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ABSTRACT

This report presents data compiled as part of a comprehensive program to measure and analyze the nation's resources expended for research and development (R&D). Industry, which carries out 69% of the R&D in the United States, spent $26.6 billion on these activities in 1976, 10% above the 1975 level. In constant dollars, this presents an increase of 5% between the two years. Other figures in this report show that the Federal R&D funds to industry rose by 7% mainly because of increased amounts for energy R&D, defense-related R&D, and development of the space shuttle. Companies spent a total of $17.4 billion of their funds on R&D in 1976, an increase of 12% over 1975. Energy R&D expenditures by industrial firms rose 17% between 1975 and 1976 to $1.6 billion. Nearly 90% of this total supported nuclear and fossil fuel R&D programs. Funds for industrial performance of basic research rose 10% to a total of $786 million in 1976. Data for years 1975 through 1977 are presented in tables and graphs. (Author/HM)

nsf SCIENCE RESOURCES STUDIES HIGHLIGHTS

NATIONAL SCIENCE FOUNDATION • WASHINGTON, D. C 20550 • MAY 5, 1978 • NSF 78-306

# Industrial R&D Spending Reached $26.6 Billion in 1976

## Assessment Highlights

• Industry's total R&D expenditures increased 10 percent in 1976, mainly as a result of a strong showing in companies' own funds which grew at nearly double the rate of inflation However, it should be noted that since 1970 industrial R&D expenditures in constant dollars have increased less than 1 percent Real growth in industrial R&D funding is expected to continue, but at a somewhat lower rate than that experienced in the 1975-76 period, assuming preliminary indicators of 1977 levels are true and current projections of industrial sales and profits are born out

• Federal funds were primarily responsible for the 10-percent increase in industrial expenditures for basic research in 1976 Since 1971 Federal funds for industry for basic research have risen by an average annual rate of 7 percent and company funds by 5 percent, the net result being a decrease of less than 1 percent in constant-dollar terms. Barring continued Federal increases, however, basic research in industry is expected to remain constant in real terms and could possibly decline

• Energy R&D expenditures increased by 17 percent, with those related to solar and geothermal sources increasing by 131 percent and 66 percent, respectively, and expected to continue their sharp year-to-year increase The principal expenditures will remain in the areas of nuclear and fossil fuels Federal and company inititatives are expected to result in 15-percent to 20-percent increases annually over the next five years

• In addition to the $17 billion companies spent in 1976 for R&D performed in the United States, they provided another $1.3 billion for R&D performed abroad For the most part, these funds support product development for local markets. It is believed, however, that the drug industry's use of foreign labs will increase as a result of government regulations that restrict the type and nature of R&D activities in the United States.

• The general upswing in employment of scientific personnel in industrial R&D is continuing. Between January 1976 and January 1977, the full-time-equivalent (FTE) number of R&D scientists and engineers rose 4 percent to 380,700 The increase in employment of scientific personnel, which began in January 1973, is expected to continue at about the same rate as real industry R&D spending, which is expected to increase at about 5 percent between 1976 and 1977

## Data Highlights

• Expenditures for industrial R&D rose to $26.6 billion in 1976, an increase of 10 percent over the 1975 level. In constant dollars, this represents an increase of 5 percent between the two years.

• Federal R&D funds to industry rose by 7 percent mainly because of increased amounts for energy R&D, defense-related R&D, and development of the space shuttle

• Companies spent a total of $17.4 billion of their own funds on R&D in 1976, an increase of 12 percent over 1975. Since 1970 company R&D funds have risen at an average annual rate of 9 percent in current dollars, compared to a 3-percent average growth in Federal funds.

