NATIONAL SCIENCE FOUNDATION

Recent Developments Affecting the Scientific Community

SURVEY OF THE NATION'S SCIENTIFIC POTENTIAL

Amounts, kinds, and costs of scientific research must be known when agencies and organizations plan programs and develop policies for research and development. Down to 1955, the roughly estimated total expenditure for scientific research and development in the United States was about $3 billion to $3.5 billion. Based on statements from 10,000 business enterprises, and on estimates of costs of research conducted by educational institutions, Government agencies, and other types of research organizations—all of whose officials generously cooperated in completing a survey sponsored by the Foundation—United States expenditures for all research and development for the survey period 1953, were not $3.5 billion, but well over $5 billion.

Of this total, private industry alone expended $3.7 billion, of which $1.4 billion (37%) represented work done for the Federal Government. Although private industry's contribution to the support of basic research was reported as nearly $150 million, this represented only 4 percent of the total expenditure by private industry in 1953 for all research and development.

Science and Engineering in American Industry

The Foundation's Office of Special Studies brought many facts out of the jungle of speculation early in fiscal year 1956 with publication of the monograph, *Science and Engineering in American Industry,* a preliminary report on a survey of research and development costs and personnel in 1953–54. Data for the publication were assembled by the Bureau of Labor Statistics, United States Department of Labor, under a grant from the Foundation. A final and more comprehensive report, containing descriptive and analytical materials based on personal interviews with industrial research executives as well as on statistical inquiry, is scheduled for publication during fiscal year 1957.

Broken down by scientific fields, industrial firms reported their basic research as predominantly in the physical sciences—such as chemistry, engineering, physics, and metallurgy—which received over 90 percent

of their total basic research funds. Less than 10 percent was reported for the life sciences—medical, agricultural, and biological.

The survey disclosed that companies in the electrical equipment and aircraft categories exceeded all others in the dollar volume of their research and development—together accounting for $1.5 billion of the $3.7 billion total for industrial firms. (See figure 1.) The chemical industry surpassed all others in dollars expended for basic research.

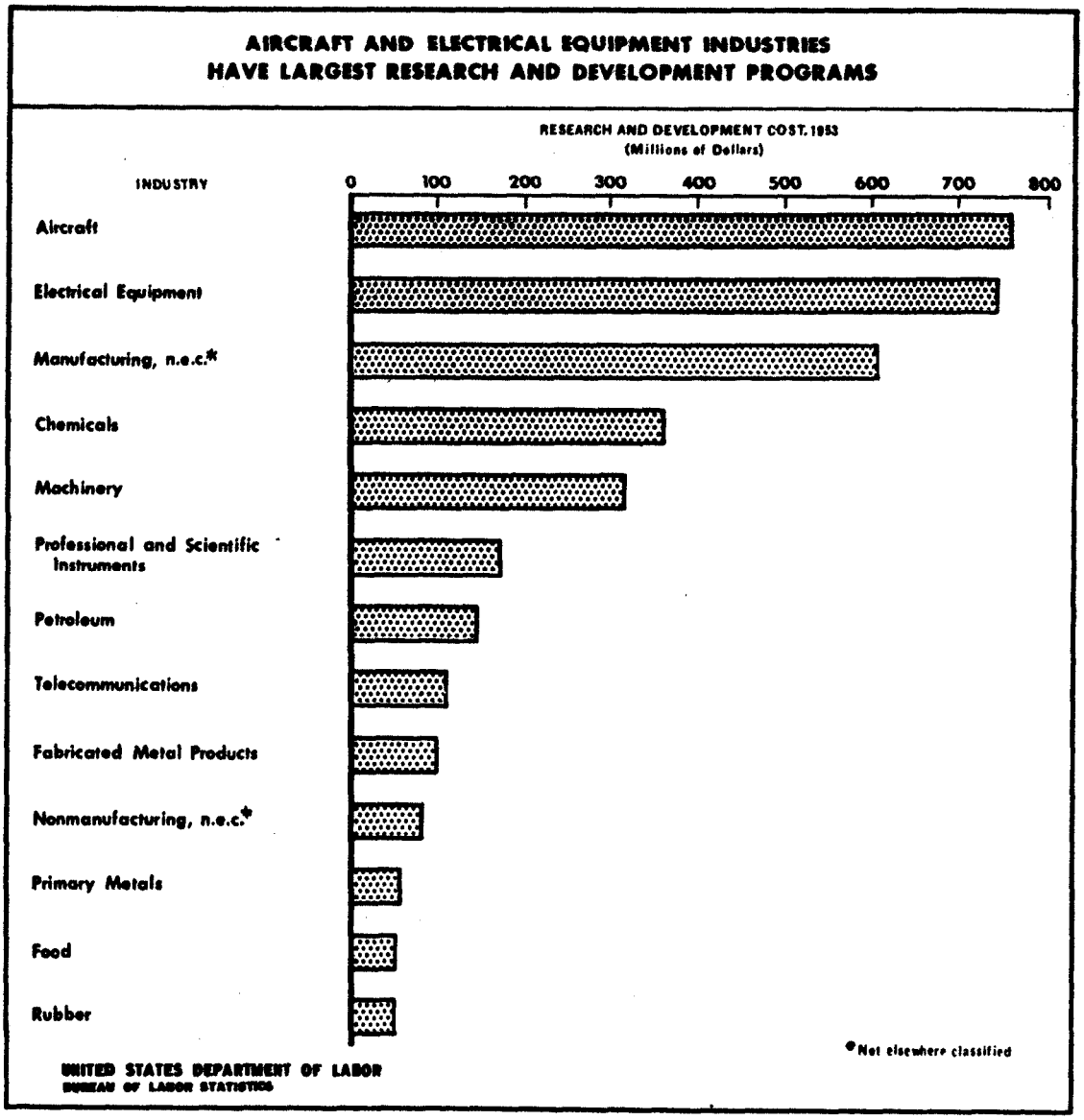


Figure 1.—*Cost of research and development program by industry.*

Of the 554,000 scientists and engineers employed by the surveyed industries in January 1954, the largest groups included 409,000 engineers, 60,000 chemists, 11,000 metallurgists, 10,000 life scientists, 10,000 earth scientists, 8,000 physicists, and 6,000 mathematicians. Included, as well, were about 34,000 scientists and engineers classified by their companies as administrators. Of this total, only about 157,000 scientists and engineers—30 percent—were engaged in research and develop-

ment, including approximately 105,000 engineers, 27,000 chemists, and much smaller numbers in other fields of science.

The survey found that more than 15,000 companies contributed to the Nation's research and development effort. Of these about 13,000 or 85 percent, employed less than 500 persons each. Cost figures show, however, that this large group of small companies performed only about one-tenth of all industrial research and development, whereas the 375 largest companies (with 5,000 or more employees) performed about 70 percent. These data are exclusive of enterprises employing less than 8 persons and of individuals working alone, as well as of scientific and engineering consulting firms and a few other types of organizations.

Science Research Support by Private Foundations

Disbursement of Government funds for whatever purposes should be directed to meet broad areas of economic or social need not adequately supported by private enterprise. Until statistics were gathered by the Russell Sage Foundation, and published in fiscal year 1956 under arrangement with the National Science Foundation, a comprehensive account of the kinds, amounts, and dollar values of scientific research supported by the larger private foundations was not available. Data for the study were assembled without cost to the National Science Foundation, and made public in a second monograph, *Scientific Research Expenditures by the Larger Private Foundations,* issued during the past fiscal year by the National Science Foundation.

