Funds for Science: The Federal Government and Nonprofit Institutions

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IT IS HARDLY NEWS that the Federal Government has become the major source of funds for scientific research and development in the United States. This is not *news*; but it is *new*. In 1940 the Federal Government spent slightly less than 100 million dollars for all types of scientific activities; in 1952, just over a decade later, it spent almost 1.9 billion dollars. In the latter year the total national expenditure for research and development probably amounted to 3.3 billion dollars. Three-fifths of the Nation's research and development bill is thus being paid out of the Federal Treasury.

It is not new, of course, for the Federal Government to engage in scientific activities. Federal agencies have for many years conducted research and development in a variety of fields. What is new, aside from the growth in magnitude of the expenditures themselves, is the extent to which the Government now "sponsors" research and development at non-governmental organizations, rather than conducting such work in its own laboratories. In 1940 sponsored research and development probably accounted for less than 10 per cent of all governmental expenditures for this purpose; in 1952, it accounted for 75 per cent.

Industrial and commercial organizations are performing the major portion of this research and development which the Government pays for, but does not itself do. In 1952 such organizations received about 60 per cent of all federal research and development funds. But nonprofit institutions, i.e., hospitals, independent research institutes, professional societies, and, above all, institutions of higher learning are also participating extensively in government-sponsored research and development. Although the portion of the total federal research and development budget, about 15 per cent, going to nonprofit institutions is less than that required for research and development done in government laboratories or by industrial organizations for the Government, it is nevertheless a significant amount both in absolute terms and in relation to other sources of funds available to these institutions for research and development.

A growing interest, not to say concern, has become evident in many quarters as to what the effects and implications of this increased government sponsorship of research and development at nonprofit institutions might be. To fill the need for factual information on the subject, the National Science Foundation has recently completed a study of the funds administered by federal agencies for research and development at nonprofit institutions during the two years 1950–51 and 1951–52.[1] This paper summarizes the more important findings of the study; for full details the reader is referred to the complete report being issued by the Foundation.

Total funds and administering agencies. According to the study, federal agencies administered 338 million dollars for scientific research and development at nonprofit institutions in 1951–52. This is an increase of 15 per cent over the 294 million dollars administered for this purpose in 1950–51.

Although the funds at nonprofit institutions increased between the two years, the relative share of nonprofit institutions in the research and development expenditures of the Federal Government decreased slightly. Such institutions received 16 per cent of all federal research and development funds in 1950–51, but only 15 per cent in the later year. The increase in funds at nonprofit institutions between the two years, while fairly significant in itself, does not greatly alter the distribution among administering agencies, receiving institutions, or the nature of the work sponsored. Subsequent analyses of the total funds are confined therefore to the 338 million dollars reported for 1951–52.

In 1951–52, 17 agencies of the Government sponsored research and development at nonprofit institutions. In reporting funds for this purpose these agencies were guided by the following definition supplied by the Foundation: scientific research and development is systematic, intensive study directed toward fuller knowledge of the subject studied and the systematic use of that knowledge for the production of useful materials, systems, methods, or processes. The term was further to be construed broadly to include all costs related to or associated with the conduct of research and development except the dissemination of scientific information and the training of scientific manpower. For the most part, funds for this purpose were reported on the basis of "obligations incurred" by the agency, rather than payments made to the institution, during the year involved. As a result, the

[1] *Federal Funds for Science: I—Federal Sponsorship of Research and Development at Nonprofit Institutions, 1950–1951 and 1951–1952* (Washington, 1953). The report is available from the Superintendent of Documents.

figures overstate in total the amount of payments made to all institutions by 15 to 25 per cent in 1951–52; for individual institutions, the variation may be considerably greater.

Although a sizable number of agencies reported funds in 1951–52, the bulk was administered by four large agencies (see Fig. 1), which administered 98 per cent of the funds. The Department of Defense accounted for 53 per cent of the total, the Atomic Energy Commission for 36 per cent, the Federal Security Agency[2] for 5 per cent, and the Department of Agriculture for 4 per cent. The other 13 agencies obligated only 2 per cent of the total—7.5 million dollars.

