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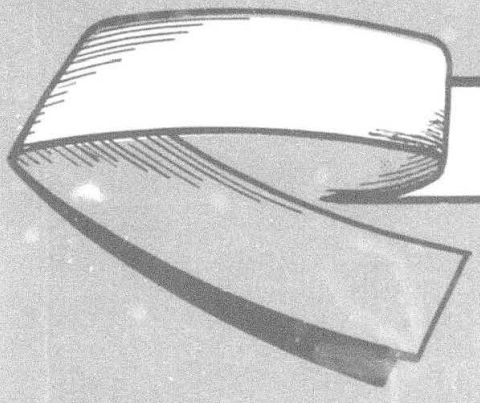
# Report of the Defense Science Board Subcommittee on

# Department of Defense RESEARCH POLICY





## Part I. Policy on Support of Basic Research

31 December 1963



Office of the Director of Defense Research and Engineering
Washington, D.C.

UNCLASSIFIED

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# DEPARTMENT OF DEFENSE

# RESEARCH POLICY

## Part I. Policy on Support of Basic Research

Report of the
Defense Science Board Subcommittee
on Department of Defense Research Policy

Office of the Director of Defense Research and Engineering
Washington, D. C.

31 December 1963

OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON, D. C. 20301

31 December 1963

TO: THE SECRETARY OF DEFENSE

THROUGH: THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING

The Defense Science Board respectfully submits its first report on Department of Defense research policy. This report is Part I of a continued study being conducted by the Board. The findings and conclusions it contains are the work of the Subcommittee on Department of Defense Research Policy, established in April 1963, which consisted of Dr. Frederick Seitz (Chairman), Dr. Harvey Brooks, Dr. Richard A. Kern, Dr. E.M. Piore, Dr. Allen E. Puckett and Dr. Clifford F. Rassweiler The subcommittee is a joint effort of the Defense Science Board and the President's Science Advisory Committee.

The subcommittee is to be commended for its searching analysis of our policies and their associated problems. The study will be continued by a reconstituted subcommittee (reflecting changes in the membership of the Board with the new year) which expects to offer recommendations to supplement the conclusions offered here. Much of the data contained in this report appears in this form for the first time and was, in fact, generated at the express request of the subcommittee. In consequence, its preparation entailed a great deal of extra work; special mention should be made of the fine cooperation of the staffs of the Director of Defense Research and Engineering and the Advanced Research Projects Agency.

This first report includes tables of fiscal data and nine conclusions based on them. Their general import is briefly summarized in Dr. Seitz's memorandum that follows.

In conclusion, I wish to express my appreciation of Dr. Harold Brown's cooperation and continuing interest in this study.

C. C. Furnas

C. C. Furnas, Chairman
Defense Science Board

OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON, D. C. 20301

31 December 1963

MEMORANDUM FOR THE CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: DSB Subcommittee Report on DoD Research Policy, Part I

The Subcommittee on Department of Defense Research Policy herewith submits Part I, "Policy on Support of Basic Research," of its report. This study will be continued by the subcommittee, as reconstituted to allow for changes in Board membership that will take effect with the advent of the new year.

This report briefly traces the history of postwar support of basic research by the Navy and by the Department of Defense. It shows how the Department of Defense, principally through the Navy, was primarily responsible for setting the pattern for support of basic research in those years.

After a period of rapid growth, fiscal support of the research, development, test and evaluation programs of the Department of Defense has essentially leveled out. (The RDT&E programs in some other segments of the Federal Government are still on the upward trend.) Nevertheless, the Defense RDT&E budget is still almost one-half of that of the Federal Government, so its structure is of great importance in research. The effect of the declining growth rate of the DoD program has already been strongly felt across the board in defense industries and in universities. The fact that the Defense program is the largest segment of the whole makes the impact of limitations on its growth even more pronounced.

Not only are these trends a cause for concern with regard to the general support of research, but they give rise to other effects that could have a markedly detrimental effect on the health of our whole national research effort. There is a steady decline in the support of independent investigators because of the preferential treatment of certain defense-oriented program packages. The national oceanographic program is a case in point.

The effects of our policies on the support of independent research and development associated with procurement contracts also need close attention. This is not an argument against a well-conceived program of support for independent research in industry; rather, it is for the consideration of a somewhat similar program for the institutional support of universities. Since the Department of Defense is still one of the largest employers of university graduates, the health of the universities is a matter of vital concern in the national defense.

In short, our study shows that, thus far, one of the main effects of the declining growth rate of DoD research funds has been to cause the various Defense agencies to limit severely below bona fide needs the support of general basic research (especially in the universities) of broad interest in relation to the DoD's mission. Because the Department of Defense plays a major role in the national research and development effort, the responsibility for the health of basic research cannot be delegated to other agencies but must remain a major concern of the Department of Defense.

F. Seitz
Chairman for the Subcommittee

## FOREWORD

This report, Part I of the Subcommittee's study, deals with policies of the Department of Defense relating to the support of basic research. In Part II, the subcommittee will consider the Department's role in the national, governmentwide research program. It is expected that recommendations will be presented in that report.

The funding figures in the tables of this report are generally valid as of 1 August 1963, although some figures reflect Congressional appropriations for 1964. In general, financial data are offered here to demonstrate trends in research support and relative emphasis rather than to represent official, approved or proposed budgets. The proposed Federal budget for 1965 and Congressional action on the President's budget for 1964 emphasize some of the conclusions drawn herein (based on earlier data) pertaining to the leveling off of Defense support of technical activity.