Research by Cooperative Organizations

Although the dollar value of scientific research support by trade associations and professional technical societies is not large, the influence of these groups may be considerable upon the policies and practices of the organizations they represent. A third monograph, *Research by Cooperative Organizations,* published by the National Science Foundation during fiscal year 1956, produced statistical data on scientific research by trade associations, professional and technical societies, agricultural cooperatives, and research-educational cooperatives. The report was prepared for the Foundation by the Battelle Memorial Institute.

The picture of the basic and applied research and the development activities of the industrially orientated sector of the research community will be rounded out, during fiscal year 1957, with publication of a monograph on the work of nonprofit research institutes and of those commercial laboratories which conduct research.

Federal Funds for Science

Research and development supported by the Federal Government has undergone a marked increase in recent years in relation to total Federal expenditures. Accounting for 1 percent of the total budget in 1940, scientific research and development was responsible for 3 percent, or $2.1 billion in fiscal year 1955, out of Government outlays of $63.5 billion for all purposes.

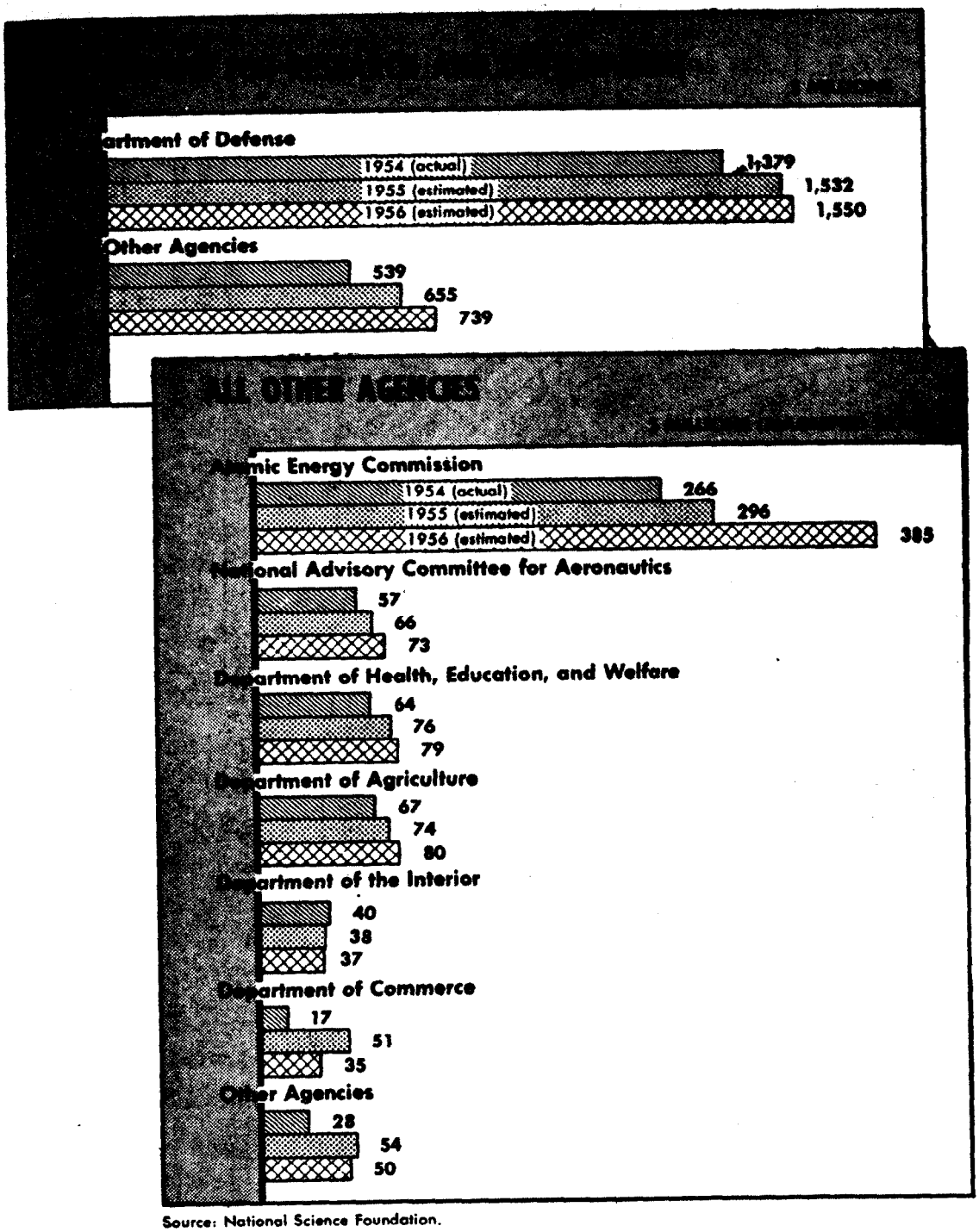
These facts were shown in the fourth issue of *Federal Funds for Science,* prepared by the Office of Special Studies and released by the Foundation during fiscal year 1956. Federal support of research and development is described in terms of administering agencies, scientific fields covered, and character of work performed.

Although more than 20 of the 56 departments and agencies of Government administer funds for scientific research and development, the Department of Defense alone accounts for about 70 percent of the total. Funds administered by the Defense Department amounted to over $1.5 billion in fiscal year 1956. Ranking next to the Department of Defense is the Atomic Energy Commission. When funds administered by five other agencies—the National Advisory Committee for Aeronautics, and the Departments of Agriculture; Health, Education, and Welfare; Interior; and Commerce—are added to those of the Department of Defense and the Atomic Energy Commission, more than 97 percent of the total Federal research and development budget is accounted for. (See figure 2.)

The mathematical, physical, and engineering sciences received 85 cents of each dollar obligated by the Government for the conduct of research and development in fiscal year 1954. Ninety-three percent, or $1.6 billion, of the Federal Government's obligations budgeted to conduct research and development in fiscal year 1954 was for applied research and development. *Less than 7 percent, or $116 million, went into basic research.* As noted above, private industry reported the expenditure of $150 million in 1953 to support basic research in the sciences.

Other Surveys Underway or in Process of Publication

During the past year, the Foundation completed a monograph entitled *Organization of the Federal Government for Scientific Activities* which is the first comprehensive account of Federal organization for such activities since 1947. (See figure 3.) It is of particular interest because it documents the marked increase in research and development activities in Government. (This publication was released during August 1956.)



Source: National Science Foundation.

