education Statistics and National Science Foundation SRS
Additional data may be obtained from Mary A Golladay, SRS, Tel (202) 634 4787

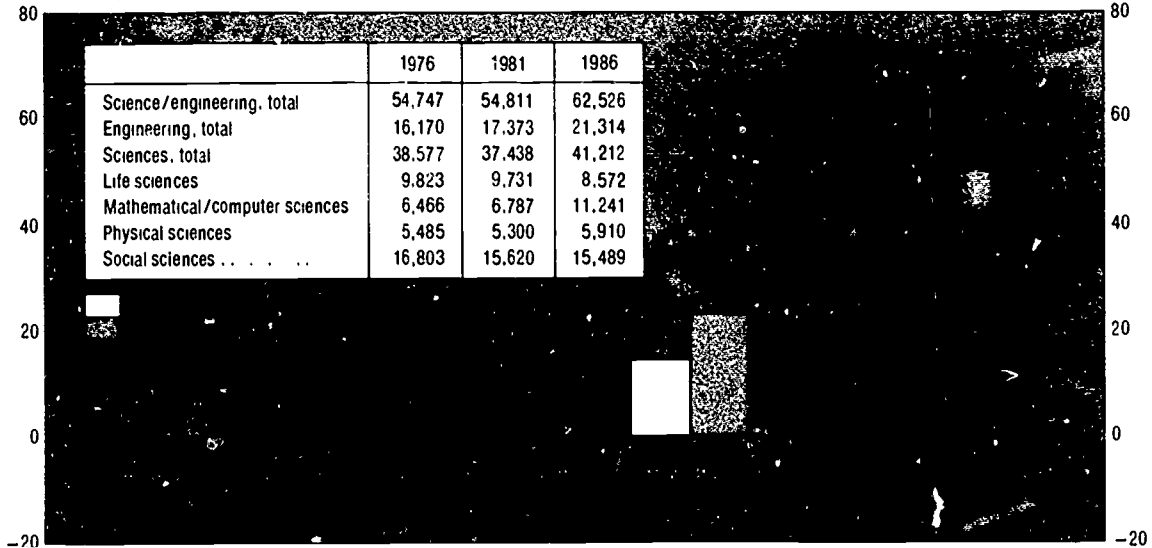
Figure 27. **Bachelor's degrees awarded in major science/engineering fields**



	1976	1981	1986
Science/engineering, total	292,174	294,867	323,950
Engineering, total	39,114	64,068	77,061
Sciences, total	253,060	230,799	246,889
Life sciences	77,301	68,086	56,465
Mathematical/computer sciences	21,749	26,406	58,583
Physical sciences	21,559	24,175	21,862
Social sciences	132,451	112,132	109,979

CES Center for Education Statistics and National Science Foundation, SRS
Additional data may be obtained from Mary A. Golladay, SRS, Tel. (202) 634-4787

Figure 28. **Master's degrees awarded in major science/engineering fields**

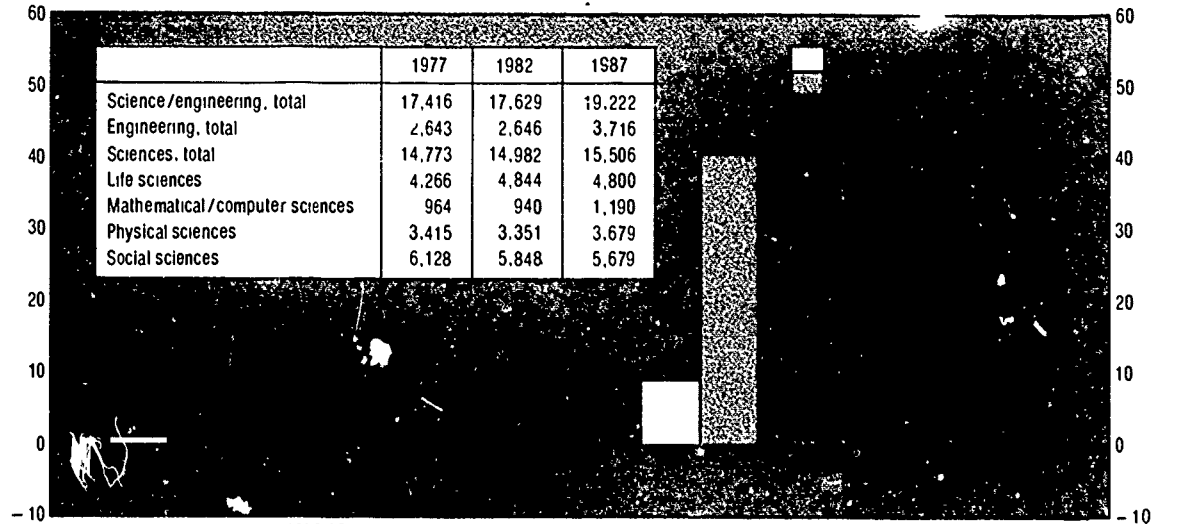


	1976	1981	1986
Science/engineering, total	54,747	54,811	62,526
Engineering, total	16,170	17,373	21,314
Sciences, total	38,577	37,438	41,212
Life sciences	9,823	9,731	8,572
Mathematical/computer sciences	6,466	6,787	11,241
Physical sciences	5,485	5,300	5,910
Social sciences	16,803	15,620	15,489

CES Center for Education Statistics and National Science Foundation, SRS
Additional data may be obtained from Mary A Golladay, SRS Tel (202) 634-4787

