

FEDERAL EXPENDITURES FOR RESEARCH AND DEVELOPMENT

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MAGNITUDE OF RESEARCH AND DEVELOPMENT ACTIVITY

The National Science Foundation Annual Report for 1956 gives Federal Government obligations for research and development for 3 fiscal years, as shown in exhibit I.

EXHIBIT I

[Millions of dollars]

	Department of Defense	All other	Total Federal
1954 (actual)	\$1, 379	\$539	\$1, 918
1955 (estimated)	1, 532	655	2, 187
1956 (estimated)	1, 550	739	2, 289

These figures for the Department of Defense do not include the several billions of planned obligations of development programs that are funded by "Procurement and production" appropriations which are discussed in a later paragraph of this paper.

A recent survey of industry expenditures for research and development made by the McGraw-Hill Publishing Co. and presumably including work done by industry for the Federal Government with government funds, developed these figures for 3 calendar years:

	<i>Millions</i>
1955	\$4, 767
1956	6, 096
1957 (planned)	7, 319

Going back to earlier years, research and development activity has shown still greater increases. According to the National Science Foundation, Federal expenditures in 1940 accounted for only 1 percent of the Federal budget, while in 1955 Federal outlays accounted for 3 percent of a much larger total budget.¹

Private-industry expenditures for research and development increased at a slow, annual rate of approximately \$15 million between 1920 and 1939. But between 1939 and 1953 these expenditures increased at an annual average rate of roughly \$300 million a year.²

It is not permissible to combine the above figures for government and industry expenditures, because the figures are not mutually ex-

¹ National Science Foundation Sixth Annual Report, 1956, p. 4.

² These annual rates are calculated from a chart in Special Reports on Major Business Problems, The New World of Research, McGraw-Hill Publishing Co.

clusive. Also, figures compiled by different organizations are based, usually, on different definitions of development and research. In some cases, research figures include expenditures for product development, and development figures may not include total development. The Department of Defense has been, until recently, a flagrant offender in this respect. Figures of planned obligations or expenditures for military research and development, given out as total obligations or expenditures, have been limited to the budget or expenditure figures funded by the budget category of "Research and development." These figures have omitted a major part of military development activity which is funded by "Procurement and production" appropriations.

At the congressional hearings on the fiscal year 1957 budget, real total figures were presented by the Department of Defense, as shown in exhibit II.

EXHIBIT II

[Millions of dollars]

	Fiscal year 1955	Fiscal year 1956	Fiscal year 1957	Fiscal year 1958 (estimate)
Included in research and development appropriations.....	1, 221. 1	1, 493. 5	1, 747. 0	1, 701. 1
Included in procurement and production appropriations.....	1, 826. 4	1, 830. 1	2, 804. 5	3, 067. 8
Activities supporting research and development (largely military payroll not included above).....	344. 3	445. 5	639. 4	549. 7
Total.....	3, 391. 8	3, 769. 1	5, 190. 9	5, 318. 5

On this more complete basis Department of Defense planned obligations amounted in fiscal year 1955 to more than 5 percent of the total Federal budget instead of the 3 percent stated by the National Research Foundation.

For the reasons given, it is difficult to do more than guess at the real total of private and Government expenditures for research and development in the United States. A conservative guess for the calendar year 1957 would be a rounded figure of \$9 billion. Possibly a better figure can be arrived at through panel discussion.

On the basis of this \$9 billion, 55 percent of total research and development activity is accounted for by the Department of Defense.

Magnitude of basic research activity

There is a general impression that in the United States too small a part of total expenditures for research and development is devoted to basic or fundamental research. Available figures justify this impression.

The National Science Foundation reports that private industry spent \$150 million for basic research in calendar year 1953, and that the Federal Government spent \$117 million for basic research in fiscal year 1954.

The Hoover Commission report to the Congress on research and development, issued May 1955, stated :

Out of about \$2,400 million Federal expenditures proposed by the budget for fiscal year 1956 on research and development work, probably less than \$130 million is to be devoted to basic research.

The total figure of \$2.4 billion obviously does not include development funded by Department of Defense procurement and productions appropriations.

EFFECT OF PRICE INCREASE ON MILITARY RESEARCH AND DEVELOPMENT EXPENDITURES

There has been considerable emphasis on price increases over the past few years as a reason for increasing expenditures by the Federal Government. It may be of interest to look at the size of this factor in the field of military research and development.

