NATIONAL SCIENCE FOUNDATION

Studies and Reports

Relating to

National Science Policies

INTRODUCTION

In fulfilling its statutory responsibility "to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences," the National Science Foundation has undertaken or completed a number of special studies and projects during the past year—either on its own initiative, or at the request of the Congress, the Executive Office of the President, and other Government agencies.

The development of national policy for promotion of basic research and education in the sciences is, of course, a large and very important matter. The importance lies essentially in the interpretation of what one means by national policy for scientific research and also how and to what extent the Federal Government, and the National Science Foundation particularly, should take the lead. It will certainly be unanimously agreed that science and technology in this country occupy a very important place in the future of our welfare and security. Certain aspects of policy with respect to the health and strength of our scientific and technological effort are indeed matters for which the Federal Government must assume a larger share of responsibility. Certainly studies of the national effort in research and education in the sciences require analysis and so, too, do the needs and requirements of the various components of these activities. However, the nature of progress in science itself has always been and should continue to be a matter of primary decision by scientists themselves. For example, who could decide better the promise and significance of research in genetics than the geneticists themselves? In any recommendations, therefore, concerning a research effort of the country, any agency, public or private, should defer to the judgment of the active and capable research scientists in that field. In fact, it is part of the very democratic tradition of science that the direction which research progress is to take is the responsibility of research workers in the particular field of science.

On the other hand, it is feasible and highly desirable to determine what the role of the Federal Government should be in the support of scientific activities, both throughout the country and in its own laboratories. In addition, factual accounts of the status of research and development throughout the country, the needs of colleges and universities and industry with respect to science and scientific personnel are pertinent. These studies may from time to time furnish the basis for recommendations when deemed desirable in the opinion of such an organization as the National Science Foundation, with the advice of leaders in science.

This section describes undertakings made during the year by the Foundation which are directed toward the development of Federal policy in support of science. For example, what should be Federal policy in relation to support of facilities and equipment and to administration of Federal financial support of research at colleges and universities? Special questions also arise, such as: What are the national needs for expensive accelerators to perform research in high-energy physics? Is there need for a minerals research institute to conduct research underlying the minerals industry? Should a Hawaiian Geophysical Institute be established?

A solid base of factual information is a prerequisite for the formulation of recommendations. In this connection, the Foundation is continuing its surveys of the United States research and development effort by various sectors of the economy—the Federal Government, industry, colleges and universities, private foundations, commercial laboratories, nonprofit research institutions, professional societies, etc. These surveys present a basis for analysis, conclusions, and recommendations.

The growing interest of the Foundation in international scientific activities is illustrated by the example cited which describes how the Foundation is administering United States participation in the International Science Section of the Brussels Universal and International Exhibition—1958.

SURVEY OF THE UNITED STATES RESEARCH AND DEVELOPMENT EFFORT

Scientific activity has become an economic factor to be reckoned with in terms of dollars and manpower. The Foundation has undertaken studies to answer such questions as what fields of science are being explored and to what extent, who performs the work, who pays the costs, what is the nature of the costs, and what proportion of the research is basic or applied. These and related matters have been the concern of the Foundation for the past several years. To close the gap in our knowledge, which has been widening over the past decade, a group of surveys was launched.

Beginning in 1952 with a study of the Government's financing of research and development, the Foundation extended its measurement techniques in 1953–54 to cover the entire economy, with the Federal Government taking its place as one of the four sectors. Three other sectors completed the picture: industry-oriented organizations; colleges and universities; and other institutions, including philanthropic foundations, health agencies, academies of science, and certain professional societies. Through these studies the Foundation has provided a new kind of measurement of national economic strength for the year surveyed, 1953–54, in terms of scientific manpower and dollars expended for research and development.

By the end of fiscal year 1957, most of the initial series of studies were completed. A bulletin entitled *Reviews of Data on Research and Development,* launched during the past fiscal year, has served the purpose of expediting information to the public on this series of surveys. The first issue presented the overall results on expenditures for research and development by the various sectors of the economy. Another issue combined the findings on basic research. Other issues were devoted to the data on expenditures and faculty personnel in the colleges and universities sector. Detailed reports published during the year on the studies of the other sectors are listed in Appendix H.