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# 1. BACKGROUND

## 1.1 Postwar Research

In the period after World War II, the Department of Defense was the first governmental organization to respond vigorously to the challenging opportunities expected to arise from the support of basic science in peacetime as well as war—a challenge effectively described by Vannevar Bush in Science: the Endless Frontier.(1)

In 1946, after a period of careful study, the Navy established the Office of Naval Research (ONR) under a broad charter to support basic and applied research in order to keep the Navy in close touch with the basic scientific work carried on within the government and by industry and the universities. The new Office reported directly to the Secretary of the Navy through an Assistant Secretary. Along with other functions, the ONR was responsible for the operation of the Naval Research Laboratory. From the start, ONR took a broad view of the mission of research in the Navy and excluded few areas of basic science from its purview. It is interesting that ONR was set in operation during the early postwar period when the challenge of the U.S.S.R. was not yet a critically motivating force in the establishment of national policy. Thus, the original guidelines for ONR were not necessarily based on the notion that we would soon face another great national emergency.

It is safe to say that the policies established by the Department of Defense (DoD) through the Navy in the late 1940s profoundly affected the support of science by all government agencies. One can clearly detect ONR's influence, not only on such other Defense agencies as the Army Research Office and the Air Force Office of Scientific Research, but in relation to other research-sponsoring government agencies, e.g., the National Science Foundation, the National Institutes of Health and the Atomic Energy Commission. It is no exaggeration to say that the Department of Defense played a crucial role in setting the pattern of basic-science support by governmental agencies in the postwar years. As late as 1954, over two-thirds of all government-supported work in basic science conducted by universities was sponsored by the Department of Defense.

Inevitably, as other agencies grew larger, the amount of DoD funds devoted to basic research became a smaller fraction of the total national effort. Meanwhile, it was natural for the Department of Defense to reexamine its own policies regarding the support of basic research.

## 1.2 Basis of Study

In this report, the subcommittee attempts to analyze the changes in support that are actually taking place, based on budget studies and discussions with responsible agency personnel. An effort is made to analyze the long-range

implications of policies, and possible changes are proposed. With regard to this survey, the subcommittee recognizes the following premises:

(1) The success of the development, testing and evaluation programs supported by the Department of Defense still depends to a substantial extent on the amount and quality of the basic research being performed throughout the country.

(2) Through the support of basic research, the Department of Defense should see that scientists and engineers in government laboratories maintain some degree of direct association with those engaged in similar research for industry and the universities. There are two good reasons for this: (a) Those people in the DoD who are assigned responsibility for programs of development, testing and evaluation should always have firsthand knowledge of the techniques and results of the basic work. (b) Scientists and engineers outside the government should appreciate that their discoveries are highly relevant to DoD programs and, in fact, contribute to the defense of the nation.

(3) The Department of Defense and its contractors will need, to an ever-increasing degree, the most highly trained scientists and engineers our educational institutions can provide. Even though the numerical demand for technically trained people may level off, the requirement for higher levels of competence, education and experience in science and engineering will continue to grow; there will be a greater and greater demand for people with Ph.D.'s, or equivalent training, in activities for which the DoD is directly responsible.

Further, to the extent to which scientists and engineers know about Defense activities from having participated in contract work, the DoD will find it easier to recruit them for permanent or temporary staff positions and for service on advisory committees, boards and panels. Thus, the contract program on basic research can be a wide-open doorway to the community of scientists and engineers.

## 1.3 Growth of Government-Supported Research

With regard to the general status of basic research in the United States, it must be recognized that since the end of World War II overall government support of research, development, testing and evaluation (RDT&E) has grown more or less geometrically, in general with a doubling time of the order of 4 or 5 years. Fluctuations in the actual rise of government activity in this area are related to special events such as the Korean War and the development of new nuclear weapons, to advances in the missile and space programs and to the increasing interest in national health. At the present time, the total Federal budget devoted to RDT&E is in the vicinity of $15 billion.

Since 1945, the government's support of basic research has tended to keep pace with its overall support of RDT&E; it has grown, as in the case of RDT&E, more or less geometrically, with a doubling time of 3 or 4 years during 1953-1963. This rapid rate of growth has been associated in part with increases in the budgets of individual agencies and in part with the establishment of new agencies over the years.

It should be emphasized that governmental agencies, including the DoD, do not define basic research in any unique way. The designation "basic," therefore, is a relative one, and different analysts draw their budgetary lines to a substantial degree

arbitrarily. As the subcommittee is interested primarily in the DoD's support of research, particularly with regard to changing trends in that area, the designations employed in this report are those commonly in use within the Department of Defense. It is realized that the degree of arbitrariness that is valid in considering the numerical information for any one year becomes less important when one compares the figures for a sequence of neighboring years, even though they still appear somewhat arbitrarily derived. The same principle applies when DoD figures are compared with those of outside agencies.

The geometrical growth of all government support of basic science in this country since World War II—doubling about every 5 years, or increasing about 15 percent per year on the average—has given rise to certain attitudes among scientists and engineers engaged in basic research; for example:

(1) There is a tendency for individual laboratories and other research institutions to regard an annual budget increase of about 15 or 20 percent as normal or healthy.

