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ABSTRACT

This report contains the findings of the National Science Foundation (NSF) Survey of Scientific and Engineering Expenditures at Universities and Colleges, FY 1977. The survey was mailed to 539 universities and colleges including all graduate-degree-granting institutions and all others that spent $50,000 or more for R&D activities. Estimates made by NSF staff for nonrespondent institutions represent less than 2% of total academic R&D spending. (Author)

SCIENCE RESOURCES STUDIES HIGHLIGHTS

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Academic R&D Expenditures Continue Real Growth Into 1977

This report contains the findings of NSF's Survey of Scientific and Engineering Expenditures at Universities and Colleges, FY 1977. The survey was mailed to 539 universities and colleges including all graduate-degree-granting institutions and all others that spent $50,000 or more for R&D activities. Estimates made by NSF staff for nonrespondent institutions represent less than 2 percent of total academic R&D spending.

Assessment Highlights

• Beginning in 1975, both Federal and non-Federal academic R&D support, when discounted for inflation, showed real growth, 2 percent and 3 percent per year, respectively, bringing the levels of constant-dollar expenditures in 1977 slightly above the previous 1973 peak.

• Since the Federal Government provides more than two-thirds of university R&D support, its budgetary decisions for the 1977-79 period provides a reasonably accurate basis for estimating future levels of overall academic R&D expenditures. These indicators point to continuous growth in academic R&D activities which will probably extend at least through fiscal year 1979. This growth trend follows a period of very little real-dollar increases during the first half of the decade.

• Two other indicators of R&D activity have shown growth, pointing to an increase in academic R&D endeavors during the seventies. The number of academic scientists and engineers engaged primarily in R&D has averaged moderate but steady growth (2 percent per year) since 1970, as has the utilization of graduate research assistants, which has increased 3.5 percent per year since 1974.

• Basic research spending by universities and colleges totaled $2.8 billion in 1977, a 3-percent real increase over 1976 levels, representing the first significant growth in the conduct of fundamental research since 1972.

• A funding shift toward the conduct of more applied research was evident during the seventies as Federal agencies increased support of research projects directed toward specific outcomes. It should be noted, however, that there was also a simultaneous and as yet unexplained movement toward applied research funding from non-Federal sources. The overall effect is apparent when the 1970 distribution between basic and applied research, 77 percent and 18 percent, respectively, is compared to the 1977 distribution, 69 percent and 26 percent.

• Industrial support for academic research, a subject of much recent discussion, has since 1970 shown marked increases amounting to an average of 6 percent per year real growth. The total amount of such support, however, represents only 3 percent of the total amount devoted to R&D by universities and colleges.

Data Highlights

• Academic R&D expenditures totaled $4.1 billion in 1977, an increase of 9 percent over the 1976 level. When converted to constant dollars to discount the effects of inflation, R&D expenditures actually increased 2 percent between 1976 and 1977.[1] Between 1970 and 1977 the growth rate in academic R&D spending averaged 1.5 percent per year in real terms, slightly ahead of total U.S. R&D spending which rose at an average rate of only 1 percent per year during this period.

• Universities performed 52 percent of all the basic research conducted in the U.S. in 1977, approximately the same share as in 1970 (including the 8 percent reported by university-administered FFRDC's).

• Federal agencies provided more than two-thirds of the total in 1977; however, this share has declined somewhat since 1970, when it amounted to 71 percent.

[1] In the absence of a reliable R&D cost index, the gross national product (GNP) implicit price deflator was used to convert current dollars to constant 1972 dollars. The GNP deflator can only indicate approximate changes in costs of R&D performance.

