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National Science Foundation: the First Six Years

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The National Science Foundation is authority for the information that 38 agencies of the Federal Government conduct scientific activities (*1*). In 36 of these agencies, the scientific work is organized about practical problems—agriculture, aviation, medicine, meteorology, or some other applied interest. The two exceptions are the National Science Foundation and the Smithsonian Institution; their focus is science itself. Other agencies support fundamental research, but only as underlying support for their more primary responsibilities. In contrast, the National Science Foundation has as its responsibility the advancement of science, in all its branches and regardless of its applications.

Depending upon the event one selects as marking the birth date, the foundation is only 6 or 7 years old. It was 10 May 1950 when President Truman signed the National Science Foundation Act of 1950; 6 April 1951 when Alan T. Waterman was sworn in as the first director; and September of 1951 when Congress voted the first operating funds to the foundation (*2*).

In those few years the foundation has shown such a lusty growth that a review of its development and an appraisal of its activities are timely.

Functions

The powers and responsibilities assigned to the foundation by Congress (*3*) are as follows: "To develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences; to initiate and support basic scientific research in the mathematical, physical, medical, biological, engineering, and other sciences . . . ; to award . . . scholarships and graduate fellowships in the mathematical, physical, medical, biological, engineering, and other sciences; to foster the interchange of scientific information among scientists in the United States and foreign countries; to evaluate scientific research programs undertaken by agencies of the Federal Government, and to correlate the Foundation's scientific research programs with those undertaken by individuals and by public and private research groups; to maintain a register of scientific and technical personnel and in other ways provide a central clearinghouse for information covering all scientific and technical personnel in the United States, including its Territories and possessions."

Administrative Structure

To carry out these responsibilities, Congress created a peculiar, two-headed structure. One head is the director; the other is the National Science Board. Both are appointed by, and both are responsible to, the President. The wording of the Act makes it clear that Congress intended neither to be a figurehead, for important responsibilities were assigned to each. The director is the chief executive officer of the foundation, and certain powers and duties are designated as his. The board can delegate additional powers and duties to him, but some responsibilities cannot be delegated. The director (with the help of his staff) selects the recipients of fellowships and scholarships and of grants and contracts in support of research. But final action on these matters must, in all cases, be taken by the board. Responsibility for establishing policy is clearly assigned to the board and cannot be delegated, even to the board's executive committee.

This structure represents a compromise between two opposed ideas of appropriate organization that were debated all through the legislative history of the National Science Foundation Act. One group of supporters thought the foundation should be headed by a Presidentially appointed board of 48 (later reduced to 24) distinguished representatives of the fields of science, education, and public affairs. This board was to be empowered to select the director of the foundation. The director, under this arrangement, would have been responsible to the board rather than to the President. Advocates of this structure hoped that a large board would insure wide representation of the views of scientific leaders, expected that the responsibility of membership would make appointment attractive to men of high competence, and believed that this administrative structure would guarantee against the appointment of the foundation's director on political grounds.

In contrast, other supporters of a science foundation—including, apparently, a majority of scientists (*4*)—thought the director should be appointed by, and should be directly responsible to, the President. To advise the director and his staff, advocates of this administrative structure recommended the appointment of an advisory board, smaller in size than the supervisory board called for by adherents of the other school of thought. Advocates of this structure pointed out that such an arrangement was in better agreement with usual ideas of good governmental administration and argued that a large board would so diffuse responsibility that no one could be held responsible for the success or failure of the organization.

This issue was more vigorously debated than any other aspect of the foundation idea. Yet once the bill became law, the argument quickly died. It is impossible to say how well an alternative type of organization would have worked, but Chester Barnard, former chairman of the National Science Board, wrote in the foundation's *Fifth Annual*

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Table 1. Annual appropriations and Presidential recommendations of funds for the National Science Foundation.

Fiscal year	Appropriation	President's recommendation
1951	$ 225,000	$ 475,000
1952	3,500,000	14,000,000
1953	4,750,000	15,000,000
1954	8,000,000	15,000,000
1955	12,250,000	14,000,000
1956	16,000,000	20,000,000
1957	40,000,000	41,300,000
1958	40,000,000	65,000,000

Report: "During the five years of its work, this peculiar organization, depending upon cooperation between the Board and the director, has worked exceedingly well." The absence of any attempt to change the administrative structure is a testimonial to both the board and the director, for good cooperation has been essential and has apparently been achieved.

Reputation

There are both favorable and unfavorable attitudes toward the foundation. As a slightly oversimplified distinction, the foundation has been applauded for what it has done and criticized for what it has not done. On the one hand, the foundation readily accepted responsibility for and quickly earned an excellent reputation for the manner in which it carried out its clearly assigned functions of making research grants, awarding fellowships, and in other ways giving direct, substantive support to research. On the other hand, the Congressional instructions to establish national science policy are subject to varying interpretations; the foundation has been more deliberate about accepting this responsibility, and what it has done has frequently not come to public notice. Thus, the bulk of the criticism has been leveled against what the critics consider the foundation's failure to take a sufficiently dominant position in the establishment of policy. In short, the foundation has been approved for carrying out its more clearly defined responsibilities and criticized for slowness and lack of aggressiveness in carrying out its less clearly defined responsibilities.

After a brief review of the growth of the foundation's annual budgets and scale of operations, I will discuss the programs of direct support to basic research. The foundation's operating policies concerning grants, fellowships, and other activities will be discussed in connection with those activities. Other policy questions will be taken up later, in a separate section.