(2) Accordingly, a growth of half that amount—say, in the neighborhood of 8 percent—is regarded as conservative or modest. Generally speaking, such a "modest" increase means that three items are placed in sharp competition: (a) increases in salary for the current staff, (b) new personnel and (c) new equipment.

(3) Finally, a growth in the overall research budget by an amount comparable to the real growth of the gross national product—that is, of the order of 3 percent per year—is regarded as exceedingly restrictive, leading in general to a decay in salary structure, personnel and equipment.

## 1.4 History of Subcommittee

One of the subsidiary activities of the Defense Science Board, on its establishment in 1956, was an Advisory Panel on General Sciences. Dr. Athelstan Spilhaus served as the Panel's first chairman; the second chairman was Dr. Robert W. Cairns. The Panel attempted to review the status of the DoD's support of basic research and to establish pertinent guidelines. During its years of activity, the Panel examined many of the trends in support of basic research. In the period immediately after Sputnik I was launched into orbit, the Panel effectively refocused the DoD's attention on the importance of work in basic science.

In 1961, when the Defense Science Board was reorganized, the Panel was eliminated, with the understanding that the Board itself would undertake the analysis of basic research as a continuing responsibility. In the winter of 1962-63, the chairman of the Board, Dr. C.C. Furnas, proposed to Dr. Harold Brown, Director of Defense Research and Engineering, and Dr. J.B. Wiesner, Special Assistant to the President for Science and Technology, that the Defense Science Board and the President's Science Advisory Committee form a joint subcommittee to review the status of basic-research support by the Department of Defense. The proposal was accepted, and Dr. Furnas appointed Dr. F. Seitz as chairman of the subcommittee. The Board and the Committee then selected the following members:

Dr. Richard A. Kern — Dr. Harvey Brooks
Dr. Allen E. Puckett — Dr. E.M. Piore
Dr. Clifford F. Rassweiler

Informal discussions within the Board and the President's Science Advisory Committee had indicated, before this subcommittee was organized, that the Department of Defense was altering in a complex way its concept of the type of basic research needed in carrying out its mission. On one hand, the Department of Defense was increasing the amount of money intended for work in oceanography (ONR and others) and materials science (interdisciplinary laboratory program of the Advanced Research Projects Agency) and for in-house Defense laboratories. Moreover, through the independent research contribution of ASPR-XV(2) and other similar mechanisms, the DoD was supporting basic research in the defense industries more broadly than ever. On the other hand, the growth of the contract program that supports individual investigations and studies outside the DoD's well-defined program packages was, in a relative sense, slowing down. It seemed advisable to assess the magnitude and consequences of those changes.

## 2. CONCLUSIONS

### 2.1 Contract Research[1]

Table I shows the Department of Defense budget for contract RDT&E in fiscal years 1962, 1963 and 1964. Roughly comparable figures (estimated expenditures) for the government as a whole appear in Table II. (It should be reemphasized that comparing the budgets of different agencies is difficult.) Two general conclusions are obvious and, indeed, have been so for some time:

Conclusion 1: The overall increase in the Federal Government's support of RDT&E (about 15 to 20 percent per year) is caused primarily by the rapid growth of the newer agencies, particularly the National Aeronautics and Space Administration (NASA).

Conclusion 2: The growth of RDT&E in the Department of Defense has substantially leveled out.

Table III shows an attempted breakdown of FY 1963 RDT&E obligations into six categories for the three Military Departments and the Advanced Research Projects Agency (ARPA). Table IV shows a similar breakdown of FY 1963 obligations for basic research. Based on Tables III and IV, the following conclusions may be drawn:

Conclusion 3: The fractions of the DoD's basic-research budget devoted to work in academic and in-house laboratories are by far the largest of the six categories in Table IV. Together, they represent about 75 percent of the total.

Conclusion 4: The funds devoted by the Navy to basic research represent about 5 percent of the Navy's total RDT&E budget. For the Army, this fraction is about 2½ percent; for the Air Force, about 2 percent and for ARPA, 9 percent. These different percentages reflect traditional differences in the Services' attitudes.

Table V shows obligations for basic research in FY 1963 by ARPA and the contracting agencies of the Military Departments. The budget for ONR includes $22 million for basic research to be conducted by the Naval Research Laboratory (NRL).

Conclusion 5: It is noted that ONR, in keeping with the Navy's tradition, devotes the largest sum to basic research, in total amount about the same as the Air Force but, percentagewise, over twice that noted above.

Table VI shows ARPA's budget for fiscal years 1962, 1963 and 1964, broken down into four categories. Currently about 65 percent of these funds is rigidly committed, and another 20 percent is in fixed categories.

Conclusion 6: The total budget of ARPA is growing relatively slowly, less than 10 percent each year.

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[1]Tables I through VII do not include any component of research arising from the so-called independent research and development program appearing as part of the overhead on procurement contracts. (See section 2.2.)

