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FEDERAL R&D RESOURCES 1960-1973

Trends in Allocations

RESEARCH REPORT

aerospace research center
1725 DE SALES STREET, N.W., WASHINGTON, D.C. 20036

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FEDERAL R&D RESOURCES 1960-1973

Trends in Allocations

A Research Report of
AEROSPACE RESEARCH CENTER
AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.
1725 DE SALES STREET, N.W., WASHINGTON, D.C. 20036

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The mission of the Aerospace Research Center is to engage in research, analyses and advanced studies designed to bring perspective to the issues, problems and policies which affect the industry and, due to its broad involvement in our society, affect the nation itself. The objectives of the Center's studies are to improve understanding of complex subject matter, to contribute to the search for more effective government-industry relationships and to expand knowledge of aerospace capabilities that contribute to the social, technological and economic well being of the nation.

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CHAPTER I

INTRODUCTION AND SUMMARY

The United States has an historic commitment to scientific excellence. The strength of its domestic economy and of its position in world markets has been, in no small part, sustained by its success in pioneering the frontiers of science and technology.

Today, however, other countries have developed scientific and technological capabilities that, in some respects, rival our own, and our international position in fields such as aircraft, electronics, steel, autos and shipbuilding is threatened. Yet, at a time when we must redouble our efforts simply to maintain our technological ground, federal funding for research and development has not only leveled off, but declined. Moreover, with the winding down of NASA's high-technology manned space efforts (and the emergence of no major replacements other than Skylab and the Space Shuttle) and the slowing down in the growth of R&D allocations for national defense, industry's share of the federal R&D dollar has been sharply reduced. As the budgetary squeeze upon federal agencies has tightened, federal R&D money, as a percent of the total, has increasingly shifted from industry to in-house government laboratories, and to a lesser degree to state and local governments to encourage them to create laboratories. The results of these developments have been high professional unemployment, depressed industries and foreign trade deficits.

In 1972, the Administration initiated an effort to revitalize and advance technology in order to strengthen the nation's economy and improve the quality of life. New government efforts were organized to re-evaluate

the nation's technological requirements and to re-assess the federal role in encouraging technical innovation in the national interest. A year later, in early 1973, the Federal Government's commitment to that effort has been cast into doubt by such events as the dismantling of the White House Office of Science and Technology and by the failure, in the fiscal year 1974 budget, to follow through on the promise represented by the President's March 1972 message to the Congress on science and technology.

This study, the fourth in a series on technology by the Aerospace Research Center, examines the trends in federal allocation of R&D resources over the 1960-1973 fiscal year period. Although many of the R&D proposals in the fiscal 1974 budget cannot readily be broken down into the categories employed in this study, an initial analysis of that budget confirms the continuation of the basic trends this study traces.

National Trends

While the Federal Government continues as a major funding source of R&D (54 percent of the total in 1972[1]), it no longer exerts its once dynamic leadership in this area. It has failed to develop a definitive national technological policy and to supply the funding necessary to maintain levels of R&D investment established in the 1950's and 1960's. Even though industry continues to receive the largest share of the national R&D dollar (69 percent in 1972), much of that share is concentrated in a few high-technology industries such as aerospace and electronics whose R&D efforts are not large enough to enable them to halt the steady increase of technical

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1 Unless otherwise noted, all dates in this study are for fiscal years ending June 30.

unemployment. At least 60,000 scientists, engineers and technicians are currently on the rolls of the unemployed or underemployed because their specialized skills do not fit the job qualification requirements of civil oriented programs.

Performers

Although industry remains the main performer of federal R&D, its share of the federal R&D dollar continues to shrink as federal in-house laboratories and universities acquire increasing portions. The government is clearly encouraging and supporting the development of a strong in-house R&D capability. This strategy could, over the long run, sap the interest and involvement of industrial laboratories in federal R&D and deprive the Federal Government of industry's technological expertise. While industrial laboratories and defense and space contractors have trimmed their technical staffs in response to federal funding curtailments, major federal laboratories have not proportionately reduced their technical employment levels.

Nature of Work

The allocation of federal R&D funds for both basic and applied research, as these categories are defined by the National Science Foundation, has steadily climbed from 25 percent of the total in 1960 to an estimated 41 percent in 1973, while development funding has declined during the same period from 75 percent to 59 percent of the total. A different accounting of R&D funding, however, reveals the substantial reduction in system development support. Currently, systems development receives only about 53 percent of the total federal R&D support, compared to 60 percent in 1970 and 62 percent

in 1965. A continued decline in support for systems development will undoubtedly undermine industry's long-run ability to support a dynamic technologically-based economy.

The Federal Government continues to heavily underwrite high risk, basic research activities while industry continues to apply most of its resources to engineering and development efforts related to product improvement and new product development. In the last few years, industry R&D investments have more than offset the cutback from federal defense and space sources. Industry funding for enhancement of the national technology base has steadily increased, currently accounting for about 38 percent of the total.

Federal R&D Allocations

Total federal R&D obligations for 1973 show an increase over 1972 of only $1 billion[2], or six percent--barely enough to keep pace with inflation. More than half of the $1 billion increase is committed to defense/space programs; $400 million of it is allocated to new domestic priority projects. Because the R&D activities of the domestic agencies are so heavily laboratory oriented, almost all of their additional money will go to support the technology base rather than into system development.[3]

DOD, NASA and AEC currently account for 76 percent of the total federal R&D funding compared to 92 percent in 1960. On the other hand,

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2 Unless otherwise noted, all values in this study are in current dollars.

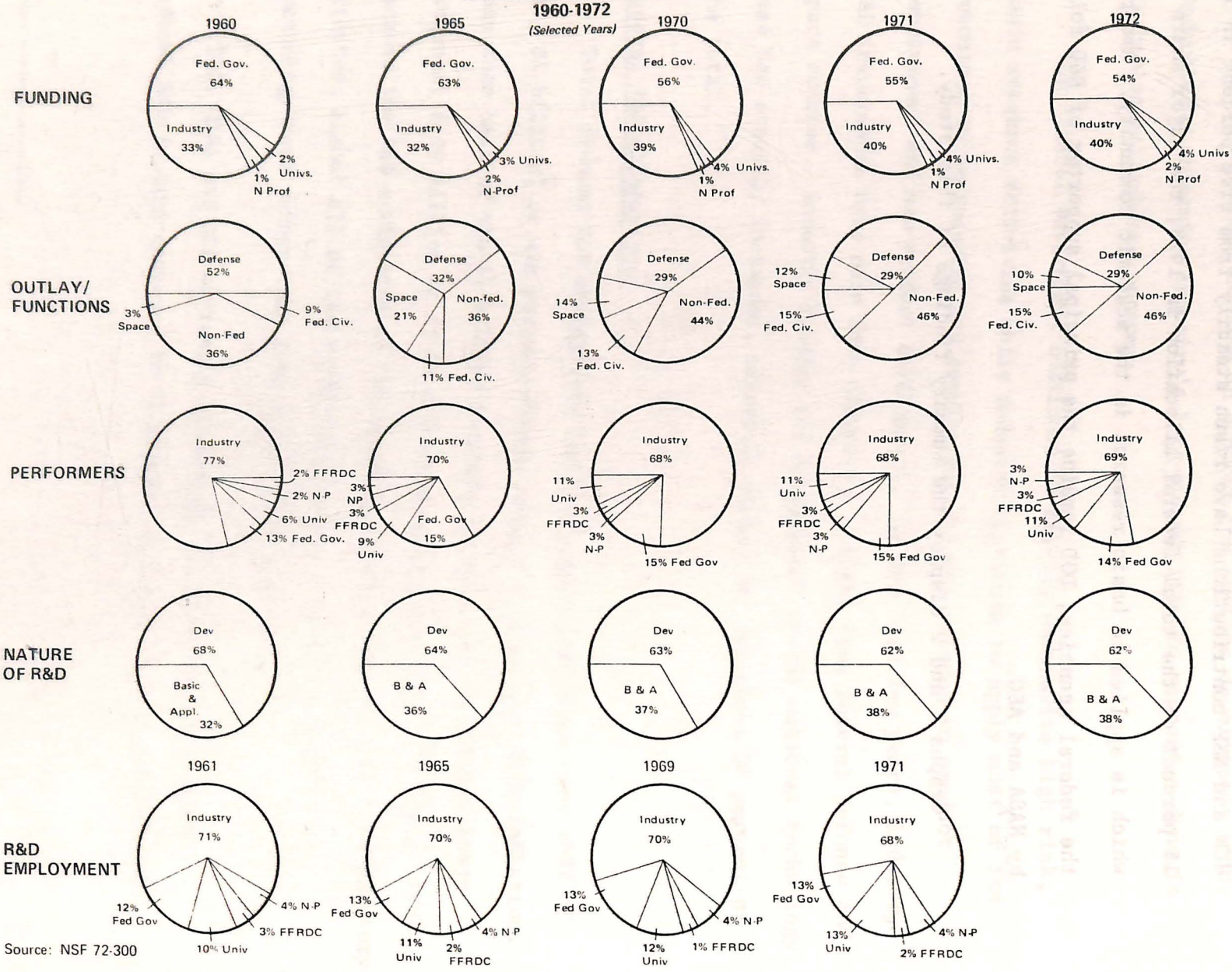
3 See "Definitions and Technical Notes" for the distinction between "Technology Base" and "System Development."

HEW and NSF contributions have risen steadily from five percent in 1960 to 15 percent of the total federal allocation in 1973, the major share of which is applied to basic research in the academic community. Among all the federal agencies, DOD remains the principal supporter of R&D followed by NASA and AEC.

Graphs 1 and 2 display the summary findings of this study.

