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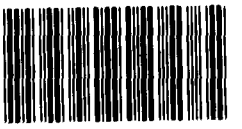
UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

MISSION ANALYSIS AND
SYSTEMS ACQUISITION DIVISION
B-201868

The Honorable Caspar W. Weinberger
The Secretary of Defense

FEBRUARY 19, 1981



Attention: Assistant for Audit Reports

Dear Mr. Secretary:

Subject: The State of Basic Research in DOD Laboratories (MASAD-81-5)

In our Government-wide study of research and development (R&D) laboratories, 1/ some Department of Defense (DOD) laboratory directors expressed concern about their laboratories' loss of opportunity to perform long term basic research because DOD had placed emphasis on solving near term problems. It is generally recognized that some basic or fundamental research is essential for most laboratories if they are to build and maintain scientific and technical capabilities to meet their applied R&D missions. Therefore, we looked at the levels and trends of in-house basic research and the extent that the levels have declined in recent years to determine what impact this might have on the future health and vitality of the DOD laboratories.

We

--used our previous study's questionnaire responses of laboratory directors;

--reviewed past DOD, National Science Foundation, National Science Board, and Office of Science and Technology Policy studies and other literature;

--analyzed basic research funding and personnel statistics which we obtained from the Army, Navy, Air Force, and the National Science Foundation;

1/"Federal R&D Laboratories--Directors' Perspectives on Management" (PSAD-80-8, Nov. 28, 1979).

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--interviewed senior R&D officials who are responsible for managing the DOD research program including the Special Assistant to the Deputy Under Secretary of Defense for Research and Engineering, Research and Advanced Technology; the Director for Research in DOD; the Assistant Directors for Research Programs and Laboratories, Office of the Director of Army Research; the Associate Deputy for Research, Applied and Space Technology, Office of the Assistant Secretary of the Navy for Research, Engineering and Systems; the Director of Research Planning and Assessment, Office of Naval Research; the Deputy for Advanced Technology, Office of the Assistant Secretary of the Air Force for Research, Development and Logistics; and the Director of the Air Force Office of Scientific Research; and

--talked to the Director and/or the Research Director and to a few bench scientist researchers at 13 DOD laboratories.

We limited our discussions to officials in these organizations because we believe they are most familiar with the trends in DOD laboratories and with the need for and impact of in-house basic research on maintaining laboratory capabilities.

As a result of our review, we concluded that:

--Defense R&D is vital to national security and in-house laboratories are vital to Defense R&D.

--Basic research is an essential ingredient of the laboratories' vitality.

--Basic research in the in-house laboratories has declined significantly and recent growth in basic research funding has emphasized external research.

The DOD Laboratory Management Task Force, chaired by the Deputy Under Secretary of Defense for Research and Engineering (Research and Advanced Technology), has initiated a laudable program to maintain the vitality of DOD laboratories and to increase their productivity. The issues the task force is addressing--staffing, facilities, equipment, and management flexibility--are important ingredients of the laboratories' success. However, positive actions in these areas without equal attention to laboratory needs for a balanced technology base program, including an adequate level of basic research, could limit the overall success of the revitalization program.

We recognize the importance of DOD's policy of seeking constant growth in its research program to strengthen and revitalize its research base and its ties with the external research community. However, this latter goal is being achieved by increasing external research funding while maintaining reduced levels of basic research at the in-house laboratories.

The 1975 DOD Laboratory Utilization Study 1/ which recommended decreasing in-house research personnel and increasing contract research, also recommended reexamining the issue in about 5 years. We believe that a program of revitalization for DOD's laboratories should consider its need for more basic research and are recommending that you give the same careful consideration to the research base represented by the in-house laboratories as has been given to the needs of the external research community. We realize that such consideration has implications for both the basic research funding level and the skills mix in the DOD laboratory personnel community.

DOD IN-HOUSE LABORATORIES ARE IMPORTANT TO NATIONAL SECURITY

DOD in-house laboratories are a vital and integral force in the Defense R&D program that provides the technological foundation for our national security. Through the program the United States strives for the technological lead in areas important to defense, guards against technological surprise by an adversary, and provides options which shape our military posture.