Figure 29. **Doctor's degrees awarded in major science/engineering fields**

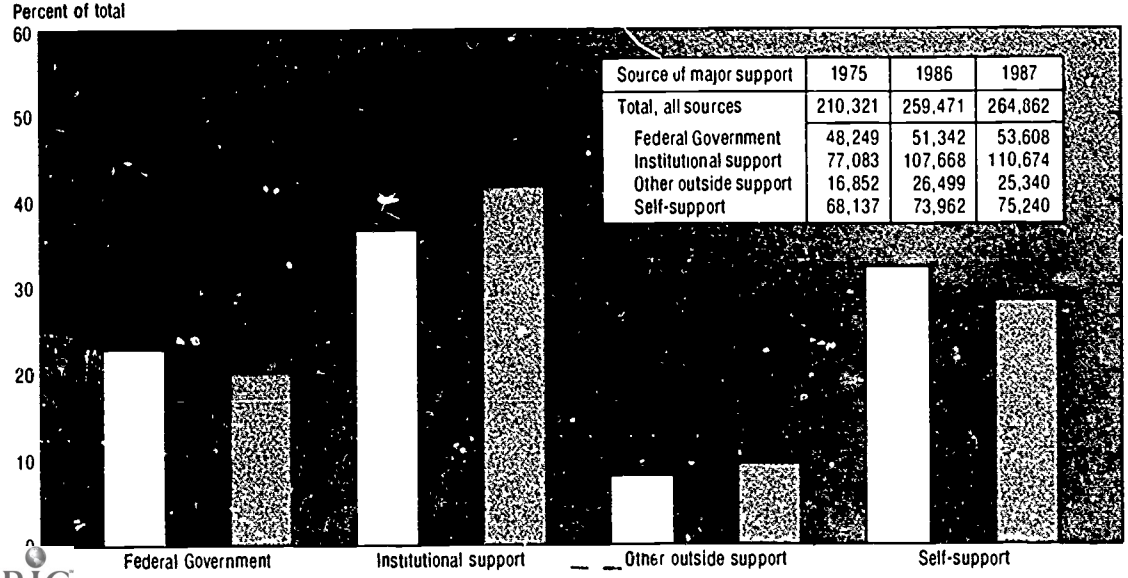
Percent change



	1977	1982	1987
Science/engineering, total	17,416	17,629	19,222
Engineering, total	2,643	2,646	3,716
Sciences, total	14,773	14,982	15,506
Life sciences	4,266	4,844	4,800
Mathematical/computer sciences	964	940	1,190
Physical sciences	3,415	3,351	3,679
Social sciences	6,128	5,848	5,679

ides earth, atmospherical and marine sciences
ides psychology
ICF National Science Foundation, SRS
Additio data may be obtained from Mary A Gotladay, SRS, Tel (202) 634 4787

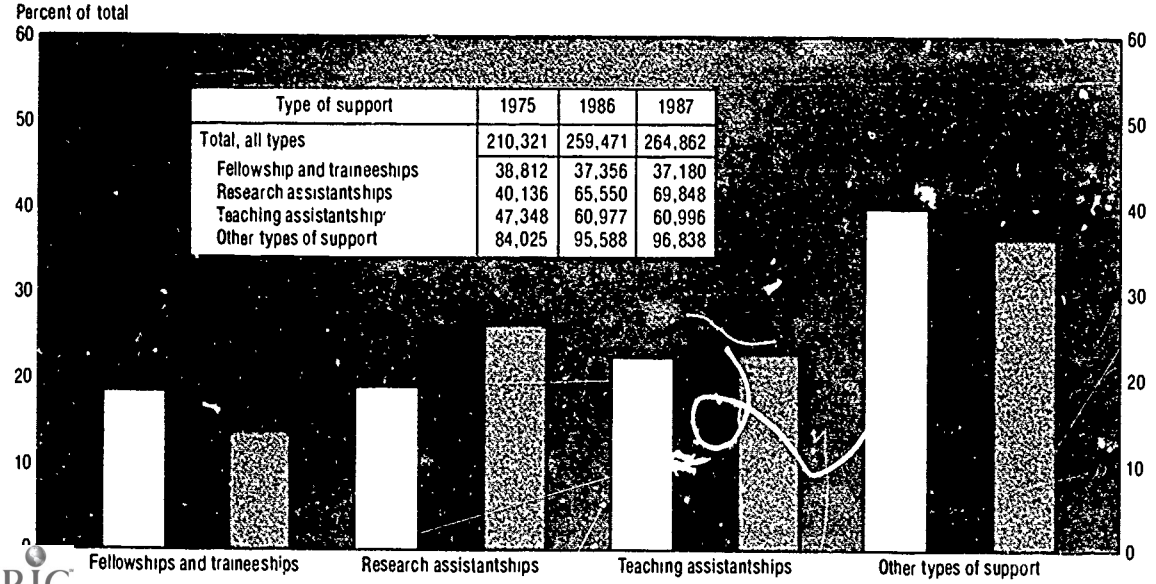
Figure 30. **Full-time science/engineering graduate students in doctorate-granting institutions by source of major support**



Source of major support	1975	1986	1987
Total, all sources	210,321	259,471	264,862
Federal Government	48,249	51,342	53,608
Institutional support	77,083	107,668	110,674
Other outside support	16,852	26,499	25,340
Self-support	68,137	73,962	75,240

E National Science Foundation SRS
Additional data may be obtained from Mary A Golladay, SRS Tel (202) 634-4787