Growth

When the National Science Foundation was first being debated in Congress, no one knew just how large it might grow or how much money it might effectively use. Early legislative proposals therefore followed the customary practice of authorizing Congress to use its own judgment in making annual appropriations. But before the enabling act was actually passed, an economy wave swept through the Federal Government, and one of the compromises that helped to secure passage was a limitation to $15 million on the amount of direct appropriations that Congress could make in any one year. Appropriations for the first few years were well below that ceiling, but in 1953 Congress removed the $15 million limitation.

In accordance with Government practice, appropriations are for fiscal years—that is, the 1956 appropriation was for the period from 1 July 1955 through 30 June 1956. The first appropriation, for fiscal year 1951, was only $225,000, an amount intended solely to allow the foundation to organize. In subsequent years, as shown in Table 1, the appropriations rapidly grew larger.

With some variation from year to year, the history of the annual appropriation has been about as follows: the President recommended a figure somewhat above the appropriation for the previous year; the House of Representatives voted the amount of the previous year's appropriation, and the Senate, approximately all of the President's request; the Senate and the House of Representatives compromised somewhere between the amounts each had voted; thus, the foundation received the increasing appropriations shown in Table 1.

The distribution of the foundation's growing budgets among the principal areas of activity is given in Table 2. The program has expanded in terms of the amount of money devoted to a particular type of support of science, and also by the addition of new types of support that were not feasible on earlier and smaller budgets. Table 3 shows the number of research grants made each year, the number of fellowships awarded, and the number of institutes for science teachers supported, and gives other indications of a growing program.

Research Grants

Grants in support of research constitute the foundation activity that has been of most direct interest to the largest number of scientists and the activity on which, in most years, the foundation has spent the largest amounts of money. The annual amount increased from $1 million in 1952 to $9.5 million in 1956 and, during those 5 years, enabled the foundation to make 1969 research grants, many of them for 2-, 3-, or 5-year terms. The average grant has been slightly above $12,000, for an average duration of 2 years, but some have been ten or

Table 2. Distribution of National Science Foundation expenditures among major activities.

Category	1952	1953	1954	1955	1956	1957 (estimated)
National science policy studies	$ 130,200	$ 207,167	$ 800,121	$ 901,278	$ 679,933	$ 750,000
Research grants in:						
Biological and medical sciences	762,675	830,586	1,971,789	3,611,562	4,793,129	16,125,000
Mathematical, physical, and engineering sciences	311,300	982,715	2,032,780	4,397,907	4,698,689	
Grants for support of research facilities:						
Biological and medical sciences					125,000	750,000
Mathematical, physical, and engineering sciences					397,500	5,135,000
Graduate and postdoctoral fellowships	1,532,971	1,366,344	1,865,978	1,783,706	2,131,026	2,500,000
Education in the sciences	7,200	40,844	160,790	315,790	1,434,275	14,000,000
Review of research and training programs		432,022	412,414	677,551	738,165	
Dissemination of scientific information	69,700	158,654	238,300	326,285	510,318	900,000
Attendance at international meetings	17,153	33,565	53,058	77,054	46,043	
Assistance to other federal scientific activities	122,755	23,272			10,000	
Executive direction and management	512,046	355,746	426,301	395,130	503,651	
Total	3,466,000	4,430,915	7,961,531	12,486,263	16,067,729	40,000,000

Table 3. National Science Foundation activities in support of research and education in the sciences.

Category	1952	1953	1954	1955	1956	1957
Number of grants in the biological and medical sciences	68	72	177	275	426	
Number of grants in the mathematical, physical, and engineering sciences	28	100	197	313	308	
Predoctoral fellowships	535	515	657	715	775	845
Postdoctoral fellowships	38	42	79	70	150	239
Institutes for college teachers of science or mathematics	0	2	3	7*	12†	9‡
Institutes for high-school teachers of science or mathematics	0	0	1	6*	18†	90‡
Conferences on special problems and areas	0	8	19	21	29	
Grants for attendance at international meetings outside the U.S.	23	54	101	132	13	

* Two of these institutes were open to both high-school and college teachers. † Five of these institutes were open to both high-school and college teachers. ‡ Four of these institutes were open to both high-school and college teachers.

more times that amount, and others have been much smaller.

The foundation's annual reports list the individual research grants made during the preceding year. The headings under which those grants are classified indicate the scope of the foundation's research support: anthropological and related sciences, astronomy, chemistry, developmental biology, mathematical sciences, molecular biology, physics, psychobiology, regulatory biology, systematic biology, and general.

The inclusion of anthropological and related sciences in this list is the outcome of debate that goes back to the first year in which Congress considered establishing the foundation. It was clear from the beginning that physical and biological sciences would be included, but whether or not to include the social sciences was a major issue. Proponents contended that it was at least as important to advance the social sciences as the other branches of science and that inclusion would aid their development. Opposition was centered on one argument and one type of confusion. The argument ran that the social sciences were not so highly developed as other branches of science and that the ability of social scientists to solve important social problems was to be doubted. The confusion was between research on human problems and the practical control of human affairs. This confusion was illustrated in some of the debate when salesmen, legislators, and other practical manipulators of social affairs were identified as social scientists.

The outcome was a compromise that gave the foundation itself freedom to decide. As early as 1947, some of the bills described the scope of the foundation as the "mathematical, physical, medical, biological, engineering and other sciences." This language, permissive but not mandatory with respect to the social sciences, was included in the enabling act as it was finally approved.

In the course of its own operations, the foundation early became engaged in studies in the social science area: studies of the state of development of individual fields of science, studies of the nation's manpower resources, studies of research trends, and studies of the economics of scientific research (*5*). In 1953 a staff position for social science was established, and the foundation began a systematic and continuing survey of the scientific status of work in the social sciences and of the foundation's role in such work. In 1954 the National Science Board approved recommendations for a limited program of support for social science research.

