

SCIENCE AND PUBLIC POLICY

With increasing participation of Federal agencies in research and development activities, there has been a growing realization of the need for formulation of sound national policies with respect to science. The day-to-day operations of an agency necessarily result in policy formulation to a degree, and the several agencies supporting research have consciously sought to broaden operating policies by interagency liaison and appointment of non-Governmental advisory groups.

In the case of the National Science Foundation many decisions having policy implications have been made during the year in connection with the research support activities, the graduate fellowship program in the sciences, and other program activities; they are reported elsewhere under appropriate headings in this report.

During the year, however, numerous additional activities were carried on which were related to policy formulation but not connected with specific programs. The first two parts of a continuing series of reports were issued under the general title, *Federal Funds for Science*. Definite plans were made for a survey of the Nation's present efforts and needs in research and development. The gathering of information on several phases of the survey was well along.

On several occasions during the year the Foundation was able to provide background information and recommendations on scientific questions raised by other executive agencies and the Congress. In such advisory capacity the Foundation was able to draw upon the opinion of the scientific community in general by means of its established system of advisory committees and panels in all fields of science.

FEDERAL RESEARCH AND DEVELOPMENT BUDGET

A comprehensive report on Federal funds for research and development was issued in June 1953, entitled *The Federal Research and Development Budget, Fiscal Years 1952 and 1953*. The information in this report is not readily available in the ordinary financial reports

issued by the Government, since the greater part of Federal scientific activities is budgeted and reported as an integral part of the operating responsibilities of the various agencies. Following congressional appropriation action in July 1953 the figures for fiscal year 1953 given in the report were revised and preliminary figures were given for fiscal year 1954. The revised figures as estimated by the Foundation are given below.

For fiscal year 1952 total Federal obligations for research and development activities reached \$2.22 billion while actual expenditures for the same purpose totaled \$1.84 billion. (See table I.)

The comparable estimated totals were \$2.19 billion in obligations and \$2.20 billion for expenditures in fiscal year 1953 and \$2.07 billion and \$2.19 billion, respectively, for fiscal 1954. Over the past several years a 9-month lag has existed between obligations and expenditures so that the downward trend in obligations in 1953 and 1954 will presumably be reflected in lower expenditures in 1954 and 1955.

TABLE I.—*Obligations and Expenditures of Federal Agencies for Scientific Research and Development in Fiscal Years 1952, 1953, and 1954*

[Millions of dollars]

Agency	Obligations			Expenditures		
	Fiscal year 1952	Fiscal year 1953	Fiscal year 1954 ¹	Fiscal year 1952	Fiscal year 1953	Fiscal year 1954 ¹
Department of Defense	1, 705	1, 650	1, 556	1, 315	1, 646	1, 636
Atomic Energy Commission	229	247	239	250	260	266
National Advisory Committee for Aeronautics	82	79	73	67	79	88
Department of Agriculture	56	57	68	57	58	63
Department of Health, Education and Welfare	53	67	63	65	74	61
Department of the Interior	36	36	32	33	37	33
Department of Commerce	31	23	17	28	24	17
Other agencies	25	28	26	24	26	24
Total, all agencies	2, 217	2, 187	2, 074	1, 839	2, 205	2, 187

¹ Estimate. Revised: August 24, 1953.

Source: National Science Foundation.

Roughly 85 percent of the total obligations and expenditures in 1952 and 1953 represent research and development operations and the remaining 15 percent went for increased research and development plant. The postwar peak in obligations for plant additions reached about \$330 million in 1951; expenditures for the same purpose reached a maximum in 1953.

The Federal research and development budget is the composite financial expression of the individual programs of many agencies. Slightly less than half of all Federal agencies—24 in 1952 and 22 in 1953—obligated funds for such programs. In both years, however, the Department of Defense accounted for about 76 percent of the total and the Atomic Energy Commission for about 10 percent. Only five other agencies, the National Advisory Committee for Aeronautics, Department of Health, Education and Welfare, Department of Agriculture, Department of Interior, and Department of Commerce had research and development budgets of one percent or more of the total.

On the whole, Federal research activities heavily emphasize the practical and immediately useful. Almost 94 percent of the research and development funds go for applied research and development; only 6 percent for basic research.