Table I. Department of Defense R&D Obligational Authority
($ millions)

| Agency | FY 1962 | FY 1963 | FY 1964 |
|---|---|---|---|
| Army | 1,337.2 | 1,226.8 | 1,422.8§ |
| Navy | 1,318.9* | 1,490.5 | 1,525.7** |
| Air Force | 2,529.9 | 3,567.8 | 3,524.1§§ |
| Defense agencies (other than ARPA) | -- | 195.5 | 159.4 |
| Emergency Fund | -- | 107.4 | 150.0 |
| Advanced Research Projects Agency | 191.6 | 252.4 | 274.6 |
| Adjustment to reflect comparability with current budget structure | 1,034.7 | -- | -- |
| Total DOD NOA*** | 6,412.3 | 6,840.4 | 7,056.6 |

Notes: *Includes $1,308.9 million in budget document, plus unprogrammed carryover of $10 million from FY 1961.
§House action on NOA, plus $59.7 million moved from FY 1963.
**House action.
§§House action, plus $108 million moved from FY 1963.
***NOA—new obligational authority.

Table II. U.S. Government Administrative Budget Expenditures for Federal R&D Programs*
($ millions)

| Agency | FY 1962 | FY 1963 | FY 1964 |
|---|---|---|---|
| Department of Defense | 6,720.4 | 7,027.0 | 7,583.6 |
| National Aeronautics and Space Administration | 1,142.8 | 2,050.0 | 3,641.0 |
| Atomic Energy Commission | 1,029.2 | 1,150.0 | 1,191.8 |
| Department of Health, Education and Welfare | 459.4 | 604.0 | 720.1 |
| Department of Agriculture | 150.4 | 164.8 | 179.6 |
| National Science Foundation | 84.2 | 105.2 | 116.0 |
| Department of the Interior | 77.5 | 95.0 | 112.1 |
| Federal Aviation Agency | 43.1 | 58.6 | 55.6 |
| Department of Commerce | 35.3 | 49.5 | 63.2 |
| Other | 50.7 | 66.9 | 82.2 |
| Total Government | 9,793.0 | 11,371.0 | 13,745.2 |

Note: *Administrative Budget of the U.S. Government for FY 1964, Table G-14, pp. 406-407.

Table III. Estimated DoD Obligations for RDT&E in FY 1963
($ millions)

| | Army | Navy | Air Force | ARPA | Total |
|---|---|---|---|---|---|
| Academic | 44.8 | 64.5 | 131.2 | 36.7 | 277.2 |
| Research centers (university-operated) | 7.8 | 53.5 | 26.2 | 24.0 | 111.5 |
| Not for profit | 17.3 | 16.3 | 198.7 | 28.4 | 260.7 |
| In-house | 509.1 | 605.8 | 668.4 | 22.1 | 1805.4 |
| Profit | 764.9 | 739.4 | 2957.9 | 172.6 | 4634.8 |
| Foreign | 7.8 | 1.8 | 5.3 | 2.9 | 17.8 |
| Total | 1351.7 | 1538.0* | 3987.7 | 286.7 | 7164.1* |

Note: *Includes $56.8 million of work done by others.

Table IV. Estimated DoD Obligations for Basic Research in FY 1963*
($ millions)

| | Army | Navy | Air Force | ARPA | Total |
|---|---|---|---|---|---|
| Academic | 8.0 | 32.9 | 29.0 | 20.7 | 90.6 |
| Research centers (university-operated) | 4.0 | 2.0 | 5.6 | -- | 11.6 |
| Not for profit | 0.3 | 6.0 | 3.2 | 0.7 | 10.2 |
| In-house | 15.3 | 30.6 | 20.1 | 1.6 | 67.6 |
| Profit | 4.9 | 4.4 | 10.6 | 7.2 | 27.1 |
| Foreign | 2.6 | 0.8 | 4.5 | 0.8 | 8.7 |
| Total | 35.1 | 76.7 | 73.0 | 31.0 | 215.8 |

Note: *Contract program exclusive of independent research and development charged to overhead on procurement and other contracts under ASPR-XV.

Table V. Estimated Obligations of Military Contracting Agencies and ARPA for Basic Research in FY 1963
($ millions)

| Agency | FY 1963 |
|---|---|
| Army Research Office | 16.5 |
| Office of Naval Research | 50.2 |
| Air Force Office of Scientific Research | 33.5 |
| ARPA | 31.0 |

Table VI. ARPA Budget for Fiscal Years 1962, 1963 and 1964
($ millions)

| | FY 1962 | FY 1963 | FY 1964 |
|---|---|---|---|
| Total budget* | 250.6 | 254.4 | 274.6 |
| Basic research | 32.8 | 30.7 | 35.2 |
| Academic | 11.3 | 16.5 | 20.3 |
| University-sponsored research centers | 32.3 | 20.8 | 23.5 |
| Interdisciplinary materials research laboratories | 14.5 | 15.5 | 16.4 |

Note: *This includes command and control research budgets of $8.2, $10.2 and $12.2 million for FY 1962, 1963 and 1964, respectively. These figures differ from expenditures because of the carryover from past years, etc. ARPA had a total of $223.7 million for applied research in FY 1963. These are program figures, chiefly from funds appropriated by the Congress but also including some emergency funds; i.e., these represent funds available for obligation or expenditure. The 1964 figures reflect Congressional appropriations in October 1963.

