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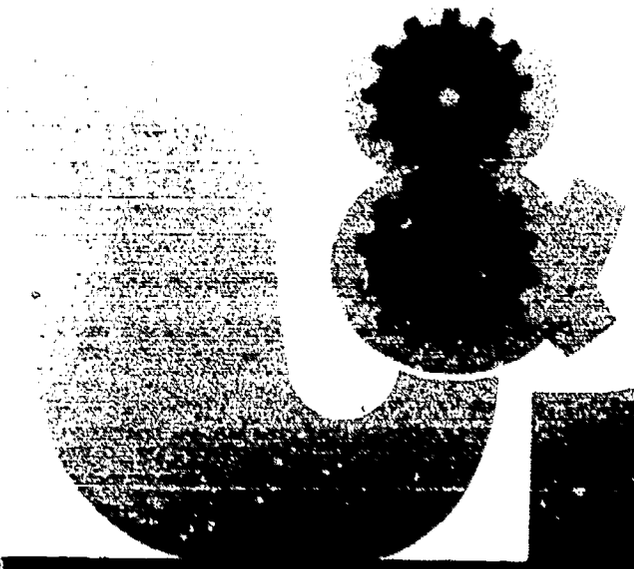
ABSTRACT

The National Science Foundation sponsored Survey of Industrial Research and Development for 1977 was conducted by the Bureau of the Census in January 1978. Approximately 1,500 R&D-performing companies participated in the survey. Remarks attributed to company officials were based on discussions with representatives from leading R&D-performing companies in the major industries. This report contains a detailed report of R&D spending during 1977, as well as historical tables showing trends for key R&D funding variables. Also included is information about industry-employed R&D scientists and engineers. R&D expenditures for U.S. firms are presented in a variety of ways: by source of funds, type of activity, major cost component, geographic area, field of basic research, product area, effort contracted out, amount performed in foreign countries, and by amounts expended on research and development devoted to energy-related and pollution abatement projects. Whenever possible, the data are presented on an individual industry basis, e.g., instruments, machinery, etc. Data presented in this report cover the period 1956-1977 for funding data and January 1957 to January 1978 for R&D scientist and engineer data. (Author/MK)

RESEARCH AND DEVELOPMENT IN INDUSTRY 1977

FUNDS, 1977
SCIENTISTS & ENGINEERS
JANUARY 1978



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FOREWORD

Private and public officials see lagging innovation among industrial establishments as a major factor in the Nation's current economic ills. Symptoms appear in the form of declining productivity, growing international trade deficits, increasing unemployment, double-digit inflation and, most recently, a decline in the gross national product (GNP). In studies undertaken to examine optional policies for stimulating innovation in the private sector, industrial research and development is cited as an important factor. It is one which, many analysts believe, suffers from underinvestment. While industry has continued to show real growth in R&D expenditures, much of this growth is attributed to energy- and regulatory-related projects which tend not to result in economic growth. Rather, according to industry officials, industry directs its R&D funds at producing marginal improvements in existing products, or at process cost-cutting improvements.

Recent evidence indicates that the pattern of industry's R&D activity may be changing toward an increased emphasis on basic research. Does this represent a return of corporate confidence in basic research's ability to stimulate innovation and company growth? Interviews with numerous company R&D officials would suggest this. Those interviewed do add, however, that R&D expenditures, especially basic research expenditures, frequently become candidates for reduction in times of economic stress.

This report, the latest of a continuing series, provides information on the magnitude and characteristics of the industrial R&D enterprise by identifying and analyzing current trends.

The National Science Foundation and the Bureau of the Census gratefully acknowledge the cooperation of the numerous organizations that provided data for this study.

Richard C. Atkinson
Director
National Science Foundation

December 1979

notes

- Statistics shown may not add to totals or subtotals because of rounding.
- Unless constant dollars are specified, data shown in this report are in terms of current dollars.
- Complete technical notes, including imputation rates, are contained in appendix A. Additional questions regarding these survey findings should be addressed to Carolyn B. Arena, Industry Studies Group, Division of Science Resources Studies, National Science Foundation, Washington, D.C. 20550 (202) 634-4648.

acknowledgments

This report was prepared in the Division of Science Resources Studies under the general guidance of Charles E. Falk, Director, and William L. Stewart, Head, R&D Economic Studies Section. Thomas J. Hogan, Study Director, Industry Studies Group, provided direction, and Roberta A. Miller, Margaret R. Grucza, and Carolyn B. Arena were responsible for interpretation of the data.

Data contained in the survey were collected and compiled by the Bureau of the Census, Department of Commerce, under the general direction of Milton Eisen, Chief, Industry Division. The 1977 survey of industrial research and development was supervised by John Wikoff, Assistant Division Chief for Current Programs, Industry Division, and assisted by Wayne M. McCaughey, Paul Beasley, Douglas Dobas, Michael Evans, Margie R. Chase and Carol Swan. J. Jerry Bell, Chief, Current Programs Programming Branch, supervised the tabulation of results, assisted by John Wasil. Donald J. Clark, Assistant Chief, Statistical Research and Methodology, served as statistical consultant for the project.

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[1] See note on p. 13

HIGHLIGHTS

- Total industrial R&D expenditures reached a level of $29.9 billion in 1977, a gain of 11 percent from the previous year. In constant dollars the gain was 5 percent, bringing real R&D expenditures to the previous high reported in 1968 and 1969.
- U.S. industry reported real 1976-77 growth of 5 percent in R&D spending from its own funds, indicating a continuation of corporate policies that have produced an average growth rate of 6 percent in real R&D dollars since 1953, when this data series began. Furthermore, industry's budget plans for research and development in 1978 point to continuing strong growth in company funding of research and development which, in 1977, reached $19.3 billion—two-thirds of industry's total R&D performance.
- Industry's commitment to research and development is also apparent by the steady 22-percent rise since 1972 in the number of R&D scientists and engineers employed. Industry science and engineering (S/E) employment reached an all time high in January 1978; this high is attributable entirely to increasing company-funded research and development.
- A trend change has occurred in Federal funding for industrial R&D activities. After nearly a decade of decreases in real funding, 31 percent between 1966 and 1975, Federal R&D funds to industry increased in constant dollars in 1976 and 1977, averaging 5 percent a year. Increased Federal money for energy, defense, and the space shuttle contributed to this growth which pushed the Federal industry R&D total to $10.5 billion in 1977.
- Industry has been characterized by a high concentration of companies funding research and development—7 of every 10 industry R&D dollars come from 100 firms. Moreover, 30 percent of the nearly $2 billion increase in company R&D funds in 1977 came from the four largest industrial R&D performers. The top four performers in the motor vehicles industry accounted for nearly one-fifth of the overall increase in total funds for research and development.
- In 1977 about 7 percent of total company R&D funds were spent outside the United States. R&D directors—from firms responsible for approximately one-fourth of the $1.4 billion of industrial R&D funds spent abroad—gave "meeting local market conditions" as the most frequent reason for locating or expanding R&D activities in foreign countries. Sales of foreign affiliates of U.S. domestic firms—paralleling growth rates of research and development performed abroad—have been continuing to increase. Because of this, NSF anticipates that, in the short run, U.S. R&D performance abroad will also continue to expand in absolute terms.
- The second consecutive real increase in industrial basic research expenditures matched the 5-percent constant-dollar increase in applied research and development. Following a decade of declining constant-dollar basic research funds, this rise was mainly the result of increases in funding by the drugs and communication equipment industries. R&D directors attributed the increase in the drugs industry to an apparent change in R&D policy, favoring more theoretical work intended to lead to significant medical breakthroughs. Communication equipment industry personnel noted that increased fundamental work reflected the intent to expand into new product areas.
- Significant increases in funds for research and development in coal, solar, and geothermal sources of energy, and in energy conservation have occurred in the past two years. Increases ranged from 39 percent in coal, to 85 percent in geothermal. Companies continued to direct the major portion of their energy R&D funds in the areas of oil and nuclear fission, which together composed 64 percent of all industry's energy research and development.
- The petroleum and motor vehicles industries registered the largest R&D funding increases of major R&D performers. Both went up 19 percent. The petroleum industry's rise resulted primarily from energy-related R&D projects, particularly in oil exploration and synthetic fuels. The increase in the motor vehicles industry was attributed by company R&D officials primarily to increases in projects designed to meet Government regulatory requirements for emission control and fuel economy.
- Results of a preliminary test indicated that in 1977 aircraft and missiles firms devoted about 5 percent of their total company-funded R&D resources to noise abatement and emission control projects that would not have been undertaken in the absence of Government regulations.
- Of the seven top R&D-performing industries, the petroleum and machinery industries have shown the highest annual growth rates in the 5-year period, 1972-77, 14 percent and 13 percent, respectively. This is in comparison with the all-industry rate of 9 percent.

INTRODUCTION

The NSF-sponsored Survey of Industrial Research and Development for 1977 was conducted by the Bureau of the Census in January 1978. Approximately 1,500 R&D-performing companies participated in the survey. Remarks attributed to company officials were based on discussions with representatives from leading R&D-performing companies in the major industries.

This report contains a detailed analysis of industrial R&D spending during 1977, as well as historical tables showing trends for key R&D funding variables. Also included is information about industry-employed R&D scientists and engineers. Complete data tables are published in a companion volume, *Research and Development in Industry, 1977* (Detailed Statistical Tables). R&D expenditures for U.S. firms are presented in a variety of ways: by source of funds, type of activity, major cost component, geographic area, field of basic research, product area, effort contracted out, amount performed in foreign countries, and by amounts expended on research and development devoted to energy-related and pollution abatement projects. Wherever possible, the data are presented on an individual industry basis, e.g., instruments, machinery, etc.

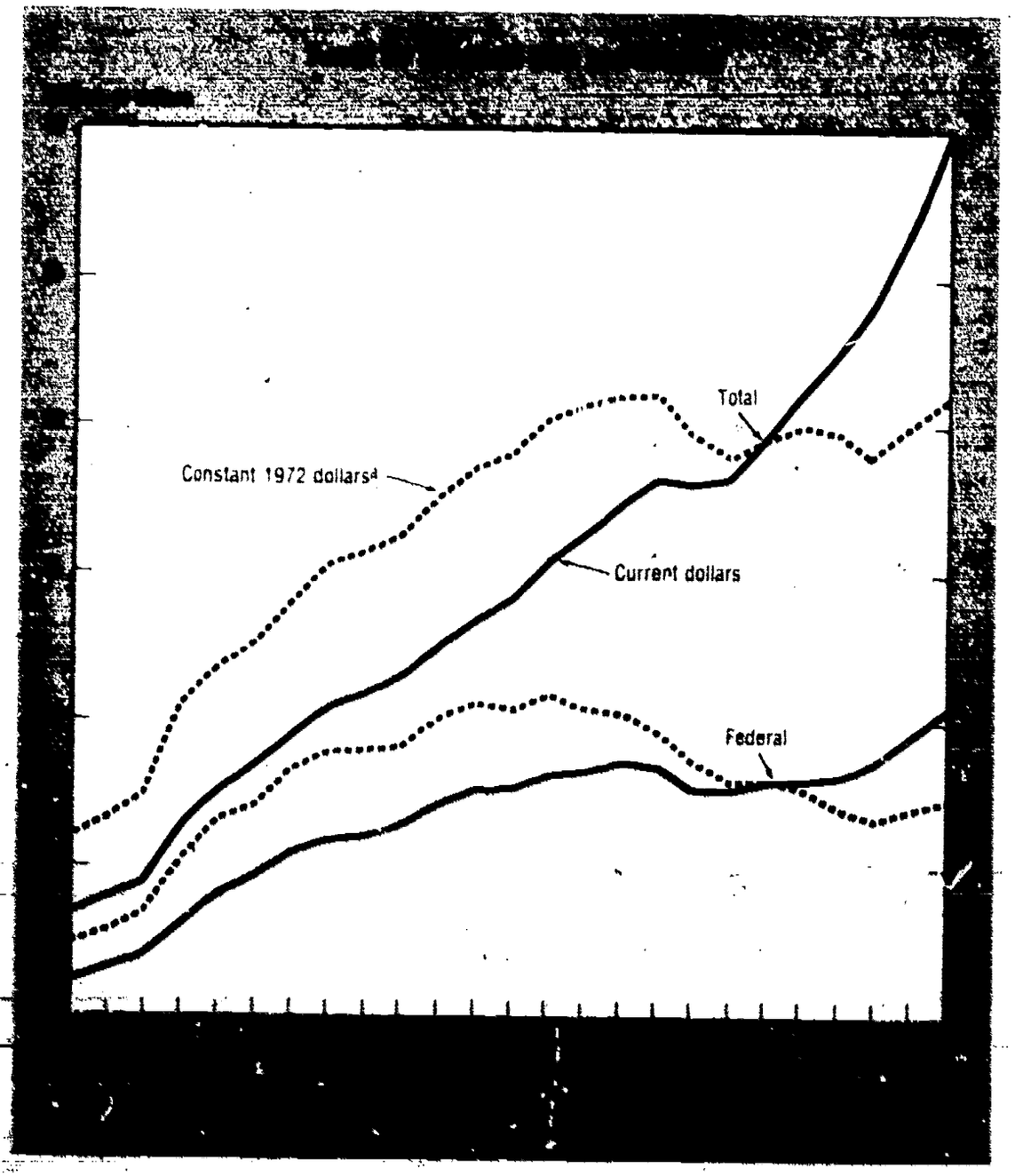
Data presented in this report cover the period 1956-77 for funding data and January 1957 to January 1978 for R&D scientist and engineer data.

The report is the 22nd in a series originating in 1953. Detailed Statistical Tables are published yearly and the more indepth analytical reports every two years.

The industry survey does not cover trade associations. Although their primary mission is to serve industry, trade associations are established as nonprofit organizations and are covered in the NSF survey of independent nonprofit institutions. R&D expenditures of trade associations are estimated at less than 1 percent of the industry R&D total.

In the absence of a reliable R&D cost index, the gross national product (GNP) implicit price deflator was used to convert R&D expenditures to constant dollars. The GNP deflator includes the effects of price changes of all goods and services in the economy and thus can only approximate changes in costs of inputs directly related to R&D performance.

R&D Funds



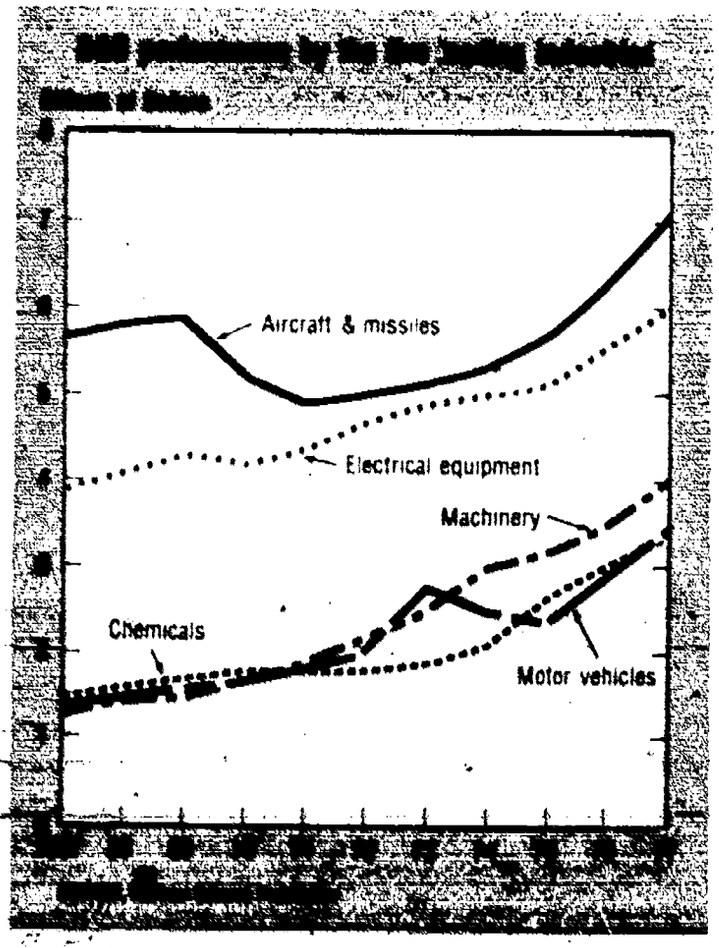
Total industrial R&D expenditures reached a level of $29.9 billion in 1977, a gain of 11 percent over the 1976 figure. In constant dollars, this represented a gain of 5 percent, bringing real R&D expenditures to the previous high reported in 1968 and 1969.

The 1976-77 increase reflects rises in spending by both Federal and company sources. Increased support for defense and energy research and development, and development of the space shuttle contributed to the 4-percent increase in constant dollars in Federal R&D funds. Company R&D funds also increased by 5 percent in real terms. This continued the overall trend of real increases in company R&D spending that began in 1972, closely paralleling sales growth during the 1971-77 period.

Major Industries

Between 1976 and 1977 the largest percentage increases among the major R&D performers were registered by the petroleum industry and the motor vehicles industry. Both went up 19 percent in current dollars. Industry officials attributed the petroleum industry's rise to increased spending for research and development in the areas of synthetic fuels, coal, and oil exploration techniques and equipment. Automotive industry personnel noted higher outlays for R&D projects to meet regulatory requirements for fuel economy and emission standards.

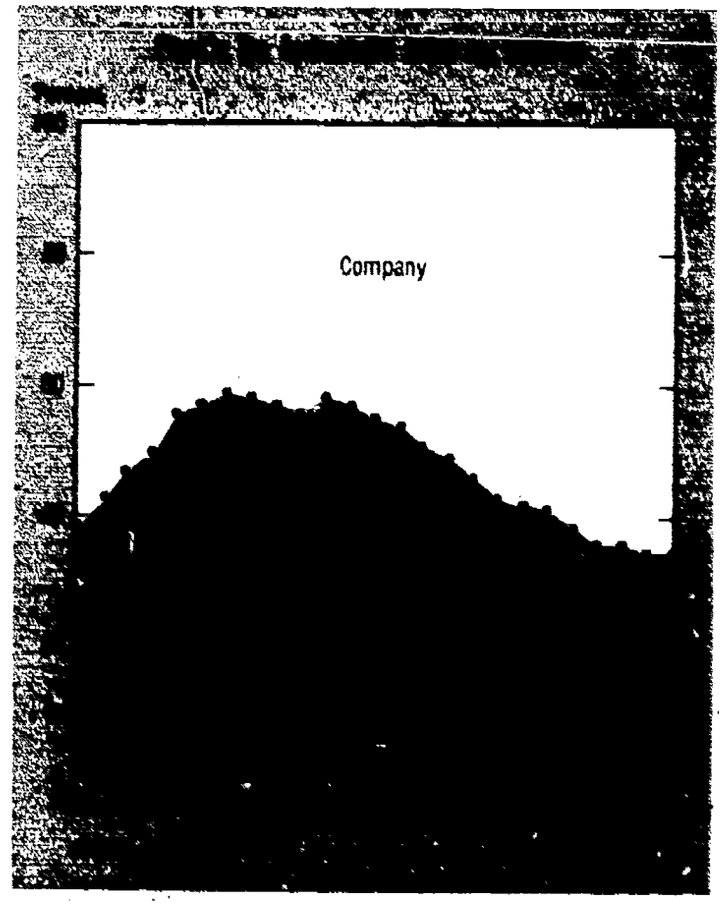
Most industries registered R&D gains in real terms between the two years; a major exception was the drugs industry. Officials of this industry cited a change in emphasis in their R&D programs—a move toward more basic research and away from applied research or development, which is usually more costly. This was the reason for the drug industry decline, rather than a decreased level of overall R&D activity.

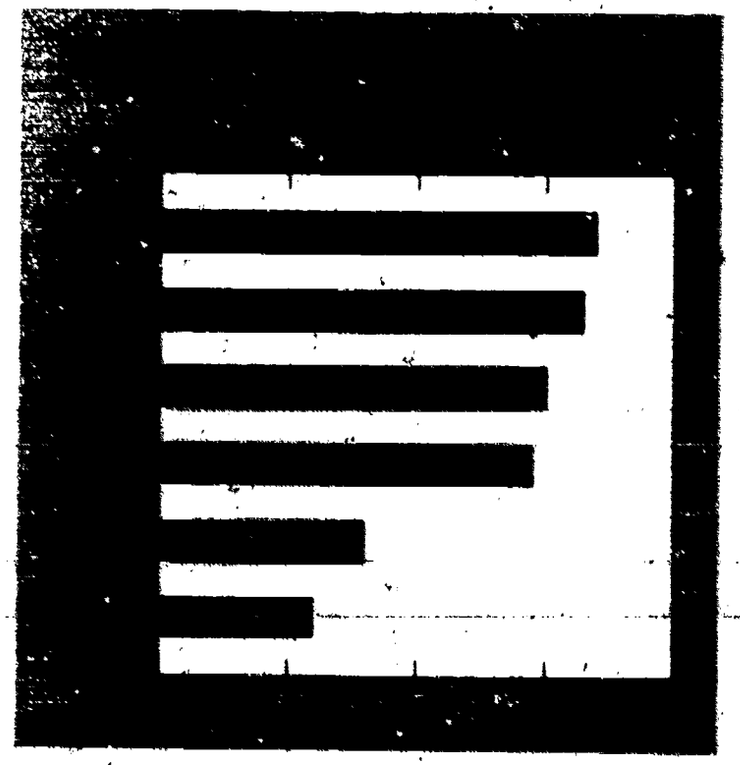


Company R&D Funds

The force behind continued real growth in industrial research and development has been the investment of companies' own funds in R&D activities. Company-financed research and development reached a 1977 total of $19.4 billion, 11 percent higher than reported in 1976. This sharp rise, 5 percent in real terms, continues a general trend of real-dollar increases begun in 1972. These gains have closely approximated the pattern of industrial sales growth during the 1971-77 period. The 1977 rise can be partially attributed to increases in company spending for energy R&D projects, and research and development performed to meet Government regulatory requirements, which have especially affected the motor vehicles, chemicals, and drugs industries. R&D managers from these industries cited Department of Energy (DOE) fuel economy requirements, Environmental Protection Agency (EPA) emission standards, Federal Drug Administration (FDA) requirements and the Toxic Substances Act as being particularly responsible for changes in their R&D programs.

Based on budgeting figures obtained in the 1977 Survey of Industrial Research and Development, the National Science Foundation expects 1978 company R&D funds to continue to increase by as much as 12 percent. In interviews with R&D directors in several leading R&D-performing companies it was noted that, beginning in 1976 and continuing into mid-1979, the industrial climate for research and development has markedly improved. In the late sixties and early seventies, corporate management tended to make short-term, results-oriented R&D funding decisions. Top management now seems to recognize, however, that longer-term research and development can contribute significantly to corporate sales growth and provide some answers to energy and pollution problems. R&D officials in a number of industries





indicated that this growth in research and development is expected to continue into the eighties.

Industrial R&D directors have indicated that a portion of the anticipated increase in R&D activity is attributable to projects conducted to meet Government regulatory requirements. A test question, designed to measure this factor, obtained sufficient response from the aircraft and missiles industry to conclude that in 1977 this industry spent approximately 5 percent of its company R&D funds on activities which would not have been undertaken in the absence of Government regulations. R&D personnel in that industry also noted that this research and development was generally in the areas of aircraft emissions and noise control.

In 1977 industry reported that 3 percent of its company-financed R&D total expenditures was contracted to outside organizations. This represents an increase of 12 percent over its 1976 level. Of this amount, most went to other companies, while a lesser proportion went to universities and colleges and other nonprofit institutions.