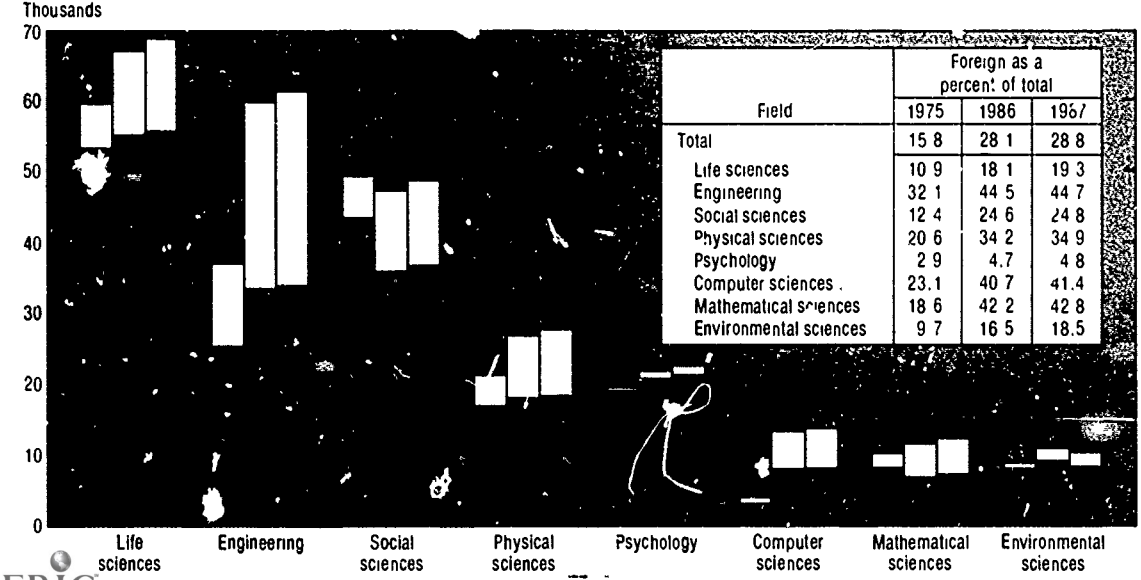
Figure 31. **Full-time science/engineering graduate students in doctorate-granting institutions by type of major support**



Type of support	1975	1986	1987
Total, all types	210,321	259,471	264,862
Fellowship and traineeships	38,812	37,356	37,180
Research assistantships	40,136	65,550	69,848
Teaching assistantship	47,348	60,977	60,996
Other types of support	84,025	95,588	96,838

SOURCE: National Science Foundation, SRS
Additional data may be obtained from Mary A. Golladay, SRS, Tel. (202) 634-4787

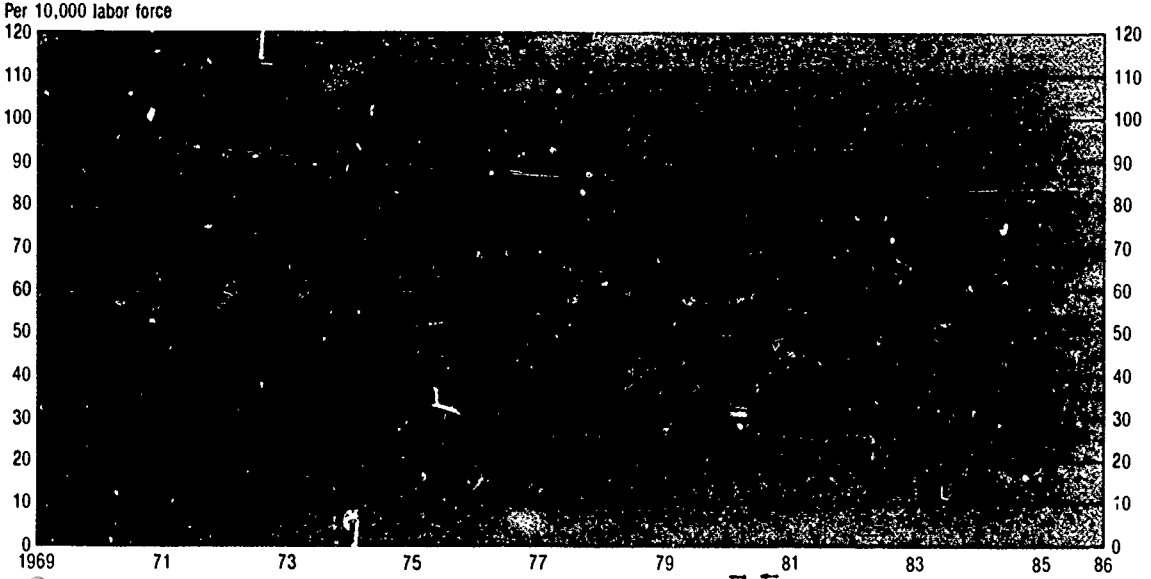
Figure 32. **Full-time science/engineering graduate students in doctorate-granting institutions by field and citizenship**



Field	Foreign as a percent of total		
	1975	1986	1987
Total	15 8	28 1	28 8
Life sciences	10 9	18 1	19 3
Engineering	32 1	44 5	44 7
Social sciences	12 4	24 6	24 8
Physical sciences	20 6	34 2	34 9
Psychology	2 9	4.7	4 8
Computer sciences	23.1	40 7	41.4
Mathematical sciences	18 6	42 2	42 8
Environmental sciences	9 7	16 5	18.5

National Science Foundation SRS
data may be obtained from Mary A Golladay, SRS, Tel (202) 634-4787