GRAPH 1

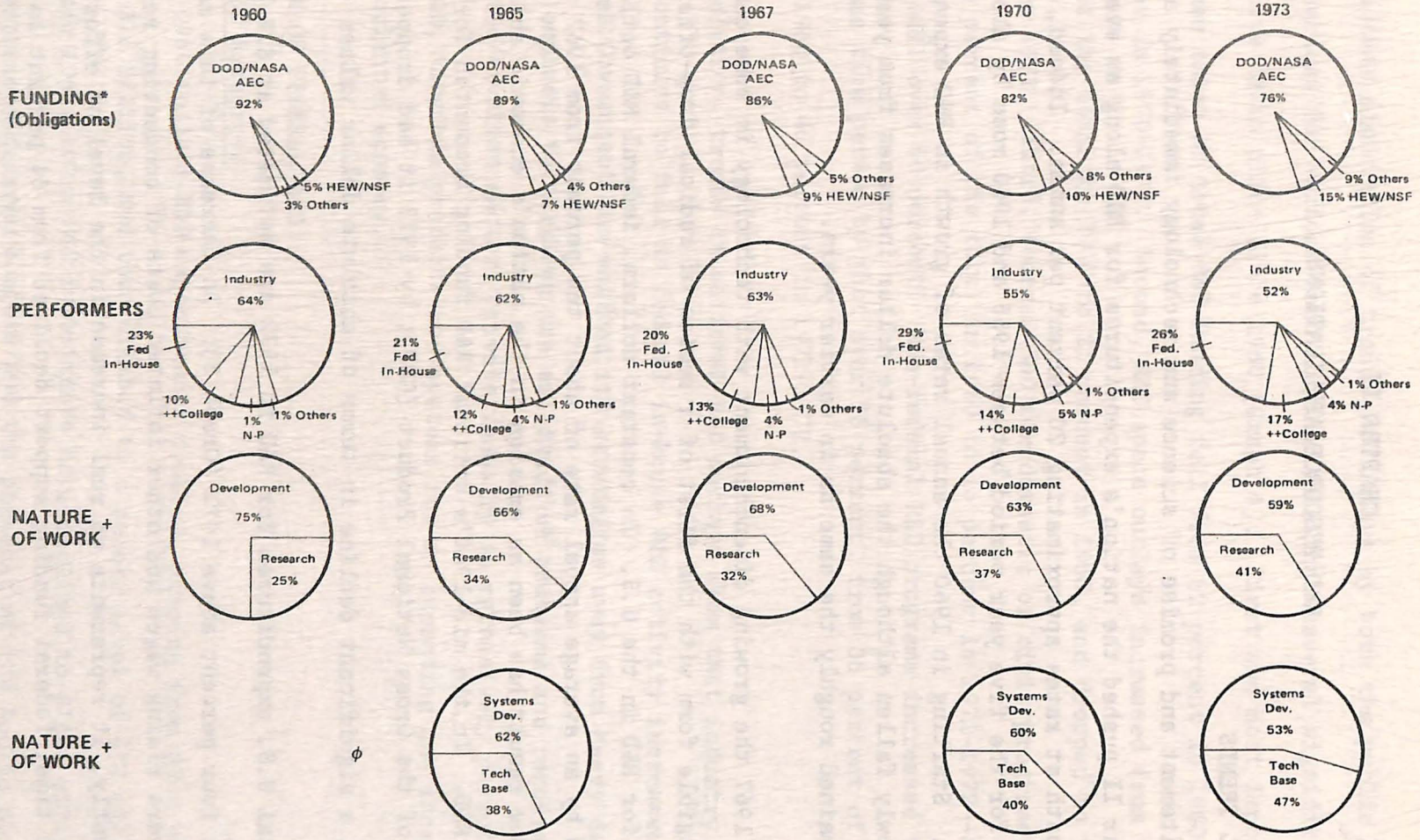
NATIONAL R&D - PROFILE
1960-1972
(Selected Years)



Source: NSF 72-300

GRAPH 2

FEDERAL R&D - PROFILE & TRENDS
FY1960-73
(Selected Years)



Source: NSF 72-300

* Minus R&D Plant; + Based on R&D definition of NSF; ++ Includes FFRDC's

ϕ AIA work definitions

CHAPTER II

R&D RESOURCE APPLICATIONS

NATIONAL TRENDS

The excitement and promise of science and technology immediately after World War II pushed the nation's expenditures for R&D along an ever-upward path at rates approximating 20 percent per annum. Indeed, R&D outlays for the five year period between 1955 and 1960 rose by about 120 percent. Starting in 1960 the annual rates of growth in R&D expenditures have slowly fallen although the absolute dollar increases from year to year have remained roughly the same as in earlier years.

In 1967 the growing disenchantment with technology in some quarters took tangible form with the first of a series of radical drop-offs in federal support for R&D in the U.S. In constant dollars, federal R&D outlays declined by an average annual rate of about ten percent from 1967 through 1972. One result has been an erosion in the nation's economic ability to conduct R&D. In the mid-1960's national R&D funding accounted for three percent of the Gross National Product (GNP); by 1973 it had dropped to 2.4 percent, a significant decline in terms of absolute dollar values (Table 1).

Total U.S. expenditures for R&D in 1972 are estimated at $28 billion, or about four percent above 1971 (Graph 3). An increase of this magnitude only covers rising wages and other inflated costs of conducting research; consequently, it represents no real increase in the level of effort. At the same time, federal funding support declined from 64 percent in 1960 to approximately 54 percent in 1972 of the total available funds, thus underscoring the diminishing role of the Federal Government in R&D leadership.

A further examination of trends in outlays by both the public and private sectors for various functions reveals that several significant changes have taken place since 1960 (Graph 4). First and most important, the defense share of total R&D funding fell from 52 percent in 1960 to 29 percent in 1970-1972. Second, R&D space outlays increased from three percent of the total in 1960 to 21 percent in 1965, and dropped to ten percent in 1972. Third, federal R&D for domestic or civil programs rose from nine percent of the total in 1960 to 15 percent in 1971-1972--an increase well over 50 percent! Non-federal R&D programs increased their share in the same time period by just over 25 percent, from 36 percent of the total in 1960 to 46 percent in 1971-1972.

In addition, trends in national R&D outlays show that industry funding support continues to fall as federal in-house R&D activity increases. While the Federal Government has shifted its strategies away from heavy defense and space emphasis to tackling the multitude of problems and requirements of the domestic/civilian sector, private industry is agressively pursuing. through R&D, tangible products and systems for an expanding and increasingly services oriented economy.

ALLOCATION OF FEDERAL R&D

Federal R&D Resources

From 1960 to 1965 R&D expenditures doubled, jumping from $7.7 billion to nearly $15 billion, and then climbed to a record level of $17 billion in 1968. Since 1968, total R&D investments have declined to $16.6 billion in 1972. Constrained defense budgets and the phaseout of the Apollo Space Program are primarily responsible for the downturn. The 1973 federal

expenditures for R&D were, however, decreased by approximately $47 million from the previous year. Since 1968, R&D's share of the total federal budget has declined from 9.5 percent to about 6.6 percent in 1973. This low is nearly two percent below the 1960 level.

Several trends can be observed in the federal R&D profiles depicted in Graph 5. The allocation of funds among the Executive Branch departments and agencies has shifted significantly since 1960 to the domestic or civil agencies. While the defense/space/nuclear agencies continue to claim the dominant portion, their share has decreased from 92 percent in 1960 to an estimated 76 percent in 1973. With the re-ordering of national priorities, a shift in emphasis toward HEW, Commerce, HUD and DOT can be anticipated, as more civil sector programs gain in public favor over defense and space efforts.

Shift in the Nature of R&D Work

Each Executive Branch department and agency has unique R&D classifications and definitions which make department/agency comparisons difficult; but using the accepted NSF classifications of R&D work, a fundamental shift in the nature of R&D can be discerned. In the 1960 budget, development received 75 percent of the federal R&D dollar compared to 25 percent for research; in the 1973 budget, the ratio has shifted to 59 percent development and 41 percent research (Graph 6).

In an attempt to shed more revealing light upon changes in the nature of R&D, this study employs two extremely useful, if generally unfamiliar, categories (Graph 6):

1. Technology Base, which covers all research and development for basic scientific research and applied research, including studies, investigations and minor developments whose objective is to evaluate feasibility of solution and determine fundamental parameters;
2. System Development, which covers all research and development efforts directed toward mission/program objectives that are usually involved in engineering development and test for either demonstration or production.

To examine federal R&D expenditures over the 1965-1973 period in terms of these categories is to discover that far less went into system development than the development/research categories suggest, and that the trend toward even less system development seems well pronounced. At the national level, the same general trends prevail when development is plotted alongside basic and applied research (Graph 7).

In 1965, 38 percent of the total federal R&D obligations (Table 3) was devoted to expanding the base for technology; by 1973, the share allocated to the technology base had jumped to 47 percent. In contrast, systems funding has steadily diminished during the same period from 62 percent to 53 percent of the total federal R&D budget. In terms of absolute dollar amounts, the federal R&D investment in systems in 1973 was almost exactly the same as it was eight years earlier in 1965 (Table 3), while over the same period the investment in the technology base has grown by more than $2 billion. Thus, a decided increase is occurring in federal technology base investment at the expense of investment in systems and products to

Summary of Government Expenditures for R&D

In 1960 defense expenditures accounted for $5.6 billion or about 75 percent of the total spent by the government on R&D, NASA with $347 million claimed five percent and HEW spent just under $300 million or four percent of the total (Table 4). In 1973 DOD's share, at $7.9 billion, is less than 50 percent of the total; NASA's portion is $3 billion or about 19 percent, and HEW with $1.7 billion receives over ten percent of the total anticipated R&D expenditures.

SUMMARY

Following are the principal findings from the data and analyses presented in this Chapter:

- National expenditures for R&D in 1972 were $28 billion, four percent above 1971. Inflation accounted for most of the increase.
- National R&D outlays in 1972 were 2.4 percent of GNP, down from an average of about three percent during the early and mid-1960's.
- The Federal Government remains the largest single contributor to national R&D support, although its position of leadership and influence in R&D is diminishing.
- The private sector's level of funding support is steadily approaching the level of the Federal Government.
- Based on dollar commitments, federal R&D growth is in the civil sector where, in 1973, funding has increased to $2 billion, an 18 percent jump over the previous year.
- The major increases in federal R&D funds are directed toward technology base support, with almost no increase in funds for system development in the 1965-1973 period. Similarly, research funds have increased at the expense of development.

CHAPTER III

R&D PERFORMANCE

GOVERNMENT PERFORMANCE

Funding for government in-house laboratories has risen gradually since 1960 (Graph 12). In fact, the period 1960-1968 saw a doubling in commitments to government laboratories. Between 1970 and 1972 allocations to in-house laboratories rose 18 percent,[4] most of which went to DOD and NASA, which together currently account for about 75 percent of all federal in-house performance. With more money in-house, the federal laboratories' share of the total federal R&D budget has been increasing--from 20 percent of the total in 1967 to 26 percent in 1973. The net result of these trends is, of course, that less and less federal R&D funds are going to industry. The percentage of in-house R&D funding support provided by each agency is shown in Table 6.

Department of Defense

The Department of Defense operates a total of 123 in-house laboratories and field test centers. These are apportioned among the military departments as follows:

	Number of Labs & Test Facilities[5]
Army	54
Navy	44
Air Force	24
Defense Nuclear Agency	1
Total	123

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4 National Science Foundation, NSF 71-35, Table C-103, p. 219.

5 Does not include headquarters organizations, e.g. AFSC, Army Chief of R&D Office, etc. Source: DDR&E, A Management Overview, November 1971.