Table VII. Summary of National Oceanographic Program*
($ thousands)

| Agency | FY 1961 | FY 1962 | FY 1963 | President's Budget FY 1964 |
|---|---|---|---|---|
| Department of Defense | 31,615 | 42,081 | 55,246 | 74,966** |
| Department of Commerce | 11,400 | 21,996 | 24,024 | 24,646 |
| Department of the Interior | 8,708 | 14,248 | 16,106 | 18,960 |
| National Science Foundation | 7,883 | 17,467 | 19,530 | 24,841 |
| Atomic Energy Commission | 1,691 | 3,850 | 5,428 | 4,915 |
| Department of Health, Education and Welfare | 694 | 1,259 | 2,809 | 4,093 |
| Department of the Treasury | 133 | 134 | 511 | 1,152 |
| Smithsonian Institution | --- | --- | 431 | 605 |
| Totals | 62,124 | 101,035 | 124,085 | 154,178** |

Notes: *See reference 3.

**It is now estimated that for FY 1964 the DoD budget will be approximately $54 million and that the total government program will be about $130 million. Defense funds for the National Oceanographic Program do not include total Defense support of oceanography. Some classified projects and projects of a more direct and unique military nature are not included in the national program.

Conclusion 7: The component of ARPA's budget that is devoted to basic research, including the interdisciplinary materials laboratories, has been relatively stable. Even if the FY 1964 figure is allowed, the percentage of ARPA's total budget earmarked for basic research will be small.

It should be stated that during FY 1963 the Director of ARPA seriously considered transferring the interdisciplinary materials program to the National Science Foundation and, in fact, discussed this matter with Dr. Wiesner and with the chairman of the appropriate committees of the Congress. Within the ODDR&E, there was by no means unanimous opinion on this issue. Negotiations with the National Science Foundation are being held in abeyance while further studies are made.

Table VII shows the budget for the National Oceanographic Program for fiscal years 1961 through 1964; for FY 1964, proposed figures are shown. It may be noted that a substantial portion of the funds (nearly half) is contributed by the Department of Defense, principally the Navy. The annual rate of growth has exceeded 20 percent in the past 3 years. The President's budget for FY 1964 reflected a desire to continue this rapid growth rate. Not all of this money originates in the RDT&E budget, but the fraction derived from that source has followed a parallel trend.

It is interesting that the government's annual expenditure for oceanography is now about the same as the total national expenditure for high-energy physics, and the Executive Branch would like it to grow faster. It should be emphasized that, of the proposed $10 million addition to the ONR budget from FY 1963 to FY 1964, $3 million is for work in oceanography, $2.8 million for a cyclotron at NRL, and $2 million for refurbishing or updating NRL equipment. Those three items account for nearly 80 percent of the increase.

Conclusion 8: At present, the DoD's attitude toward the support of general research bearing broadly on its mission is uncertain; Defense funds are being directed preferentially to pragmatic program packages and in-house laboratories—that is, to those activities which are more and more narrowly related to missions of the Military Services.

## 2.2 Independent Research and Development

For many years it has been standard practice to permit certain charges against DoD contracts for industrial research and development and technical work associated with the preparation of proposals. In 1959 the cost principles in ASPR-XV(2) were revised and made uniform to provide for the recovery of certain costs for independent R&D as an element of overhead, the amount being negotiable. Thus, through this provision, a considerable amount of support for research and development is now provided under both RDT&E and procurement contracts.

A preliminary estimate indicates that, in calendar year 1962, industry recovered through ASPR-XV about $480 million[2] of cost for independent R&D on about $25 billion of procurement. About $370 million of this went to 80 large companies, each with programs in excess of a billion dollars a year. The remaining $110 million was divided among a great number of smaller companies.

[2]The figures have been adjusted to provide for uniform treatment of overhead.

This estimate also indicates that another sum of approximately $275 million was charged to contracts for technical work in connection with the preparation of bids and proposals. In addition, about $140 million of cost for various other types of technical activity, accumulated in many Defense contractors' accounts, was recovered by industry. Table VIII is an approximate breakdown of this $895 million for technical work charged to procurement.

**Table VIII. General Breakdown of Charges for Technical Work to Procurement Contracts in CY 1962**

| Type of work | Percent |
|---|---|
| Research | 10% |
| Development | 50% |
| Preparation of bids and proposals | 30% |
| Other | 10% |

At the present time, an effort is being made through a governmentwide study to arrive at uniform principles and procedures, with a view to their adoption by as many agencies as feasible. A more inclusive definition of independent research and development is being proposed to avoid the uncertainties arising from the diversity of accounting treatments of these costs throughout industry.

There is no doubt that the recovery of such R&D costs under government contracts is both desirable and necessary. Moreover, as long as potential contractors follow competitive bidding procedures and cost allowances are carefully reviewed and negotiated, it should be relatively easy to keep these costs within reasonable bounds. It is also clear that the use of such funds constitutes an excellent means by which government-oriented industries can maintain stable research policies and keep outstanding research staffs on a continuing basis.

Conclusion 9: Through the ASPR-XV provision for the recovery of cost for independent research and development and related work, the Department of Defense is now supporting scientific and technical work in industry at a rate of nearly a billion dollars a year. The amount devoted to research is of the order of $90 million.

It is probably not coincidental that the establishment of this ASPR-XV provision was paralleled by the establishment and expansion of research laboratories by the defense industry. Presumably, the total numbers of scientists and engineers needed to staff these industrial laboratories and the distribution of maturity of technical and scientific people are comparable to similar needs of the DoD-supported basic research programs of the universities. Thus, despite the great value of the independent industrial research programs, it must be recognized that they tend to compete with the universities for staff personnel over a range of ages.