Policy Issues on Grants

The foundation has considerable freedom to decide for itself how its support should be distributed and what types of grants will most effectively promote scientific progress. Thus, the foundation could make grants for individual projects, or it could make general-purpose grants that do not specify the particular studies to be supported. There is ample precedent for both types. For example, the National Heart Institute reported in 1956 that it had made 650 grants for individual projects, 60 grants in support of broader programs of research, and 12 grants under which the institution being supported was given almost complete freedom to work on any research problem that seemed appropriate. The American Cancer Society makes large grants to selected universities to permit each to endow a research professorship for the life of the incumbent.

The type of grant that it will make is a matter of fundamental operating policy of any foundation, and the National Science Board of necessity had to consider this matter very early in its deliberations. The decision was to support individual projects. It is hard to see how the foundation, with its small early budgets, could have decided otherwise, yet the basis for the decision went well beyond budget limitations. Support of individual projects was the technique followed by the Office of Naval Research, which in some respects was a pattern-maker for the foundation and from which the foundation secured a number of members of its staff, including the director. Moreover, the foundation has from time to time discussed this point with research scientists and has concluded that a majority of them favor grants for individual projects over other types of grants. The foundation's policy was given emphasis in the *Fifth Annual Report*: "Research can be supported by aiding departments or institutions without specification as to the precise nature of the scientific work to be done. However, the Foundation believes that at present it can best aid progress in science and the development of a concerted scientific effort throughout the country by selecting for support those problems in science adjudged most meritorious in the eyes of the country's leading experts in the respective fields."

Along with the advantages of the policy adopted by the foundation there are also disadvantages. The method is in some respects a neutral one, for it merely adds a comparatively small amount of money to a larger amount that is already available, from other sources, for the same purpose and distributes that money in the same way that most of the funds from other sources are distributed. Thus, although the foundation's decision has been made, perhaps it will want to reconsider that decision as its stature and budget increase. For it is an exceedingly interesting question to ask: How soon, or on top of what level of already existing support, or in what stage of development of a field is it desirable to make broad program grants, as distinct from individual project grants?

Assuming that grants are to be made on an individual project basis, the foundation might passively wait for proposals and then make grants in support of those that seem most meritorious, or it might decide, in advance, to concentrate its support in those areas of investigation that seem in greatest need. These alternatives face every research-supporting agency, and the usual decision is to select some areas that the agency decides to emphasize. To some extent the foundation has also followed this course. Initially, as has already been pointed out, it did not support work in the social sciences; later, it announced that selected work in the social sciences would be supported. In some of its annual reports the foundation has announced that it would emphasize certain research areas, for example those related to the International Geophysical Year.

Facilities for Research

In 1955 and 1956 the foundation undertook the systematic study of the national need for scientific installations that were not likely to be provided from other sources. It recommended that the Federal Government assume responsibility for providing large-scale and expensive research facilities when the need is clear and when support is not likely to come from other sources. Although Congress has not approved this recommendation as a statement of general policy, appropriations permitted the foundation to broaden its scope in 1956 by allotting half a million dollars to the construction of research facilities. This small beginning was greatly increased in 1957, when a markedly enlarged budget permitted the allotment of $4 million to the construction of a radio-astronomy installation in West Virginia, $500,000 toward the construction of a nuclear reactor at Massachusetts Institute of Technology, $135,500 toward the construction of computation centers and for research in numerical analysis at five universities, and $750,000 to assist field stations for biological research.

Fellowships

In contrast to its policy with respect to other activities, the foundation began its fellowship program at about the same level that has been maintained during subsequent years. This early emphasis on graduate fellowships was dictated by the growing shortage of research scientists and by the termination of the fellowship program of the Atomic Energy Commission.

The 3200 graduate fellowships that have been awarded have been divided in roughly equal proportions among students who are entering their first year of graduate study, those who have already had one or more years of graduate work, and those who are in their final year of graduate work. The percentage of fellowships awarded to students who are just beginning graduate work has, however, increased somewhat over the years.

The foundation has also awarded 327 postdoctoral fellowships—typically to young scientists. In 1956 a program of senior postdoctoral fellowships was initiated, with 52 awards to mature scientists who gave promise of profiting from a year of research or study free from their usual duties. In 1957 a program of fellowships for teachers of science was started, with 100 grants.

Classified by field of study, the fellowships, at all levels, were distributed as follows during the first 5 years: 28 percent in the life sciences, 23 percent in chemistry, 22 percent in physics and astronomy, 13 percent in engineering, 9 percent in mathematics, and 5 percent in the earth sciences. By geographic region, distribution of these fellowships matched, almost exactly, the distribution of applications and was in close agreement with the geographic distribution of graduate students. The universities attended by the fellowship winners have been much more concentrated geographically, for the highly selected students to whom fellowships were awarded have tended to concentrate in the universities of greatest renown and best scientific facilities.

The foundation has authority to award undergraduate scholarships as well as graduate and postdoctoral fellowships but has not exercised that authority. The decision may not be a permanent one, but thus far the foundation has adopted the farsighted position that it is not in the national interest to offer federal scholarships to undergraduates who wish to become scientists so long as similar support is not available to undergraduates who wish to specialize in other fields.