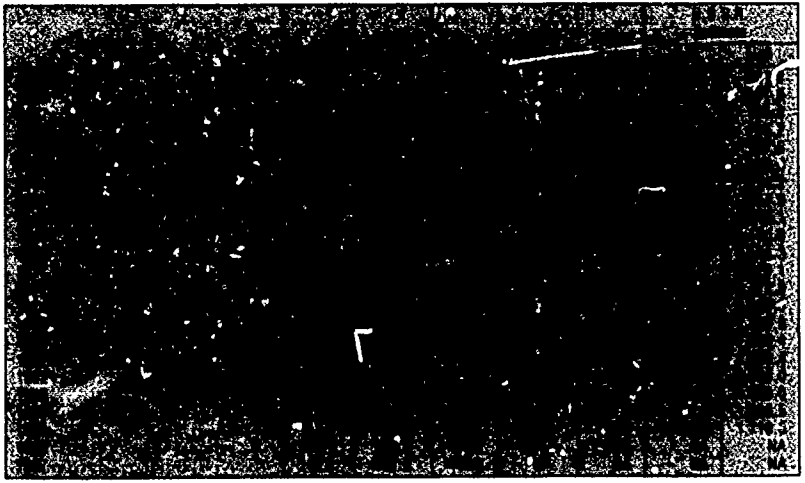
Figure 33. Scientists and engineers engaged in R&D per 10,000 labor force by country



range has been provided for the U S S R because of the difficulties inherent in comparing Soviet scientific personnel data
S National Science Foundation SRS Organisation for Economic Co operation and Development, Dr Robert Campbell (Indiana University)
l data may be obtained from Jennifer Bond, SRS, Tel (202) 634 4640

Figure 34. Scientists and engineers engaged in research and development by country: 1965-87

(In thousands)



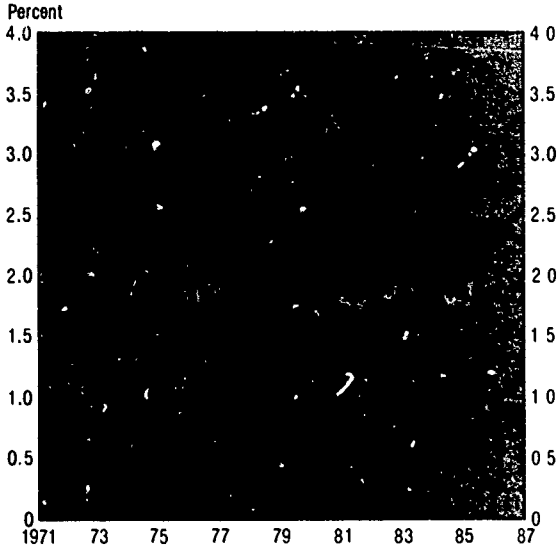
NA = Not available

NOTES Table includes all scientists and engineers engaged in research and development on a full time basis except Japan, whose data include persons primarily employed in research and development in natural sciences and engineering and the United Kingdom whose data include only the Government and industry sectors The figures for West Germany increased in 1979 in part because of increased coverage of small and medium enterprises not surveyed in 1977 The figures for France increased in 1981 in part due to a re evaluation of university research efforts Data are estimated by the National Science Foundation for the following countries and years France 1986 and 1987 We ermany, 1978 1980 1982, 1984, 1986 and 1987, United Kingdom 1984

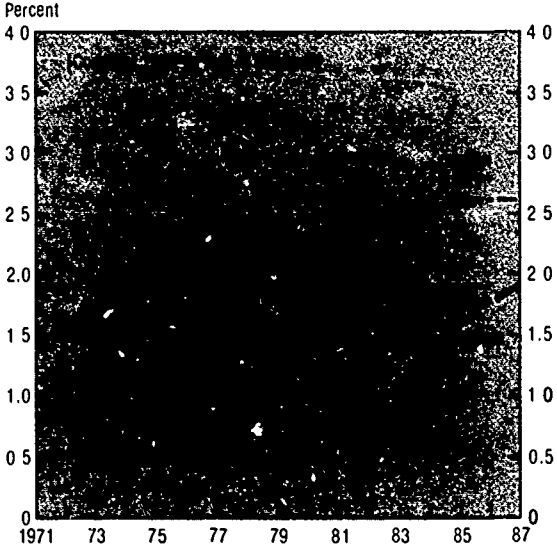
SOURCES National Science Foundation, SRS, Organisation for Economic Co operation and Development and national country data Data for the Soviet Union were provided by Robert Campbell, Indiana University and Harley Balzer, Georgetown University

Additional data may be obtained from Jennifer Bond, SRS, Tel (202) 634 4640

Figure 35. **R&D/GNP by country**

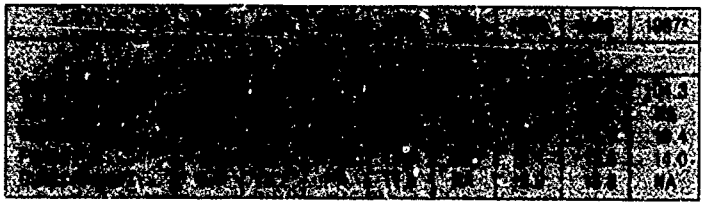


Nondefense R&D/GNP by country



Data are based on GDP and consequently percentages may be slightly overstated compared to GNP
Currency conversions to U S dollars are calculated with OECD Purchasing power parity exchange rates Constant 1982 dollars are based on U S Department of Commerce GNP implicit price deflators
Data for 1987 are based on national estimates of R&D expenditures After 1977, U S data are budget authority instead of budget obligations
S National Science Foundation, SRS Organisation for Economic Co-operation and Development the International Monetary Fund and national sources
Data may be obtained from Jennifer Bond, SRS. Tel (202) 6344 4640