The Department of Commerce price deflators which are used to reduce the several categories of gross national product to a constant price base may be used to reduce military research and development expenditures to a constant 1947 price level, and so eliminate the factor of price increase.

In exhibit III the price deflator used is the deflator for Federal Government purchases of goods and services. The deflators shown for fiscal years are the average of the deflators for the two appropriate calendar years.

EXHIBIT III.—*Military research and development programs*

[Millions of dollars]

Fiscal year	At current prices	Price deflator	At 1947 prices	Ratio at constant prices
1955.....	3,392	121.4	2,790	100
1956.....	3,769	126.7	2,980	107
1957.....	5,191	¹ 131.0	3,960	142

¹ Estimated.

The price increase from 1955 to 1957 was about 8 percent. Using the same method of measurement, the price increase from fiscal year 1953 to fiscal year 1957 was 11.4 percent.

Department of Defense research and development planned programs increased 42 percent from 1955 to 1957 at constant prices and an additional 8 percent because of price increase.

ORGANIZATION FOR RESEARCH AND DEVELOPMENT IN THE DEPARTMENT OF DEFENSE

This discussion of the organization of research and development activity will be confined to the organization in the Department of Defense because military research and development is much the largest research and development activity in the Federal Government, because it presents the most difficult problems, and because it offers the greatest opportunity for remedial action.

The historical development of the organization of advanced types of research and development within the Military Establishment may be divided conveniently into three different organizational periods: (1) 1941-45: The period of the Office of Scientific Research and Development

- (2) 1946-53: The period of the Research and Development Board
- (3) 1953-57: The period of the Assistant Secretaries of Defense under Organization Plan No. 6

Office of Scientific Research and Development, 1941-45

Research and development for general military application within the Military Establishment started with the organization of the National Defense Research Committee in June 1940, with Dr. James Conant, then president of Harvard University, as Chairman. Within a year, in June 1941, the NDRC was superseded by the OSRD—the Office of Scientific Research and Development—with Dr. Vannevar Bush as Chairman.

Significantly, OSRD was organized as a part of the Office of Emergency Management of the White House. It was not a part of the Military Establishment, but coordination with the War Department and the Navy was provided for by military representation on the official board and on the numerous committees and panels of the Board. Also, Dr. Bush was Chairman of the Joint Committee on New Weapons and Equipment of the Joint Chiefs of Staff, and was expected to coordinate the related activities of JCS and OSRD.

The OSRD produced a remarkable record of achievement under conditions that prevailed during the war years of 1941-45, but which no longer prevail. Two illustrations may be cited: The OSRD was given authority—and funds to go with it—to initiate research projects and development projects independently of the military departments. This was an important factor in the success of OSRD. Under the conditions then existing there was no competition or conflict between the OSRD and the military in this new activity of applying scientific principles and information to the development of radically new types of military equipment.

By the end of the war OSRD had over 2,000 contracts with industrial and academic organizations, and was spending funds of its own at the rate of \$175 million a year, a truly modest sum considering its accomplishments and the size of current expenditures.

Research and Development Board, 1946-53

With the end of the war, OSRD rapidly disintegrated. Personnel hurried back to more congenial civilian tasks; appropriations ceased. At the initiative of the Navy, a Joint Research and Development Board was established in June 1946 by joint action of the Secretary of War and the Secretary of the Navy. Interestingly, the structure of this Joint Board did not grow out of the structure of OSRD; it was patterned on the Joint Chiefs of Staff Committee on New Weapons and Equipment—a military rather than a civilian agency.

This Joint Research and Development Board was granted broad authority. By its charter, the Board could decide important questions without recourse to higher military authority, and could issue its decisions as “orders” of the two Secretaries. But before the Joint Board could get into operation and could test this broad authority, it was superseded by an agency with more limited powers, under the provisions of the National Security Act of 1947.

The National Security Act of 1947 and its revision in 1949, created and strengthened the Department of Defense. The act created two boards—the Research and Development Board and the Munitions

Board. Broadly, the Research and Development Board was responsible for research and development activities up to the point of the availability and approval of the equipment for service use. The Munitions Board, among other duties, was responsible for the procurement, production, and supply of equipment for service use and for inventory stocks.

Although the act provided that the two boards were "subject to the authority of the Secretary of Defense," the Boards operated, largely, as independent agencies. Partly because of this attempted independence and, more importantly, because of a complicated committee structure, lack of prompt action, even when the Chairman of the Board had the necessary powers, and lack of cooperation by the military departments, the Research and Development Board never realized the hopes of its sponsors.