• Energy R&D expenditures by industrial firms rose 17 percent between 1975 and 1976 to $1 6 billion Nearly 90

**NOTE**

*The 1975 data published in this Highlights have been revised from that published in earlier reports in this series (Science Resources Studies Highlights of October 27, 1976, "Energy Increase of 18 Percent Paces Industrial R&D Spending in 1975" (NSF 76-324) and National Patterns of R&D Resources Funds and Manpower in the United States, 1953-1977 (NSF 77-310) ).*

*These data revisions reflect the following*

*(1) Reassignment of companies into different industry classifications This reassignment is carried out periodically to assure that firms are properly identified in the industry that represents their major business*

*(2) Company revisions in 1975 R&D spending estimates All of these changes will be discussed in greater detail in Detailed Statistical Tables Research and Development in Industry, 1976 These tables will show historical data for each industry with appropriate revisions for each year affected.*



Prepared in the Industry Studies Group, Division of Science Resources Studies.

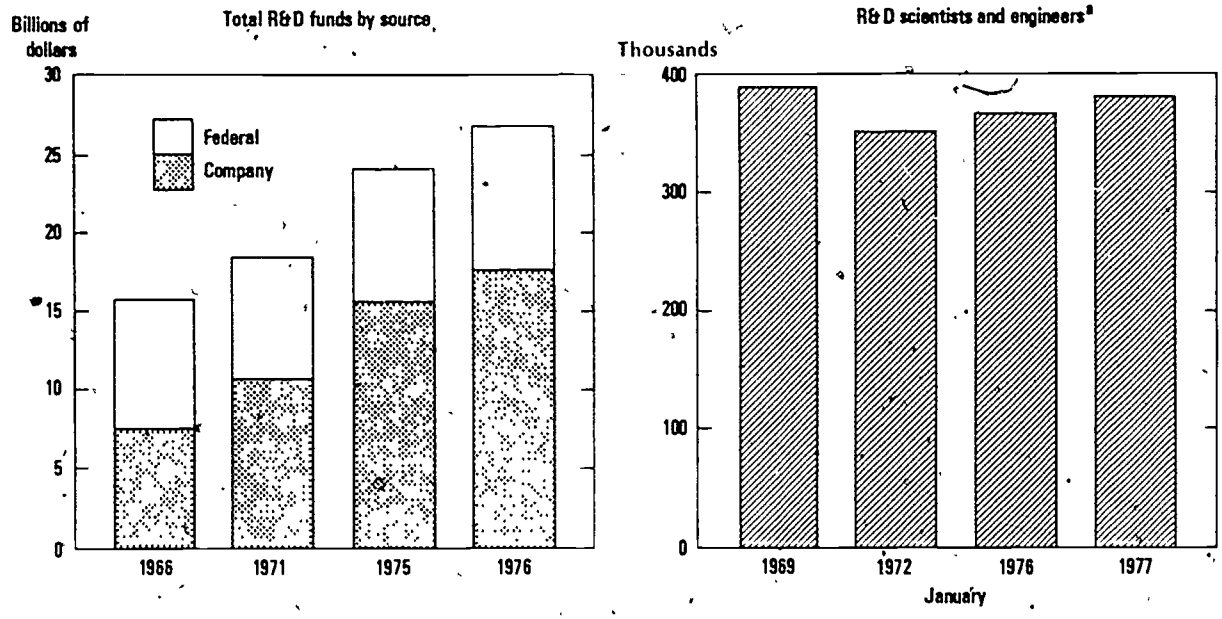
**Table 1. Selected industrial R&D data**
[Dollars in millions]