Figure 2.—*Obligations of the Federal Government for research and development by department and agency.*

Another study completed during this year was *Federal Support for Science Students in Higher Education.* (See figures 4 and 5.) The information contained in this report on the present Federal programs which support higher education in the sciences should prove of considerable assistance in evaluating the many proposals for Government-financed scholarship and fellowship programs in the sciences. (This publication was released during September 1956.) A companion study was also well underway during 1956. This was a survey of graduate

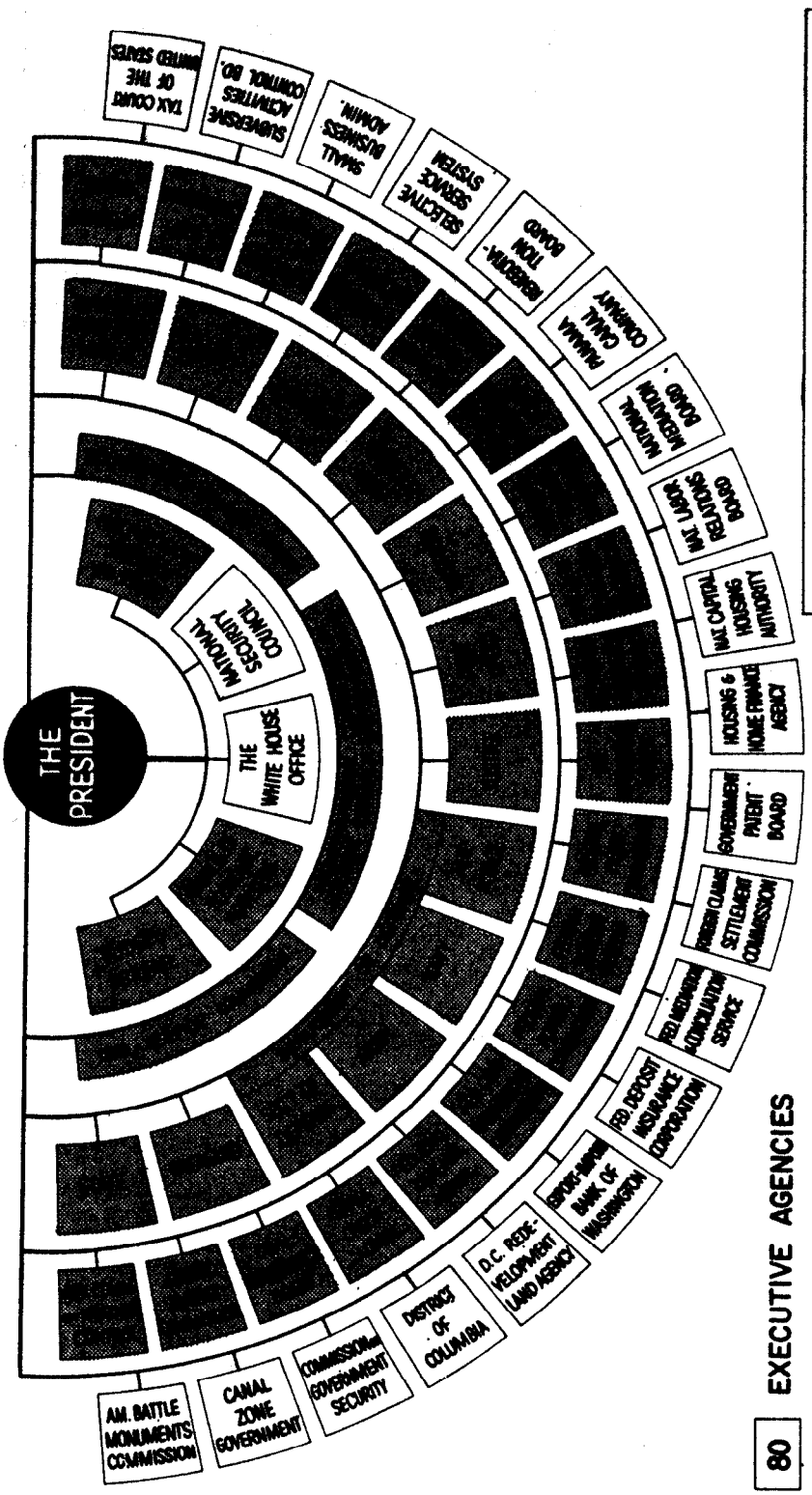
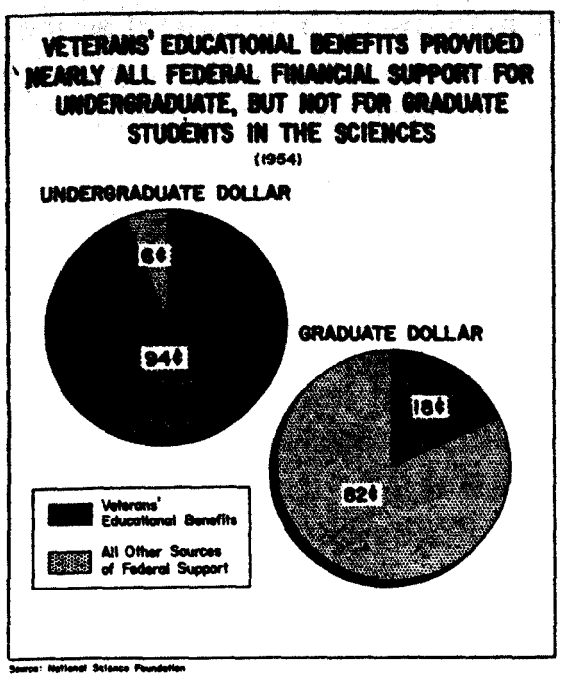


Figure 3.—*Organization of the executive branch of the Government for scientific activities.*



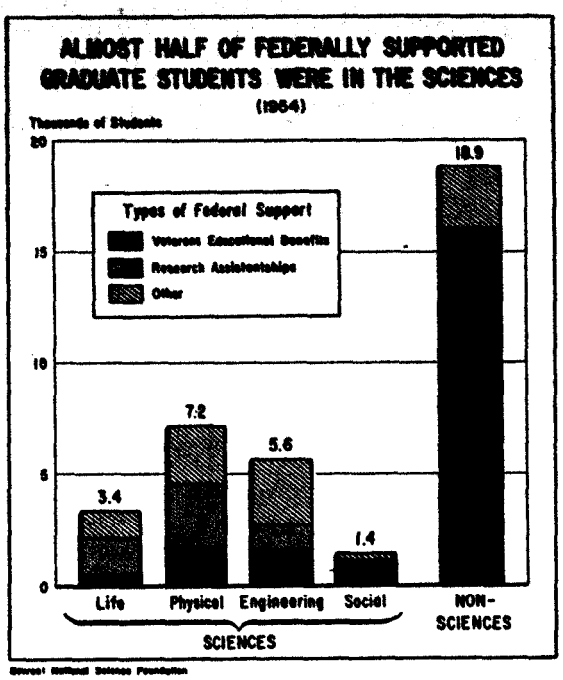


Figure 4.—*Amount of the Federal support dollar provided through veterans' educational benefits at the undergraduate and graduate college level.*

Figure 5.—*Federal support of graduate students by field and type of support.*

student enrollment, higher degrees granted, and financial support for graduate students.

A historical study of the growth of Federal scientific activities from Colonial times to World War II was prepared under contract with the Foundation by Dr. A. Hunter Dupree of Harvard University. It is entitled *Science in the Federal Government, a History of Policies and Activities to 1940* and will be published by the Harvard University Press in February 1957.

Portions of a pilot study of the scientific activities of State governments were also completed under contract with the University of North Carolina during fiscal year 1956. Reports were received on 4 of the 6 States taking part in the study. The four are: New York, Wisconsin, New Mexico, and Connecticut. This study will provide a picture of the role of State governments in scientific activity.

New Knowledge About Total United States Scientific Research Effort

Thus, fiscal year 1956 saw the beginning of the public presentation of what is probably the most complete overall factual reporting of the Nation's scientific research and development effort during a given year. Public officials, educators, scientists, industrialists, and the press will have available, as time goes on, a broader and more accurate picture than was previously available for this mainspring of American culture and technology.

