NATIONAL TECHNOLOGY SUPPORT

A Study of Research and Development Trends and Their Implications

AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.

National Technology Support

A Study of Research and Development Trends and Their Implications

Charts

Table

Appendix: Statistical Tables

Abstract

The direction of government and industry-supported research and development has undergone a gradual but significant shift over the past decade which is indicative of changing national policies and priorities. The current leveling trend in Federally-supported R&D raises serious questions about the future of the U.S. technological base. In view of the role advanced technology plays in long-term economic growth and in the security of the nation, the Aerospace Industries Association's (AIA) Aerospace Research Center has undertaken an examination of R&D activities and their implications for the future.

This first study provides an overview of both current and historical expenditure trends for research and development within the government and industry. Special attention is given to the allocation of Federal R&D, particularly within DOD and NASA, as these expenditures constitute the major portion of the Federal R&D effort. Basic data was drawn primarily from the National Science Foundation, the U.S. Budget, AIA, and other selected R&D studies.

Future reports in the R&D series will focus on such subjects as foreign R&D trends, independent research and development, constraints on innovation, and benefits of technology.

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.

Executive Summary

Much of the economic growth of the United States can be attributed to the level of scientific and technical resources applied to furthering technological advance. Moreover, national security and relative international position can be linked closely to the willingness of the government to allocate economic resources to the exploration and solution of sophisticated problems in the areas of defense and space exploration.

In view of the role attributed to advanced technology in economic growth and in national security, there now exists concern in many policy and professional circles over the current social and political attitudes surrounding the recent downturn in Federally-funded R&D and the viability of the nation as a leading economic and military power. For this reason the Aerospace Industries Association's (AIA) Aerospace Research Center has undertaken an examination of recent national research and development trends. Conclusions derived therefrom are intended to provide an insight into future national capabilities.

The following sub-headings summarize the principal findings derived from an examination of the data compiled during the study.

General Trends in National R&D

Total funding for research and development has doubled over the last decade, but this dramatic increase is somewhat misleading since total R&D expenditures remained essentially level after 1968. The annual growth rate of R&D declined sharply after 1966 as a result of declining Federal activity. While the growth rate in non-Federal funding, primarily industrial, remained fairly constant at about 9 to 10 percent annually, the Federal growth rate dropped sharply after 1966, from a previous average of 9 percent per year to 1 percent.

Because the Federal Government and industry account for more than 95 percent of the total national research and development funds, the relative share expended by each influences the direction of the national research effort. Recent shifts, plus the markedly different growth rates indicate changes in the type of research now being emphasized.

In broad terms, the major focus of industrial R&D is on applied research and development related to product improvement and to new-product development. By contrast, the Federal Government finances most of the nation's basic research and the high risk—high cost activity directed toward satisfying national military, economic, political and social needs. Although industry has established its technological capability to meet these demands, the financial requirements necessitate Federal initiation or sponsorship. Consequently, a reduction in Federal R&D funding produces a negative impact upon the overall advancement of highly sophisticated technology.

The impact of inflation, the higher costs associated with increasingly sophisticated technology and the fact that more complex technological advancements usually require longer leadtimes, suggest an even greater decline in the nation's research effort than the quantitative comparisons indicate.

Federal Support of R&D

Federal R&D expenditures declined after 1968, but the ratio of R&D to total Federal budget expenditures started declining after 1965, primarily as a result of budgetary pressures. The substantial reductions in defense, space, and nuclear programs, especially in applied research and in development, were not offset by commensurate increases in agencies other than DOD, NASA, and AEC.

Basic research continues to be supported largely by the Federal Government. However, the allocation among agencies also reflects shifting Federal priorities. The Mansfield Amendment, constraining DOD support of basic research may be symptomatic of new Congressional thinking regarding mission-oriented research. Of the major agencies supporting basic research, only DOD and AEC have declined significantly.

Applied research obligations have remained fairly constant since 1964, but shifts occurred in the allocation among agencies. DOD, HEW, and NASA still account for a major portion of the total share of applied research, however only the HEW share has increased, indicating a changing emphasis toward domestic programs.

Development programs continued to constitute the largest share of Federal R&D obligations, but new trends are evident in the relative share devoted to development, and in the allocation of development funding. The level of development activity by DOD and AEC has remained fairly stable since 1967; thus much of the recent downward trend in total development obligations is the result of the rapid decline in NASA obligations stemming from the phasing out of the manned lunar landing program. Total development obligations for agencies other than DOD, NASA, and AEC still amount to less than one billion dollars, indicating that the transfer of resources to other areas has not materialized to any significant degree.

The major factors influencing trends in the scope, nature and level of Federally-funded R&D include: budgetary constraints, the re-ordering of national priorities, reduced support for defense and space expenditures, growing criticism of technology, and the lack of established long-range national scientific and technological objectives.

Trends in Industrial R&D

Since 1960, industrial expenditures for R&D and the relative share financed by industry increased gradually, indicating the high priority attached to a consistent and continuing research capability. While industry finances slightly less than half the national research and development activity, industry performs more than 70 percent of the total. Prior to 1968, Federal contracts financed more than half the industrial performance of R&D and the recent shift here simply results from the changed level of support by the Federal Government and industry.

Five major industries (aerospace, electrical equipment and communications, motor vehicles, chemicals and allied products, and machinery) account for about 80 percent of all industrial R&D. The largest single industrial performer of R&D continues to be the aerospace industry, although its share declined from a peak of 37 percent in 1963 and 1964 to an estimated 30 percent in 1970.

Scientific and Technical Manpower

Investments in higher education, the level and nature of R&D expenditures, and the mobility of existing manpower, provide key indicators of the long-term scientific and technical capability of the nation. Additionally, lack of adequate consideration of the long-term relationship among various fields of science implies future imbalances due to the leadtime required in establishing different capabilities and in providing incentives to pursue certain disciplines.

CONCLUSIONS

In view of the findings and the quantitative data developed in this study, the following conclusions were derived.

- Recent trends in the national R&D effort reflect diminishing governmental leadership which could lead to an erosion of national scientific and technological capability.
- The continued growth of industrially-funded R&D, with major emphasis on product improvement and end-product development, and the leveling of Federally-funded R&D, indicate a significant shift in the over-all direction of the national R&D effort, resulting in a reduction of highly advanced technological projects traditionally financed by the Federal Government.
- The apparent lack of consideration of the long-term relationship among various fields of science implies future imbalances in scientific and technical manpower, due to the leadtime required for education and training.
- Current shifts in the allocation of Federal funds for basic and applied research are indicative of changing national priorities, which may be reflected in future development funding. Erosion in certain research areas could limit or predetermine future technological options.

These factors underscore the already recognized need to establish longer range R&D priorities, along with a well defined national technological strategy.

I. Introduction

Much of the economic growth of the United States can be attributed directly to the level of scientific and technical resources applied to furthering technological advance. Moreover, national security and relative international position can be linked closely to the willingness of the government to allocate money, scientific talents, and facilities to the exploration and solution of sophisticated problems in the areas of defense and space exploration.

In view of the role attributed to advanced technology in economic growth, in social improvement, and in national security, there now exists concern in many policy and professional circles over the current social and political attitudes surrounding R&D. Indeed, most informed sources, including government officials and industry representatives, believe that the viability of the nation as a leading economic and political power depends largely upon adequate support of R&D.

This paper is the first in a series directed toward examining this national concern. Chapter II sets the stage by reviewing trends in funding patterns and depicting the dramatic shift in national priorities over the last several years. Sources of funds and the mix of government-industry performance are analyzed. Chapter III identifies the level of Federal basic and applied research and development, by agency. Particular attention is devoted to DOD and NASA, as their expenditures constitute a major portion of Federal R&D. Chapter IV presents an analysis of the industrial contribution to the overall national R&D effort. Chapter V briefly addresses the major implications to the scientific and technical manpower base. Conclusions derived from this first study are presented in Chapter VI.

Subsequent studies in the R&D series will focus on such subjects as national benefits of a well-financed and properly balanced R&D program, an analysis of the numerous constraints to innovation, and an assessment of trends and policies of other nations in the areas of R&D.

II. National R & D Trends

An analysis of research and development (R&D) trends over the past decade reflects a reordering of priorities at the national level and a consequent change in the allocation of scientific and technological resources. Moreover, funding has remained level for the past several years. The implications of these trends are now receiving national attention, particularly in light of concern among policy makers about the future of the U.S. technology base.

[1] All expenditures and obligations are reported in current dollars unless otherwise indicated. Federal Government R&D expenditures and obligations are reported by fiscal year, industry by calendar year, and industry-government comparisons are in accordance with NSF reporting techniques (See Technical Notes). Total national R&D expenditures include all R&D expenditures by the Federal Government, industry, academic and other non-profit institutions.

A. Funding Patterns

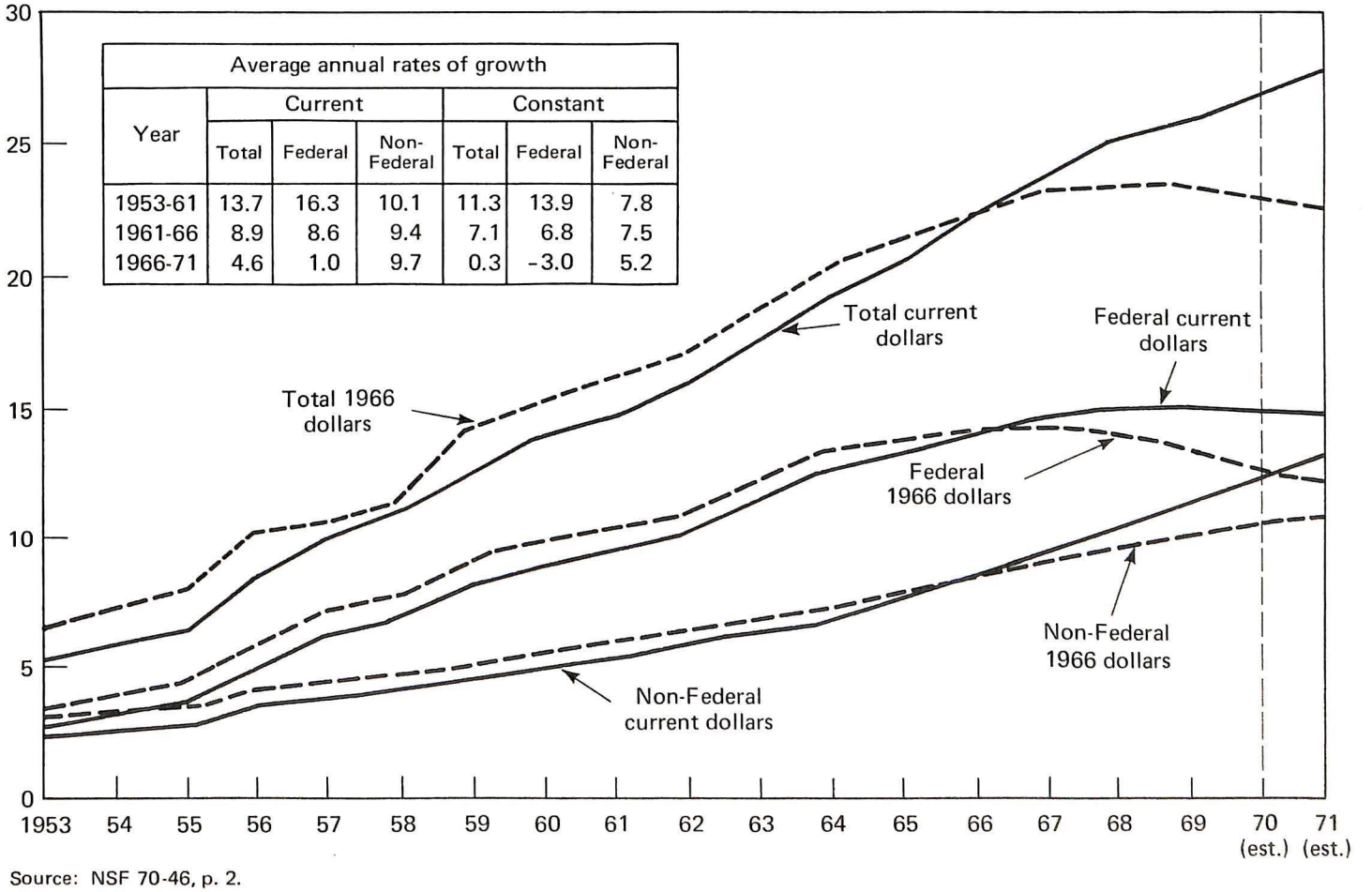
Total R&D expenditures doubled over the last decade, but the most rapid increase occurred from 1961 through 1966, when the average annual growth rate in R&D funding approached 9 percent.[1] Since 1966, the annual growth rate has slowed to 5 percent, as a result of the marked slowdown in Federally-funded R&D. Whereas non-Federally funded R&D increased from 9 percent annually in the first part of the decade to almost 10 percent per year since 1966, the Federal growth rate dropped sharply from 9 percent annually to only one percent (Chart 1).

The recent decline in the total R&D growth rate can be attributed to reduced Federal R&D expenditures, particularly in applied research and development associated with defense and space programs. These decreases have not been offset by

CHART 1
R&D FUNDING PATTERNS

Billions of dollars

Average annual rates of growth						
Year	Current			Constant		
	Total	Federal	Non-Federal	Total	Federal	Non-Federal
1953-61	13.7	16.3	10.1	11.3	13.9	7.8
1961-66	8.9	8.6	9.4	7.1	6.8	7.5
1966-71	4.6	1.0	9.7	0.3	-3.0	5.2



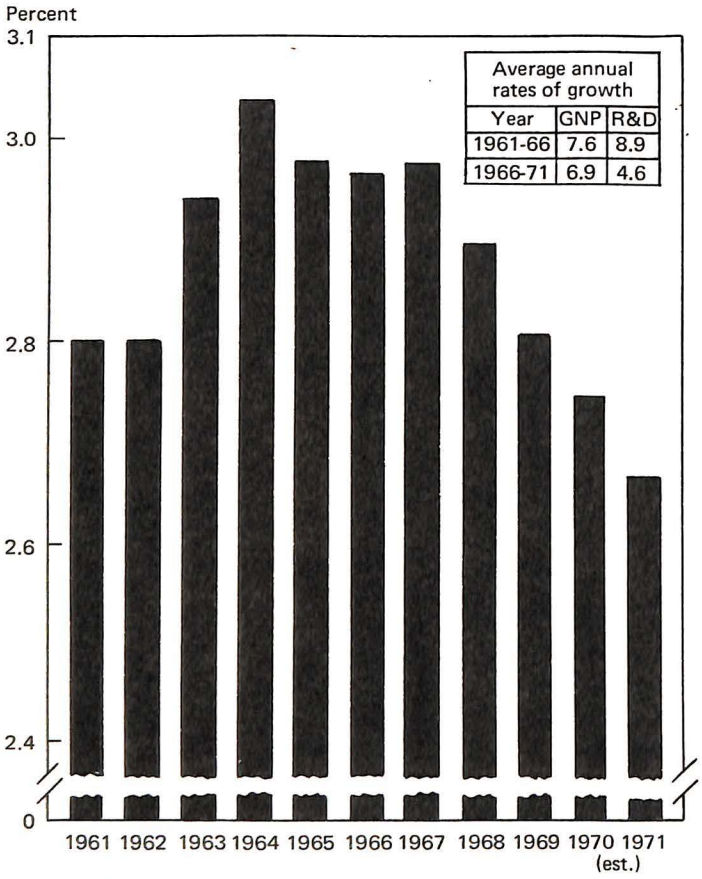
Source: NSF 70-46, p. 2.

commensurate increases in the level of R&D funding by other agencies. In constant 1966 dollars, the total R&D growth rate amounted to less than one-half percent per year since 1966.