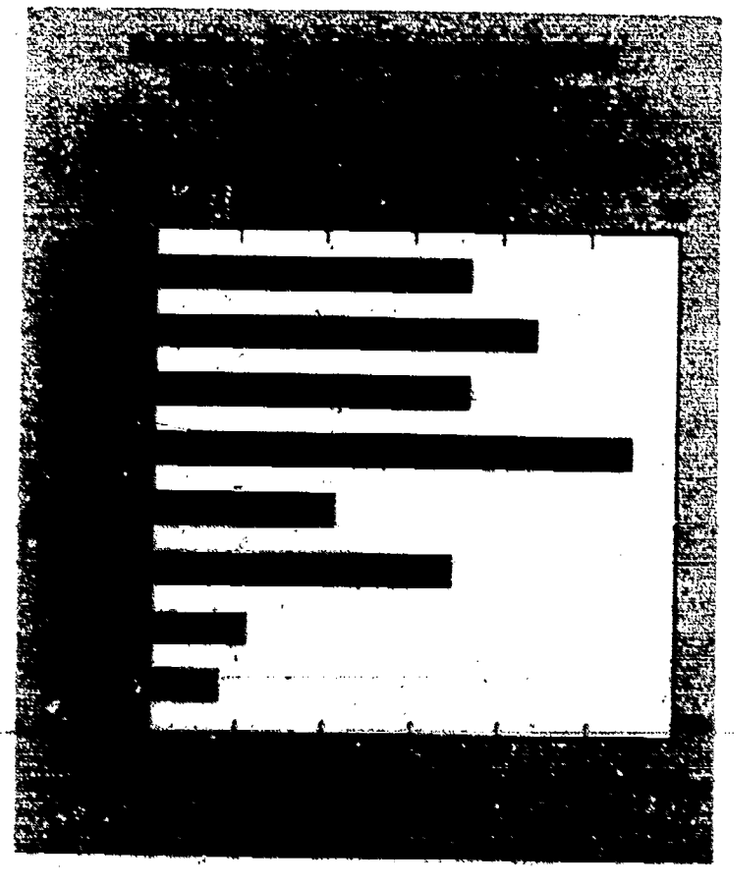
R&D performed abroad by U.S. companies

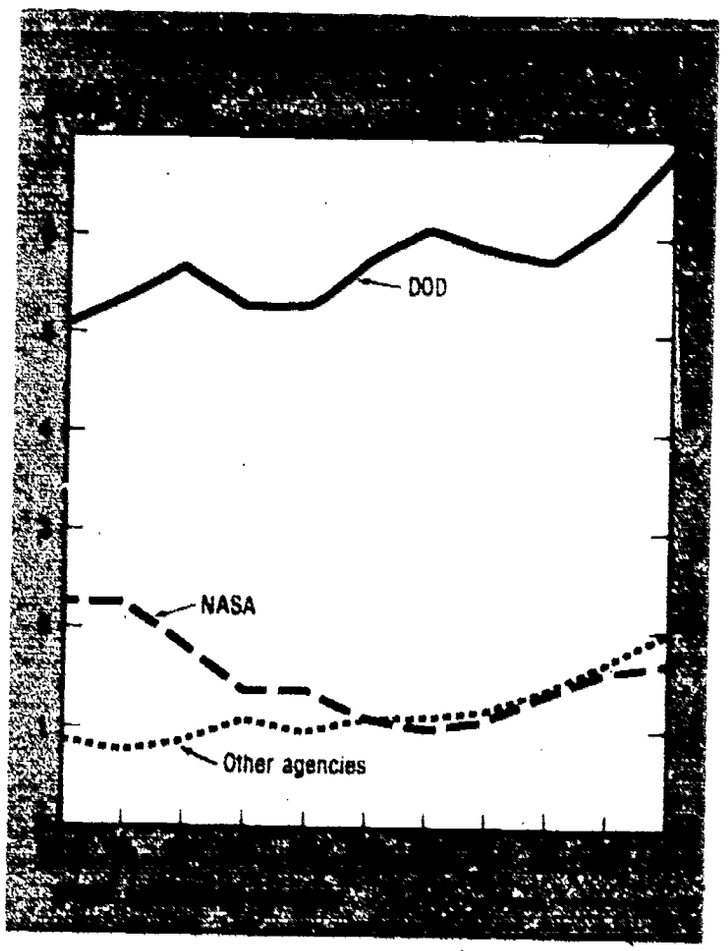
The ability of U.S. industry to compete in foreign markets depends in part on its ability to tailor products to the particular needs of local markets. Toward this end, U.S. industry spends an additional amount, equal to about 7 percent of company-funded domestic R&D expenditures, for research and development performed abroad. Most of these funds finance experimental development activities rather than research. In 1977 industry spent $1.5 billion for R&D activity abroad, some 9 percent over the previous year. Department of Commerce data indicate that sales by foreign affiliates of U.S. manufacturing firms rose at a healthy annual rate in the midseventies. If these sales continue to rise, it is anticipated that there will be a continuing need for development projects abroad.

Federal R&D Funds

Federal R&D funds to industry rose by 10 percent between 1976 and 1977 to a total of $10.5 billion, an increase of 4 percent in constant-dollar terms. The 1977 increase was the second consecutive year of real growth in Federal R&D funds to industry and the second largest real-dollar gain since 1966. The rises in recent years (1975-77) are primarily attributable to R&D increases for defense and energy, and increased outlays for development of the space shuttle. The two Federal agencies with primary responsibility in these areas, the Department of Defense (DOD) and the National Aeronautics and Space Administration (NASA), together provided more than four-fifths of the Federal total R&D support to industry ($6.9 billion and $1.7 billion, respectively) with the bulk of the remainder coming from DOE.

Historically, over three-fourths of all Federal R&D funds to industry has gone to two industries—electrical equipment and communication, and aircraft and missiles. These two industries perform the bulk of space and defense research and development for the





Federal Government. In addition, the electrical equipment industry is the largest performer of Federal energy research and development.

In 1977 the $5.5 billion in Federal funds received by aircraft and missiles firms financed 78 percent of their total research and development, and represented over one-half of total Federal outlays to industry. The electrical equipment and communication industry received $2.7 billion in Federal funds, which totaled 45 percent of all their R&D expenditures during 1977.

Federally funded research and development centers administered by industry

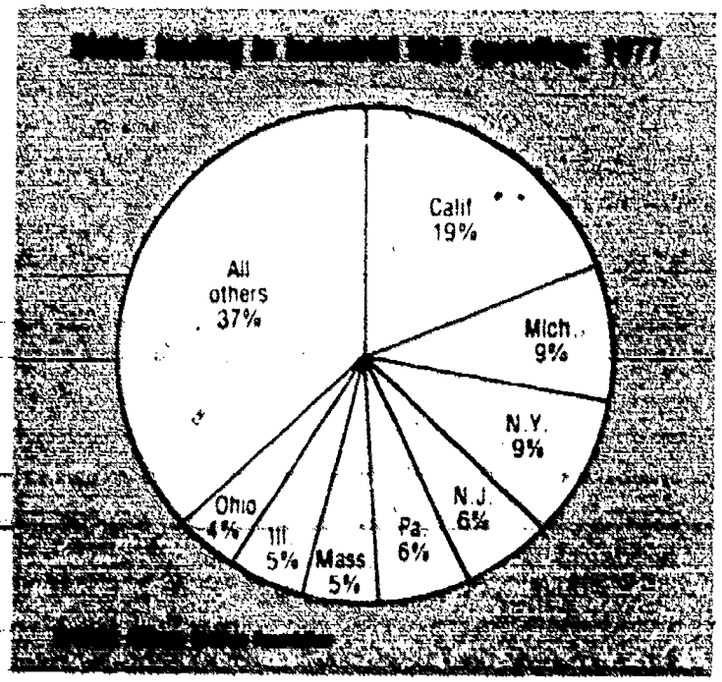
Federally funded research and development centers (FFRDC's) are organizations administered by industrial, educational, or other institutions on a non-

profit basis which carry on R&D activities almost exclusively for the Federal Government. R&D performance by industry-administered FFRDC's rose only 6 percent over the 1976-77 period. By character of work, the FFRDC expenditures were distributed as follows: Basic research, 8 percent; applied research, 22 percent; and development, 70 percent. These proportions have changed little in recent years. Appendix C lists current industry-administered FFRDC's.

Geographic Distribution

Aerospace firms located in California make up the largest R&D-performing industry group in the country. Since this series began in 1957, this group has kept California in the lead in terms of total industrial R&D spending. Industry spent 19 percent of its total R&D funds here, including 37 percent of its Federal funds. Other leading States include the heavily industrialized States of Michigan, New York, New Jersey, Pennsylvania, Illinois, Ohio, and Massachusetts.

Company-financed R&D expenditures were highest in Michigan, accounting for 14 percent of all company funds. This State's leadership in company-sponsored research and development comes from the motor vehicles industry which has a large company-supported R&D effort.



R&D Funds by Size of Company

Although an estimated 15,000 firms perform research and development in the United States, a relatively small number account for the bulk of the effort. Approximately 1 percent of all R&D-performing firms, or 128 R&D-performing companies, had more than 25,000 employees during 1977. These 128 companies reported R&D expenditures of $22 billion, 73 percent of the U.S. industry total. On the other hand, companies with less than 1,000 employees, which comprised 91 percent of the number of R&D-performing firms, reported only 5 percent of the total R&D expenditures during the year.

The federally funded R&D effort was even more concentrated among large companies. Of the 128 R&D-performing companies with more than 25,000 employees, 73 reported Federal R&D funding during 1977. These 73 companies performed 84 percent of all the federally financed research and development during the year.

The four U.S. companies with the largest R&D expenditures during 1977 performed 20 percent of all industrial research and development for the year. (For perspective, note that these same four companies accounted for 9 percent of the total net sales of R&D-performing manufacturing firms and 8 percent of their total employment during 1977.) The source of funding for their R&D activities was roughly proportional to their total share of the effort; these firms received 19 percent of all Federal R&D funds contracted to industry and performed 21 percent of all company-sponsored research and development during the year.

Examination of the R&D performance of the major companies in each industry indicates that the large companies dominate the R&D field. Table 1 for selected industries shows the percentage of total and Federal R&D funds expended by the top 4 and top 20 companies in each industry. Note that the top 20 companies perform virtually all the federally funded research and development in most industries.

Table 1. Proportion of R&D funds spent by the largest R&D-performing companies: 1977

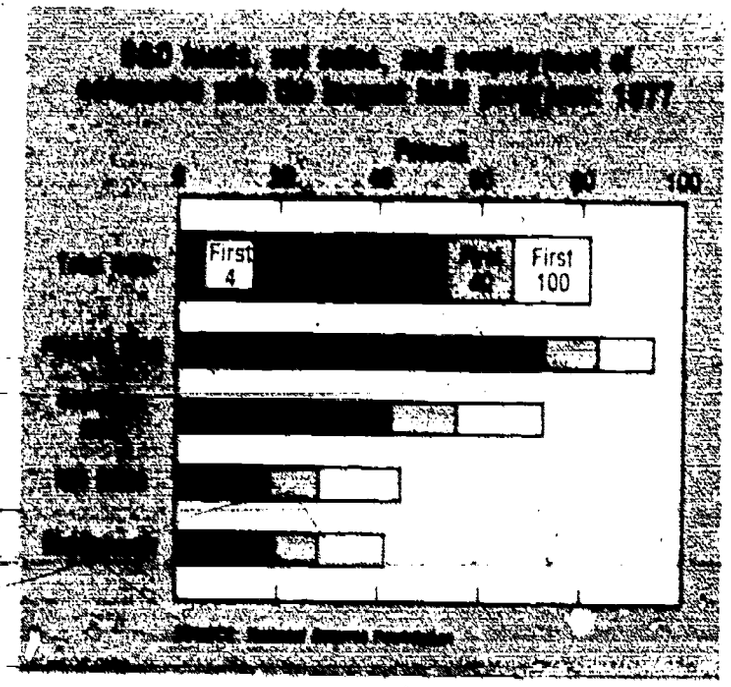
Industry	Percent of total R&D funds		Percent of Federal R&D funds	
	First 4 companies	First 20 companies	First 4 companies	First 20 companies
Total	20	53	19	73
Chemicals and allied products	32	69	84	99
Petroleum, mining and extraction	59	98	90	100
Primary metals	33	75	34	92
Fabricated metals	36	71	45	91
Machinery	61	82	94	95
Office computing and accounting machines	83	97	99	99
Electrical equipment and communication	57	85	66	94
Motor vehicles and motor vehicles equipment	94	99	97	100
Aircraft and missiles	53	98	58	100
Professional and scientific instruments	55	82	82	91

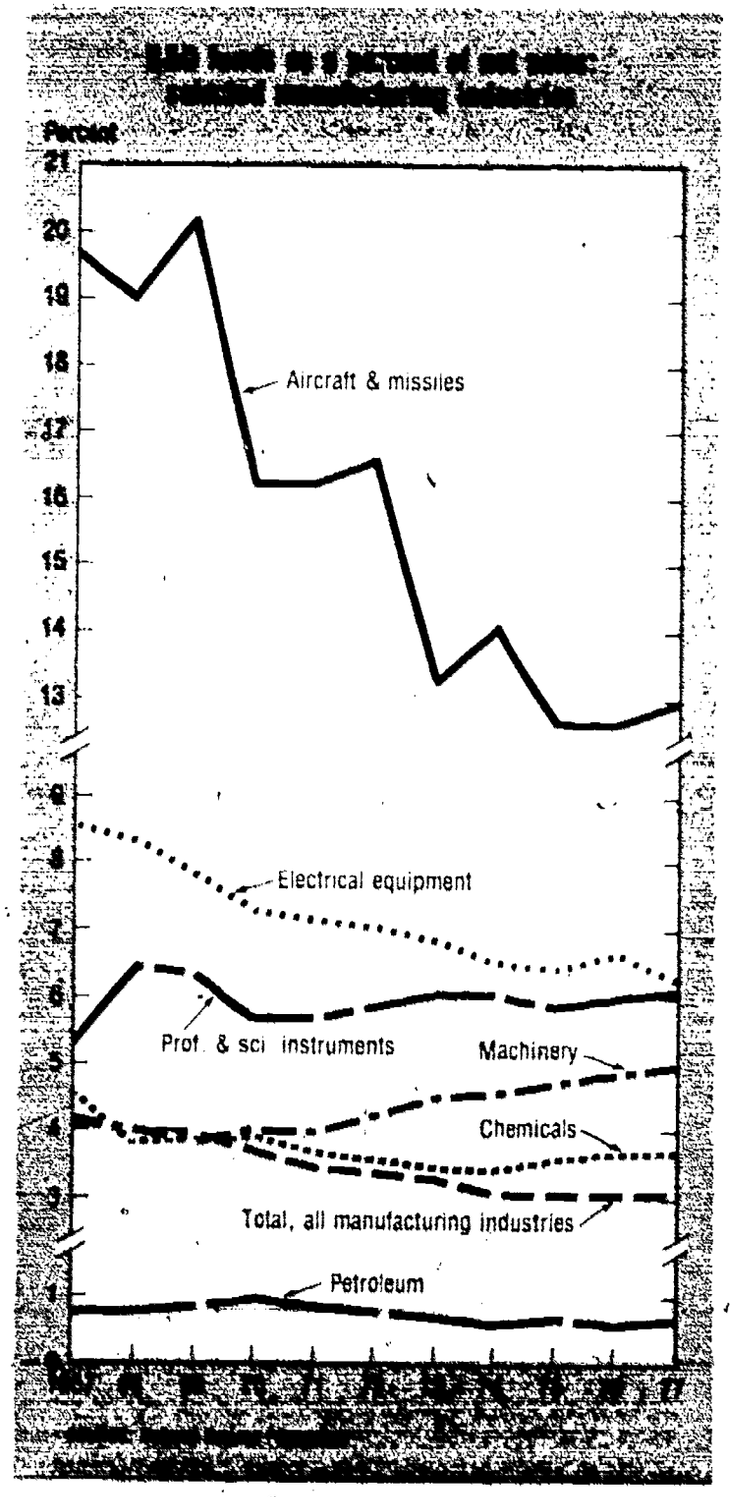
Note: All rankings are based on total R&D funds.
Source: National Science Foundation

R&D Funds Related to Net Sales

Research and development comprises but one of many activities competing for a portion of a firm's total revenues. The ratio of R&D expenditures to revenues, or net sales, provides one means of identifying high technology industries that have displayed heavy dependence on research and development over the years. In such R&D-intensive industries, e.g., electrical equipment and instruments, the R&D/net sales ratios ranged from 5 percent to 9 percent during the 1967-77 period. Because of the large amount of Federal defense- and space-related work, the aircraft and missiles industry is unique in this respect, reporting an R&D/net sales ratio as high as 20 percent in the late sixties. Low technology manufacturing industries, on the other hand, typically report ratios under 1 percent.

Between 1967 and 1974, the average R&D/net sales ratio for all manufacturing industries dropped sharply, from 4.2 percent to 3.1 percent, where it remained through 1977. The aircraft and missiles industry and the electrical equipment industry, the largest industrial performers of Federal research and development, were the primary factors in this trend as a result of the federally funded portion of industrial R&D expenditures declining from 51 percent in 1967 to around 36 percent in 1974 and subsequent years. Those high technology industries that are less involved in Federal R&D programs showed slight increases in their R&D/net sales ratios, or remained at roughly the same level throughout the 1967-77 period.

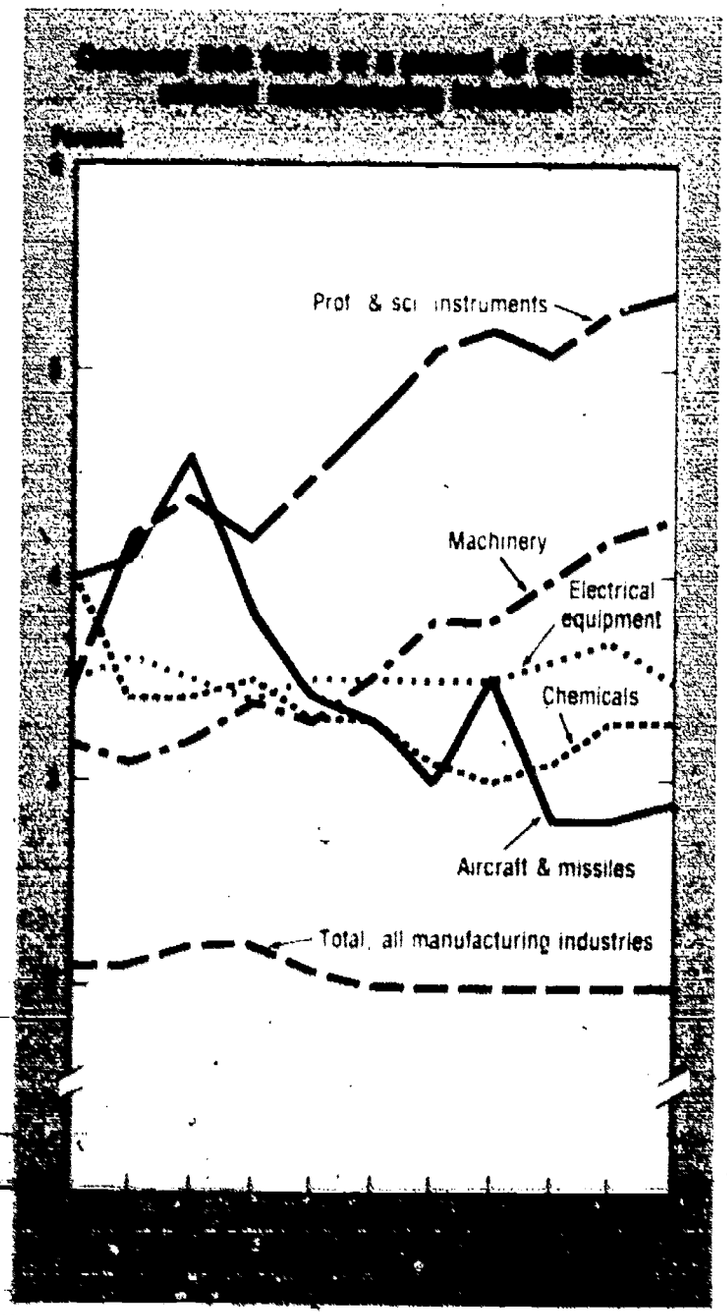




A reflection of corporate attitudes and policies on research and development as a means of achieving company growth can be seen in the relationship between the amount of companies' own funds (excluding Federal awards) spent for research and development and net sales. The company R&D/net sales ratio has remained relatively constant for more than 20 years. It has been 2.0 percent since 1972 and has never been higher than 2.2 percent since this series began in 1957. Among individual industries, the ratio of company R&D/net sales has also tended to be relatively constant over time, although the size of each ratio is largely dependent upon the degree of R&D intensity of a particular industry. For example, companies in highly competitive, technical industries—such as office, computing and accounting machines, and professional and scientific instruments—must invest a large portion of their budgets in research and development to help ensure future sales in areas where technology is changing rapidly; thus their company R&D/net sales ratios are high (9.4 percent and 5.4 percent, respectively, in 1977). On the other hand, company research and development in an industry such as petroleum refining and extraction, while extremely important in this age of energy concern, is relatively small when compared to the volume of sales made by the industry. The company R&D funds/net sales ratio in the petroleum industry was 0.6 percent in 1977. (The ratio for the petroleum industry does not contain expenditures for exploration for new sources of fuel.)

The total R&D funds/net sales ratio tends to be more changeable than the company ratio in those industries which are heavily dependent upon Federal support; while companies as a rule make gradual changes in their own spending, the gain or loss of a Federal contract can cause wide yearly swings in a company's total R&D expenditures. For example, the total R&D/net sales ratio in the aircraft and missiles industry went from a high of 28.3 percent in 1964 to a low of 12.7 percent in 1975 and 1976, and climbed to 13.0 percent in 1977. Federal R&D expenditures for space had been increasing with the growth of the

Apollo lunar landing program and reached a peak in the late sixties. Thereafter, Federal R&D funds for space declined each year through 1973 as the expenditures for the space shuttle, begun in 1970, were not as large as those for the Apollo program. Federal R&D space expenditures began an upswing again in 1974 with increased outlays for space shuttle development. The aircraft and missiles industry is of course greatly affected each time there are such large changes in Federal outlays for space research and development. At the same time, gradual increases in Federal defense R&D outlays have helped to minimize the fluctuations in this industry.

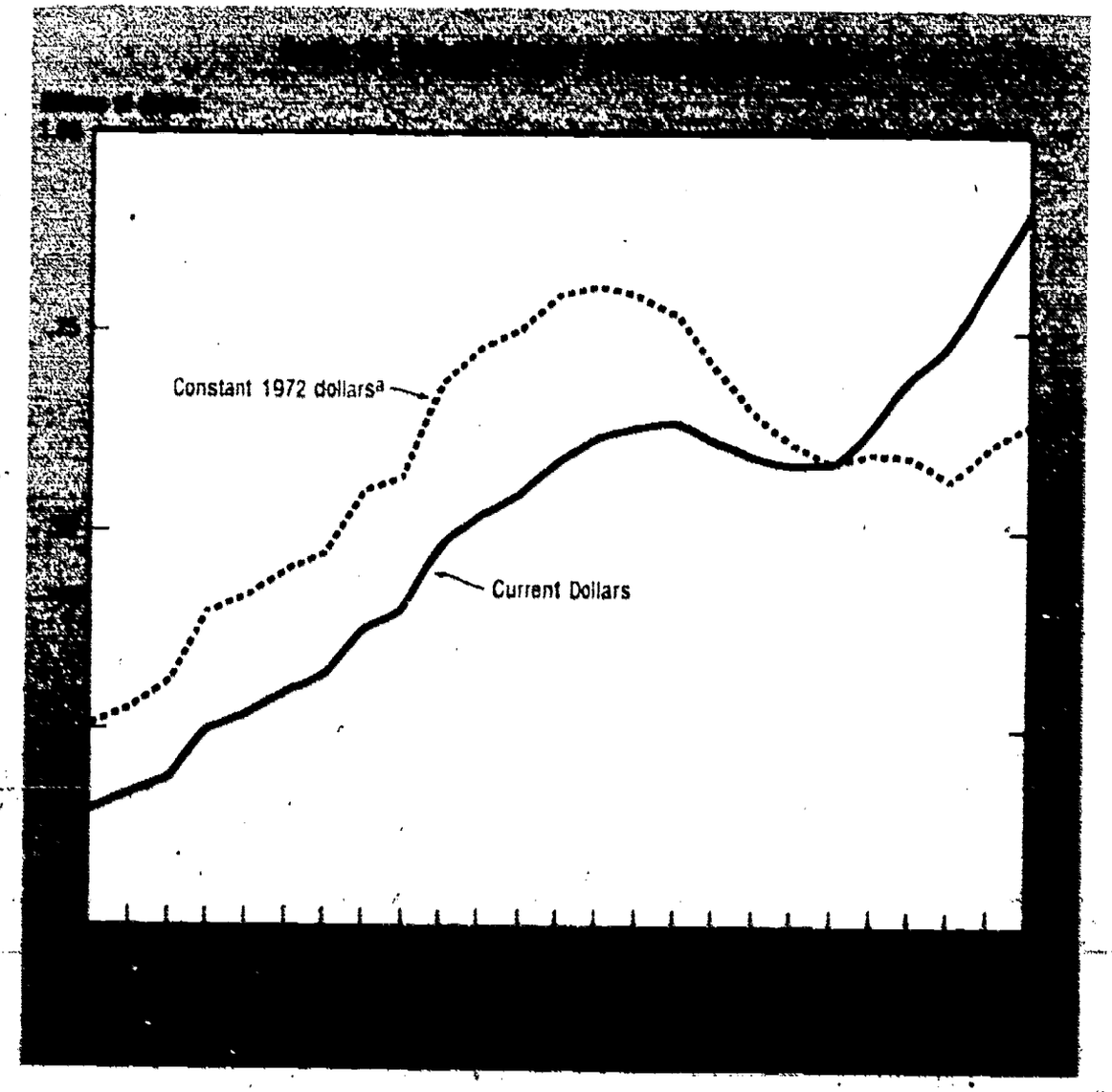


Character of Work

All three types of R&D activity, basic research, applied research, and development, increased by 11 percent between 1976 and 1977, the second consecutive year that all three rose at the same rate. Following a decade of increases larger in applied research and development than in basic research, the 1976-77 pattern reflects the change in R&D strategy mentioned in the "Company R&D Funds" section.

Basic research

In 1977 industrial basic research spending rose to $910 million, increasing by 11 percent over the preceding year—the same growth rate as applied research and development. If measured in constant dollars, this represents a 5-percent increase, the second consecutive real increase following more than a decade of steady decline. Industry officials in basic research-intensive industries see this as the start of a reversal of that trend.