Figure 36. National expenditures on research and development[1] by selected countries: 1980-87



[1]Gross expenditures for performance of R&D including associated capital expenditures except for the United States where total capital expenditure data are not available

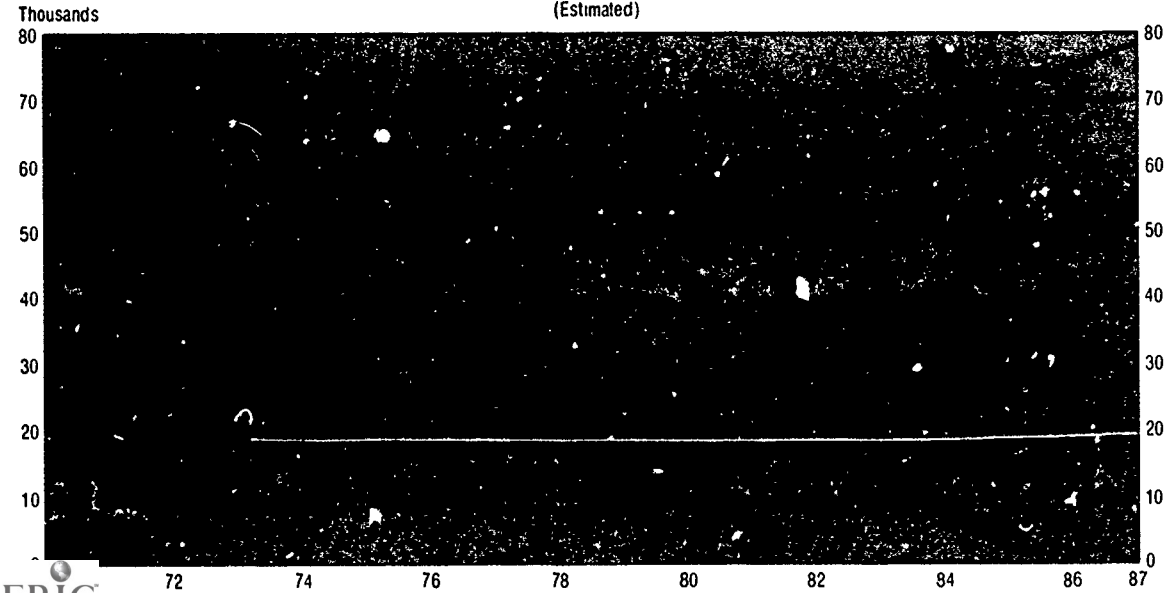
[2]Conversions of foreign currencies to U S dollars are calculated based on OECD purchasing power parity exchange rates Constant 1982 dollars are based on U S Department of Commerce GNP implicit price deflators

[3]Data for 1987 are national estimates

SOURCES National Science Foundation SRS Organisation for Economic Co operation and Development and national sources

Additional data may be obtained from Jennifer Bond SRS Tel (202) 634 4640

Figure 37. **U.S. patents granted to U.S. and foreign inventors by year of application**



U.S. Patent and Trademark Office
Additional data may be obtained from Carlos Kruytbosch, SRS, Tel (202) 634 4682

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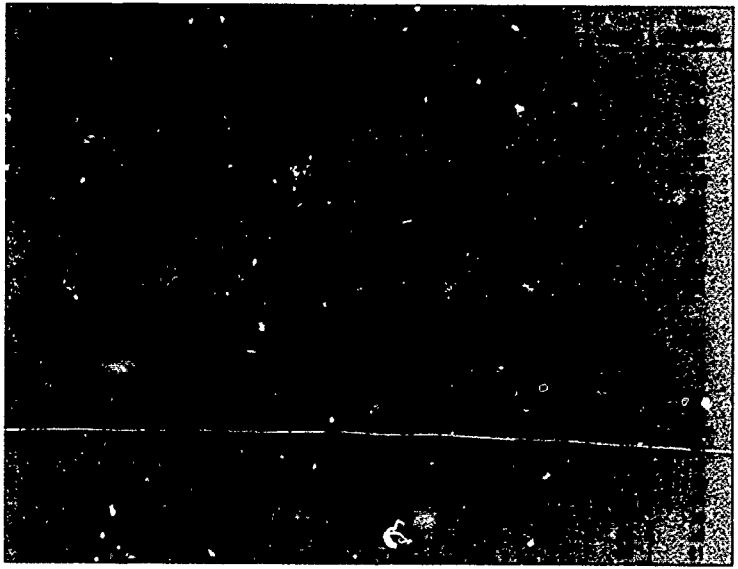
Figure 38. **U.S. receipts and payments of royalties and license fees associated with unaffiliated residents of selected countries**
[Millions of dollars: constant (1982)[1]]