Each of the three subdivisions of the Department of Defense administered a greater sum than any of the other agencies except the Atomic Energy Commission. The Department of the Navy accounted for 64 million dollars, 36 per cent of Defense's total. Within the Navy, the Office of Naval Research and the Bureau of Ordnance reported the bulk of the obligations, 37 million and 19 million dollars respectively. The Department of the Air Force accounted for 62 million dollars, that entire amount being administered by the Air Research and Development Command. The Department of the Army administered 51 million dollars, with the Army Ordnance Corps responsible for 30 million dollars.

Single subdivisions of the Federal Security Agency and the Department of Agriculture reported the greater part of the funds administered by those agencies. Funds for the Federal Security Agency represent the grants program of the National Institutes of Health of the Public Health Service. Over 90 per cent of Agriculture's funds were grants-in-aid allocated to the agricultural experiment stations and administered by the Office of Experiment Stations.

As previously pointed out, the sponsoring of research and development at nonprofit institutions is only one of three methods by which the Federal Government carries out its research and development activities, and, in magnitude of funds involved, it is the least significant. The federal agencies, of course, vary greatly in their utilization of the research resources of nonprofit institutions. For example, funds of the Department of Defense loom large in this study, representing over 50 per cent of the funds going to nonprofit institutions; yet these funds were only about 10 per cent of that agency's total obligations in 1951–52 for research and development. By contrast, the other three agencies administering sizable portions of the total funds—the Atomic Energy Commission, Department of Agriculture, and Federal Security Agency—obligated from one-quarter to one-half of their total funds at nonprofit institutions.

The recipient institutions. The total of 338 million dollars in 1951–52 was distributed to 427 institutions. Of these, 403 were located in the United States,

[2] Under Reorganization Plan No. 1, 83rd Congress, approved April 1, 1953, the Federal Security Agency was absorbed in the newly created Department of Health, Education, and Welfare.

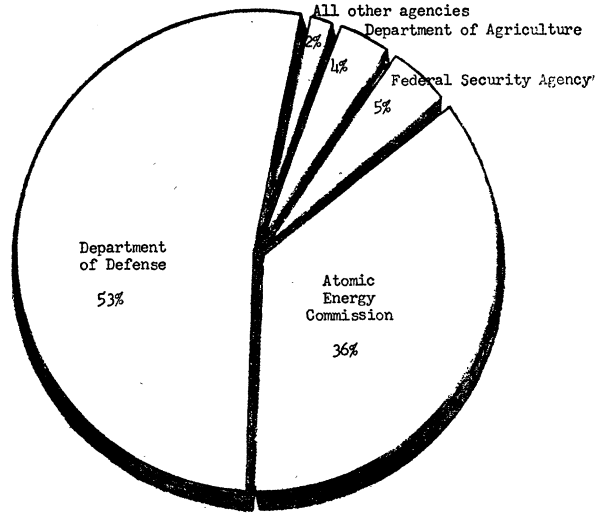

FIG. 1. Four agencies distributed 98 per cent of the funds, 1951–52.

Alaska, Hawaii, and Puerto Rico. The remainder (24) were in foreign countries and accounted for a relatively small portion of the total funds, 0.8 million dollars. These foreign institutions have been eliminated in the analyses which follow.

A large variety of institutions was represented. Most numerous were educational institutions, and foremost in this group was the large university. But the Government also sponsors research and development in many small colleges, in a number of hospitals and related medical institutions, in independent research organizations, and in a group of associations, boards, museums, and the like, whose excursions into research are not always readily apparent from their primary purpose.

In the distribution of total funds by institutional types, the *educational institutions* dominate (see Fig. 2). Two hundred and twenty-five educational institutions received 295 million dollars in 1951–52. Representing 56 per cent of the total number of institutions, they received approximately 87 per cent of the total funds. Because of their relative importance, more detailed information on funds going to educational institutions is given in a subsequent section.

The three institutions classified as *special research organizations* are closely related to educational institutions. Two of the three are the Brookhaven National Laboratory and the Oak Ridge Institute of Nuclear Studies, both sponsored by the Atomic Energy Commission and operated under the joint auspices of groups of universities. The third is the Rand Corporation, which derives its support from the Air Force and is operated by an independent organization. In all cases, however, the special research organizations are creations of the Federal Government, legally and administratively separate from any operating organization, and hence they constitute a separate institutional class.