DOD recognizes the importance of the laboratories to its technological foundation by having invested more than $4 billion in facilities and equipment in over 70 laboratories. Of DOD's $13.5 billion Research, Development, Test and Evaluation (often referred to as R&D) budget for fiscal year 1980, the laboratories received over $3.5 billion (total laboratory funding from all sources was about $6 billion) to carry out their responsibilities in the Defense R&D process. The laboratories usually use about half of these funds for performing work in-house and half for contracting R&D work by other performers.

1/"The DOD Laboratory Utilization Study" (Office of the Director of Defense Research and Engineering, Apr. 28, 1975).

The 1975 DOD Laboratory Utilization Study found that DOD's R&D process could not function without the in-house laboratories. They participate in and help guide the process from beginning to end, from the search for new knowledge and concepts to the design, development, and procurement of new systems.

The in-house laboratories provide analytical advice and technical services in planning DOD's R&D program. They must maintain high scientific and technical competence so that outside technical advice can be evaluated and put into proper perspective in decisionmaking. They must maintain a strong base of technical knowledge to provide effective assistance in acquiring new systems; that is, to help make DOD a smart buyer. They contribute by offering technical advice in selecting contractor awardees, providing technical supervision over contractor activities, and technically evaluating DOD contractors' results and performance.

Among the laboratories' more basic responsibilities is the maintenance of a technical staff to keep DOD and the services informed of the latest scientific knowledge originating elsewhere and to contribute new scientific knowledge by their own research efforts. A dynamic program of basic research is one of the things needed to accomplish these responsibilities.

BASIC RESEARCH IS AN ESSENTIAL INGREDIENT OF THE LABORATORIES' VITALITY

Basic research enables the laboratories to be at the forefront of the search for scientific knowledge. Through a vigorous program of basic research, laboratories provide their researchers with opportunities to keep abreast of new discoveries and to engage in meaningful interaction with the rest of the scientific community. Also, such a program serves to increase the overall level of the laboratories' technical abilities and to attract new and imaginative people into the laboratories.

Basic research is the systematic scientific search for new knowledge without a particular application in mind. Most basic research performed in-house by a mission agency, such as DOD, tends to be in the scientific disciplines and research areas in which the agency believes the discovery of new knowledge will have the greatest potential for contributing to its mission. DOD does not have a specific budget category called basic research. It does, however, have a budget category called Defense Research (6.1), and for the purposes of this

report, we have considered the 6.1 research to be basic research. Monetarily, this research is only about 4 percent of DOD's R&D budget, $558 million in fiscal year 1980, but without the support of the information and techniques developed in basic research programs, mission-oriented efforts to provide new technical options for national security would be severely hampered.

A program of basic research helps the researcher acquire a firsthand knowledge and awareness of current scientific activity, thus providing him the expertise to use the results of the vast amount of research not performed in DOD laboratories, much of which has potential for military application. The researcher is also able to use this experience to gain the respect of contractor personnel and achieve meaningful interaction with the scientific community. Collectively, these scientists and engineers provide competent advice to laboratory directors, program managers, and operational planners, enabling the laboratories to couple the newest scientific capabilities with DOD needs.

Another benefit attributed to a basic research program is that it aids in securing topflight scientific and technical personnel. In the competition for talent among Government, university, and industry laboratories, the opportunity to do some research must often be offered along with inducements of modern facilities, a creative working environment, and so forth. Therefore, the maintenance of a viable program of basic research by DOD would seem to be a desirable plus for its laboratories to be competitive. On the other hand, a significant reduction in basic research would appear to work against maintaining an environment to which scientists and engineers could be attracted by the opportunity to keep up with rapidly changing technologies.

BASIC RESEARCH IN DOD LABORATORIES HAS DECLINED SIGNIFICANTLY

DOD's overall support of basic research declined over 45 percent during the decade from the mid-1960s to the mid-1970s. As a result, basic research funding for DOD's in-house laboratories decreased more than 40 percent. 1/

1/All funds referred to in this section, unless specifically noted otherwise, have been converted to constant dollars. Constant dollars have been adjusted for inflation, thereby more closely approximating real purchasing power.

Since the mid-1970s, DOD has planned for annual growth in its basic research program. While the actual increases have not been as great as were hoped for, the additional funds that were received have been used to emphasize university research while funding for in-house basic research has remained near the low points reached in the mid-1970s.