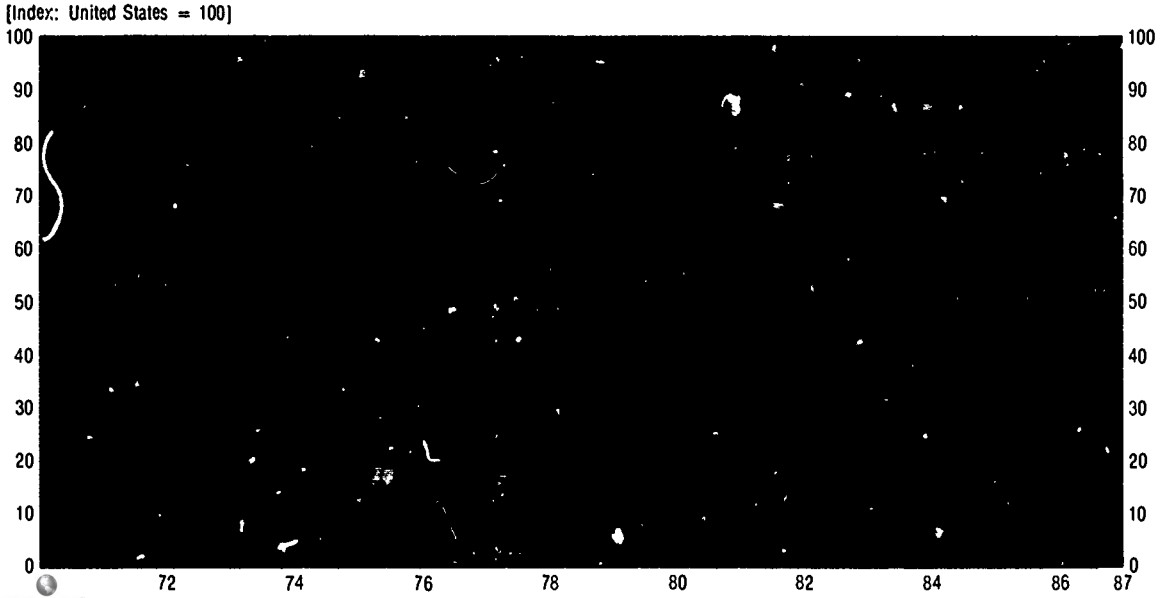
[1]GNP implicit price deflators used to convert current to constant 1982 dollars
NOTE NA = Not available
SOURCE U S Department of Commerce, Bureau of Economic Analysis unpublished data
Additional data may be obtained from Carlos Kruytbosch, SRS, Tel (202) 634 4682

Figure 39. Foreign direct investment in the United States

[Millions of dollars constant 1982[1]]

[1]GNP implicit price deflators used to convert current dollars to constant 1982 dollars
SOURCES U S Department of Commerce Bureau of Economic Analysis *Selected Data on U S Direct Investment Abroad 1966 78* (1980) *Survey of Current Business* (February 1981) pp 50 51 and *Survey of Current Business* (annual August issues)
Additional data may be obtained from Carlos Kruytbosch SRS Tel (202) 634 4682

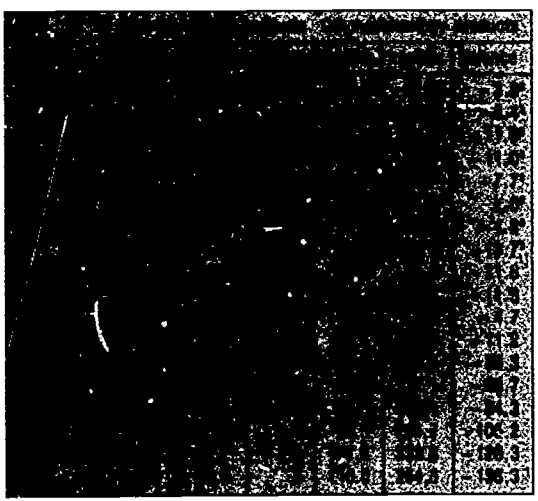
Figure 40 Gross domestic product per employed person

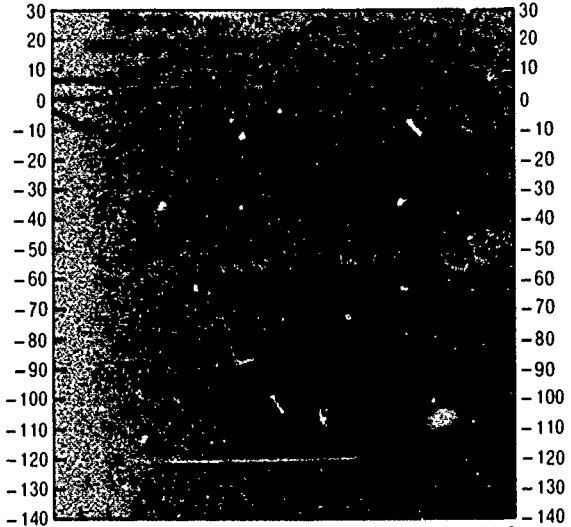


Bureau of Labor Statistics, Department of Labor
I data may be obtained from Jennifer Bond, SRS, Tel (202) 634 4640

Figure 41. **U.S. trade balance[1] in high-tech..ology[2] and nonhigh-technology manufactured products, 1970-87**

[Billions of dollars]





[1] U.S. Department of Commerce DOC 3 definition

[2] = estimated

s for 1973-77 exclude special category exports and 1978-80 exclude trade with U.S. Virgin
oreign countries. After 1977, U.S. non high technology exports also include undocumented
nada.