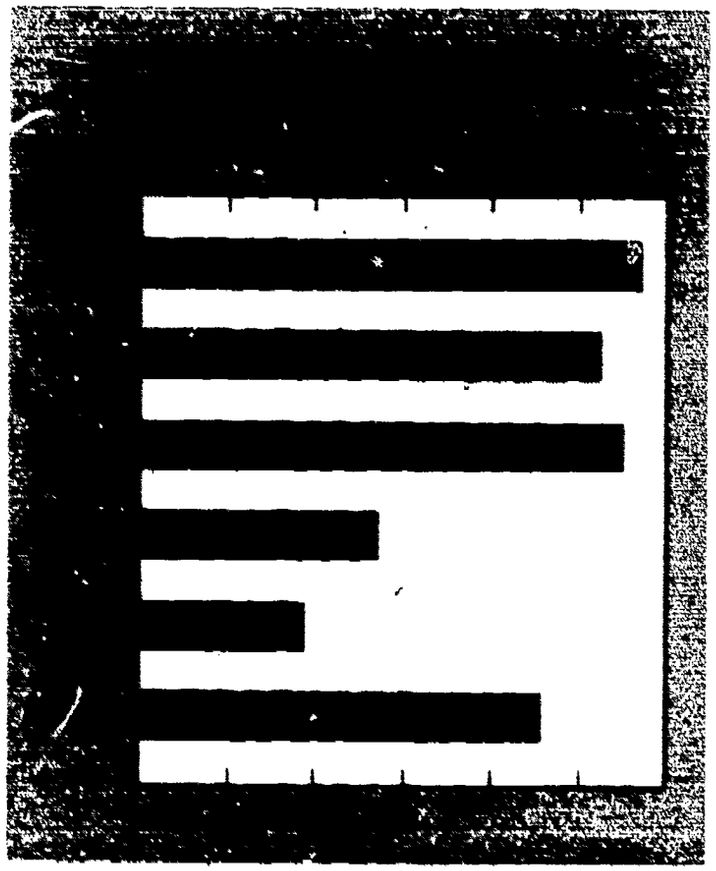


Larger companies are the largest performers of basic research. In 1977, 66 companies, representing over one-half of the R&D-performing companies with 25,000 or more employees, reported basic research expenditures. These large companies performed 54 percent of all industrial basic research. The percentage of R&D performers with basic research expenditures declines as the size of firms becomes smaller. Smaller and medium-sized firms, however, devoted a higher percentage of their R&D funds to basic research than did firms with 25,000 or more employees.

Three-quarters of total industrial basic research was financed by companies' own funds in 1977. In the past this number has fluctuated from 75 percent to 80 percent of funds for basic research. Although the chemicals industry received the largest absolute amount from the Federal Government for basic research, $68 million, this industry also spent nearly four times that amount of its own funds on basic research. On the other hand, nonmanufacturing industries, which include independent R&D laboratories, received 85 percent of their basic research funds from the Federal Government. Just 2 percent of all Federal R&D support to industry was for basic research in 1977. The Federal Government has traditionally depended upon universities and colleges to perform the majority of the Federal basic research effort.

As in the past, the chemicals industry, including drug companies, led all other industries in basic research performance with a 1977 expenditure of $336 million—11 percent above the 1976 level. Other major basic research performers included the electrical equipment and communication industry, $181 million; machinery, $59 million; and aircraft and missiles, $56 million.

Two industries—the drugs and medicines segment of the chemicals industry and the communication equipment portion of electrical equipment—led the rise in basic research spending with increases of 10 percent and 12 percent, respectively. Representatives from the drugs industry indicated that the cost of premarket testing of new drugs has precipitiously increased in recent years, with the result that it is no longer sufficiently profitable for drug companies to market marginal improvements in or reformulations of existing drugs. Instead, the industry is searching for breakthrough products which will yield a significant return on the amount spent for testing. They feel that these products can best be found through an increased basic research effort. Communication equipment industry officials also cited a desire to find new products and expand into new markets as responsible for their increase in expenditures for basic research.



The distribution of funds for industrial basic research by field of science has fluctuated little since 1967. Almost one-half of industrial basic research in 1977 was in the physical sciences, with approximately 70 percent of this total in chemistry. Engineering accounted for an additional 26 percent of industry's basic research performance. This concentration by field reflects the dominating interests of the chemicals and electrical equipment industries in basic research.

Table 2. Proportion of industrial basic research by field of science
[Percent distribution]

Field of science	1967	1972	1976	1977
Total	100	100	100	100
Chemistry	26	31	31	31
Other physical sciences	23	16	13	13
Mathematics	2	2	2	2
Environmental sciences	2	1	2	2
Engineering	27	31	25	26
Biological sciences	11	10	12	14
Clinical and medical sciences		4	4	3
Other	8	6	10	9

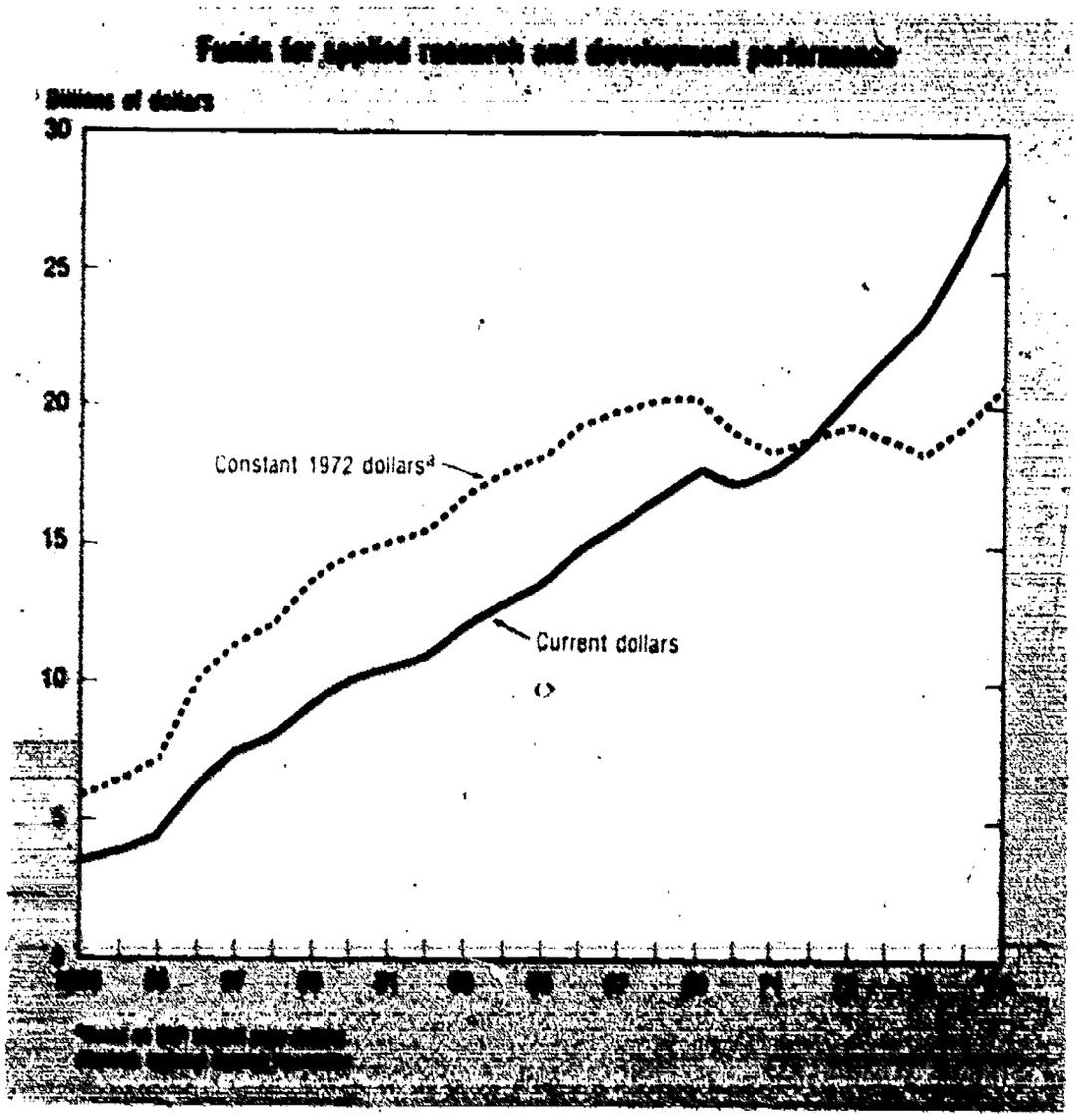
Source: National Science Foundation

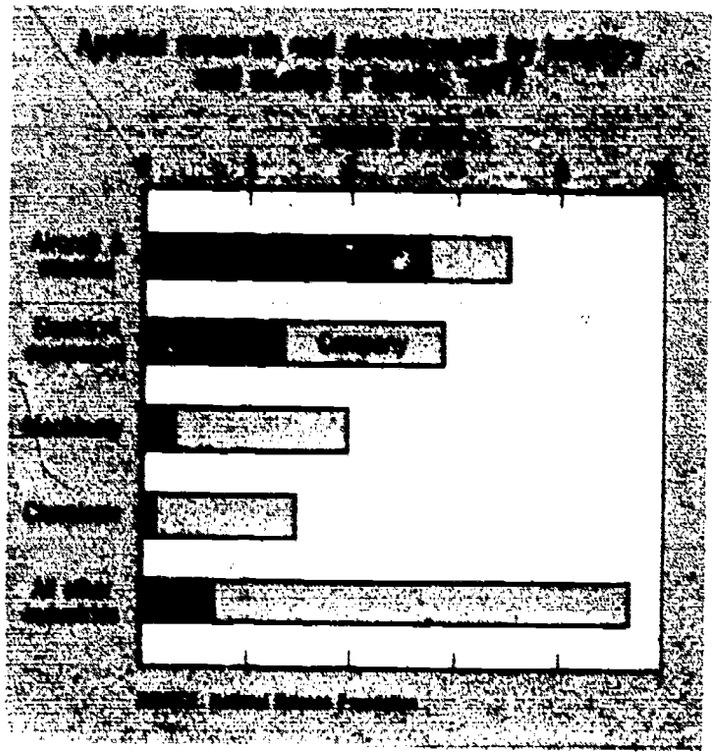
Applied research and development

By industry

Expenditures for applied research and development rose $2.9 billion during 1977 to a total of $29.0 billion, representing an 11-percent increase for the second year in a row. In terms of constant dollars, 1977 expenditures rose 5 percent, down slightly from the 6-percent increase during 1976. Federal funds of $10.3 billion accounted for 36 percent of industrial applied research and development during 1977.

Over two-thirds of the combined applied research and development expenditures were made by four industries. Aircraft and missiles ($7.0 billion); electrical equipment and communications ($5.8 billion); machinery ($3.9 billion); and motor vehnicles ($3.3 billion). Since applied research and development expenditures have historically accounted for over 95 percent of total R&D spending, the pattern of expenditures for both Federal and company applied research and development has closely paralleled that of total research and development. Almost 80 percent of Federal support was channeled into two industries—aircraft and missiles ($5.5 billion, representing 78 percent of the total applied research and development expenditures of that industry) and electrical equipment and communication ($2.7 billion, or 46 percent of the total industry effort).





By product field

The NSF industrial survey collects statistical data on applied research and development not only by individual industry, but also on a product field basis within each industry. (See tables B-50 through B-55 of the companion volume.) Product field data provide a valuable supplement to the broader-based, traditional industry classification.

In the industrial R&D survey, companies are classified by industry as a total unit into the Standard Industrial Classification (SIC) code which contains the largest percentage of their sales. Thus, the classification for conglomerates and other diversified companies may not wholly represent the field in which their research and development is accomplished. For example, a company which has most of its sales volume in a food subsidiary would be included in the food industry category although most of its R&D program may be directed toward its chemicals business. The product field data show the exact product field where applied research and development is directed, irrespective of the primary industrial classification of the performing firms. In using these data, it should be

emphasized that company officials usually do not keep their official records by product field; thus, greater emphasis is placed on the use of informed estimates in providing these data.

Seventy percent of all industrial applied research and development expenditures in 1977 were made in six product fields: Electrical equipment and communication, $5.9 billion; machinery, $3.6 billion; aircraft and parts, $3.1 billion; guided missiles and spacecraft, $3.0 billion; motor vehicles and other transportation equipment, $2.6 billion; and chemicals, $2.0 billion.

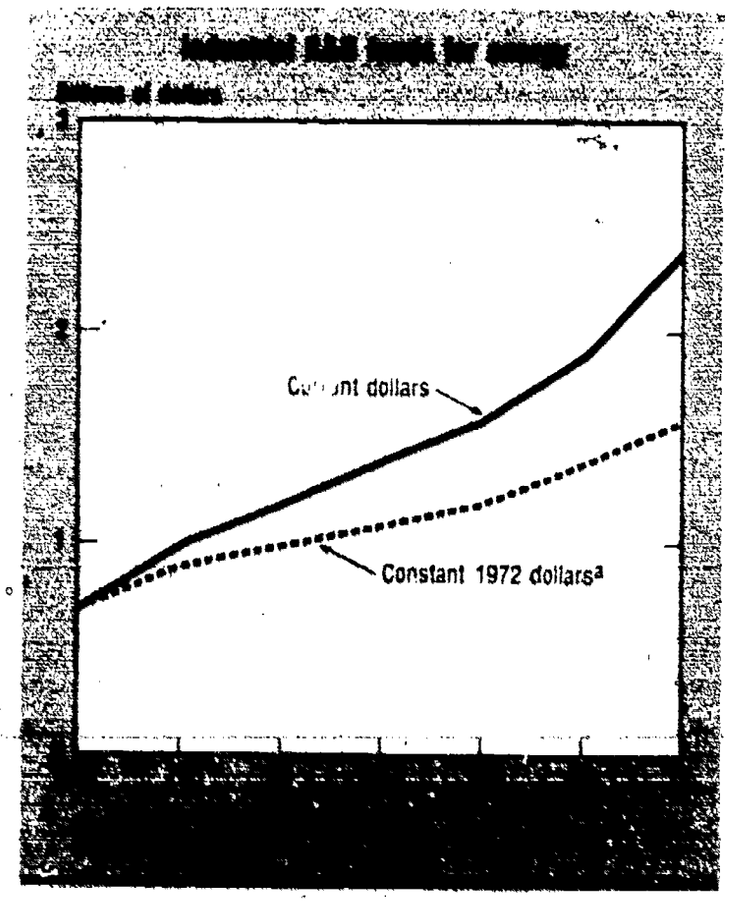
Many companies are becoming increasingly diversified in the markets they serve and their R&D expenditures are also being spread over a wider variety of products. The following tabulation shows a "specialization" ratio for selected industries; that is, the percentage of applied research and development that a company directs towards its major product field. The specialization ratios were derived by dividing the R&D funds spent on an industry's primary product by the total applied research and development expenditures of that industry.

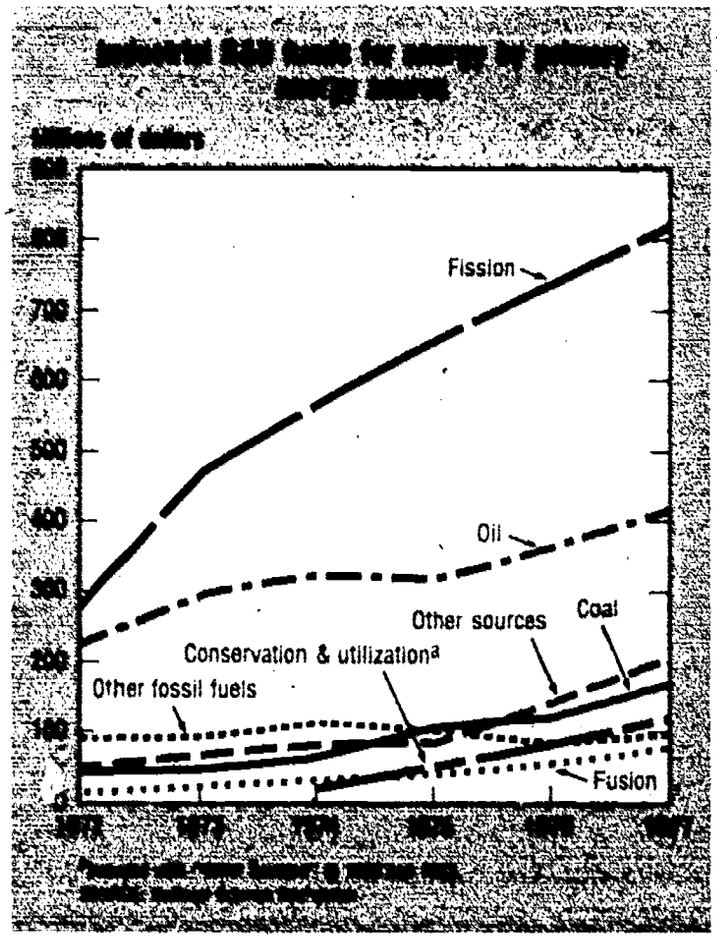
	1970	1977
Chemicals and allied products	80	76
Drugs and medicines	83	74
Aircraft and missiles	87	73
Machinery	60	67
Electrical equipment and communication	51	56
Primary metals	64	47
Petroleum refining and extraction	41	45
Fabricated metal products	40	38

Although the majority of industries decreased their specialization ratios between 1970 and 1977, a third of the selected industries had a greater concentration of research and development in their major product in 1977 than they did in 1970. There are many reasons for the changes that industries make in the intensity of research and development they put into their primary products. Three of the most important ones are: (1) companies diversify for financial reasons and acquire businesses unrelated to the parent companies' line of business, (2) companies find a need to do in-house research and development in other product fields to enhance the development of their major product, and (3) parent companies acquire other companies in their own line of business or companies doing research and development in areas that are needed by the parent company. The first two reasons would dilute the proportion of research and development done in a company's major product field, while the third would generally tend to increase the specialization ratio of a company.

Energy R&D

Industry's performance of energy research and development reached $1.9 billion in 1977, an increase of 20 percent during the year. According to company officials, expenditures were expected to rise an additional 11 percent during 1978. Since 1972, the first year that data were collected for this category, energy R&D performance by industry has risen at an average annual rate of 22 percent.





Leading industries were electrical equipment and communication, $670 million, up 15 percent over 1976; and petroleum, $531 million, up 21 percent. The electrical equipment industry's rise is tied to increases in coal and nuclear research and development. The petroleum industry's increase has been concentrated in fossil fuel research and development.

Federal support for energy research and development rose 21 percent over 1976, primarily as a result of increases in coal R&D support, nuclear fission, and solar research and development. The company-funded R&D increase of 19 percent is accounted for by sizable rises in company funds for R&D projects for oil, nuclear fission, conservation, coal, and geothermal energy.

The nuclear energy category continued to dominate industry's energy research and development, accounting for 47 percent of all expenditures in 1977.

Its prominence is due to the large amount of Federal funding in this category, $669 million, nearly three-quarters of all Federal energy R&D funds to industry.

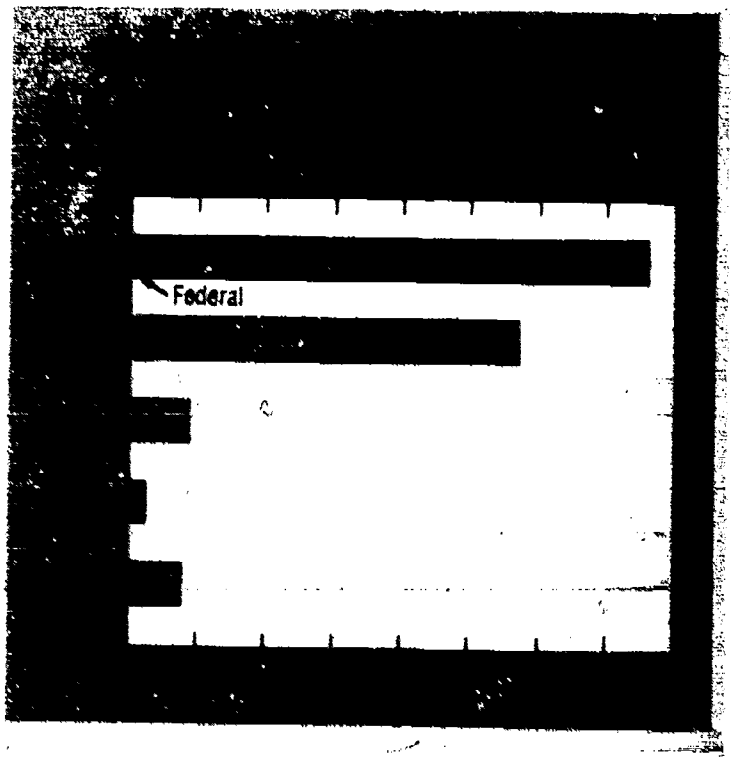
Company R&D funds are most concentrated in the fossil fuels area, which rose 19 percent between 1976-77. While the largest amount of this category was directed toward oil research and development, coal research and development registered the largest percentage increase, 40 percent, over the 1976-77 period.

Solar energy increased 51 percent, generally due to a 65-percent increase in Federal funds for that area. Geothermal energy also registered a large increase, 85 percent. However, even when the two energy sources are added together, their R&D expenditures totaled less than $100 million in 1977.

Conservation has been the fastest growing area of industrial energy research and development. In 1974 energy conservation research and development was $20 million, less than 2 percent of industry's total energy R&D outlays. In 1977, the R&D expenditure in this area reached $124 million, and represented over 6 percent of the energy R&D total.

Pollution Abatement R&D

R&D expenditures for pollution abatement totaled $918 million in 1977, a 21-percent increase over the 1976 total. This increase is the largest since the data series began in 1973. Industry R&D personnel have attributed this rise to increases in R&D spending to meet government regulatory requirements, which have primarily affected the motor vehicles and chemicals industries. The motor vehicles industry has traditionally accounted for over one-half the R&D expenditures for pollution abatement and it is likely that this trend will continue for the next several years.

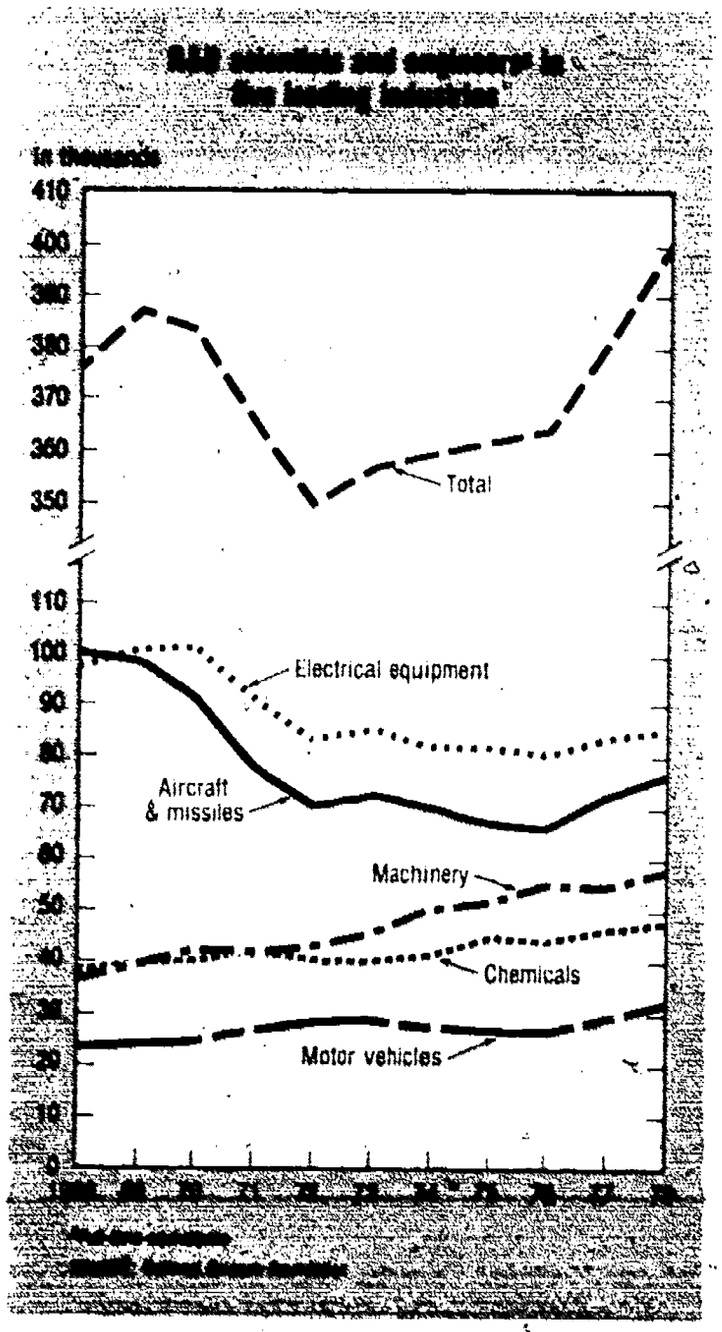


Employment of R&D Scientists and Engineers

Total industrial employment of R&D scientists and engineers (full-time-equivalents) reached an all-time high of 400,100 in January 1978. This represents an increase of 17,700—5 percent over the January 1977 level—and surpasses the previous peak of 387,100 set in 1969. After that date, the number of industrial R&D scientists and engineers declined for three years during a period of decreases in Federal R&D funding. Since 1972 there has been a gradual rise in the number of R&D scientists and engineers employed by industry, advancing even during the 1974 recession when total civilian employment declined over 1 percent.

An examination of employment by individual industry reveals a wide variation in the relative increases in the number of scientists and engineers. This is especially apparent when examining the 2-year period from January 1976 to January 1978. The sharpest increases were seen in the motor vehicles and the aircraft and missiles industries. Employment of R&D scientists and engineers increased almost 20 percent in the motor vehicles industry during this period, reflecting the industry's intensified efforts to design and develop lighter, more fuel-efficient vehicles. Increases in funding of industrial research and development, resulting largely from the development of the space shuttle, contributed to the 16-percent increase in the employment of scientists and engineers in the aircraft and missiles industry from January 1976 to January 1978.