| Industry | Total R&D funds | | 1976 R&D funds | | | | | R&D scientists & engineers | |
|---|---|---|---|---|---|---|---|---|---|
| | 1975 | 1976 | Federal | Company | Basic research | Applied research | Development | January 1976 | January 1977 |
| Total | $24,096 | $26,618 | $9,195 | $17,423 | $786 | $5,104 | $20,728 | 364,700 | 380,700 |
| Food and kindred products | 309 | 339 | (1) | (1) | 13 | 141 | 185 | 6,500 | 6,700 |
| Textiles and apparel | 65 | 71 | (1) | (1) | (1) | (1) | 47 | 1,600 | 1,600 |
| Lumber, wood products, and furniture | 91 | 101 | 0 | 101 | 3 | 27 | 71 | 2,000 | 2,200 |
| Paper and allied products | 249 | 279 | (1) | (1) | 6 | 91 | 182 | 5,200 | 5,500 |
| Chemicals and allied products | 2,731 | 3,009 | 266 | 2,744 | 323 | 1,224 | 1,463 | 43,900 | 46,600 |
| Industrial chemicals | 1,200 | 1,331 | 249 | 1,082 | 143 | 521 | 668 | 16,900 | 17,600 |
| Drugs and medicines | 992 | 1,092 | 10 | 1,083 | 127 | 473 | 492 | 16,700 | 18,000 |
| Other chemicals | 539 | 586 | 7 | 579 | 53 | 230 | 303 | 10,300 | 11,000 |
| Petroleum refining and extraction | 692 | 766 | (1) | (1) | 45 | 313 | 408 | 8,600 | 8,700 |
| Rubber products | 467 | 499 | (1) | (1) | 4 | 147 | 348 | 8,600 | 9,200 |
| Stone, clay, and glass products | 234 | 269 | (1) | (1) | 38 | 81 | 150 | 4,900 | 5,000 |
| Primary metals | 443 | 506 | 27 | 479 | 15 | 207 | 284 | 8,100 | 8,600 |
| Ferrous metals and products | 215 | 254 | 4 | 250 | 4 | 88 | 162 | 3,900 | 4,000 |
| Nonferrous metals and products | 228 | 252 | 23 | 229 | 11 | 119 | 122 | 4,200 | 4,600 |
| Fabricated metal products | 321 | 351 | 36 | 316 | 3 | 80 | 268 | 6,800 | 7,200 |
| Machinery | 3,192 | 3,493 | 534 | 2,959 | 37 | 405 | 3,051 | 55,700 | 56,400 |
| Office, computing and accounting machines | 2,219 | 2,397 | 509 | 1,888 | 29 | 239 | 2,129 | 38,000 | 38,800 |
| Electrical equipment and communication | 5,075 | 5,628 | 2,489 | 3,133 | 146 | 953 | 4,524 | 80,100 | 84,000 |
| Radio and TV receiving equipment | 51 | 52 | 0 | 52 | (1) | (1) | 37 | 1,100 | 1,000 |
| Electronic components | 548 | 684 | (1) | (1) | 5 | 67 | 612 | 10,300 | 12,800 |
| Communication equipment and communication | 2,370 | 2,519 | 1,087 | 1,431 | 120 | 453 | 1,946 | 37,400 | 38,000 |
| Other electrical equipment | 2,106 | 2,368 | (1) | (1) | (1) | (1) | 1,929 | 31,300 | 32,200 |
| Motor vehicles and motor vehicles equipment | 2,333 | 2,777 | 329 | 2,448 | 8 | 181 | 2,588 | 25,400 | 27,000 |
| Other transportation equipment | 88 | 94 | 46 | 48 | (1) | (1) | 42 | 1,700 | 1,700 |
| Aircraft and missiles | 5,71 | 6,114 | 4,724 | 1,390 | 52 | 677 | 5,385 | 66,900 | 69,500 |
| Professional and scientific instruments | 1,188 | 1,307 | 156 | 1,152 | 20 | 158 | 1,128 | 19,000 | 20,300 |
| Scientific and mechanical measuring instruments | 265 | 313 | 10 | 304 | 10 | 48 | 255 | 6,700 | 17,200 |
| Optical, surgical, photographic, and other instruments | 923 | 994 | 146 | 848 | 10 | 111 | 873 | 12,300 | 13,100 |
| Other manufacturing industries | 202 | 221 | 4 | 217 | 9 | 49 | 163 | 4,200 | 4,700 |
| Nonmanufacturing industries | 705 | 798 | 333 | 466 | 27 | 330 | 441 | 14,800 | 15,400 |

(1) Not separately available but included in total

SOURCE: National Science Foundation

R&D resources in industry: selected years




[a]Full-time-equivalents

SOURCE: National Science Foundation

percent of this total supported nuclear and fossil fuel R&D programs.

• Funds for industrial performance of basic research rose 10 percent to a total of $786 million in 1976.