Eighty *hospitals* were reported as receiving a total of 4.6 million dollars in 1951–52, 1 per cent of all funds. Significantly, all these hospitals had some training function. However, compared with the total number of hospitals affiliated with a medical school or approved for the training of interns (over 2000), the number conducting research is small. It would seem, in relation to the total scientific research picture, that hospitals per se do not constitute a very significant research resource for the Federal Government.

The most significant characteristic of the *independent research organizations* is that, with the exception of the special research centers formed at the request of the Government, they are the sole institutional group whose primary purpose is the conduct of scientific research and development. Although the earliest such research institute was established around 1913, their number and importance have increased in recent years. Of the 48 independent research organizations which received funds from the Federal Government in 1951–52, almost half have been established within the last 20 years and many of them during and since World War II. These organizations, such as the Battelle Memorial Institute, the Armour Research Foundation, and the Stanford Research Institute, received a total of 17 million dollars in 1951–52. During the two years for which data are available, the number of such organizations participating in federally sponsored research and development increased from 43 to 48. It may be hypothesized that with a continued availability of funds for the sponsorship of scientific research and development, the importance, as well as the number, of these organizations will tend to increase as a significant research resource for the Federal Government.

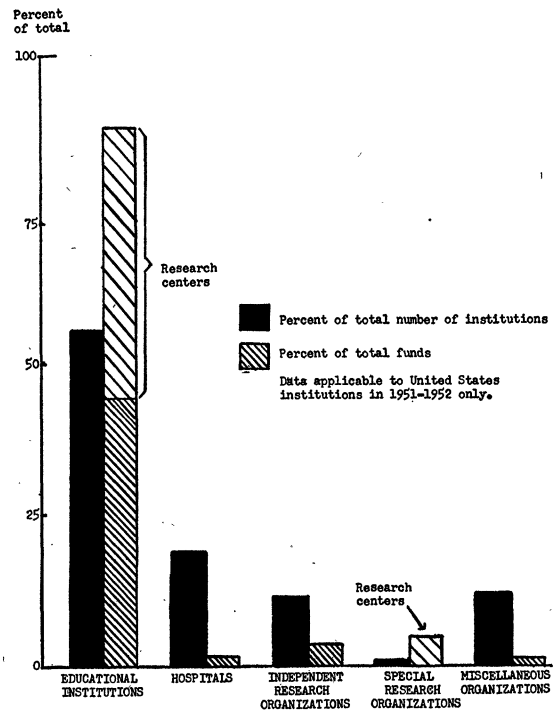

FIG. 2. The educational institutions led in numbers, even more so in funds.

Forty-seven *miscellaneous organizations* received a total of 5 million dollars in 1951–52. About a third (17) of these were private societies and trade associations; a second group (11) was composed of units of state and local governments; and the remainder were libraries, botanical gardens, museums, and the like.

In the above analysis, institutions have been classified according to their primary purpose. However, the great increase in federally sponsored research and development at nonprofit institutions in the last decade has fostered what is almost a new institutional form, the "research centers." Some appreciation of the nature of these centers is essential to a proper understanding of the funds going to nonprofit institutions in general.

Research centers, as the term is used here, are large research and development projects administered by nonprofit institutions for the Federal Government. For the most part these centers have been established at the request of the Government and represent a continuing collaboration between the Government and the institution, in which the Government determines the general work plan of the center while the contracting institution provides principally managerial services. With respect to its substantive work, the center tends to be a self-contained entity, and its operations are usually characterized by some degree of segregation from other research and development done by the institution. In all cases, there is an administrative segregation, and, in many cases, a physical segregation as well. Originally pioneered during World War II to assist the Government in carrying out certain emergency projects, the research center, operated under contract, has now become an accepted administrative device through which the Government fulfills certain of its research and development needs.

In 1951–52, 24 research centers received funds. All but three were operated by educational institutions. Some of the larger and better known are the Los Alamos Scientific Laboratory (operated by the University of California for the Atomic Energy Commission), the Johns Hopkins Applied Physics Laboratory (operated by Johns Hopkins University for the Department of Defense), the Argonne National Laboratory (operated by the University of Chicago for the Atomic Energy Commission), and the Government Laboratories (operated by the University of Akron for the Reconstruction Finance Corporation). The three not operated by an educational institution are the three special research organizations already discussed above.