Expenditures for Research and Development

The total amount spent for research and development in the natural sciences—physical and life—for the year 1953–54, the starting point of the study, was $5.4 billion, which represents 1.5 percent of the gross national product of $363.2 billion for that period. Figure 1 details the amounts provided by the four sectors of the economy and the extent of their performance of research and development.

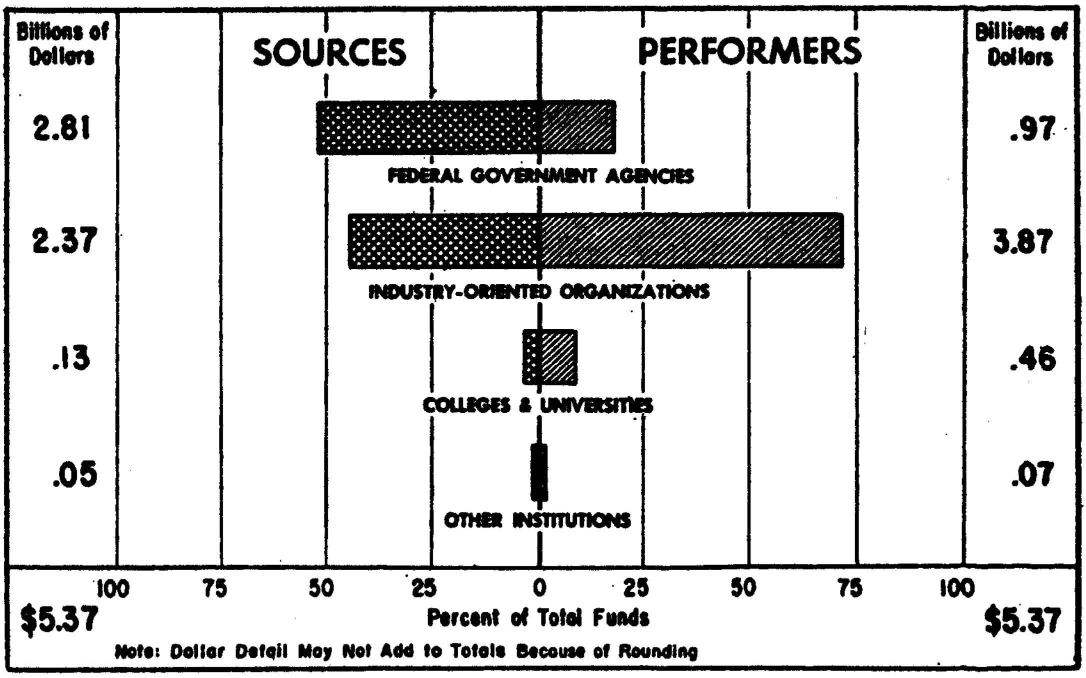


Figure 1.—Funds for research and development by sources and performers for various sectors of the economy in the United States, 1953–54.

The Federal Government was primarily a source of funds while industry combined the two functions, spending slightly more in performance than it contributed from its own funds. Industry performed about two-thirds of all the research and development in the natural and engineering sciences in the United States.

The colleges and universities sector, spending a total of $460 million in performance, was analyzed in terms of money spent for research at the universities proper, the agricultural experiment stations, and the Federal research centers operated by educational institutions under contract with the Government. (The table below presents sources of funds in the colleges and universities sector.)

Research and Development Performed by the Colleges and Universities Sector, by Sources of Funds, 1953–54

Source of funds	*Volume of research and development performed by colleges and universities* — *Millions of dollars*	*Percent of total*
Federal Government agencies	[1] $280	61
Industry-oriented organizations	20	4
Colleges and universities	130	28
Other institutions	30	7
Total	460	100

[1] Includes funds for the conduct of research and development at research centers administered by colleges and universities under contract with Federal agencies.