Experience gained in the course of inquiries such as those described above will indicate fruitful lines of analysis to meet the need for knowledge about our Nation's scientific research and development activities.

CONSIDERATIONS OF LOYALTY IN RELATION TO GOVERNMENT SUPPORT OF UNCLASSIFIED RESEARCH

One of the basic objectives of the National Science Foundation is the promotion of progress in science. For this reason the Foundation is vitally concerned with the relationship between the Federal Government and American scientists. If this relationship is not healthy, and results in mutual distrust, scientific progress is retarded. The Nation is deprived of the fruits of much research and the scientist of a source of support needed for his investigations.

Therefore, in keeping with fundamental concepts of justice and freedom, and in fairness to the scientific community, the Foundation early in its career determined that:

> In appraising a proposal submitted by or on behalf of a scientist for the support of unclassified research not involving considerations of security, the Foundation will be guided as to an individual's experience, competence, and integrity by the judgment of scientists having a working knowledge of his qualifications. However, the Foundation does not knowingly give nor continue a grant in support of research for one who is—
>
> 1. An avowed Communist or anyone established as being a Communist by a judicial proceeding, or by an unappealed determination by the Attorney General or the Subversive Activities Control Board pursuant to the Subversive Activities Control Act of 1950, or anyone who avowedly advocates change in the United States Government by other than constitutional means, or
> 2. An individual who has been convicted of sabotage, espionage, sedition, subversive activity under the Smith Act, or a similar crime involving the Nation's security.

Furthermore, if substantial information coming to the attention of the Foundation indicates that a potential or actual researcher might be guilty of violation of any such law, the information will be forwarded to the Department of Justice for its consideration.

The policy of the Foundation was endorsed by the American Association for the Advancement of Science at its Berkeley meeting in December 1954.

During the past year, Sherman Adams, the Assistant to the President, requested Detlev W. Bronk, President of the National Academy of Sciences, to appoint a committee to survey the whole problem and report its findings to him. Dr. Bronk appointed the following Committee on Loyalty in Relation to Government Support of Unclassified Research:

> Chairman: J. A. Stratton, Vice President and Provost (now Chancellor), Massachusetts Institute of Technology. Members: Robert F. Bacher, Professor of Physics, California Institute of Technology; Laird Bell, Attorney, Chicago, Ill., Wallace O. Fenn, Professor of Physiology, University of Rochester, Robert F. Loeb, Bard Professor of Medicine, College of Physicians and Surgeons, Columbia University; E. Bright Wilson, Jr., Professor of Chemistry, Harvard University; and Henry M. Wriston, President, Brown University.

Recommendations of the Committee were as follows:

1. The test in the award of (Government) grants and contracts for unclassified research should be the scientific integrity and competence of the individuals responsible for carrying out the research, and the scientific merits of their program.
2. When an official of the Government comes into possession of evidence which in his opinion indicates the possible existence of disloyalty in violation of law, he should promptly refer that information to the Federal agencies of law enforcement established to deal with such matters.
3. An allegation of disloyalty should not by itself be grounds for adverse administrative action on a grant or contract for unclassified research by scientifically competent investigators; if the indications of disloyalty appear sufficiently serious to warrant any action at all, the Government in the opinion of the Committee has no other course than to bring formal charges and to produce the evidence in open hearing before legally constituted authority.

The report of the Committee, submitted to Governor Adams by Dr. Bronk, was made public shortly after the end of fiscal year 1956. In his acknowledgment, Governor Adams said in part:

> The report of the Committee on Loyalty in Relation to Government Support of Unclassified Research has been carefully studied by the executive departments and agencies which

are primarily involved in this problem. The principles set forth in the recommendations of the report have generally been found satisfactory as a basis for actions regarding grants or contracts for unclassified scientific research. It is noted that these principles are essentially those which support the policy of the National Science Foundation. The departments and agencies will, therefore, follow practices consistent with the recommendations contained in the report of the Academy's Committee.

SCIENCE AND SCIENTIFIC MANPOWER IN THE U. S. S. R.

Since the death of Stalin, there have been many indications that scientists in the U. S. S. R. are being allowed to renew contacts with the international community of science. The past year in particular was marked by a freer exchange between scientists of the U. S. S. R. and other nations than any time in recent years. Russian scientists have appeared more frequently at international meetings and conferences and a number of invitations to scientific meetings within the Soviet Union have been extended to Western scientists as well as to scientists of satellite nations. In February 1956, about a dozen American physicists were invited to attend a conference on high energy physics to be held in Moscow in May, and three Russian physicists attended the Sixth Annual Conference on High Energy Physics at the University of Rochester. The U. S. S. R. was admitted to membership in the International Council of Scientific Unions in August 1955, and is participating extensively in the research programs of the International Geophysical Year.

Because of lack of knowledge in this country concerning the scientific manpower resources of the U. S. S. R., Nicholas DeWitt undertook a study, sponsored jointly by the National Science Foundation and the National Academy of Sciences-National Research Council, which has resulted in the publication of *Soviet Professional Manpower*. This is the first book that pulled together all known facts on the deployment and utilization of Soviet professional manpower.

Interest in *Soviet Professional Manpower* is an encouraging sign of desire by Americans to be better informed about what is going on in other countries. Because few American scientists understand Russian, they tend to overlook literature published in that language, despite the fact that in recent years there is increasing evidence that Russian science cannot be ignored.

The National Science Foundation provided travel grants that enabled a small group of American physicists to attend the conference on high energy physics in Moscow in May. Upon their return, they gave uniformly commendatory accounts of the competence of Russian physicists. To quote from one of them:

> The Soviet scientists are capable, well trained, and well informed scientifically. They are for the most part better informed on both American and Soviet scientific literature than are most of the corresponding people in America. There can be no question that they are up to date on the American literature. (I am very pleased to hear that the *Doklady* as well as the *Journal of Experimental and Theoretical Physics* will henceforth routinely be translated into English.)