The costs of these centers absorbed nearly half (47 per cent) of the funds going to nonprofit institutions. In 1951–52 the amount involved was 159 million dollars. The work of the centers is largely defense-

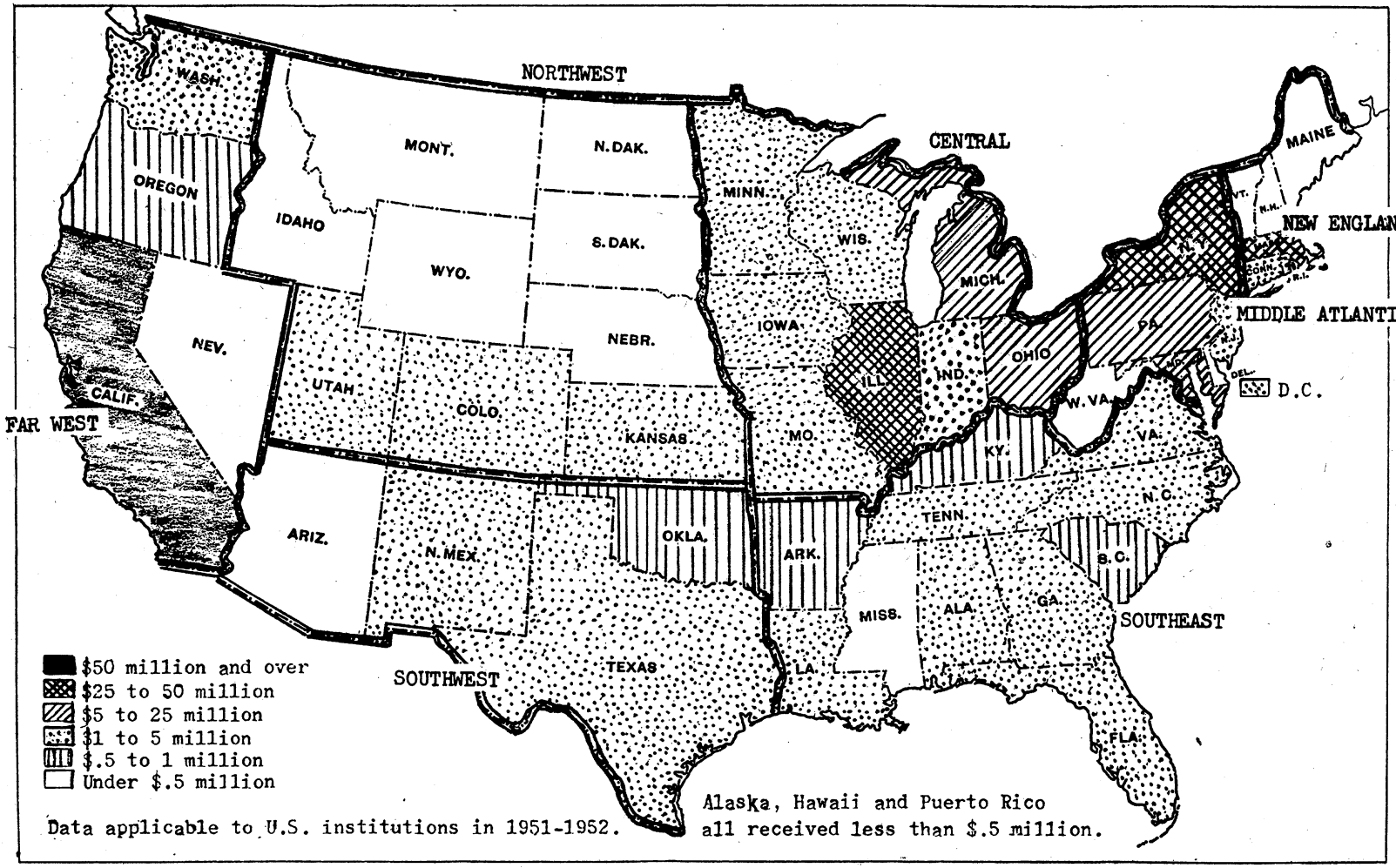

FIG. 3. Geography of the funds.

oriented and defense-related. With one exception, funds for all 24 centers in 1951–52 were supplied by two agencies, both of which are concerned with large-scale defense-type operations—the Atomic Energy Commission and the Department of Defense.