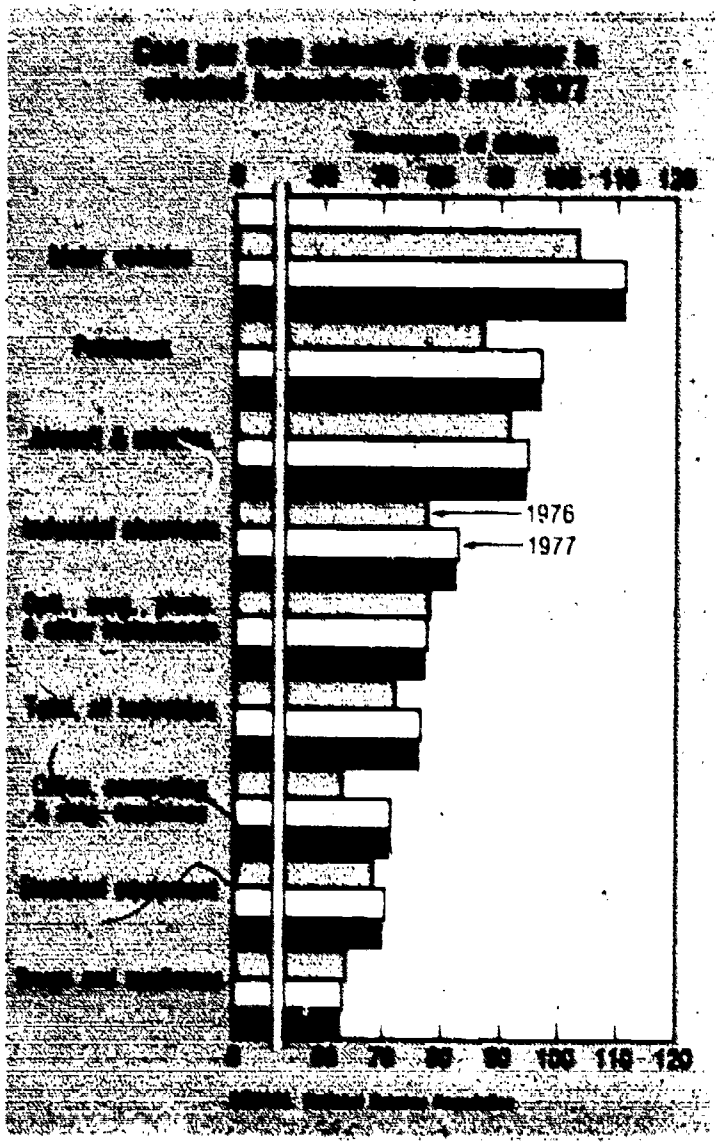
In January 1978 the proportion of all R&D scientists and engineers employed in industry by companies with more than 25,000 employees has accounted for almost two-thirds of their total employment and has



remained relatively constant since 1973, the first year that this size class was separately identified. In January 1978, except for the smallest size class of less than 1,000 employees, which remained level, all other size categories showed an absolute increase in their number of R&D scientists and engineers during 1977.

A frequently used measure, which allows comparisons of relative unit costs between industries, is the cost per R&D scientist and/or engineer. These ratios vary sharply by individual industry, depending on the type of R&D activity undertaken. The all-industry average for funds spent on R&D programs increased 6 percent during 1977 to $76,400 per scientist or engineer. Although the all-industry average of cost per scientist or engineer has increased every year during the 1972-77 period, there has been no growth at all in this ratio when put in terms of constant dollars. Corporate outlays per scientist or engineer, on a constant-dollar basis, rose from $55,300 in 1972 to $56,000 in 1973, fell to a 12-year low of $52,300 in 1975, and rose again to $54,000 by 1976. This reflects the real-dollar decline of R&D expenditures (caused by a drop in Federal outlays) which occurred between 1973 and 1975.

Although the actual corporate outlays for these R&D scientists and engineers and their supporting personnel increased 51 percent between 1972 and 1977, the proportion of R&D funds spent on wages and salaries has declined. The share of R&D expenditures attributed to materials and supplies also declined 11 percent since 1972, while the proportion for other costs increased 9 percent. Industrial leaders have attributed this rise to increases in overhead, particularly energy and real estate costs, and a rapid rise



in depreciation. Table 3 shows R&D expenditures broken down by the major costs.

The ratio of scientists and engineers in industry to total employment increased to 27 in 1977 from its 1972 low of 24. During the 1972-77 period industry experienced relative economic health, increasing sales nearly 22 percent in real terms. At the same time, companies increased their R&D programs, hiring more scientists and engineers (14 percent more than in 1972) as well as increasing funds for R&D programs. Total industrial employment rose less than 4 percent over this entire period. Department of Commerce data indicate that from 1972 to 1974 the constant-dollar value of inventories increased, probably due to the recession during that period. In 1974 to 1977 the real value of inventories actually declined. This may indicate a desire on the part of industrial firms to reduce the value of inventories. Thus, companies did not need to hire more production workers, but, in view of increasing R&D programs, did need additional R&D scientists and engineers.

Table 3. Industrial R&D expenses distributed by type of cost

[Dollars in millions]

Year	Total R&D expenditures	Wages and salaries		Materials and supplies		Other costs	
		Expenditures	Percent of total	Expenditures	Percent of total	Expenditures	Percent of total
1972	$19,539	$9,528	49	$3,696	19	$6,315	32
1973	21,233	10,561	50	3,904	18	6,768	32
1974	22,867	11,367	50	4,166	18	7,334	32
1975	24,164	11,992	50	4,285	18	7,887	33
1976	26,938	13,136	49	4,690	17	9,112	34
1977	29,907	14,415	48	5,060	17	10,431	35

Source: National Science Foundation

APPENDIXES

A. Technical Notes
B. Statistical Tables
C. FFRDC's Administered by Industrial Firms
D. Reproduction of Covering Letters, Questionnaires, and Instructions

NOTE The detailed statistical tables for this volume have been published separately. Included on pp. 21-29 in this volume are selected tables, showing historical R&D data, as well as a complete listing of all tables. Detailed statistical tables may be obtained gratis from the National Science Foundation, Washington, D. C. 20550

APPENDIX A
Technical Notes

Scope of Study

The National Science Foundation sponsored its first survey of industrial research and development in 1953. Since then, the scope of the survey has gradually been modified in response to changing needs for information on the Nation's R&D effort.

This 1977 industry survey is the 21st in an annual series sponsored by the Foundation and conducted by the Bureau of the Census, U.S. Department of Commerce. The Foundation also sponsored two industry surveys covering the years 1953-56, which were conducted by the Bureau of Labor Statistics (BLS), U.S. Department of Labor.[1] Data obtained in the BLS surveys are not directly comparable with the Census figures for 1957-77 because of methodological and other differences in the surveys conducted by the two agencies. In addition, the Census surveys have collected data on the R&D activities of the federally funded research and development centers (FFRDC's) that are operated by business firms, while the earlier BLS surveys did not. (FFRDC's are organizations administered by industrial, educational, or other institutions on a nonprofit basis, they conduct R&D activities almost exclusively for the use of the Federal Government. R&D expenditures of industry-administered FFRDC's included in this survey as part of the Federal R&D data, are listed under the classifications of the administering firms. Total R&D expenditures and selected personnel data for FFRDC's are shown in table B-56.) To account for the R&D performance of these research centers in 1956, Census adjusted data for that year (collected in the 1957 survey) to provide comparable trend data for 1956 and earlier years.

Data on scientific personnel are not directly comparable with data in surveys formerly conducted by BLS. For example, the reporting unit used in the Census surveys of industrial research and development is the company, which is defined to include all establishments under common ownership or control. Surveys of scientific and technical personnel conducted by BLS were on an establishment reporting-unit basis. Further, the Census surveys obtain data on the number of R&D scientists and engineers on a full time-equivalent (FTE) basis, unlike the surveys of BLS in which data were provided in terms of scientists and engineers primarily employed in research and development. Other variations in the two sets of data may be the result of different offices in the same company preparing the estimates, or the varying response rates of the two surveys.

The statistics presented in this report are subject to response and concept errors caused by differences between survey and industry concepts and definitions of R&D activities and by variations in company accounting procedures.

[1] National Science Foundation, *Science and Engineering in American Industry, Final Report on a 1953-54 Survey* (NSF 56-16) and *Science and Engineering in American Industry, 1956* (NSF 59-50) (Washington, D.C. 20402: Supt. of Documents, U.S. Government Printing Office, 1956 and 1960).

Since the first industry survey in 1953, the quality of the data has improved substantially, mainly as a result of more accurate and sophisticated accounting procedures adopted by respondents. In addition, the Foundation and Census have endeavored to reduce response and concept errors arising from difficulties in interpreting or applying survey definitions.

Survey Definitions[2]

Research and development.—Basic and applied research in the sciences and engineering and the design and development of prototypes and processes. This definition excludes quality control, routine product testing, market research, sales promotion, sales service, research in the social sciences or psychology, and other nontechnological activities or technical services.

Basic research.—Original investigations for the advancement of scientific knowledge not having specific commercial objectives, although such investigations may be in fields of present or potential interest to the reporting company.

Applied research.—Investigations directed to the discovery of new scientific knowledge having specific commercial objectives with respect to products or processes. This definition differs from that of basic research chiefly in terms of the objectives of the reporting company.

Development.—Technical activities of a nonroutine nature concerned with translating research findings or other scientific knowledge into products or processes. Does not include routine technical services to customers or other activities excluded from the above definition of research and development.

Funds for research and development.—Operating expenses incurred in the conduct of research and development in a company's own laboratory or other company-owned or -operated facilities. Includes wages and salaries, materials and supplies consumed, property and other taxes, maintenance and repairs, depreciation, and an appropriate share of overhead, but excludes capital expenditures. All funds for R&D performance in this publication are expressed in current dollars rather than in constant dollars.

Federally financed research and development.—Work done by the company on Federal R&D contracts or subcontracts and R&D portions of procurement contracts and subcontracts.

Company-financed research and development.—Cost of the company-sponsored research and development performed within the company. Does not include company-financed

[2] For more detailed information on definitions, as well as the instructions for individual items covered in the survey questionnaire, see appendix C.

research and development contracted to outside organizations such as research institutions, universities and colleges, or other nonprofit organizations.

R&D scientists and engineers – The January number of those engaged full time in research and development and the full-time equivalent (FTE) of those working part time. Scientists and engineers are defined as persons engaged in scientific or engineering work at a level which requires a knowledge of physical, life, engineering, or mathematical sciences equivalent at least to that acquired through completion of a 4-year college course with a major in one of those fields.

Employment – Total number of persons employed by the company in all activities during the pay period which includes the 12th of March. These data are not completely comparable with employment of R&D scientists and engineers data which are collected as of January.

Net sales and receipts – Recorded dollar values for goods sold or services rendered by a company to customers outside the company, including the Federal Government, less such items as returns, allowances, freight charges, and excise taxes. Excludes domestic intracompany transfers as well as sales by foreign subsidiaries but includes transfers to foreign subsidiaries. Net sales and receipts figures are expressed in current dollars rather than constant dollars.

Geographic area covered – Includes only those operations located in the 50 States and the District of Columbia.[3]

Explanation of Tabular Data

Industry classification – Industries and industry groups shown separately in statistical tables are classified according to their Standard Industrial Classification Manual[4] codes as follows:

Food and kindred products (20)
Textiles and apparel (22, 23)
Lumber, wood products, and furniture (24, 25)
Paper and allied products (26)

Chemicals and allied products (28)
- Industrial chemicals (281-82)
- Drugs and medicines (283)
- Other chemicals (284-89)

[1] For comparison purposes, the [illegible] broken down by industry and the number of companies contracting research and development to outside organizations are reported in tables [illegible] but excluded from all other tables.

[2] For comparison purposes, the company-sponsored research and development [illegible] outside the United States [illegible] but excluded from all other tables.

[4] [illegible] Management and Budget, Standard Industrial Classification Manual, [illegible] Supt. of Documents, U.S. Government Printing Office [illegible] code number [illegible] shown in parentheses.

Petroleum refining and extraction (29, 13)[5]
Rubber products (30)

Primary metals (33)
- Ferrous metals and products (331-32, 3398-3399)
- Nonferrous metals and products (333-36)

Fabricated metal products (34)
Machinery (35)
- Office, computing, and accounting machines (357)

Electrical equipment and communication (36, 48)[5]
- Radio and TV receiving equipment (365)
- Electronic components (367)
- Communication equipment and communication (366, 48)
- Other electrical equipment (361-64 and 369)

Motor vehicles and motor vehicles equipment (371)
Other transportation equipment (373-75, 379)
Aircraft and missiles (372, 376)

Professional and scientific instruments (38)
- Scientific and mechanical measuring instruments (381-82)
- Optical, surgical, photographic, and other instruments (383-87)

Other manufacturing industries – tobacco manufacturers (21), printing and publishing (27), leather products (31), and miscellaneous manufacturing industries (39)

Nonmanufacturing industries – agriculture, forestry, and fisheries (07-09), mining (10-12, 14), contract construction (15-17), transportation and other public utilities (41-47, 49), wholesale and retail trade (50-59), finance, insurance, and real estate (60-67), and selected service industries (737, 739, 807, 891)

Company size class – The size of a company as determined by the total number of its employees. The five company size classes used in this report are less than 1,000 employees, 1,000 to 4,999 employees, 5,000 to 9,999 employees, 10,000 to 24,999 employees, and 25,000 or more employees.

Classification of reporting units – The company or corporate family which includes all establishments under common ownership or control. Similarly, each company is classified in a single size category on the basis of its total employment.

Cost per R&D scientist or engineer – Derived by dividing the arithmetic mean of the number of R&D scientists and engineers reported in each industry for January in two consecutive years into the total R&D expenditure for each particular industry.

[5] For the purposes of this study, crude petroleum and extraction (13) is grouped with petroleum refining (29), and communication (48) is grouped with electrical equipment (36) in the manufacturing groups of industries.

Nonavailability of certain statistics – Estimates are withheld for not meeting publication standards for reasons such as extremely high associated sampling error of estimate, high rate of imputation (over 50 percent) because of failure of companies to report, possible disclosure of data on an individual company, or cases where data were inconsistent for inclusion in a time series. In tables, the term "not separately available but included in total" indicates statistics were not published for any of these reasons. In some instances, withheld data can be derived by subtraction from higher level totals. Where this is possible the data user should be aware that the derived numbers are statistically unreliable. In *no* instance, however, can any data be derived which would disclose the operations of an individual company.

Questionable data – Data with imputation rates over 50 percent have not been published. Users should consult appendix table A-1 for imputation rates of specific items.

Method of computation – Detailed statistics in the tables may not add to totals or subtotals because of rounding. Also, percentages were calculated on the basis of thousands of dollars and may differ from those based on the rounded figures shown.

Methodology of Survey[*]

The sample used for the 1977 Survey of Industrial Research and Development represented all manufacturing industries and those nonmanufacturing industries known, on the basis of earlier, more detailed samples, to conduct or to finance research and development. The sampling unit for the survey was the company, defined as a business organization consisting of one or more establishments under common ownership or control. Approximately once every five years, a new panel for the R&D survey is selected. A new panel was selected for the 1976 survey (the first since the 1971 survey). Approximately 11,500 manufacturing and nonmanufacturing companies are included in the current sample, which consists of about 4,500 certainty companies (those with 100 percent chance of inclusion in the panel) and about 7,000 noncertainty companies.

Companies in the new panel which had received an RD-1 form in the old panel once again received an RD-1 form in 1976 (about 1,100 companies). This form seeks detailed R&D information. The remaining certainty and noncertainty companies in the new panel received an RD-2 survey report in 1976. Form RD-2 is an abbreviated version of RD-1 and is only mailed to companies in the year in which a new sample is drawn. The purpose of Form RD-2 is to canvass smaller R&D performers with a minimum of reporting burden. Once the RD-2 forms were received and tabulated from the survey respondents in 1976, they were re-

[*] This section was prepared in the Industry Division of the Bureau of the Census, the collecting and compiling agent for the National Science Foundation in this survey.

Table A-1. Imputation rates for selected items on the research and development survey by industry: 1977

[Percent]

Industry	SIC Code	Item 2		Item 4	Item 5 – R&D expenditures											
					Basic research			Applied research			Development			Total R&D		
		Sales[1]	Employment[1]	Scientists/ engineers	Total	Federal	Company	Total	Federal	Company	Total	Federal	Company	Total[1]	Company[1]	Federal[1]
Total		1.5	2.3	19.6	16.1	17.5	15.6	26.1	12.5	30.8	27.1	15.2	34.4	1.5	2.0	.7
Food and kindred products	20	.9	2.1	20.5	21.2	–	21.2	19.6	–	19.6	14.4	–	14.4	1.5	1.5	–
Textiles and apparel	22,23	5.6	5.6	10.9	14.5	–	14.5	15.3	–	15.3	11.2	–	11.2	1.5	3.3	–
Lumber, wood products and furniture	24,25	-	-	25.4	–	–	–	.3	–	.3	6.0	–	6.0	–	–	–
Paper and allied products	26	2.4	2.5	20.8	7.7	–	7.7	26.6	–	26.6	18.6	–	18.6	1.2	1.2	–
Chemical and allied products	28	1.5	2.2	29.6	7.3	.7	8.8	33.6	4.8	38.1	32.1	27.9	32.4	1.7	1.9	.5
Industrial chemicals	281,82	–	–	22.0	5.7	.7	8.1	38.0	4.9	49.3	43.5	27.1	46.4	–	–	–
Drugs and medicines	283	2.4	6.1	28.8	8.1	–	8.3	38.5	7.6	38.7	24.9	52.4	24.9	2.9	2.9	2.4
Other chemicals	284-89	2.6	2.9	42.7	10.7	–	11.0	12.9	–	13.2	17.3	66.6	17.2	3.4	3.4	–
Petroleum refining and extraction	29,13	-	.2	21.5	10.8	–	10.9	21.2	.2	23.4	13.2	1.9	14.1	–	–	–
Rubber products	30	2.9	9.3	31.2	19.2	–	19.3	18.5	5.5	32.0	41.5	62.0	28.9	.6	1.0	–
Stone, clay and glass products	32	3.1	2.4	16.0	–	–	16.1	10.9	–	11.1	13.7	7.6	13.9	1.2	2.5	–
Primary metals	33	1.4	3.2	25.5	.2	–	.2	19.3	11.0	19.5	25.1	62.9	25.9	3.8	3.8	1.7
Ferrous metals and products	331-32,3398,3399	2.5	2.9	14.5	.6	–	.6	37.0	38.5	37.0	34.4	58.5	33.8	4.3	3.9	9.0
Nonferrous metals and products	333-36	2.6	3.7	34.6	–	–	–	6.4	–	6.6	21.3	63.9	13.9	3.3	3.5	–
Fabricated metal products	34	1.4	2.6	15.5	–	–	–	21.7	–	22.3	22.9	52.3	18.2	2.5	2.4	3.6
Machinery	35	1.3	1.5	19.3	13.6	48.9	11.5	24.1	8.7	31.6	18.3	31.7	16.2	.8	.9	–
Office, computing, and accounting machines	357	1.1	1.0	23.1	12.0	64.3	8.9	13.3	8.8	18.1	16.1	33.2	12.6	.3	.4	–
Electrical equipment and communication	36,48	.6	.8	23.6	32.0	39.0	30.8	19.5	23.6	17.9	27.5	27.1	24.6	1.4	1.5	1.3
Radio and TV equipment	365	2.0	3.9	2.9	–	–	–	73.5	–	73.5	82.3	–	82.3	.9	.9	–
Electronic components	367	1.2	1.6	49.8	7.1	–	8.1	42.1	73.7	35.5	50.4	51.6	49.7	2.3	2.1	2.9
Communication equipment and communication	366,48	.9	.9	11.4	32.6	27.1	33.4	16.0	32.0	11.0	17.7	20.4	15.0	2.1	2.2	2.1
Other electrical equipment	361-64,369	–	.1	27.8	36.1	67.9	22.3	16.9	14.1	19.2	30.4	28.7	32.6	.1	.2	–
Motor vehicles and motor vehicles equipment	371	–	.1	4.8	34.1	26.8	34.3	92.9	50.4	95.3	82.2	50.4	85.1	–	–	–
Other transportation equipment	373-75,379	.9	5.1	9.7	.4	.5	–	.9	–	.9	8.6	3.5	21.2	4.0	9.4	–
Aircraft and missiles	372,376	4.2	1.3	5.6	27.4	53.1	6.3	.6	2.7	10.5	2.7	2.1	5.4	–	.1	–
Professional and scientific instruments	38	11.7	12.4	33.0	28.0	–	41.8	44.3	23.0	45.8	67.9	40.3	71.7	1.8	14.6	–
Scientific and mechanical measuring instruments	381-82	1.3	1.6	30.2	22.3	–	22.7	21.8	12.5	22.1	26.9	76.2	26.9	.8	1.1	–
Optical, surgical, photographic, and other equipment	383-87	16.9	17.8	34.5	46.1	–	60.7	54.7	24.8	57.1	60.1	38.3	60.1	17.4	20.2	–
Other manufacturing industries	21,27,31,39	5.3	5.3	35.6	60.1	–	60.1	36.0	–	36.8	28.8	–	29.4	8.1	8.9	–
Nonmanufacturing industries	07-12,14-17,41-47, 737,739,807,891	.4	1.9	35.1	37.4	38.2	33.6	46.9	58.4	26.2	21.8	21.9	24.0	6.5	5.4	8.1

– Represents no imputation

[1]These items calculated from form RD-1 (detailed form mailed to large corporations conducting R&D), and form RD-2 (abbreviated version of RD-1 form mailed to smaller R&D performers).
All other items calculated from form RD-1 only. RD-2 respondents were not asked these questions.

Table A-1. Imputation rates for selected items on the research and development survey by industry: 1977 — Con.

Item 7			Item 8			Item 9				Item 11		Item 12	Item 13	Industry
R&D by cost			Fields of basic research			Applied R&D by product field								
Wages	Materials	Other costs	Total	Chemistry	Engineering	Total	Electrical equipment	Aircraft and parts	Motor vehicles	Energy R&D	Pollution abatement	Outside company[1]	Foreign R&D	
18.0	36.2	18.2	16.1	30.2	28.0	18.0	24.0	11.7	45.6	5.2	37.3	2.3	5.3	Total
18.0	23.5	9.4	1.3	1.2	8.3	11.4	100.0	–	–	–	29.5	–	–	Food and kindred products
8.7	5.2	7.7	14.5	–	–	8.8	–	–	100.0	–	–	–	–	Textiles and apparel
34.4	22.4	77.5	–	44.3	–	4.2	–	–	–	–	–	7.3	–	Lumber, wood products, and furniture
21.0	36.6	17.4	8.1	16.3	–	19.8	–	–	–	–	.2	–	–	Paper and allied products
34.6	43.1	26.9	2.5	35.3	3.5	14.2	12.3	–	52.0	2.0	7.4	8.7	25.5	Chemical and allied products
42.4	46.1	37.3	7.2	16.7	–	8.3	2.1	–	52.0	1.9	7.5	11.9	14.1	Industrial chemicals
29.7	47.1	18.5	8.1	25.5	–	21.3	–	–	–	–	–	7.9	9.6	Drugs and medicines
21.0	21.1	14.1	10.8	79.0	51.8	15.3	100.0	–	–	4.9	9.1	13.6	57.3	Other chemicals
13.3	18.3	7.1	10.8	16.5	6.5	11.0	..	–	–	11.2	.8	.4	–	Petroleum refining and extraction
37.8	42.9	39.4	8.4	23.5	11.8	21.4	.5	92.4	90.0	–	.7	–	–	Rubber products
16.4	8.1	12.0	8.0	-	43.8	10.7	..	1.6	49.1	3.5	7.4	–	2.2	Stone, clay and glass products
21.0	23.7	27.9	..	–	-	9.4	65.8	28.0	11.4	2.0	1.6	-	40.0	Primary metals
38.3	50.1	35.9		–	–	10.8	..	30.1	18.7	–	.6	–	–	Ferrous metals and products
7.4	7.1	3.4	..	..	–	7.9	65.8	–	..	3.5	1.2	–	54.2	Nonferrous metals and products
5.0	6.1	6.4	..	.	..	7.4	–	53.0	8.2	.1	1.1	–	–	Fabricated metal products
15.8	18.4	10.4	9.2	11.3	3.3	12.4	20.7	87.7	.2	–	–	1.2	1.2	Machinery
17.8	22.1	10.8	11.0	11.9	3.2	15.6	20.9	93.3	–	–	–	.8	5.1	Office, computing, and accounting machines
18.4	11.3	25.9	31.9	38.7	47.8	24.2	27.0	18.6	46.5	.4	14.7	.9	.4	Electrical equipment and communication
18.1	20.4	28.1	7.1	–	29.7	43.1	37.3	76.2	–	–	5.7	–	11.2	Radio and TV equipment
6.7	7.3	4.1	32.6	45.9	46.7	17.5	23.6	90.6	66.2	2.4	33.7	–	–	Electronic components
30.6	41.2	9.1	25.8	–	61.9	26.9	34.2	16.2	1.1	.1	5.7	10.2	1.1	Communication equipment and communication
														Other electrical equipment
3.1	12.3	5.6	34.1	71.7	6.8	40.4	91.4	.2	46.7	62.7	54.7	3.6	–	Motor vehicles and motor vehicles equipment
5.2	4.9	4.1	.4	100.0	–	11.0	7.3	–	–	–	–	–	–	Other transportation equipment
8.4	6.4	5.6	28.2	–	35.4	2.3	1.6	6.7	19.0	13.6	9.4	–	–	Aircraft and missiles
46.4	29.6	26.2	35.7	54.9	16.0	56.3	8.5	66.5	9.8	–	21.4	3.4	5.7	Professional and scientific instruments
30.8	31.3	19.8	22.3	83.4	9.3	25.6	62.3	57.9	9.9	–	–	7.2	–	Scientific and mechanical measuring instruments
53.0	24.2	60.9	46.1	19.2	29.1	66.2	5.4	87.9	–	–	36.3	2.6	6.7	Optical, surgical, photographic, and other equipment
24.6	25.4	23.9	61.0	56.4	–	29.1	17.8	–	–	–	6.2	–	–	Other manufacturing industries
40.6	35.3	10.6	39.3	86.8	35.6	17.5	22.6	24.5	7.8	.5	.3	–	–	Nonmanufacturing industries

viewed for size. Those RD 2 companies which reported R&D expenditures of $500,000 or greater were converted to Form RD 1 and mailed with other RD 1 companies in the 1977 survey. There were about 450 such companies. The remaining RD 2 companies are not mailed another form but data for them are estimated by the Bureau of the Census based upon their 1976 report.