Support for the physical sciences far outranked the other fields, absorbing about 90 percent of the total funds in 1952 and 1953. From 7 to 8 percent of the funds is for work in the life sciences and the remainder for work in the social sciences. The designation "social science" includes the gathering and processing of statistical data on social phenomena where the information has general utility. Although not research in a conventional sense, the collection of general-purpose statistics by the Government forms the basis for much of the research done in the social sciences, especially for population and economic studies. (See figs. 1 and 2.)

Trend in Research and Development, 1940-54

From fiscal year 1940 through fiscal year 1954, the longest period for which reasonably comparable data are available, there has been a general tendency for Federal research and development expenditures to rise. In 1940, these expenditures amounted to \$97 million, while in 1953 they are estimated at \$2.20 billion, a more than twentyfold increase in 13 years. The 1954 estimates show a slight decline which may continue in 1955. (See fig. 1.)

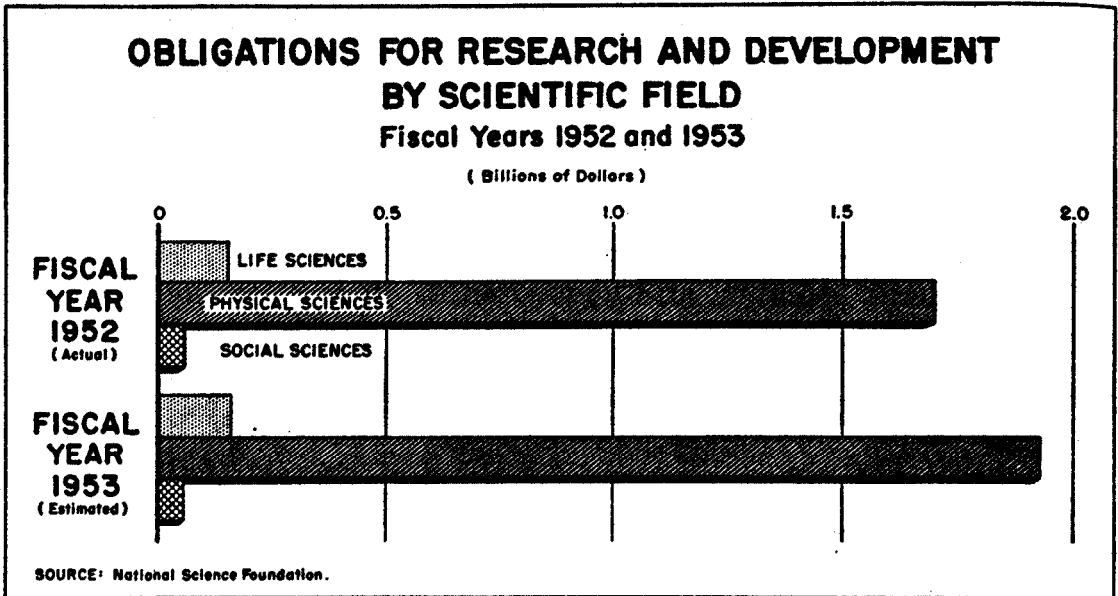


Figure 1

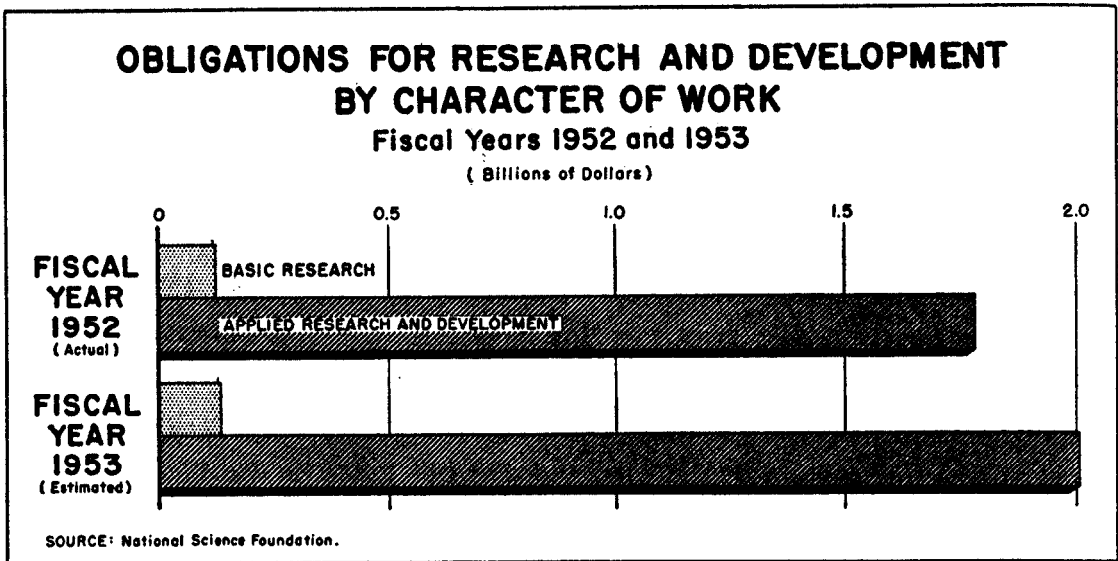


Figure 2

During this period two separate cycles of Federal research and development expenditures are discernible. The first, starting in 1940, reached its peak in 1945. About half of the total research and development expenditures during the peak period of the first cycle is directly traceable to the activities of the Manhattan Engineer District, the organization responsible for the development of the atom bomb.

The second cycle began in 1946. It appears to have reached its peak in 1953. The sharp rise beginning in 1951 was the result of heavy defense expenditures for research and development stimulated by Korean hostilities. During the same period, however, there was a general tendency for the expenditures of all agencies to increase.

Not only have expenditures for research and development increased in absolute terms, but during this period the relative proportion of the Federal budget for these purposes has increased from roughly 1 percent of the total budget in 1940-43 to about 3 percent in 1952-54.

FEDERAL FUNDS FOR SCIENCE AT NONPROFIT INSTITUTIONS

A second published study entitled *Federal Funds for Scientific Research and Development at Nonprofit Institutions, 1950-51 and 1951-52*, was issued by the Foundation during the year. This report shows that about \$338 million out of total Federal research and development obligations of \$2.22 billion in fiscal year 1952 financed research and development activities at nonprofit institutions. Seventeen Federal agencies administered the funds, but four agencies—the Department of Defense, the Atomic Energy Commission, the Department of Health, Education, and Welfare, and the Department of Agriculture—accounted for about \$330 million (98 percent) of the total. About 1 out of every 5 dollars which went to nonprofit institutions in 1951-52 was for basic research; the other 4 went for applied research, development, and large-scale additions to the research and development plants of these institutions.