Geographical distribution. There was at least one nonprofit institution receiving funds in each of the 48 states, the District of Columbia, Alaska, Hawaii, and Puerto Rico.[3] There were, however, significant differences in the geographical distribution of both the institutions and the funds. One state, New York, was the principal location of 71, or 18 per cent of the institutions. Twenty-four of the 52 jurisdictions had 3 or fewer institutions. Four states received 25 million dollars or more; thirteen received less than half a million dollars.

On a regional basis (Fig. 3), the Middle Atlantic, Central, Far West, and New England states accounted for 92 per cent of the total funds. The remaining 3 regions and the outlying parts received 8 per cent. The Middle Atlantic States had a far larger number of institutions receiving funds than any of the other regions and led slightly in terms of the percentage of funds received when research centers are excluded. The Far West led in percentage of total funds, largely because of the inclusion of the Los Alamos Scientific Laboratory with California. Table 1 illustrates well the effect of research center funds in changing the ranking of the regions. The four regions lead although the rank order changes.

TABLE 1

PERCENTAGE DISTRIBUTION OF INSTITUTIONS AND FUNDS BY REGION
1951–52

Region	Number institutions	Total funds	Without research centers
New England	12.4	13.3	19.6
Middle Atlantic	34.2	24.2	26.9
Southeast	11.9	4.0	7.3
Southwest	5.2	2.1	3.9
Central	18.4	23.9	26.7
Northwest	6.7	1.7	3.2
Far West	10.2	30.5	11.9
Territories	1.0	0.3	0.5
Total	100.0	100.0	100.0

Source: National Science Foundation.

On an individual state basis there are four key states, Massachusetts, New York, Illinois, and California. These four form the core of the four leading regions. Significantly all are the seats of research center activity.

The funds for research centers tend to increase the concentration of funds. Of the total funds, 7 states received 80 per cent; however, without research centers, these same 7 received only 64 per cent. The geographical distribution is not a uniform one, but the distribution of research resources and research potential is also not uniform. Because of their magnitude, the distribution of federal funds may well be interpreted as a reflection of the location of the scientific research resources of the nation.

Analysis of the work sponsored. It is important to distinguish between two different motivations which may prompt the Federal Government to sponsor research and development. In one instance, the Government's purpose may be simply to increase the existing body of scientific knowledge. In this case, the Government is *supporting* scientific activity. However, if it is seeking specific information to assist in carrying out a program (other than the support of research and development) for which it is responsible, the Government is then *purchasing* scientific services. Although in the latter case the specialized nature of the object, the production of new knowledge, may soften or blur the character of the negotiation, the relationship between the Government and the contracting institution is essentially that of buyer and seller.

Some programs of the federal agencies fall clearly in one or the other category. But, as in any dichotomy of this type, there are programs in which the distinction is not always obvious. Scientific knowledge sought by an agency for the sole purpose of solving some problem may have general applications far beyond the specific need prompting the work in the first instance. Conversely, information developed in a general support program may prove useful in meeting specific needs. The interests of many agencies, the Department of Defense in particular, are so broad that much scientific knowledge, even the most abstract, may be interpreted as having a possible relation to their missions.

Programs which may be clearly labeled "support" are, in order of magnitude, the contract research program of the Office of Naval Research, the grants program of the National Institutes of Health, payments to agricultural experiment stations by the Department of Agriculture, and the research support program of the National Science Foundation. In addition, there are a number of programs which bear many of the characteristics of both types of research sponsorship. These mixed programs, primarily in the Department of Defense and the Atomic Energy Commission, are undertaken to assist in carrying out an agency mission, but they are often extremely broad in coverage and may bear only an indirect relation to current agency needs.

Funds for the programs devoted primarily to support of scientific research and development amounted to 58 million dollars in 1951–52. In addition, funds for support included in the mixed programs were approximately 15 million dollars. Thus, it would appear that total funds for support of research and development were of the order of 75 million dollars, or slightly more than 20 per cent of the total, with the remainder going for the purchase of research and development.

[3] Those institutions located in foreign countries have been omitted in this analysis, as they were in the preceding discussion of recipient classes.