Fellowship Policy Problems

Prior to World War II, most graduate students in the sciences earned a considerable portion of their expenses by serving as assistants in classroom or laboratory. There were a few fellowships, and there were always a few students whose graduate work was financed in other ways. But an assistantship was the standard method of support, and the number of assistantships largely determined the number of graduate students. After World War II it became desirable to increase the number of scientists, and the Atomic Energy Commission, the National Institutes of Health, the National Science Foundation, and other agencies began offering graduate fellowships in numbers that would have been inconceivable a few years earlier. An increase in the number of graduate students materialized, but perhaps there have also been other results that should be considered. Some faculty members complain that the large number of fellowships makes it difficult to get assistants and that the students who are appointed to assistantships are consequently of lower quality. A few critics have even expressed the wish that first-year graduate fellowships be abolished. The facts of the case are not clearly known, but if the effects are as some people claim, then one cannot help but wonder about such questions as these: What are the educational advantages of a fellowship over an assistantship, and vice versa? Does the alleged lower quality of graduate assistants have an adverse effect on the education and motivation of the undergraduate students who are taught, in part, by these graduate assistants? Is there some pattern for combining the educational values of fellowships and assistantships that would be more desirable that the present system of granting fellowships for all years of graduate training? This is not a nice, neat set of problems that can be solved in a year or two. The problems will be with us for a long time, and they deserve more systematic analysis than they appear to have received. The National Science Foundation alone cannot do this job, but, in cooperation with university and college teachers, it could conduct a study that would be of wide interest to the educational world.

Conferences and Institutes

The foundation has supported a number of research conferences, beginning with eight in 1953 and rising to 29 in 1956. Many of these conferences have crossed disciplinary boundaries, and many have attracted eminent participants from other countries. One was the International Arid Lands Meetings, arranged by the AAAS in 1955. Others have been centered on such diverse topics as anomalous magnetization of rocks, radiocarbon dating, problems of nuclear structure, quantitative biology, Lie groups and Lie algebras, radio astronomy, and problem-solving behavior.

As another contribution to the exchange of scientific information, the foundation has enabled a number of American scientists to attend international meetings held in other countries. After a steady increase (Table 2), the number of travel grants dropped sharply in fiscal year 1956, for in approving the 1956 budget, the House of Representatives refused to authorize funds for foreign travel. A year later Congress reversed its attitude, so this useful service was resumed and is again in full swing.

In 1953 the foundation began to support summer conferences or institutes for college teachers of science. The number of such institutes grew steadily in the following years. A year after the first institutes for college teachers were held, the foundation scheduled a similar institute for high-school teachers. The usefulness of these institutes in providing additional knowledge of science and mathematics to high-school teachers of these subjects was quickly recognized. One such institute, in 1954, was followed by six in 1955, 18 in 1956, and 90 in 1957.

In 1956–57 the foundation tried out the idea of year-long institutes for high-school teachers. Emphasis, as in the summer institutes, was on science and mathematics rather than on pedagogy, and the universities and colleges that give institutes of both types developed, in many cases, special courses to meet the teach-

ers' special needs. The number of academic-year institutes will jump from two in 1956–57 to 16 in 1957–58.

The foundation's efforts to improve the teaching of science and mathematics in high schools has had a widespread appeal; in the 1957 budget, Congress included $5 million more for this purpose than the foundation had requested. The history of the foundation's summer institutes also illustrates both the possibilities and some of the difficulties of foundation leadership. Similar institutes, with financial support from industry, had been running for several years before the foundation entered the field. The foundation's entry apparently had an encouraging effect on the development of additional industrially supported institutes. But this good effect has been partially canceled, and perhaps even reversed, by the recent great increase in the number of foundation institutes and by the fact that the stipends offered to participating teachers have been larger than those given to most of the teachers who attend the industrially supported institutes.

Dissemination of Information

The rapid increase in amount of scientific publication makes it more and more difficult to locate and secure those research reports that are pertinent to a particular study. The foundation has interested itself in several aspects of this problem. It has given financial assistance to several abstracting services; it has cooperated with the Library of Congress in developing a center for storing and duplicating translations of foreign materials; it has arranged with several scientific societies for the regular publication of English translations of Russian research reports; it has supported studies of automatic or machine translation, and, to increase the background of knowledge upon which such efforts must draw, has supported fundamental studies of language and linguistics.

To make the large number of research reports that are published within the Federal Government more readily available, the foundation supports a report reference service in the Library of Congress. More recently it has established its own Government Research Information Clearinghouse, from which a research worker can secure help in locating information about Government-sponsored research in his field.

Scientific Manpower Register

In 1952 the foundation assumed responsibility for the National Scientific Register, which had been established earlier at the instigation of the National Security Resources Board. When the foundation itself studied the operation and use of specialized manpower rosters, it decided to decentralize the register by using the resources of the specialized scientific societies. Accordingly, contracts were written with a number of societies (for example, the American Chemical Society and the American Institute of Physics) to maintain registers in their fields. These separate registers are conducted on a coordinated basis and can, if conditions ever require, be quickly combined into a single and centrally administered register.

National Science Policy

Three passages in the basic legislation define the foundation's policy-forming responsibilities. One is the clear mandate "to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences." The other two are "to appraise the impact of research upon industrial development and upon the general welfare" and "to evaluate the scientific research programs undertaken by agencies of the Federal Government."

As was described earlier, the foundation has made a number of policy decisions to guide its own operations. It has been on perfectly safe ground in these matters, for it has been dealing with its own activities and has not encroached on the preserves of any other agency. How much farther should it go? The basic legislation requires interpretation. It seems clear that the Congressional instructions "to develop and encourage the pursuit of a national policy" were not meant to be limited to the foundation's own research-supporting activities. Surely Congress did not create a National Science Board of 24 distinguished leaders of science, education, and public affairs solely for the purpose of settling the issues that arise in the normal operations of the foundation itself. Without minimizing the importance of these issues, it seems clear that Congress must have expected the National Science Board to play a larger role, to go beyond the confines of the foundation's own operations, and to establish *national*—as contrasted with *foundation*—policy. The instructions to evaluate the programs of other agencies and to appraise the impact of research on industrial development and general welfare support this interpretation.