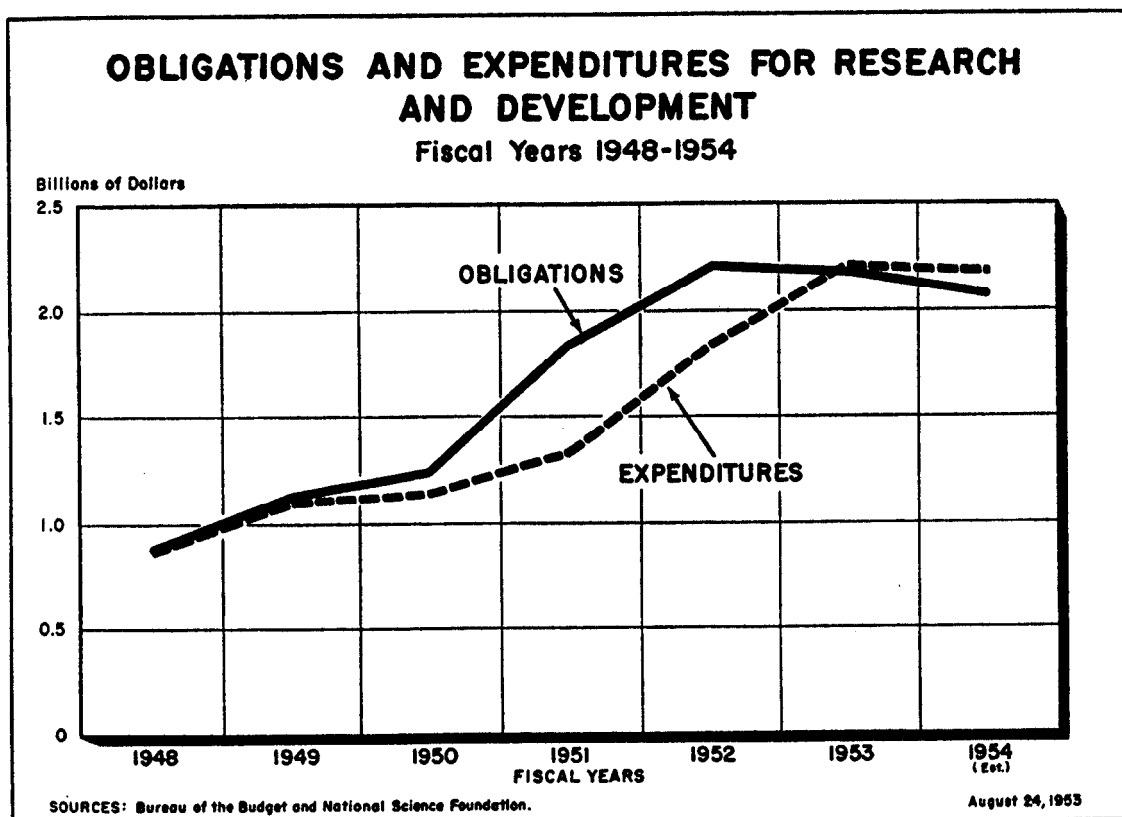


Figure 3

The report also shows that of about 700 educational institutions which appear to have immediate potential capacity for carrying out research and development, 225 received Federal funds. With research centers excluded, five of these institutions received about 29 percent of the total funds going to such institutions, the 50 getting the largest amounts receiving 83 percent of the funds. This concentration is largely accounted for by the more fully developed scientific facilities and staff of the institutions receiving the most funds and by the critical national defense needs. The capacity to do research is also concentrated geographically. The report indicates, however, that scientific resources do exist in many smaller American colleges and universities not receiving support from Federal research programs.

The report points out that the increased activities of the Government in scientific research have resulted in the establishment of "research centers" which are operated for the Government by nonprofit institutions. These centers are usually associated with educational institutions but because the primary emphasis is upon research they seldom maintain a teaching staff or engage in educational activities. In general the research centers carry out special scientific programs closely tied to the operating responsibilities of the supporting Government agency. The funds expended by the Government at these research centers amounted to \$159 million, or a little less than half the funds expended at all nonprofit institutions.

In discussing Federal support of research and development at educational institutions, the report points out that about half the total—\$143 million out of \$295 million in 1951–52—supports research, especially applied research and development, that probably contributes little to the primary objectives of these institutions. There is apparent an increasing tendency to separate research sponsored by the Government and others from the normal functions and activities of the institutions, the report states, adding that as this trend grows, the value of sponsored research for educational purposes is lessened.

Imbalance in Research Programs at Nonprofit Institutions

The amount of money spent for applied research and development in itself is understandable since there is no question that agencies having specific responsibilities for improving our military potential or industrial and agricultural productivity must provide support for applied research and development devoted toward immediately practical ends.

An imbalance between basic and applied work is a portent of danger, however. As was pointed out in the Foundation's *Second Annual Re-*

port, "unlimited expansion of effort toward applied research and development, without corresponding support for basic research, will defeat the entire effort by limiting technological progress to minor improvements and refinements of obsolete processes and equipment."

Of some concern is the fact, brought to light in the report on nonprofit institutions, that a large part of the total Federal research support at educational institutions is devoted to applied and developmental work. This is common practice in certain fields, notably medicine, agriculture and engineering, where work in applied areas is an accepted part of the educational process. On the other hand, in the fundamental scientific areas, the educational process stresses basic research and the fundamentals of the subject, studied both in the classroom and in the laboratory, where first principles can be demonstrated. It will be desirable periodically to review the relative support furnished to basic and applied science.

RESPONSIBILITY OF THE FOUNDATION FOR BASIC RESEARCH

It has been the stated policy of the Executive branch of the Government to increase the responsibility of the National Science Foundation for Federal support of basic research. At the same time, it is desirable for other agencies to support basic research closely related to the solution of problems for which they have statutory responsibility.

The appropriation requests for fiscal year 1954 of the various agencies reflected this point of view to some extent and the pattern of distribution of Federal funds for research during the year ending June 30, 1953, indicated that the research agencies were already making adjustments in their programs.