In considering the effect of independent R&D on competition between industry and the universities, one ought to stress the importance of the institutional nature of industry's program. One of the most discouraging and depressing factors of academic scientific life is the constant worry over research support and the

constant arguments over, and competition for, support. This is most serious in fields in which industry already has fairly strong basic programs. This is not an argument against the industrial program, but rather for some similar type of support for universities.

Some newer tables are provided in Appendix B to this report; they contain figures that are generally comparable to those already presented and will, in turn, require revision as FY 1964 progresses. Discrepancies are due in part to changes in funding estimates and in part to the reworking and reclassification of the figures.

Table IX gives the DoD's total obligational authority for fiscal years 1960 through 1964.

**Table IX. New DoD Total Obligational Authority**
**($ millions)**

| Fiscal year | TOA |
|---|---|
| 1960 | 40,628 |
| 1961 | 41,321 |
| 1962 | 47,846 |
| 1963 | 49,961 |
| 1964 | 49,913 |

To supplement the foregoing general summary of Defense research, military medical research is briefly discussed in Appendix A to this report.

## 3. EFFECT OF DOD'S RDT&E FUNDING LEVEL ON BASIC RESEARCH

With regard to DoD funds for the support of RDT&E, the subcommittee notes that a ceiling on their rate of increase has emerged that is far below the average annual increase (15 to 20 percent) in all government-supported research over the last 15 years. Unless this matter is given very special attention, it will pose grave problems relating to the DoD's support of basic research. If such a ceiling is maintained in the years ahead, the situation will become even more severe, because, with the rise in technological sophistication that characterizes weapons development, typical RDT&E items will cost more and more.

The evolution of the pattern of supporting independent research by allowing some of its cost to be charged to procurement contracts has, in one sense, eased the financial problem. But this helps only in one segment of our national research capability—the Defense-supported industry.

The subcommittee's study shows that, thus far, the main effect of this ceiling has been to cause the various Defense agencies to restrict severely the support of general basic research (especially in the universities) of broad interest in relation to the DoD's mission. There has been a growing tendency to focus on highly specialized program packages and on work by the in-house laboratories, which indeed have been in financial difficulties for years.

Although about 4 years ago university programs in materials research were considerably enhanced, in a special way, as a result of ARPA's interdisciplinary laboratory program, that effort is now reaching the point of saturation.

The present level of support for broad university research would be justifiable if the DoD's activities and interests in research could be cleanly separated from those of the universities. It seems highly debatable, however, that in the long run such a separation would work to the DoD's advantage for the following reasons:

(1) The university laboratories—in particular, where independent investigators are concerned—are still the source of an enormous amount of the most valuable basic work. This will remain the case for the foreseeable future, because creative research and graduate teaching are so very closely coupled.

(2) The currently rapid conversion of new scientific discoveries to applications involves the participation of academic personnel at all levels. (There are countless examples of this which need not be cited here.)

(3) Through its own organizations and its contractors, the Department of Defense is one of the largest employers of university graduates in science and engineering. The subcommittee sees no way for the DoD to avoid accepting a direct responsibility for the well-being of academic research groups that play such an enormous role in graduate training. This is no less valid than the DoD's responsibility for research in the Defense-supported industry and must be regarded in a similar light. By insufficiently supporting universities' basic research that is relevant to its general mission, the Department of Defense is, in essence, starving the goose that lays the golden eggs.

DoD support accounts for more than 50 percent of all Federal support of academic research in the mathematical, physical and engineering sciences. In this situation it seems totally unrealistic to argue, as some have done, that the general support of academic science should be the responsibility of the National Science Foundation, which now supports only 10 percent of academic science. In connection with reason (2) above, even more stress should be laid on the importance of the continuing flow of people trained in basic academic research into the applied programs of the Federal Government; the transfer of scientific knowledge takes place mainly through the transfer of people.

(4) If the DoD dissociates itself from universities, their faculties and research, a generation of graduates will arise that has no experience of association with the activities of Defense agencies. Such a trend would surely weaken the DoD's ability to obtain the services of outstanding scientists and engineers in its own organization. It is safe to say that a substantial reason for the difficulty experienced by Defense in-house laboratories in acquiring more high-quality scientists and engineers for their staffs is related to this trend, though it is by no means the only cause of this problem.

It does not appear easy to correct this present trend within the agencies of the Military Services. The Navy, which has a history of consistent and enlightened support of basic research through its contract programs, now seems to be rather fully absorbed in increasing the support of its in-house laboratories and its work in the field of oceanography. The agencies of the Army and the Air Force, unlike the Office of Naval Research, report to the Offices of their Chiefs of Staff, which presumably subjects them to controls ensuring that the programs supported are tied rather closely to requirements.

## 4. PLAN FOR MONITORING BASIC RESEARCH

The ODDR&E plans to introduce a new system of monitoring the basic research program of the Department of Defense. It will start with the recognition of four general areas and 14 divisions of research activity and possibly lead eventually to the establishment of a corresponding number of advisory panels to review programs in those fields. The panels' advice will be employed by the ODDR&E staff in determining the allocation of funds to the divisions. This plan is worthy of the attention and support of everyone associated with the Defense research program, for if the system is successful it could serve as a means of guiding programs in basic research that are of interest to the entire Department.