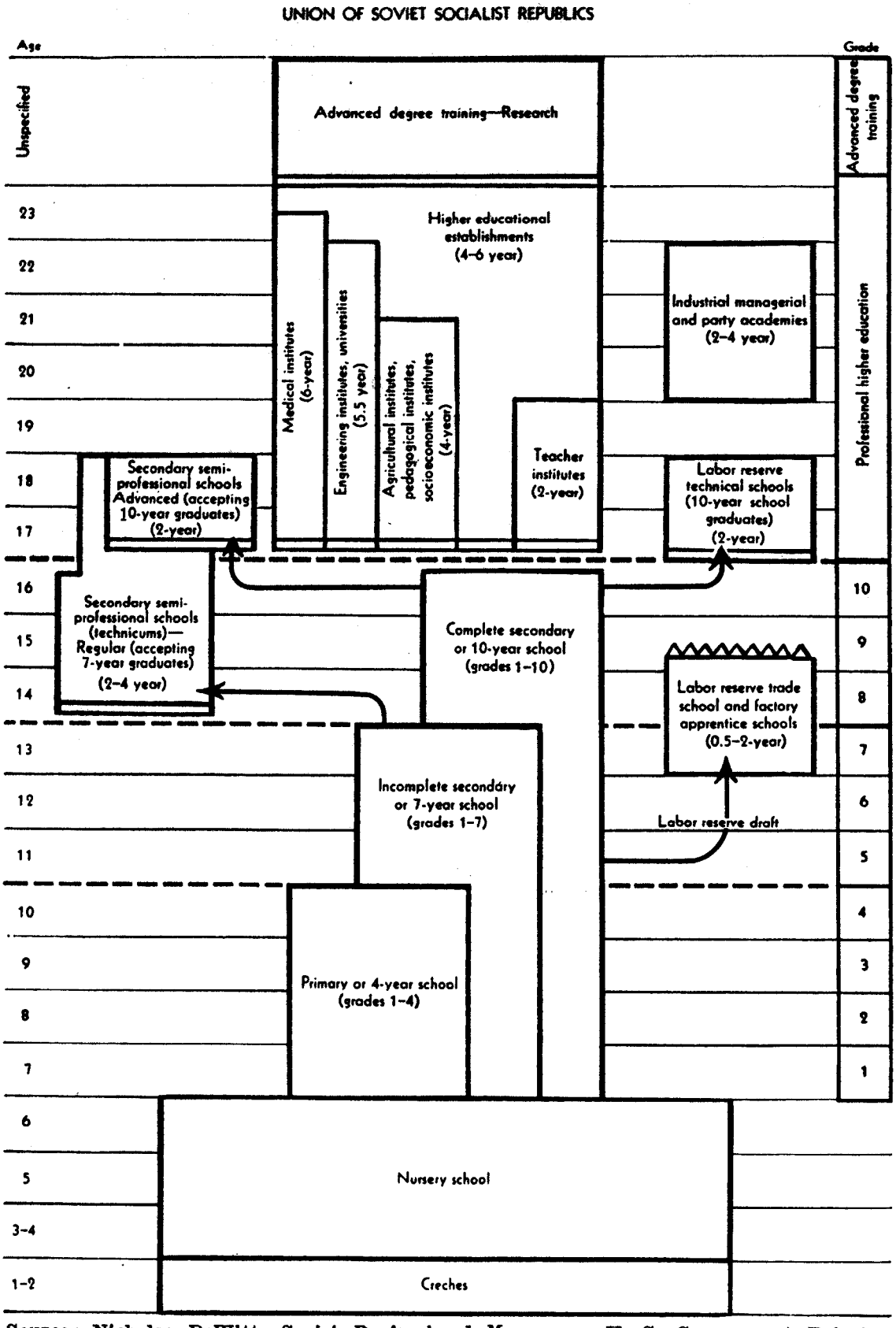
The translation program mentioned is another effort on the part of the National Science Foundation to make significant scientific findings freely available to American scientists, despite language barriers. (See p. 80 for fuller description of this program.)

Although the U. S. S. R. is producing scientists and engineers at a higher rate than the United States (about 2½ times as many science field graduates and nearly 3 times as many engineers in 1955), there is great need to see the problem in its proper perspective. As Dr. Lee DuBridge, President of the California Institute of Technology, told members of the National Committee for the Development of Scientists and Engineers last June:

> It is true that in Russia more men and women received degrees in science and engineering last year than in the United States. So what? Maybe that is because in the past 100 years they have so neglected their technical strength that they must now exert strenuous efforts to build it up. If this is true, then our rate of production should not be determined by their weakness—only by our own. Let us ask how many engineers we need to do our job, and not take over their figures for the numbers they require to do their job.

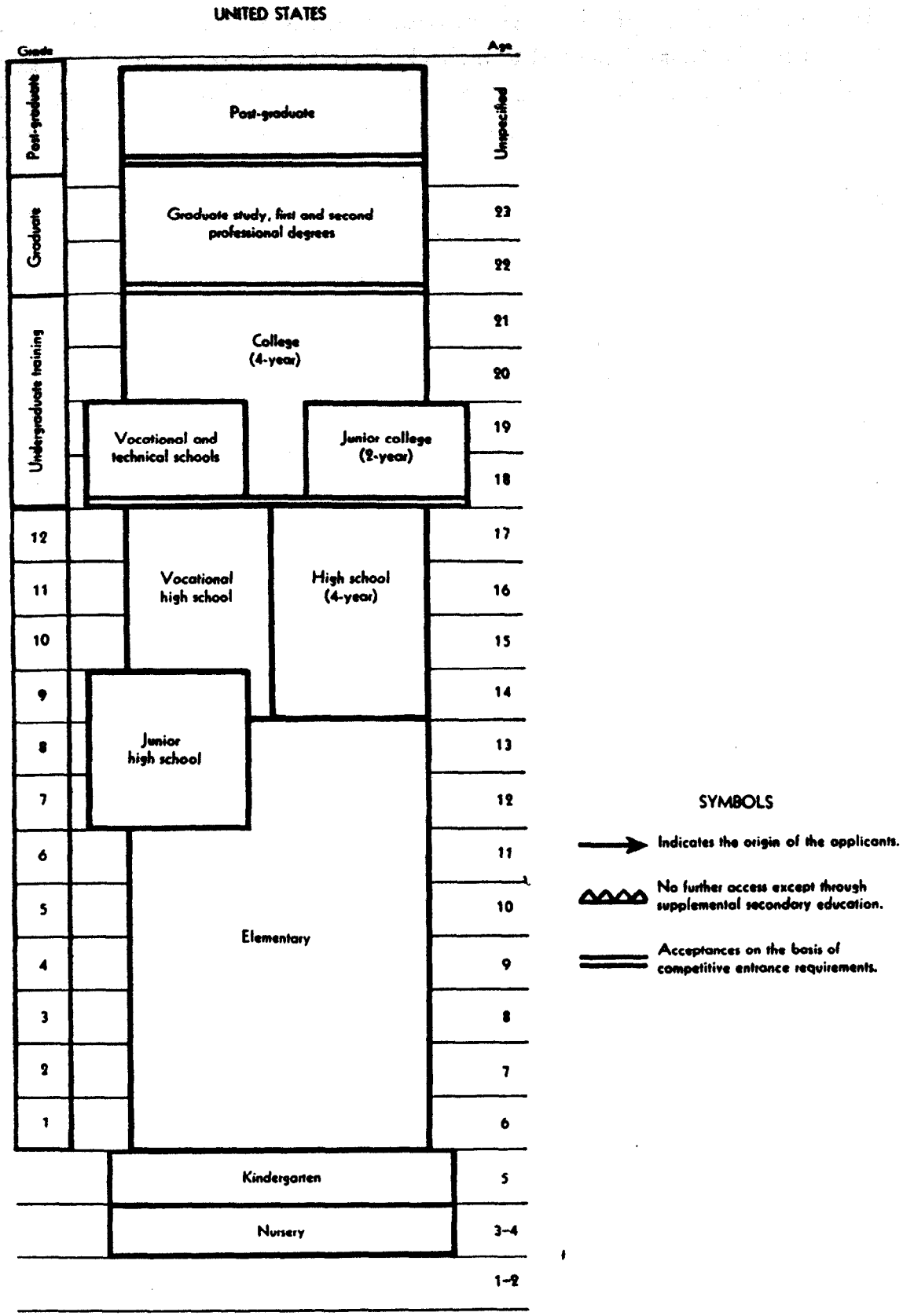
Soviet Professional Manpower is a careful exposition of the Soviet educational system. It is accompanied by statistical data in tabular and chart form. The book shows that the Russians are seeking to improve their educational system to the point where it is capable of producing all the skills their growing economy demands. They have apparently concluded that they need scientists and engineers more than anything else, so a system of incentives and awards, coupled with highly disciplined training in these fields, has been developed to promote training of scientists and engineers at a high rate. (See figure 6.)