The effort to centralize support of basic research in the Foundation is desirable from the standpoint of logical administration of Federal research support, but it will clearly work against the best interests of science in the United States unless the Foundation together with the other research agencies can provide adequate support for basic research in order to balance support given to applied research and development. The Foundation has been fully aware of this danger. In order that the Foundation might be able to carry its appropriate share of basic research support, the Congress removed the limitation in the National Science Foundation Act which restricted the appropriation in any fiscal year to \$15 million.

Basic Research Needs of Operating Agencies

The Foundation is in full accord with the view that other agencies should carry on basic research programs directly related to their operating functions. There are two principal factors in support of this position. First, there is the need of an operating agency for an assured and continuing direct flow of fundamental knowledge relating to its practical problems. Second, in view of the increasing dependence of these agencies upon scientific and technical developments, it is essential that the operating personnel maintain effective contact with the scientists of the country. Conversely, it is to the advantage of the country that scientists be encouraged to be interested in fields of great potential importance to national defense and welfare. Support of basic research in areas of immediate interest to the agency provides opportunity to maintain this two-way exchange on a healthy basis.

SURVEY OF SCIENCE IN THE UNITED STATES

By June 30, 1953, the Foundation had completed preliminary plans for a survey of the Nation's present efforts and needs in research and development and was well along toward completion of several phases of the plan. The over-all survey will include six major sections, namely:

1. Research programs of the Federal Government.
2. Research in industry.
3. Research at nonprofit institutions.
4. Studies on scientific manpower.
5. Studies on the exchange of scientific information.
6. Studies on the current status of scientific progress.

Three previous overall studies of the status of research and development in the United States have been issued in the last 20 years. The earliest of these, *Research—A National Resource*, was published in 1937 by the National Resources Committee. At the close of World War II, *Science—the Endless Frontier*, prepared under the direction of Vannevar Bush, drew attention to the increasing importance of basic research to our national security and welfare and reassessed our scientific resources at that time. In 1947 the Steelman report, *Science and Public Policy*, made strong recommendations for a continuing Federal program in support of science. Many of the recommendations of the Bush and Steelman reports were incorporated into the legislation establishing the National Science Foundation in 1950. At the present time there is a

clear need for a reappraisal of the status of science in this country. The survey being undertaken by the Foundation will attempt to assess relevant portions of the information now available.

COORDINATION OF FEDERAL RESEARCH

Many groups have need for current lists of research and development activities supported by Federal agencies through grant or contract. The Foundation has taken several steps toward this end. Quarterly lists of projects in psychology and human resources research and research in the social sciences are compiled and distributed to other interested agencies. The Foundation participates in the support and administration of the Biological Sciences Information Exchange for compiling project information in the biological and medical sciences. It has also encouraged the formation of informal liaison groups made up of representatives of interested agencies to review research activities in specific areas, such as high temperature research. This type of interagency cooperation and liaison is expected to continue.

One of the problems in obtaining comparable fiscal and statistical information from the several agencies is that of defining the terms used in reporting research and development work. Working definitions have been adopted for basic research, applied research and development. It is difficult to arrive at mutually satisfactory definitions of subject field categories used by the various agencies for reporting and record purposes. Complications arise since some agencies are accustomed to keep records based upon the operational goals of research and development programs while others used traditional subject categories. Agencies also differ widely in the use of such terms as project, task, and program as a unit of research and development. These differences and distinctions are gradually being worked out, or at least noted and accounted for, in the statistics being gathered.

ADVISORY COMMITTEE ON MINERALS RESEARCH

The President's Materials Policy Commission in June 1952, recommended that there be undertaken an extensive program of basic scientific research and technical development on techniques and instruments of exploration for minerals. The first step in such a program, the Commission suggested, should be the appointment of a committee under the National Science Foundation, of experts from Government, private industry, and universities, to make a full inventory of existing scientific and technical knowledge in the field, to determine the subject

areas of greatest need for further research and development, to devise a coordinated program to be carried out by private groups and Federal agencies, and to estimate the cost and the extent to which the program will require supporting funds from the Government.