The survey of colleges and universities was of particular value because of the Foundation's concern with regard to the Federal Government's responsibility for indirect costs of federally supported research conducted at colleges and universities.

Expenditures for Basic Research

Perhaps of primary interest from the Foundation's point of view has been the measurement of basic research support in the various sectors of the economy. The Foundation has published the results of this survey with a full realization of the difficulties inherent in asking a wide variety of respondents from all fields of science to identify their research as basic or applied in accordance with definitions furnished on the questionnaires.

Figure 2, following the same pattern as figure 1, presents for the year 1953 the corresponding amounts by each sector for basic research in terms of amounts spent in performance versus the amounts derived from the sectors for the financial support of the work. The total amount for basic research, $435 million, was 8 percent of the $5.4 billion for research and development.

Colleges and universities, traditionally the seat of basic research, emerge as the performer of just under half the total basic research effort, two-thirds of which was supported by outside sources. The major supporters of basic research in terms of sources of funds were the Federal Government and industry-oriented organizations, the latter playing a major role both as a source and as a performer.

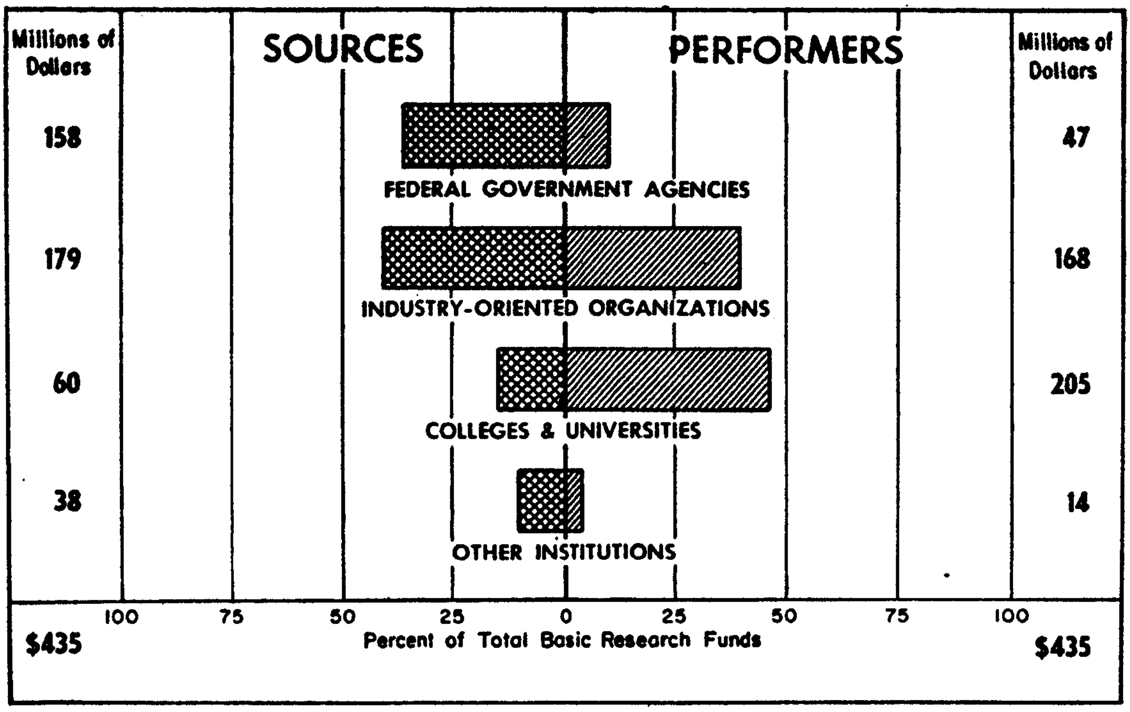


Figure 2.—Funds for basic research by sources and performers for various sectors of the economy in the United States, 1953–54.

Of this total basic research performance, 70 percent was devoted to the physical sciences, the remainder going to the life sciences. Industry performed half and the colleges and universities one-third of all the physical science research. Industry devoted its efforts largely to the fields of chemistry and engineering. In the life sciences, colleges and universities performed over two-thirds of the total; the next largest performer, the Federal Government, accounted for one-seventh of the total.