This 1:4 ratio has important consequences on every facet of the problem studied here. In purchasing services from an institution, the contracting agency is necessarily limited by the nature of its need. Its needs may be concentrated in a particular scientific area or require a specialized talent, thus forcing it to locate an institution which can perform the required services quickly and economically. Principal emphasis must be on the existing research capacity of an institution, whereas agencies supporting research may also take into consideration the potential of an institution, geographical factors, and similar factors. The bulk of the funds, however, were used for the *purchase* of research and development services and the findings of this study must be so interpreted.

As might be expected, a wide variety of scientific projects, covering many disciplines, comprise the total of 338 million dollars obligated for research and development in 1951–52. In an effort to classify the types of research involved, two sets of categories were used.

First, the agencies were asked to report the data according to the character of the work, i.e., whether it was for "basic research," "applied research," "development," or for "increase of research and development plant." The classificatory decisions were made by the agencies participating in the study, using definitions submitted by the Foundation.[4]

In 1951–52, applied research received 50.1 per cent of the funds (170 million dollars), developmental activity 22.9 per cent (77 million dollars), and basic research 21.0 per cent (71 million dollars). Funds for the increase of research and development plant represented 6.0 per cent of the total, or 20 million dollars. This last figure includes only funds specifically reported for this purpose, and therefore represents large, general-purpose construction.

The second classification used was that of the scientific field covered. Agencies were requested to assign the funds for individual projects to the most appropriate of the following headings: (1) the life sciences —biological, medical, and agricultural sciences; (2) the physical sciences—physical sciences proper, mathematical, and engineering sciences; and (3) the social sciences. Again, many problems are inherent in such an attempt to pigeonhole scientific research and development. Many of the undertakings reported here are large, interdisciplinary projects, which as a practical matter were classified in the category corresponding to their primary emphasis. There is, too, a tendency for the basic mission of a reporting agency to influence the classification of its funds.

Within the limitations of the data, it may be seen that the bulk of the funds were assigned for work in the physical sciences. In 1951–52, life sciences received 19 per cent of the total funds, social sciences 3 per cent, increase of research and development plant 6 per cent. The largest portion, 72 per cent, was reported for the physical sciences. The research centers, absorbing almost half of the total funds, are concentrated in this latter category, and when the funds for research center activity are excluded, the pattern shifts significantly. Physical sciences then received only 63 per cent of the total, life sciences 31 per cent, the social sciences 5 per cent, and increase of research and development plant 1 per cent.

The role of educational institutions. Colleges and universities traditionally have been considered as the seats of advanced learning and scholarly research in the United States. They have, indeed, long been considered as the natural, and almost sole, home of basic or pure research. For many years, the only direct research aid that educational institutions received from the Federal Government was that of the grants to agricultural experiment stations attached to land-grant schools.

As the Federal Government has felt the need to increase its sponsored work, it understandably turned to the colleges and universities. These institutions represented one of the largest available sources of scientific manpower and facilities. The extent to which the Government has come to rely on them is evident from the data presented in this study.

In receiving the bulk of the funds, the educational institutions set the pattern for this entire study. It then becomes important to inquire into the number of participating institutions and the distribution of funds among them.

Two hundred and twenty-five educational institutions received funds for research and development from the Federal Government in 1951–52. There are, according to the United States Office of Education, 1871 institutions of higher education in the United States and its outlying parts. If junior colleges, seminaries, teachers colleges, independent schools of art and music, and unaccredited institutions are subtracted, there remain approximately 687 schools in which one might expect present research activity or the capacity to develop such activity. Of these potential 687 institutions, only 225 were actually conducting research under the sponsorship of the Federal Government.

Thirty-nine per cent of the recipient educational institutions were "universities," i.e., complex educational centers composed of several schools and awarding the doctor's degree. Eighteen per cent were professional-technical schools. The remainder were liberal arts colleges.[5] The distribution of funds, however, was not at all similar to the distribution of types of program. Universities received 77 per cent of the funds going to educational institutions, professional-technical schools 20 per cent, and liberal arts colleges 3 per cent.

Individual institutions varied widely in the amounts of funds received. One institution was reported as receiving 70 million dollars in 1951–52; at the other

[4] The reader is referred to the complete report of this study for the definitions used for both character and field of work.

[5] The definitions of the various educational program types and examples are to be found in the complete report.