Following the Soviet Sputnik launching in 1957, Federal support of basic research experienced a tremendous growth until the mid-1960s. The following decade--the mid-1960s to the mid-1970s--saw a steady decline, but it never declined as low as the pre-1957 Federal basic research support levels. DOD's funding of basic research followed a similar pattern, but with a less dramatic rise and fall. (See enc. I.)

The drop in basic research support by DOD affected the in-house laboratories as well as contract research performed by universities and industry. In our previous study, 60 percent of the DOD laboratory directors reported that during the 1972-77 time period, their basic research funding, even without considering the effects of inflation, had either decreased or remained constant. We found that in terms of real dollars, funds provided to the in-house laboratories for either their own use or for contracting out declined 41 percent from 1966 through 1975 before leveling off. The individual services followed generally similar patterns, with the Air Force experiencing a more severe decline than the Army and Navy. (See enc. II.)

We asked the services for the amounts of basic research funds retained and used by the in-house laboratories during the period under study. The Army, which spent about 65 percent of its basic research funds in-house in the mid-1960s and now spends about 55 percent in-house, had a 44-percent decline in basic research funds used in-house between 1966, its peak funding year, and 1975, after which in-house funding rose slightly before leveling off. The Air Force, which spent over 35 percent of its basic research funds in-house in the late 1960s and now retains about 20 percent of its funds for in-house basic research, had a 70-percent decline in basic research funds used in-house from 1968, its peak funding year, through 1976, with over half of the decline occurring between fiscal years 1976 and 1977. (See enc. III.) Although the Navy could not furnish comparable figures, the experience of the Army and Air Force clearly illustrates the extent of the overall decline of basic research performed in-house.

We felt that the severity of the decline could be substantiated by the numbers of DOD scientists and engineers

devoted to in-house basic research. However, only the Air Force, which showed the sharpest decline in funding, could supply figures. The Air Force had an average of more than 800 persons engaged in basic research from 1964 through 1975. Then the number dropped to about 250 in 1976, where it has since remained. A significant portion of this drop resulted from the Air Force's decision to close its Aerospace Research Laboratories located at Wright-Patterson Air Force Base, Ohio, and its Cambridge Research Laboratories located at Hanscom Field, Massachusetts, and to increase contracted research. Part of the drop also resulted from a shift to Exploratory Development (6.2) funding of work which had evolved into a more applied nature. These actions were taken in response to the DOD Laboratory Utilization Study.

The authorized personnel levels for all DOD laboratories dropped from about 72,000 in 1967 to about 59,000 in 1979. It seems reasonable that some considerable but immeasurable amount of basic research capability was lost to DOD in these personnel and basic research funding reductions.

DECLINE COULD ERODE LABORATORY CAPABILITY

A December 1975 report to the National Science Foundation, "Basic Research and Federal Laboratories: Problems of Institutional Choice," expressed concern that DOD decreases in in-house basic research would erode the quality of R&D in DOD laboratories. The report further stated that good reasons exist, such as maintaining laboratory health and the contributions that the laboratories make to American science, for even increasing the Federal laboratory role in basic research. Other studies point out that DOD has a continuing need to perform a significant level of in-house research 1/ and that the in-house research program should be strengthened as DOD's research program grows. 2/

1/"A Research and Development Management Approach: Report of the Committee on Application of OMB Circular A-76 to R&D" (Oct. 31, 1979, Executive Office of The President, Federal Coordinating Council for Science, Engineering, and Technology).

2/"Report of the Working Group on Basic Research in the Department of Defense" (June 22, 1978, Executive Office of the President, Office of Science and Technology Policy).

Laboratory directors also show concern about the decline of in-house basic research. In our earlier Government-wide study, one third of DOD's laboratory directors expressed concern about their laboratories' loss of opportunity to perform long term basic research. Officials at several DOD laboratories we visited for this study said that at the current level of in-house basic research, their laboratories' capabilities are eroding, although they stressed that personnel ceilings and grade controls, as well as the basic research funding level, are responsible for the perceived erosion.

DOD IS EMPHASIZING EXTERNAL BASIC RESEARCH

In the mid-1970s DOD became concerned about weaknesses in its research base, but primarily about its relationship with the academic community. Beginning in 1977, a policy commitment was made to seek 10 percent annual real growth in basic research funding until past declines were offset. Although the 10-percent goal has not been achieved, sufficient budget increases have been obtained to achieve some real growth after considering inflation. However, in-house laboratory efforts have been held constant while the budget increases have been used to enhance university relationships. For example, the decline of in-house basic research by the Air Force in 1976 (see enc. III) was offset by a sharp increase in Air Force support of university research. (See enc. IV.)