In line with these suggestions the Foundation has appointed a committee to assist in planning and executing research support and training programs, in studying Government programs of research and development, and in developing policies in research and training in the fields of science and technology important to exploration for minerals. This includes:

1. The formulation of a broad program of research and training oriented toward strengthening exploration and discovery of mineral resources.
2. Development of measures to finance and execute such a program through the Foundation, other Government agencies, and industry.
3. Identification and study of background data and policy questions which affect the conduct of sound research and training in this field.

The Committee gave considerable thought to the subject areas of interest and prepared a sample catalog of the problems facing the nation in the minerals research field. While recognizing the importance of Federal support of research and training in the minerals field, the Committee thought it desirable for industry to support the preponderate amount of research in this field, especially applied research and development. A list of areas of minerals research developed by the Advisory Committee on Minerals Research is given in appendix VII, page 109.

TRAVEL RESTRICTIONS ON FOREIGN SCIENTISTS

In October 1952, the Director was invited to testify before the President's Commission on Immigration and Naturalization concerning the impact of existing immigration laws upon science. In assessing the problem, he drew upon the experience of other Government agencies and of scientists themselves. Upon the basis of information available to the Foundation through these channels, it was clear that the provisions of the immigration laws governing the temporary admission of aliens to this country, and the administration of those laws, had created a problem.

The problem arose in the enlargement between 1948 and 1950 of restrictions on temporary admission of an alien visitor. These restrictions were retained in the codified law becoming effective in December 1952. In the practically unanimous opinion of scientists

these restrictions have brought about deterioration in the relationships of American scientists with their opposite numbers in countries friendly to the United States, particularly in the United Kingdom and other countries in Western Europe.

In his statement, the Director called attention to the fact that creative scientific ability is not circumscribed by national boundaries. He pointed to the evidence that the observations and conclusions reached by competent scientists in any one country are invaluable to the research of scientists in other countries working on the same or similar problems. He further pointed out that in achieving the advanced technology and living standards of present day America, we have drawn heavily on the findings and accomplishments in pure science abroad. Without ready access to these foreign sources of scientific information this progress would have been impossible.

The number of foreign scientists excluding students visiting the United States in 1951 was estimated at less than 3,000, or about 1 percent of the 300,000 visitors and tourists entering the country in that year. The Director pointed out that these scientists were important to our scientific strength out of all proportion to their number, for they consist, generally speaking, of the best scientific minds of the free world outside the United States.

It appears that under existing statutes at least 50 percent of all foreign scientists who apply to enter the United States meet difficulties or serious delays. The number of actual refusals of permission to enter is much less, but the principal damage to our international relationships appears to occur in a small number of cases involving refusals to outstanding persons which are difficult for the public to understand on the basis of the published facts, coupled with the tedious, cumbersome, and uncertain process experienced by those who do pass through the screen.

Recommendations

In closing his comment on the visitor visa problem, the Director made four specific recommendations for improving the law and its administration. In so doing he recognized that rigorous and effective security measures are required under present world conditions to preserve the integrity of our Government and our country. It is believed, however, that the recommendations will achieve better balance between security by isolation and security by technological achievement. The recommendations may be summarized as follows:

1. That a distinction be made in the statute between procedures and criteria for temporary admission of a nonimmigrant alien and require-

ments for admission of an alien who intends to become a permanent resident of the United States. Complicated administrative procedures, extensive security checks, exhaustive questionnaires and careful interrogations are acceptable as part of an application for permanent entrance and ultimate citizenship in the United States. The need for the same administrative procedures and criteria is less apparent in the case of an application for a visit of a few weeks or months. It is implicit in this suggestion, of course, that strict measures be employed to screen out foreign agents, saboteurs, and secret couriers.

2. That the criterion requiring exclusion of an alien visitor might rationally become *present, sympathetic* association with a foreign subversive organization rather than, as now, affiliation, in an extremely broad sense of the word, at any time in the past with such an organization. The Congress has already taken a step in this direction by providing exceptions for persons who in the past were so affiliated but who have terminated such affiliation and for five years prior to the date of application for a visa have been actively opposed to the program of subversive organizations.

3. That consideration be given to providing for selective audit from time to time of applications for temporary admission, by a competent, reliable and disinterested group with appropriate experience both inside and outside of Government. This suggestion grows out of recognition that our Government has been accumulating a wealth of experience with security programs in which a balance must be struck between security by isolation and security by technological achievement.