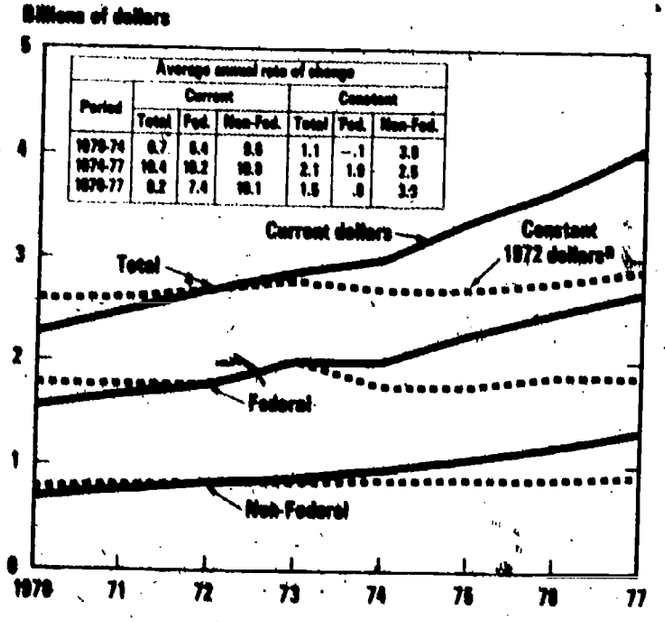
Prepared in University and Nonprofit Institutions Studies Group, Division of Science Resources Studies.

Sources of Support

Universities provide both the specialized skills and environment for basic research. For this reason, and in recognition of its role in fostering basic research, the Federal Government provided more than two-thirds of all academic R&D funds. In 1977 these funds totaled $2.7 billion. As a result of the substantial Federal involvement, changes in the pattern of Federal R&D support influence the overall focus of R&D activity within the academic sector. Furthermore, in most of the major science and engineering (S/E) fields Federal support comes primarily from one or two agencies, and changes that occur in funding patterns of such agencies can have a significant impact upon those fields where an agency's funds tend to be concentrated.

The federally sponsored share of total R&D activities at universities and colleges has been gradually declining during the seventies, more as a result of a relatively rapid rise in non-Federal R&D support than a deliberate shift in Federal funding policy. While in real terms Federal academic R&D funds actually remained stable between 1970 and 1974, other sources of this support were expanding at an average annual rate of 4 percent per year. Beginning in 1975, however, increases in Federal funds started to be comparable to those in non-Federal funds. The pattern of Federal support, e.g., the heavy concentration of research in the life sciences and significant increases in Federal support in this area, can be traced to agency priorities, but the reasons for the steady growth shown among non-Federal sources are not clear (chart 1).

Chart 1. R&D expenditures in the sciences and engineering at universities and colleges by source: FY 1970-77



[a]Based on GNP implicit price deflator.

SOURCE: National Science Foundation

Industrial funding of academic R&D efforts has grown at the most rapid pace of all R&D sources, averaging 6 percent per year in real terms since 1970. Since industrial support accounts for only 3 percent of academic R&D total, however, changes in its support patterns have a minimal impact. Of greater significance, academic institutions have increased the use of their own funds—e.g., unrestricted endowment and tuition income—to finance R&D projects. As a result, the institutional share of non-Federal R&D support has risen from 10 percent in 1970 to 13 percent in 1977 and has grown at an average rate of 11 percent per year in real dollars.

Character of Work

In 1977 academic basic research spending totaled $2.7 billion and accounted for seventh-tenths of this sector's R&D spending. More than one-half of the Nation's basic research performed since 1970 has come from the academic sector.[2]

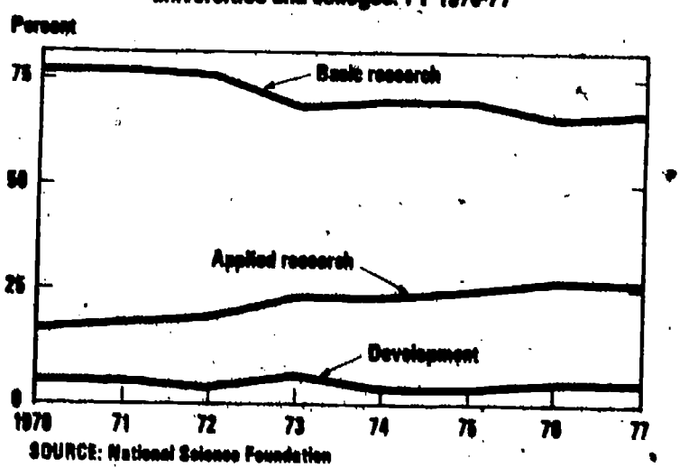
During the seventies a shift toward more applied research was observed in academic R&D funding trends (chart 2). A large part of this shift was the result of increased support by Federal agencies directed toward research aimed at producing specific outcomes. There was a similar, though unexplained movement toward applied research funding from non-Federal sources. Between 1970 and 1977, academic applied research increased at an average rate of 14 percent per year compared to 6.5 percent for basic research.