The GNP/R&D ratio allows a broad comparison of the relationship of research activity to the national economy. From 1961 through 1966, increases in total national R&D outlays outpaced the growth in the Gross National Product (GNP) whereas from 1966 through 1971, the average annual growth rate of GNP exceeded that of R&D. R&D, as a percentage of GNP, reached a peak of around 3.0 percent in the mid-1960's and declined to about 2.7 percent in 1970 (Chart 2).

Several factors suggest an even greater decline in the nation's R&D effort than these comparisons indicate. The higher costs associated with increasingly sophisticated technology, as well as the fact that more complex technological advancements usually require longer leadtimes, suggest that the current low priority of R&D may have more serious long-term consequences.

CHART 2
R&D AS A PERCENTAGE OF GNP



Source: NSF 70-46, p. 1.

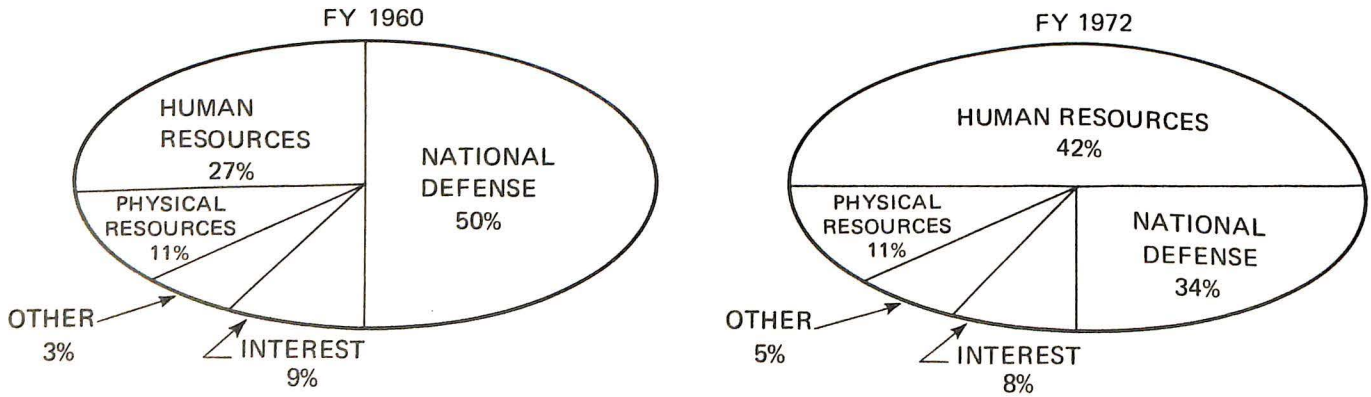
B. Changing Federal Priorities

Gradual shifts in national priorities and government spending are reflected in the changing allocation of Federal budget resources and in the recent downward trend and changing nature of Federal R&D expenditures (Chart 3). Although total Federal expenditures for human resources and national defense have continued to account for about 75 percent of the Federal budget, the relative share of defense has dropped from 50 percent in 1960 to a projected level of 34 percent by 1972, whereas the percentage allocated to human resources has increased from 27 percent to 42 percent over the same time period.

The change in Federal budget expenditures points up the gradual shift in total Federal spending from defense and space oriented programs toward domestic programs. Changes are evident in the relative share expended for defense, space, health, housing, and education.

The relationship of Federal R&D expenditures to total Federal outlays and the allocation of R&D funds among agencies and programs further highlight the recent changes in national priorities. Federal R&D expenditures, as a percentage of Federal budget outlays, reached a peak of about 13 percent in 1965, primarily as a result of significant increases in the National Aeronautics and Space Administration (NASA) R&D budget and then declined gradually to a present level of about 8 percent. From 1960 to 1965, increases in NASA R&D

CHART 3
CHANGING COMPOSITION OF THE FEDERAL BUDGET



Source: *The U.S. Budget in Brief,* FY 1972, p. 29.

TABLE 1

NATIONAL PRIORITIES AS REFLECTED IN BUDGET EXPENDITURES

FY 1960		FY 1965	
DEFENSE	49.8%	DEFENSE	41.9%
INCOME SECURITY	19.7	INCOME SECURITY	21.7
VETERANS	5.9	COMMERCE & TRANSPORTATION	6.2
COMMERCE & TRANSPORTATION	5.2	VETERANS	4.8
AGRICULTURE	3.6	SPACE	4.3
INTERNATIONAL AID	3.3	AGRICULTURE	4.1
NATURAL RESOURCES	1.1	INTERNATIONAL AID	3.7
HOUSING *	1.1	EDUCATION & MANPOWER	1.9
EDUCATION & MANPOWER	1.1	NATURAL RESOURCES	1.7
HEALTH	.8	HEALTH	1.5
SPACE	.4	HOUSING	.2
ALL OTHER	8.0	ALL OTHER	8.0

FY 1970		FY 1972	
DEFENSE	40.8%	DEFENSE	33.8%
INCOME SECURITY	22.3	INCOME SECURITY	26.5
HEALTH	6.6	HEALTH	7.0
COMMERCE & TRANSPORTATION	4.7	COMMERCE & TRANSPORTATION	4.8
VETERANS	4.4	VETERANS	4.6
EDUCATION & MANPOWER	3.7	EDUCATION & MANPOWER	3.8
AGRICULTURE	3.2	AGRICULTURE	2.5
SPACE	1.9	HOUSING	2.0
INTERNATIONAL AID	1.8	NATURAL RESOURCES	1.9
HOUSING	1.6	INTERNATIONAL AID	1.8
NATURAL RESOURCES	1.3	SPACE	1.4
ALL OTHER	7.7	ALL OTHER	9.9

* [ ] Identifies areas of significant change.

Source: The U.S. Budget in Brief, FY 1972, p. 29.

tended to offset the variations in the level of the Department of Defense (DOD) R&D.

Until 1965, the combined total of DOD, NASA, and the Atomic Energy Commission (AEC) R&D expenditures accounted for nearly 90 percent of the total Federal R&D budget. Part of the disparity in R&D expenditures among these three agencies and all other agencies can be attributed to the high costs of development associated with complex defense and space programs. With the completion of the development phase of the lunar space program and reductions in the level of DOD and AEC R&D, the FY 1970 share of DOD, NASA, and AEC dropped to about 82 percent. The downward trend in the total share of these agencies continues to prevail in the FY 1972 budget request.

These emerging trends in Federally funded R&D are the result of several factors, some of the major ones being:

1. Budgetary constraints on all controllable elements of Federal spending to combat inflation, resulting in increased Congressional pressure for justifying R&D;[2]
2. The reordering of national priorities which has intensified competition among defense-space related programs and urban and other domestic programs for limited funds;
3. A growing criticism of technology;
4. The continuing pressure for decreasing defense and space oriented expenditures, and
5. The failure to establish long-range national scientific and technological objectives which could lead to a consistency of effort related to national priorities.

[2] "In 1971, built-in costs for relatively uncontrollable programs will account for an estimated 69% of total outlays. The comparable amounts for 1969 and 1970 are estimated at 64% and 66%, respectively—showing a growth in the proportion of outlays which is relatively uncontrollable. This fact makes it difficult for the budget to reflect fully even significant changes in priorities in the short run."

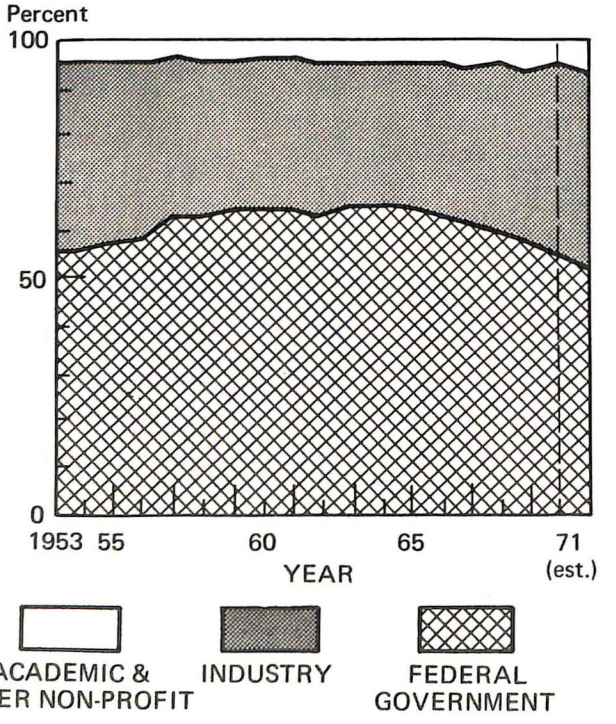
Hearings on NATIONAL SCIENCE POLICY, U.S. House of Representatives, Committee on Science and Astronautics, 1970, p. 54, hereafter referred to as National Science Policy Hearings.

C. The Federal Government/Industry R&D Mix

Government and industry expenditures on R&D dominate the research effort of the nation, accounting for approximately 96 percent of the total. Academic and other non-profit institutions finance the remainder. Consequently national R&D trends are determined largely by the allocation of funds within industry and government-sponsored research and development. As a result of the increase in company-funded R&D and concomitant decline in Federal R&D, changes have occurred in the nature, level, and orientation of total R&D.

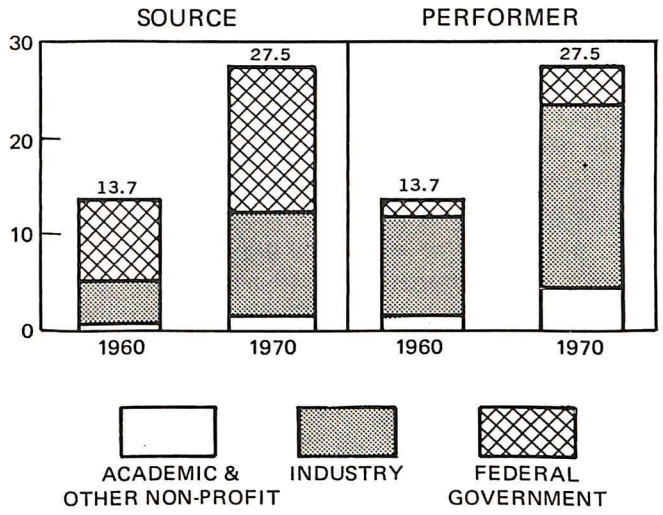
Federal expenditures have increased from roughly 9 billion dollars in 1960 to almost 15 billion dollars in 1970, while industry expenditures went from about 5 billion dollars to 11 billion dollars (Appendix, Table 2). The Federal share, as a percentage of the total, reached a high point of 65 percent in 1963 and 1964, and declined to 55 percent in 1970. The industrial share has exhibited an opposite trend in moving from a low of 31 percent in 1963 and 1964 to 41 percent in 1970 (Chart 4). Because industrial R&D focuses primarily upon development, this shift has implications for the allocation of funding among basic research, applied research, and development.

CHART 4
SOURCE OF R&D FUNDS



Source: NSF 70-46, p. 36.

CHART 5
SOURCE OF R&D FUNDS AND PERFORMANCE OF R&D CONTRACTS
(Billions of dollars)



Source: BMI, *Probable Levels of R&D Expenditures in 1971,* December 1970, p. 2.

Industrial firms continue to account for roughly 70 percent of the performance of total R&D, indicating a drop from 77 percent in 1960.[3] While industrial performance of R&D has remained at a fairly constant percentage of the total since 1965, the source of funding has shifted (Chart 5). Prior to 1968, the Federally-financed share of industrial R&D exceeded that of industry. Now, company financing of industrial R&D exceeds that of the government, reflecting the impact of reductions in defense and space oriented R&D.

Chapters III-V of this study address specific changes in the level and orientation of Federal and industrial R&D, and technical manpower resources.

[3] Industrial performance of R&D includes all company-sponsored research and development, and work done by a company on Federal R&D contracts or subcontracts and R&D portions of procurement contracts and subcontracts. The source of funding separates the Federally-financed and industrially-financed shares.

III. Federal R & D

A. General Trends

Historically, government participation in or initiation of technological projects occurred when the scale of risk or investment requirements exceeded the capabilities of private enterprise, when national military, economic, political, or social requirements dictated such action, or when it was apparent that there was little or no profit incentive for industry to make an independent commitment. This participation implied Federal support of long-term economic growth and security of the nation. For example, with respect to the trade balance, the U.S. currently has a competitive advantage in high technology items such as aircraft and computers. This is largely the payoff from previous Federal investments in basic and applied research in these areas. It has been suggested that "U.S. exports of high technology items might retrieve our balance of trade lost in low technology items. Thus a national policy designed to support the national objectives of a favorable balance of trade would be one which would enhance production of high technology items."[4]

Recent trends indicate diminishing governmental leadership in the nation's R&D effort. This has a direct effect on the initiation of certain high risk—high cost technologically oriented programs, which cannot be independently financed by industry.[5] This is true not only with defense and space programs, but also with domestic programs, where the markets are dispersed, small or undeveloped. The uncertainty of forthcoming Federal support for R&D in defense and space programs and the seeming lack of direction in domestic programs, underscore the already recognized need for establishing national science policies and priorities.[6]

While it is not possible to establish a dollar value for continuity and consistency of Federal R&D, these factors exert a profound influence on future R&D capabilities of the country. With a crisis-oriented approach to R&D, total efforts are dissipated both in the start-up process and in the break-up of experienced teams. Dr. Philip Handler pointed out in the National Science Policy hearings that "Most scientific ventures require leadtime for planning, and subsequent decisions to terminate them arbitrarily and abruptly, for whatever reason, are highly wasteful."[7] In contrast, a long-term commitment to maintain a continuing R&D effort at the Federal level, in effect, would guarantee a technological base capable of responding to many problems of national concern.

Federal R&D expenditures have declined from a peak of 17 billion dollars in 1968 to less than 16 billion dollars in 1970 (obligations reached a high point in 1967, indicating the slight lag in expenditures). Obligations for applied research, which can be considered indicative of future development obligations, started declining at the same time. The decline in Federal R&D dollars stems primarily from the decreased spending in applied research and in development associated with defense and space programs, which dominated Federal R&D for more than a decade. The recent decreases in DOD/NASA/AEC R&D have not been offset by commensurate increases in other agency funding.

Comparisons of R&D expenditures with total budget outlays and with GNP further underscore the declining priority of Federal R&D. R&D and R&D plant expenditures, as a percentage of total budget outlays, have declined from a high point of 12.6 percent in 1965 to 8.0 percent in 1970. The 1971 and 1972 budgets indicate an additional drop in this ratio to about 7 percent, which is lower than the 1960 relationship (Chart 6 and Table 3). Prior to 1966, the rate of annual increases in R&D exceeded that of increases in total budget outlays, although 1965 actually marked the beginning of the slowdown in the Federal R&D growth rate.