4. That, particularly if the other suggestions prove to be impracticable, a separate section of the immigration law be established, which would create a much-simplified and expeditious system for admitting "students, trainees, teachers, guest researchers, professors and leaders in fields of specialized knowledge or skill," who have applied for admission to this country for a purpose directly related to the activities of a Government agency, an accredited institution of higher learning or a scheduled meeting of an accredited international professional organization.

LEGISLATION ON WEATHER CONTROL

At the invitation of the House Committee on Interstate and Foreign Commerce, the Foundation in July 1953, presented comment on pending legislation relating to weather control and modification. The Foundation's recommendations were favorable to several alternate bills in view of the close correspondence of most of their provisions. Subsequent

action of the Congress was in accord with these recommendations and a bill was approved in August 1953, as Public Law 256, first session, Eighty-third Congress. The National Science Foundation was included as a member of the interagency advisory committee established under the law.

The bills had a common objective of establishing an advisory committee to make a complete study and evaluation of public and private experiments in weather control, for the purpose of determining the extent to which the Federal Government should experiment with, engage in, or regulate activities designed to control weather conditions.

In endorsing the principal objective of these bills, the statement of the Foundation presented a brief review of the present status of knowledge regarding artificial weather modification as follows:

Developments in the study of cloud nucleation and in experimental seeding of clouds have indicated that significant artificial modifications of weather may be possible. Current studies, as supplemented by field experiments, do not afford a satisfactory basis for belief that widespread practical applications of weather modification efforts are feasible at the present time. Present knowledge is inadequate for formation of definitive conclusions as to the nature and extent of possible modifications, the means by which they may best be accomplished and the conditions and circumstances required for successful and beneficial effects. Because of the lack of necessary basic data, much current cloud-seeding activity appears to represent inefficient expenditure and perhaps actual waste of energy and funds.

The greatest need at the present time is for additional basic research in cloud nucleation processes. Such basic research should go forward both in the laboratory, to gain an understanding of the nucleation processes, and in the field, to investigate natural processes of cloud nucleation. Controlled field experimentation, applying the knowledge thus gained to more effective understanding and practical use of cloud nucleation, is also necessary and desirable.

Insofar as the Federal Government is concerned, these recent scientific developments present issues and problems which deserve attention. Further knowledge of mechanisms underlying possible modifications of the weather and the potentialities of practical application is a matter of broad interest and significance to several departments and agencies including the Foundation. The nature, extent and distribution of Federal research activities in nucleation processes also require careful consideration and are of special interest to the National Science Foundation.

A further problem is presented by the possible need for Federal regulation of weather modification operations. Current operations have prompted several States to enact regulatory legislation. The potential interstate and possibly international effects of such operations, the need to avoid indiscriminate or wasteful seeding and the further need to prevent interference with soundly conceived and significant field experimentation are factors which may ultimately impel some exercise of Federal authority. Until more evidence of the practicality of weather modification is available, however, Federal regulation seems premature. Informal liaison with State regulatory agencies and private operators would perhaps be useful, and would seem to be sufficient to protect Federal interests at the present time.

SURVEY OF THE STATUS OF THE SCIENCES OF HUMAN SOCIAL BEHAVIOR

During the year ending June 30, 1952, Federal agencies obligated over \$53 million for research and development in the social sciences. These activities were highly weighted in the direction of collection of statistics and applied and development work, with slightly more than \$3 million for basic research studies.

In view of these data, the Foundation undertook in March 1953 a systematic and continuing study of the present status of the sciences of human social behavior to determine its own position with respect to research in the field. The Foundation is following with interest the programs of the private foundations in the behavioral sciences.

The term "behavioral sciences" covers a wide range of activities. These may be thought of in terms of a continuum. At one end lie the hard-core scientific studies of human social behavior—the use of experimental techniques, controlled experiments, laboratory studies, statistical and mathematical methods, survey design techniques, development of measurement devices and instruments such as standardized tests and scales, empirical testing of hypotheses and concepts, and other characteristic features of scientific research. At the other end of the continuum lie the philosophical, ethical and political studies and interpretations of human social conduct.

In its current survey of the status of research in this broad area, the Foundation will seek to identify the hard-core scientific end of the continuum. Of particular interest are certain interdisciplinary areas of convergence of the natural and social sciences. These include such areas, for example, as anthropology, human ecology, statistical and experimental design, and demography.