The effectiveness of this system would be enormously increased if the administrators of the program controlled a discretionary fund—say, of the order of 5 percent of the overall research budget—to distribute in accordance with their best judgment and that of the advisory panels. In appropriate cases, this fund could be assigned to the Military Departments, or when the new programs are regarded as having broad value, cutting across all the Services' interests, it could be assigned to ARPA, which has contracting authority. In that case, ARPA's staff could be reorganized as necessary to provide supervisory competence in the divisions of research monitored.

The provision of independent funds to Defense laboratory directors for use according to their best judgment has greatly boosted morale in some of the laboratories, according to advice received by the subcommittee. It is recommended that this funding practice, which at present involves only a few percent of total DoD research funds, be continued and that these funds remain unfettered.

## 5. FUTURE ACTIVITY OF THE SUBCOMMITTEE

The subcommittee, as reconstituted to allow for changes in membership of the Board on 1 January 1964, will continue the study and evaluation of DoD policy in Part II. It is expected that in Part II the subcommittee will make recommendations for improving the DoD program in basic research.

## REFERENCES


1. Bush, Vannevar. Science, the Endless Frontier. A report to the President on a Program for Postwar Scientific Research. Washington, D.C.: National Science Foundation, July 1945.

2. Department of Defense. Section XV, "Contract Cost Principles and Procedures," Armed Services Procurement Regulation.

3. Department of the Navy, Office of Naval Research. Annual Report of the Chief of Naval Research to the Naval Research Advisory Committee. June 1963, p. 39 (Table I).

## APPENDIX A

### Medical Research in the Department of Defense

Though medical research by the Military Departments shares the problems affecting other kinds of research, some problems are peculiar to it alone. The field of military medical research is increasingly beset with problems relating to financial support, personnel shortages and lack of qualified representation in ODDR&E.

A prime factor in this situation is the failure of both the Congress and DoD administration to appreciate the important and growing differences between military and civil medicine in content as well as emphasis. In consequence, since civilian medical research—represented by the National Institutes of Health (NIH)—receives generous support, the DoD has slighted research in military medicine. Faced with fixed budgets, administrators in the Armed Forces have given only limited support to the effort on medical research.

Important among the differences between civil and military medicine are these:

(1) The global distribution of our Armed Forces has multiplied their medical problems. At home, civil medicine has little interest in typhoid fever, smallpox or cholera, and malaria has been eliminated. Yet today in Africa and Southeast Asia we are facing new and growing problems involving those diseases and others, including malarial strains that are resistant to all our synthetic drugs.

(2) Because of the tremendous technical advances in weapons systems, military personnel are placed in hostile environments, not found in civilian experience, that exceed the limits of unaided human tolerance, for example, high-intensity noise, vibration, extremes of temperature and barometric pressure, and exposure to radiation and to toxic gases at close range.

(3) The medical implications of biological, chemical and radiological warfare are obvious.

Between fiscal years 1955 and 1964, the Congress raised NIH's budget from $46 million to over $800 million. The Military Departments' support of medical research was $23 million in FY 1955 and, by FY 1961, had increased only to $25 million. In fiscal years 1962 and 1963, it reached nearly $50 million but was cut in FY 1964. Even these increases are, to a degree, fictitious, because administrative charges have at times more than wiped out apparent increases in the budget. (When the Naval Medical Research Institute was charged with a share of the cost of maintaining the grounds of the Navy Medical Center at Bethesda, this took a 9-percent cut of the funds available for research.)

The lean years when there was a flat ceiling on support of military medical research resulted not only in reductions in the research effort but also in personnel. From this there has been a recovery, thanks to the recent budget increases mentioned before and to NASA's support of areas in which no competency in civil medicine could be found, either in personnel or with respect to laboratory equipment.

A new threat to military medical research is now appearing on the horizon—possible action by the government to reduce spending overseas with a view to protecting our gold reserves. Yet some of the most important research activities of military medicine are outside the United States. (For example, the activities at the Naval Medical Research Unit No. 3 in Cairo, Egypt, may be threatened by this action.)

The Defense Science Board recognizes the need for growing support of the research effort in military medicine. The Congress was so advised in May 1960 by a Committee of Consultants on Medical Research to the 86th Congress, which recommended that such support be doubled.

To ensure that military medical research is properly monitored and to plan an orderly growth of its effort, there is a need to strengthen the ODDR&E organization to this end. There is today no civilian physician in the ODDR&E; there is only one military medical officer, who is, of course, subject to change of duty; his departure, therefore, would leave the ODDR&E no continuity of staff.

In terms of dollars, the medical research effort may be only a minuscule fraction of the total DoD research program, but it is nevertheless an essential part. A weapon system is only as effective as the people who operate it. A 150-pound man needs only 0.75 milligram of thyroxin a day, but without it he is useless. Military medical research should have a civilian medical representative in the ODDR&E.