There have been very few consolidations of laboratories since 1970 and apparently no new additions are planned for the near term.

These in-house laboratories, in many instances, act as program managers for equipment and systems development for their agency. In this capacity, many of these laboratories have been diverting to in-house R&D sources an increasing quantity of the workload normally contracted to industry.

The growth in in-house laboratories is further evidenced by the increase in scientific and engineering manpower within the DOD in-house laboratories since 1967 (Graph 10). During the 1967-1971 period, professional manpower (military and civilian) increased by 16 percent, while total supporting personnel ranks declined by 12 percent. For the three year period 1969-1971 defense laboratory professional manpower increased by three percent while the employment of professionals in industry supported by federal funds declined by 18 percent. Such trends tend to discourage industry from participating in future federal R&D.

Under operational control of the Director, Defense Research and Engineering, DOD also supports 12 Federal Contract Research Centers (FCRC's) consisting of five university labs, two systems engineering companies and five study and analysis centers. Some modest reductions (around 200-300 scientists and engineers) have been made at these installations over a two-year period, as a result of increased budgetary and political pressures, which today seem to have subsided somewhat.

National Aeronautics and Space Administration

Approximately 28 percent of NASA's R&D total obligational authority is kept in-house; 60 percent is contracted to private industry. Since 1970, facility funding support has decreased eight percent, a continuing trend initiated by the phasing out of Apollo activities. Currently, NASA operates seven major laboratory complexes and two field test centers, where R&D program funds are applied to in-house activities and apportioned to industry through competitive contracts.

From 1967 NASA's manpower levels have gradually decreased (Graph 11). Since 1968 the laboratories' technical manpower has declined about 12 percent, but total NASA personnel decreased 21 percent over the same period. An analysis of NASA's possible future budget would indicate a likely leveling off of the technical work force in its laboratories in the immediate future.

Atomic Energy Commission

The AEC accomplishes 95 percent of its work through 21 Federally Funded Research and Development Centers (FFRDC's) administered by universities and industrial corporations. As a result, AEC does not operate in-house laboratories. Over the past three years, its budget has been relatively stable--an important trend for the FFRDC's administered by universities, as they obtain approximately 75 percent of their total support from AEC.

Health, Education and Welfare

HEW maintains through the National Institutes of Health (NIH) sizable in-house laboratories for health research. In the area of education, the

Office of Education performs its R&D through 27 supported FFRDC's operated by universities and non-profit groups. HEW, over the last few years, has been allotting approximately 20 percent of its funds to support of in-house laboratories.

Other Agencies

Other federal agencies, such as USDA, DOT, HUD and Commerce, support in-house R&D laboratory activity. The amount of funding appropriated by each agency is portrayed in Table 6.

COLLEGES AND UNIVERSITIES

Federal allocations of R&D funds to colleges and universities (including FFRDC's administered by universities) have steadily advanced since 1960 (Graph 12), when they received ten percent of the total allocated to all performers. Their share in 1973 is 17 percent of the total. During the 1971-1972 period, R&D funds allocated to academic institutions increased by 14 percent; in 1973 they were able to increase their funding by nine percent. Such increases contrast sharply with industry growth rates of six and seven percent during the same time period. Thus, gains in the academic sector have come mainly at the expense of industry, whose share of the total R&D funds available to performers declined from 63 percent in 1967 to 55 percent in 1970, to 52 percent in 1973.

Most of the university and college gains reflect growth in HEW and NSF program areas. HEW supplies the largest federal support for the academic sector in 1973, with 47 percent of its R&D funds flowing to colleges and universities as compared to NSF's 20 percent; NSF's involvement with universities and colleges during the 1971-1973 period, however, is relatively greater (63 percent) compared to HEW's 32 percent.

Influenced greatly by campus demonstrations, DOD reduced its funding support to universities and colleges by approximately three percent from 1970 to 1972; however, the 1973 budget shows a five percent increase to the academic sector. Since 1970, much of the DOD workload of academic institutions has been either cancelled or transferred to in-house federal laboratories.

While it is prudent to maintain a healthy level of R&D support to the academic sector, care must be taken to distribute such support more equitably among all participating sectors in order to maintain the critical balance of essential technical information transfer from all these sources.

OTHER NON-PROFITS

Other non-profit institutions (comprised of non-profit private organizations other than educational institutions) have received increasing R&D support since 1960, and the non-profits' share of the total federal allocation to performers has remained fairly constant since 1965--at four percent. DOD predominates in the sponsorship of FFRDC's administered by other non-profits. No significant increase in the non-profits' share of the total federal R&D funds is anticipated for the near term.

INDUSTRY PERFORMANCE

Industry in 1973 continues to be the principal R&D performer, although its share of the federal R&D total has declined from a high of 66 percent in 1963 to its present 52 percent. This downward trend in industry's federal share, of course, is commensurate with the steady drop in R&D

federal obligations since the peak of 1967. The seven percent rise that the 1973 budget offers industry is significantly less than the increases of the 1960's that resulted from concentrated development of new weapon systems, spacecraft and atomic reactors. Since 1970, federal emphasis and attention has increasingly centered upon the domestic civilian sector; although major problem areas, they are all under-funded and will probably never reach in the foreseeable future the magnitude of spending for defense and space. Since DOD and NASA together provide 90 percent of the federal support to industry, the impact on industrial R&D of this shift in federal focus will, at least over the near term, be adverse. All other agencies combined account for the remaining ten percent.

Industry-provided funds for its own independent research and development in 1972 are estimated at 40 percent of the national total--the highest since 1954. R&D funds provided by private industry, as compared to federal allocations for the years 1968 through 1971, were as follows:[6]

Funding ($ Billions)	1968	1971	Dollar Change
Federal Government	$ 8.6	$ 7.8	-0.8
Company	8.9	10.5	+1.6
Total performed by Industry	17.5	18.3	+0.8

From this data it is readily apparent that the withdrawal of federal allocations from industry triggered no decline in private industry R&D support. In fact, the increase in company-provided funds during the 1968-1971 period was nearly double the amount lost through federal withdrawals.

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6 National Science Foundation, NSF 72-300, Table B-1, p. 25.

The aerospace and electronic industries have been especially hit hard by major federal funding cutbacks. In addition to the loss they have suffered in federal contract sales, they have had to lay off substantial numbers of highly specialized scientists, engineers and technicians, who have joined the ranks of the unemployed (NSF estimates their number at 60,000 since 1969[7]). The civil agencies, because of their small in-house laboratories and comparatively low level program funding, have been unable to absorb the massive numbers of displaced technical manpower. Too, there exists a widening gap in wages between professional technical personnel in government and federal contract related areas compared to pay scales in private industry. According to NSF the average annual cost per aerospace scientist and engineer in 1970 was $43,500.[8] For the same period, the average yearly cost of a government scientist or engineer was $55,200 (Table 11). Since 1970 there have been at least two federal pay increases, each of approximately four percent, which have tended to maintain the difference between federal and industrial engineering wages. Since the cost per R&D engineer is more economical in the private sector, the Federal Government would save money by contracting more with industry instead of continuing to expand in-house activities.

SUMMARY

- The Federal Government supports substantial in-house R&D efforts which absorb from 22 percent to 25 percent of the annual R&D obligations.

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7 Ibid.

8 National Science Foundation Survey 72-309, R&D in Industry, 1970.

- Since 1960 federal R&D funds allocated to industry have, as a result of defense cutbacks and NASA program phaseouts, declined steadily from 69 percent to 52 percent estimated for 1973.
- During a period when industry was experiencing major cutbacks in professional manpower, federal in-house laboratories were increasing, or at least maintaining, their levels of technical staff.
- Universities and colleges continue to gain larger shares of federal R&D money allocations. Universities and colleges in 1972 and 1973 increased their funding share by 14 percent and nine percent, respectively, vs. industry increases of six percent and seven percent, respectively. HEW and NSF were the great contributors to the advances by the academic sector.
- The decline in industry employment opportunities for scientists and engineers, partially generated by federal R&D support reductions, has been followed by a drop in college and engineering school enrollments, which could, in three to five years, result in a serious shortage of trained manpower. The long-run economic impact of such a shortage could be detrimental to the nation.
- Annual salaries of scientists and engineers in private industry are below those of comparable positions in the Federal Government, thus attracting the better technical talents to government service.