DOD's policy emphasizing the support of university research appears to be consistent with overall Federal policy. National Science Foundation figures show basic research funding to universities and colleges steadily climbing to new highs with the Federal Government supplying the bulk of the increases. (See enc. V.) However, if DOD is to continue its pattern of recent years, favoring university research with the growth contained in its budget, it would appear that in-house basic research will be held to the levels reached during past declines.

CONCLUSIONS AND RECOMMENDATION

Defense R&D provides the technological foundation for our national security. DOD in-house laboratories play a vital role in striving for technological leads in areas important to defense, guarding against technological surprise by an adversary, and providing options which shape our military posture. Doing basic research is essential to the laboratories' vitality because it helps them to attract good scientists, keep up with and use advances in science, and increase the overall level of technical ability.

The level of basic research performed at the in-house laboratories has seriously declined, and DOD's research growth is planned for the external research community. Allowing the laboratories to remain at the current level of basic research performance could erode their long term ability to perform those functions which are basic to supporting a mission organization. Therefore, we recommend that DOD's laboratory revitalization program consider whether the present level of in-house research is adequate to maintain the health and vitality of the laboratories and that you give the same careful consideration to the research base represented by the in-house laboratories as has been given to the needs of the external research community.

In discussing this report, spokesmen for the Army, Navy, and Air Force (the Acting Assistant Director for Research Programs, Office of the Director of Army Research; the Associate Deputy for Research, Applied and Space Technology, Office of the Assistant Secretary of the Navy for Research, Engineering and Systems; and the Deputy for Advanced Technology, Office of the Assistant Secretary of the Air Force for Research, Development and Logistics) agreed with our conclusions and recommendation. The Director for Research, Office of the Under Secretary of Defense for Research and Engineering (Research and Advanced Technology), also agreed, but emphasized that any consideration of the level of basic research must recognize that:

--Personnel ceilings and grade controls are also some of the primary factors inhibiting effective laboratory basic research efforts.

--It is the prerogative of the military departments to define the roles that their in-house laboratories should play in the R&D process, taking into account the sometimes highly specialized, capital intensive nature of some aspects of Defense research.

--The level of basic research for each laboratory should differ because it should be geared to the unique mission of the laboratory.

--It would be better to affect a true increase in 6.1 in-house funding by an overall increase in 6.1, and not achieve it through a corresponding reduction of the planned growth in extramural basic research.

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As you know, section 236 of the Legislative Reorganization Act of 1970 requires the head of a Federal agency to submit a written statement on actions taken on our recommendations to the House Committee on Government Operations and the Senate Committee on Governmental Affairs not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

We are sending copies of this report to the Directors, Office of Management and Budget and Office of Science and Technology Policy; the chairmen, Senate and House Committees on Appropriations and Armed Services; the chairmen, House Committees on Government Operations and Science and Technology; the chairmen, Senate Committees on Governmental Affairs and Commerce, Science, and Transportation; the Under Secretary of Defense for Research and Engineering; and the Secretaries of the Army, Navy, and Air Force.

We would appreciate being informed of the actions you plan to take in response to our recommendation. If you have questions or wish to discuss the report, please call Earl Morrison on (202) 275-3195.