Near the end of its career in 1953 the Research and Development Board had over 100 active committees, panels and working groups, on which over 2,000 names were listed. The full-time staff of the Board consisted of 260 civilians and 16 military personnel and over 350 part-time consultants.

Under the complicated and rigid committee structure of the Research and Development Board, and lack of cooperation of the military departments, effective coordination of military department development programs and the elimination of unnecessary development projects proved to be well-nigh impossible.

The military departments dominated the committees of the Board. The military representatives on committees, panels and working groups were expected to sit in judgment on the acts of their superior officers: To sit in judgment on projects previously approved by their departments. This is not done in a military organization; and programs and projects submitted to Research and Development Board committees for review were seldom disapproved. When a new Secretary of Defense came into office in 1953, the Research and Development Board and the Munitions Board had been discredited by their records and were on the way out.

The Assistant Secretaries of Defense, 1953-57

In February 1953 a committee was appointed by Secretary Wilson to review the organization of the Department of Defense and to make recommendations. Nelson A. Rockefeller was Chairman. The report of this committee was approved and became effective June 30, 1953, as Organization Plan No. 6.

Among other major changes, the plan abolished the Research and Development Board and the Munitions Board and substituted additional Assistant Secretaries of Defense to take over the duties of the two Boards.

The President in his letter transmitting Organization Plan No. 6 to Congress, emphasized two objectives of the new organization:

The first objective is clarification of lines of authority within the Department of Defense so as to *strengthen civilian responsibility*. Our second objective is effectiveness *with economy*. [Italic added.]

Under Organization Plan No. 6 an Assistant Secretary of Defense for Research and Development took over the major part of the func-

tions, organization structure, and personnel of the superseded Research and Development Board. The plan also provides an Assistant Secretary of Defense for Applications Engineering—a new position.³ Unfortunately, neither the Rockefeller Committee nor the Secretary of Defense clearly defined the division of responsibilities between these two offices, in the field of review and approval of development programs and projects; and this uncertainty remained a cause of controversy and confusion until the two offices were consolidated, during the spring of 1957 into one office of “Research and Engineering.”

From June 1955 until the time the two offices were consolidated, in the spring of 1957, the following division of responsibility for the review coordination and approval (or disapproval) of research and development programs and projects was established by the Secretary of Defense:

Part 1. Responsibility for the review and approval of all research programs and projects rested with the Assistant Secretary of Defense (Research and Development).

Part 2. The review and approval of development programs and individual projects funded by research and development appropriations was the joint responsibility of the two Assistant Secretaries of Defense (for Research and Development and for Engineering).

Part 3. The review and approval of development programs and individual projects funded by procurement and production appropriations was the sole responsibility of the Assistant Secretary of Defense (Engineering).

This division of responsibilities was by no means ideal but it was the best arrangement on which agreement could be reached, and was far better than previous arrangements. It was not until the above arrangement was established in June 1955, that the major part of the military development program that was funded by procurement and production appropriations was officially recognized and subjected to technical program review by either the Assistant Secretary of Defense (Research and Development) or by the Assistant Secretary of Defense (Engineering).

The two Assistant Secretaries followed different policies and established different procedures for carrying out their review responsibilities.

It was stated that when the new Office of Assistant Secretary of Defense (Research and Development) was organized in 1953, this Office took over the major part of the functions, organization structure, and personnel of the superseded Research and Development Board. And an important part of this RDB organization structure was the structure of committees and technical advisory panels of the RDB. The policy of military representation on the committees set up for review and coordination of military programs was continued. In this matter, little attention was paid to carrying out the President's expressed desire “to strengthen civilian responsibility” and to “increase effectiveness with economy” in the new organization.

In the first two parts of review responsibility listed above, for which the Assistant Secretary of Defense (Research and Develop-

³ Later this title was changed to Assistant Secretary of Defense (Engineering). This shorter title will be used in this paper.

ment) was either solely or jointly responsible, the Research and Development Office took the lead and the coordinating-committee structure with military representation was employed.

In connection with the third part of this review responsibility for which the Assistant Secretary of Defense (Engineering) was solely responsible, a new procedure was worked out in cooperation and agreement with the three military departments. In this procedure there were no committees and no voting by military department representatives. Action was entirely within and by the staff of the Assistant Secretary of Defense (Engineering) and of other interested Assistant Secretaries of Defense. This procedure was designed to carry out the President's policy of stronger civilian responsibility, and effectiveness with economy.