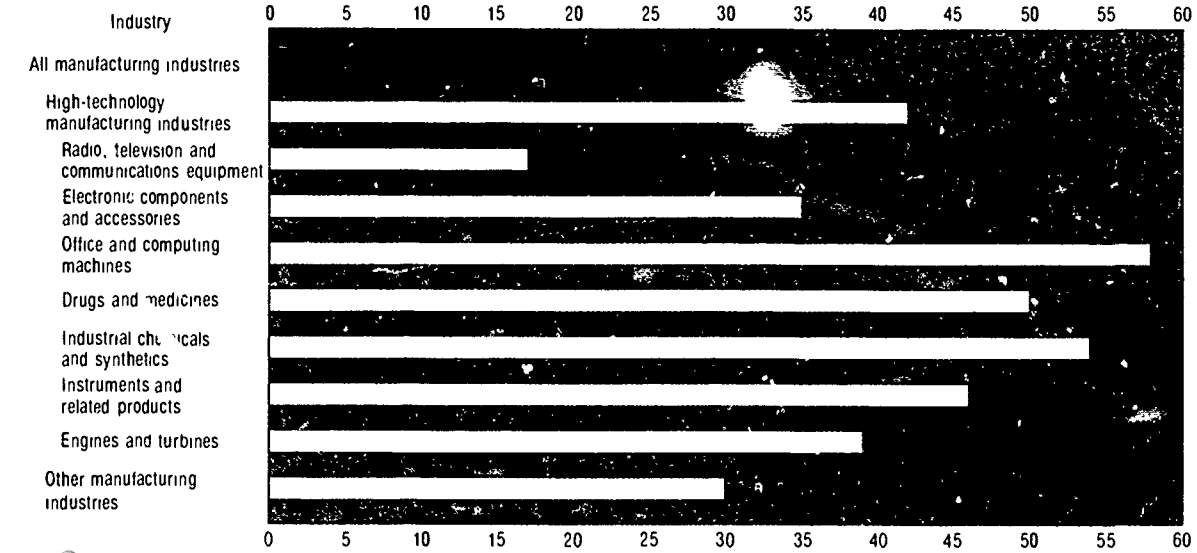
S. Department of Commerce, *U.S. Trade Performance in 1983 and Outlook, 1984* and
Trade Performance in 1985 and Outlook, 1986 and unpublished data.

Exports less imports

SOURCE: Department of Commerce, International Trade Administration

Additional data may be obtained from Jennifer Bond, SRS, Tel. (202) 634-4640

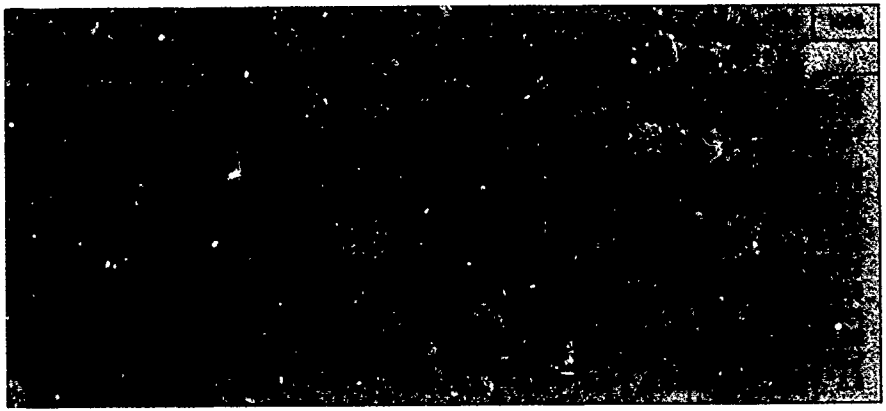
Figure 42. **Total foreign affiliate assets of U.S. corporations, as a percent of total parent assets: 1986**



SOURCE U S Department of Commerce Bureau of Economic Analysis U S Direct Investment Abroad Selected data for Foreign Affiliates and U S Parents in all Industries Preliminary 1986 Estimates

Additional data may be obtained from Carlos Kruytbosch SRS, Tel (202) 634 4682

Figure 43. **Exports of high-technology[1] products as a percent of shipments: 1978-86**

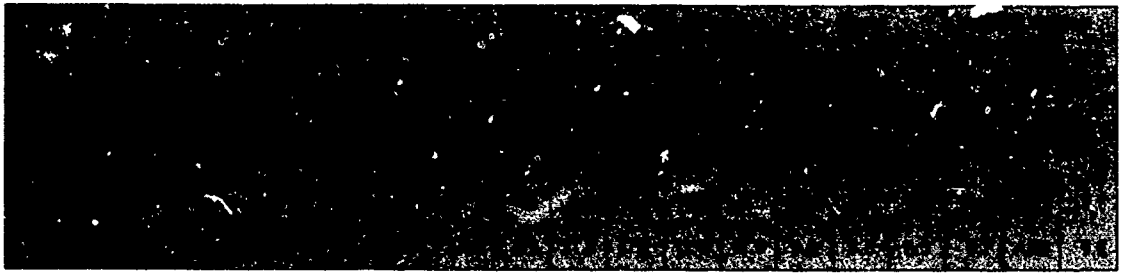


[1]U S Department of Commerce DOC 3 definitions

SOURCES U S Department of Commerce International Trade Administration *U S Trade Performance in 1983 and Outlook* (June 1984) and unpublished data Bureau of the Census *Statistical Abstract of the United States 1986* (1987) and Bureau of the Census *Annual Survey of Manufactures Value of Product Shipments* (M85(AS)-2) January 1987 and previous editions