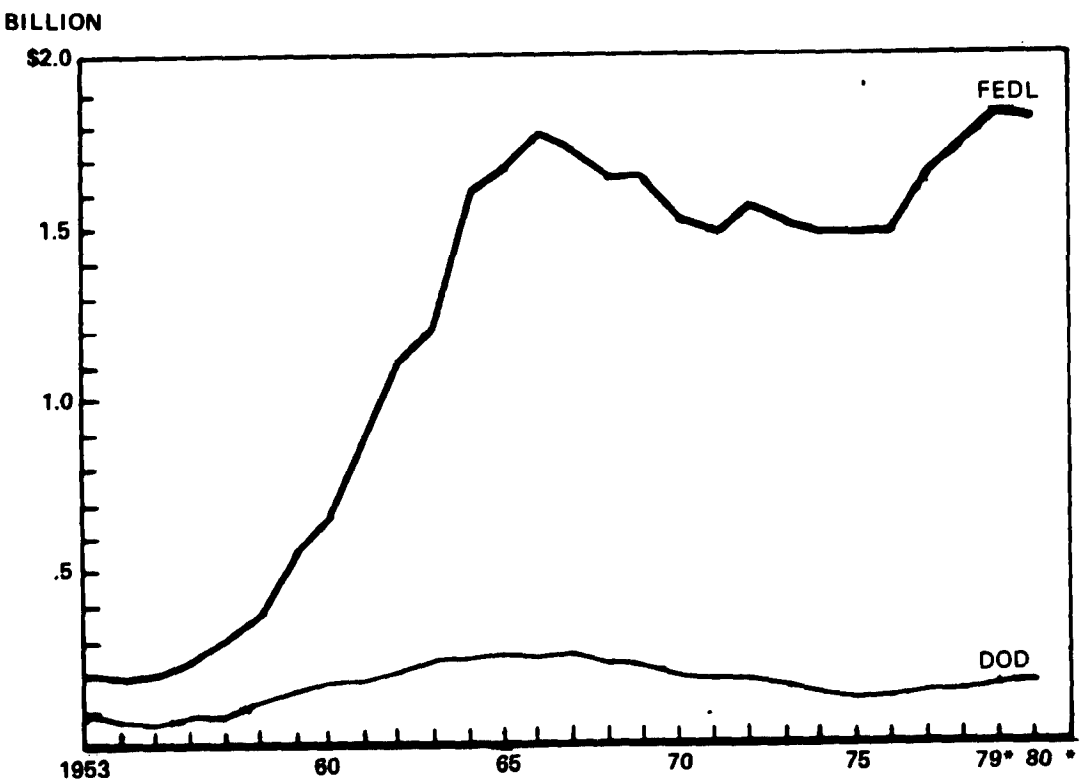
Sincerely yours,

W. H. Sheley, Jr.
Director

Enclosures - 5

ENCLOSURE I

TOTAL FEDERAL AND DOD BASIC RESEARCH OBLIGATIONS (a)



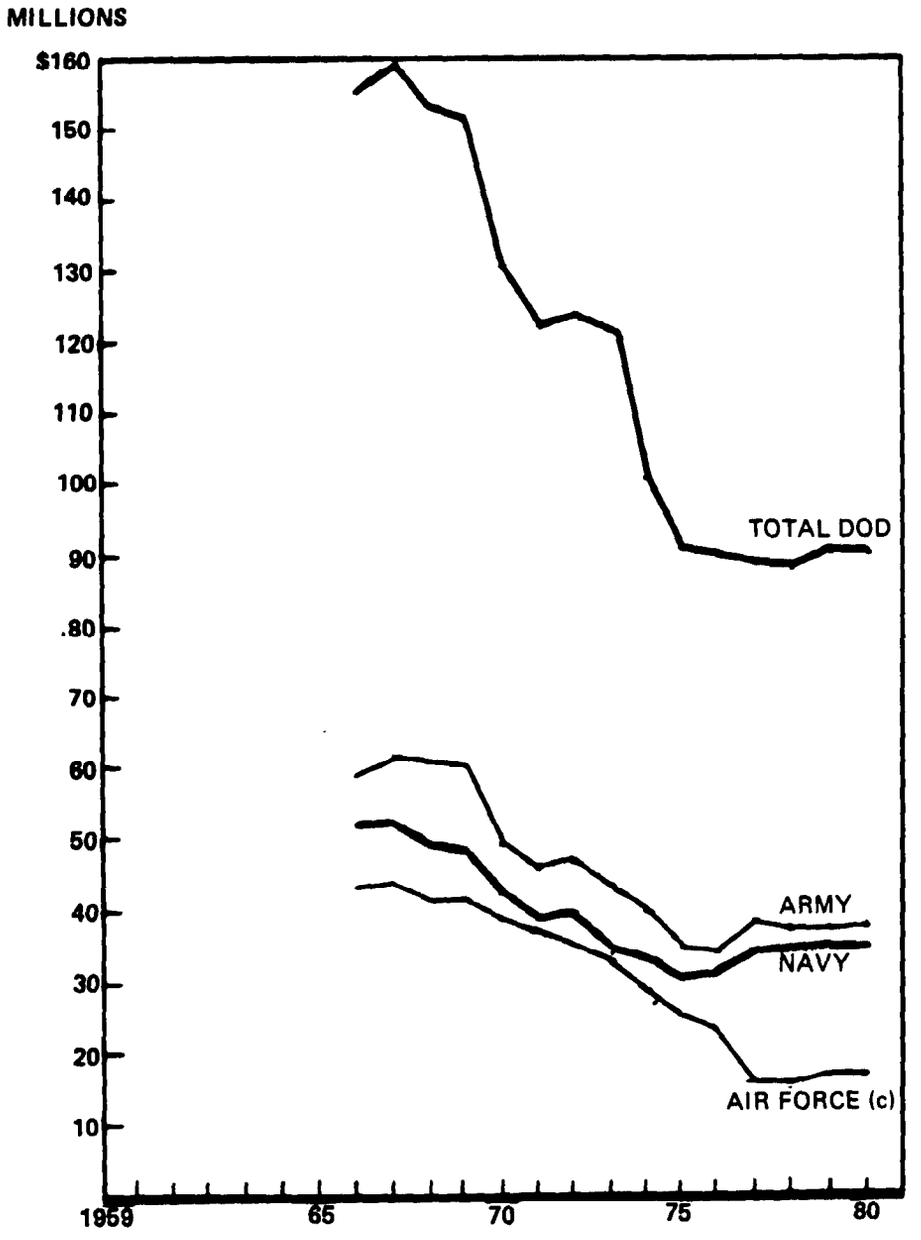
Source: Prepared by GAO using National Science Foundation Basic Research figures and DOD's RDT&E Deflator.