### Total R&D Funds, 1976

Industry, which carries out 69 percent of U S research and development, spent $26 6 billion on these activities in 1976, a 10-percent increase over 1975 Although the 1976 level represents an almost 50-percent increase in current dollars since 1970, the constant-dollar[1] increase over the 6-year period has been less than 1 percent overall This results from the leveling off of Federal R&D funding which occurred in the midsixties and continued into the early seventies when Government R&D spending in industry resumed its growth. Since industry is expected to continue to increase R&D expenditures generally apace with increases in sales, it is expected that industrial R&D spending in the remainder of the seventies will continue rising in real terms.

Six industries continued to account for over four-fifths of industrial R&D performance (table 1) These industries, with the exception of motor vehicles, increased their R&D spending in 1976 by about 10 percent over 1975. The motor vehicles industry increased its R&D expenditures by nearly twice as much—19 percent—as its sales and profit levels sharply improved.

Company R&D funds rose by 12 percent between 1975 and 1976, while Federal R&D funds to industry rose by 7 percent. The 1975-76 change for both sources of funds was well above the average annual rate of change experienced since 1970. Including 1976, company funds have risen at an annual rate of about 9 percent in current dollars since 1970, while Federal funds have risen at an annual rate of 3 percent. Companies provided 65 percent of total industrial R&D funds in 1976, a ratio that has been increasing steadily since 1965, when Federal R&D support to industry began to decline with deemphasis of the space program and a slowing in defense research and development. Based on industry sources, NSF estimates that company R&D funds will reach $19.1 billion in 1977, a rise of about 10 percent. All six of the leading R&D-performing industries anticipate spending more for research and development in 1977.

### Energy and Pollution Abatement R&D

Industrial spending for energy research and development reached $1.6 billion in 1976, a rise of 17 percent over the 1975 figure of $1.4 billion. Energy research and development was expected to rise an additional 16 percent between 1976 and 1977, reaching a projected 1977 total of $1.9 billion. The largest energy R&D performer, the electrical equipment and communication industry, paced this rise increasing its energy R&D spending 26 percent to a 1976 total of $585 million (table 2). Electrical industry spokesmen attribute this rise to projects evolving from research into the more costly development stage in 1976.

[1] The GNP implicit price deflator was used to convert from current to constant dollars.

**Table 2. Total industrial R&D expenditures for energy and pollution abatement by selected industry: 1975-77**
[Dollars in millions]

| Industry | Energy | | | Pollution abatement | | |
|---|---|---|---|---|---|---|
| | 1975 | 1976 | 1977 (est.) | 1975 | 1976 | 1977 (est.) |
| Total | $1 374 | $1 611 | $1 862 | $647 | $739 | $763 |
| (Federal Funds) | 622 | 712 | ( ) | 41 | 49 | ( ) |
| (Company Funds) | 752 | 899 | ( ) | 606 | 690 | ( ) |
| Chemicals and allied products | 102 | 123 | 166 | 71 | 72 | 81 |
| Machinery | 23 | 35 | 41 | 23 | 27 | 28 |
| Electrical equipment and communication | 464 | 585 | 656 | 19 | 19 | 17 |
| Motor vehicles and motor vehicle equipment | (1) | (1) | (1) | 347 | 413 | 428 |
| Aircraft and missiles | 134 | 109 | 130 | 36 | 47 | 46 |
| Other manufacturing | 614 | 707 | 813 | 120 | 123 | 129 |
| Nonmanufacturing | 37 | 52 | 56 | 31 | 38 | 34 |

[1] Not separately available but included in other manufacturing
SOURCE: National Science Foundation