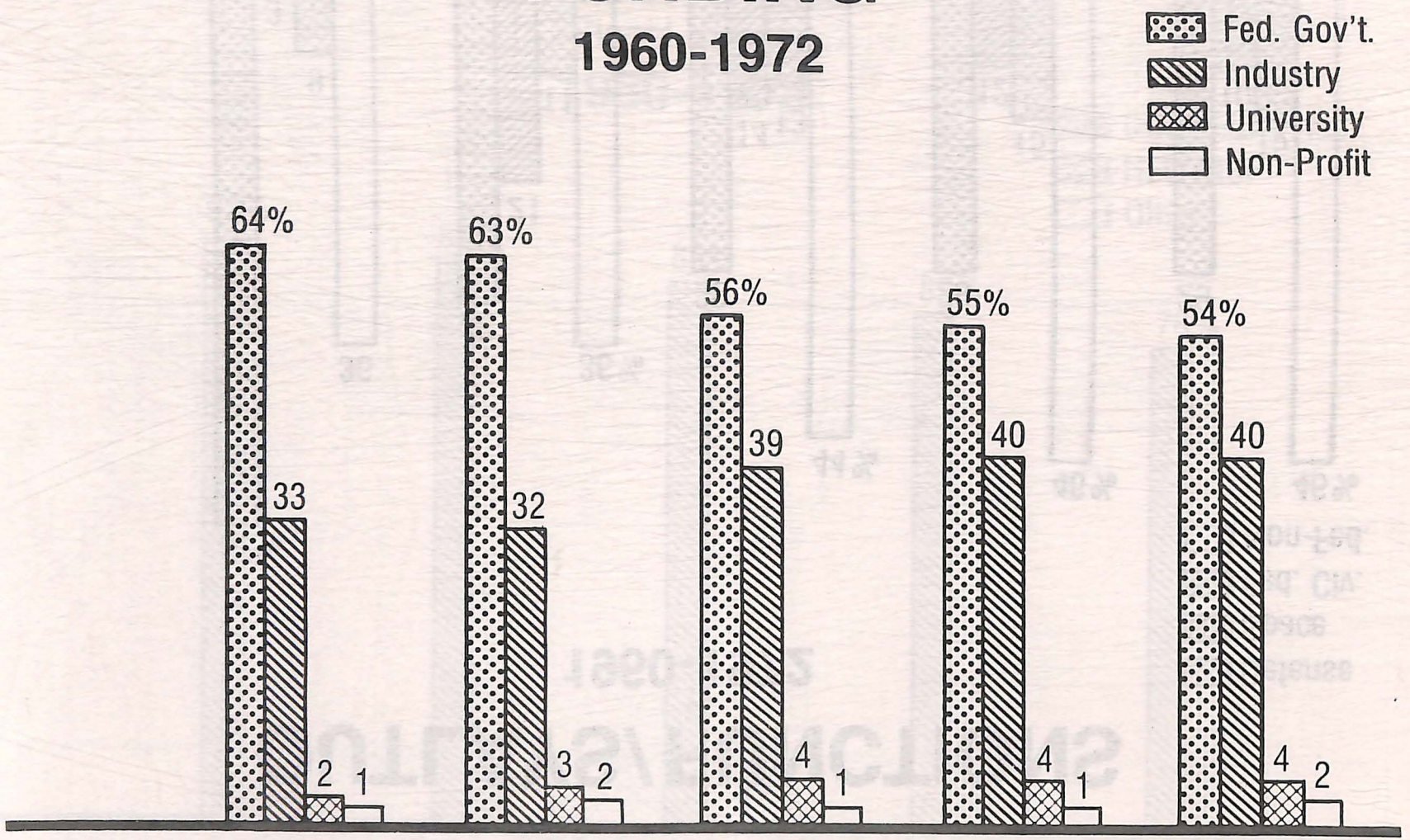
GRAPHS

3 through 12

GRAPH 3

NATIONAL R&D

FUNDING
1960-1972



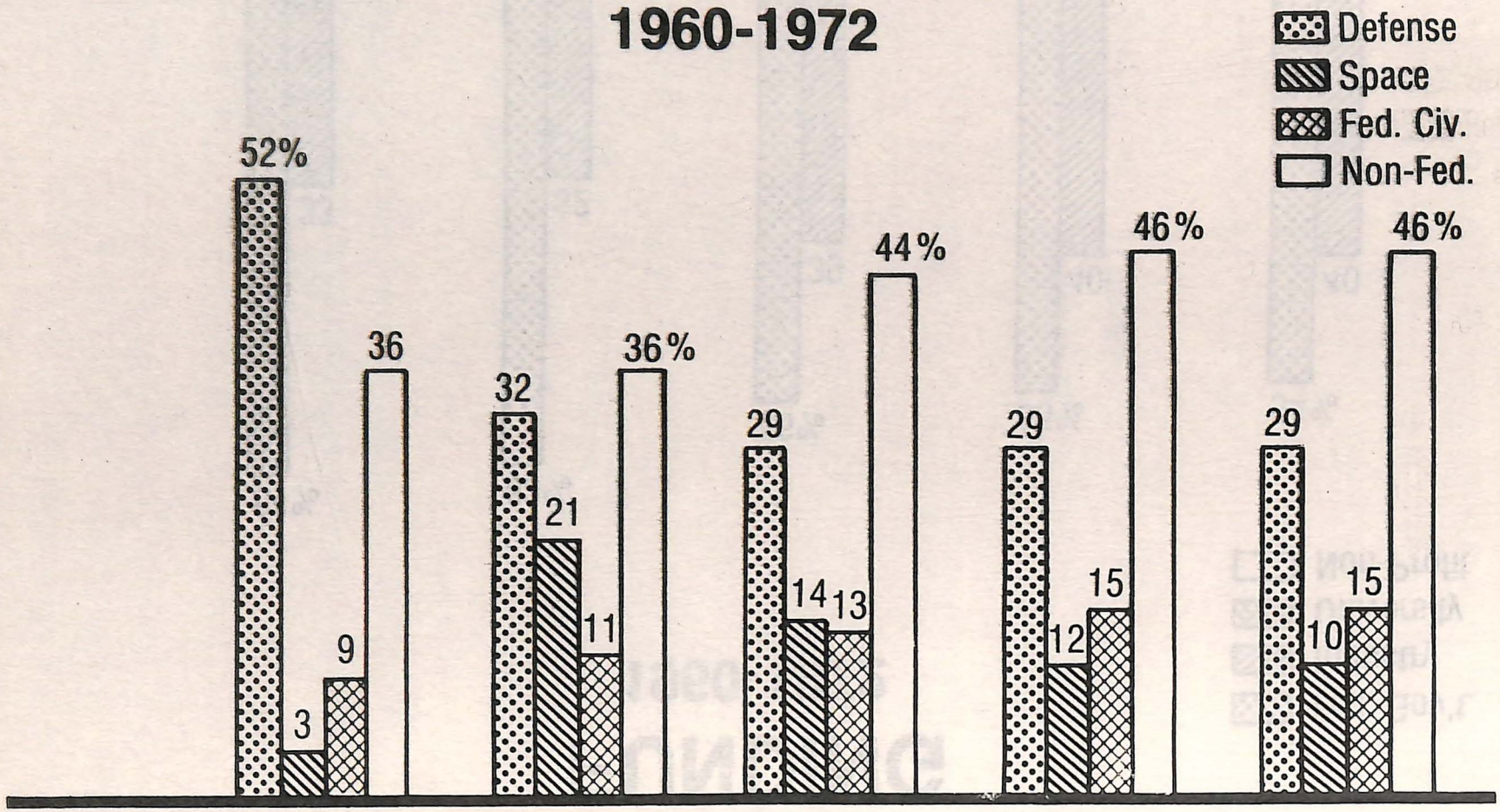
	1960	1965	1970	1971	1972
Total Billions Dollars	$13.7	$20.4	$26.3	$26.9	$28.0