* Estimated

a/ Funding figures in this graph were converted to constant dollars using 1965 as the base year.

ENCLOSURE II

DOD BASIC RESEARCH (6.1) FUNDS GIVEN TO IN-HOUSE LABS (a and b)



Source: Prepared by GAO from figures obtained from DOD and using DOD's RDT&E Deflator.

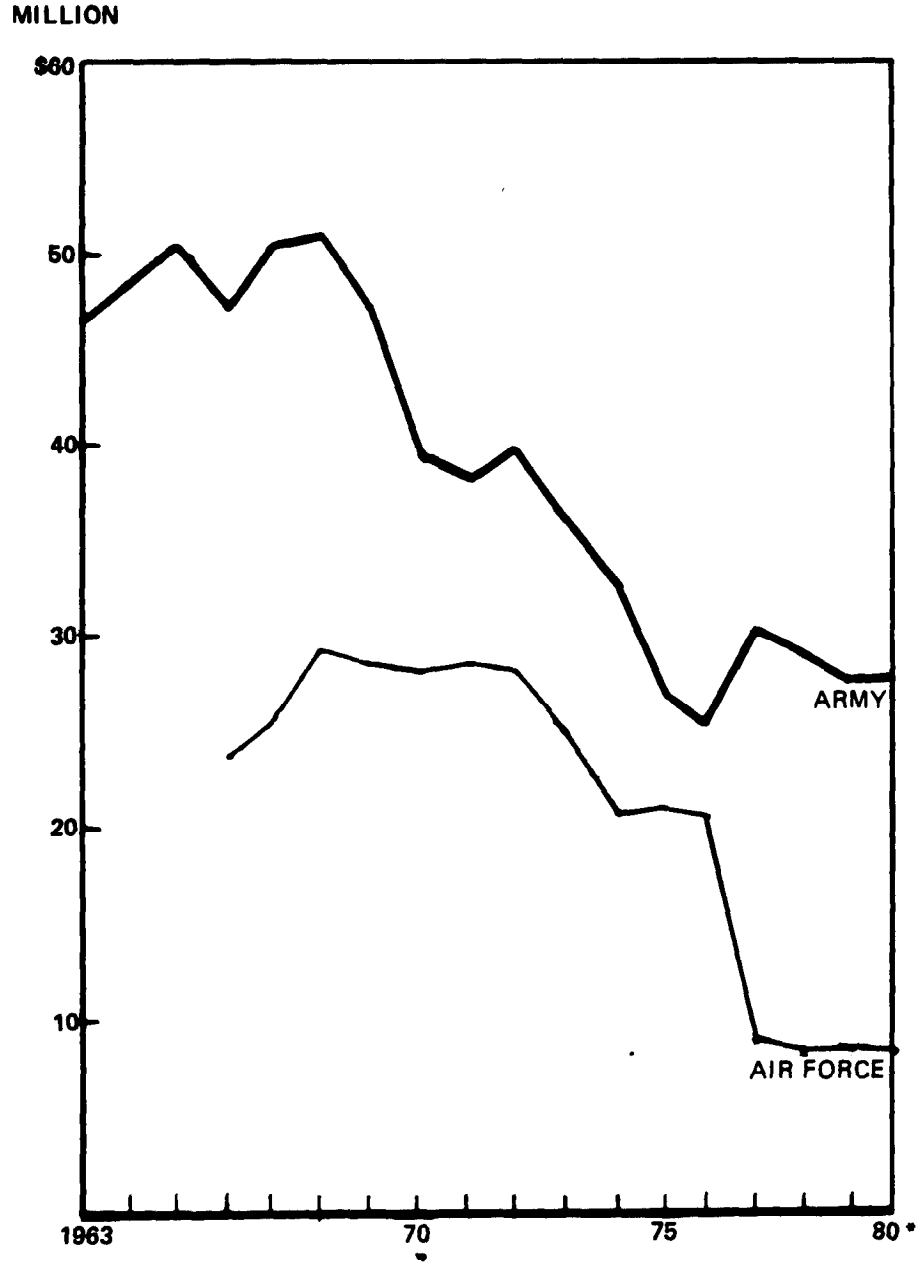
a/ Funding figures in this graph were converted to constant dollars using 1965 as the base year.