Scientific Manpower

Related to the dollar volume of research and development is the scientific manpower employed in each sector—information vital to our national defense and our economic strength. For the first time, more complete statistics concerning the total number of scientists and engineers employed in 1953–54 were collected from the four sectors on the basis of those engaged in research and development, by field, and those engaged in other activities. The returns showed that, in the organizations surveyed, one-third (approximately 235,000) of the scientists and engineers were engaged in natural science research activities. Of the number in research, approximately three-fourths were employed by industry.

Completion of these studies of human and material resources mobilized for the advancement of science has provided a new basis for appraising the Nation's research effort. Facts gathered and analyzed will be useful for dealing with questions of policy such as support of particular areas of science, and proper balance to be maintained between basic and applied research.

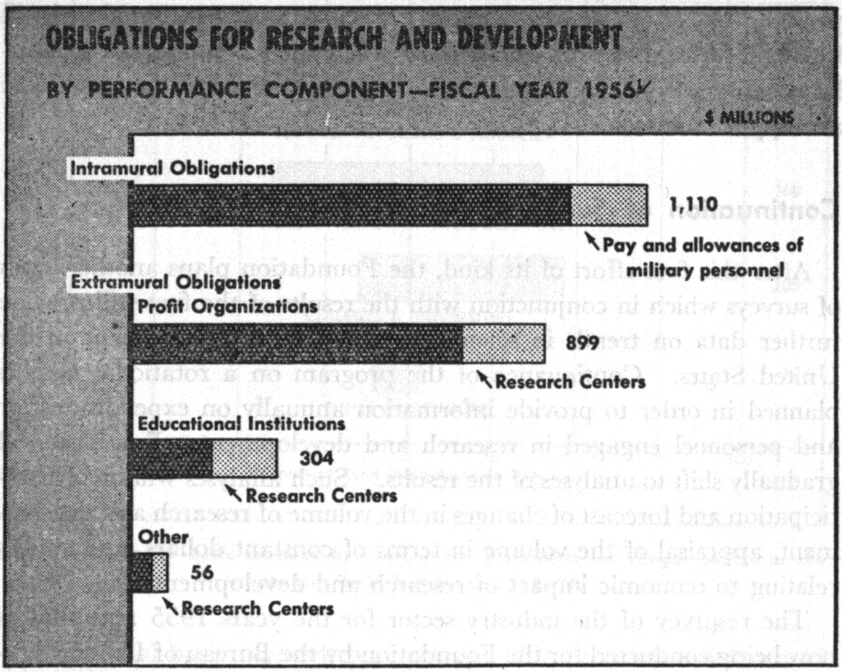
Continuation of Survey Program

After this first effort of its kind, the Foundation plans another series of surveys which in conjunction with the results of the first will provide further data on trends in scientific research and development in the United States. Continuance of the program on a rotational basis is planned in order to provide information annually on expenditures for and personnel engaged in research and development. Emphasis will gradually shift to analyses of the results. Such analyses will involve anticipation and forecast of changes in the volume of research and development, appraisal of the volume in terms of constant dollars, and studies relating to economic impact of research and development.

The resurvey of the industry sector for the years 1955 and 1956 is now being conducted for the Foundation by the Bureau of Labor Statistics. Preliminary results are expected to be available soon, thus providing trend data on industry. Wider in scope than the previous study, this survey is seeking to obtain more data on basic research. In an effort to establish the compilation of the industrial data on an annual basis for future years, the Foundation has sought the cooperation of the Bureau of the Census. This agency has agreed to collect research and development statistics in connection with their annual surveys of other cost data pertaining to manufacturing and certain nonmanufacturing industries.

Other Studies Completed or Underway

Federal Funds for Science V.—The Federal Research and Development Budget, Fiscal Years 1955, 1956, and 1957, the annual issue in this continuing series, presented a fuller accounting of the Federal research and development effort than had been done previously. In addition to analysis of the Federal research and development budget according to administering agencies, scientific fields, and character of research, the report presented data on the distribution of funds obligated for the performance of research and development in the Government laboratories, profit organizations and nonprofit agencies including educational institutions. (See fig. 3.)