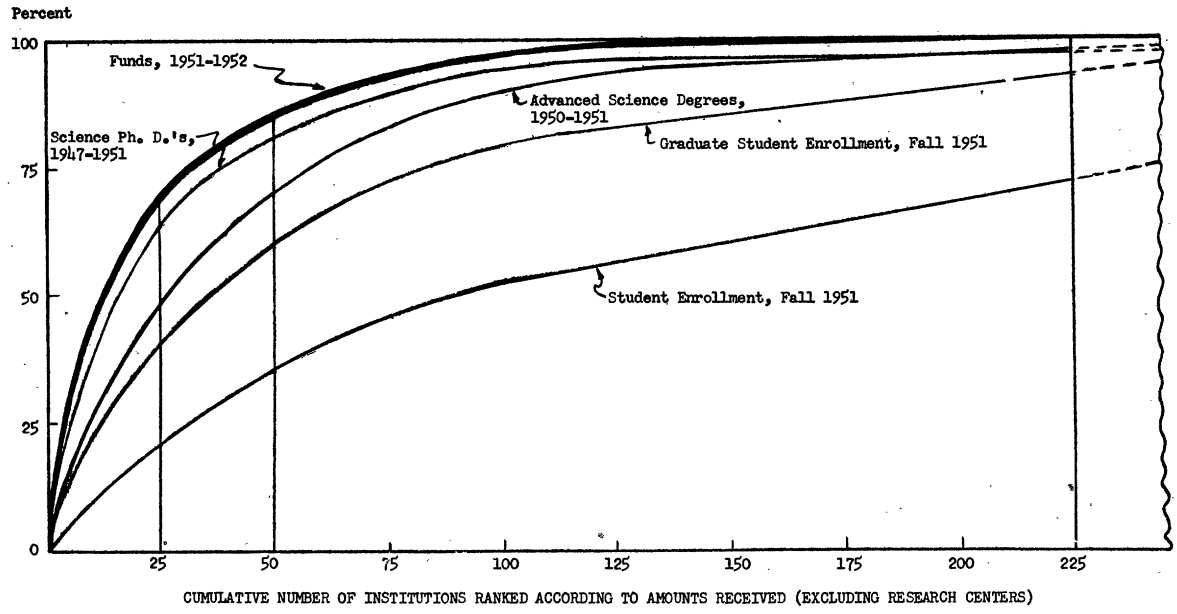

FIG. 4. Concentration of funds at educational institutions compared with concentration of selected measures of institutional size.

extreme, three institutions were reported receiving one thousand dollars or less. Five institutions received 55 per cent of the total funds going to educational institutions, and the top 50, approximately 91 per cent. Without the funds for research centers, the leading 5 institutions received 29 per cent, and the leading 50 received 83 per cent. Although the rank order of the leading educational institutions changes slightly when funds for research centers are excluded, there are no major changes in the list of the 50 educational institutions conducting the largest amounts of federally sponsored research.

It would, of course, be desirable to have objective criteria for the evaluation of the research capacity of an educational institution. Such a task is confronted with certain handicaps at the present time. Both the decision on the part of the Federal Government to contract with a given educational institution for scientific research and development and the institution's decision to accept—or even to seek—research contracts are governed by factors which cannot be measured quantitatively and which are not necessarily related to research capacity. There are, however, certain measures on which objective data are available which give some indication, however limited, of the research capacity of an educational institution. These are student enrollment, graduate student enrollment, advanced (master's, second professional, and above) degrees in science, and doctorates awarded in the sciences. When compared with these, federal research funds show a somewhat greater concentration than do any of the indices (see Fig. 4). For example, the 50 institutions receiving the largest amounts of funds received 83 per cent of all funds (excluding those for research centers), but enrolled only 35 per cent of the total student population. As the indices become more refined, the disparity between each of them and the funds becomes less. The 50 ranking institutions accounted for 60 per cent of the graduate student population, and awarded 67 per cent of the advanced science degrees and 83 per cent of the science doctorates.

Within the educational institutions conducting substantial amounts of research, several components can be identified (see Table 2). Their isolation and a proper view of their role are essential to a true understanding of the effect and influence of federal research funds in the academic setting.