b/ Funds given to in-house labs for research and the amount they perform is not exactly the same because labs contract some of their research work and get a small amount of research funds from other organizations, but it is indicative of the trend in the level they perform.

c/ Air Force provided figures for the Defense Research Sciences funding given to Air Force in-house labs, which accounts for about 92 percent of total 6.1 funding.

ENCLOSURE III

ARMY AND AIR FORCE BASIC RESEARCH (6.1) FUNDING USED IN-HOUSE AT LABORATORIES (a and b)



Source: #Prepared by GAO using Army and Air Force figures and DOD's RDT&E Deflator.

* Estimated

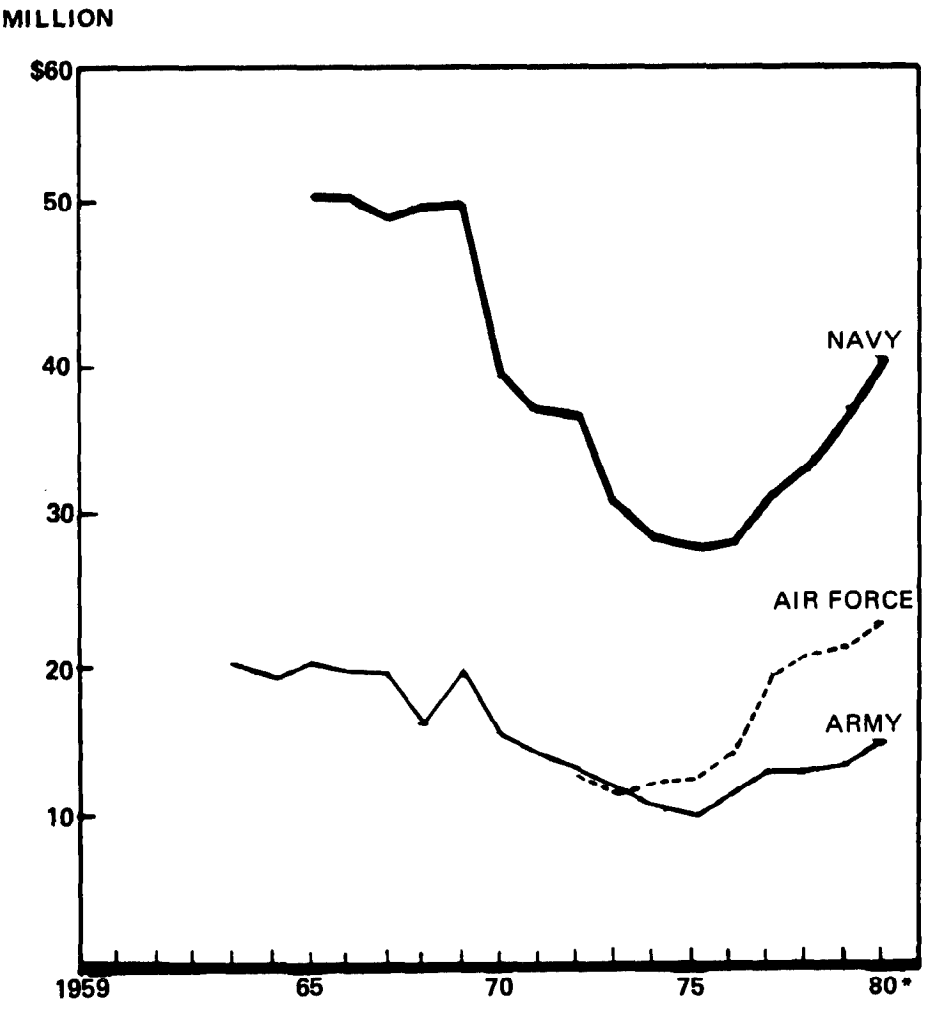
a/Funding figures in this graph were converted to constant dollars using 1965 as the base year.