[1] Estimated.

Figure 3.—*Obligations of the Federal Government for research and development by performance components, fiscal year 1956.*

NOTE.—Intramural obligations include those for work performed within the Federal Government's own research laboratories and facilities; extramural obligations cover work performed by all non-Federal organizations.

Science in the Federal Government, by A. Hunter Dupree. Publication of this book during the spring of 1957 by the Belknap Press of Harvard University Press, marks completion of a study pursued under a Foundation grant. The grant was made to the American Academy of Arts and Sciences, with Dr. Dupree conducting the study under the general guidance of the Foundation and an advisory committee. The book is a history of the growth of Federal scientific activities from colonial times to World War II.

Advisory and Coordinating Mechanisms for Federal Research and Development, 1956–57.—This publication, released during the summer of 1957, describes mechanisms used by Federal departments and agencies in planning, coordinating, and executing their scientific research and development programs.

Scientific Manpower in the Federal Government, 1954.—This study issued in the early fall of 1957 shows that over 142,000 persons, or almost

7 percent of the 2 million Federal civilian employees in 1954, were engaged in scientific activities (the conduct of research and development and other closely related activities). Almost 77,000 officers and enlisted personnel were also so engaged—2 percent of all military personnel.

Of the 142,000 civilian personnel engaged in scientific activities, over 37,000 were scientists and engineers; the rest were supporting personnel. In the military there were 9,000 scientists and engineers, plus about 68,000 supporting personnel.

The 37,000 civilian scientists and engineers engaged in scientific activities made up little more than one-third of the more than 102,000 civilian scientists and engineers employed by the Federal Government. The other two-thirds were engaged in such activities as architectural design, treatment of patients in Federal medical facilities, and zoo management. Over 70 percent of the 25,000 physical and mathematical scientists were employed in scientific activities, compared with about 25 percent of the 77,000 in the engineering, life, and social sciences.

Women scientists and engineers totaled 4,000, about 4 percent of all Federal civilian scientists and engineers.

Graduate Student Enrollment and Support in American Universities and Colleges, 1954.—One of the most striking findings of this study, published in the fall of 1957, was the enormous extent of graduate enrollment in the field of education. An estimated 88,500 students (41 percent of the total surveyed) were enrolled in education in April 1954. By comparison, only 58,000 graduate students were estimated to be in natural sciences, including engineering; another 68,000 were enrolled in psychology, social sciences, humanities, and certain professional fields.

In education, the average graduate department enrolled over 100 students, most of them in their first year of study, taking courses part time toward a master's degree. In the natural sciences, by contrast, the average graduate department enrolled less than 20 students and most students were in their second or later year of study, taking a full-time program in many cases for a doctor's degree.

Half of all resident students of the natural sciences, including engineering, held assistantships or fellowships in April 1954; the median stipend awarded was $1,395. In all remaining fields combined, only 14 percent of the students had received stipends; and their median award was $1,035.

Science and Engineering in American Industry, 1953–54.—The final report of the study, undertaken by the Bureau of Labor Statistics for the Foundation, was published in October 1956. It covers dollar-volume measurement of industrial research and development and detailed employment data.

FEDERAL FINANCIAL SUPPORT OF RESEARCH FACILITIES AND EQUIPMENT

Over the past few years, the National Science Foundation has studied the growing need, throughout the United States, for new and improved physical facilities for scientific research, particularly basic research, and the many problems and difficulties associated therewith. Therefore, when the Bureau of the Budget in 1956 indicated its interest in a report on the current status and future needs for research facilities against which annual requests for Federal support funds could be evaluated, the Foundation agreed to undertake such a general assessment, which would be helpful both to individual agencies and to the Executive Office of the President. It would also furnish useful information to research scientists and university administrators throughout the country.

Accordingly the study was made, and its principal findings and recommendations can be summarized as follows:

1. Technological advancement and the acquisition of new fundamental scientific knowledge require the employment of increasingly complex and expensive research tools.