As a result of growing concern over this shift from basic research, Federal budgets for 1977 and 1978 showed significant increases, 19 percent and 14 percent, respectively, in basic research funding; academic research expenditures[3] in 1978 and 1979 are expected to reflect these increases.

[2]National Science Foundation, *National Patterns of R&D Resources, 1953—78-79* (NSF 78-313) in press.

[3]National Science Foundation, *Detailed Statistical Tables. Federal Funds for Research and Development, Fiscal Years 1977, 1978, and 1979*, Volume XXVII (NSF 78-312) (Washington, D.C. 20550, 1978).

Chart 2. Character of work as percent of total R&D expenditures in the sciences and engineering at universities and colleges: FY 1970-77



SOURCE: National Science Foundation

Field of Science

R&D expenditures rose in all major fields of science and engineering in 1977, expanding at the fastest rates in the mathematical and computer sciences, up 23 percent, and engineering, up 15 percent. Because of the major role of the Federal Government in sponsoring academic R&D efforts, it is not surprising that expanding Federal support is chiefly responsible for these growth patterns. Federal support (primarily from NSF and DOD) increased in the mathematical and computer sciences and engineering by 19 percent and 16 percent, respectively (chart 3).

An analysis of various fields of science and engineering between 1970 and 1977 shows two emerging patterns: Academic R&D expenditures have become increasingly concentrated in the life and environmental sciences, primarily as a result of Federal interest in biomedical and ecological programs; and, the gradually diminishing Federal share of R&D spending in universities and colleges was felt in all major S/E fields except the environmental sciences, where it actually increased. The drop in the proportion of Federal R&D funds was most acute in engineering.

20 Leading R&D Performers

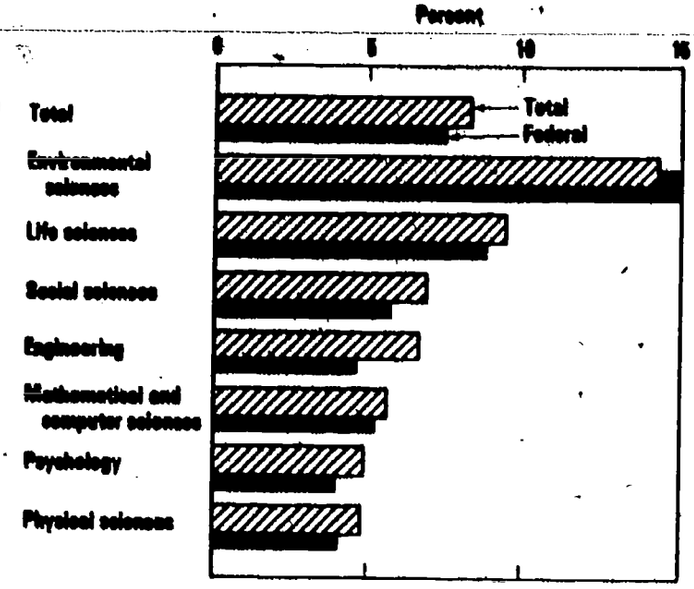
There were no new entries into the leading 20 R&D performers, and all 20 institutions reported increases in both total and federally supported R&D spending. The University of Wisconsin at Madison and the Massachusetts Institute of Technology continued to rank first and second with over $100 million each in total R&D performance.

Institutional Control

Both publicly and privately controlled universities and colleges reported real R&D growth between 1976 and 1977, with expenditures rising 3 percent in constant dollars in public institutions and 1 percent in private schools. Throughout the seventies, however, R&D spending has expanded in public universities and colleges, growing at an average of 3 percent per year, while declining 1 percent per year in private institutions. Public universities and colleges have increased their share of the total academic R&D effort to 65 percent in 1977 compared to 59 percent in 1970. This trend is also reflected in the distribution of Federal R&D funds—public schools received a larger share of Federal R&D monies, 59 percent in 1977, compared to 53 percent in 1970. A recent study of financial conditions in private institutions of higher education reported that the relative decline in Federal funding may contribute to adverse financial conditions in independent R&D performers in the future.[4]

[4] W. John Minter and Howard R. Bowen. *Independent Higher Education, Fourth Annual Report on Financial and Educational Trends in the Independent Sector of American Higher Education*: 1978 (Washington, D.C.: National Association of Independent Colleges and Universities, July 1978).