The United States has for years maintained a position of leadership in technology. It now appears that such leadership can no longer be taken for granted. We do not wish to be forced into a position of competition with the U. S. S. R. on its own terms; but Russian emphasis on science and mathematics, particularly in secondary schools, lends added weight to the need for scrutinizing our own educational system closely.



Source: Nicholas DeWitt, *Soviet Professional Manpower*, U. S. Government Printing Office, Washington, 1955.

Figure 6.—*Structure of the Soviet educational*



system compared with that of the United States.

Another American physicist, commenting on his observations of education in the U. S. S. R., noted that the U. S. S. R., in common with other nations of Europe, lays great stress on thorough training in secondary schools. Students emerging from secondary schools in European countries are generally well prepared in languages and mathematics as well as in science, so that when they approach the university, they are ready to specialize in their chosen subject.

There is some evidence of widespread relaxation of requirements in American secondary schools for such subjects as languages, mathematics, and the sciences. Many students attracted to the study of science in college find that they have been inadequately prepared to pursue studies in fields that require thorough grounding in mathematics. A sober reappraisal of secondary school training in science and mathematics may be in order as a guide to the extent this country may fall short of achieving its high potentialities.

THE NATIONAL COMMITTEE FOR THE DEVELOPMENT OF SCIENTISTS AND ENGINEERS

Functions and Program

The National Committee for the Development of Scientists and Engineers was brought into being on April 3, 1956, by President Dwight D. Eisenhower. Membership of the National Committee includes representatives from the fields of engineering, science, education, management, labor, State, and local governments, and the humanities. In a letter to Dr. Howard L. Bevis, Chairman of the National Committee, the President charged the Committee as follows:

> It is my hope that the Committee will—
>
> 1. Assist the Federal Government in identifying the problems associated with the development of more highly qualified scientists and engineers.
> 2. Enlist the cooperation of all interested individuals and groups in analyzing the problem and developing programs to deal with it, and to take the lead in coordination of interested organizations outside the Federal Government.
> 3. Make available to all interested organizations information on effective ways of overcoming the obstacles to the training of more qualified scientists and engineers.
> 4. Publicize the problem and possible solutions in order to stimulate widespread public understanding and support.

In setting up the Committee, the President requested the National Science Foundation to supply staff services and to provide leadership to other departments and agencies in carrying forward activities which will contribute to a solution of the assigned problems.

Work in Progress

The National Committee held its first meeting on May 15, 1956. At this first meeting the Committee, in addition to determining its method of operation, organized two working groups. The first group was to develop a program looking toward increasing the number and improving the quality of engineering and scientific technicians. The second

group was to explore ways and means of encouraging the long-range improvement of science and mathematics programs in the elementary and secondary schools.

These working groups reported at the second meeting of the Committee on June 21–22, 1956.

The working group concerned with scientific and engineering technicians developed a number of recommendations to expand the available supply of qualified technicians. These include:

1. More widespread recognition of the capabilities of technicians by management, scientists, and engineers.
2. Publicizing techniques for improving on-the-job utilization of technicians.
3. Expanding physical facilities of technical institutes.
4. Increasing the supply of adequately trained teachers in these institutes.
5. Increasing the number of students capable of pursuing the technical institute type of schooling.

The working group assigned the task of long-range improvements in science and mathematics programs in elementary and secondary schools made the following recommendations:

1. A reevaluation should be made of the scope, content, and quality of elementary and secondary school science and mathematics programs by the appropriate agencies in communities and States.
2. Organizations represented on the National Committee should take an active part, as appropriate, in stimulating and participating in such reevaluation at the local, state, and national levels in the ways suggested in the working group's report.

The National Committee determined that the most practical way of translating these recommendations into action was to establish a task force charged with the responsibility of designing a mechanism for bringing together in each State, teachers, school administrators, scientists, engineers, and representatives of industry and the public, to work toward the improvement of mathematics and science programs in elementary and secondary schools. The task force is also to concern itself with the quality and content of mathematics and science textbooks and other teaching materials.

The National Committee, at its second meeting, instructed the Chairman to organize additional working groups to develop programs looking toward the improvement of teachers and teaching in elementary and

secondary schools, and toward identification and guidance of students with aptitude for science and mathematics in the elementary and secondary schools.

The Committee also requested that study be made of the need for, and possible sources of, additional scholarships for high school graduates intending to enter into science and engineering courses in college.

MEMBERS OF THE NATIONAL COMMITTEE FOR THE DEVELOPMENT OF SCIENTISTS AND ENGINEERS

DR. HOWARD L. BEVIS, *Chairman,* President, Ohio State University.

Dr. ERIC A. WALKER, *Vice Chairman,* President, Pennsylvania State University.

Mr. ROBERT L. CLARK, *Executive Secretary,* National Science Foundation.

Engineering

Mr. THOMAS H. CHILTON, President, Engineers Joint Council.

Dr. MAYNARD M. BORING, President, American Society for Engineering Education.

Science

Dr. DETLEV W. BRONK, President, National Academy of Sciences.

Dr. PAUL B. SEARS, President, American Association for the Advancement of Science.

Management

Mr. COLA G. PARKER, President, National Association of Manufacturers.

Mr. A. BOYD CAMPBELL, President, U. S. Chamber of Commerce.

Labor

Mr. GEORGE MEANY, President, American Federation of Labor-Congress of Industrial Organizations.

Education

Dr. ARTHUR S. ADAMS, President, American Council on Education.

Dr. IRVIN STEWART, President, American Association of Land Grant Colleges and State Universities.

Dr. J. LESTER BUFORD, President, National Education Association.

Dr. ROBERT STOLLBERG, President, National Science Teachers Association.

Dr. LELAND N. DRAKE, President, National Association of Secondary School Principals.

Dr. ARTHUR G. COONS, President, Association of American Colleges.

State and Local Governments

HON. ARTHUR B. LANGLIE, Governor of the State of Washington, Chairman of the Governors' Conference Council of State Governments.

HON. JOHN B. HYNES, Mayor of Boston, Mass., President of the United States Conference of Mayors.

Dr. EDGAR FULLER, Executive Secretary, Council of Chief State School Officers.

Social Sciences and the Humanities

Dr. FRED EGGAN, Chairman of the Board, Social Science Research Council.

Dr. HOWARD M. JONES, Chairman, American Council of Learned Societies.

RECRUITING AND RETAINING SCIENTIFIC PERSONNEL IN GOVERNMENT SERVICE

Of continuing concern to all Government agencies is the need to improve the status of scientific personnel in the Federal service. The Interdepartmental Committee on Scientific Research and Development (ICSRD), comprising representatives of major Government agencies engaged in scientific research, has been particularly concerned with difficulties in recruiting and retaining the qualified scientific personnel needed for the effective prosecution of Federal programs. Meetings have been held with officials of the Civil Service Commission from time to time to discuss the status of scientific personnel in Government and possible remedial programs, including proposals for legislative and administrative action.

The Federal Government finds itself in a weak competitive position in attempting to recruit and retain people with scientific training. Salaries and other benefits in industry have moved ahead more rapidly than they have in Government. Many agencies find it difficult to accomplish their research work successfully. In addition to the fact that salaries of scientists in Government employment are generally lower than those for comparable work in industry, the Committee has found that industrial practices with regard to recruitment, payment of expenses to place of employment, travel to scientific meetings, and support for further advanced education and training combine to make Government employment less attractive than industrial employment.