b/Air Force provided figures for the Defense Research Sciences funding given to Air Force in-house labs. This represents about 92 percent of total 6.1 funding given to Air Force labs.

#Navy was unable to supply figures on 6.1 funding actually used in-house at its laboratories.

ENCLOSURE IV

ARMY, NAVY, AND AIR FORCE 6.1 FUNDING TO UNIVERSITIES (a)



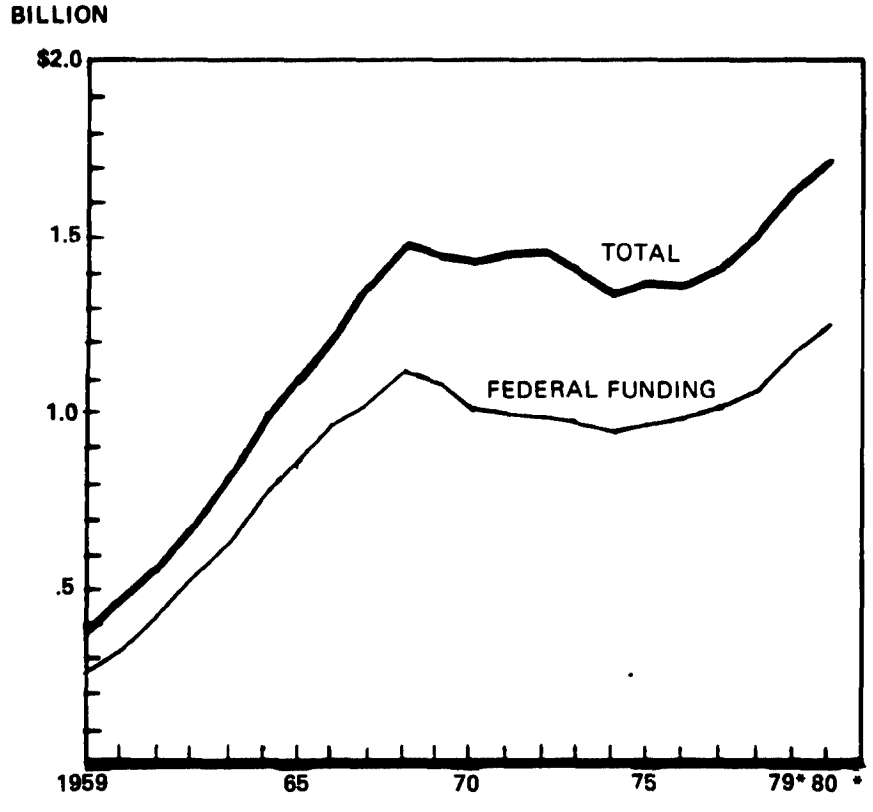
Source: Prepared by GAO from figures obtained from Army, Navy, and Air Force using DOD's RDT&E Deflator.

* Estimated

a/ Funding figures in this graph were converted to constant dollars using 1965 as the base year.

ENCLOSURE V

UNIVERSITY AND COLLEGES TOTAL BASIC RESEARCH FUNDING AND THE PORTION SUPPLIED BY THE FEDERAL GOVERNMENT(a)



Source: Prepared by GAO using figures obtained from the National Science Foundation and DOD's RDT&E Deflator.

* Estimated

a/ Funding figures in this graph were converted to constant dollars using 1965 as the base year.