2. Since the end of World War II the Federal Government has been financially supporting scientific research and development facilities and major equipment to an increasing extent. Current and immediately projected expenditures for this purpose range, depending upon precise definitions used between $350 and $450 million annually; expenditures alone for "extramural" facilities, Government supported but not Government operated, are likely to reach an annual rate of $200 million by 1962.

3. It has been a healthy and effective part of American tradition that individuals, groups, and institutions have done their utmost to meet their needs from their own local resources—private, industrial, State, etc. When local resources have proven insufficient, supplementary aid has often been obtained from a wide variety of sources. This sense of local responsibility should be preserved. The spread of interest and the assurance of freedom of procedure which result from a multiplicity in both the sources and forms of support are objectives which should be constantly pursued. Nevertheless, and in view of the nature of present-

day scientific developments, there have been and undoubtedly will continue to be major demands for physical facilities for science in the United States which cannot reasonably be met without Federal contributions. The evaluation of the individual cases must of course include an assessment of the urgency of the need, the national significance of the development, the availability of adequate personnel, and the degree and character of local backing. Because it does not seem feasible to set up, in advance, definite conditions on such aid which are at once sufficiently flexible and usefully meaningful to cover all cases, it seems best to evaluate these cases one at a time as they arise. Cases which are considered worthy of support will probably require a substantial total of Federal funds.

4. Important qualifications and conditions which should precede the rendering of financial assistance under this general policy include: (a) financial participation where appropriate by recipient institutions or other entities concerned; (b) availability of competent scientific manpower to operate the facility; and (c) recognition that while ideally desirable to confine Federal contributions to original establishment or construction costs, continued Federal support for facility operation and maintenance should be recognized as unavoidable in certain types of situations.

5. In certain specialized areas of the natural sciences, Federal support may be required for the establishment or refurbishment of graduate research laboratories. Before Federal support is extended in such situations, the following conditions should be established: (a) the need is urgent, (b) it is clearly in the national interest, and (c) necessary funds are not available and cannot feasibly be stimulated from other sources.

446243—57——3

STATUS OF HIGH-ENERGY NUCLEAR RESEARCH IN THE UNITED STATES

The fundamental importance of research in high-energy nuclear physics is generally acknowledged. The heavy costs of equipment and laboratories for the conduct of such research are also recognized. Despite the costs, however, the United States must continue in a strong position in this field, not only to maintain leadership in an important field of research but because no one can tell what knowledge of significance to the national economy and defense may come out of such work. We cannot afford the risk of being shut out of immediate participation in whatever benefits the work may yield. Hence we must be prepared to make the necessary investments to assure a vigorous research program in this field.

Realizing that private funds cannot possibly meet the needs in this field, the National Science Foundation, the Department of Defense, and the Atomic Energy Commission jointly surveyed the status of high-energy nuclear research, with the aid of an advisory panel of outstanding specialists in the field (Dr. L. J. Haworth, of the Brookhaven National Laboratory, chairman), appointed by the Foundation. Their report was submitted to the Foundation in September 1956, reviewed by the three agencies, and published. The substance of the report is summarized below.

Significance of High-Energy Physics Research

High-energy physics research is at this time one of the most challenging activities with respect to both its technology and its central importance in basic science. Its pursuit is necessary to an understanding of elementary particles which is, in turn, necessary to any real understanding of atomic nuclei.

The core structure of matter is the atom's nucleus. In a way not fully understood, these nuclei are believed to be bound together by the same kind of forces which control the lifespan of unstable elementary particles. Scientists believe that a vigorous and sustained study of these particles will reveal the secret of nuclear forces. Included in the list of particles are the antimatter particles which when combined with ordinary matter particles become totally annihilated, meanwhile releasing tremendous amounts of energy, e. g., the proton and the antiproton.

Physicists are searching for a universal law which will explain why some of these elementary pieces of matter, such as pi-mesons, change to other particles after very short existence in their present form; others, such as positrons, have longer life times; and still others, such as electrons, remain indefinitely unchanged. There is no doubt in physicists' minds that when a law of elementary particles is found, it will constitute one of the great scientific discoveries of the century.