The proposed FY 1972 budget indicates an increase of less than half a billion dollars in Federal R&D expenditures. The proposed increase of about $1.2 billion in obligations may

---

[4] Dr. Myron Tribus, Assistant Secretary of Commerce for Science and Technology (Former). National Science Policy Hearings, p. 118, and pp. 134-35.

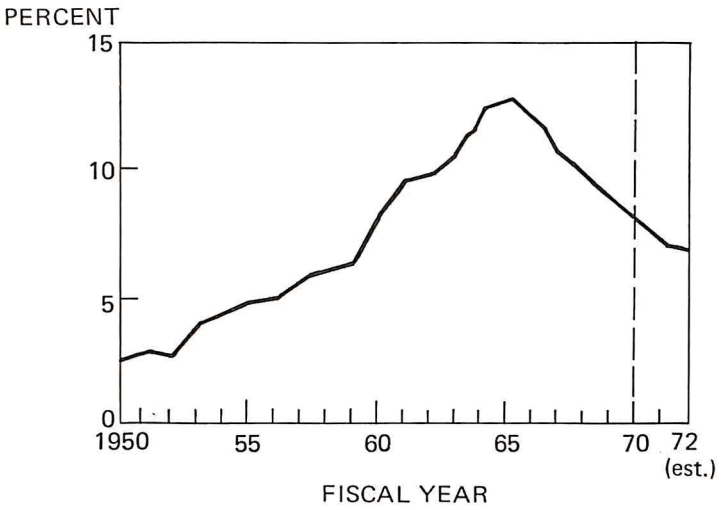
[5] ". . . . in some sense we have in this country a state of technological underambition. There are certainly many more needs and opportunities that we can identify, very concrete ones, than we can bring to fruition.

To bring those to fruition and to make a program out of them for the future must be done with the cooperation of industry and Government. Neither industry nor Government can do it by themselves." Dr. Edward E. David, Jr., Science Advisor to the President, Press Conference at San Clemente, California, April 1, 1971.

[6] Dr. Philip B. Handler, President, National Academy of Sciences, has stated that "the time could not be more propitious, the moment more appropriate, for a searching inquiry into Federal-science relationships. A concatenation of circumstances warrants that statement: (1) substantial changes have been made in the organization of some branches of the executive form of government that deal with science; (2) the Mansfield amendment which limits the manner in which research-supporting funds may be utilized by the Department of Defense has begun to influence not only that department but the behavior of other agencies of the Government as well; (3) Federal funding for fundamental studies has remained essentially plateaued in absolute dollars for four consecutive fiscal years while, in constant dollars, such funding has declined by perhaps 25 percent; (4) the appropriation to the National Aeronautics and Space Administration has been reduced significantly and one frequently hears that Federal military and space expenditures for R&D are to be reduced for some years to come; (5) the nation seems determined to mitigate the damage which has been done to our natural environment, but flounders in the attempts; (6) our Nation is engaged in the painful exercise of assessing and reassembling our priorities; (7) and our country now seems uncertain in what light, and with what resolution, it should view the pace of future scientific progress." National Science Policy Hearings, pp. 84-5.

[7] National Science Policy Hearings, p. 90.

CHART 6
FEDERAL R&D AND R&D PLANT EXPENDITURES
(As a percentage of total budget outlays)



Source: Appendix, Table 3.

indicate a slight reversal of the leveling trend in Federal R&D support. In other words, expenditures are estimated to increase by about 3 percent, whereas obligations are projected to increase by about 8 percent. Although DOD will receive the greatest dollar increase, substantial percentage increases are projected for transportation, law enforcement, environmental problems, and cancer research.

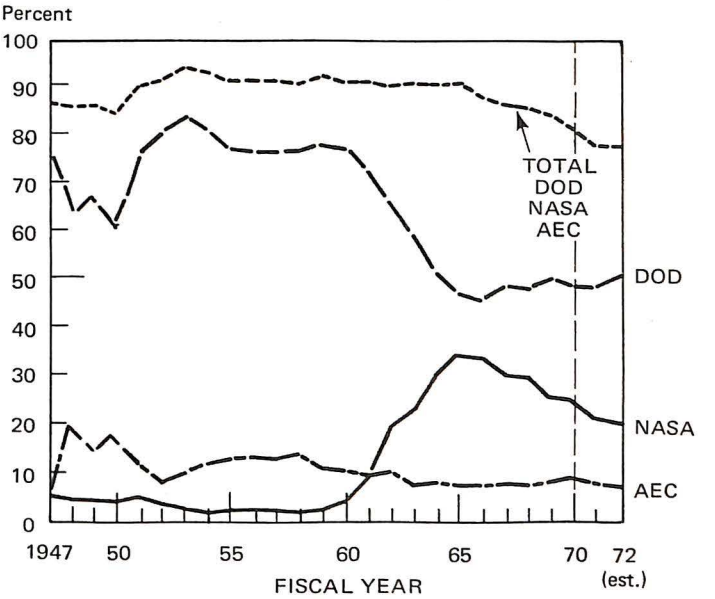
B. Agency Trends

From 1951 through 1964, the combined total obligations for DOD, NASA, and AEC R&D accounted for nearly 90 percent of the total Federal R&D budget. Since 1964, their combined share declined by 1 to 2 percent per year. These three agencies are the only ones with projected obligations for 1971 at levels lower than 1967. From 1967 through 1970, total DOD/NASA/AEC obligations declined by almost 2 billion dollars. Although the proposed increase for DOD R&D obligations in FY 1972 is about 900 million dollars, the total share of these agencies may drop to about 76 percent, which is lower than any previous World War II share (Chart 7).

The decline in DOD, NASA, and AEC R&D obligations has serious implications for future research potential and advanced technology capability, as all three agencies support programs that call for scientific endeavors of the most advanced nature. While the funding share among agencies shifted in the first part of the decade, the overall effort guaranteed the maintenance of certain technological capabilities. Now the erosion in the DOD/NASA/AEC obligations, along with the impact of inflation, and the apparent failure of the Federal Government to draw upon the existing scientific base in new programs initiated by other agencies may threaten the long-term R&D capability of the nation.

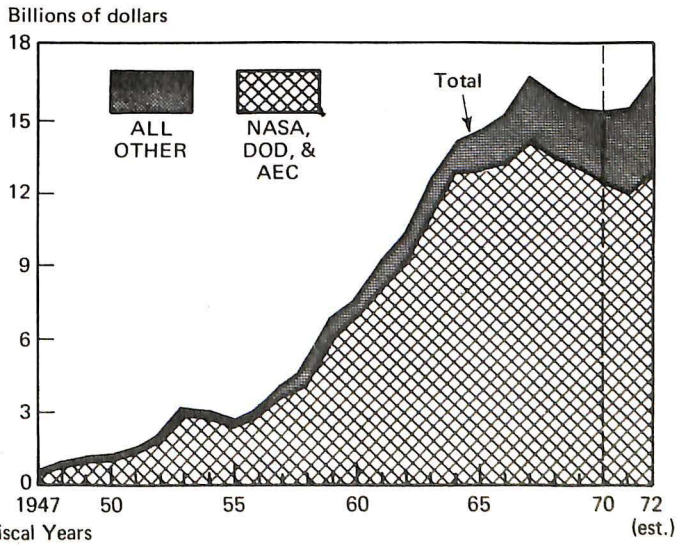
Although projected increases in FY 1972 R&D obligations suggest a slight change from the leveling trend of the past few years, the increase is considered insufficient to offset the effects of continued inflation. Additional dissipation of Federal research and development may occur through the spreading of R&D funding across more agencies and programs (Chart 8).

CHART 7
FEDERAL R&D OBLIGATIONS, BY SELECTED AGENCIES FY 1947-72
(Percentage Share)



Source: Appendix, Table 7.

CHART 8
FEDERAL R&D OBLIGATIONS, BY AGENCY FY 1947-72

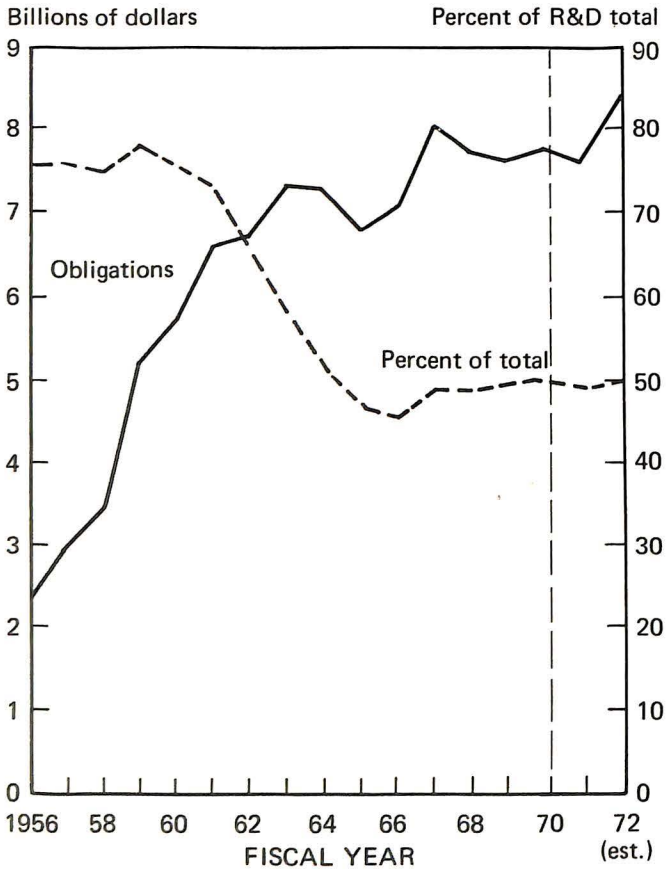


Source: Appendix, Table 6.

1. Department of Defense (DOD)

Since 1967, DOD's share appears to have stabilized at about 50 percent of the total Federal R&D budget (See Appendix, Tables 4-7). Modest increases have been proposed for DOD R&D in FY 1972, but the proposed FY 1972 obligations are only slightly higher than the previous peak of about 8 billion dollars in FY 1967. Although DOD obligations increased steadily from 1960-63, the percentage actually started declining in 1960, and then leveled off after 1967 (Chart 9). Significant reductions were made in the funding for astronautics and missiles. These declines were offset to some extent by increases in aircraft R&D.

CHART 9
TRENDS IN DOD R&D OBLIGATIONS
FY 1956-72

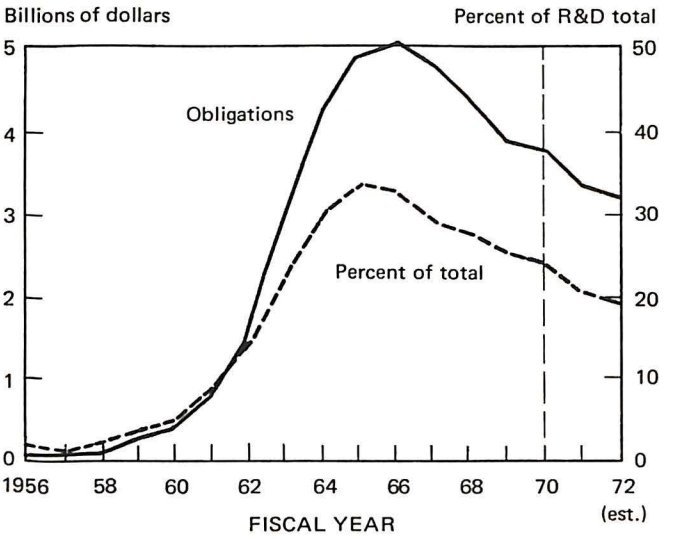


Source: Appendix, Tables 6 and 7.

2. National Aeronautics and Space Administration (NASA)

From 1960 through 1963, during the intensive buildup of the post-Sputnik period, NASA obligations almost doubled each year. After 1966, NASA R&D obligations declined sharply as a result of the slowdown of the Apollo manned lunar landing program. Over the decade, NASA's percentage share climbed from 5 percent in 1960 to a high of 34 percent in 1965 and then down to 25 percent by 1970. R&D obligations have dropped from a peak of about 5 billion dollars in 1966 to less than 4 billion dollars in 1970. It appears that the rapid downward trend in NASA R&D obligations may slow in FY 1972, with the NASA R&D budget stabilizing at a projected 19 percent of the FY 1972 Federal R&D budget (Chart 10). In the early 1970's, NASA's R&D effort will focus on unmanned missions, aspects of the space shuttle program, satellite capabilities, and selected aircraft technologies.

CHART 10
TRENDS IN NASA R&D OBLIGATIONS
FY 1956-72

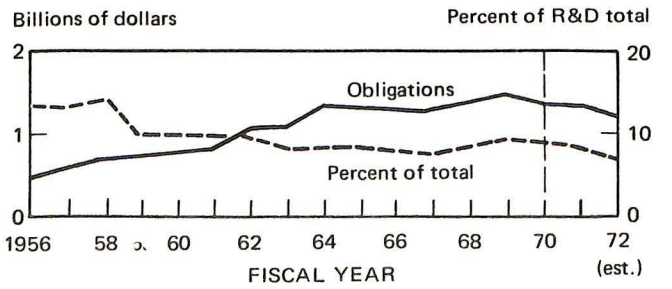


Source: Appendix, Tables 6 and 7.

3. Atomic Energy Commission (AEC)

Since 1960 AEC R&D obligations have remained fairly constant, at about 8 to 10 percent of the total Federal R&D obligations (Chart 11). AEC obligations have amounted to slightly more than one billion dollars per year since 1964. This pattern is expected to persist through the early 1970's, indicating minor reductions in obligations. Most of the decline will be in obligations for facilities, but some reductions are expected in physical and biomedical research, and in weapon and reactor development.

CHART 11
TRENDS IN AEC R&D OBLIGATIONS
FY 1956-72

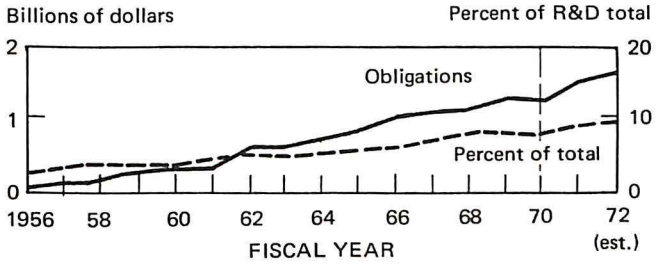


Source: Appendix, Tables 6 and 7.

4. Department of Health, Education and Welfare (HEW) and All Other Agencies

Agencies other than DOD, NASA, and AEC have increased their combined share of obligations from 9 percent in 1960 to 18 percent in 1970. Of the other agencies, HEW R&D has made substantial gains over the past decade, increasing from 4 percent of the Federal R&D expenditures in 1960 to 8 percent in 1970, which constitutes a four-fold increase in dollar funding, from $0.3 billion to about $1.3 billion (Chart 12). The proposed FY 1972 budget indicates further increases, to about 10 percent of the Federal R&D budget or more than 5 times the dollar amount obligated to HEW in 1960. The emphasis on biomedical research and development will continue, with a large portion of HEW funds going to the National Institutes of Health (NIH).

CHART 12
TRENDS IN HEW R&D OBLIGATIONS FY 1956-72



Source: Appendix, Tables 6 and 7.