All manufacturing and selected nonmanufacturing companies (in SIC's 49, 7391, 7392, 7399, and 8911) with 1,000 or more employees were included in the sample with certainty. Manufacturing and selected nonmanufacturing companies with fewer than 1,000 employees were sampled at rates depending upon their industry and employment size (table A-2). The source of this sample was the 1974 Standard Statistical Establishment List (SSEL). The SSEL was used for the first time in 1976 as a source for the R&D sample. For other nonmanufacturing industries, the sample was based on the 1966 records of the Social Security Administration.

Each year, the annual Department of Defense (DOD) and National Aeronautics and Space Administration (NASA) lists of R&D contractors are reviewed to ensure that the large contractors are included in the sample. For the 1977 survey, the R&D performing manufacturing companies from the 50 largest NASA contractors were included in the reporting panel with certainty.

The particular sample selected is one of a large number of samples of the same type and size that, by chance, might have been selected. Estimates from each of the different samples would differ somewhat from each other and from the results of a complete canvass conducted under essentially the same conditions as the survey. This variation among the possible estimates is defined by the sampling error, measured in standard error units. The complete canvass total would be included in the range:

1. From one standard error below to one standard error above the derived estimate for about two-thirds of all possible samples.
2. From two standard errors below to two standard errors above the derived estimate for about 95 percent of all possible samples.
3. From three standard errors below to three standard errors above the derived estimate, almost always.

An inference that the comparable complete canvass total would be within the indicated ranges would be correct in approximately the relative frequencies shown. Those proportions, therefore, may be interpreted as defining the confidence that the estimates from a particular sample would differ from complete coverage results by as much as one, two, or three standard errors, respectively.

For example, suppose an estimated total is shown as 400 with an associated relative standard error of 2 percent. Then, there is approximately 67 percent confidence that the interval 392 to 408 includes the complete canvass total, about 95-percent confidence that the interval 384 to 416 includes the complete canvass total, and almost certain confidence that the interval 376 to 424 includes the complete canvass total.

As stated, the standard error refers only to sampling variations. In addition to the sampling errors as measured by the standard error, the estimates are subject to errors in response, coding, processing, and imputation for nonresponse. These nonsampling errors would also occur if a complete canvass were to be conducted under the same conditions as the survey.

The 1977 standard errors of estimates for each industry, for all companies and for those with fewer than 1,000 employees, are shown in table A-3.

The forms for the survey were mailed in January 1978, and nonrespondents received followups by mail. Since total R&D performance funds, total Federal R&D funds, total net sales, and total employment are included in the Census Bureau's mandatory statistical program, the few companies that did not reply to Forms RD 1 in 1977 were mailed the Census Form MA-121, which collects these mandatory items.

In the absence of respondent distributed data, Census has estimated data for items as required in accordance with past performance and industry averages. Table A-1 shows imputation rates for most items on the R&D survey form.

Comparability of Data Over a Period of Several Years

In the surveys of industrial research and development, there has been substantial comparability over any 2-year period. This is because the respondent has had before him, on the same report form used in filing current data, the figures for the previous year as reported by the respondent and as entered on the form by the Census Bureau before mailing, the respondent has been asked to adjust the data for the previous year as necessary to make it comparable to those of the current year. Such adjustments have been made to reflect, for example, changes in reporting concepts or changes in company structure such as mergers or acquisitions. To maintain some measure of consistency, the employment-size classification of any company affected by such changes has been adjusted so that the company is tabulated in the same employment-size category for two consecutive years.

Some measure of the degree of change reflecting these adjustments in contrast to an actual change in R&D activity can be gained by comparing figures for the same year reported for two succeeding reporting periods, e.g., 1976 R&D statistics in the final report of the 1976 survey and the revised 1976 R&D statistics in the final report of the 1977 survey. The totals for broad classifications are likely to be very close in the two reports, but in the finer detail, larger differences are noticeable. The results underscore the point that the measures are approximate and indicative rather than precise.

Efforts to Improve Data Quality

Beginning in May 1975 and extending through the following year, Census Bureau personnel, in coordination with NSF staff, conducted an extensive "Response Analysis" of the Survey of Industrial Research and Development. The purpose of the analysis was to discuss, on an in-depth basis, each of the items on the survey form to determine the sources used by companies to provide the data, the extent and methodology of estimating procedures, completeness of reporting, problems encountered by respondents, and related questions. Interviews (112) were conducted with representatives from firms in a wide variety of industries with emphasis primarily on the larger R&D performers in the most R&D-intensive industries.

The consensus among members of the Response Analysis interview team was that reporting of data on total R&D expenditures by sources of support, (i.e., Federal or company funds), and geographic location, net sales, total employment, and R&D scientists and engineers, was based on company records and these data elements could be considered an accurate reflection of company activities.

Questions on scientific and technical information (STI) expenditures and company research and development as indirect costs of Federal contracts were found to be very difficult for companies to answer and the data were determined to be unreliable. These items were removed from the survey. Also deleted was the question on the employment of scientists and engineers in terms of "man-years." Analysis of historical data showed little differences between these employment data and the average of two January totals; this finding was confirmed by company officials.

It was learned that most companies do not maintain separate accounts for salaries and wages for scientists and engineers and for supporting personnel and that the estimates provided in the survey were extremely weak. Therefore, the item was simplified to obtain a total figure for scientists, engineers, and supporting personnel.

The breakdown of R&D expenditures by basic research, applied research, and development data was cited as one of the more difficult items to provide and one requiring further clarification in the definitions and instructions. To assist respondents in overcoming these difficulties, a number of steps were taken. First, Census Bureau personnel offered suggestions regarding specific problems. Company officials were encouraged to rely to a greater extent on "informed estimates" when precise data were not available. Some changes were made to the survey form to emphasize the more important instructions, to provide the opportunity to report that certain R&D activities were not undertaken by the firm, and to clarify the definitions of both net sales and "contracted-out" research and development.

Industry Codes for 1967-77[a]

The industry codes appearing in the tables are based on the 1972 Standard Industrial Classification (SIC) Manual. The SIC classifications for individual companies for 1967-74 (which were utilized in the publications for those years) were originally determined by data reported in the 1967 Economic Censuses. Between 1967 and 1974, the SIC code for a company on the R&D survey generally remained fixed and reflected that company's principal activity as of 1967. However, under certain circumstances — such as the merger of two or more companies, the acquisition of one company by another, or the formation of conglomerates — the 1967 SIC code for a company could have changed. The Bureau of the Census could not be aware of a possible new SIC code for a company until the 1976 new sample was drawn based upon the 1974 SSEL file. (See above description of the new sample.) When the new sample was selected, the industry codes of companies in both the old and new panels were examined for possible change. For larger R&D companies which had switched industry codes between panels, the historical R&D tables (e.g., 1968-74) have been adjusted to reflect the change in company activities. As it is not known normally when a company changed its industrial activities, the data were adjusted in the following fashion: for companies changing industry codes between 1967 and 1974, the industry total for each of the years affected (1968 through 1974) were estimated to have changed at a constant rate of 14.3 percent per year. Accordingly, the data for the industry in which such a company had been classified in 1967 were deflated by 14.3 percent per year for each of the years 1968-74 (e.g., 14.3 percent subtracted in 1968, 28.6 percent in 1969, 42.9 in 1970, etc.). Similarly, the data for the industry in which such a company was classified in 1974 were inflated by 14.3 percent per year for each of the years 1968-74. The industry code assigned to a company for 1974 is also used to classify that company's activities for the years 1975-77.

The following measures were adjusted in this manner: Number of scientists and engineers, funds for research and development — total, Federal, and company, net sales, cost per R&D scientist and engineer, and basic research expenditures. These historical data appear, for example, in selected tables of this NSF publication on research and development in industry. (See tables B-3, B-6, B-9, B-26, B-29, B-34, and B-46.) No adjustments were made in data for other measures.

[a] For discussion of industry codes for 1966 and earlier years, see National Science Foundation, *Research and Development in Industry, 1975: Funds, 1975, Scientists & Engineers, January 1976* (NSF 77-324), and *Research and Development in Industry, 1970: Funds, 1970, Scientists & Engineers, January 1971* (NSF 72-309) (Washington D.C. 20402: Supt. of Documents, U.S. Government Printing Office, 1977 and 1972).

Table A-2. Sampling ratios used in the selection of manufacturing and nonmanufacturing companies included in the survey of industrial research and development by industry and size of company: 1977

Industry	SIC code[1]	Companies with total employment of —			
		1-99	100-499	500-999	1000 +
Food and kindred products	20	.008	.050	.750	1.000
Textiles and apparel	22,23	.006	.031	1.000	1.000
Lumber, wood products, and furniture	24,25	.010	.100	.750	1.000
Paper and allied products	26	.006	.062	1.000	1.000
Chemicals and allied products					
Industrial chemicals	281-82	.111	1.000	1.000	1.000
Drugs and medicines	283	.333	1.000	1.000	1.000
Other chemicals	284-89	.014	.666	1.000	1.000
Petroleum refining and extraction	29,13	.062	1.000	1.000	1.000
Rubber products	30	.010	.200	1.000	1.000
Stone, clay, and glass products	32	.008	.200	1.000	1.000
Primary metals					
Ferrous metals and products	331-32,3398-9	.008	.142	1.000	1.000
Nonferrous metals and products	333-36	.006	.625	1.000	1.000
Fabricated metal products	34	.010	.200	1.000	1.000
Machinery	35	.006	.125	1.000	1.000
Office, computing, and accounting machines	357	.006	.125	1.000	1.000
Electrical equipment and communication					
Radio and TV receiving equipment	365	.083	1.000	1.000	1.000
Electronic components	367	.031	1.000	1.000	1.000
Communication equipment and communication	366,48	.031	1.000	1.000	1.000
Other electrical equipment	361-64,369	.062	.333	1.000	1.000
Motor vehicles and motor vehicles equipment	371	.018	.500	1.000	1.000
Other transportation equipment	373-75,379	.029	.666	1.000	1.000
Aircraft and missiles	372,376	.111	1.000	1.000	1.000
Professional and scientific instruments					
Scientific and mechanical measuring instruments	381,82	.200	1.000	1.000	1.000
Optical, surgical, photographic, and other instruments	383-87	.062	1.000	1.000	1.000
Other manufacturing industries	21,27,31,39	.006		.062	1.000	1.000
Nonmanufacturing industries	07-12,14-17,[2] 41-47,49-67, 739,807,891, 737	1-49	50-99			
		.010[3]	.500[3]	.500	1.000	1.000

[1] Executive Office of the President, Office of Management and Budget, *Standard Industrial Classification Manual* 1972. Washington D.C. 20402: Supt. of Documents, U.S. Government Printing Office.

[2] Sampling in these cells was a 2-stage process. An initial rate of ½ was used for the entire cells. The selected cases with TE 50 was then subsampled at a 1/50 rate. Those with TE 50 were not subsampled.

[3] Companies in SIC's 07-12,14-17,44,50,53,60 and 63 were not sampled, but were hand-selected from the previous mailing panel.

Table A-3. Standard error of estimate (percentage) of funds for R&D performance for all company size groups and for companies with less than 1,000 employees by industry: 1977[1]

Industry	SIC code	Total	Companies with less than 1,000 employees
Total		(2)	5
Food and kindred products	20	3	59
Textiles and apparel	22,23	6	36
Lumber, wood products, and furniture	24,25	3	30
Paper and allied products	26	3	38
Chemicals and allied products	28	(2)	5
Industrial chemicals	281,82	(2)	6
Drugs and medicines	283	(2)	3
Other chemicals	284-89	1	8
Petroleum refining and extraction	29,13	(2)	15
Rubber products	30	1	11
Stone, clay, and glass products	32	3	32
Primary metals	33	2	27
Ferrous metals and products	331-32,3398-9	(2)	16
Nonferrous metals and products	333-36	3	32
Fabricated metal products	34	2	13
Machinery	35	1	12
Office, computing, and accounting machines	357	1	25
Electrical equipment and communication	36,48	(2)	7
Radio and TV receiving equipment	365	(2)	3
Electronic components	367	1	6
Communication equipment and communication	366,48	(2)	8
Other electrical equipment	361-64,369	1	22
Motor vehicles and motor vehicles equipment	371	(2)	23
Other transportation equipment	373-75,379	1	16
Aircraft and missiles	372,376	(2)	11
Professional and scientific instruments	38	1	6
Scientific and mechanical measuring instruments	381-82	2	9
Optical, surgical, photographic, and other instruments	383-87	1	8
Other manufacturing industries	21,27,31,39	3	25
Nonmanufacturing industries	07-12,14-17,41-47, 49-67,737,739, 807,891	6	17

[1] A description of the standard error of estimate is given in appendix A under "Methodology of Survey." The percentage (or relative) standard errors in this table may be converted to standard errors of estimate by multiplying the percentage shown by the associated estimate. For example, the relative standard error of estimate for R&D performance for all company size groups in the food and kindred products industry (SIC 20) is shown as 3 percent, and the associated total R&D estimate for this industry is shown as $368 million in table B-3, "Funds for R&D by Industry and Size of Company: 1977." The standard error of estimate, then, is .03 times 368 or 11.0.

[2] Less than 0.5 percent.

SOURCE: National Science Foundation.

APPENDIX B
Statistical Tables

In all tables of this report

- Details may not add to totals because of rounding
- Percentages were calculated on the basis of thousands of dollars and may differ from those based on the rounded figures shown.
- Percentage changes are increases unless otherwise indicated.

Total Funds for Research and Development

Federal Funds for Research and Development

Company Funds for Research and Development

Geographic Distribution of R&D Funds

Distribution of R&D Funds, by Major Type of Cost

Employment of R&D Scientists and Engineers

B-27 Full-time-equivalent number of R&D scientists and engineers by industry and source of R&D funds: January 1977 and January 1978

B-28 R&D scientists and engineers per 1,000 employees by industry and size of company: 1958, 1963, and 1966-77

R&D Funds Related to Employment and Net Sales

B-29 Cost per R&D scientist or engineer by industry and size of company: 1957, 1963, and 1966-77

B-30 Cost per R&D scientist or engineer by industry and selected company size group: 1977

B-31 Cost per R&D scientist or engineer in companies ranked by size of R&D program: 1972-77

B-32 Total employment of R&D performing companies by industry and size of company: 1976 and 1977

B-33 Total and company R&D funds per employee by size of company: 1963-77

B-34 Net sales of R&D performing manufacturing companies by industry and selected company size group: 1976 and 1977

B-35 R&D funds as a percent of net sales in R&D performing manufacturing companies by industry and size of company: 1957, 1963, and 1966-77

B-36 Company R&D funds as percent of net sales in R&D performing manufacturing companies by industry and size of company: 1957, 1963, and 1966-77

B-37 R&D funds as a percent of net sales in R&D performing manufacturing companies ranked by size of R&D program by industry: 1977

B-38 Company R&D funds as percent of net sales in R&D performing manufacturing companies ranked by size of net sales by industry: 1977

Energy and Pollution Abatement R&D

B-39 Expenditures for energy research and development by selected industry and source of funds: 1976-78

B-40 Industrial expenditures for energy research and development by primary energy source and source of funds: 1976-78

B-41 Expenditures for pollution abatement research and development by industry and source of funds: 1976-78

B-42 Industrial expenditures for pollution abatement research and development by type of pollution and source of funds: 1976-78

Funds for Research and Funds for Development

B-43 Funds for basic research, applied research, and development: 1953-77

B-44 Funds for basic research, applied research, and development by industry and selected company size group: 1976 and 1977

B-45 Funds for basic research, applied research, and development, by industry, source of funds, and selected company size group: 1977

B-46 Funds for basic research by industry and size of company: 1957, 1963, and 1966-77

B-47 Funds for industrial basic research by field of science: 1967-77

B-48 Funds for basic research by industry and field of science: 1977

B-49 R&D performing companies with 5,000 or more employees and number of companies performing basic research by industry: 1977

B-50 Funds for applied research and development by product field: 1963 and 1966-77

B-51 Funds for applied research and development by product field and source of funds: 1977

B-52 Funds for applied research and development by industry and product field: 1977

B-53 Funds for applied research and development by industry and product field: 1976

B-54 Funds for applied research and development by industry and secondary product field: 1977

B-55 Funds for applied research and development by industry and secondary product field: 1976

FFRDC's

B-56 Industry administered federally funded research and development centers—funds by character of work and composition of work force

Table B-3. Funds for research and development by industry and size of company: 1956, 1963, and 1966-77

(Dollars in millions)

Industry and size of company	SIC code	1956	1963	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Total		$6,605	$12,630	$15,548	$16,385	$17,429	$18,308	$18,062	$18,311	$19,539	$21,233	$22,867	$24,164	$26,938	$29,907
Distribution by industry															
Food and kindred products	20	64	130	164	183	184	199	225	231	246	263	278	312	329	368
Textiles and apparel	22,23	(1)	30	51	57	58	60	58	59	61	64	69	70	82	81
Lumber, wood products, and furniture	24,25	(1)	11	12	12	20	18	52	53	64	71	84	88	107	127
Paper and allied products	26	36	69	117	128	144	188	178	187	189	194	237	249	313	340
Chemicals and allied products	28	641	1,239	1,407	1,507	1,589	1,660	1,773	1,832	1,932	2,116	2,450	2,727	3,017	3,267
Industrial chemicals	281,82	460	809	918	966	965	974	980	942	941	999	1,127	1,200	1,323	1,460
Drugs and medicines	283	94	216	308	343	398	444	485	549	607	698	807	981	1,091	1,153
Other chemicals	284-89	87	214	181	198	226	242	308	341	384	419	516	545	602	654
Petroleum refining and extraction	29,13	182	317	371	371	437	467	515	505	468	498	622	693	767	913
Rubber products	30	(1)	156	168	182	223	261	276	289	377	426	469	467	502	586
Stone, clay and glass products	32	60	100	117	136	142	159	167	164	183	199	217	233	263	293
Primary metals	33	90	183	232	242	251	257	275	272	277	307	358	443	506	526
Ferrous metals and products[3]	331 32,3398,3399	(1)	106	139	135	135	136	149	144	146	163	181	215	256	259
Nonferrous metals and products[3]	333-36	(1)	77	93	107	115	121	126	128	130	145	177	228	250	267
Fabricated metal products	34	116	153	154	163	183	182	207	242	253	291	313	324	358	389
Machinery	35	543	958	1,217	1,326	1,483	1,546	1,729	1,860	2,158	2,549	2,985	3,196	3,487	3,970
Office, computing, and accounting machines	357	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	1,456	1,733	2,103	2,220	2,402	2,758
Electrical equipment and communication	36,48	1,516	2,866	3,626	3,867	4,083	4,348	4,220	4,389	4,680	4,902	5,011	5,105	5,636	5,952
Radio and TV receiving equipment	365	(5)	(5)	47	45	55	57	70	64	48	49	51	50	52	58
Electronic components	367	(5)	1,773	2,249	2,425	2,520	2,671	2,604	2,739	330	406	489	549	691	761
Communication equipment and communication	366,48									2,583	2,613	2,424	2,385	2,511	2,798
Other electrical equipment	361-64,369	(1)	1,093	1,330	1,397	1,508	1,620	1,546	1,586	1,719	1,834	2,047	2,121	2,382	2,345
Motor vehicles and motor vehicles equipment	371	688	1,090	1,344	1,354	1,499	1,566	1,591	1,768	1,954	2,405	2,389	2,340	2,778	3,302
Other transportation equipment	373 75,379									56	72	87	90	94	117
Aircraft and missiles	372,376	2,138	4,712	5,526	5,669	5,765	5,882	5,219	4,881	4,950	5,052	5,278	5,713	6,339	7,078
Professional and scientific instruments	38	200	284	468	542	663	742	744	746	838	961	1,075	1,173	1,298	1,405
Scientific and mechanical measuring instruments	381-82	97	70	87	104	118	123	131	133	163	186	221	266	325	375
Optical, surgical, photographic and other instruments	383-87	103	214	381	438	545	619	613	612	675	775	854	907	974	1,030
Other manufacturing industries	21,27,31,39	(1)	54	77	90	101	104	128	131	146	158	177	205	217	245
Nonmanufacturing industries	07-12,14-17,41-47, 49-67,737,739, 807,891	(1)	276	497	559	603	655	705	704	707	715	768	735	845	950
Distribution by size of company (based on number of employees)															
Less than 1,000		369	619	621	687	(1)	(1)	904	884	929	940	1,058	1,222	1,384	1,448
1,000 to 4,999		550	1,022	1,043	1,017	(1)	(1)	1,233	1,195	1,215	1,248	1,370	1,385	1,500	1,679
5,000 to 9,999		5,686	10,989	793	892	960	1,033	1,095	1,170	1,076	1,168	1,346	1,478	1,648	1,829
10,000 to 24,999				13,092	13,790	14,780	15,435	14,830	15,063	2,159	2,236	2,416	2,633	2,874	3,266
25,000 or more										14,160	15,641	16,677	17,446	19,533	21,585

[1] Not separately available but included in total
[2] Estimated by the National Science Foundation
[3] SIC codes 3398 and 3399 included in the nonferrous metals and products group for 1956 to 1965
[4] Data not tabulated at this level prior to 1972.
[5] Included in the other electrical equipment group.
SOURCE: National Science Foundation

Table B-6. Federal funds for research and development by industry and size of company: 1957, 1963, and 1966-77

[Dollars in millions]

Industry and size of company	SIC code	1957	1963	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Total		$4,335	$7,270	$8,332	$8,365	$8,560	$8,451	$7,779	$7,666	$8,017	$8,145	$8,220	$8,605	$9,561	$10,545
Distribution by industry															
Food and kindred products	20	(1)	(2)	3	2	2	1	3	2	1	1	1	(2)	(2)	(2)
Textiles and apparel	22,23	(3)	(2)	(2)	(2)	(2)	(2)	(2)	1	1	1	(2)	(2)	(2)	(2)
Lumber, wood products, and furniture	24,25	(3)	(2)	0	(2)	0	0	0	(2)	(2)	(2)	(2)	0	0	0
Paper and allied products	26	(1)	0	(2)	(2)	(2)	(2)	(2)	(2)	2	(2)	(2)	(2)	(2)	(2)
Chemicals and allied products	28	89	234	188	210	199	192	180	184	189	203	214	236	266	294
Industrial chemicals	281-82	80	146	158	181	172	165	158	159	171	184	195	218	249	278
Drugs and medicines	283	(1)	9	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Other chemicals	284-89	9	79	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Petroleum refining and extraction	29,13	11	21	18	16	34	10	22	17	15	14	20	(2)	o2	74
Rubber products	30	37	46	19	22	37	65	71	69	123	146	(2)	(2)	(2)	(2)
Stone, clay, and glass products	32	(2)	3	3	2	3	1	11	10	14	15	14	(2)	(2)	(2)
Primary metals	33	5	10	8	8	9	10	10	6	12	11	8	21	26	25
Ferrous metals and products[4]	331-32,3398,3399	1	2	3	1	1	2	1	2	3	4	(2)	3	4	5
Nonferrous metals and products[4]	333-36	4	8	5	6	8	9	9	4	10	7	(2)	17	22	20
Fabricated metal products	34	38	24	17	13	18	8	7	11	12	13	14	27	36	45
Machinery	35	272	250	286	322	340	260	262	315	401	429	511	509	532	577
Office, computing, and accounting machines	357	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(2)	(2)	(2)	486	509	546
Electrical equipment and communication	36,48	1,196	1,849	2,201	2,296	2,333	2,390	2,211	2,258	2,367	2,410	2,307	2,307	2,555	2,696
Radio and TV receiving equipment	365	(6)	(6)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	0	0
Electronic components	367	518	1,209	1,428	1,495	1,526	1,557	1,420	1,479	125	146	184	(2)	(2)	(2)
Communication equipment and communication	366,48									1,417	1,362	1,137	1,057	1,093	1,206
Other electrical equipment	361-64,369	678	640	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Motor vehicles and motor vehicles equipment	371	190	291	344	360	374	290	314	309	293	385	288	318	383	414
Other transportation equipment	373-75,379									26	39	47	47	(2)	(2)
Aircraft and missiles	372,376	2,275	4,261	4,724	4,531	4,533	4,524	4,005	3,864	3,970	3,889	4,003	4,434	4,930	5,496
Professional and scientific instruments	38	109	81	145	189	234	237	194	164	161	160	164	166	155	156
Scientific and mechanical measuring instruments	381,82	80	16	22	37	35	32	20	14	13	11	7	9	6	10
Optical, surgical, photographic, and other instruments	383-87	29	65	123	152	199	205	174	150	148	149	157	157	148	146
Other manufacturing industries[3]	21,27,31,39	74	3	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	7	5	5
Nonmanufacturing industries	07-12,14-17,41-47, 49-67,737, 739,807,891	...	190	367	387	431	448	480	452	431	416	463	310	375	437
Distribution by size of company (based on number of employees)															
Less than 1,000		167	194	234	228	(2)	(2)	355	318	326	307	367	273	299	328
1,000 to 4,999		226	425	385	351	(2)	(2)	412	367	372	357	378	253	270	315
5,000 to 9,999				182	251	299	267	211	214	186	187	230	287	313	388
10,000 to 24,999		3,942	6,651							619	505	430	370	548	643
25,000 or more				7,530	7,536	7,662	7,525	6,801	6,766	6,514	6,789	6,815	7,423	8,130	8,871

[1]Less than $0.5 million

[2]Not separately available but included in total.