How to carry out these larger responsibilities has been a source of considerable puzzlement. Basic work in science is not amenable to central coordination, and scientists oppose vigorously any attempt at direction and control. Clearly, the policies of the foundation cannot be dictatorial ones. Equally clearly, if the foundation is to exercise a constructive influence on the development of research and education in the sciences, it has to do more than merely approve the existing state of affairs. Understandably, therefore, the foundation has moved cautiously into its area of policy-making responsibility. Moreover, the foundation is not the only federal agency that supports research. The potential friction and jealousies confronting a fledgling agency that tried to "evaluate" the programs of other, and frequently much larger, federal agencies are obvious.

Nevertheless, the foundation was given responsibility for policy. In carrying out that responsibility it was obviously necessary to start with things as they were, for the foundation came into existence after many other scientific agencies were already at work and after the policies that guided their operations had already been established. This fact seems to have been overlooked by some of the foundation's critics; they have acted as if no policy existed prior to the foundation's establishment, and as if the foundation should suddenly create policies. This is unrealistic. The foundation might modify existing policies; it might recommend directions of change that seemed desirable; it might study what has worked well and what less well in the past and make recommendations on that basis. Through such means the foundation might evolve changes and improvements in policy, and to support those changes it could keep Congress, other agencies, and the scientific community aware of the directions in which it sought to move and the future policy goals that it considered desirable.

During the foundation's beginning years there was comparatively little emphasis on these matters, for the foundation deliberately chose to get its operating programs started first and not to devote much of its energies to policy matters until it had established its position in the scientific world. Some critics were dissatisfied with this course and kept urging the foundation to move more rapidly.

In 1954 the foundation, the other interested agencies, and the President's office prepared an executive order (*6*) that defined more clearly the responsibilities of the principal federal agencies that had research interests. Each agency that had scientific interests was given authority to conduct and support basic research in fields closely related to its operating responsibilities. The foundation was given the wider responsibility of supporting general-purpose basic research. In order to maintain this division of responsibility, the heads of other agencies with research interests were instructed to keep the foundation informed of their activities and to keep their own applied work under review to make certain that it was undertaken with appro-

priate consideration for the existing knowledge in underlying basic fields.

The Executive Order also instructed the foundation to review the research programs and activities of the Federal Government, in cooperation with the federal agencies concerned, and to make recommendations to the heads of the other agencies involved; to make studies and recommendations concerning research, scientific manpower, resources, and the foreseeable needs of the nation; and to recommend to the President policies for the Federal Government that would strengthen the total scientific effort and help to define federal responsibilities within that effort.

Here was clarification. The foundation was made the principal adviser to the rest of the Federal Government on all of its research activities. Moreover, it was given responsibility for surveying national (federal and nonfederal) research, manpower, and resource needs and for making appropriate recommendations. A clear-cut example of a policy decision under these general powers was the foundation's recommendations, in 1956, that the Government should terminate its research efforts to develop a substitute for natural rubber and that the Government laboratories for this purpose should be transferred to private hands. These recommendations were approved.

Against the background of the executive order, and to judge by its own actions, the foundation seems to have defined its policy responsibilities as being of two types: (i) The collection and dissemination of statistical and other information—concerning trends in science, scientific personnel, and the support of science—that may be used as a basis for policy; (ii) the issuance of statements concerning conditions that are considered desirable for the advancement of science.

Information as Basis for Policy

This was the first policy function to be adopted. It has accounted for much the largest portion of the expenses that the foundation classifies under the heading "National science policy studies" (Table 2).

The foundation publishes annually a report entitled *Federal Funds for Science* (*7*). Each report gives figures on obligations and expenditures for three consecutive years. Various breakdowns present detailed information, by field of science, government agency, type of expenditure, and so forth, of the money the Federal Government is investing in research and development. Other reports have also appeared: the foundation has studied the financial support of graduate students (*8*) and the demand in industry for scientists and engineers (*9*); it reports, at regular intervals, the grants made by federal agencies in some fields of science (10); its "fact book" on scientific manpower (*11*) is the best single source of statistical information on the number and characteristics of scientists in the United States. The information in these reports is valuable to many persons and grows increasingly so as reports on the same topics accumulate and permit the study of trends in the support of science.

Foundation support is enabling three fields of science to make detailed studies of their own occupational characteristics, problems, and trends with respect to research, manpower, and education. These studies of the fields of mathematics, physiology, and psychology will furnish information that will be useful to members of those fields in a variety of policy decisions, in planning educational programs, and in assessing current developments.

In its statistical studies and in its support of the analysis of individual fields of science, the foundation is in an admirable fashion fulfilling its own first definition of its policy role: the provision of useful information.

Some of the science legislation bills that were considered in Congress would have given the foundation responsibility for coordinating the scientific activities of other federal agencies. Other bills would have required the foundation to coordinate its own program with those of other agencies. There was obvious disagreement about the proper relationship between the foundation and other agencies that had scientific interests. The disagreement has continued. As was pointed out earlier, the President's executive order of 1954 instructed the foundation to review other research programs, but to do so in cooperation with the agencies concerned, and to make recommendations to the heads of those agencies as well as to the President.

Some critics would like to have seen the foundation enter with a reformer's zeal into the task of reviewing the activities of other agencies, but they have not presented evidence that great reform is necessary or that strong action would have been effective. The foundation has decided that a quieter and truly cooperative type of review is its proper course of action and has begun to make such reviews when requested to do so by another agency.