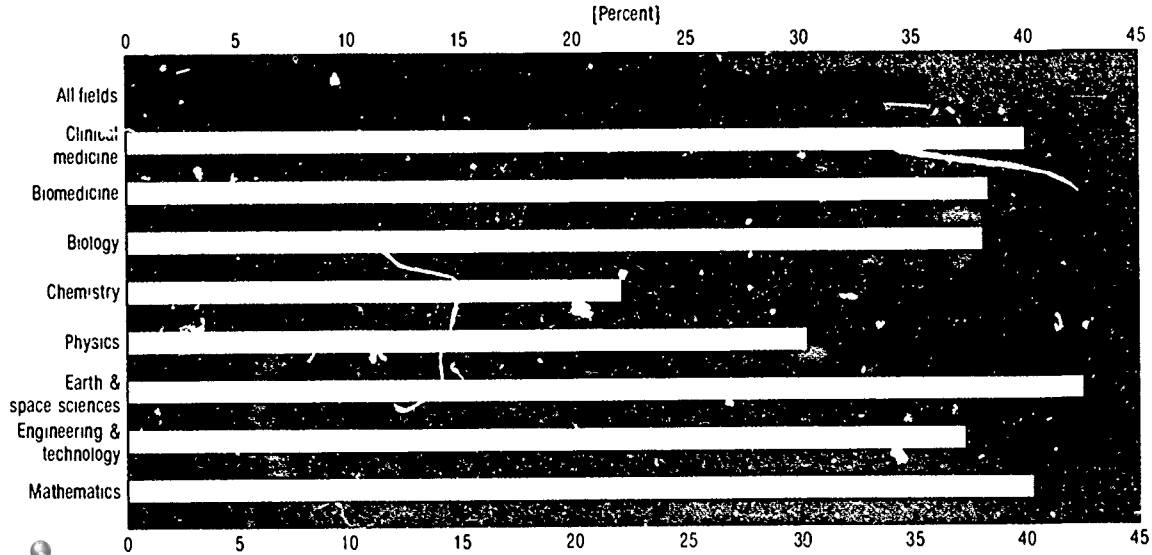
Additional data may be obtained from Carlos Kruytbosch SRS Tel (202) 634 4582

Figure 44. **Export market shares, selected high-technology products: 1976, 1980, and 1986**



SOURCES National Science Foundation SRS DRI Special Tabulations of International Trade 1988
Additional data may be obtained from Jennifer Bond SRS Tel (202) 634 4640

Figure 45. **U.S. scientific and technical (S/T) publications as a percent of world S/T publications: 1986**



NOTE These data are based on the articles notes and reviews in over 3 000 influential journals carried in the 1981 *Science Citation Index* of the Institute for Scientific Information An article written by researchers from more than one country is prorated across the countries involved

SOURCE Computer Horizons, Inc

Additional data may be obtained from Carlos Kruytbosch, SRS, Tel. (202) 634-4682

Other Science Resources Publications

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"Industrial Biotechnology R&D Performance Increased an Estimated 12 Percent in 1987 to $1 4 Billion"	88-306
"Non Federal Sources Lead Growth in Academic Research Instrumentation Support"	88-319
"Real Growth in Academic R&D Spending Slowed to 2% in FY 1987, Down from 9% in 1986"	88-314
"Real Increase in 1988 National R&D Funds Estimated at Lowest Rate in Eleven Years"	88-303
"Universities Report Improvement in Computer and Physical Science Instrumentation, but Deterioration in Engineering"	87-316
S/E Personnel	
"Foreign Students Fueled 2% Rise in 1985 Graduate Science and Engineering Enrollment	87-306
"More Recent Science and Engineering (S/E) Graduates Finding S/E Jobs"	88-310
"Recent-Doctorate Faculty Increase in Engineering and Some Science Fields"	87-310
"Scientists and Engineers Now Account for Over 4 Percent of Total U S Employment"	87-313
"Services Led in Private Industry Growth in Science/Engineering Jobs but Manufacturing Rebounds and Tops 1 Million in 1987"	88-304

Detailed Statistical Tables

NOTE Data sets from most Detailed Statistical Tables reports are obtainable on both diskette and in paper copy, and data sets from all Tables reports are available through the SRS Electronic Bulletin Board An SRS Number is given for any title for which only a diskette is available, all numbers given below are NSF Numbers except those specified as SRS

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Academic Science/Engineering Graduate Enrollment and Support, Fall 1986	88-307
Academic Science/Engineering R&D Funds, Fiscal Year 1986	88-312
Federal Funds for Research and Development Fiscal Years 1986, 1987, and 1988, Volume XXXVI	87-314
Federal Support to Universities, Colleges, and Selected Nonprofit Institutions Fiscal Year 1986	87-318
S/E Personnel	
Characteristics of Doctoral Scientists and Engineers in the United States 1985	SRS 86-D3
Characteristics of Recent Science/Engineering Graduates 1986	87-321
Federal Scientists and Engineers Fiscal Year 1986	87-320
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Scientists, Engineers, and Technicians in Manufacturing Industries 1983	SRS 86-D5
Scientists, Engineers, and Technicians in Nonmanufacturing Industries 1984	SRS 86-D6
Scientists, Engineers, and Technicians in Trade and Regulated Industries 1985	88-313
U S Scientists and Engineers 1988	88-322

Reports (analytical)

Note: All Reports are available in paper copy Additionally, selected tables from some of these Reports [designated in the following list by an asterisk] are obtainable on diskette and through the SRS Electronic Bulletin Board

Overviews	
Biotechnology Research and Development Activities in Industry 1984 and 1985	87-311
Foreign Citizens in U S Science and Engineering History, Status, and Outlook	86-305 (rev)
Geographic Distribution of Industrial R&D Expenditures . . .	88-317

	NSF No
International Science and Technology Data Update 1987	87-319*
National Patterns of Science and Technology Resources 1987	88-305*
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