Indicative of the changing trends in Federal R&D obligations in the 1970's is the fact that HEW will surpass the AEC in annual R&D obligations. Obligations for all other agencies amount to less than 2 billion R&D dollars, suggesting stiff competition among other agencies for the remaining Federal R&D dollars. Furthermore, wide dispersion of these dollars among several agencies probably is the principal factor that prevents the establishment of an effective R&D program plan for these agencies.

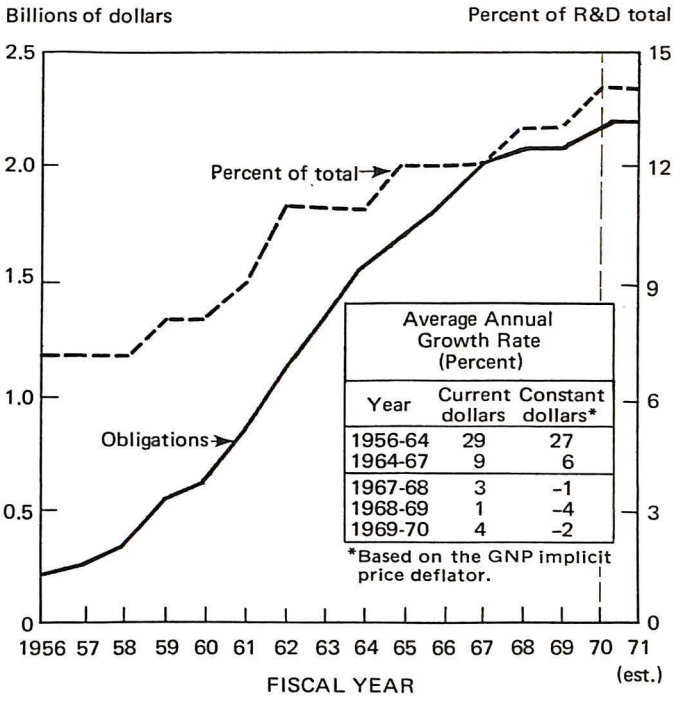
C. Research and Development Mix

1. Basic Research

Basic research continues to be supported largely by the Federal government, however, the allocation among agencies has changed since 1960, indicating a gradual shift in Federal priorities. Even with a gradually rising percentage share of basic research, and close to a four-fold increase in obligations from about half a billion dollars in 1960 to more than 2 billion dollars in 1970, basic research still accounted for only 14 percent of the Federal R&D in 1970 (Chart 13).

Five agencies, NASA, HEW, AEC, the National Science Foundation (NSF) and DOD accounted for nearly 90 percent of the 1970 Federal basic research obligations (Appendix, Tables 9-A and 9-B). In the 1970's, a slightly larger share of Federal R&D may be devoted toward increasing basic research obligations for HEW and NSF research. DOD support of basic research has been constrained in that funds appropriated to DOD research must have "in the opinion of the Secretary of Defense, a potential relationship to a military function or operation."[8] It has been suggested that this change reflects congressional interest in curtailing mission-oriented research, as well as recent budgetary constraints which have undermined Federal support of R&D.[9]

CHART 13
TRENDS IN FEDERAL BASIC RESEARCH OBLIGATIONS FY 1956-71



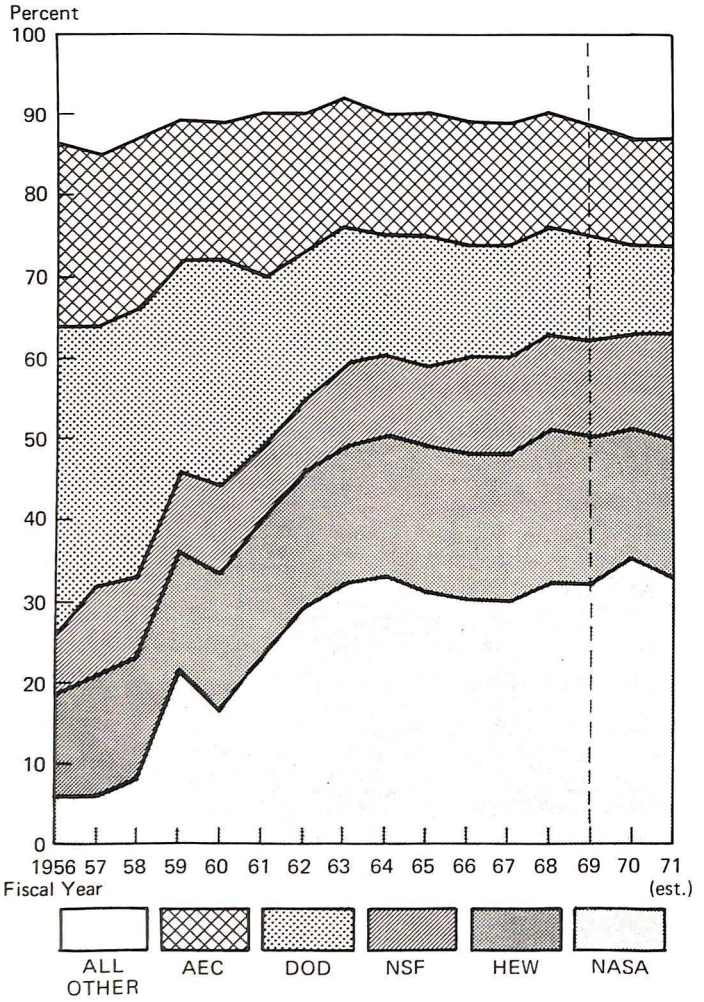
Source: NSF 70-38, pp. 8 and 238.

The greatest growth has occurred in NASA basic research. From 1963 through 1970, NASA basic research obligations have accounted for about one-third of the total. HEW and NSF obligations for basic research also have increased since 1960 and accounted for 16 and 12 percent, respectively, by 1970. Of the five key agencies financing basic research, only DOD and AEC have declined (Appendix, Table 9-A). Whereas DOD and AEC accounted for 60 percent of the basic research total in 1956 and about 45 percent in 1960, their total share had dropped to 24 percent in 1970. Most of this decline is a result of the sharp drop in the DOD share, from a high point of 38 percent in 1956 to a 1970 level of 11 percent (Chart 14).

[8] Public Law 91-441, October 7, 1970, p. 3.

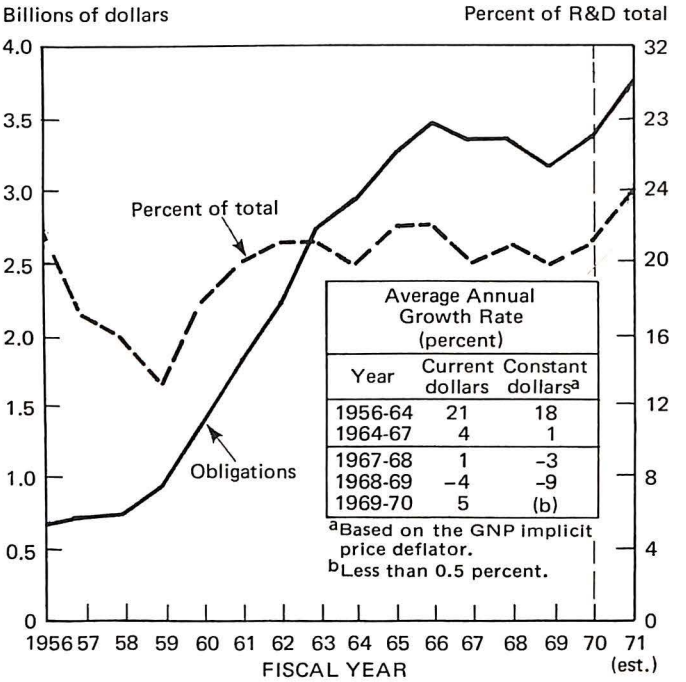
[9] Rodney Nichols, "Mission-Oriented R&D," SCIENCE, Vol. 172, April 2, 1971, p. 29.

CHART 14
AGENCY TRENDS IN OBLIGATIONS FOR BASIC RESEARCH FY 1956-71



Source: Appendix, Tables 9-A and 9-B.

CHART 15
TRENDS IN FEDERAL APPLIED RESEARCH OBLIGATIONS FY 1956-71



Average Annual Growth Rate (percent)		
Year	Current dollars	Constant dollars[a]
1956-64	21	18
1964-67	4	1
1967-68	1	-3
1968-69	-4	-9
1969-70	5	(b)

[a] Based on the GNP implicit price deflator.
[b] Less than 0.5 percent.

Source: NSF 70-38, pp. 16 and 238.

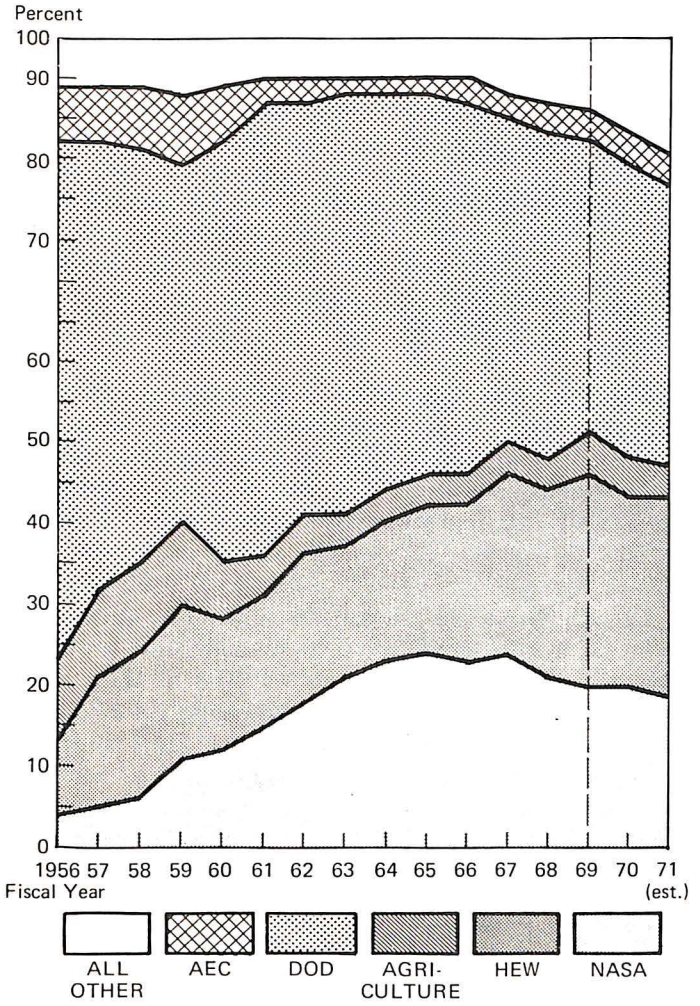
2. Applied Research

Applied research obligations have remained fairly constant at slightly over 3 billion dollars annually since 1964. As a percentage of Federal R&D, applied research has fluctuated between 20 and 22 percent of the total since 1960. The FY 1971 obligations, however, indicate an increase of almost half a billion dollars bringing applied research up to 24 percent of the total. But the projected increase in the applied research share reflects the decline in the Federal share devoted to development, rather than an increase in applied research obligations (Chart 15).

Although the applied research total remained fairly constant after 1964, significant dollar and percentage shifts occurred in the allocation among agencies. DOD, HEW, and NASA still account for a major portion of the total, but only HEW has increased its share since 1964, primarily as a result of increased NIH obligations (Appendix, Tables 10-A and 10-B and Chart 16). From 1964 through 1970, DOD and NASA obligations declined by about $300 million whereas HEW obligations increased by about $300 million. For the first time, NASA applied research obligations dropped below basic research obligations, as a result of the reduction in the level of funding for the manned space flight program and the progression of unmanned satellite programs to the development phase.

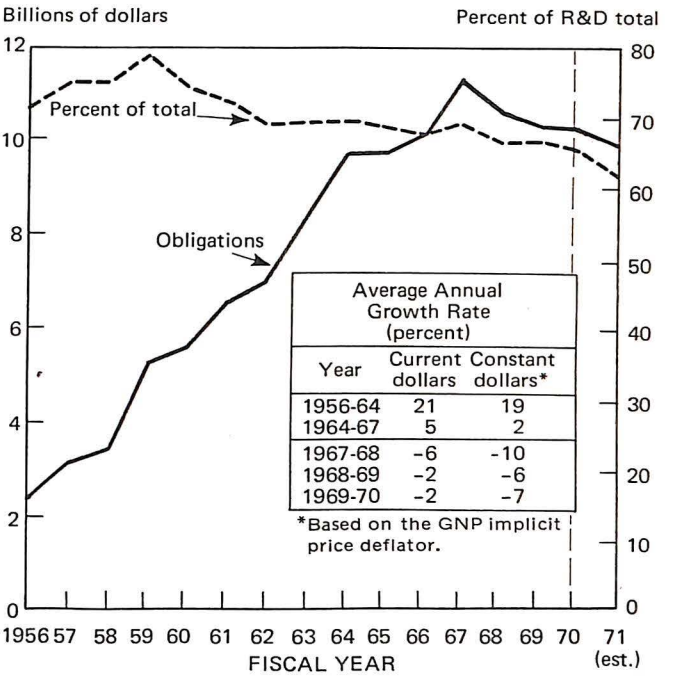
In the future, applied research funds are expected to be devoted increasingly toward domestically-oriented programs such as housing, transportation, pollution control, and health. Changes in the emphasis of basic and applied research probably are indicative of future trends in development funding.

CHART 16
AGENCY TRENDS IN OBLIGATIONS FOR APPLIED RESEARCH FY 1956-71



Source: Appendix, Tables 10-A and 10-B.

CHART 17
TRENDS IN FEDERAL DEVELOPMENT OBLIGATIONS FY 1956-71



Average Annual Growth Rate (percent)

Year	Current dollars	Constant dollars*
1956-64	21	19
1964-67	5	2
1967-68	-6	-10
1968-69	-2	-6
1969-70	-2	-7

*Based on the GNP implicit price deflator.

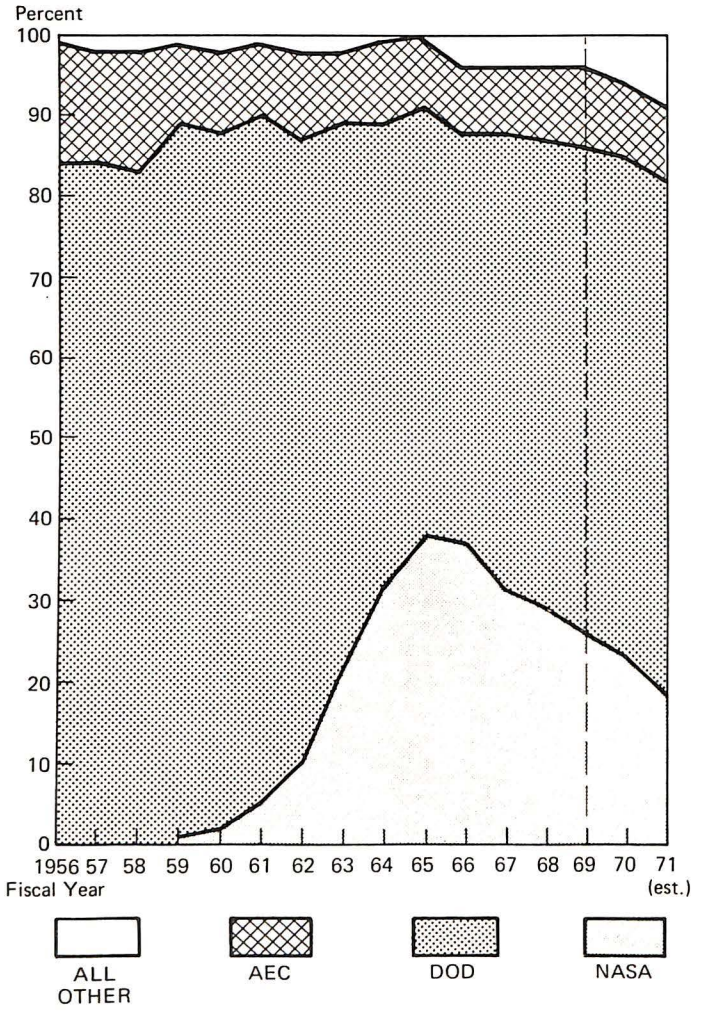
Source: NSF 70-38, pp. 23 and 238.