**Table 3. Industrial R&D expenditures for energy and pollution abatement by category: 1975, 1976, and projected 1977**
[Dollars in millions]

| Energy source categories | Total | | Federal | | Total projected funds |
|---|---|---|---|---|---|
| | 1975 | 1976 | 1975 | 1976 | 1977 |
| Total | $1 374 | $1 611 | $622 | $712 | $1 862 |
| Total fossil fuels | 532 | 605 | 42 | 64 | 680 |
| Oil | 321 | 374 | 6 | 9 | 409 |
| Gas | 66 | 75 | (1) | (1) | 82 |
| Shale | 14 | 14 | (1) | (1) | 15 |
| Coal | 109 | 126 | 32 | 47 | 156 |
| Synthetic fuels | 50 | 70 | ( ) | ( ) | 95 |
| Mining | 9 | 10 | ( ) | (1) | 11 |
| All other | 50 | 46 | 16 | 18 | 50 |
| Other fossil fuels | 23 | 16 | ( ) | (1) | 18 |
| Total nuclear | 700 | 800 | 540 | 581 | 916 |
| Fission | 659 | 743 | 503 | 528 | 843 |
| Fusion | 41 | 57 | 37 | 53 | 73 |
| Geothermal | 6 | 10 | (1) | (1) | 10 |
| Solar | 19 | 44 | (1) | ( ) | 51 |
| Conservation and utilization | 52 | 78 | 10 | 16 | 102 |
| All other sources | 64 | 75 | 18 | 18 | 104 |
| Pollution abatement categories | | | | | |
| Total | 647 | 739 | 41 | 49 | 763 |
| Air | 478 | 559 | 14 | 23 | 574 |
| Automotive emission | 348 | 420 | (1) | ( ) | 431 |
| Electric power plant emissions | 28 | 27 | ( ) | (1) | 24 |
| All others | 102 | 112 | | 14 | 118 |
| Water | 71 | 79 | (1) | (1) | 83 |
| Solid Waste | 23 | 22 | ( ) | (1) | 24 |
| Other | 75 | 78 | 23 | 19 | 82 |

[1] Not separately available but included in total
SOURCE: National Science Foundation

Although R&D expenditures for alternative sources continued to increase more rapidly than conventional energy sources (solar energy, up 131 percent; geothermal, up 67 percent; and conservation and utilization, up 50 percent) these amounts are insignificant when compared to those for nuclear and fossil fuel energy sources. Indications from industry officials are that the expenditures for those alternative-source energies will remain small in the next 5-year period, but that the sharp year-to-year increases will undoubtedly continue.

Both nuclear energy and fossil fuel research and development rose by 14 percent in 1976 to $800 million and $605 million, respectively. The 1977 increases for both these energy sources are expected to be at nearly the same rate as in 1976 (table 3).

Pollution abatement R&D expenditures increased 14 percent to $739 million in 1976. This represented the largest increase since this data series began in 1973. Most of this increase can be attributed to increased efforts by the motor vehicles industry to control automotive emissions. The motor vehicles industry, responsible for 56 percent of all pollution abatement research and development, spent $413 million for this activity in 1976, an increase of 19 percent over its 1975 total of $347 million. Automobile industry spokesmen attribute this rise to the improved sales picture in 1976. A further rise of 3 percent was projected for all pollution abatement research and development in 1977.

## R&D Funds/Net Sales

The ratio of total R&D spending to net sales for all R&D-performing manufacturing companies amounted to 3.1 percent in 1976, the same as in 1975. This ratio had been declining since it reached a peak of 4.6 percent in 1964. The decline is directly attributable to the decline in Federal R&D funding experienced over that period, since the company R&D/sales ratio has remained relatively constant during that time. The latter's stability in recent years has indicated industry's willingness to maintain a strong, viable R&D program, keeping expenditures apace with sales.

Of the six leading R&D-performing industries, only the instruments industry showed an increase in the ratio of total R&D spending to net sales between the two years—from 5.9 percent to 6.2 percent. Electrical equipment, chemicals, and machinery remained level, while aircraft and missiles and motor vehicles registered declines. In the latter two industries R&D expenditures increased but at a somewhat lower rate than sales.

## R&D Expenditures by Character of Work

The percentage of R&D funding devoted to basic research has dropped since 1965 when it constituted about 4 percent of industrial R&D spending. Currently, basic research represents about 3 percent of the industry total. The portion of industry R&D expenditures devoted to development has increased, probably because of a more conservative financial climate.