GRAPH 4

NATIONAL R&D

OUTLAYS/FUNCTIONS

1960-1972



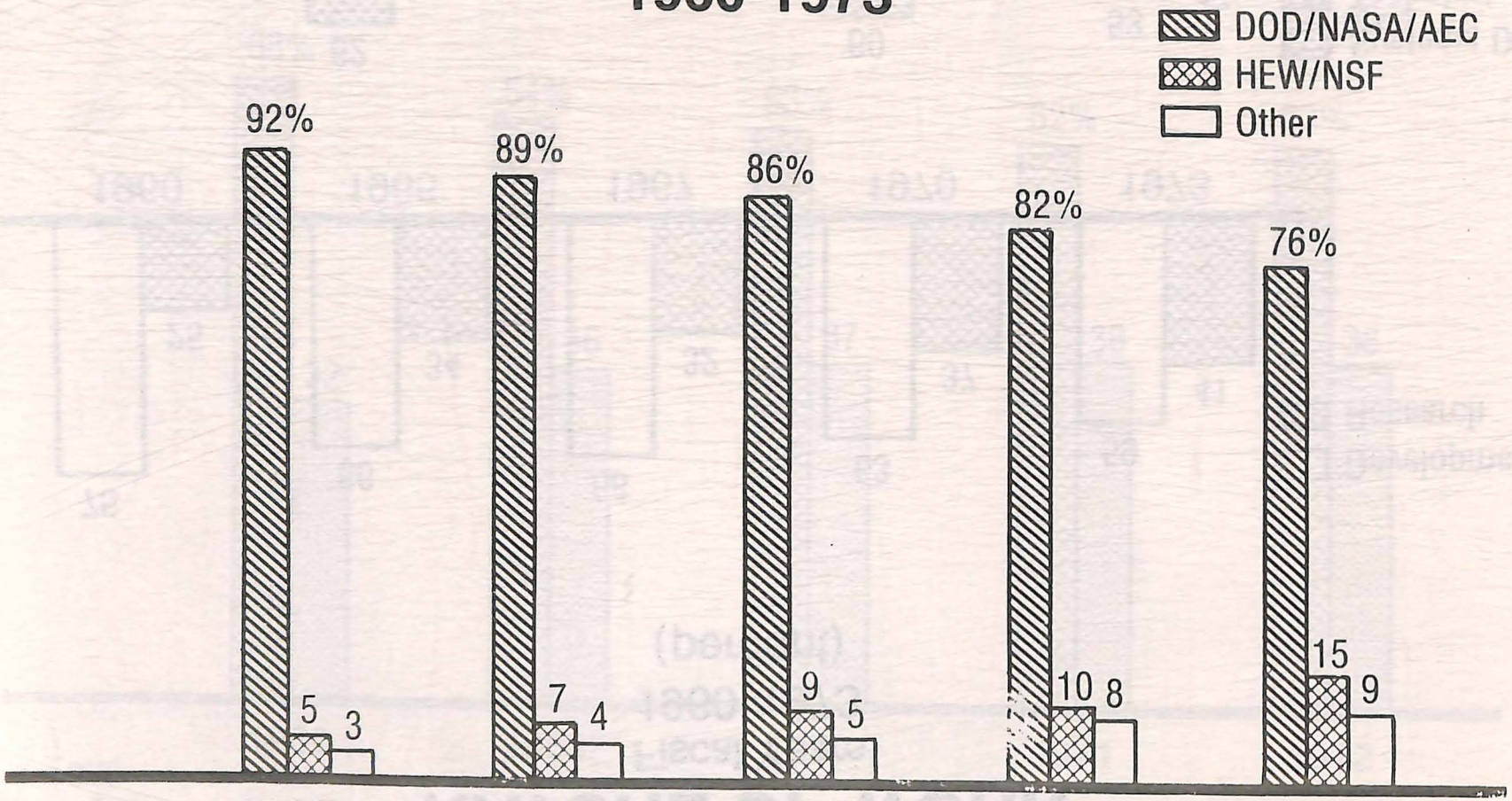
GRAPH 5

FEDERAL R&D

FUNDING

Fiscal Years

1960-1973

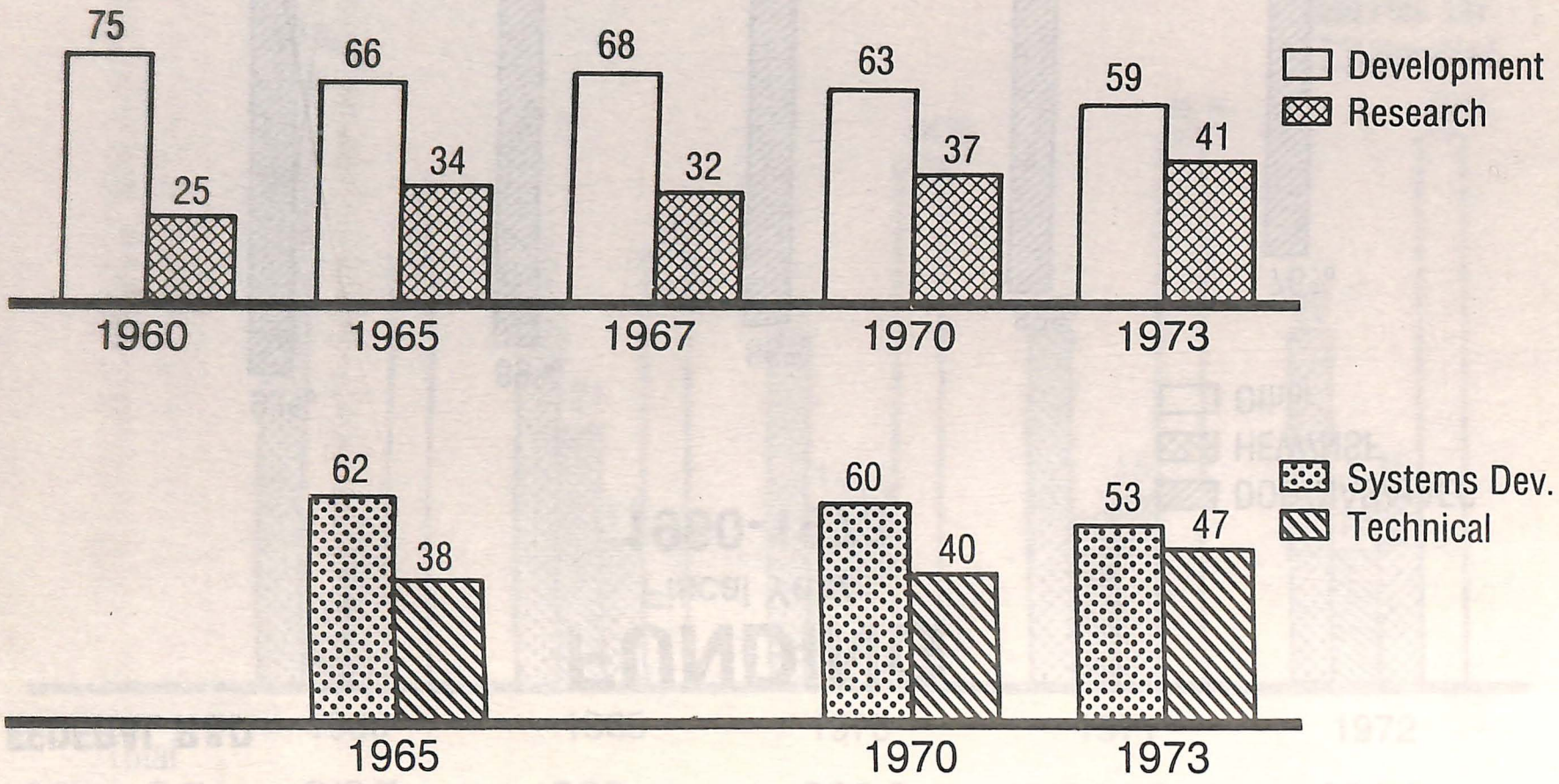


FEDERAL R&D

GRAPH 6

NATURE OF WORK

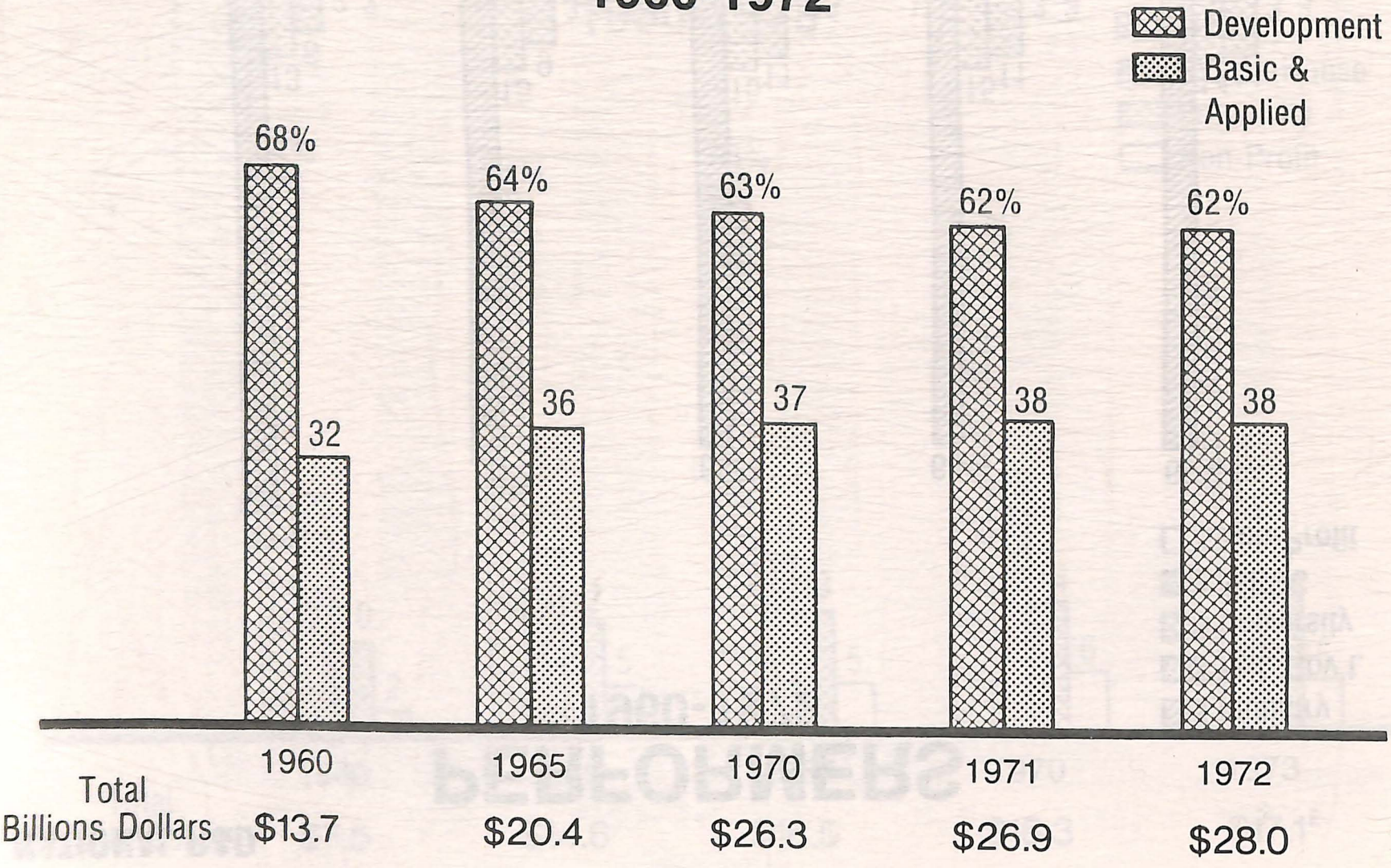
Fiscal Years
1960-1973
(percent)