3. Development

Development programs continue to dominate the Federal R&D obligations, but new patterns are evident in the relative share devoted to development, and in the allocation of development funding. As a percentage of Federal R&D, development obligations were down from a peak of 79 percent in 1959 to 65 percent in 1970 (Chart 17).

Although the total DOD, NASA and AEC share remained fairly constant, the relative share of DOD and NASA development obligations shifted significantly from 1960 through 1970 (Appendix, Table 11). NASA obligations increased from 100 million dollars in 1960 to more than 2 billion dollars in 1970, while DOD obligations increased about 1 billion dollars from about 5 billion to slightly more than 6 billion. In percentage shares, NASA went from 2 percent in 1960, to a peak of 38 percent in 1965 and down to 23 percent in 1970. DOD declined from 86 percent in 1960 to 62 percent in 1970. But much of the recent downward trend in total development obligations is a result of phasing out NASA's manned lunar landing program. From the peak levels of 1965-66, NASA development obligations declined more than 1 billion dollars by 1970, which exceeded the total decline in Federal development dollars (Chart 18).

CHART 18
AGENCY TRENDS IN OBLIGATIONS FOR DEVELOPMENT FY 1956-71



Source: Appendix, Table 11.

From 1960 to 1966, DOD development obligations, as a percentage of the total, declined steadily, but the decline was offset in part by increases in NASA obligations. Since 1967, DOD has shown little change in total obligations for development, although the allocation among programs changed. There is increasing evidence that DOT and HEW will allocate larger amounts of their total R&D to development. However, the total development obligations for agencies other than DOD, NASA, and AEC still amount to less than one billion dollars. Consequently, the much talked about transfer of technological manpower and skills to other areas has not materialized to any significant degree. But the projected budgets for FY 1971 and 1972 indicate some acceleration of "other agency" development expenditures, which may result in additional diversion potential.

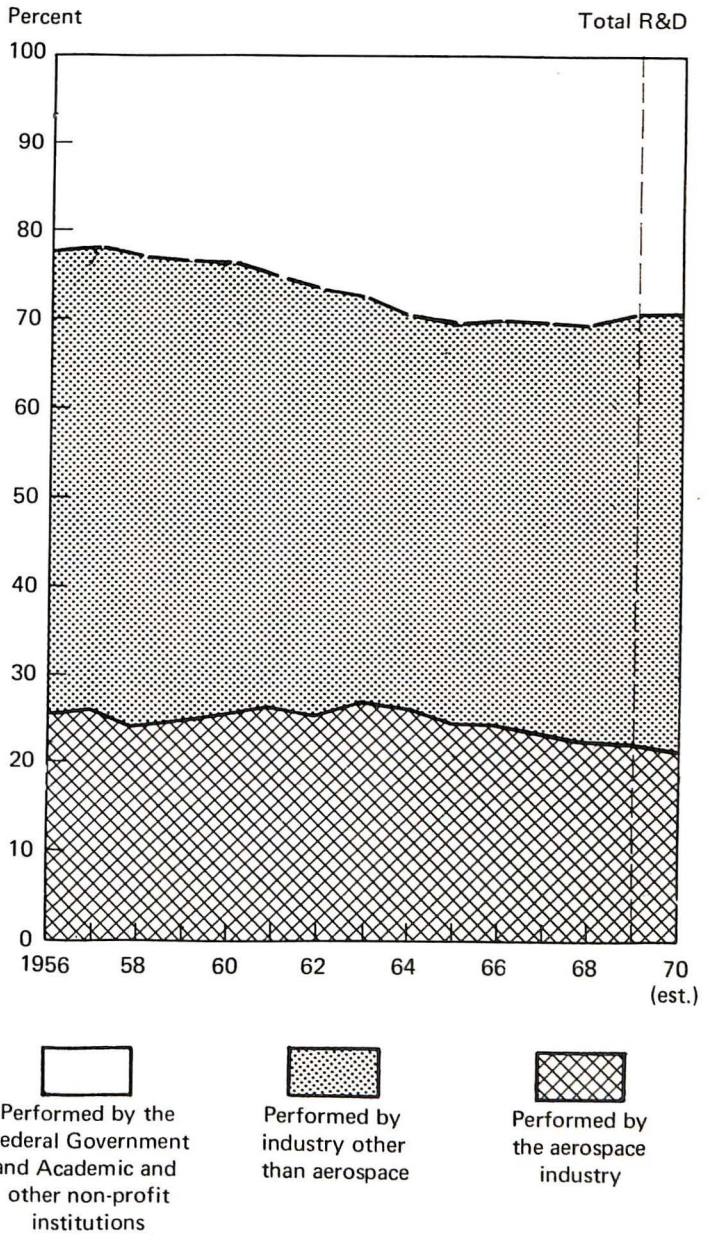
IV. Industrial R & D

Next to the Federal Government, industry finances the largest share of R&D, with academic and other non-profit institutions accounting for less than five percent of the total. Historically, industrial research and development differs from the Federal Government in that a considerably larger portion of the total is devoted to development (about 80 percent) and a smaller amount to basic research (about 4 percent). The relative shares for applied research are roughly the same (Appendix, Table 14).

Since the mid-1960's, industrial expenditures for R&D and the relative share financed by industry increased gradually, indicating the priority attached to a consistent and continuing research capability. As early as 1964, Federal funds contracted to the industrial sector, particularly aerospace,[10] started declining (Appendix, Tables 13 and 15). Although company-financed R&D increased steadily, it failed to take up the slack created by reductions in Federal R&D. According to one estimate, R&D financed by industry, is expected to increase from 1969 to 1973 by about 10 percent per year versus a projected 1.2 percent per vear increase in Federal financing of industrial R&D.[11] Obviously this shift in expenditures suggests a change in R&D priorities at the national level, partly as a result of Federal budget constraints, and a consequent change in the total R&D program.

Total industrial performance of R&D (company-financed and Federally-financed R&D performed by industry) has amounted to about 70 percent of the national R&D effort since 1963 (Chart 19). This reflects a drop from a peak of 78 percent in 1957. With the recent increase in company-financed R&D, the industrial performance share is rising gradually (Appendix, Table 13). From the mid-1950's through 1967, Federal contracts financed more than half the industrial performance of R&D. In 1970, Federal R&D contracted to industry declined to 43 percent of the industry total, compared to a peak of 59 percent in 1959 (Appendix, Table 13). Projections indicate that by 1973, the government share may drop to 37 percent.[12]

CHART 19
PERFORMANCE OF R&D
1956-70
(Percentage Share)



Source: Appendix, Tables 12 and 15.

Over the last decade, the following industries have accounted for more than 80 percent of all industrial R&D performance: (1) aerospace, (2) electrical equipment and communications, (3) motor vehicles, (4) chemicals and allied products, and (5) machinery. Only the first two continue to

[10] No clear-cut definition exists for the aerospace sector, inasmuch as many companies from other manufacturing sectors (such as communications equipment) are indirectly involved in aerospace-related activities. Although efforts are being made to refine the definition, aerospace information cited in this paper refers to the broad category of "aircraft and missiles" (including spacecraft), as defined by the National Science Foundation. All industry information is based upon the NSF Industry Surveys and the McGraw-Hill estimates for 1970-73. Differences in Federal and industry reporting stem from the fact that Government agencies report the entire cost of an R&D contract to research and development, while firms do not count off-the-shelf items as part of R&D. Industry reports are by calendar year.

[11] McGraw-Hill Survey "Business' Plans for Research and Development Expenditures, 1970-1973," p. 2.

[12] McGraw-Hill Survey, p. 2.

finance more than half their R&D efforts with Federal contract funds, although aerospace companies have increased their company share of the funding by more than 10 percentage points since 1964 (Appendix, Table 15).

These two industrial sectors, however, are unique in several respects. Because of their sophisticated and highly advanced technological content, the ratio of R&D scientists and engineers to total employees in these industries exceeds that of all other industries (Chart 20). Whereas the all-industry ratio has remained fairly stable since the mid-1960's, significant reductions have been made in aerospace, despite increased company-financed R&D.

Research and development, as a percentage of net sales, also is highest in these two industries (Chart 21). In 1968, the all-industry ratio was 4 percent while the ratio in aerospace was over 19 percent and electrical equipment and communication about 8 percent. Company-financed R&D, as a percentage of net sales, also was highest in aerospace, almost 4 percent versus a 2 percent total for all industries (Appendix, Table 16).

Finally, the three major Federal R&D contracting agencies have relied almost exclusively upon these industrial sectors for R&D in defense, space, and atomic energy. Consequently, the reductions in DOD and NASA R&D, in particular, have created a severe curtailment of R&D activities within these industries and industry assumption of an increasingly larger share of R&D has not compensated for the reduced level of Federal expenditures.

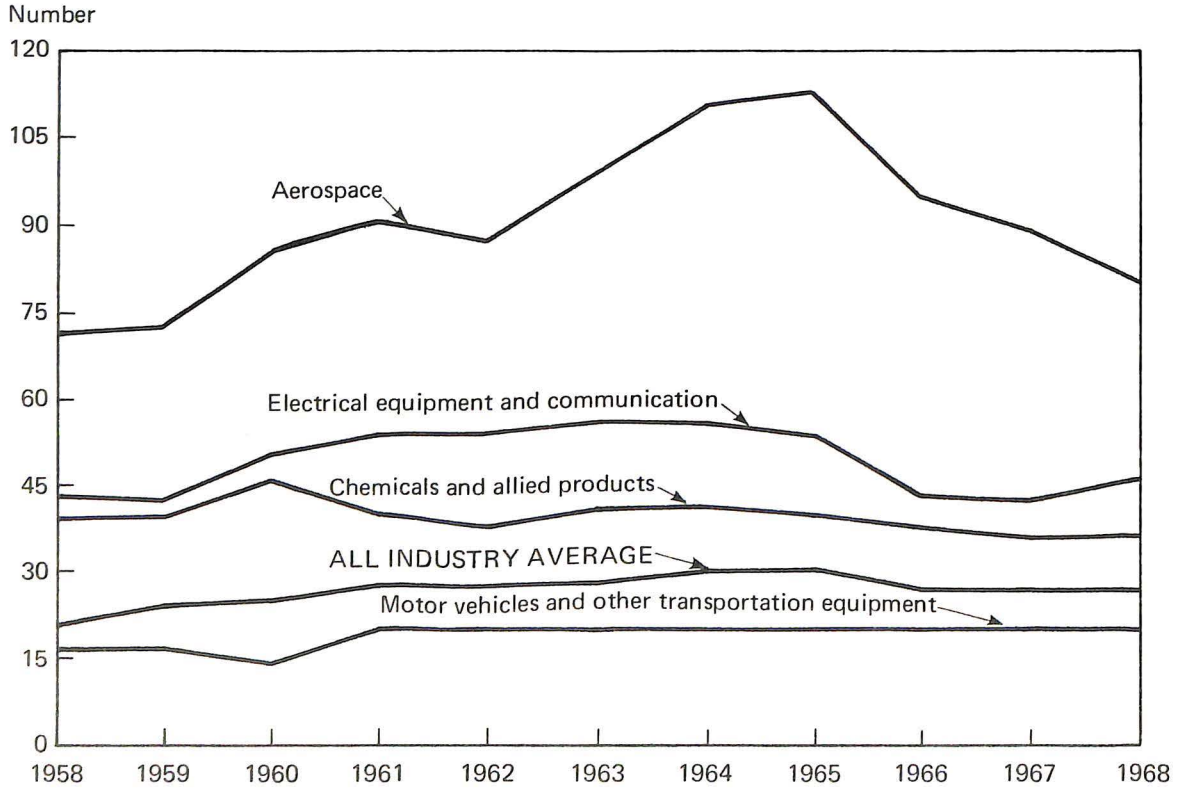
In looking at industrial performance of R&D, aerospace accounted for more than one-third of total industrial performance from 1960 through 1969. But the percentage share of this sector declined steadily from a peak of 37 percent in 1963 and 1964 to 30 percent in 1970. The McGraw-Hill estimates indicate a further decline to an estimated 26 percent by 1973 (Chart 22).

Although the aerospace industry will maintain its leadership in R&D, estimates indicate that R&D in the electrical equipment and communications industry will increase by 26 percent compared to a 9 percent increase for aerospace between 1970 and 1973. The combined total of these two sectors will drop from 56 percent of the total industrial R&D to about 50 percent.[13] Even with the slower growth rate in aerospace R&D, estimated new product sales (not produced in 1969) are expected to account for 52 percent of the total 1973 sales, in contrast to an average for all industry of 19 percent (Chart 23).

---

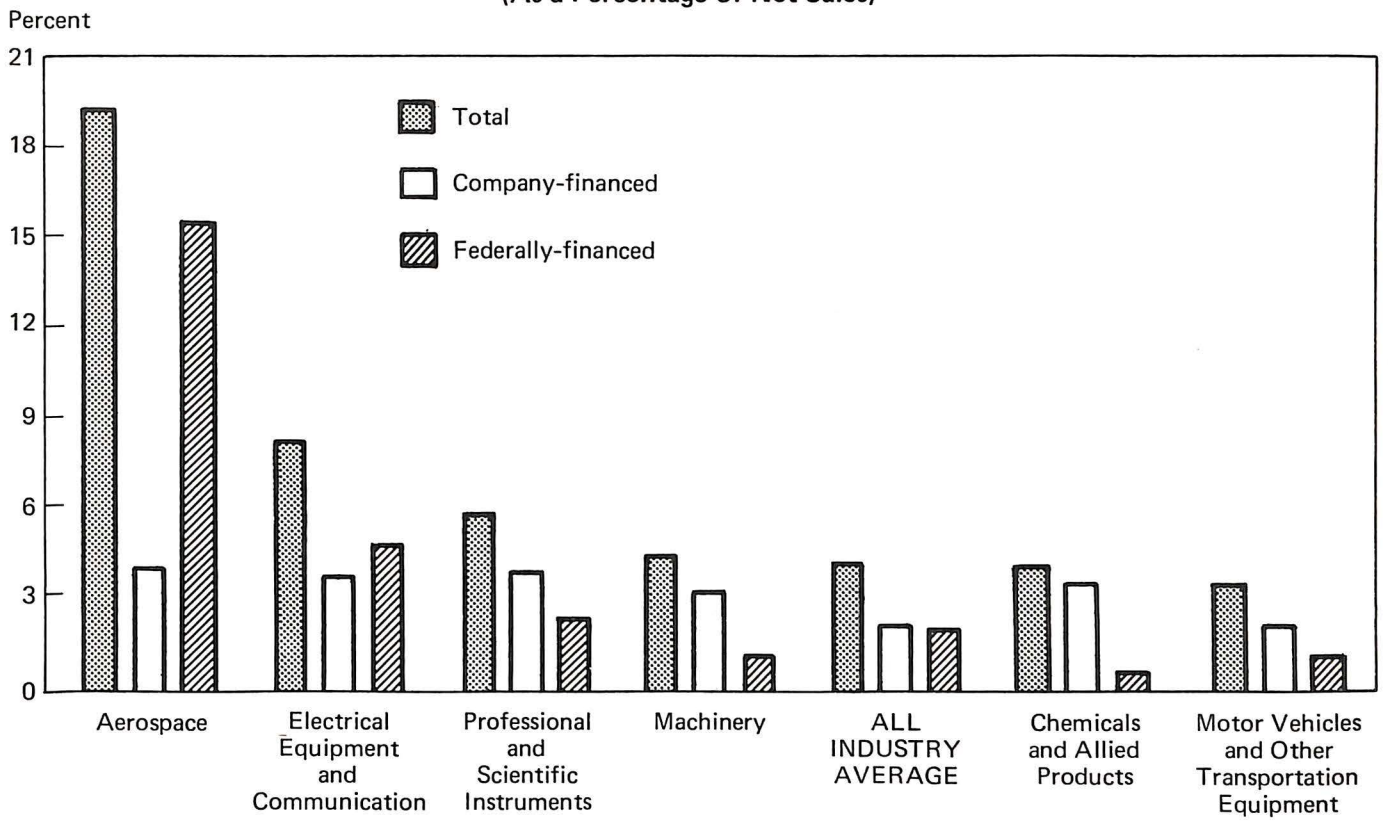
[13] McGraw-Hill Survey, p. 1.