This past history is important and pertinent only because of what has happened since in the recent organization of the combined Office of Research and Engineering. With only one Office of Research and Engineering, the need to distinguish between development funded by research and development appropriations and development funded by procurement and production appropriations exists no longer. One review and approval procedure can now be used for all development programs and individual projects. But both procedures are being used with continued duplication of effort.

Experience over the past 10 years has demonstrated the futility of expecting effective and economical control of research and development programs and expenditures if the military departments are permitted to sit as judge and jury in the review and approval procedure of their own military programs.

The relative success of the completely civilian review procedure developed by the former Office of the Assistant Secretary of Defense (Engineering) shows that military representation in an official form as it exists in the coordinating committees is not necessary for effective reviews.

Another example of the comparative success of a completely civilian review and approval agency is provided by the organization and operation of the Ballistic Missile Committee of the Office of the Secretary of Defense. This Committee has no military representatives. The Chairman is the Special Assistant for Guided Missiles and the membership consists of the interested Assistant Secretaries of Defense.

If the Assistant Secretary of Defense (Research and Engineering) desires to retain the existing coordinating committees as advisory committees to consider questions of a general nature or for any purpose other than the review of research and development programs and projects, the existing charters of the committees should be changed to specifically exclude voting action on research projects and development projects. This review function should be the sole responsibility of the appropriate office directors within the office of the Assistant Secretary of Defense and should be carried out according to existing office procedure.

Another practical requirement for effective control of research and development programs and expenditures is close cooperation between the Assistant Secretary of Defense (Research and Engineering) who is responsible for technical or program approvals, and the Assistant Secretary of Defense (Comptroller) who is responsible for all fund-

ing approvals. Funds for a program or project should be approved by the Assistant Secretary of Defense (Comptroller) only after a program or project has received technical approval, or approved conditionally, subject to such approval.

THE PREPARATION OF THE MILITARY BUDGET

The effective control of military research and development is only a part—although a very important part—of the larger problem of the control of total military expenditures. And much of the difficulty of the problem has been centered in the way in which the military budget has been determined in the past.

The usual way of establishing the size of the military budget has been for each military department to determine its own needs, invariably on the high side, and to submit these estimates to the Secretary of Defense for approval. There follow months of negotiation and revisions to bring the military estimates down to some lower figure which the President will accept. Even when “guidelines” have been announced in advance by the Secretary of Defense, the military departments have not accepted such limiting figures as final.

The results of this procedure are an excessive waste of time, effort, and money, and a final budget figure that is usually higher than really desired by the Secretary of Defense and the President.

The British procedure in this matter is much more sensible. The size of the military budget is determined jointly by the Chancellor of the Exchequer and the Minister of Defense and when this ceiling figure is announced work on the budget is started. This figure is then accepted as final and binding by the Military Establishment.

The Secretary of Defense announced recently that in the preparation of the fiscal year 1959 budget the military departments will for the first time have an “obligational authority” appropriation and budget expenditure ceiling set in advance.

This step represents a major improvement in the determination of the size of the budget and in the more effective control of military expenditures.

A PROGRAM FOR BASIC RESEARCH

When pressure is applied to reduce military research and development expenditures, as during the recent session of Congress, there is danger that basic research programs will suffer unduly. It is only natural that when funds are reduced the military departments will give preference to equipment development; and then to applied research having near-term application to military needs.

The amount of funds that can be sensibly used for basic research projects is relatively small. How much money is spent by the Department of Defense on basic research projects is not known with accuracy. The amount has been estimated at something between \$20 million and \$50 million. Even this higher amount is a minor sum when compared with the more than \$5 billion that was available for research and development during fiscal year 1957.

I propose that the Secretary of Defense have a basic research fund that can be used only for basic research projects. A fund of from 80 to 100 millions would be ample and need not appreciably affect applied research or development programs.

The Secretary of Defense now has a separate fund called an emergency fund that is supposed to be used only for unforeseen emergency research or development projects. Actually this fund is used as a supplemental fund for any kind of research or development project that appears to be desirable.

Without any change, except in name, this emergency fund could be used as a basic research fund, or an additional restricted fund could be established. An added feature of considerable value would be authority delegated to the Assistant Secretary of Defense for Research and Engineering to initiate basic research projects, that might not be of immediate interest to any one of the military departments. The important objective of this plan is to preserve reasonable activity in basic research under conditions of limited research and development funds.

An adequate basic research program can be assured only by setting up a restricted fund that can be used only for funding basic research.