Most prominent in terms of funds are the research centers which have been discussed previously. Although the centers must rightly be considered as a part of the over-all research effort at non-profit institutions, these funds do not flow into the mainstream of educational activity, but represent instead a segregated, specialized effort.

TABLE 2

FUNDS AT EDUCATIONAL INSTITUTIONS BY RESEARCH COMPONENTS
1951–52

Research component	Amount (thousands of dollars)	Percentage of total funds
Instructional departments	135,834	46.1
Affiliated research organizations	2,943	1.0
Agricultural experiment stations	12,460	4.2
Research centers	143,480	48.7
Total	294,717	100.0

Source: National Science Foundation.

Agricultural experiment stations are the oldest and most clear-cut of the research components of educational institutions. There is a station affiliated with a land-grant college in each of the 48 states and in each of the outlying parts. Federal grants for the support of the stations are of the order of 12 million dollars annually. In addition, the experiment stations can and do contract with federal agencies other than the Department of Agriculture's Office of Experiment Stations for research and development. In total, federal funds account for one-quarter of the funds available to the stations.

The need for a distinct research division has not been limited to agriculture, if one is to judge by the recent upsurge in the number of research affiliates of large universities. These organizations are devoted primarily to the conduct of organized research and may be within the legal framework of the institution, or may be separate entities with an interlocking governing board connecting them with the university. They may be functioning research organizations with their own staffs, or may serve simply as a negotiating agency to supervise the administrative aspects of the contract, while the research is performed by regular faculty members using the facilities of the institution proper. In 1951–52, 18 such research affiliates received a total of 2.9 million dollars.

The last of these components are the regular instructional departments of the institutions, which received 136 million dollars in 1951–52. The demarcation between this component and the others previously discussed, namely, the research center, the experiment station, and the affiliated organization, is obviously neither distinct nor emphatic. The difference between the different components is likely to be more a matter of administrative convenience than of substance. Admitting this, however, there is nevertheless a trend here which may portend significant consequences for the future, for it is fairly evident that there is a growing tendency toward a segregation in educational institutions of research activities from instructional activities. Although federal funds are by no means responsible for this development, they are very probably contributing to it.

Since this is only a factual report, it is not within its scope to discuss the policy implications of the data which have been presented. Obviously many questions are raised by the study. Is it desirable, for example, that such a large portion of funds for research and development at nonprofit institutions should be administered by agencies whose interests are primarily military? Is it desirable for educational institutions to operate research centers for the Government? Are there other techniques for handling this type of work? What are the consequences of concentration in a small number of institutions? To what extent should federal research and development funds be used to develop the research potential of smaller institutions? What are the long-run implications of the Government's emphasis on applied research and development in contrast to basic research? Does the difference between the amount of federal funds for work in the physical sciences and those in the biological and social sciences indicate a serious imbalance which should be corrected? What are the effects of the tendency toward formalization of research activities in educational institutions?

These and many similar questions are now receiving increasing attention and thought by individuals and by groups who are concerned with educational and research policies, both within and outside of Government. The National Science Foundation hopes that the factual study which has been summarized here and others of a similar character now projected will be helpful in solving such questions.

News and Notes

Scientists in the News

Roger Adams, Head of the Department of Chemistry, University of Illinois, spent last April in Madrid, attending the 50th Jubilee Anniversary meeting of the Spanish Chemical Society. In July he will receive the August von Hoffman Award of the German Chemical Society.

L. Earle Arnow, Director of Research, has been appointed a Vice President of the Sharp & Dohme Division of Merck & Co. Dr. Arnow came to Sharp and Dohme in 1942 from the University of Minnesota Medical School, and has been Director of Research since 1944. He is author or joint author with H. C. Reitz of two textbooks, *Introduction to Physiological and Pathological Chemistry* and *Introduction to Organic and Biological Chemistry,* respectively.

Robert L. Bennett has been appointed Medical Director of the Georgia Warm Springs Foundation. He has been Assistant Medical Director for many years, and is also Professor of Physical Medicine at Emory University School of Medicine.

H. O. Beyer of the Anthropology Department of the University of the Philippines, Manila, has been elected an honorary member of the Chicago Natural History Museum, an honor accorded to only eight other persons in the history of the Museum. Dr. Beyer is an international authority on the ethnology and archaeology of the Philippines.