NATIONAL R&D

NATURE OF R&D

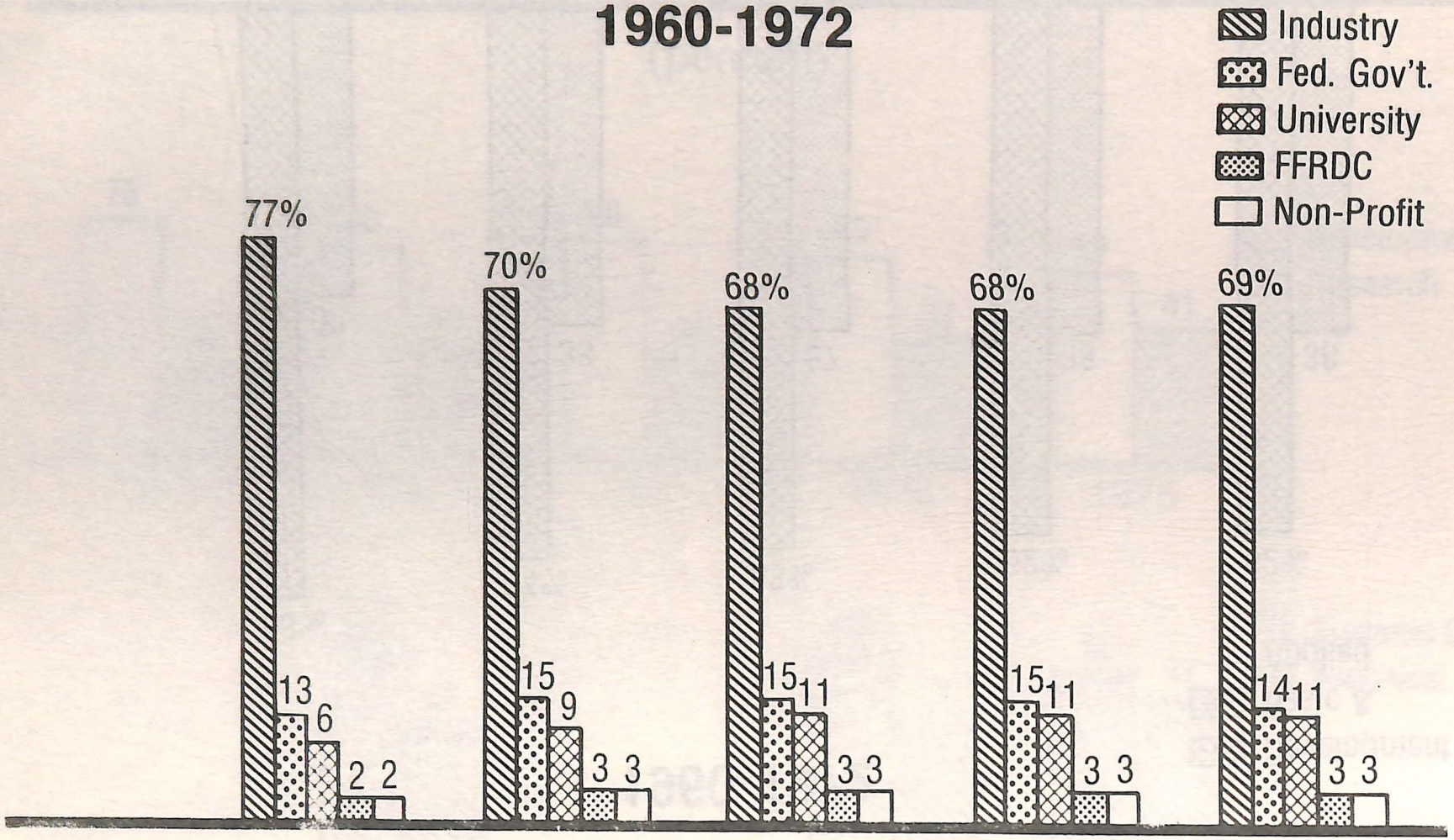
1960-1972



GRAPH 8

NATIONAL R&D

PERFORMERS
1960-1972

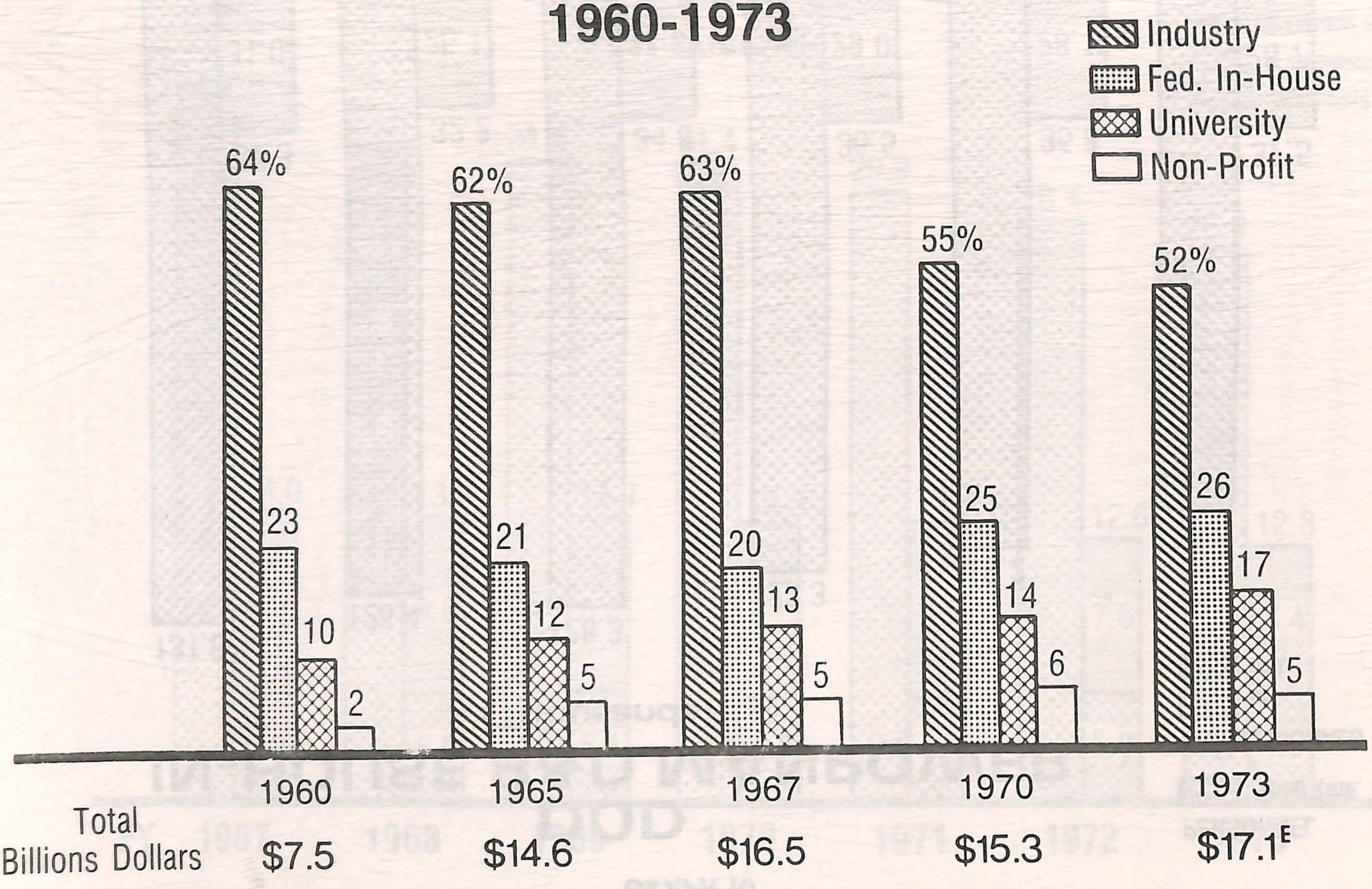


	1960	1965	1970	1971	1972
Total Billions Dollars	$13.7	$20.4	$26.3	$26.9	$28.0

FEDERAL R&D

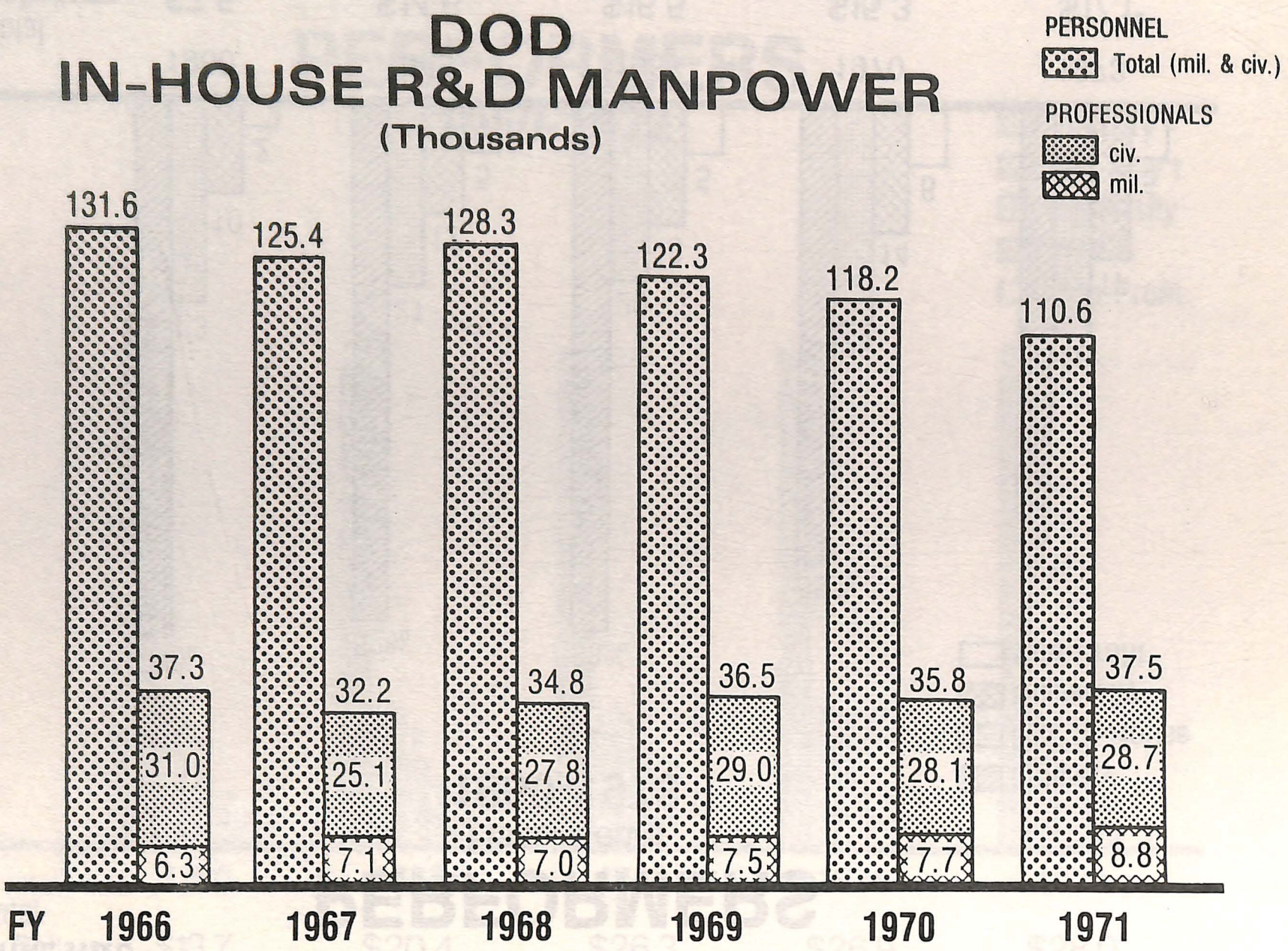
PERFORMERS

Fiscal Years
1960-1973



GRAPH 10

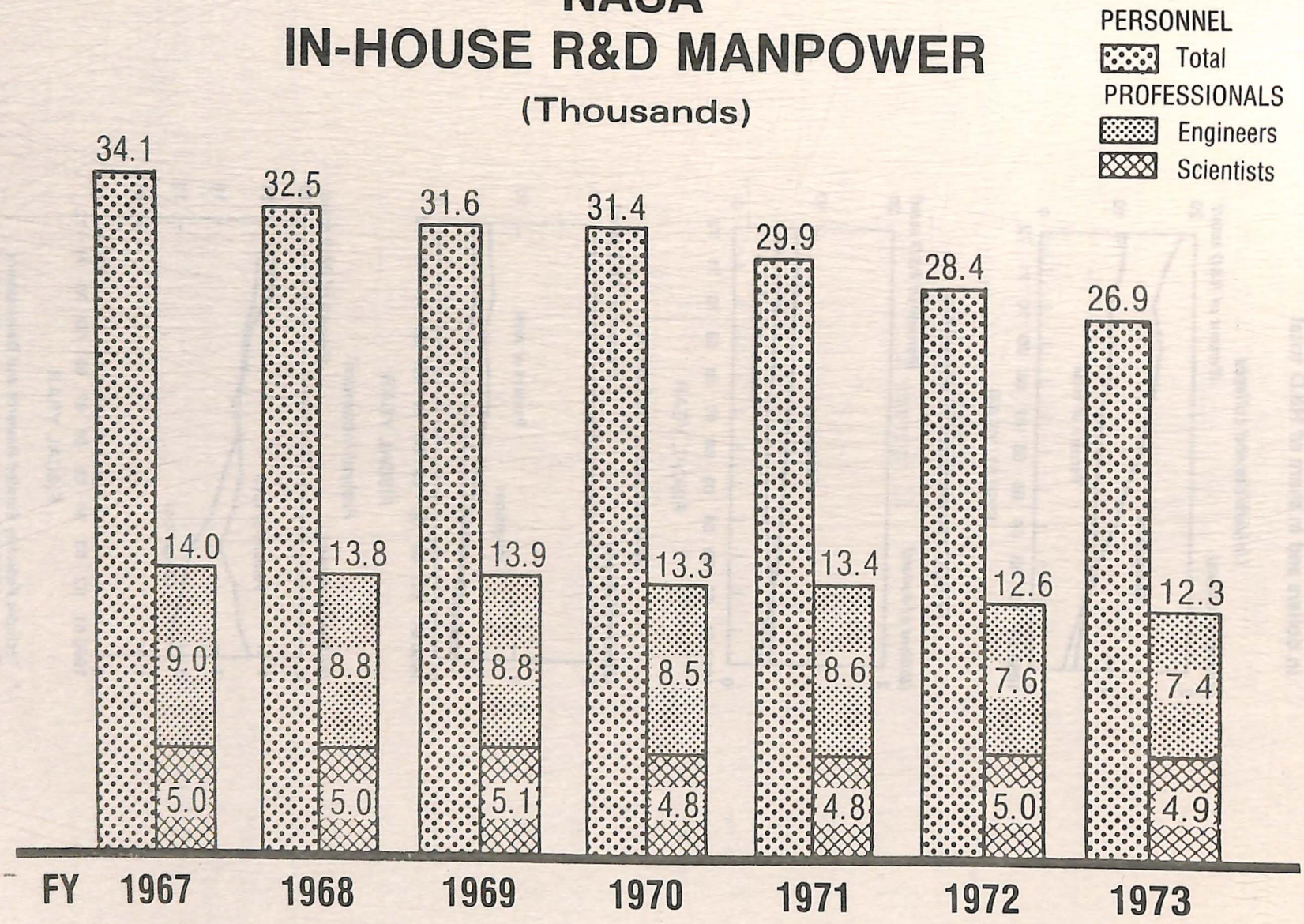
DOD
IN-HOUSE R&D MANPOWER
(Thousands)