[3]For 1957 textiles and apparel and lumber, wood products, and furniture are included in nonmanufacturing industries.

[4]SIC codes 3398 and 3399 included in the nonferrous metals and products group for 1957 to 1965.

[5]Data not tabulated at this level prior to 1972.

[6]Included in the other electrical equipment group.

[7]Estimated by the National Science Foundation.

SOURCE: National Science Foundation

Table B-9. Company funds for research and development by industry and size of company: 1957, 1963, and 1966-77[1]

(Dollars in millions)

Industry and size of company	SIC code	1957	1963	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Total		$ 3,396	$ 5,360	$ 7,216	$ 8,020	$ 8,869	$ 9,857	$10,283	$10,645	$11,522	$13,088	$14,647	$15,559	$17,377	$19,362
Distribution by industry															
Food and kindred products	20	74	([2])	161	181	182	198	222	230	246	252	277	([2])	([2])	([2])
Textiles and apparel	22,23	14	28	([2])	([2])	([2])	([2])	([2])	59	61	63	([2])	([2])	([2])	([2])
Lumber, wood products, and furniture	24,25	14	([2])	12	12	20	18	52	([2])	([2])	([2])	([2])	([2])	([2])	([2])
Paper and allied products	26	35	69	([2])	123	([2])	([2])	([2])	([2])	188	([2])	([2])	88	106	127
Chemicals and allied products	28	616	1,004	1,219	1,297	1,389	1,468	1,593	1,639	1,741	1,897	2,217	2,490	2,751	2,973
Industrial chemicals	281,82	423	662	760	785	794	809	822	783	770	816	933	982	1,074	1,182
Drugs and medicines	283	104	207	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])
Other chemicals	284-89	89	135	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])
Petroleum refining and extraction	29,13	200	296	353	355	403	457	493	488	454	485	603	([2])	715	839
Rubber products	30	70	111	149	160	186	196	205	221	255	280	([2])	([2])	([2])	([2])
Stone, clay, and glass products	32	([2])	97	114	134	139	158	156	153	168	184	203	([2])	([2])	([2])
Primary metals	33	103	174	224	234	241	247	265	266	264	297	350	422	481	501
Ferrous metals and products	331-32,3398,3399	63	105	136	134	134	135	148	142	144	159	([2])	211	252	254
Nonferrous metals and products	333-36	40	69	88	100	108	112	117	124	121	138	([2])	211	229	247
Fabricated metal products	34	97	129	137	151	165	174	201	230	243	279	299	297	322	344
Machinery	35	397	709	931	1,004	1,142	1,286	1,469	1,545	1,758	2,120	2,473	2,687	2,955	3,393
Office, computing, and accounting machines	357	([4])	([4])	([4])	([4])	([4])	([4])	([4])	([4])	([2])	([2])	([2])	1,734	1,893	2,212
Electrical equipment and communication	36,48	608	1,017	1,426	1,571	1,749	1,957	2,008	2,131	2,313	2,491	2,704	2,798	3,081	3,256
Radio and TV receiving equipment	365	([5])	([5])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	49	52	58
Electronic components	367	230	564	[illegible]1	930	993	1,113	1,183	1,252	205	260	306	([1])	([2])	([2])
Communication equipment and communication	366,48									1,165	1,251	1,287	1,328	1,418	1,591
Other electrical equipment	361-64,369	378	453	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])
Motor vehicles and motor vehicles equipment	371	517	799	1,000	994	1,124	1,278	1,278	1,461	1,662	2,020	2,101	2,022	2,395	2,888
Other transportation equipment	373-75,379									29	33	40	43	([2])	([2])
Aircraft and missiles	372,376	299	452	802	1,138	1,230	1,354	1,213	1,017	978	1,154	1,275	1,279	1,409	1,582
Professional and scientific instruments	38	140	202	323	353	429	505	550	583	678	801	911	1,007	1,144	1,249
Scientific and mechanical measuring instruments	381,82	59	53	65	67	83	91	111	120	151	175	214	257	318	365
Optical, surgical, photographic, and other instruments	383-87	81	149	258	286	346	414	439	463	527	626	697	750	826	884
Other manufacturing industries	21,27,31,39	19	52	([2])	88	([2])	([2])	([2])	([2])	([2])	([2])	([2])	198	212	239
Nonmanufacturing industries	07-12,14-17,41-47, 49-67,737, 739,807,891	([2])	85	130	172	172	207	225	252	277	299	306	425	471	514
Distribution by size of company (based on number of employees)															
Less than 1,000		375	425	387	459	([2])	([2])	540	565	603	633	691	949	1,085	1,120
1,000 to 4,999		406	596	657	666	([2])	([2])	821	828	843	891	992	1,132	1,231	1,364
5,000 to 9,999				611	642	661	775	884	956	890	981	1,111	1,190	1,334	1,441
10,000 to 24,999										1,540	1,731	1,986	2,252	2,325	2,623
25,000 or more		[6]2,615	4,338	5,561	6,254	7,118	7,909	8,038	8,297	7,646	8,852	9,862	10,023	11,403	12,814

[1]See table 1, footnote 1

[2]Not separately available but included in total.

[3]SIC codes 3398 and 3399 included in the nonferrous metals and products group for 1957-1965.

[4]Data not tabulated at this level prior to 1972

[5]Included in the other electrical equipment group.

[6]Estimated by the National Science Foundation.

SOURCE: National Science Foundation

Table B-26. Full-time-equivalent number of R&D scientists and engineers by industry and size of company: 1957, 1963, and 1966-78

(In thousands)

Industry and size of company	SIC code	January 1957	1963	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Total		229.4	327.3	353.2	367.2	376.7	387.1	384.1	366.8	349.9	357.3	359.6	362.8	364.3	382.4	400.1
Distribution by industry																
Food and kindred products	20	3.8	5.1	6.2	6.1	6.3	6.2	6.2	6.4	6.2	6.2	6.0	6.3	6.5	6.5	6.7
Textiles and apparel	22,23	.7	1.0	1.4	1.9	2.5	2.6	2.9	1.8	1.8	1.9	1.8	1.8	1.8	1.7	1.7
Lumber, wood products, and furniture	24,25	.8	.5	.6	.5	.5	1.0	1.2	1.8	1.8	1.9	2.1	2.3	2.1	2.1	2.2
Paper and allied products	26	1.5	2.5	4.3	4.7	4.8	4.8	5.0	5.0	4.9	4.9	4.9	5.0	5.2	6.3	6.6
Chemicals and allied products	28	29.4	38.3	38.0	36.9	38.9	40.0	40.1	42.7	41.0	40.9	41.8	45.2	44.4	46.4	48.3
Industrial chemicals	281,82	18.0	22.9	23.3	21.7	22.3	21.9	20.7	20.6	17.6	17.1	16.5	18.0	16.9	17.3	18.0
Drugs and medicines	283	4.7	6.9	7.5	8.7	9.8	10.2	11.8	12.3	13.1	13.0	14.0	15.6	16.6	17.8	18.7
Other chemicals	284,89	6.7	8.5	7.2	6.5	6.8	7.9	7.6	9.8	10.3	10.8	11.3	11.6	11.0	11.3	11.6
Petroleum refining and extraction	29,13	6.9	8.9	8.9	8.7	9.2	10.0	9.9	9.2	8.3	8.2	8.2	8.4	8.6	8.9	9.9
Rubber products	30	4.7	5.8	5.7	5.8	6.1	6.6	7.4	6.7	6.7	7.5	7.7	8.4	8.6	9.1	9.5
Stone, clay, and glass products	32	(1)	3.8	3.1	3.3	4.1	4.2	4.6	4.3	4.1	4.2	4.5	4.5	4.6	4.5	4.8
Primary metals	33	5.1	5.2	5.5	5.9	5.9	6.3	6.5	6.6	6.4	6.0	6.4	6.3	8.1	8.4	8.4
Ferrous metals and products	331-32,3398,3399	2.9	2.9	3.2	3.3	3.1	3.2	3.2	3.4	3.4	3.2	3.3	3.3	3.9	3.9	3.8
Nonferrous metals and products	333-36	2.2	2.3	2.3	2.5	2.7	3.1	3.3	3.2	3.0	2.8	3.1	3.0	4.2	4.5	4.6
Fabricated metal products	34	8.4	6.8	6.3	6.3	5.6	6.6	5.9	7.1	6.6	6.7	7.3	7.4	6.8	7.1	7.2
Machinery	35	24.9	31.4	30.5	33.6	37.4	39.8	42.3	42.7	43.7	46.3	51.0	52.8	55.7	55.3	58.0
Office, computing, and accounting machines	357	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	30.1	34.5	36.1	38.1	37.7	39.8
Electrical equipment and communication	36,48	42.9	85.8	92.0	98.6	98.4	100.4	100.6	91.8	83.6	85.4	82.6	82.6	80.3	84.1	85.4
Radio and TV receiving equipment	365	(1)	(1)	(1)	.9	1.0	1.2	1.9	2.4	2.1	1.4	1.3	1.0	1.1	.9	.8
Electronic components	367	19.2	55.1	62.3	66.7	67.4	66.3	64.8	60.3	53.2	9.4	9.6	10.6	10.2	13.0	14.1
Communication equipment and communication	366,48										45.3	42.0	40.2	37.4	38.0	39.8
Other electrical equipment	361-64,369	23.7	30.7	29.7	31.0	30.0	32.9	33.9	29.1	28.3	29.3	29.7	30.8	31.6	32.2	30.7
Motor vehicles and motor vehicles equipment	371	13.6	21.1	24.8	25.2	24.3	25.2	25.5	28.2	29.7	28.2	27.4	26.0	25.4	28.2	30.3
Other transportation equipment	373,75,379										1.7	1.8	1.9	1.7	1.9	2.1
Aircraft and missiles	372,376	58.7	90.7	99.3	100.4	101.1	99.7	92.2	78.2	70.8	72.1	70.6	67.5	66.9	72.0	77.4
Professional and scientific instruments	38	10.2	9.4	12.5	13.0	14.1	15.2	15.0	15.1	15.2	16.3	17.5	17.9	18.8	20.1	21.5
Scientific and mechanical measuring instruments	381,82	5.8	3.9	3.8	3.6	3.8	4.1	4.1	4.6	4.7	5.3	5.6	5.9	6.7	7.2	7.8
Optical, surgical, photographic, and other instruments	383-87	4.4	5.5	8.7	9.4	10.3	11.1	10.9	10.5	10.5	11.0	11.9	12.0	12.1	12.9	13.7
Other manufacturing industries	21,27,31,39		2.8	2.3	2.2	2.4	2.8	2.6	3.8	3.6	3.6	3.7	3.7	4.2	4.5	4.2
Nonmanufacturing industries	07-12,14-17, 41-47,49-67, 737,739,807,891	17.8	8.2	11.7	14.1	15.1	15.1	16.3	15.6	15.7	15.3	14.4	14.9	14.6	15.3	15.9
Distribution by size of company (based on number of employees)																
Less than 1,000		44.8	34.1	30.0	27.4	27.2	(5)	(5)	28.2	28.4	29.0	28.0	30.1	30.2	31.1	31.3
1,000 to 4,999		22.4	35.0	30.1	30.5	29.9	(5)	(5)	31.8	30.9	28.9	28.8	29.9	29.3	28.9	30.3
5,000 to 9,999					24.0	24.6	24.6	28.5	28.7	28.4	27.0	26.4	27.4	26.1	28.6	30.7
10,000 to 24,999		162.2	258.2	293.1							45.1	46.9	47.4	50.6	49.3	51.5
25,000 or more					285.3	295.0	307.3	299.1	278.1	262.4	227.3	230.5	228.0	228.1	244.5	256.3

[1]Data included in the other manufacturing industries group

[2]SIC codes 3398 and 3399 included in the nonferrous metals and products group for January 1957 to January 1966

[3]Data not tabulated at this level prior to 1972-1973

[4]Included in the other electrical equipment group.

[5]Not separately available but included in total

SOURCE: National Science Foundation

Table B-35. R&D funds as percent of net sales in R&D-performing manufacturing companies by industry and size of company: 1957, 1963, and 1966-77

Industry and size of company	SIC code	1957	1963	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Total		3.4	4.5	4.2	4.2	4.0	4.0	3.7	3.5	3.4	3.3	3.1	3.1	3.1	3.1
Distribution by industry															
Food and kindred products	20	.3	.4	.4	.5	.5	.4	.5	.5	.4	.4	.4	.4	.4	.4
Textiles and apparel	22,23	(1)	.5	.5	.5	.5	.6	.5	.5	.4	.4	.4	.4	.4	.4
Lumber, wood products, and furniture	24,25	(1)	.5	.4	.3	.4	.4	.8	.7	.8	.7	.8	.7	.7	.8
Paper and allied products	26	.6	.8	.9	.9	.9	1.0	.9	.8	.8	.7	.8	.9	1.0	.9
Chemicals and allied products	28	3.5	4.3	4.4	4.6	3.8	3.9	3.9	3.7	3.6	3.5	3.5	3.7	3.7	3.6
Industrial chemicals	281-82	5.0	5.1	4.6	4.8	4.0	4.0	4.1	3.8	3.7	3.4	3.2	3.5	3.6	3.6
Drugs and medicines	283	3.6	4.7	7.3	8.0	6.0	6.0	6.7	6.2	6.5	6.5	6.3	6.4	6.3	6.2
Other chemicals	284-89	1.3	2.8	2.2	2.3	2.1	2.1	1.9	1.9	2.1	2.0	2.1	2.2	2.1	2.1
Petroleum refining and extraction	29,13	.7	1.0	.9	.8	.8	.9	1.0	.9	.8	.7	.6	.7	.6	.7
Rubber products	30	1.7	2.3	1.9	1.9	2.1	2.2	2.3	2.2	2.6	2.6	2.5	2.5	2.4	2.4
Stone, clay, and glass products	32	(2)	1.6	1.5	1.8	1.6	1.7	1.8	1.8	1.7	1.7	1.7	1.2	1.2	1.2
Primary metals	33	.5	.8	.7	.8	.8	.8	.8	.8	.7	.7	.6	.8	.8	.8
Ferrous metals and products[3]	331-32,3398,3399	(1)	.7	.7	.8	.7	.7	.7	.7	.6	.5	.5	.6	.6	.6
Nonferrous metals and products[3]	333-36	(1)	1.1	.8	1.0	1.0	1.0	1.0	1.0	.9	.9	1.0	1.2	1.2	1.1
Fabricated metal products	34	1.6	1.6	1.3	1.3	1.3	1.2	1.2	1.2	1.1	1.2	1	1.2	1.2	1.2
Machinery	35	3.4	4.2	3.9	4.2	4.0	3.8	4.0	4.0	4.3	4.6	4	4.8	4.9	5.0
Office, computing, and accounting machines	357	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	11.1	11.6	12.6	12.0	11.6	11.8
Electrical equipment and communication	36,48	7.6	10.1	8.5	8.6	8.4	7.9	7.3	7.2	7.1	6.9	6.6	6.6	6.7	6.3
Radio and TV receiving equipment	365	(5)	(5)	2.0	1.9	2.2	2.2	2.7	2.4	1.6	1.7	1.7	1.4	1.4	1.3
Electronic components	367									5.9	6.2	6.2	6.9	7.3	7.0
Communication equipment and communication	366,48	(1)	13.0	10.3	10.3	10.9	9.7	8.2	8.2						
Other electrical equipment	361-64,369	(1)	7.3	6.3	7.3	6.8	6.6	6.6	6.4	8.7 6.3	8.1 6.3	7.6 6.3	7.6 6.0	7.6 6.3	7.6 5.6
Motor vehicles and motor vehicles equipment	371	2.9	3.4	3.2	3.4	3.1	3.1	3.5	3.1	3.3	3.5	3.7	3.5	3.2	3.1
Other transportation equipment	373 75,379									1.0	1.2	1.3	1.3	1.3	1.5
Aircraft and missiles	372,376	16.8	26.7	23.7	19.7	19.0	20.2	16.2	16.2	16.6	13.3	14.1	12.7	12.7	13.0
Professional and scientific instruments	38	7.0	5.9	5.5	5.4	6.5	6.4	5.7	5.7	5.9	6.1	6.1	5.9	6.0	6.1
Scientific and mechanical measuring instruments	381-82	9.5	4.1	3.7	3.9	4.1	3.8	3.5	3.7	4.1	4.3	4.5	4.9	5.4	5.6
Optical, surgical, photographic, and other instruments	383-87	5.2	6.9	6.1	6.0	7.4	7.4	6.6	6.4	6.6	6.8	6.7	6.3	6.2	6.2
Other manufacturing industries	21,27,31,39	(1)	.7	.6	.6	.8	.8	.8	.8	.8	.8	.9	.8	.7	.7
Distribution by size of company (based on number of employees)															
Less than 1,000		1.8	1.9	2.7	1.7	(1)	(1)	1.9	1.7	1.7	1.6	1.8	1.6	1.7	1.7
1,000 to 4,999		1.8	2.4	2.3	1.7	(1)	(1)	1.7	1.6	1.7	1.6	1.5	1.4	1.4	1.5
5,000 to 9,999		3.9	5.3	4.9	2.1	2.3	2.1	2.3	2.2	1.9	1.8	1.8	1.8	1.9	1.9
10,000 to 24,999				5.3	5.2	4.7	4.7	4.4	4.2	1.9 4.7	1.7 4.5	1.6 4.2	1.7 4.5	1.8 4.2	1.8 4.2
25,000 or more															

[1] Not separately available but included in total

[2] Included in the other manufacturing industries group

[3] SIC codes 3398 and 3399 included in the nonferrous metals and products group for 1957-1965

[4] Data not tabulated at this level prior to 1972

[5] Included in the other electrical equipment group

[6] Separate data for companies with 5,000 or more employees and for companies with 1,000 to 4,999 employees were estimated by the National Science Foundation for 1957. Revisions of statistics by the U.S. Bureau of the Census for this year did not yield separate data for companies in these size groups.

SOURCE: National Science Foundation

Table B-36. Company R&D funds as percent of net sales in R&D-performing manufacturing companies by industry and size of company: 1957, 1963, and 1966-77

Industry and size of company	SIC code	1957	1963	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Total		1.5	1.9	2.0	2.1	2.1	2.2	2.2	2.1	2.0	2.0	2.0	2.0	2.0	2.0
Distribution by industry															
Food and kindred products	20	.3	(1)	.4	.5	.5	.4	.5	.5	.4	.4	.4	(1)	(1)	(1)
Textiles and apparel	22,23	(1)	.4	(1)	(1)	(1)	(1)	(1)	.5	.4	.4	(1)	(1)	(1)	(1)
Lumber, wood products, and furniture	24,25	(1)	(1)	.2	.3	.4	.3	.8	(1)	(1)	(1)	(1)	.7	.7	.8
Paper and allied products	26	.6	.8	(1)	(1)	(1)	(1)	(1)	(1)	.8	(1)	(1)	(1)	(1)	(1)
Chemicals and allied products	28	3.1	3.6	3.8	4.0	3.4	3.4	3.5	3.3	3.3	3.1	3.0	3.1	3.3	3.3
Industrial chemicals	281,82	4.2	4.1	3.8	3.9	3.3	3.3	3.5	3.2	3.1	2.8	2.6	2.9	2.9	2.9
Drugs and medicines	283	3.6	4.5	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Other chemicals	284-89	1.2	1.8	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Petroleum refining and extraction	29,13	.7	1.2	.9	.8	.8	.9	.9	.8	.7	.7	.5	(1)	.6	.6
Rubber products	30	1.1	1.6	1.7	1.7	1.8	1.6	1.7	1.7	1.7	1.7	(1)	(1)	(1)	(1)
Stone, clay, and glass products	32	(2)	1.6	1.5	1.7	1.6	1.7	1.7	1.6	1.6	1.5	1.5	(1)	(1)	(1)
Primary metals	33	.5	.7	.7	.8	.8	.8	.8	.8	.7	.6	.5	.7	.8	.7
Ferrous metals and products[3]	331 32,3398,3399	(1)	.7	.7	.7	.7	.7	.7	.7	.6	.5	(1)	.6	.6	.6
Nonferrous metals and products[3]	333 36	(1)	.9	.8	.9	.9	.9	.9	1.0	.9	.8	(1)	1.1	1.1	1.0
Fabricated metal products	34	1.1	1.4	1.1	1.2	1.2	1.2	1.1	1.1	1.1	1.2	1.1	1.1	1.1	1.1
Machinery	35	2.0	3.1	3.0	3.2	3.1	3.2	3.4	3.3	3.5	3.8	3.8	4.0	4.2	4.3
Office, computing, and accounting machines	357	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(1)	(1)	(1)	9.4	9.1	9.4
Electrical equipment and communication	36,48	2.6	3.6	3.4	3.5	3.6	3.5	3.4	3.5	3.5	3.5	3.5	3.6	3.7	3.5
Radio and TV receiving equipment	365	(5)	(5)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	1.4	1.4	1.3
Electronic components	367	(1)	4.2	3.8	3.9	4.3	4.0	3.7	3.8	3.7	3.9	3.9	(1)	(1)	(1)
Communication equipment and communication	366,48									3.9	3.9	3.9	4.2	4.3	4.3
Other electrical equipment	361-64,369	(1)	3.0	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Motor vehicles and motor vehicles equipment	371	2.1	2.5	2.4	2.5	2.4	2.6	2.8	2.5	2.8	2.9	3.2	3.0	2.7	2.7
Other transportation equipment	373 75,379									.6	.6	(1)	.6	(1)	(1)
Aircraft and missiles	372,376	2.0	2.6	3.4	4.0	4.1	4.6	3.8	3.4	3.3	3.0	3.5	2.8	2.8	2.9
Professional and scientific instruments	38	3.9	4.2	3.8	3.5	4.2	4.4	4.2	4.5	4.8	5.1	5.2	5.1	5.3	5.4
Scientific and mechanical measuring instruments	381-82	4.0	3.1	2.8	2.5	2.9	2.8	2.9	3.3	3.8	4.0	4.4	4.7	5.3	5.4
Optical, surgical, photographic, and other instruments	383-87	3.8	4.8	4.1	3.9	4.7	5.0	4.7	4.9	5.1	5.5	5.5	5.2	5.3	5.3
Other manufacturing industries	21,27,31,39	(1)	.6	(1)	(1)	(1)	.7	.8	(1)	(1)	(1)	(1)	.7	.7	.7
Distribution by size of company (based on number of employees)															
Less than 1,000		1.4	1.5	1.4	1.6	(1)	(1)	1.6	1.5	1.5	1.5	1.6	1.4	1.5	1.6
1,000 to 4,999		[1]1.2	1.5	1.3	1.4	(1)	(1)	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.3
5,000 to 9,999				1.5	1.6	1.6	1.7	1.8	1.8	1.5	1.5	1.4	1.5	1.6	1.5
10,000 to 24,999		[1]1.6	2.1							1.4	1.3	1.3	1.5	1.4	1.5
25,000 or more				2.2	2.3	2.3	2.4	2.4	2.3	2.5	2.6	2.4	2.6	2.5	2.4

[1]Not separately available but included in total
[2]Data included in the other manufacturing industries group
[3]SIC codes 3398 and 3399 included in the nonferrous metals and products group for 1957 to 1965
[4]Data not tabulated at this level prior to 1972
[5]Included in other electrical equipment group
[6]Estimated by the National Science Foundation.
SOURCE: National Science Foundation

Table B-42. Industrial expenditures for pollution abatement research and development by type of pollution and source of funds: 1976-78

[Dollars in millions]

Type of pollution	1976			1977			1978 (est.)
	Total	Federal	Company	Total	Federal	Company	Total
Total	$759	$51	$708	$918	$57	$861	$1,050
Air	571	26	545	685	23	662	787
Automotive emission	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Electric power plant emissions	31	(1)	(1)	67	(1)	(1)	93
All other	114	16	98	123	13	110	163
Water	87	7	80	105	7	98	114
Solid waste	21	1	20	28	7	21	30
Other	80	17	63	100	20	80	119

[1] Not separately available but included in total.

SOURCE: National Science Foundation.

Table B-43. Funds for basic research, applied research, and development performance: 1953-77

[Dollars in millions]

Year	Total	Basic research	Applied research	Development
1953	$3,630	$151	$[1]726	$[1]2,753
1954	4,070	166	[1]814	[1]3,090
1955	4,640	[1]189	[1]928	[1]3,523
1956	6,605	253	1,268	5,084
1957	7,731	271	1,670	5,790
1958	8,389	295	1,911	6,183
1959	9,618	320	1,991	7,307
1960	10,509	376	2,029	8,104
1961	10,908	395	1,977	8,537
1962	11,464	488	2,449	8,527
1963	12,630	522	2,457	9,651
1964	13,512	549	2,600	[illegible]2
1965	14,185	592	2,658	10,934
1966	15,548	624	2,843	12,081
1967	16,385	629	2,915	12,842
1968	17,429	642	3,124	13,663
1969	18,308	618	3,287	14,403
1970	18,062	602	3,426	14,034
1971	18,311	590	3,413	14,308
1972	19,539	593	3,512	15,434
1973	21,233	631	3,822	16,780
1974	22,867	699	4,284	17,884
1975	24,164	729	4,566	18,869
1976	26,938	817	5,101	21,020
1977	29,907	910	5,652	23,345

[1] Estimated by the National Science Foundation.

SOURCE: National Science Foundation.