Chart 3. R&D expenditures in the sciences and engineering at universities and colleges by field and source: FY 1970-77
Average annual growth rate



SOURCE: National Science Foundation

Twenty universities reporting the largest amounts of R&D expenditures in the sciences and engineering: FY 1977
[Dollars in thousands]

Institution	Total		Federal	
	1977	Percent change, 1976-77	1977	Percent change, 1976-77
Total, all institutions	$4,064,220	8.9	$2,716,767	8.6
Total, leading 20 institutions	1,423,180	7.3	1,031,197	7.9
1. Univ. of Wisconsin-Madison	103,556	5.6	53,386	2.9
2. MIT	102,045	8.2	85,066	11.0
3. Univ. of Calif. San Diego	87,636	6.5	78,719	6.8
4. Univ. of Minnesota	82,679	10.1	48,409	7.5
5. Univ. of Michigan	79,922	1.0	50,908	3.4
6. Univ. of Washington	77,757	13.9	66,066	21.4
7. Stanford Univ.	77,019	5.9	71,1[illegible]	6.2
8. Harvard Univ.	73,301	12.2	55,4[illegible]	9.8
9. Columbia Univ.	72,948	8.9	58,973	10.1
10. Cornell Univ.	71,346	7.8	45,895	9.9
11. Univ. of Pennsylvania	70,721	1.5	47,313	2.6
12. Univ. of Calif.-Berkeley	70,148	3.2	50,197	2.6
13. Univ. of Calif.-Los Angeles	69,277	10.3	55,956	9.4
14. Johns Hopkins Univ.	61,858	8.0	50,445	5.8
15. Univ. of Chicago	59,332	7.7	46,109	7.7
16. Univ. of Illinois-Urbana	59,320	4.1	40,558	5.3
17. Univ. of Rochester	53,129	14.0	33,502	9.0
18. Texas A & M Univ.	51,810	10.2	21,757	22.1
19. Univ. of Texas-Austin	49,899	6.1	30,118	10.3
20. Univ. of Calif.-San Francisco	49,677	3.9	41,220	1.2
Total, all other institutions	2,641,040	9.9	1,685,570	9.1

SOURCE: National Science Foundation

Funding for R&D-Related Equipment

The replacement rate for scientific instrumentation used in academic research and development has not kept pace with the rate of equipment obsolescence, as reported in various recent publications on the higher education sector.[1] While no "hard" data exist to demonstrate the effect of this lack of up-to-date equipment, spokesman for universities and colleges have expressed concern about their ability to supply science departments with the progressively sophisticated apparatus required for modern research because of tightened Federal funding policies. Federal policymakers share a concern that the growing obsolescence of R&D equipment may not only affect the quality of research performed, but may also handicap the training of S/E graduate students. The successful employment of these future scientists and engineers in research positions in all sectors of the economy is dependent in part upon their experience and familiarity with the latest scientific gear. Recently, Federal agencies and researchers have proposed several solutions to this problem, including better coordination among principal investigators on research grants to expand sharing of equipment. NSF has adopted more flexible requirements for institutional cost-sharing of equipment and is promoting the cooperative use of research equipment by providing $3 million in 1978 for regional instrumentation centers.

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The *Detailed Statistical Tables* (NSF 78-311) containing more extensive tabulations of FY 1977 data was published in August 1978 and can be obtained from the Division of Science Resources Studies, National Science Foundation, Washington, D.C. 20550. For information on the availability of data tapes, please call Moshman Associates, Inc., at 301-229-3000.

[1] For example, Bruce L. R.Smith and Joseph J. Karlesky, *The State of Academic Science: The Universities in the Nation's Research Effort* (New York: Change Magazine Press, 1977)