GRAPH 11

NASA
IN-HOUSE R&D MANPOWER

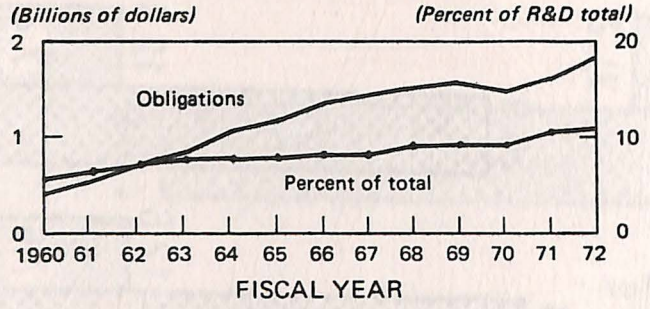
(Thousands)



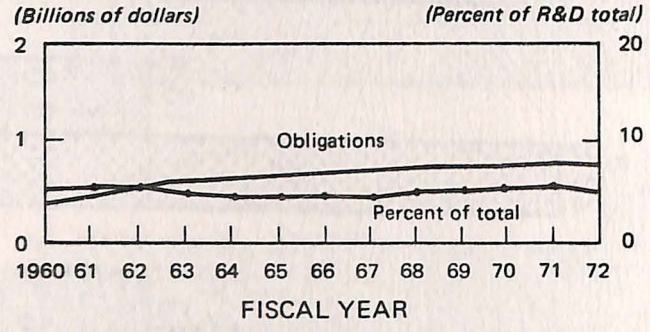
GRAPH 12

Federal R&D obligations by performer group in dollars and in share of R&D total

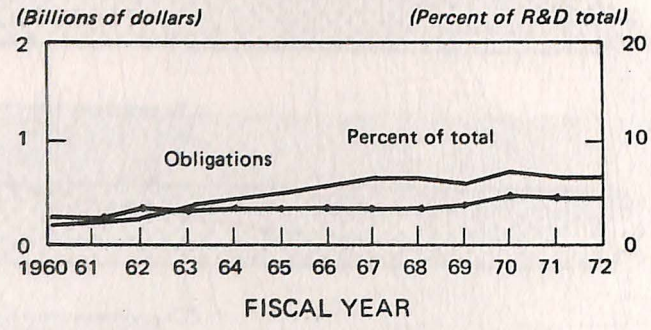
Universities and colleges



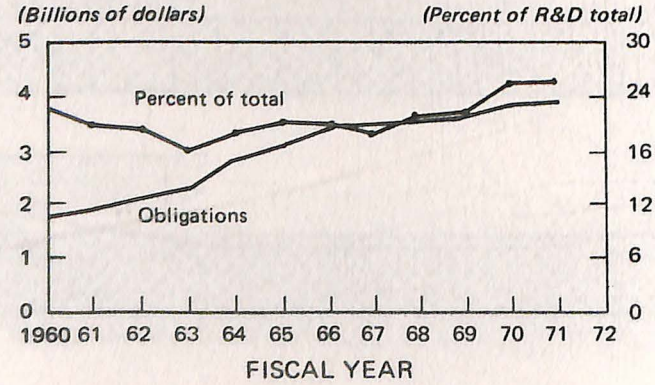
FFRDC's administered by universities



Other nonprofit institutions



Federal Intramural



* Includes Federally Funded Research and Development Centers (FFRDC's) administered by nonprofit institutions.

SOURCE: National Science Foundation

Source: National Science Foundation

TABLES

1 through 11

TABLE 1

RESEARCH AND DEVELOPMENT
VS
GROSS NATIONAL PRODUCT
1960-1973*
($ Billions)

Year	GNP	Total U.S. R&D Expenditures	R&D/GNP
1960	$ 503.7	$ 13.7	2.8 %
1961	520.1	14.6	2.8
1962	560.3	16.7	3.0
1963	590.5	17.4	2.9
1964	632.4	19.2	3.0
1965	684.9	20.4	3.0
1966	749.9	22.3	3.0
1967	793.9	23.6	3.0
1968	864.2	25.2	2.9
1969	930.3	26.2	2.8
1970	976.4	26.3	2.7
1971	1050.4	26.9	2.6
1972	1152.1	28.0	2.4

* Calendar Years

Sources: Economic Report of the President, Table C-1(GNP), p. 193, January 1973; National Science Foundation, NSF 72-30, Table B-1, pp. 22-24.

TABLE 2

FEDERAL OBLIGATIONS
AND EXPENDITURES
Fiscal Years 1960-1973
($ Millions)

Fiscal Year	Total Budget Outlays	R&D and R&D Plant		R&D Expenditures As a Percent of Total Budget Outlays
		Obligations	Expenditures	
1960	$ 92,230	$ 8,080	$ 7,744	8.4 %
1961	97,802	9,607	9,284	9.5
1962	106,830	11,069	10,381	9.7
1963	111,314	13,663	11,999	10.8
1964	118,585	15,324	14,707	12.4
1965	118,431	15,746	14,889	12.6
1966	134,654	16,179	16,018	11.9
1967	158,352	17,149	16,842	10.6
1968	178,682	16,525	17,030	9.5
1969	184,556	16,306	16,384	8.9
1970	196,588	15,854	15,736	8.0
1971	211,425	15,733	15,612	7.4
1972	231,876	17,109	16,630	7.1
1973(est)	249,796	17,992	16,583	6.6

Sources: National Science Foundation;
The U.S. Budget, FY1974;
Special Analyses--U.S. Budget FY1974.

TABLE 3

FEDERAL R&D (OBLIGATIONS)*
TECHNOLOGY VS SYSTEMS FUNDING+
($ Millions)

Agency	Tech. Base Percent Total R&D	1965		1970		1971		1972		1973	
		Tech	Sys	Tech	Sys	Tech	Sys	Tech	Sys	Tech	Sys
DOD[a]	20-25	$ 1676	$ 4784	$ 1508	$ 5931	$ 1601	$ 5745	$ 1765	$ 6123	$ 1795	$ 6232
NASA	30('65)[b] 40('70-'73)[c]	1486	3466	1140	2660	1320	1953	1283	1925	1310	1965
AEC	50	620	620	673	673	651	651	654	654	688	688
NSF	100	187	----	289	----	337	----	451	----	526	----
HEW	100	869	----	1221	----	1476	----	1763	----	1957	----
USDA	100	225	----	281	----	305	----	349	----	361	----
Commerce	80	49	12	98	24	115	29	138	35	182	46
Interior	100	113	----	158	----	194	----	224	----	256	----
DOT	90	----	----	255	32	435	48	329	36	343	38
EPA	100	----	----	89	----	137	----	176	----	186	----
Others	100	170	----	347	----	404	----	430	----	472	----
Total		$ 5395	$ 8892	$ 6090	$ 9320	$ 6975	$ 9026	$ 7532	$ 8773	$ 8074	$ 8970
Mix (%)		38 %	62 %	40 %	60 %	47 %	53 %	46 %	54 %	47 %	53 %

Period	Change Tech	Sys
FY1965-1970	+13%	+ 5%
FY1971-1973	+16%	-0.7%

a DDR&E--RDT&E TOA; all other agencies--obligations cited.

b,c derived from Hearing analyses.

* Less R&D Plant.

\+ See Technical Notes for definitions.

Source: AIA Analysis based on unofficial data provided by related government agencies.

TABLE 4

FEDERAL EXPENDITURES FOR R&D*
BY AGENCY FY1960-1973
($ Millions)

Agency	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973E
DOD	$ 5553	$ 6501	$ 6720	$ 6794	$ 7433	$ 6628	$ 6680	$ 7607	$ 7990	$ 7661	$ 7447	$ 7541	$ 8117	$ 7873
NASA	347	646	1143	2327	3733	4562	5361	5137	4598	4186	3697	3337	3373	3008
HEW	292	344	476	590	747	681	831	994	1217	1187	1218	1288	1513	1670
AEC	762	850	1029	1078	1236	1241	1212	1257	1369	1406	1346	1303	1298	1513
NSF	58	71	92	111	154	150	176	224	267	280	293	335	418	423
DOT	----	----	----	----	----	----	158	231	212	203	259	198	274	290
USDA	121	141	151	164	178	200	228	254	263	270	285	315	349	360
Interior	63	71	80	96	92	109	131	147	178	196	152	175	210	262
Commerce	30	32	38	48	53	58	53	69	75	75	123	114	165	179
EPA	----	----	----	----	----	----	----	----	----	----	68	101	133	146
Others	74	92	103	131	133	182	140	153	164	231	271	298	253	316
Total	$ 7300	$ 8748	$ 9832	$11339	$13759	$13811	$14970	$16073	$16333	$15695	$15159	$15005	$16103	$15886

* Minus R&D Plant.

E Estimated.

Sources: National Science Foundation, NSF 71-35;
National Science Foundation, NSF 72-305;
The U.S. Budget FY1974, Special Analyses.

TABLE 5

FEDERAL CIVILIAN R&D PROGRAMS
Fiscal Years 1972-1973[E]
(Obligations $ Millions)

Program	FY 1972	FY 1973	Percent Change
Transportation	$ 602	$ 666	+ 11
Clean Energy	537	642	+ 20
Cancer & Heart Disease	513	588	+ 15
Natural Disaster Control	36	48	+ 33
Drug Rehabilitation	44	84	+ 91
Crime Prevention & Control	18	29	+ 61
Total	$1750	$2057	+ 18

E Estimate

Sources: The U.S. Budget, FY1973;
Special Analyses--U.S. Budget, FY1974.