APPENDIX C

Industry-Administered Federally Funded Research and Development Centers, 1977

FFRDC	ministered by
Frederick Cancer Research Center	Litton Bionetics, Inc., Litton Industries
Bettis Atomic Power Laboratory	Westinghouse Electric Corp.
Hanford Engineering Development Laboratory	Westinghouse-Hanford Corp.
Idaho National Engineering Laboratry	Aerojet Nuclear Corp.
Knolls Atomic Power Laboratory	General Electric Company
Liquid Metal Engineering Center	Rockwell International Corp.
Mound Laboratory	Monsanto Research Corp.
Oak Ridge National Laboratory	Union Carbide Corp.
Sandia Laboratory	Western Electric Co., Inc.-Sandia Corp.
Savannah River Laboratory	E. I. du Pont de Nemours and Co., Inc.

APPENDIX D

Reproduction of Covering Letters, Questionnaires, and Instructions

NSF-1-L2 (1977)

NATIONAL SCIENCE FOUNDATION
WASHINGTON D C 20550

nsf

January 23, 1978

OFFICE OF THE DIRECTOR

Gentlemen:

The National Science Foundation requests the cooperation of your company in completing the enclosed questionnaire for the 1977 survey of industrial research and development. This is one of a series of surveys conducted to assist us in better understanding and strengthening the overall national effort in research and development.

The Foundation is well aware of the increased reporting burden on industry in recent years. In response to this problem, each item on the survey form has been carefully reviewed to determine if some of the requested data could be collected less frequently than annually. This has led to a decision to alternate between the full survey form, similar to the enclosed questionnaire designed for the 1977 survey, and an abbreviated form containing only principal data elements. This abbreviated version will be used next year for the first time to collect 1978 data. We hope that this will be of assistance in reducing your overall reporting burden.

Data obtained in this survey of industry are used by Government officials in developing policies and programs to strengthen science and technology. Individual companies have also found the data valuable in assessing and planning their own research and development programs. Since industrial firms account for approximately three-fourths of total R&D performance, the survey results represent a major source of needed information in this area.

To provide you with some of the key findings from last year's survey, we will soon be providing you, through the Bureau of the Census, with copies of a release which summarizes the results of that study. A more detailed report, providing substantial additional data, is expected to be available later in the spring.

The U.S. Bureau of the Census collects and compiles the survey responses for the Foundation. Inquiries regarding the survey should be directed to the U.S. Department of Commerce, Bureau of the Census, Washington, D. C. 20233.

Your participation in this survey is very much appreciated. We would be grateful for any suggestions you may have for improving any aspect of the survey. Please direct any such comments to my office.

Sincerely,

Richard Atkinson

Richard C. Atkinson
Director

Enclosures

RD-1-L1 (1977)
(12-7-77

UNITED STATES DEPARTMENT OF COMMERCE
Bureau of the Census
Washington, D.C. 20233

OFFICE OF THE DIRECTOR

FROM THE DIRECTOR
BUREAU OF THE CENSUS

Enclosed are report forms and file copies of Census Form RD-1, "Survey of Industrial Research and Development During 1977," an instruction manual to assist you in completing the report, and a letter from the National Science Foundation, which sponsors this survey, describing the importance of the survey results.

The instruction manual provides guidelines for reporting. However, it is recognized that book records for particular items may not be maintained. In such cases, carefully prepared estimates are acceptable.

This report is authorized by law (title 13, United States Code). Items 2A and 2B, and columns 2 and 4 of item 5C, are a basic part of the statistical program of the Bureau of the Census for manufacturing companies and, if not reported in this survey, would have to be reported on mandatory Census Form MA-121. Response to the remainder of the inquiries is voluntary; however, your cooperation is needed to make the results comprehensive, accurate, and timely. By section 9 of the law (title 13), your report to the Census Bureau is confidential. It may be seen only by sworn Census employees and may be used only for statistical purposes. The law also provides that copies retained in your files are immune from legal process.

Requests for copies of the resulting publications and questions concerning the form should be directed to Mr. Paul Beasley of our Industry Division, phone (301) 763-5598.

We appreciate your past cooperation with the Bureau of the Census and look forward to your continued participation in this important survey.

Sincerely,

MANUEL D. PLOTKIN

Enclosures

FORM RD-1 (11-8-77)
(Instruction Manual)

U.S. DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS
COLLECTING AND COMPILING AGENT FOR
THE NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20233

INSTRUCTIONS FOR SURVEY OF INDUSTRIAL RESEARCH AND DEVELOPMENT DURING 1977

GENERAL

Information About Reporting: Additional Forms – Reporting on this form may require that companies resort to the use of estimates in answering some of the questions. We are satisfied, however, that the comparability of data among companies with research and development programs is sufficient to develop meaningful totals and measures of changes from year to year.

If you require additional copies of the form, write to the Bureau of the Census, 1201 East Tenth Street, Jeffersonville, Indiana 47132. If you have any questions regarding reporting on this form, write to the Bureau of the Census, ATTN: Industry Division, Washington, D.C. 20233, or call Area Code (301) 763–5598.

Companies Reporting in Survey for the First Time – Companies not reporting in 1976 survey should fill in the figures for both years. If the company had no expenditures for research and development, complete only "Item 2." Enter "No R&D" in the space for remarks on page 2 of the form, sign, and return the form.

Figures for Earlier Years are Preposted on the Form If your company reported on form RD-1 for 1976 certain figures from that form have been copied to the present form. Please describe in the "Remarks" section (page 3 of the form) the reasons for any substantial increases or decreases in the 1977 figures entered on this form when compared to corresponding 1976 figures. Examples of such reasons are new government contracts, acquisitions, and disposals, revised accounting method, etc. If you acquired or disposed of a unit performing an important amount of research and development during the two-year period, please identify the unit in remarks, and give the total amount of research and development accounted for by such unit.

Revision of Earlier Year Figures – The 1976 figures should be revised if necessary to assure comparability with 1977 data. Please explain in remarks, any significant change in the 1976 figures. If your company did not report for 1976 or no entries have been entered in the 1976 column, fill in the figures for both years.

Report for Your Entire Company – Research and development activities for your entire domestic company should be reported, including all subsidiaries and divisions of the company. If you desire to have subsidiaries report separately, please write to the Bureau of the Census and list your subsidiaries.

Period Covered by Report – The figures reported should cover the calendar year if at all possible. However, fiscal year data are acceptable for all items except employment, provided your fiscal year ends between September and March. Please report employment figures (items 2B and 4) for the period identified in each of the items mentioned.

Geographic Area Covered – The data are intended to relate to business firms in the fields of manufacturing, minerals, and other economic areas which operate one or more establishments in one or more of the 50 States or the District of Columbia.

▶Section I – GENERAL COMPANY DATA

■**Item 2 – Sales and Employment for Company** – In item 2A, report the net sales and receipts of this company and its subsidiaries to customers outside the company. (Exclude domestic intra-company transfers and sales by foreign subsidiaries, however, include transfers to such foreign subsidiaries and export sales to foreign companies. The reported figures should represent value f.o.b. plant after discounts and allowances and should not include freight charges; excise taxes should be excluded. In item 2B report the number of persons employed at the company in all activities in the 50 States or the District of Columbia during the pay period which includes the 12th of March 1976 and 1977. This figure would be the same as that shown by the company in item 14 of Treasury Form 941, if the company filed one form 941 for the entire company.

▶DEFINITION OF RESEARCH AND DEVELOPMENT

Research and development includes basic and applied research in the sciences and in engineering, and design and development of prototype products and processes. For the purposes of this questionnaire, research and development includes activities carried on by persons trained, either formally or by experience, in the physical sciences including related engineering, and the biological sciences including medicine but excluding psychology, if the purpose of such activity is to do one or more of the following things:

1. Pursue a planned search for new knowledge, whether or not the search has reference to a specific application.

2. Apply existing knowledge to problems involved in the creation of a new product or process, including work required to evaluate possible uses.

3. Apply existing knowledge to problems involved in the improvement of a present product or process.

Research and development includes the activities described above whether assigned to separate research and development organizational units of the company or carried on by company laboratories and technical groups not part of a research and development organization. We recognize that the reporting activities of such latter groups will require the use of estimates for some of the questions.

Activities to be Excluded From Research and Development – Research and development for purposes of this survey does not include quality control, routine product testing, market research, sales promotion, sales service, research in the social sciences or psychology, or other nontechnological activities or technical services.

More specifically, exclude from research and development such nontechnological activities as market research, including statistical surveys of product acceptance, estimates of market size, and studies of channels of distribution; and market development, including the sale of either old or new products to obtain acceptance of them in new outlets; economic research and other research in the social sciences; and legal work in connection with patent applications and litigation, and the sale or licensing of patents.

Also exclude from research and development such technical services as: quality and quantity control tests and analyses, trouble-shooting in connection with breakdowns in full-scale production, including related analytical work; technical plant sanitation control, work required for minor adaptations of a specific product to meet the requirements of a specific customer, including installation and servicing in a customer's plant; engineering and other technical service furnished in accordance with agreements to licensees outside the company; aid furnished by the research and development organization to manufacturing divisions to enable them to operate in accordance with previously determined formulas, standard practice instructions, or finished product specifications; aid furnished to develop advertising programs and to promote or demonstrate new products or processes, including the cost of material furnished for trial or demonstration; assistance in preparation of speeches and publications for persons not engaged in research and development; and experimental work performed at the request of the patent division to provide information needed during the prosecution of a patent litigation.

▶Section II – RESEARCH AND DEVELOPMENT PERFORMED WITHIN THE COMPANY, IN THE UNITED STATES

■**Item 4 – Research and Development Scientists and Engineers** – Scientists and engineers for this survey are defined as all persons engaged in scientific or engineering work at a level which requires a knowledge of physical or life sciences or engineering or mathematics, equivalent at least to that acquired through completion of a four-year college course with a major in these fields, regardless of whether they hold a college degree in the field.

Section II – RESEARCH AND DEVELOPMENT PERFORMED WITHIN THE COMPANY, IN THE UNITED STATES – Continued

As in the past, the figure on R&D scientists and engineers will be obtained primarily from two sources

1. Records on the number of scientists and engineers assigned to research and development. This source is satisfactory so long as the scientists and engineers of the unit are assigned to research and development on a full-time basis (i.e., no more than 5 percent of their time is spent on nonresearch and development). For example, for company laboratories performing only research and development, report the number of scientists and engineers on the rolls in January. For other units, use source 2.

2. Figures on the proportion of total work time of scientists and engineers that is devoted to research and development. For example, if the engineering department of a manufacturing plant had 60 scientists and engineers in January 1977 and one-fourth of the scientists' and engineers' time during that month was charged to research and development projects, the figure for the number of research and development scientists and engineers included for that unit would be 15.

Separate figures are requested on the number of scientists and engineers working on Federal and company and other research and development projects. Where research and development work for the Government and for the company is performed by the same group of scientists and engineers, it will be necessary to distribute the total number of such scientists and engineers according to the program, Federal or company, for which the research and development work was performed (i.e., to use the proportion of the total work time of research and development scientists and engineers that is devoted to Federal and company research and development programs, in order to distribute the total reported in item 4C). The resulting figures should be reported to the nearest man-year, in order to present a reasonable division of time assigned to Federal and company and other research and development programs.

Please divide the requested figures into the related cost figures and check the resulting cost figure of research and development per scientist and engineer for reasonableness.

Cost or Receipts for Research and Development Performed Within the Company, by Major Type and Source of Funds – Include all costs incurred to support research and development, exclusive of capital expenditures, but including depreciation and overhead. If you perform research and development for others on contract, include the total charged for the work performed, including profit.

The relevant costs usually include but are not limited to the elements listed below

1. Wages, salaries, and related costs. Material and supplies consumed (or purchased, if consumption figures are not available), utilities, such as telephone, telegraph, electricity, water, gas, and fuel; books and periodicals; travel and entertainment costs and professional dues.

2. Property taxes and other taxes (except income taxes) incurred on account of the research and development organization or on the facilities which the research and development organization uses. Insurance expense. Maintenance and repair, including the maintenance of buildings and grounds, depreciation on buildings, equipment, and vehicles, or rentals, if any facilities are leased.

3. Company overhead. Estimate a fair share of the cost of any functions which support research and development activities. The basis and method of estimating overhead costs will depend upon company practice. The important point is to be sure that all companies include an allowance for overhead. Items normally covered in overhead include the following.

Personnel, including personnel, medical and safety departments, and employee or industrial relations department, accounting control and fiscal (Treasurer's office), procurement and inventory, including purchasing, receiving, inspection, storage, transportation, control, and issue of materials and supplies, other services, including legal, public relations, shopwork, analytical work, plant protection, rearrangement of facilities, drafting, printing, duplicating, transportation of material and personnel, maintenance of motor vehicles, messenger service, stenographic service, and photography, salaries and related costs of research executives not on the payroll of the research and development organization.

Do not net your research and development expenditures by the amount of royalties received from either noncompany organizations or company units, or the credits received for research and development work charged or "sold" to other departments or divisions of reporting company or to outside organizations.

Types of Expense to be Excluded From Research and Development Costs – Exclude from the cost of research and development performed within the company the cost of research and development carried on for the company by noncompany research and development organizations of any kind; or fellowships, grants, and gifts to promote research and development or the study of the sciences and engineering. That part of company-held research and development contracts subcontracted to research and development organizations outside reporting company. All work that was done for your laboratories and other technical units by noncompany organizations which are not research and development organizations (for example, model construction by a noncompany model shop) is to be considered as a purchase of equipment, material, or supplies for the company research organization rather than as subcontracted research and development.

Types of Expense to be Excluded From Research and Development Costs – Continued

Also exclude capital expenditures, royalties paid, patent expense, income taxes, or interest. Income from sale of products manufactured in the research and development organization if these were sold to bona fide customers.

■ Item 5 – Research and Development Performed Within the Company by Type and by Source of Funds

This item provides separate columns for reporting in 1977 the costs of research and development in Federal contracts and subcontracts, and Company and Other research and development by the three types: basic, applied, and development. Definitions of "Federal," and of "Company and Other" are provided below, after the definitions of types and methods for estimating the breakdowns by type.

Types of Research – Break down the total reported in item 5 into the categories shown below.

Item 5A – Basic Research – Include the cost of research projects which represent original investigation for the advancement of scientific knowledge and which do not have specific commercial objectives, although they may be in the fields of present or potential interest to the reporting company.

Item 5B1 – Applied Research – Include the cost of research projects which represent investigation directed to discovery of new scientific knowledge and which have specific commercial objectives with respect to either products or processes. Note that this definition of applied research differs from the definition of basic research chiefly in terms of the objectives of the reporting company.

Item 5B2 – Development – Include the cost of projects which represent technical activity concerned with nonroutine problems which are encountered in translating research findings or other general scientific knowledge into products or processes. Do not include routine technical services to customers or other items excluded from definition of research-development above.

Methods of Estimating Research and Development Expenditures by Type – Many of the companies in this survey have accounts they believe substantially meet the definitions used in this survey for basic research, applied research, and development. In most cases, companies have found it possible to allocate their own accounts to these categories.

If your company does not keep records that meet or can be allocated to these specific categories, there are two principal ways to reduce the task of providing the data requested.

1. Isolate the projects that clearly fall in the development category. If your company fabricates products, such development activity will include the design, construction, and testing of prototypes and models. Some defense contracts typically call for several test models. If your company's research and development frequently involves the development of a "process" as in chemicals and petroleum, such development activity would include operations beyond the bench scale, primarily the design and operations of pilot plants or semiworks.

2. Isolate the organizational units whose research and development can be readily classified. If a company has two or more laboratories, the expenditures of some of these laboratories may be all classified in one or another type of research and development on the basis of the function assigned to the laboratory. There are laboratories assigned only development type work. There are others engaged only in applied or basic research. If research and development work is done in production units as well as in various laboratories, the research and development work in the production units will generally be of a development type.

The separate classification of clearly identified development operations, particularly in the industries producing expensive prototypes, will greatly reduce the balance to be distributed. The distribution will have to be estimated on the basis of a review of individual projects or on the basis of other summaries of the work. Please use the definitions for basic, applied, and development, as given above. If, despite these instructions, you feel that you are unable to distribute your research and development expenditures into groupings approximating the categories requested, please write to the Bureau of the Census describing your accounts and indicating your special problems. The Bureau may be able to make or obtain some suggestions that will be helpful in completing the report form.

Types of Activity Included in Development – The design and operation of pilot plants or semi-works plants so long as the principal purposes are to obtain experience and to compile engineering and other data to be used in evaluating hypotheses, in writing product formulas or in establishing finished product specifications, in designing special equipment and structures required by a process, and in preparing operating instructions or manuals. The engineering activity required to advance the design of a product or a process to the point where it meets specific functional and economic requirements and can be turned over to manufacturing units. The design, construction, and testing of preproduction prototypes and models and "engineering follow-through" in the early production phase is included.

The development of designs for special manufacturing equipment and tools is included but tool making and tool tryout are not included. The preparation of reports, drawings, formulas, specifications, standard practice instructions or operating manuals, and other media for transmitting to operating units information obtained from the above activities is included. However, the production of detailed construction drawings or manufacturing blueprints is not included. The question, "When does development end and production begin?" is often asked. If the primary objective is to make further improvements on the product or process, then the work comes within the definition of research and development. If, on the other hand, the product or process is substantially "set," and the primary objective is to develop markets or to do preproduction planning, or to get the production process going smoothly, then the work is no longer research and development.

Source of Funds – A separate column in item 5 is provided for each of the following:

Item 5, Column 2 – Federal – Include the cost of work done on research and development contracts or subcontracts, and research and development portions of procurement contracts and subcontracts during the year.

Do not include here, or elsewhere in the report, research and development contracts and the portions of procurement contracts that you subcontracted to other research and development organizations. To do so would cause duplication in the statistical totals derived from these reports.

Item 5, Column 3 – Company and Other – Include the cost of all company-sponsored research and development performed within the company. (Report company-sponsored research and development performed outside the company in item 12.) Research and development is performed by a few manufacturing companies for others than the Federal Government. Such research and development should be included in this column.

In item 5E, report the expected or estimated cost of company-sponsored research and development that will be performed within the company during 1978.

■**Item 6 – Cost of Research and Development by Principal Federal Agency. Distribute the cost of Federal Research and Development Work (item 5c, column 2 of Form RD-1) by Federal agency** – Companies reporting Federal research and development are asked to provide separate figures for the three categories of Federal agencies: Department of Defense, National Aeronautics and Space Administration, and all other Federal agencies. In general, most companies performing large amounts of research and development for the Government will have one or more separate organizational units charged with responsibility for most Federal contracts. Reporting of the requested data has been simplified for some companies by using the data available from the accounts of such units as the basis for the overall company figures on the number of scientists and engineers and the costs of Federal programs. For example, if 80 percent of the work for Federal agencies is performed by units with separate accounts, it should be reasonable to estimate the company totals on the basis of such figures rather than make special tabulations or separate estimates for each of the company units that may be doing some work on Government research and development.

■**Item 7 – Cost or Contract Value of Research and Development Performed Within the Company by Major Type of Expense** – The type of information requested here will be available for separate research and development organizational units or for companies with separate research and development accounts. It is not requested that special analyses be made of cost records where research and development and other functions are combined and if existing records do not yield estimates for this item, the item need not be completed. However, if most research and development is performed in units where summaries are regularly prepared by element of cost it should be possible to base the breakdown of research and development costs upon the records of such establishments.

For wages and salaries report the gross earnings paid in calendar year 1977 to employees engaged in research and development, including dismissal pay, paid bonuses, vacation and sick-leave pay, and compensation in kind, and prior to such deductions as employees' Social Security contributions, withholding taxes, group insurance, and savings bonds. (You should follow the definition of salaries and wages that is used for calculating the withholding tax.) Include salaries of officers in the research establishment(s), if a corporation; exclude payments to proprietor or partners, if an unincorporated concern. Exclude payments to members of armed forces and pensioners carried on your active payroll. (Scientists and engineers are defined on page 3, item 4.)

For materials and supplies, report the delivered cost for all purchased materials consumed, whether received from other companies, withdrawn from inventory, or received from other establishments of this company.

Item 7B – Materials and Supplies, and Item 7C – Other Costs may be combined if a separate figure cannot be obtained or reasonably estimated from present accounts.

■**Item 8 – Fields of Basic Research** – The following definitions are supplied for fields included in the item:

Engineering – Includes aeronautical, astronautical, chemical, civil, electrical, and mechanical engineering, and metallurgy and materials.

Geological sciences – Includes geodesy, hydrology, geochemistry, seismology, soil sciences, etc.

Atmospheric sciences – Includes aeronomy, weather modification, meteorology, etc.

Biological sciences – All sciences, other than clinical medical sciences, which deal with life processes, including plant and animal sciences, bacteriology, pathology, microbiology, pharmacology, etc.

Clinical medical sciences – All sciences concerned with the use of scientific knowledge for the identification, treatment, and cure of disease. Includes internal medicine, neurology, preventive medicine and public health, psychiatry, dentistry, pharmacy, etc.

Other sciences – To be used for multidisciplinary and interdisciplinary projects which cannot be classified within one of the above primary fields of science.

■**Item 9 – Applied Research and Development by Product Group** – Enter both Federal and total costs of Applied Research and Development by product group. Costs should be entered in the field or product group in which the research and development project was actually carried on regardless of the classification of the field of manufacturing in which the results are to be used. For example, research on an electrical component for a farm machine should be reported as research on electrical machinery. Also, research on refractory bricks to be used by the steel industry should be reported as research on stone, clay, glass, and concrete products rather than primary ferrous metals, whether performed in the steel industry or the stone, clay, glass, and concrete industry.

Research and development work on an automotive head lamp would be classified in group 25, regardless of whether performed by an automotive or electrical company. Fields of Applied Research and Development are listed below. For those companies familiar with the Standard Industrial Classification, the 1972 SIC number or numbers are given after each title. Note, however, that the SIC definition here applies to the field of research and development effort, and not necessarily to the field in which your company's manufacturing output is classified.

Product Group

1 **Atomic Energy Devices** – Applied Research and Development on atomic energy devices, previously reported separately, should be included with research and development as classified in the categories listed on lines 2–33. Examples of the fields of research and development activities on atomic energy devices and the product groups in which such activities should be reported are as follows:

Activity	Product Group No.
Radioactive isotopes and other radiation sources	4
Partially fabricated reactor fuel element materials and control rods	12
Nuclear reactors	14
Reactor components and equipment	
Core structurals (barrels, cans, boxes, plates, etc.)	
Heat exchangers and condensers	
Valves	
Complete reactor fuel elements and control rods for use in:	
Propulsions	
Power plants	
Other	
Atomic waste casks	
Fuel handling equipment	20
Control rod drive mechanism and components for:	
Power plants	
Propulsions	
Other	
Pressurizers, components and auxiliary equipment	
Pumps	
Accessory instrumentation for reactor control	22
Atom smashers (particle accelerators)	24
Hot laboratory equipment	31
Special instrumentation	

2 **Foods and Kindred Products (SIC 20)** – Foods and beverages for human consumption and certain related products, such as vegetable and animal fats and oils, prepared feeds for animals and fowls.

3 **Textile Mill Products (SIC 22)** – Mill preparation of fibers and mill manufacture of yarn, thread, braids, twine, and cordage; manufacture of broad and narrow woven fabric, knit fabric, carpets and rugs from yarn; dyeing and finishing fiber, yarn, and knit apparel; coating, waterproofing, or otherwise treating fabric; the integrated manufacture of knit apparel; and other finished articles from yarn; the manufacture of felt goods, lace goods, bonded fiber fabrics, and miscellaneous textiles.

4 **Basic Industrial Inorganic and Organic Chemicals (SIC 281 and 286)** – Includes radioactive isotopes and other radiation sources.

5 **Plastics Materials and Synthetic Resins, Synthetic Rubber, Synthetic and Other Manmade Fibers Except Glass (SIC 282)** – Exclude glass.

6 **Drugs (SIC 283)** – Medicinal chemicals, biological and botanical products, and pharmaceutical preparations.

7 **Agricultural Chemicals (SIC 287)** – Fertilizers, agricultural pesticides, and other agricultural chemicals.

8 **All Other Chemicals (balance of SIC 28)** – Explosives, soaps, glycerins, detergents and cleaning preparations, paints and varnishes, toilet preparations, and miscellaneous chemical products.

9 **Petroleum Refining and Extraction, and Natural Gas (SIC 13 and 29)** – Exclude geological and geophysical exploration activities.

10 **Rubber and Miscellaneous Plastics Products (SIC 30)** – Fabricated rubber such as industrial and mechanical rubber goods and fabricated plastics products.

11 **Stone, Clay, Glass, and Concrete Products (SIC 32)** Ceramics, glass, clay products, abrasives and asbestos products, cement, stone products, concrete products, and other nonmetallic mineral products.

12 **Primary Ferrous Products (SIC 331, 332, 3462, and 3399)** – Products of blast furnaces, steel works, rolling and finishing mills, iron and steel castings and forgings. Includes partially fabricated reactor fuel element materials and control rods.

13 **Primary and Secondary Nonferrous Metals (balance of SIC 33 and 3462)** – Primary and secondary smelting and refining of nonferrous metals; rolled, drawn, and extruded nonferrous metal products, castings and forgings.

14 **Fabricated Metal Products (SIC 34)** – Tinware, hand tools, nonelectric heating apparatus, fabricated structural metal products, metal stampings, fabricated wire products, etc. Includes: nuclear reactors; reactor components and equipment; core structurals (barrels; cans, boxes, plates, etc.); heat exchangers and condensers; valves; complete reactor fuel elements and control rods for use in: propulsions, power plants, and other systems; atomic waste casks.

15 Engines and Turbines (SIC 351) – Steam engines, steam, gas and hydraulic turbines, diesel and other internal combustion engines, n.e.c.