Total basic research expenditures by industry increased 10 percent in 1976 to $786 million—the sharpest increase in this series since the 1973-74 period. As in past years, chemical companies accounted for the largest share of industrial basic research—$323 million or 41 percent of the total in 1976. Electrical equipment firms spent the second largest portion, 19 percent or $146 million. Indications from industry officials are that, in the next five years, the amount devoted to basic research will, at best, remain level in terms of constant dollars, or, possibly, decline. This reflects the current industry philosophy of primarily supporting projects which have a more certain expected return to the company.

Applied research rose from a 1975 level of $4.6 billion to a 1976 total of $5.1 billion, an increase of about 12 percent. Again, the chemicals and electrical equipment industries were the largest performers of applied research—$1.2 billion and $1.0 billion, respectively.

Development spending reached $20.7 billion in 1976, 10 percent above the 1975 level of $18.8 billion. By far, the largest performer of development is the aircraft and missiles industry, which spent $5.4 billion in 1976, approximately 26 percent of the industrial total. The motor vehicles industry, with development expenditures of $2.6 billion, accounted for 12 percent of the total.

## R&D Scientists and Engineers

Continuing a trend that began in January 1973, industry again increased its employement of R&D scientists and engineers (full-time-equivalent) in January 1977 to 380,700. This represents a 4-percent increase over the January 1976 figure of 364,700. After steadily increasing since this data series began in January 1957, the number of R&D scientists and engineers reached a high point in January 1969. When economic conditions began to decline in the early seventies, industry cut back its R&D programs and its employment of R&D professionals. As sales and profit levels began to increase after the 1970-72 recession, so did R&D programs and R&D employment. The January 1977 increase marks the largest absolute increase in this number since the recent upward trend began. All of the major R&D-performing industries increased their employment of R&D scientists and engineers between 1976 and 1977.

## R&D Performed Outside the U.S. by Domestic Companies

Beginning with the 1975 survey, a question concerning company-funded research and development performed by foreign affiliates of U.S. companies outside the United States was added to the complete panel for the Survey of Research and Development in Industry. The data are presented here for the first time.

Between 1975 and 1976, research and development performed outside the United States by domestic companies increased 11 percent from $1.2 billion to $1.3 billion (table 4). This compares with a 10-percent rise in total R&D spending by domestic firms in U.S.-based facilities over the same period. The drug industry spent $151 million abroad in 1976, 16 percent above the 1975 level. It is suspected that industry's reaction to Government regulations account for much of this increase. The drug industry expects to continue to increase foreign research and development at a higher rate than their domestic R&D investment, while other industries will increase their R&D program abroad at about the same rate as their U.S. programs. The prime emphasis of the other industries is toward developing products to meet local markets, and it is unlikely that a sharp increase will occur in this effort.

**Table 4. Total company research and development performed by foreign affiliates of U.S. domestic companies outside the United States, by selected industry: 1975 and 1976**

[Dollars in millions]

| Industry | SIC code | 1975 | 1976 |
|---|---|---|---|
| Total | | $1,167 | $1,298 |
| Food and kindred products | 20 | 13 | 18 |
| Chemicals and allied products | 28 | 215 | 244 |
| Drugs and medicines | 283 | 130 | 151 |
| Stone, clay, and glass products | 32 | 7 | 8 |
| Primary metals | 33 | 9 | 10 |
| Machinery | 35 | 287 | 320 |
| Electrical equipment and communication | 3,648 | 232 | 253 |
| Electronic components | 367 | 7 | 8 |
| Aircraft and missiles | 372,376 | 5 | 5 |
| Professional and scientific instruments | 38 | 49 | 49 |
| Other manufacturing industries | | 346 | 382 |
| Nonmanufacturing industries | 07-12, 14-17, 41-47, 49-67, 739-807, 891-737 | 4 | 4 |

SOURCE: National Science Foundation.

**Henceforth, *only* a final analytical report will be published biennially; the next report will contain data from the 1977 survey. For 1976, *only* the *Detailed Statistical Tables* will be published; these will be available gratis upon request from the Division of Science Resources Studies, NSF.**