While reviews of other agencies have not been a major feature of foundation activities, reviews of the support given to the different fields of science have been. The foundation and other federal agencies that support research exchange information concerning applications received and grants made. Thus, the foundation staff member who is responsible for work in any particular field is aware of other work in his field that is being supported by the Government. He and his advisory panel also keep informed of work being done outside of Government. This information is used by the foundation in determining the support that it gives to a particular area of research and provides, for all of the agencies concerned, a continuous overview of the distribution of support among the fields of science.

In addition to having an information-gathering and advisory role with respect to purely scientific matters, the foundation has an advisory role with respect to decisions that are made primarily on other grounds but that have an influence on scientific progress. It has an opportunity to play a peculiarly constructive role in such problems, for it has the whole of science as its realm of interest while other agencies have their centers of interest somewhere else. Yet these other agencies make decisions that influence scientific developments. The Atomic Energy Commission decides to give nuclear reactors to schools of engineering so that more young engineers will be acquainted with nuclear technology. The Selective Service System decides to induct or to defer graduate students who are approaching age 26. The Department of Defense decides to place great emphasis on research and development leading to a particular new weapon. In none of these cases should the effects on science be the sole determinant of whether the program is approved. But science and scientists will be affected by the decisions that are made. As the chief scientific adviser to the rest of the Government, the foundation has an opportunity to make clear—insofar as it can see clearly—the implications of such decisions for the scientific welfare of the country. How extensively the foundation has engaged in this advisory function is not known. Advice can frequently be most useful if given quietly and without public notice. To the extent that it is given in this fashion, it does not appear on the public record.

Statements of Policy

To some persons, a policy is a formal pronouncement. Examples are easy to find; the Cabinet member or agency head who announces, "It is our stated policy that . . ." and the document that begins, "Henceforth it shall be the uniform policy of the . . ." are well known in Government circles. The President seemed to have this type of policy pronouncement in mind when, in his budget message for 1952, he told Congress: "the Foundation will formulate a broad national policy designed to assure that the scope and the quality of basic research in this country are adequate for national security and technological progress."

This statement embodies a quite different concept of policy from the one illustrated by the foundation's information-gathering activities. There probably never will be "*a* broad national policy [on scientific matters]." At least, the foundation has shown no evidence of trying to write one, and probably their answer to anyone who suggests that they should would be, "Go ahead and try it!"

The foundation has, however, made a few formal statements of policy concerning matters of broad interest and importance. The foundation itself lists several such cases (including policy recommendations concerning federal responsibility to aid in the training of scientists and science teachers—matters that were considered earlier in this article).

Increased support for basic research. On a number of occasions the foundation has stated that support for fundamental or uncommitted research is at too low a level in comparison with the support for applied and developmental research. Because it is easier to secure legislative and popular support for research that has an obvious bearing on such practical matters as military technology or the cure of disease, it will undoubtedly continue to be necessary to hammer away at the importance of basic research, even though the rate at which the foundation's own budget has increased is an encouraging sign that the foundation's insistence on the importance of basic research is being heeded.

Considerations of loyalty in connection with grants for nonclassified basic research. Probably all thoughtful observers agree on the necessity for inquiring into the loyalty and security of scientists who are working on classified problems. But judgments vary about the appropriateness of these considerations when the work is not classified. In a period in which extremists were willing to disqualify a person from receiving federal support for research on unclassified problems if charges—even unverified and untested ones—were raised concerning his loyalty, the foundation courageously proclaimed and followed a policy that was subsequently adopted by the National Institutes of Health and that the President, on recommendation by the National Academy of Sciences, announced as Government-wide policy (*12*). Under this policy the foundation does not knowingly support anyone who, either by admission or conviction, has been shown to be disloyal to the United States but in all other cases makes its decisions concerning the support of unclassified research solely on the merit of the proposal and the experience, competence, and integrity of the investigator, as judged by scientists who have a working knowledge of the investigator and the research area in which he plans to work.

Overhead on research contracts. With the rapid growth of Government support of research since World War II, there has been much interest, and some confusion, in the matter of payment for the indirect costs of research. Universities do not keep such detailed cost accounts that they can accurately separate the costs of instruction from the costs of research. When the same faculty member engages in both teaching and research, when he uses his research program as a means of teaching his advanced students, and when he sometimes dips into the same supply for research and teaching materials, it would be costly to maintain the detailed records that would completely separate research from instruction costs. In contrast, Government agencies that are more familiar with procurement contracts than with the support of research insist on detailed cost accounting. The result, over the years, has been that different agencies have allowed different amounts for overhead on research grants.

To prevent such confusion, the military services, after extensive discussion with university officials, developed what has come to be called the "Blue Book" as a guide to the determination of allowable indirect costs. The problem remained, however, and in 1954 the Bureau of the Budget requested the foundation to study the whole matter of payment for indirect costs of research and to recommend policies that could be uniformly followed by the several federal agencies. The foundation complied with this request and recommended that indirect costs be paid to universities when the university requested such payment; that the university have some option in deciding how indirect costs were to be computed; that when a university has selected its preferred method of determining indirect costs, all federal agencies pay at the same rate; and that, to protect the public interest, the Government reserve the right to determine an appropriate overhead rate when the option selected by a university results in a rate that is significantly higher than 25 percent of the salaries paid to members of the project staff or that exceeds the rate determined in accordance with "Blue Book" principles. The foundation estimated that, during 1956, the uniform adoption of these recommendations would have increased federal research costs by not more than $8 million.

Unfinished Business

Any foundation faces the dilemma of following in the traditions established by other foundations or of striking out on newer and bolder pathways. If it follows traditional patterns and has little money, it can expect to add only bits and pieces to what is already being accomplished, but it will be reasonably free from criticism. If it acts with boldness, it is certain to be criticized and likely to make some fairly serious mistakes, but it also stands a chance of accomplishing a great deal more than it would have achieved in more traditional ways.