16 Farm and Garden Machinery and Equipment (SIC 352) Farm machinery, including tractors for farm use.

17 Construction, Mining, and Material Handling Machinery and Equipment (SIC 353) – Construction, mining, and oil field machinery and equipment, elevators, conveyors, hoists, industrial trucks, tractors, trailers and stackers.

18 Metalworking Machinery and Equipment (SIC 354) Machine tools, dies, machine tool accessories, rolling mill machinery, power driven hand tools, wire fabricating machinery and equipment, and automobile maintenance machinery and equipment.

19 Office, Computing, and Accounting Machines (SIC 357) – Typewriters, electronic computing equipment, calculating and accounting machines, scales and balances (except laboratory), and other computing and office machines.

20 Other Machinery, Except Electrical (balance of SIC 35) – Special industrial machinery, except metalworking, such as food products machinery, textile and paper industries machinery, general industrial machinery and equipment, and miscellaneous machinery except electrical. Includes atomic fuel handling equipment, control rod drive mechanism and components for power plant, propulsions, pressurizers, components and auxiliary equipment, pumps.

21 Electric Transmission and Distribution Equipment (SIC 361 and 3825) – Electric measuring instruments and test equipment, power, distribution and specialty transformers, switchgear and switchboard transformers, etc.

22 Electrical Industrial Apparatus (SIC 362) – Electric motors and generators, motor starters and controls, welding apparatus, carbon and graphite brushes, electrodes, capacitors, condensors, and rectifiers. Includes accessory instrumentation for reactor control.

23 Radio and Television Receiving Sets, Except Communication Types (SIC 365) – Radio and television receiving sets, except communication types and phonograph records.

24 Electronic Components and Accessories, Communications Equipment (SIC 366-67) – Electron tubes, cathode ray tubes, resistors-capacitors, transformers and other components for electronic end products, solid state electronic devices, and telephone and telegraph apparatus. Also includes electronic guidance control subassemblies, radar and radio equipment, and electronic sighting devices. Includes atom smashers (particle accelerators).

25 Other Electrical Machinery Equipment and Supplies (balance of SIC 36) – Household appliances, electric lighting and wiring equipment, and miscellaneous electrical machinery equipment and supplies.

26 Missiles (SIC 376) – Including frames or structures, launching and handling support equipment and work on the missile system as a whole. Electronic guidance control subassemblies and radar should be included in group 24 above. Rocket motors should be included in group 28 below.

27 Space Vehicles (SIC 376) – Including frames or structures, launching and handling support equipment and work on the space vehicle as a whole.

28 Aircraft and Parts (SIC 372) – Piloted and unpiloted aircraft and parts of all types, including engines and auxiliary equipment such as landing gear, deicing equipment, and other auxiliary equipment specifically adopted for aircraft. Radar and radio equipment and electronic sighting devices should be included in group 24 above. Aeronautical instruments should be included in group 31 below.

29 Motor Vehicles and Equipment (SIC 371) – Applied research and development related to motor vehicles, including automobiles, trucks, busses, and special purpose motor vehicles such as ambulances, fire engines, personnel carriers, amphibian motor vehicles, and truck and automobile trailers, and to motor vehicle equipment and parts (exclude batteries, tires, engine electrical equipment, etc.).

30 Other Transportation Equipment (balance of SIC 37) Ship and boat building and repairing, railroad equipment, motorcycles, bicycles and parts, etc.

31 Measuring, Analyzing and Controlling Instruments, Photographic, Medical and Optical Goods; Watches and Clocks (SIC 38) – Engineering, laboratory, and scientific and research instruments, instruments for measuring, controlling and indicating physical characteristics. Optical instruments and lenses, surgical, medical, and dental instruments; fire control apparatus; ophthalmic goods, photographic equipment; and watches, clocks, etc. Includes hot laboratory equipment, and special instrumentation.

32 Ordnance, Except Missiles (SIC 348, 3795) – Artillery, small arms, ammunition, tanks, and parts, etc.

■ **Item 10 – Cost of Research and Development Performed Within the Company, by State** – List the States in which your research and development laboratories or facilities are located and report the cost of research and development for each State. It is not intended that information reported reflect individual assignments outside the home State of the particular research staff. As much as 10 percent of the total may, if desired, be reported as "Not distributed by State."

■ **Item 11 – Research and Development by Functional Category**

Energy Research and Development – Include all R&D spending whose purpose is to increase energy resources or capabilities, including the development of energy equipment. Some R&D spending is for joint or multiple purposes. In these instances, estimate and report the portion of cost incurred due to the energy purpose. Energy R&D can include costs of R&D projects (both product and process) on exploration, extraction, transportation, processing, storage, generation (including conversion), distribution, conservation, etc., of present, new, or improved forms of energy. Record energy R&D spending according to type of energy.

Coal R&D activities are to be assigned into three sub-categories. "**Synthetic fuels**" includes programs designed to convert coal to gaseous and liquid products. "**Mining**" is composed of programs for developing equipment and techniques to improve the productivity and recovery rates of coal mining.

"**Conservation and Utilization**" includes R&D activities undertaken to reduce consumption either at the point of energy use or in the transmission, transportation, storage, and conversion of energy. Examples of such are R&D undertaken primarily to reduce fuel consumption in manufacturing, to improve the efficiency of transportation of energy products, or to produce an end product which is more efficient in energy consumption.

"**All other energy**" includes areas such as wind, waste, hydroelectric, etc. Also include in this category, (F), the development of energy equipment which cannot be readily classified in A to E. If the energy source is waste or any other area with pollution abatement aspects, consider carefully whether one of the purposes of the project is pollution abatement.

In a limited number of cases, the separation of joint (multiple) costs which is encouraged in the preceding paragraph may not be feasible. In this circumstance, include total project cost if the primary purpose of a project is energy R&D; do not include any of project cost if the primary purpose of the project is other than energy R&D.

Pollution Abatement Research and Development – Pollution abatement R&D spending for the purpose of reducing or eliminating the emission of pollutants. As used here, abatement includes prevention, treatment, or recycling; pollution refers to the emission of pollutants to the outside of a firm's (or household's) property or activities. Do not include R&D spending to contribute to environmental aesthetics, to increase equipment durability in corrosive environments, to conserve energy (include as energy R&D) and natural resources, or to increase employee comfort, safety, and health.

There can be two types of pollution abatement R&D spending. In some cases, the only purpose of the R&D spending is pollution abatement. Examples are spending on projects to improve or design alternatives to electrostatic precipitators, wet scrubber systems, waste treatment systems, effluent monitoring devices, etc. In such cases, include the total expenditures on the R&D project. In other cases, pollution abatement is one of several purposes. Examples are spending on projects to improve production processes or products and simultaneously reduce the emission of pollutants. Pollution abatement purposes could also be combined with other types of environmental control purposes such as energy conservation or employee safety and health. In all these instances, estimate and report only the portion of cost incurred due to the pollution abatement purpose.

In a limited number of cases, the separation of joint costs which is encouraged in the preceding paragraph may not be feasible. In this circumstance, do not include any of project cost unless the primary purpose of the project is pollution abatement. When the primary purpose is pollution abatement, include the total project cost in your answer.

Do not include any of project cost as being for pollution abatement if expected pollution abatement benefits are incidental. Incidental benefits are those obtained at no extra cost.

Show R&D spending according to the form of pollution being abated. For example, "air" has three subcategories, automotive emissions, electric power plant emissions, and all other, are included under "air." Automotive emissions includes all R&D efforts undertaken to reduce exhaust emissions from automobiles. Electric power plant emissions includes efforts directed toward reducing air-borne emissions from electric power plants. All other includes efforts directed at removing sulfer oxide, nitrogen oxides and particulates, and other fossil-fuel pollutants from the atmoshpere. Water should include R&D spending on water recirculation or thermal pollution abatement. R&D spending on waste compacting devices should be included under "solid waste," and R&D spending on noise and radiation pollution abatement should be included under "other."

▶Section III – RESEARCH AND DEVELOPMENT PERFORMED OUTSIDE THE COMPANY – (R&D not included in Item 5)

■ **Item 12 – Total Company Funds Spent for Research and Development Activities Performed Outside the Company Within the United States** – Report the amount of company funds spent for research and development performed outside of the company within the United States. This item includes contracts to outside organizations, but specifically excludes subcontracting of Federal Government or other company contracts.

■ **Item 13 – Total Company Funds Spent for Research and Development Activities Performed by Foreign Affiliates Outside the United States** – Report the amount of research and development financed by the U.S. parent or its foregin affiliates performed in R&D laboratories, branch plants, divisions, and subsidiaries located outside the United States.

This item excludes R&D activities performed in foreign affiliates financed by foreign governments or other outside organizations.

NOTE: Foreign affiliates are those outside the 50 States or the District of Columbia.

DUE DATE: 60 DAYS AFTER RECEIPT OF FORM

Form Approved: O.M.B. No. 41-R1863

FORM RD-1
(11-1-77)

U.S. DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS
COLLECTING AND COMPILING AGENT FOR
THE NATIONAL SCIENCE FOUNDATION

SURVEY OF INDUSTRIAL RESEARCH AND DEVELOPMENT DURING 1977

RETURN TO: Bureau of the Census
1201 East Tenth Street
Jeffersonville, Indiana 47132

Name of person who supplied 1976 data

NOTE: Data supplied in items 2A and 2B and in item 5C, columns 2 and 4, for 1977 on this form, will satisfy the mandatory reporting requirement of Census Form MA-121 (title 13, U.S. Code). Although you are not required to complete the other items, your cooperation on these voluntary items is needed to make the results of this survey comprehensive, accurate, and timely.

NOTICE – Your report to the Census Bureau is confidential by law (title 13, U.S. Code). It may be seen only by sworn Census employees and may be used only for statistical purposes. The law also provides that copies retained in your files are immune from legal process.

Item 1 – NAME AND ADDRESS OF COMPANY – *Please correct any error in name and address including ZIP code*

Group	Survey
4	4901

PLEASE RETURN THIS COPY

CENSUS USE ONLY	1	2	3	4	5	6

GENERAL INSTRUCTIONS

- Please complete and return this form in the envelope provided within 60 days. Retain the file copy for your records. This report should cover your entire company, including all subsidiaries and affiliates, unless otherwise designated.
- Enter "None" where appropriate rather than leaving a blank space.
- Reasonably accurate estimates are acceptable.
- Be sure 1976 and 1977 figures are comparable.

PLEASE READ ENCLOSED INSTRUCTIONS BEFORE COMPLETING THIS FORM

Section I – GENERAL COMPANY DATA

Item 2 – DOMESTIC SALES, RECEIPTS, AND EMPLOYMENT FOR COMPANY

	CT1	1976 [1]	1977 [2]
A. Domestic net sales and receipts of this company *(Thousands of dollars)*	2001	$	$
B. Total domestic company employment in all activities during the pay period which includes the 12th of March 1976 and 1977	2002		

Item 3 – RESEARCH AND DEVELOPMENT EXPENDITURES

Are research and development expenditures for entire domestic company, including subsidiaries and affiliates, reported on this form? ☐ Yes ☐ No – *Please explain in remarks or on transmittal letter*

Section II – RESEARCH AND DEVELOPMENT PERFORMED WITHIN THE COMPANY IN THE UNITED STATES

Exclude R&D carried out by the company but performed by others. Report such R&D in section III.

Item 4 – NUMBER OF RESEARCH AND DEVELOPMENT SCIENTISTS AND ENGINEERS *(See instruction manual, page 3)*

	CT2	January 1977 [1]	January 1978 [2]
A. Federal research and development	3001		
B. Company and other research and development	3002		
C. TOTAL *(Sum of A and B)*	3099		

Item 5 – COST OF RECEIPTS FOR RESEARCH AND DEVELOPMENT PERFORMED WITHIN THE COMPANY BY MAJOR TYPE AND SOURCE OF FUNDS

Thousands of dollars

		CT2	1976 TOTAL [1]	1977 Federal funds [2]	1977 Company and other funds, except Federal [3]	1977 TOTAL *(Sum of columns 2 and 3)* [4]
A. Basic research		3510	$	$	$	$
If "None" please mark ⇨ 35105						
B. Applied research and development	1. Applied research	3521				
	2. Development	3522				
	3. Total *(Sum of lines 1 and 2)*	3529				
C. TOTALS *(Sum of A and B3)*		3599	$	$	$	$
D. 1976 TOTALS				$	$	$

	CT1	
E. Company and other funds, except Federal, budgeted for the year 1978	3600	$

Item 6 – COST OF RESEARCH AND DEVELOPMENT BY PRINCIPAL FEDERAL AGENCY

Cost of Federal research and development during 1977 *(Breakdown of item 5C, column 2, of this form)*

Thousands of dollars

	CT1	1976 [1]	1977 [2]
1. Department of Defense	3701	$	$
2. National Aeronautics and Space Administration	3702		
3. All other Federal Agencies	3703		
4. TOTAL COST *(Sum of 1, 2, and 3)*	3799	$	$

Please continue on page 2

Section [illegible] – R&D PERFORMED WITHIN THE COMPANY IN THE UNITED STATES [illegible]
[illegible] R&D [illegible]

Item 7 – COST OR CONTRACT VALUE OF RESEARCH AND DEVELOPMENT PERFORMED WITHIN THIS COMPANY BY MAJOR TYPE OF EXPENSE

	CT1	Thousands of dollars	
		1976 [1]	1977 [2]
A. Wages and salaries of research and development personnel (include scientists and engineers, technicians, secretaries, and other personnel)	4010	$	$
B. Costs of materials and supplies consumed (do not include in this item components, models, and other materials supplied by other research organizations)	4020		
C. Other costs (include service and supporting costs, depreciation, and share of overhead)	4030		
D. TOTAL COSTS *(Sum of A through C) (Same as item 5C, columns 1 and 4)* →	4099	$	$

Item 8 – FIELDS OF BASIC RESEARCH *(Of the total reported in item 5A for basic research, please give cost for the following fields.)*

		[1]	[2]
A. Chemistry	5001	$	$
B. Engineering (including metallurgy)	5002		
C. Geological sciences	5003		
D. Mathematics	5004		
E. Physics	5005		
F. Astronomy	5006		
G. Atmospheric sciences	5007		
H. Oceanography	5008		
I. Biological sciences	5009		
J. Clinical medical sciences	5010		
K. Other sciences	5011	$	$
L. TOTAL BASIC RESEARCH COST *(Same as item 5A, columns 1 and 4)* →	5099	$	$

Item 9 – APPLIED RESEARCH AND DEVELOPMENT BY PRODUCT GROUP *(Of the total reported in item 5B, line 3, for applied research and development, please give cost of project fr each of the following. See the instructions on how to classify and define research and development, page 6.)*

	CT2	Thousands of dollars			
		1976		1977	
		Federal [1]	Total [2]	Federal [3]	Total [4]
1. Atomic energy devices *(See Instruction Manual, page 6)*					
2. Food and kindred products	6200	$	$	$	$
3. Textile mill products	6220				
4. Industrial inorganic and organic chemicals	6281				
5. Plastics materials and synthetic resins, rubber, and fiber	6282				
6. Drugs	6283				
7. Agricultural chemicals	6287				
8. All other chemicals	6289				
9. Petroleum refining and extraction	6290				
10. Rubber and miscellaneous plastics products	6300				
11. Stone, clay, glass, and concrete products	6320				
12. Primary ferrous products	6331				
13. Primary and secondary nonferrous metals	6339				
14. Fabricated metal products	6340				
15. Engines and turbines	6351				
16. Farm machinery and equipment	6352				
17. Construction, mining, and materials handling machinery	6353				
18. Metalworking machinery and equipment	6354				

19. Office, computing, and accounting machines	6357				
20. Other machinery, except electrical	6359				
21. Electric transmission and distribution equipment	6361				
22. Electrical industrial apparatus	6362				
23. Radio and television receiving sets, except communication types	6365				
24. Electronic components and accessories, communications equipment	6366				
25. Other electrical machinery equipment and supplies	6369				
26. Missiles	6197				
27. Space vehicles	6198				
28. Aircraft and parts	6372				
29. Motor vehicles and equipment	6371				
30. Other transportation equipment	6379				
31. Professional and scientific instruments	6380				
32. Ordnance, except missiles	6199				
33. Other – *Specify*	6998				
34. TOTAL APPLIED RESEARCH AND DEVELOPMENT COSTS *(Same as Item 5.d, line 3, columns 1, 2, and 4)* →	6999	$	$	$	$

Item 10 – COST OF RESEARCH AND DEVELOPMENT PERFORMED WITHIN THE COMPANY, BY STATE

Were all of the research and development costs reported in Item 5C, column 4, on this form for 1977 performed in the State listed in the address block (Item 1) of this form? ☐ Yes ☐ No

If "No," list the home State and any other States in which the various research and development laboratories or facilities are located, and estimate the costs associated with each State. If necessary, you may report up to 10 percent of your total as "Not distributed by State."

State *(Attach an additional sheet if necessary)*	CT1	Thousands of dollars			
		1976		1977	
		Federal 1	Total 2	Federal 3	Total 4
A.	71	$	$	$	$
B.	71				
C.	71				
D.	71				
E.	71				
F.	71				
G.	71				
H.	71				
I.	71				
J.	71				
K	71				
L.	71				
M.	71				
N.	71				
O.	71				
P. TOTAL COSTS *(Same as Item 5C, on this form)* →	7199	$	$	$	$

Item 11 – RESEARCH AND DEVELOPMENT BY FUNCTIONAL CATEGORY *(Of the total reported in Item 5C, COSTS OR RECEIPTS FOR RESEARCH AND DEVELOPMENT, columns 2 and 4, report the following functional categories.)*

ENERGY RESEARCH AND DEVELOPMENT – Include the project cost or portion of project cost incurred for the purpose of increasing energy resources or capabilities. Include cost by type of energy. *If "None," please mark* ▷ 80996	CT2	Thousands of dollars				
		1976		1977		1978
		Federal funds [1]	Total funds [2]	Federal funds [3]	Total funds [4]	Total projected costs [5]
A. Total nuclear	8010	$	$	$	$	$
1. Fission	8011					
2. Fusion	8012					
B. Total fossil fuels	8020					
1. Oil	8021					
2. Gas	8022					
3. Shale	8023					
4. Coal	8024					
a. Synthetic fuels	8025					
b. Mining	8026					
c. All other	8027					
5. Other fossil fuels	8028					
C. Geothermal	8030					
D. Solar	8040					
E. Conservation and utilization	8050					
F. All other energy	8060					
G. Total of A through F ⟶	8099	$	$	$	$	$

POLLUTION ABATEMENT RESEARCH AND DEVELOPMENT – Include the project cost or portion of the project cost incurred for the purpose of designing pollution abatement products or product characteristics or of designing pollution abatement features into processes. Include cost by form of pollution to be abated. *If "None," please mark* ▷ 81996	CT2	Thousands of dollars				
		1976		1977		1978
		Federal funds [1]	Total funds [2]	Federal funds [3]	Total funds [4]	Total projected costs [5]
H. Air	8110	$	$	$	$	$
1. Automotive emission	8111					
2. Electric power plant emissions	8112					
3. All other	8113					
I. Water	8120					
J. Solid waste	8130					
K. Other	8140					
L. Total of H through K ⟶	8199	$	$	$	$	$

RESEARCH AND DEVELOPMENT PERFORMED OUTSIDE THE DOMESTIC COMPANY

Item 12 – TOTAL COMPANY FUNDS SPENT FOR RESEARCH AND DEVELOPMENT ACTIVITIES PERFORMED OUTSIDE THE COMPANY WITHIN THE UNITED STATES

If "None," please mark ▷ ☐ 90013

CT1	Thousands of dollars			
	1976 [1]		1977 [2]	
9001	$		$	

Item 13 – TOTAL COMPANY FUNDS SPENT FOR RESEARCH AND DEVELOPMENT ACTIVITIES PERFORMED BY FOREIGN AFFILIATES OUTSIDE THE UNITED STATES

If "None," please mark ▷ ☐ 11603

CT2	Thousands of dollars			
	1976 [1]		1977 [2]	
1160	$		$	

Remarks – *Attach additional sheet if necessary*

Name of person to contact regarding this report	Address – *Number and street, city, State, ZIP code*	Telephone		
		Area code	Number	Extension

Period covered by this report ☐ Calendar year ☐ Fiscal year – *Specify* ⟶	From – *Month/day/year*	To – *Month/day/year*

CERTIFICATION – This report is substantially accurate and has been prepared in accordance with instructions.

Name of company	Address – *Number and street, city, State, ZIP code*	
Signature of authorized official	**Title**	**Date**

FORM NSF-1 (11-1-77)

▶ GENERAL INSTRUCTIONS

A report should be filed by each company receiving a copy of this form. If your company does not conduct research and development, so state in remarks, fill in items 1a and 1b, sign, and return the form. If you have questions regarding reporting problems on this form, please write to the Bureau of the Census, Industry Division, Washington, D.C. 20233.

Report for your entire company – Research and development activities for your entire domestic company should be reported.

Period covered by report – The cost figure reported should cover the calendar year if at all possible. However, fiscal year data are acceptable, provided your fiscal year ends between September and March.

▶ DEFINITION OF RESEARCH AND DEVELOPMENT

Research-development includes basic and applied research in the sciences (including medicine) and in engineering, and design and development of prototypes, products, and processes. It does not include quality control, routine product testing, market research, sales promotion, sales service, research in the social sciences or psychology, or other nontechnological activities or technical services.

▶ SPECIFIC INSTRUCTIONS BY ITEM

Item 1 – Sales and Employment for Company. In item 1a, report the net billings of this company and its subsidiaries to customers outside the company. (Exclude domestic intra-company transfers and sales by foreign subsidiaries. Include the transfers to such foreign subsidiaries, however.) In item 1b, report the number of persons employed by the company in all activities in the 50 States and the District of Columbia during the pay period which includes the 12th of March 1977.

This figure would be the same as that shown by the company in item 14 of Treasury Form 941, if the company filed one form 941 for the entire company.

Item 2 – Show all costs incurred within the company for wages, and salaries, direct material costs, services and supporting costs, and an appropriate share of company overhead to conduct research and development activities.

Under Federal funds, include research and development in procurement as well as research and development contracts and research and development subcontracts. Exclude research and development subcontracted to others.

Remarks (Continued)

FORM MA-121 (11-8-77)

DUE DATE: 15 DAYS AFTER RECEIPT OF FORM

Form Approved: O.M.B. No. 41-R188

FORM MA-121
(11-8-77)

U.S. DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS

COMPANY SUMMARY OF RESEARCH AND DEVELOPMENT
1977

RETURN TO: Bureau of the Census, ATTN: Industry Division, Washington, D.C. 20233

Please complete and return this form in the return envelope not later than 15 days after you receive it. Companies with no research and development expenditures should so state in the "Remarks" section, fill in items 1a and 1b, sign, and return the form.

NOTICE – Response to this inquiry is required by law (title 13, U.S. Code). By the same law, your report to the Census Bureau is confidential. It may be seen only by sworn Census employees and may be used only for statistic purposes. The law also provides that copies retained in your files are immune from legal process.

(Please correct any error in name and address including ZIP code)

Group	Surve
4	9901

PLEASE RETURN THIS COPY

PLEASE READ INSTRUCTIONS ON REVERSE SIDE BEFORE COMPLETING YOUR REPORT

▶ Item 1 – SALES AND EMPLOYMENT FOR COMPANY	C.T.1	*(Thousands of dollars)*
a. Net sales and receipts of this company and its subsidiaries during 1977	2001	$
b. Number of employees in this company in all activities in the 50 States and the District of Columbia during the pay period which includes the 12th of March 1977	2002	*(Number)*

▶ Item 2 – COST OR RECEIPTS FOR RESEARCH AND DEVELOPMENT PERFORMED WITHIN THE COMPANY DURING 1977	C.T.2	1977 *(Thousands of dollars)*		
		1 Federal funds	2 Company and other funds, except Federal	TOTAL *(Sum of columns 1 and*
	3599	$	$	$

Remarks

Name of person to contact regarding this report	Address *(Number and street, city, State, ZIP code)*	Telephone *(Area code, number, and extension)*

▶ CERTIFICATION – This report is substantially accurate and has been prepared in accordance with instructions.

Name of company	Address *(Number and street, city, State, ZIP code)*	
Signature of authorized official	Title	Date

Other Science Resources Publications

REPORTS	NSF No.	Price
Federal Support to Universities, Colleges, and Selected Nonprofit Institutions, Fiscal Year 1977	79-311	$3.50
Projections of Science and Engineering Doctorate Supply and Utilization, 1982 and 1988	79-303	$2.25
DETAILED STATISTICAL TABLES		
Characteristics of Experienced Scientists and Engineers, 1978	79-322	
Academic Science: R&D Funds, Fiscal Year 1978	79-320	
Academic Science: Graduate Enrollment and Support, Fall 1978	79-316	—
Federal Support to Universities, Colleges, and Selected Nonprofit Institutions, Fiscal Year 1977	79-311	—
Characteristics of Doctoral Scientists and Engineers in the United States, 1977	79-306	—
U.S. Scientists and Engineers, 1976	79-305	—
Human Resources for Scientific Activities at Universities and Colleges, January 1978	78-318	—

REVIEWS OF DATA ON SCIENCE RESOURCES		
No. 32, "Employment Patterns of Recent Entrants Into Science and Engineering"	78-310	$0.80
HIGHLIGHTS		
"Academic Scientists and Engineers Increase 3% in 1978"	79-315	—
"Manufacturing Industries with High Concentrations of Scientists and Engineers Lead in 1965-77 Employment Growth"	79-307	—
"Decline in Recent Science an Engineering Doctoral Faculty Continues into 1978"	79-301	—
"Hiring of Science and Engineering Faculty by 2- and 4-Year Colleges"	78-309	—
"Utilization of Science and Engineering Doctorates in Industrial Research and Development"	78-301	—