## APPENDIX B

### Fiscal Data on DoD Research

B-1. Estimated DoD Obligations for Basic Research

B-2. Estimated DoD Obligations for RDT&E

B-3. Basic Research Funding for the Past 10 Years

B-4. DoD Basic Research—Comparison of Budget Estimate with Actual Obligations

B-5. Performance of DoD Research and Development Fiscal Year 1963

Table B-1. ESTIMATED DOD OBLIGATIONS FOR BASIC RESEARCH
($ millions)

| | Fiscal Year 1962 | | | | |
|---|---|---|---|---|---|
| | Army | Navy | Air Force | ARPA | Total |
| Academic | 11.3 | 32.1 | 33.9 | 17.3 | 94.6 |
| Not for profit | 0.2 | 5.6 | 2.8 | 4.5 | 13.1 |
| In-house | 14.0 | 24.1 | 18.8 | 1.6 | 58.5 |
| Profit | 4.5 | 4.1 | 10.8 | 3.4 | 22.8 |
| Foreign | 1.8 | 0.6 | 4.0 | 0.3 | 6.7 |
| Total | 31.8 | 66.5 | 70.3 | 27.1 | 195.7 |

| | Fiscal Year 1963 | | | | |
|---|---|---|---|---|---|
| | Army | Navy | Air Force | ARPA | Total |
| Academic | 12.0 | 34.9 | 34.6 | 20.7 | 102.2 |
| Not for profit | 0.3 | 6.0 | 3.2 | 0.7 | 10.2 |
| In-house | 15.3 | 30.6 | 20.1 | 1.6 | 67.6 |
| Profit | 4.9 | 4.4 | 10.6 | 7.2 | 27.1 |
| Foreign | 2.6 | 0.8 | 4.5 | 0.8 | 8.7 |
| Total | 35.1 | 76.7 | 73.0 | 31.0 | 215.8 |

| | Fiscal Year 1964 | | | | |
|---|---|---|---|---|---|
| | Army | Navy | Air Force | ARPA | Total |
| Academic | 16.9 | 40.9 | 35.9 | 24.0 | 117.7 |
| Not for profit | 0.3 | 7.0 | 3.2 | 0.8 | 11.3 |
| In-house | 17.2 | 33.6 | 20.5 | 1.9 | 73.2 |
| Profit | 3.1 | 5.1 | 11.5 | 8.4 | 28.1 |
| Foreign | 2.0 | 0.6 | 6.6 | 0.9 | 10.1 |
| Total | 39.5 | 87.2 | 77.7 | 36.0 | 240.4 |

## Table B-2. ESTIMATED DOD OBLIGATIONS FOR RDT&E
($ millions)

| | Fiscal Year 1962 | | | | |
|---|---|---|---|---|---|
| | Army | Navy | Air Force | ARPA | Total |
| Academic | 35.6 | 111.9 | 157.3 | 54.7 | 359.5 |
| Not for profit | 15.5 | 14.3 | 198.7 | 8.5 | 237.0 |
| In-house | 489.9 | 537.8 | 668.5 | 26.2 | 1722.4 |
| Profit | 840.9 | 709.6 | 2907.5 | 112.0 | 4570.0 |
| Foreign | 2.7 | 2.4 | 5.3 | 2.8 | 13.2 |
| Total | 1384.6 | 1376.0 | 3937.3 | 204.2 | 6902.1 |

| | Fiscal Year 1963 | | | | |
|---|---|---|---|---|---|
| | Army | Navy | Air Force | ARPA | Total |
| Academic | 52.6 | 117.9 | 157.3 | 60.7 | 388.5 |
| Not for profit | 17.3 | 16.3 | 198.7 | 28.4 | 260.7 |
| In-house | 509.1 | 605.8 | 668.4 | 22.1 | 1805.4 |
| Profit | 764.9 | 739.4 | 2957.9 | 172.6 | 4634.8 |
| Foreign | 7.8 | 1.8 | 5.3 | 2.9 | 17.8 |
| Total | 1351.7 | 1481.2 | 3987.6 | 286.7 | 7107.2 |

| | Fiscal Year 1964 | | | | |
|---|---|---|---|---|---|
| | Army | Navy | Air Force | ARPA | Total |
| Academic | 73.0 | 116.1 | 182.3 | 61.7 | 433.1 |
| Not for profit | 18.9 | 18.1 | 198.6 | 28.8 | 264.4 |
| In-house | 517.2 | 646.3 | 565.8 | 22.5 | 1751.8 |
| Profit | 886.9 | 790.8 | 2971.6 | 175.1 | 4824.4 |
| Foreign | 11.7 | 1.4 | 16.6 | 3.0 | 32.7 |
| Total | 1507.7 | 1572.7 | 3934.9 | 291.1 | 7306.4 |

Table B-3. BASIC RESEARCH FUNDING FOR THE PAST 10 YEARS
($ millions)

| Fiscal years | Amount |
|---|---|
| 1956 | 72.0 |
| 1957 | 74.5 |
| 1958 | 105.7 |
| 1959 | 101.8 |
| 1960 | 141.0 |
| 1961 | 148.8 |
| 1962 | 177.7 |
| 1963 | 198.3 |
| 1964 | 208.7 |
| 1965 | 234.6 |

Table B-4. DOD BASIC RESEARCH—COMPARISON OF BUDGET ESTIMATE WITH ACTUAL OBLIGATIONS
($millions)

| | FY 1961 | FY 1962 | FY 1963 |
|---|---|---|---|
| Budget estimate | 136.5 | 178.0 | 186.4 |
| Actual obligations | 148.8 | 177.7 | 198.3 |

Table B-5. PERFORMANCE OF DOD RESEARCH AND DEVELOPMENT FISCAL YEAR 1963

| | Percent |
|---|---|
| Federal Government | 20 |
| Profit organizations | 73 |
| Educational institutions* | 5 |
| Other nonprofit institutions* | 2 |

Note: *Includes grants as well as contracts.