CHART 20
R&D SCIENTISTS AND ENGINEERS
(Per 1000 Employees)
1958-68



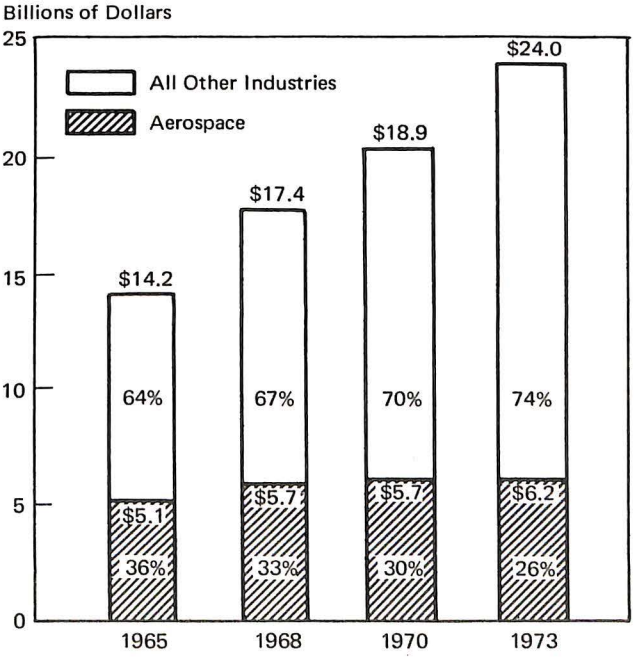
Source: NSF 70-29, p. 51.

CHART 21
R&D PERFORMANCE BY SELECTED INDUSTRIES
1968
(As a Percentage of Net Sales)



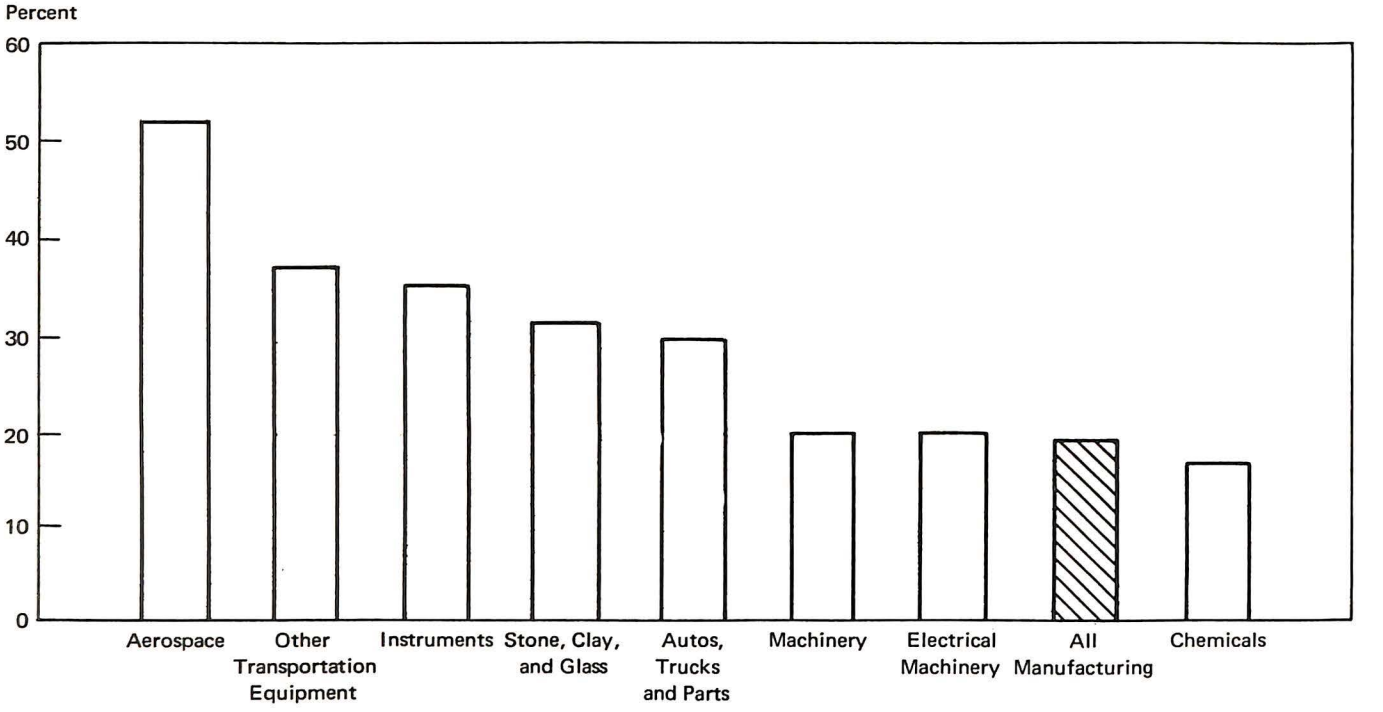
Source: Appendix, Table 16.

CHART 22
R&D PERFORMANCE BY AEROSPACE AND OTHER INDUSTRIES
(Dollar Figures in Billions)



Source: Appendix, Tables 12 and 15, and McGraw-Hill Survey.

CHART 23
ESTIMATED NEW PRODUCT SALES IN SELECTED INDUSTRIES
1973



Source: McGraw-Hill Survey, Table IV.

V. Scientific And Technical Manpower Resources

Investments in higher education, the level and nature of support, and the mobility of existing manpower resources, provide key indicators of the long-term scientific and technical capability of the nation. Due to the obvious relationship between higher education and the future scientific manpower base, investment in higher education partially determines future R&D capabilities. The long leadtime from classroom to career raises the issue of the degree to which educational policies and manpower requirements could or should be coordinated.

Previous changes in Federal support of various activities or programs have had a feedback effect on the desirability of pursuing certain careers, although changes have been gradual. This feedback on scientific careers was evident particularly in the post-Sputnik period, and now another shift is emerging in the current interest in environmental and social problems. Whereas the number of natural science and engineering graduates increased significantly from 1955 to 1960, the number of graduates in these fields has leveled off since 1965. In the National Science Policy Hearings, Dr. Handler, President of the National Academy of Sciences, pointed out that the "effect on student attitudes of Federal vacillation and seeming disinterest in science is reflected, in part, in declining undergraduate enrollments, particularly in the 'hard sciences' and will soon affect graduate enrollments in all of the natural sciences."[14]

[14] National Science Policy Hearings, p. 85.

The lack of adequate consideration of the long-term balance among various fields of science implies future imbalances due to the leadtime required in establishing different capabilities and in providing incentives to pursue certain disciplines. Dr. Handler cautioned that:

> "... those who could arbitrarily restrict the size of our future total pool of scientific personnel are taking a limited view of the national future and indeed placing a mortgage on that future. Such proposals, generated in the current Federal atmosphere, is conditioned by those events which make for stringency of funding .... Clearly, if we seriously restrict the number of people entering graduate school hereafter, we may lose our options for the future.... Federal decision should not be conditioned exclusively by current projections of the level of effort in defense or space R&D."[15]

In addition to assuring future scientific capability through higher education policies, provisions for the retraining and transfer of current manpower resources also ensures the maintenance of a skilled scientific base. The current lack of mobility within the aerospace industry and constraints on the transferability of capabilities to other industries have become critical issues. Along with the declining rate of Federal R&D expenditures, the average annual rate of growth in R&D scientists and engineers also has declined.

[15] National Science Policy Hearings, p. 96.

VI. Conclusions

The viability of the nation as a leading economic and political power has been attributed largely to the maintenance of scientific and technological capabilities. Underlying factors in the present debate over technology involve the level and orientation of funding to be devoted to research and development activities. The quantitative data developed in this study indicate that new patterns are emerging in the magnitude and direction of research and development in the United States and lead to the conclusions that follow.

1. Diminishing Governmental Leadership

Recent R&D trends reflect diminishing governmental leadership in R&D which could lead to an erosion of the national research effort. The impact of continued inflation, the higher costs and longer leadtimes associated with increasingly sophisticated projects, plus accelerated efforts to meet specific national goals, suggest an even greater degradation of the total R&D effort than an examination of expenditures would indicate.

2. Changing Allocation of Funds

Because of the different nature and emphasis of industrial and Federal R&D programs, the recent growth of industrial financing and leveling of Federal funding indicate a shift in the overall direction of national R&D activities. Whereas industrial research and development has focused primarily upon product improvement and product development, most of the nation's basic research and the high risk, high cost activity has been financed by the Federal Government. Although their respective R&D programs frequently are complementary, certain technological projects traditionally initiated or sponsored by the Federal Government are beyond the financial scope of private enterprise. Consequently, a reduction in Federal R&D activity could have a negative impact on the level of sophisticated effort nationally.

3. Scientific and Technological Manpower

Investments in higher education, the level and nature of Federal R&D support, and the utilization of existing manpower, provide some indication of the long-term scientific and technical capability of the nation. Previous Federal support of certain programs has had a feedback effect on the desirability of pursuing certain careers. Thus the failure to consider the long-term relationship among various fields of science implies future imbalances due to the leadtime required in developing trained manpower.

4. Implications for Development

Investments in research frequently have an impact on future development capabilities. Consequently, current shifts in research expenditures, which are indicative of changing priorities at the national level, may be reflected in the future allocation of development funding. More importantly, erosion in certain research areas could limit or predetermine future technological options.

These factors underscore the already recognized need to establish longer range R&D priorities, along with a well defined national technological strategy. In contrast to the fluctuations over the past decade, a long-term commitment to maintain a continuing and consistent R&D effort at the Federal level would guarantee a scientific and technological base capable of responding to problems of national concern. The failure to establish a national R&D strategy clearly could limit future options and establish serious constraints on the adequacy and quality of the technological base upon which our future national progress is dependent.

Abbreviations

AEC: Atomic Energy Commission

AIA: Aerospace Industries Association

ARC: Aerospace Research Center

BMI: Battelle Memorial Institute

DOD: Department of Defense

DOT: Department of Transportation

FAA: Federal Aviation Administration

FY: Fiscal Year

GNP: Gross National Product

HEW: Department of Health, Education, and Welfare

NASA: National Aeronautics and Space Administration

NIH: National Institutes of Health

NSF: National Science Foundation

R&D: Research and Development

VA: Veterans Administration

Technical Notes

Budget Authority—Authority provided by the Congress—mainly in the form of appropriations—which allows Federal agencies to incur obligations to spend or lend money. While most authority is voted each year, some becomes available automatically under permanent laws—for example, interest on the public debt. Budget authority is composed of: *New Obligational Authority,* which is authority to incur obligations for programs in the expenditure account; plus *Loan Authority,* which is authority to incur obligations for loans made under programs classified in the loan account.*

Constant Dollar Estimates—Constant dollar estimates represent an effort to remove the effects of price changes from statistical series reported in dollar terms. In general, constant dollar series are derived by dividing current dollar estimates by appropriate price indexes. The result is a series as it would presumably exist if prices were the same throughout as in the base year—in other words, as if the dollar had constant purchasing power. Any changes in such a series would reflect only changes in the real (physical) volume of output.

Expenditure—See Outlays.

Expenditure Account—The portion of the budget consisting of (1) budget receipts, and (2) budget authority and outlays for all nonlending programs, lending programs not classified in the loan account, and the administrative and other net expenses of programs in the loan account.*

Fiscal Year—Year running from July 1 to June 30 and designated by the calendar year in which it ends.*

Gross National Product—Gross national product is the market value of the output of goods and services produced by the Nation's economy. GNP is a "gross" measure because no deduction is made to reflect the wearing out of machinery and other capital assets used in production. An alternative measure—net national product (NNP)—is defined as GNP minus allowances for the consumption of capital during the period.

Obligations—Commitments made by Federal agencies to pay out money for products, services, loans, or other purposes—as distinct from the actual payments. Obligations incurred may not be larger than the budget authority.*

Outlays—Checks issued, interest accrued on the public debt, or other payments made, net of refunds and reimbursements. Budget outlays are composed of: *Expenditures*—Outlays relating to the expenditure account: plus *Net Lending*—Gross loan disbursements minus repayments in the loan account.*

Research and Development—Research and development in this report consist of basic and applied research in the sciences (including medical sciences) and in engineering and activities in development. The natural sciences—life, physical, and engineering— as well as the social and psychological sciences are covered in the Federal sector. Industry coverage is limited to the natural sciences.

Research—Research, which may be classified as basic or applied, is defined as "systematic, intensive study directed toward fuller scientific knowledge of the subject studies."**

Basic Research—For the Federal sector, basic research primarily involves "gaining a fuller knowledge or understanding of the subject under study, rather than a practical application thereof." The definition for the industrial sector is modified to indicate that basic research projects represent "original investigations for the advancement of scientific knowledge . . . which do not have specific commercial objectives, although they may be in fields of present or potential interest to the reporting company."**

Applied Research—For the Federal sector, "applied research is directed toward practical application of knowledge." The industrial survey covers ". . . research projects which represent investigations directed to the discovery of new scientific knowledge which have specific commercial objectives with respect to either projects or processes."**

Development—Development may be summarized as ". . . the systematic use of scientific knowledge directed toward the production of useful materials, devices, systems or methods, including design and development of prototypes and processes."**

Single-Year Designation for National Totals—Data for calendar year for industry and non-profit institutions are combined with Federal and university data for each fiscal year (that is, July through June) in the R&D funds series. The sector data for all years are grouped accordingly and the annual national totals are based on this phasing.**

*The U.S. Budget in Brief, FY 1972, p. 4.