The National Science Foundation has not had as much freedom to chart its own course as have the private foundations. Dependent as it is on annual appropriations from Congress, the foundation has been limited in the extent to which it could depart from traditional patterns. Another conservative force has been the foundation's relations with other federal agencies. Under these circumstances the foundation started out on the path of conservative operation. What its future practices will be is not clear, but there has been a broadening of operations into newer areas, and a somewhat bolder approach may develop after the foundation has established its reputation and gained the full confidence of scientists, Congressmen, and representatives of other agencies interested in research. Reading, seriatim, its six annual reports gives one an impression of increasing confidence on the part of the foundation and a basis for belief that the next few years may see more boldness than have the earlier ones.

Nevertheless, there are major problems that have important long-run implications for the welfare of science but that have not yet been seriously studied, either by the National Science Foundation or by anyone else. The two following examples are intended not to exhaust the list but to indicate the range of difficult policy issues that can be tackled more appropriately, and probably more effectively, by the National Science Foundation than by any other agency.

Policies of other agencies. The foundation's own policies affect science. So do those of other agencies, sometimes in unknown ways. An interesting example is the scheme for circumventing Civil Service salary limitations by contracting with a nongovernmental institution to provide services that the Government agency might itself perform. Recently the Department of Defense contracted with five universities to establish and manage the Institute for Defense Analysis, to replace the Weapon Systems Evaluation Group that had operated as an in-service Government agency employing Civil Service personnel. The function continues to be that of comparing and evaluating the weapons and weapon systems developed by the Army, Navy, and Air Force. The announced reason for the change was that each of the three services maintained a similar organization on a contract basis and that the Department of Defense could not compete with the individual services in employing scientists and engineers of high quality unless it also used the contract basis.

There are some administrative advantages in operating through a contract, and greater flexibility is sometimes achieved in this way. Moreover, the contract relationships have given the military services access to the specialized competence of many individuals who would not be willing to accept Civil Service appointments. The liaison thus established with civilian science has advantages. On the other hand, there are disadvantages in a dual system. Scientists employed on a Civil Service basis within the Government have had their status disparaged, and competition for employees has occurred. The assumption by a university laboratory of responsibility for applied work has not always been advantageous to the university. The point of these statements, however, is not to decide whether it is desirable or undesirable to have a dual system of in-service and contract-managed scientific installations; the problem is too complex to admit of a simple yes-or-no answer. The point is that the foundation is responsible for advising the President on matters of broad scientific policy and for consulting with other federal agencies on the problems that affect scientific progress. The proliferation of contract agencies may strengthen the total scientific resources of the federal departments or may detract from the in-service research laboratories and weaken the bonds of confidence, common purpose, and day-to-day contact between research man and administrator. Certainly, the foundation has no ready answer to this problem. But neither does it have a vested interest in any particular answer or management system. Who better than the foundation could watch the situation, point out the implications of various methods of managing research programs, study the effectiveness—and perhaps the growing or declining effectiveness—of research installations, and express the best judgment of thoughtful and impartial advisers?

Size of research budgets. It takes only relatively brief discussion with university presidents to uncover a considerable body of uneasiness about the long-term effects of the rapidly increasing federal expenditures for research and development and the heavy concentration of funds on the physical sciences. The Federal Government has become the major source of research funds for some of the universities. What are the effects of this situation on the education, utilization, and distribution of scientists, on education in other fields, on the ways in which the Federal Government is using its powers to influence the development of science? The university officers and faculty members who ask these questions are well aware of the national need for a large-scale scientific effort and they appreciate the role of the universities in that effort, but they also want to guard the universities against distortion and damage that might result from too great emphasis on one aspect—even on one very important aspect—of a university's function.

There are other questions that are raised by the size of current research budgets. Are we getting diminishing returns for our expanding research budgets? Are there adequate means of maintaining an appropriate level of support for important, but in the public eye less popular, areas of research? Decisions made on the basis of little knowledge nevertheless influence the trends being considered, and such decisions are made every day.

The foundation has recognized these questions. Its own studies have provided most of the available information. It has recommended policies for the payment of compensation for the indirect costs of research. It has repeatedly stated that too small a fraction of the total research budget of the nation is being devoted to basic research. But the heart of the problem remains untouched. With appropriations for research going steadily upward, with the belief generally held that there are not enough well-qualified research scientists, and with the statement frequently made that the limitation on scientific progress is men and not dollars, the question is inevitable: Where are we heading?

There are obvious difficulties in tackling such problems as those just described, and there is no guarantee that every effort will be wholly successful. The problem of understanding the effects on universities of the greatly increased level of Government support for research and development illustrates at least one of the difficulties. There has been much enthusiasm for the greater amounts of money available for the support of science, but there are also widely held fears that the current emphasis on science may work to the detriment of the humanities and social sciences; that the emphasis on project research and applied problems may work to the detriment of basic uncommitted research; that the team approach and the formal project, with its deadlines and required progress reports, weaken the research training of graduate students; and that perhaps in other ways long-term values are being sacrificed for short-term objectives. Whether these attitudes—both the enthusiasm and the fears—are justified or not, they exist, and attention should be given to them. Certainly the scale and pattern of financial support for research have changed drastically in the past decade, and the changes have undoubtedly had important effects on the character of university organization and university education. It would be highly desirable to begin to study these effects.

The foundation initiated such a study several years ago. The study committee gave careful and constructive thought to the matter of overhead payments on research contracts but, so far, has not reported on the other, and more fundamental, problems. Perhaps this early concentration of attention on one aspect of a broad problem was due to the inherent difficulties of the other aspects. Perhaps it indicated the special interests of the committee members. In any event, the educational world is still waiting for a report on some major issues that the foundation hoped to study constructively.