TABLE 6

FEDERAL IN-HOUSE R&D
FUNDING BY AGENCY
Fiscal Year 1971

Agency	R&D TOA ($ Mil)	In-House R&D As Percent of R&D TOA
Agriculture	$ 303	75 %
Commerce	160	70
Interior	185	58
EPA	116	33
NASA	3,248	28
DOD	7,420	27
HEW	1,480	20
DOT	437	19
HUD	49	12
Justice	10	10
AEC	1,307	0

Source: National Science Foundation, NSF 71-35, pp. 34-38.

TABLE 7

DOD IN-HOUSE RDT&E MANPOWER
Fiscal Years 1966-1971

Fiscal Year	Total Personnel (Mil & Civ)	Professionals		Total Professionals
		Military	Engineers	
1966	131,641	6,262	31,022	37,284
1967	125,345	7,138	25,118	32,256
1968	128,260	6,957	27,830	34,787
1969	122,272	7,469	28,902	36,471
1970	118,201	7,693	28,064	35,757
1971*	110,550	8,786	28,687	37,473

* Latest year available. (Figures do not include R&D organizations of headquarters type, e.g. Air Force Systems Command, Army Office of Chief of R&D, etc.)

Source: DOD In-House Activity Reports, DDR&E, pp. 66-71.

TABLE 8

NASA IN-HOUSE R&D MANPOWER
Fiscal Years 1965-1973

Fiscal Year	Total Personnel*	Professionals		Total Professionals
		Scientists	Engineers	
1965	N.A.	5,007	7,850	12,866
1966	N.A.	4,815	8,877	13,692
1967	34,126	5,034	9,025	14,059
1968	32,500	5,017	8,841	13,858
1969	31,600	5,101	8,817	13,918
1970	31,400	4,810	8,541	13,351
1971	29,850	4,826	8,091	13,370**
1972	28,350	5,028	7,530	12,558**
1973	26,850	4,955	7,350	12,305**

* House Appropriations Hearings, FY1972, Permanent Civil Service Employment (10 installations including NASA headquarters), p. 995.

** House Committee on Science and Astronautics Hearings, NASA FY1973 Authorizations, Part 1, p. 45.

N.A. Not available.

Source: National Science Foundation.

TABLE 9

MAJOR DOD ACADEMIC AND
NON-PROFIT CONTRACTORS, RDT&E
($ Millions)

	FY1970		FY1971		FY1972	
	Amount	Rank	Amount	Rank	Amount	Rank
Aerospace Corp.	$ 72.7	2	$ 71.1	2	$ 70.5	3
Battelle	9.2		8.4		7.9	
U. of California	18.2	7	18.7	8	18.7	6
Cornell Aero Labs	16.2	8	20.7	6	16.6	8
ITT Research Instit.	11.0		11.2		13.5	9
Johns Hopkins U.	60.5	3	70.6	3	71.6	2
MIT	94.6	1	90.2	1	126.4	1
MITRE Corp.	38.2	4	34.9	4	35.2	4
Penn State U.	8.6		8.4		9.0	
RAND Corp.	19.5	6	19.6	7	16.9	7
Research Analysis Corp.	9.5		9.2		8.0	
Riverside Research Instit.	6.9		8.7		7.1	
U. Rochester	9.8		9.1		10.5	
Stanford Research Instit.	24.8	5	25.3	5	28.3	5
U. Texas	5.2		5.9		5.6	
Woods Hole Ocean Instit.	5.5		6.9		7.6	
Michigan U.	7.6		6.9		7.2	
Illinois U.	12.3	10	12.9	9	5.7	
Instit. for Defense Analysis	11.5		12.5	10	11.7	10
Washington U.	4.5		4.5		6.7	
S.W. Research Instit.	3.9		5.3		5.8	
Syracuse Research Corp.	3.7		3.2		3.1	
New Mexico State U.	4.4		4.2		3.7	
Stanford U.	10.3		7.7		8.2	
Duke U.	3.0		4.0		1.9	
System Development Corp.	16.0	9	7.6			

Source: House Appropriations Hearings 1973, Part 4, RDT&E, pp. 833-34;
DOD RDT&E Contractors FY1969-1972.

TABLE 10

MAJOR NASA ACADEMIC AND
NON-PROFIT CONTRACTORS, R&D
($ Millions)

	FY1970		FY1971		FY1972	
	Amount	Rank	Amount	Rank	Amount	Rank
MIT	$ 26.8	1	$ 28.4	1	$ 20.3	1
Harvard U.	6.2	3	5.0	3	4.5	5
U. California-Berkeley	6.7	2	7.3	2	4.0	6
Smithsonian Instit.	5.9	4	4.5	7	3.9	7
Stanford U.	4.5	7	4.6	4	3.6	8
Nat'l Acad. Sciences	5.4	6	4.6	5	5.0	3
Princeton U.	3.9	8	3.4		3.0	
U. Corp. Atmos. Research	2.2		2.2		1.8	
Michigan U.	5.6	5	4.5	6	5.4	2
U. California-San Diego	3.5	9	3.9	9	4.6	4
California Instit. Tech.	3.2		4.1	8	3.4	9
Battelle Instit.	3.1		2.5		2.8	
Stanford Research Instit.	2.2				1.4	
U. Minnesota			2.9		2.6	
U. Maryland	3.3	10	2.2		2.3	
U. Chicago	2.8		3.5	10	2.8	
ITT Research Instit.	2.7		1.9		1.5	
U. California-L.A.	2.4		2.6		1.6	
U. Wisconsin	1.6		2.7		2.4	
U. Iowa	1.9		2.0		1.7	
New Mexico State U.	2.2				1.5	
Rice U.	1.9				1.0	
Amer. Instit. Aero & Astro	1.6				1.5	
U. Colorado					2.7	
U. New Hampshire					0.5	
U. Texas	2.9		2.4		2.1	
Columbia U.	1.9		2.3		2.7	
George Washington U.	1.6				0.9	
Purdue			2.7		1.4	
Aerospace Corp.			2.2		3.3	10
Johns Hopkins U.			2.2		2.8	
Cornell Aero Labs			1.9		0.4	

Source: NASA Annual Procurement Reports, FY1969-1972.

TABLE 11

R&D SCIENTISTS AND ENGINEERS
MAN-YEARS AND COST
BY SOURCE OF FUNDS AND FEDERAL AGENCY
Fiscal Year 1970

Industry	SIC Code	Total	Company	Federal			
				Total	DOD	NASA	All Other Agencies
		Man-years of R&D scientists and engineers					
TOTAL		369,900	231,400	138,500	93,400	28,700	16,400
Chemicals and allied products	28	42,200	38,700	3,500	1,100	(a)	2,300
Machinery	35	43,100	36,000	7,200	4,500	2,100	600
Electrical equipment and communication	36,48	97,700	50,700	47,000	33,000	7,200	6,800
Motor vehicles and other transportation equipment	371,373-79	24,200	19,500	4,700	3,400	(a)	(a)
Aircraft and missiles	372,19	83,000	20,400	62,600	42,600	16,100	3,900
Other industries		79,700	66,100	13,500	8,800	2,000	2,600
		Cost per R&D scientist or engineer					
TOTAL		$ 48,300	$ 43,500	$ 56,200	$ 55,200	$ 54,500	$ 64,800
Chemicals and allied products	28	42,900	42,000	53,700	43,600	(a)	58,700
Machinery	35	40,100	40,100	39,200	39,600	38,600	38,300
Electrical equipment and communication	36,48	44,300	40,700	48,100	45,500	41,400	68,200
Motor vehicles and other transportation equipment	371,373-79	61,000	63,200	51,700	57,400	(a)	(a)
Aircraft and missiles	372,19	62,300	54,300	65,000	64,300	64,700	73,300
Other industries		42,000	39,400	55,000	56,700	51,500	53,800

[a] Not separately available but included in total.

Source: National Science Foundation Survey 72-309, R&D in Industry, 1970.

DEFINITIONS AND TECHNICAL NOTES

Obligations - Represent the amounts for orders placed, contracts awarded, services received and similar transactions during a given period, regardless of when the funds are appropriated and when future payment of the money is required. The obligations cover all transactions from all funds available to the agency from direct appropriations, trust funds or special account receipts, corporate income or other sources.

Expenditures - Represent the total amounts for checks issued and cash payments made during a given period, regardless of when the funds were appropriated.

Outlays - Include expenditures plus net lending.

Research (Technology Base) Funds - Includes all R&D funds for basic scientific research and fundamental applied research which includes studies, investigations and minor developments pointed to user problem areas where the objective is to evaluate the feasibility of solution and determination of the fundamental parameters.

System Development Funds - Includes all R&D monies for programs involving research and development efforts directed toward mission objectives which usually involve development engineering and test of systems for either demonstration or production. In the DOD system acquisition process the major portion of system development dollars is basically covered by DCP's (Development Concept Papers) and PM's (Program Memorandum).

FFRDC's - Are R&D performing organizations exclusively or substantially financed by the Federal Government (at least 70 percent) that are supported by the Federal Government either to meet a particular R&D objective or, in some instances, to provide major facilities at universities for research and associated training purposes. The FFRDC is expected to have long-term relationships with its sponsoring agency--five years or more, and an average annual budget (operating and capital) of $500,000 or more.

Full-Time-Equivalent Number (R&D Scientists and Engineers) - The common demoninator for combined numbers of full-time employees and part-time employees.

Research, Development and R&D Plant (According to National Science Foundation) - This term includes all direct, indirect, incidental or related costs resulting from or necessary to research, development and R&D plant, regardless of whether the research and development are performed by a federal agency (intramural) or performed by private individuals and organizations under grant or contract (extramural). Research and development exclude routine product testing, quality control, mapping and surveys, collection of general-purpose statistics, experimental production and activities concerned primarily with the dissemination of scientific information and the training of scientific manpower.

a. Research is systematic, intensive study directed toward fuller scientific knowledge or understanding of the subject under study. In basic research the investigator is concerned primarily with gaining a fuller knowledge or understanding of the subject under study.

In applied research the investigator is primarily interested in a practical use of the knowledge or understanding for the purpose of meeting a recognized need.

b. Development is systematic use of the knowledge and understanding gained from research, directed toward the production of useful materials, devices, systems or methods, including design and development of prototypes and processes. It excludes quality control, routine product testing and production.

c. R&D Plant (or R&D facilities and fixed equipment, such as reactors, wind tunnels and radio telescopes) includes acquisition or construction of, major repairs to or alterations in structures, works, equipment, facilities or land, for use in R&D activities at federal or non-federal installations. Excluded from the R&D plant category are expendable equipment and office furniture and equipment. Obligations for foreign R&D plant are limited to federal funds for facilities located abroad and used in support of foreign research and development.

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