**NSF 70-46, pp. 24-25.

Bibliography

Aerospace Industries Association of America, Inc., AEROSPACE FACTS AND FIGURES, 1970.

"Business' Plans for Research and Development Expenditures, 1970-1973," McGraw-Hill Survey, May 22, 1970.

Lessing, Lawrence, "The Senseless War on Science," FORTUNE, Vol. LXXXIII, No. 3, March, 1971.

March, Michael S., *Federal Budget Priorities for Research and Development,* The University of Chicago Center for Policy Study, 1970.

National Science Foundation, *Federal Funds for Research, Development, and Other Scientific Activities, Fiscal Years 1968, 1969, and 1970,* NSF 69-31, Volume XVIII, GPO, 1969.

National Science Foundation. *Federal Funds for Research, Development and Other Scientific Activities, Fiscal Years 1969, 1970, and 1971,* NSF 70-38, Volume XIX, GPO, 1970.

National Science Foundation, *National Patterns of R&D Resources, 1953-70,* NSF 69-30, GPO, 1969.

National Science Foundation, *National Patterns of R&D Resources, 1953-71,* NSF 70-46, GPO, 1970.

National Science Foundation, *Research and Development in Industry, 1967,* NSF 69-28, GPO, 1969.

National Science Foundation, *Research and Development in Industry, 1968,* NSF 70-29, GPO, 1970.

National Science Foundation, *R&D in the Aircraft and Missiles Industry, 1957-1968,* NSF 69-15, GPO, 1969.

Nichols, Rodnev W., *"Mission-Oriented R&D,"* SCIENCE, Vol. 172, April 2, 1971, pp. 29-37.

Organization for Economic Co-operation and Development, *Reviews of National Science Policy: United States,* Paris, 1968.

Probable Levels of R&D Expenditures in 1971: Forecast and Analysis, Battelle Memorial Institute—Columbus Laboratories, December, 1970.

Public Law 91-441, October 7, 1970.

"SPECIAL ANALYSIS Q: Federal Research, Development, and Related Programs," *Special Analyses: Budget of the United States Government, Fiscal Year 1971,* GPO, 1970, pp. 255-266.

"SPECIAL ANALYSIS R: Federal Research and Development Programs," *Special Analyses: Budget of the United States Government, Fiscal Year 1972,* GPO, 1971, pp. 271-285.

The U.S. Budget in Brief, Fiscal Year 1972, GPO, 1971.

U.S. House of Representatives, Subcommittee on Science, Research and Development of the Committee on Science and Astronautics, *National Science Policy,* GPO, 1970.

Appendix: Statistical Tables

TABLE 2

SOURCE OF R&D FUNDS

1954-71

FISCAL YEAR	TOTAL*	FEDERAL		INDUSTRY	
		Million Dollars	Percent of Total	Million Dollars	Percent of Total
1954	$ 5,738	$ 3,138	55%	$ 2,367	41%
1955	6,279	3,509	56	2,513	40
1956	8,483	4,859	57	3,336	39
1957	9,912	6,119	62	3,460	35
1958	10,870	6,791	62	3,700	34
1959	12,540	8,059	64	4,057	32
1960	13,730	8,752	64	4,508	33
1961	14,552	9,264	64	4,749	33
1962	15,665	9,926	63	5,114	33
1963	17,371	11,219	65	5,449	31
1964	19,214	12,553	65	5,880	31
1965	20,439	13,033	64	6,539	32
1966	22,266	13,992	63	7,317	33
1967	23,642	14,449	61	8,134	34
1968	25,083	14,972	60	8,941	36
1969 Prel.	26,175	14,979	57	9,957	38
1970 Est.	26,850	14,650	55	10,910	41
1971 Est.	27,850	14,735	53	11,780	42

*Total includes universities and other nonprofit institutions.

Source: NSF 70-46, p. 36.

TABLE 3

TOTAL FEDERAL BUDGET AND FEDERAL R&D EXPENDITURES
FY 1950-72
(Dollar Figures in Millions)

FISCAL YEAR	TOTAL BUDGET OUTLAYS	R&D AND R&D PLANT	
		Expenditures	% of Total Budget
1950	$ 43,147	$ 1,083	2.5%
1951	45,797	1,301	2.8
1952	67,962	1,816	2.7
1953	76,769	3,101	4.0
1954	71,138	3,148	4.4
1955	68,503	3,308	4.8
1956	70,461	3,446	4.9
1957	76,748	4,462	5.8
1958	82,575	4,991	6.0
1959	92,111	5,806	6.3
1960	92,230	7,744	8.4
1961	97,802	9,284	9.5
1962	106,830	10,381	9.7
1963	111,314	11,999	10.8
1964	118,585	14,707	12.4
1965	118,431	14,889	12.6
1966	134,654	16,018	11.9
1967	158,352	16,842	10.6
1968	178,862	17,030	9.5
1969	184,556	16,348	8.9
1970	196,588	15,632	8.0
1971 Est.	212,755	15,960	7.5
1972 Est.	229,232	16,258	7.1

Source: 1950-69 from NSF 70-38, p. 2.
1970-72 from The U.S. Budget, Special Analysis B, p. 22 and Special Analysis R, pp. 273-4.

TABLE 4

FEDERAL EXPENDITURES FOR RESEARCH, DEVELOPMENT, AND R&D PLANT, BY AGENCY
FY 1954-72
(Millions of Dollars)

FISCAL YEAR	TOTAL	DOD	NASA	AEC	HEW	NSF
1954	$ 3,148	$2,487	$ 90	$ 383	$ 63	$ 4
1955	3,308	2,630	74	385	70	9
1956	3,446	2,639	71	474	86	15
1957	4,462	3,371	76	657	144	31
1958	4,991	3,664	89	804	180	34
1959	5,806	4,183	145	877	253	54
1960	7,744	5,654	401	986	324	64
1961	9,284	6,618	742	1,111	374	83
1962	10,381	6,812	1,251	1,284	512	113
1963	11,999	6,849	2,539	1,336	632	153
1964	14,707	7,517	4,171	1,505	793	203
1965	14,889	6,728	5,093	1,520	738	206
1966	16,018	6,735	5,933	1,462	879	241
1967	16,842	7,680	5,426	1,467	1,075	277
1968	17,030	8,164	4,724	1,594	1,283	315
1969	16,348	7,858	4,252	1,654	1,221	342
1970	15,632	7,565	3,753	1,616	1,505	324
1971 Est.	15,960	7,706	3,369	1,619	1,671	359
1972 Est.	16,258	7,887	3,152	1,523	1,749	431

Source: Special Analysis Q, FY 1971, p. 266 and
Special Analysis R, FY 1972, pp. 273-74.

TABLE 5

FEDERAL EXPENDITURES FOR RESEARCH, DEVELOPMENT, AND R&D PLANT, BY AGENCY
FY 1954-72
(Percentage Share)

FISCAL YEAR	DOD	NASA	AEC	HEW	NSF	ALL OTHERS
1954	79%	3%	12%	2%	*	4%
1955	80	2	12	2	*	4
1956	77	2	14	2	*	5
1957	76	2	15	3	1%	3
1958	73	2	16	4	1	4
1959	72	2	15	4	1	6
1960	73	5	13	4	1	4
1961	71	8	12	4	1	4
1962	66	12	12	5	1	4
1963	57	21	11	5	1	5
1964	51	28	10	5	1	5
1965	45	34	10	5	1	5
1966	42	37	9	5	2	5
1967	46	32	9	6	2	5
1968	48	28	9	8	2	5
1969	48	26	10	7	2	7
1970	48	24	10	10	2	6
1971 Est.	48	21	10	10	2	9
1972 Est.	49	19	9	11	3	9

*Less than 0.5 percent.

Source: Based on Special Analysis Q, FY 1971, p. 266 and
Special Analysis R, FY 1972, pp. 273-74.

TABLE 6

FEDERAL RESEARCH AND DEVELOPMENT OBLIGATIONS, BY AGENCY
FY 1947-72
(Millions of Dollars)

FISCAL YEAR	TOTAL	AGRICULTURE	COMMERCE	DOD	HEW	INTERIOR	DOT	AEC	FAA*	NASA†	NSF	VA	ALL OTHER
1947	$ 619.5	$ 40.0	$ 5.7	$ 469.3	$10.6	$ 16.9	–	$ 39.9	–	$ 26.7	–	$ 1.4	$ 9.0
1948	776.5	45.7	8.9	485.3	24.3	20.3	–	145.4	–	33.0	–	3.1	10.0
1949	937.7	53.2	10.9	626.1	25.2	30.2	–	140.0	–	38.3	–	4.3	9.5
1950	972.6	56.9	22.4	599.7	34.2	28.7	–	172.2	–	42.8	–	3.8	11.9
1951	1,481.9	55.1	11.0	1,125.9	37.9	30.4	–	157.9	–	45.4	$ .1	5.1	13.1
1952	1,887.3	55.3	10.3	1,508.5	43.6	30.7	–	168.9	–	50.5	.9	3.9	14.7
1953	3,106.2	56.0	10.9	2,577.2	49.9	32.1	–	309.9	–	48.4	2.3	5.1	14.4
1954	2,874.9	59.3	7.8	2,320.0	58.2	37.7	–	323.4	–	47.3	4.6	5.3	11.3
1955	2,532.8	72.2	15.0	1,945.1	68.0	32.4	–	327.3	–	43.0	9.7	5.6	14.5
1956	2,988.2	83.0	18.2	2,268.6	86.0	36.1	–	410.7	–	49.5	16.0	6.5	13.6
1957	3,932.0	99.8	17.7	2,985.6	144.2	45.2	–	528.0	–	55.3	30.6	7.7	17.9
1958	4,569.7	110.2	18.3	3,403.3	184.9	51.1	–	644.0	$16.3	77.1	33.6	10.1	20.8
1959	6,693.5	120.7	25.6	5,161.6	242.8	60.6	–	699.8	27.3	261.7	60.4	12.8	20.2
1960	7,551.7	125.8	31.4	5,711.5	319.8	64.0	–	761.7	47.9	369.3	74.7	15.1	30.5
1961	9,058.6	143.4	32.3	6,574.0	428.5	73.3	–	850.2	48.2	776.9	84.0	22.0	25.8
1962	10,289.9	157.2	40.1	6,722.9	576.9	85.6	–	1,029.2	66.2	1,439.2	113.9	27.5	31.2
1963	12,494.7	168.0	52.2	7,285.7	656.2	92.1	–	1,077.9	83.5	2,857.4	154.1	29.9	37.7
1964	14,225.4	189.0	53.8	7,261.9	776.9	106.4	–	1,236.0	62.8	4,286.6	170.2	33.7	48.1
1965	14,614.3	224.6	61.3	6,796.5	869.4	113.2	–	1,240.7	64.4	4,951.5	187.2	37.4	68.1
1966	15,320.4	234.9	55.2	7,023.6	1,014.4	143.2	$171.7	1,212.4	–	5,050.0	243.7	40.1	131.2
1967	16,529.3	252.6	74.8	8,049.2	1,146.6	170.4	283.6	1,257.3	–	4,867.0	262.4	40.9	124.5
1968	15,921.4	253.5	83.9	7,709.3	1,251.8	190.6	171.7	1,369.0	–	4,429.4	283.5	44.7	134.0
1969	15,637.2	260.1	72.1	7,696.3	1,297.4	207.6	228.0	1,405.9	–	3,963.3	273.8	50.2	182.5
1970‡	15,331.0	289.0	124.0	7,338.0	1,251.0	160.0	315.0	1,346.0	–	3,825.0	288.0	59.0	336.0
1971 Est.	15,555.0	312.0	157.0	7,400.0	1,506.0	188.0	468.0	1,307.0	–	3,382.0	343.0	62.0	430.0
1972 Est.	16,737.0	321.0	181.0	8,309.0	1,637.0	213.0	566.0	1,251.0	–	3,215.0	495.0	62.0	487.0

*FAA included in DOT after 1965.

†National Advisory Committee for Aeronautics prior to fiscal year 1958.

‡Obligations for 1970-1972 from FY 1972 Special Analysis R are rounded off to the nearest million.

Source: 1947-69 from NSF 70-38, pp. 234-5.
1970-72 from 1972 Special Analysis R, p. 273.

TABLE 7

FEDERAL RESEARCH AND DEVELOPMENT OBLIGATIONS, BY AGENCY
FY 1947-72
(Percentage Share)

FISCAL YEAR	AGRICULTURE	COMMERCE	DOD	HEW	INTERIOR	DOT	AEC	FAA*	NASA†	NSF	VA	ALL OTHER
1947	6.5%	1.0%	75.8%	1.7%	2.7%	–	6.4%	–	4.3%	–	.2%	1.5%
1948	5.9	1.1	62.6	3.1	2.6	–	18.7	–	4.2	–	.4	1.3
1949	5.7	1.2	66.8	2.7	3.2	–	14.9	–	4.1	–	.5	1.0
1950	5.9	2.3	61.7	3.5	3.0	–	17.7	–	4.4	–	.4	1.2
1951	3.7	.7	76.0	2.6	2.1	–	10.7	–	3.1	–	.3	.9
1952	2.9	.5	79.9	2.3	1.6	–	8.9	–	2.7	–	.2	.8
1953	1.8	.4	83.0	1.6	1.0	–	10.0	–	1.6	.1%	.2	.5
1954	2.1	.3	80.7	2.0	1.3	–	11.2	–	1.6	.2	.2	.4
1955	2.9	.6	76.8	2.7	1.3	–	12.9	–	1.7	.4	.2	.6
1956	2.8	.6	75.9	2.9	1.2	–	13.7	–	1.7	.5	.2	.5
1957	2.5	.5	75.9	3.7	1.1	–	13.4	–	1.4	.8	.2	.5
1958	2.4	.4	74.5	4.0	1.1	–	14.1	.4%	1.7	.7	.2	.5
1959	1.8	.4	77.1	3.6	.9	–	10.5	.4	3.9	.9	.2	.3
1960	1.7	.4	75.6	4.2	.8	–	10.1	.6	4.9	1.0	.2	.4
1961	1.6	.4	72.6	4.7	.8	–	9.4	.5	8.6	.9	.2	.3
1962	1.5	.4	65.3	5.6	.8	–	10.0	.6	14.0	1.1	.3	.3
1963	1.3	.4	58.3	5.3	.7	–	8.6	.7	22.9	1.2	.2	.3
1964	1.3	.4	51.0	5.5	.7	–	8.7	.4	30.1	1.2	.2	.3
1965	1.5	.4	46.5	5.9	.8	–	8.5	.4	33.9	1.3	.3	.5
1966	1.5	.4	45.8	6.6	.9	1.1%	7.9	–	33.0	1.6	.3	.9
1967	1.5	.5	48.7	6.9	1.0	1.7	7.6	–	29.4	1.6	.2	.8
1968	1.6	.5	48.4	7.9	1.2	1.1	8.6	–	27.8	1.8	.3	.8
1969	1.7	.5	49.2	8.3	1.3	1.5	9.0	–	25.3	1.8	.3	1.2
1970‡	1.9	.8	47.9	8.2	1.0	2.1	8.8	–	24.9	1.9	.4	2.2
1971 Est.	2.0	1.0	47.6	9.7	1.2	3.0	8.4	–	21.7	2.2	.4	2.8
1972 Est.	1.9	1.1	49.6	9.8	1.3	3.4	7.5	–	19.2	3.0	.4	2.9

*FAA included in DOT after 1965.