A number of legislative proposals have been advanced to improve this situation. In view of the present very rapid growth of research and development in the United States, much of it supported and directed by Federal agencies, the ICSRD feels strongly that the position of the Government as an employer of scientists must be improved in order that it may obtain and keep competent scientific personnel, both to conduct research and to supervise research handled by industry on contract. During the fiscal year reported upon, the ICSRD sent a resolution to the President recommending that he request early enactment of legislation by Congress to authorize competitive compensa-

tion and benefits for scientific and professional engineering positions in the Federal service. The ICSRD also sent a resolution to the Civil Service Commission recommending that the Commission ask for authority from Congress on an emergency basis to adjust salaries of scientists and engineers in categories found to be scarce.

These recommendations helped bring about material increases in salaries for scientists and engineers in the junior professional levels in time for effective recruitment among the June 1956 graduates. The summer employment of science teachers in the Federal Government was facilitated by a change in civil service regulations, which permitted greater utilization of scarce scientific skills.

Program Objectives

The International Geophysical Year (IGY) is a global program of coordinated measurements of the earth, its oceans, and its gaseous mantle, including observations of particles and radiation received from the sun and other extraterrestrial sources. The observational phase of the IGY will occur during the period July 1, 1957, through December 31, 1958.

National committees of some 50 nations are now involved in the planning and execution of suitable scientific programs and their integration into an effective whole. Additional nations are participating in this endeavor although without the formal creation of national committees. The measurements of various geophysical phenomena will be made on a coordinated time schedule with due regard to adequate geographical coverage.

The planning and technical direction of the United States program is in the hands of the United States National Committee for the International Geophysical Year (USNC–IGY) under the chairmanship of Dr. Joseph Kaplan. The committee exists under the aegis of the National Academy of Sciences-National Research Council. Members of the committee and its technical panels include many prominent scientists in geophysics and related fields in the United States.

The National Science Foundation, on the application of the National Academy of Sciences, sought and obtained appropriations from Congress for the United States program in the International Geophysical Year. The Foundation is also responsible for the administration of these funds and for coordination of Government interests in the undertaking. Federal appropriations made to the Foundation for support of the United States program are in turn made available by grant or transfer of funds to other Government agencies and private institutions engaged in the work on the basis of recommendations made by the USNC–IGY.

The United States plans observational programs in aurora and airglow, cosmic rays, geomagnetism, glaciology, gravity measurements, ionospheric physics, longitude and latitude determinations, meteorology, oceanography, seismology, and solar activity. High altitude rockets and

earth satellites are essential techniques which will extend the coverage of geophysical measurements to the outer limits of the high atmosphere.

Program Activities

The early stages of preparation for the IGY were concerned primarily with the planning of operations, the establishment of technical program details, and the initiation of the procurement of those equipments and supplies which would be required to carry out the various program objectives. As the period of actual operations is approached, emphasis shifts to such operational factors as the testing of equipment, the recruitment and training of suitable personnel, and the establishment of special observing station sites and facilities including instrumental installations. By the end of June 1956, the program had definitely moved into the operational phase. Planning at this stage was primarily to accommodate minor adjustments in the program or to make modifications on the basis of available appropriations. Principal effort is now being devoted to the completion of instrument and material procurement, instrument testing, station construction, and personnel recruitment and training.

Technical planning of the program on a worldwide basis has been accomplished through a series of meetings of various international committees. The most important of these committees is the Comité Spécial de l'Année Géophysique Internationale of the International Council of Scientific Unions, commonly abbreviated CSAGI. Through CSAGI the various participating countries were invited to establish their own special national committees for the IGY and to submit appropriate programs which were synthesized and coordinated under the auspices of the CSAGI to form the final IGY program. To accomplish this, CSAGI has held a number of meetings which have included, in addition to its own members, suitable representative delegations of scientists from the various participating countries.

During fiscal year 1956, a further meeting of the CSAGI was held as well as several meetings of various groups of nations for the discussion of programs and problems in the Arctic, Antarctic, and Western Hemisphere regions. As a consequence, the modified and enlarged United States program was endorsed and suitable cooperative negotiations have been and are being conducted for the work in various regions. Changes in the United States program consist of the addition of gravity measurement and seismological studies and of increased emphasis on all fields of geophysics, particularly oceanography. Additional stations are to be established in the Arctic and Antarctic regions. The earth satellite

program, discussed later, is now a principal part of the United States program.

World Data Centers

One of the fundamental precepts of the IGY is the availability of IGY data to all scientists and countries. Plans for the establishment of world data centers to be located in strategic geographical areas were agreed to at the Brussels meeting of CSAGI in the fall of 1955. Detailed planning for such centers is now in progress. A special group has been appointed by the United States National Committee for the IGY to plan the establishment of a world data center for the Western Hemisphere.

Progress in the Antarctic

Procurement of all scientific equipment for the United States IGY Antarctic program has been initiated and in many cases completed. The Navy expedition "Deepfreeze I" left the United States in November 1955, and returned in the spring of 1956. This expedition carried scientific and logistic equipment and materiel for the establishment of the air operations facility at McMurdo Sound and for the three scientific stations at Little America, Marie Byrd Land, and the South Pole. The air operations facility and the Little America station have been completely established and logistics parties are wintering over at both bases. Ground explorations for the establishment of the Marie Byrd station and air reconnaissance for the establishment of the South Pole station were conducted. For the first time in history heavy aircraft were flown all the way to the Antarctic continent, and photomapping of a considerable portion of the continent was carried out.

In the coming year, the Navy expedition "Deepfreeze II" will transport all scientific and logistic equipment and materiel for the establishment of the Weddell Sea, Knox Coast, and Cape Adare stations and will transport the full United States scientific party for the first year's operations. Dr. Laurence M. Gould, a member of the National Science Board, is director of the US–IGY Antarctic program and Dr. Harry Wexler is chief scientist for the Antarctic program.

Progress in the Arctic

In the augmented United States program, additional stations have been planned in the Arctic for work in aurora and airglow, geomagnetism, glaciology, ionospheric physics, meteorology, oceanography, and

rocketry, as well as for appropriate segments of the new programs of seismology and gravity.

A rocket-launching facility has been virtually completed at Fort Churchill, Canada, under a bilateral agreement with Canada. Numerous rockets from this site will probe the upper atmosphere during the IGY and will extend measurements in many of the IGY disciplines. The largest of these rockets is the type called Aerobee-Hi, specifically designed for research purposes.

Plans are now being made for long-term occupancy of two ice-floe stations by scientific parties. These stations will reduce the gaps in Arctic positions for measurement of aurora and airglow, ionospheric physics, and meteorology, and will yield valuable information concerning Arctic oceanography.

Progress in the Continental and Equatorial Regions

The IGY effort within the United States and its Possessions will make use of existing weather, magnetic, and ionospheric stations by augmenting in some cases the observations normally conducted at such sites. Many additional temporary stations will be activated to reduce geographical gaps, to create finer networks, and to complete chains of stations whose locations will be significant for the observations to be made. This "chain" concept is particularly significant in the case of all of the planned pole-to-pole chains. The United States is especially concerned with the series of stations along the 75°–80° west longitude meridian line which falls within the Western Hemisphere. In this case the United States and certain of the Latin American countries will cooperate in order to assure the success of the observations along this line.