Regulation and Control?

In addition to the policy functions considered in the preceding section, some of the foundation's critics would have it go still farther beyond its basic function of promoting science. They have wanted the foundation to help Congress or the President control the budgets and programs of other agencies.

Some critics are not content to have the foundation establish policy for the promotion of basic research and education in the sciences but would have it also assume responsibility for initiating actions and recommending policy that should be adopted in response to, or as a result of, developments in science. An illustration will make the distinction clear. In 1956 the National Academy of Sciences published a series of reports on the biological effects of atomic radiation and made a number of recommendations for action. The foundation, instead of the National Academy of Sciences, *might* have carried out these studies and made these recommendations. Perhaps, however, it should not; perhaps the nongovernmental status of the National Academy of Sciences makes it the more disinterested, and hence the more appropriate, agency for such difficult judgments. The question is, should the foundation, in terms of its Congressionally given responsibility, make such studies and recommendations—if not on the biological effects of radiation (since that was done by the Academy), then on other actions that the Federal Government or the nation as a whole should take in response to developments in science?

There is growing sentiment that someone should be seriously and continuously concerned about such issues. Because no agency has accepted this kind of responsibility, many are being urged to do so—the National Science Foundation, the AAAS, and others.

If the foundation were to attempt to determine the budgets for other federal agencies and if it were to attempt to tell the nation what should be done as a con-

sequence of scientific findings and developments, two great difficulties would immediately become apparent. First, the foundation would be assuming responsibility for formulating policy in areas which extend far beyond its authority for regulation and enforcement. It is quite true that, within carefully defined limits, other federal agencies have both scientific activities and regulatory powers; pure food and drug laws and various other safety measures are examples. But the foundation does not have regulatory authority; it can only advise.

If it did have regulatory authority, the second difficulty would arise. The concentration in a single agency of such colossal power over the whole course of science would almost certainly alienate the general scientific support that is essential for the foundation's success.

There have been several attempts in past decades to establish a federal department of science or, through other means, to bring about strong central coordination of federal scientific effort. Every one of these efforts has failed. In discussing the attempts and the reasons for their failure, A. H. Dupree has analyzed the requirements for a successful central coordinating agency. Among the requisites, such an institution would have to have "not only a legal authority within the government, but a moral authority with all the estates of science in the country and a position of honor among the great scientific societies of the world. . . . In the twentieth century, government research became so colossal that by its use of funds and personnel it could control the dynamics of the other estates of science. With this dominant position, the approbation of all science became an absolute necessity. To be truly representative of the varied interests of the professional natural scientists, engineers, and social scientists who demand a voice implies a certain amount of independence in the face of the government's interests. The need for reconciliation of the government's legitimate demand for responsibility and the scientists' essential stake in independence is one way of stating the unsolved dilemma of all attempts at central scientific organization" (*13*).

If Dupree's analysis is sound, an attempt by the foundation to adopt as strong a role as some of its critics seem to demand would guarantee its collapse and failure.

The National Science Board appears to have recognized this danger, for it explicitly rejected the belief "that government can and should direct the course of scientific development in this country." In commenting on this decision, the chairman of the board wrote: "It is clearly the view of the members of the National Science Board that neither the National Science Foundation nor any other agency of the Government should attempt to direct the course of scientific development and that such an attempt would fail. Cultivation, not control, is the feasible and appropriate process here" (*14*).

Over-all Appraisal

Each friend and each critic of the foundation is entitled to his own appraisal of how well it has done, of how the progress of science has been influenced by the foundation's existence, and of how well it has measured up to his expectations. On the basis of a fairly close acquaintance, since 1946, with the problems of bringing the foundation into being and getting its activities started, I feel more complimentary than critical. If the pace of development has sometimes seemed slow, that is less important than the direction of movement, and the foundation has moved progressively in what seem to be desirable directions. If the pace has seemed slow, one must also remember the puzzling problems of a new federal agency that was established with some doubts about its necessity and some limitations on its activities. If, in spite of these difficulties, one wants to be severely critical, he should have a well-thought-out answer to the question of how he, under similar circumstances, would have guided the foundation in its first 6 years.

References and Notes

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2. As is required by law, the foundation reports annually to the President, who transmits the reports to the Congress. These reports are published. The first report covered fiscal years 1950 and 1951. The most recent report is the sixth, for the fiscal year 1956. Much of the information that is drawn on in this article comes from the foundation's annual reports.
3. Public Law 507, 81st Congress, the National Science Foundation Act of 1950. The Act includes two additional functions, neither of which, in practice, has been of major importance: to carry out research connected with national defense, when requested to do so by the Secretary of Defense, and to establish such special commissions as the National Science Board deems necessary.
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H. H. Goddard and the Hereditary Moron

If the early history of mental deficiency may be said to date from Itard, so its later "vogue" dates 100 years later from Henry Herbert Goddard. From the Wild Boy of Aveyron, at the end of the 18th century, to the modern understanding of mental retardation of today is more than a span of 150 years; it marks the transition from an era of ignorance and callous feeling to one of enlightened human acceptance. And for the last 50 of those years we are most heavily indebted to the "discovery" of the moron. For the heartsick parents of the mentally retarded and their children who never grow up all owe Goddard a debt which far transcends his scientific research and the many social ramifications of his effective publications.

There have been periods when the feeble-minded were considered *les enfants du bon Dieu,* and others when they were thought to be inhabited of devils. In our time they have been the intermittent objects of faltering scientific inquiry or of maudlin welfare sentiment. Their very designation has moved from such terms as *idiocy,* to *imbecility, feeblemindedness, mental deficiency,* and now an ambiguous *mental retardation,* with