†National Advisory Committee for Aeronautics prior to fiscal year 1958.

‡Obligations for 1970-1972 from FY 1972 Special Analysis R are rounded off to the nearest million.

Source: Based on Table 6.

TABLE 8

COMPOSITION OF FEDERAL R&D OBLIGATIONS
(Basic Research, Applied Research and Development)
FY 1956-71
(Dollar Figures in Millions)

FISCAL YEAR	TOTAL	BASIC RESEARCH		APPLIED RESEARCH		DEVELOPMENT	
		$	%*	$	%	$	%
1956	$ 2,988	$ 206	7%	$ 646	22%	$ 2,136	71%
1957	3,931	262	7	662	17	3,007	76
1958	4,570	335	7	744	16	3,491	76
1959	6,694	517	8	886	13	5,291	79
1960	7,552	610	8	1,331	18	5,611	74
1961	9,059	825	9	1,796	20	6,438	71
1962	10.289	1,106	11	2,166	21	7,017	68
1963	12,495	1,389	11	2,652	21	8,454	68
1964	14,226	1,567	11	2,898	20	9,761	69
1965	14,614	1,690	12	3,164	22	9,760	67
1966	15,321	1,844	12	3,427	22	10,050	66
1967	16,529	2,015	12	3,258	20	11,256	68
1968	15,922	2,072	13	3,293	21	10,557	66
1969	15,637	2,094	13	3,145	20	10,398	66
1970 Est.	15,700	2,173	14	3,312	21	10,215	65
1971 Est.	15,638	2,227	14	3,743	24	9,668	62

*Due to rounding, totals may not equal 100.

Source: NSF 70-38, p. 238.

TABLE 9-A

FEDERAL OBLIGATIONS FOR BASIC RESEARCH
(DOD, AEC AND NASA)
FY 1956-71
(Dollar Figures in Millions)

FISCAL YEAR	TOTAL	DOD		AEC		NASA	
		$	%	$	%	$	%
1956	$ 206	$ 78	38%	$ 45	22%	$ 13	6%
1957	262	84	32	55	21	16	6
1958	335	111	33	72	21	26	8
1959	517	137	26	87	17	107	21
1960	610	168	28	104	17	97	16
1961	825	173	21	167	20	190	23
1962	1,106	204	18	192	17	316	29
1963	1,389	231	17	219	16	447	32
1964	1,567	241	15	238	15	524	33
1965	1,690	263	16	258	15	528	31
1966	1,844	262	14	281	15	559	30
1967	2,015	284	14	302	15	603	30
1968	2,072	263	13	282	14	656	32
1969	2,094	276	13	285	14	678	32
1970 Est.	2,173	248	11	288	13	768	35
1971 Est.	2,227	251	11	282	13	741	33

Source: NSF 70-38, p. 239.

TABLE 9-B

FEDERAL OBLIGATIONS FOR BASIC RESEARCH
(HEW, NSF, AND ALL OTHERS)
FY 1956-71
(Dollar Figures in Millions)

FISCAL YEAR	TOTAL	HEW		NSF		ALL OTHERS	
		$	%	$	%	$	%
1956	$ 206	$ 26	13%	$ 15	7%	$ 29	14%
1957	262	38	15	30	11	39	15
1958	335	50	15	33	10	43	13
1959	517	75	15	54	10	57	11
1960	610	103	17	68	11	69	11
1961	825	137	17	77	9	80	10
1962	1,106	190	17	104	9	100	9
1963	1,389	236	17	141	10	115	8
1964	1,567	274	17	155	10	134	9
1965	1,690	303	18	171	10	167	10
1966	1,844	326	18	223	12	192	10
1967	2,015	372	18	239	12	215	11
1968	2,072	397	19	252	12	222	11
1969	2,094	371	18	248	12	236	11
1970 Est.	2,173	354	16	255	12	260	12
1971 Est.	2,227	376	17	293	13	284	13

Source: NSF 70-38, p. 239.

TABLE 10-A

FEDERAL OBLIGATIONS FOR APPLIED RESEARCH
(DOD, AEC AND NASA)
FY 1956-71
(Dollar Figures in Millions)

FISCAL YEAR	TOTAL	DOD		AEC		NASA	
		$	%	$	%	$	%
1956	$ 646	$ 404	63%	$ 42	7%	$ 29	4%
1957	662	361	55	44	7	31	5
1958	744	378	51	59	8	41	6
1959	886	386	44	83	9	95	11
1960	1,331	693	52	95	7	166	12
1961	1,796	1,000	56	53	3	263	15
1962	2,166	1,107	51	55	3	398	18
1963	2,652	1,374	52	62	2	558	21
1964	2,898	1,431	49	71	2	653	23
1965	3,164	1,488	47	76	2	762	24
1966	3,427	1,587	46	90	3	799	23
1967	3,258	1,307	40	90	3	775	24
1968	3,293	1,313	40	120	4	701	21
1969	3,145	1,135	36	132	4	618	20
1970 Est.	3,312	1,186	36	136	4	663	20
1971 Est.	3,743	1,264	34	136	4	706	19

Source: NSF 70-38, p. 239.

TABLE 10-B

FEDERAL OBLIGATIONS FOR APPLIED RESEARCH
(AGRICULTURE, HEW, AND ALL OTHERS)
FY 1956-71
(Dollar Figures in Millions)

FISCAL YEAR	TOTAL	AGRICULTURE		HEW		ALL OTHERS	
		$	%	$	%	$	%
1956	$ 646	$ 68	11%	$ 57	9%	$ 46	7%
1957	662	76	11	104	16	46	7
1958	744	81	11	133	18	52	7
1959	886	87	10	165	19	71	8
1960	1,331	87	7	214	16	75	6
1961	1,796	97	5	291	16	92	5
1962	2,166	101	5	384	18	121	6
1963	2,652	104	4	416	16	137	5
1964	2,898	114	4	497	17	132	5
1965	3,164	128	4	559	18	151	5
1966	3,427	134	4	640	19	178	5
1967	3,258	137	4	710	22	239	7
1968	3,293	140	4	750	23	269	8
1969	3,145	145	5	803	26	312	10
1970 Est.	3,312	157	5	773	23	397	12
1971 Est.	3,743	165	4	904	24	568	15

Source: NSF 70-38, p. 239.

TABLE 11

FEDERAL OBLIGATIONS FOR DEVELOPMENT
(DOD, AEC, NASA, AND ALL OTHERS)
FY 1956-71
(Dollar Figures in Millions)

FISCAL YEAR	TOTAL	DOD		AEC		NASA		ALL OTHERS	
		$	%	$	%	$	%	$	%
1956	$ 2,136	$1,786	84%	$324	15%	$ 7	—	$ 19	1%
1957	3,007	2,540	84	429	14	9	—	29	1
1958	3,491	2,914	83	513	15	11	—	53	2
1959	5,291	4,638	88	530	10	61	1%	62	1
1960	5,611	4,850	86	563	10	105	2	93	2
1961	6,438	5,401	84	630	10	324	5	83	1
1962	7,017	5,411	77	783	11	725	10	98	1
1963	8,454	5,680	67	797	9	1,852	22	125	1
1964	9,761	5,590	57	928	10	3,109	32	134	1
1965	9,760	5,045	52	907	9	3,662	38	146	1
1966	10,050	5,174	51	842	8	3,692	37	342	3
1967	11,256	6,458	57	866	8	3,488	31	444	4
1968	10,557	6,132	58	967	9	3,073	29	385	4
1969	10,398	6,284	60	989	10	2,667	26	458	4
1970 Est.	10,215	6,322	62	923	9	2,345	23	625	6
1971 Est.	9,668	6,115	63	901	9	1,826	19	826	9

Source: NSF 70-38, p. 240.

TABLE 12

R&D PERFORMANCE BY INDUSTRY
1956-71
(Dollar Figures in Millions)

FISCAL YEAR	R&D TOTAL	PERFORMED BY INDUSTRY	PERCENT OF TOTAL R&D
1956	$ 8,483	$ 6,605	77.9%
1957	9,912	7,731	78.0
1958	10,870	8,389	77.2
1959	12,540	9,618	76.7
1960	13,730	10,509	76.5
1961	14,552	10,908	75.0
1962	15,665	11,464	73.2
1963	17,371	12,630	72.7
1964	19,214	13,512	70.3
1965	20,439	14,185	69.4
1966	22,266	15,548	69.8
1967	23,642	16,415	69.4
1968	25,083	17,393	69.3
1969 Prel.	26,175	18,367	70.2
1970 Est.	26,850	18,910	70.4
1971 Est.	27,850	19,800	71.1

Source: NSF 70-46, pp. 28-9.

TABLE 13

SOURCE OF FUNDS FOR INDUSTRIAL R&D

1956-71

FISCAL YEAR	RESEARCH PERFORMED BY INDUSTRY	FUNDED BY FEDERAL GOVERNMENT		FUNDED BY INDUSTRY	
		Million Dollars	% of Industry Total	Million* Dollars	% of Industry Total
1956	$ 6,605	$3,328	50.4%	$ 3,277	49.6%
1957	7,731	4,335	56.1	3,396	43.9
1958	8,389	4,759	56.7	3,630	43.3
1959	9,618	5,635	58.6	3,983	41.4
1960	10,509	6,081	57.9	4,428	42.1
1961	10,908	6,240	57.2	4,668	42.8
1962	11,464	6,435	56.1	5,029	43.9
1963	12,630	7,270	57.6	5,360	42.4
1964	13,512	7,720	57.1	5,792	42.9
1965	14,185	7,740	54.6	6,445	45.4
1966	15,548	8,332	53.6	7,216	46.4
1967	16,415	8,395	51.1	8,020	48.9
1968	17,393	8,580	49.3	8,813	50.7
1969 Prel.	18,367	8,551	46.6	9,816	53.4
1970 Est.	18,910	8,160	43.2	10,750	56.8
1971 Est.	19,800	8,200	41.4	11,600	58.6

*Does not include industry R&D support to academic and other non-profit institutions.

Source: NSF 70-46, pp. 28-9.

TABLE 14

INDUSTRIAL PERFORMANCE OF BASIC RESEARCH,
APPLIED RESEARCH, AND DEVELOPMENT
1956-71
(Dollar Figures in Millions)

FISCAL YEAR	TOTAL	BASIC RESEARCH		APPLIED RESEARCH		DEVELOPMENT	
		$	%	$	%	$	%
1956	$ 6,605	$253	3.8%	$1,268	19.2%	$ 5,084	77.0%
1957	7,731	271	3.5	1,670	21.6	5,790	74.9
1958	8,389	295	3.5	1,911	22.8	6,183	73.7
1959	9,618	320	3.3	1,991	20.7	7,307	76.0
1960	10,509	376	3.6	2,029	19.3	8,104	77.1
1961	10,908	395	3.6	1,977	18.1	8,536	78.3
1962	11,464	488	4.3	2,449	21.4	8,527	74.4
1963	12,630	522	4.1	2,457	19.5	9,651	76.4
1964	13,512	549	4.1	2,600	19.2	10,363	76.7
1965	14,185	592	4.2	2,658	18.7	10,935	77.1
1966	15,548	624	4.0	2,843	18.3	12,081	77.7
1967	16,415	629	3.8	2,915	17.8	12,871	78.4
1968	17,393	622	3.6	3,111	17.9	13,660	78.5
1969 Prel.	18,367	620	3.4	3,316	18.1	14,431	78.6
1970 Est.	18,910	635	3.4	3,420	18.1	14,855	78.6
1971 Est.	19,800	645	3.3	3,540	17.9	15,615	78.9

Source: NSF 70-46, pp. 30-35.

TABLE 15

AEROSPACE R&D
1956-70
(Dollar Figures in Millions)

FISCAL YEAR	RESEARCH PERFORMED BY INDUSTRY	AEROSPACE RESEARCH AND DEVELOPMENT			
		Total	% of Industry Total	Funded By Federal Contract	
				$	%
1956	$ 6,605	$2,138	32.4%	N.A.	N.A.
1957	7,731	2,574	33.3	$2,275	88.4%
1958	8,389	2,609	31.1	2,276	87.2
1959	9,618	3,090	32.1	2,754	89.1
1960	10,509	3,514	33.4	3,150	89.6
1961	10,908	3,829	35.1	3,438	89.8
1962	11,464	4,042	35.3	3,588	88.8
1963	12,630	4,712	37.3	4,261	90.4
1964	13,512	5,055	37.4	4,610	91.2
1965	14,185	5,098	35.9	4,476	87.8
1966	15,548	5,448	35.0	4,695	86.2
1967	16,415	5,570	33.9	4,499	80.8
1968	17,393	5,658	32.5	4,506	79.6
1969 Est.	18,367	5,801	31.6	4,524	78.0
1970 Est.	18,910	5,704	30.2	N.A.	N.A.

N.A. = Not available.

Source: AEROSPACE FACTS AND FIGURES, 1970, p. 65, and McGraw-Hill Survey, Table 1.

TABLE 16

FUNDING FOR R&D PERFORMANCE BY SELECTED INDUSTRIES
1957-68
(Percentage of Net Sales)

YEAR	ALL INDUSTRIES	AEROSPACE	ELECTRICAL EQUIPMENT & COMMUNI-CATIONS	INSTRUMENTS	MACHINERY	CHEMICALS	MOTOR VEHICLES
TOTAL FUNDING							
1957	3.4%	16.8%	7.6%	7.0%	3.4%	3.5%	2.9%
1958	3.8	17.7	10.3	7.8	3.8	3.8	4.2
1959	3.9	20.7	11.0	7.2	4.3	3.9	2.9
1960	4.2	23.2	11.2	6.3	4.7	4.5	3.0
1961	4.3	23.5	10.1	6.0	4.2	4.3	4.0
1962	4.3	23.8	9.9	6.3	4.0	4.2	3.5
1963	4.5	26.7	10.1	5.9	4.2	4.3	3.4
1964	4.6	28.9	9.8	6.1	4.3	4.5	3.6
1965	4.3	28.1	9.5	6.1	4.1	4.2	3.1
1966	4.2	25.3	8.6	5.6	3.9	4.2	3.2
1967	4.2	21.4	8.6	5.6	4.3	4.3	3.4
1968	4.1	19.3	8.3	5.9	4.4	4.0	3.2
FUNDED BY INDUSTRY							
1957	1.5%	2.0%	2.6%	3.9%	2.0%	3.1%	2.1%
1958	1.6	2.3	3.3	4.1	2.1	3.2	2.8
1959	1.6	2.2	3.2	3.8	2.4	3.2	2.5
1960	1.8	2.4	3.8	3.4	2.7	3.7	2.3
1961	1.8	2.4	3.6	3.7	2.7	3.5	3.0
1962	1.9	2.7	3.5	4.1	2.9	3.4	2.5
1963	1.9	2.6	3.6	4.2	3.1	3.6	2.5
1964	2.0	2.5	3.6	4.3	3.2	3.8	2.6
1965	2.0	3.4	3.6	4.1	3.1	3.6	2.3
1966	2.0	3.5	3.4	3.8	3.0	3.7	2.4
1967	2.1	4.1	3.5	3.6	3.2	3.8	2.5
1968	2.1	3.9	3.7	3.8	3.2	3.5	2.3

Source: NSF 70-29, pp. 58-9.

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