In the equatorial regions similar observations will be made at locations critical in the world coverage in areas of natural interest to the United States, such as islands in the Trust Territory and islands close to the geographic and geomagnetic equators. Rocket firings will be conducted at Guam in order to strengthen the coverage of upper atmosphere observations. Extended oceanographic observations in the Atlantic and Pacific will be made.

The Earth Satellite

On July 29, 1955, the CSAGI electrified the world with the announcement from Brussels that the United States would launch earth-circling satellites for scientific purposes during the period of the IGY. This was immediately followed by announcement from the White House.

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This decision was the culmination of studies which had been stimulated by a resolution passed at Rome in 1954 by the CSAGI, inviting any nation that had the capability to launch such a satellite during the interval July 1, 1957, through December 31, 1958.

To the scientist the satellite is a natural extension of high-altitude rocket techniques which have been applied so effectively to the measurement of various physical properties and quantities in the upper atmosphere. The scientific experiments planned in the earth satellite program will include temperature and pressure measurements; micrometeorite and cosmic dust density measurements; primary cosmic ray measurements; solar ultraviolet measurements; and possibly geomagnetic measurements. These measurements will be transmitted to the ground by telemetering equipment for later use by scientists. In addition, by exact calculations of the satellite's orbit based primarily on optical observations, a determination can be made of air density and gross variations in the form and structure of the earth. Ultimately, as the satellite is slowed down by the slight atmospheric drag, it will spiral in closer to the earth and be burned up in the lower denser atmosphere and thus will not return to earth.

The responsibility for the development and launching of a successful satellite for scientific purposes was assigned to the Department of Defense, with the Navy as the manager of the technical program. The Naval Research Laboratory was assigned the actual task of carrying out the project, which was given the code name of VANGUARD.

By the end of June 1956, decisions had been made on all important characteristics of the satellite and the launching vehicle required to put it on orbit. The launching site was selected and the orbit characteristics agreed to.

Appropriations

The increased United States programs for the IGY, including the earth satellite, have necessitated additional funding. On the basis of revised needs, the Congress appropriated $27 million to the Foundation in 1956 to cover these items. This, added to the $12 million already made available, gives a total appropriation for the special IGY operations of $39 million. This does not include the cost of logistics support for Arctic, Equatorial, and Antarctic operations or the contributions in services, materiel, and facilities made by the Department of Defense to the earth satellite program. Grants totaling $14,789,817 were awarded during fiscal year 1956.

Conclusion

The IGY, a worldwide effort of tremendous complexity, is proceeding on a satisfactory schedule because of the effective cooperation of the fifty-odd countries now actively participating in the program. Indeed, this operation may well serve as a pattern for future international scientific efforts, particularly in various fields of geophysics where the need is indicated for continued or more detailed studies beyond the period of the IGY.

FEDERAL POLICY ON CONDUCT AND SUPPORT OF RESEARCH AND DEVELOPMENT IN SYNTHETIC RUBBER

Under the terms of the report of the Rubber Producing Facilities Disposal Commission of January 1955, which received congressional sanction in April 1955, the National Science Foundation was charged with: (1) assuming responsibility for the Government's program of synthetic rubber research previously carried on by the Federal Facilities Corporation, including the operation of the Government laboratories at Akron, Ohio; and (2) evaluating the future role of the Federal Government with respect to research in this field.

Through the 1956 fiscal year, the Foundation continued rubber-research contracts with universities which had been originally placed by the Federal Facilities Corporation. Likewise, the Foundation supported operation, at a reduced scale, of the Government laboratories at Akron. With a view toward full utilization of laboratory facilities during the period of evaluation, the Foundation authorized the University of Akron to undertake privately sponsored research under contracts with various firms. This not only afforded a partial basis for evaluating the degree of industrial interest in the laboratories, but also, through income from private contracts, reduced the Government's outlay toward laboratory operation during the year by about $250,000.

In meeting the second responsibility with which the Foundation was charged—namely, the evaluation of the future role of the Government with respect to research in synthetic rubber—the Foundation appointed a special commission made up of scientific, university, industrial, and other representation. (Appendix A, p. 102). The Commission was asked to recommend what future Federal support, if any, should be given to research in the field of synthetic rubber and also to recommend a course to be followed with regard to the Government laboratories at Akron.

The following constituted, in essence, the findings and recommendations of the Foundation's Special Commission for Rubber Research:

1. Funds for the governmental support of basic research should not be requested from the Congress for specific industries or commodities in the absence of overriding considerations of defense or other special national interests, and the Commission found no such compelling considerations with respect to the synthetic rubber industry.

2. Research on problems directed toward specified end products involving rubber and needed by the military agencies, whether called basic research or applied research, is most appropriately carried on through contracts placed by the Department of Defense with individuals or groups chosen by it.

3. Government-sponsored research is no longer necessary to develop a natural rubber substitute since three or more companies have recently succeeded independently in synthesizing material with composition and properties similar to natural rubber, using isoprene as a raw material. However, the executive branch of the Government should give careful consideration to the actions needed to insure an adequate production base for the new synthetic natural rubber in the event of an emergency.

4. The program of Government-sponsored rubber research projects, formerly conducted by the Federal Facilities Corporation and assumed from the Corporation by the Foundation, should be terminated; in place of this program the Foundation should support basic research in the general area of high polymers (of which rubber is only an example).

5. Transfer of the Government laboratories to non-Government hands would not handicap the activities and programs of Federal agencies.

6. Moderate interest exists in rubber and related industries in acquiring the laboratories.

7. The Government laboratories should be offered for sale after June 30, 1956, unless the University of Akron (the then existing contractor) accepted a lease for operating the facility under its own responsibility for an additional year.

The report of the Special Commission was approved by the National Science Board at its 37th meeting dated December 5, 1955. Subsequently, the report was endorsed by the Office of Defense Mobilization and was incorporated into the President's message to the Congress on rubber resources, requirements, and research, dated April 30, 1956.

In implementing the recommendations of the Commission, the National Science Foundation, other agencies, and the Congress took the following actions:

1. The rubber research program which had been taken over a year earlier from the Federal Facilities Corporation was terminated as of June 30, 1956.

2. In February 1956, an Advisory Panel for High Polymer Research was appointed and out of its reviews and recommendations a variety of research grants were approved for Foundation support during fiscal year 1957. During the fiscal year 1958, it is planned to continue the support of high polymer basic research as an integral part of the chemistry program of the Foundation.

3. The operations of the Government laboratories at Akron were gradually phased out and brought to complete termination on June 30, 1956.

4. The Foundation offered to the University of Akron a 1-year lease of the laboratories under terms recommended by the Commission. The university rejected this offer and, consequently, the Foundation recommended legislation to the Congress authorizing the disposal of the laboratories. In the closing days of the 2d session of the 84th Congress, legislation was passed and signed by the President transferring jurisdiction over the laboratories to the General Services Administration and authorizing the Administrator of General Services to sell the laboratories, after taking into account the possible value of the laboratories to other agencies of the Federal Government.

5. The Office of Defense Mobilization and the Department of Defense have been giving continuing attention to the production base of the new synthetic natural rubber. The Department of Defense has placed orders for limited quantities of tires made from the new rubber. In his message to the Congress dated April 30, 1956, President Eisenhower said in part: "The Government has available a number of means for assisting industrial development and expansion where such aid is found to be essential to national security. It is not now expected that any unique measures, such as would require new legislation, will need to be taken with reference to the development of capacity to produce synthetic natural rubber."