The importance of the field is perhaps best shown by the number of able scientists now working in it, both in this country and abroad. This represents a judgment that the field is both important and fruitful for basic science. The correctness of this judgment has been demonstrated by results from high-energy accelerators now in operation. A need for increasing available facilities is demonstrated by the great demand for operating time at the two existing multi-Bev (Billion electron volt) accelerators. Even though multi-Bev physics is barely 3 years old, there is already a several-years backlog of important experiments awaiting time on the accelerators. It is clear that this situation will become worse, even taking into account new and improved machines now under construction.

In addition to the direct scientific results, programs in this field yield many indirect technical benefits. Indeed, several developments have led directly to new instruments and equipment of importance to industry and Government in completely different scientific and technological fields.

Present Position of the U. S. A.

During recent years international interest in high-energy physics has broadened considerably. The number of high-energy installations abroad has increased significantly, notably in the U. S. S. R. where the world's largest accelerator is now in operation. Although at present the United States is leading in the number and diversity of its facilities and in the productivity of its research programs, the rate of Soviet progress has been such that this situation may not persist. Unless increased support is provided for high-energy physics, the peak in high-energy machines is likely to remain in Soviet installations because of the apparently unlimited government support and the high numbers of qualified technical people produced by the Soviet educational system.

Because of the great scientific interest and prestige that attaches to this field of research, it is important for the United States to remain among the leaders. This leadership can be best preserved by maintaining a strong, well-balanced program rather than by permitting the work to be influenced if not controlled by specific developments abroad.

Cost of the National Program in High-Energy Physics

High-energy physics research is exceptionally expensive; indeed, it is almost uniquely so in all the domain of pure science. The basic reason lies in the nature of the fundamental particles. To produce and study most of these requires them to have very high speeds that can be achieved at present only by large and costly equipment. To high initial investments must be added operating and improvement costs, which can be expected to duplicate the initial expenditures every 2 to 4 years. Both the initial construction costs and those resulting from operations and from capital improvements are too great for educational institutions and other private research organizations to provide primarily from their own funds. In consequence, intensive work in the field is made possible only by major Government support.

The Bevatron, located at the University of California at Berkeley, is the largest accelerator constructed in this country. Another, still larger, is under construction at the Brookhaven National Laboratory—a 25–30 Bev proton accelerator. The Berkeley instrument consists of a complex arrangement of electric and magnetic fields which whip protons through 50-foot circles until speeds close to the velocity of light are reached. Some idea of the bulk of the Bevatron can be obtained from the size of its electromagnet—14 feet high with an outside diameter of 135 feet. Power is provided by 2 generators which supply 100,000 kilowatts of power. The accelerated protons have an energy of 6 billion electron volts.

The Berkeley accelerator cost from $10 to $13 million to build and about $4 million to run. Recent discoveries resulting from the use of this machine have been among other things, the antiproton and a new nuclear fusion process using mesonic atoms.

The increased complexity and costs of major high-energy facilities demand that an increasing amount of time and effort be devoted to preliminary studies and design in order to assure economical and efficient results. The magnitude of the effort required to initiate such new technological advances is so large as to require comprehensive long-range programs, supported by long-term budgets leading from initial concepts, through a series of reevaluations, to a practicable design and construction, and finally the research project.

The development, design, and construction, as well as the effective use of the more advanced machines, require large staffs of highly qualified, full-time scientific and technical specialists in numbers well above the normal staffs of most institutions. Such requirements inevitably limit the number of institutions where advanced programs can be located, and accordingly, the number of well-considered, realistic, and meritorious grant requests for research in the field.

If individual proposals by qualified groups be considered carefully in the light of criteria discussed later, and no overall limit is set, it is estimated that by 1962, construction of 2 to 5 machines in the 3- to 12-Bev range should be underway and commitments made for studies and construction projects to attain much higher ranges of energy. This would increase the annual rate of expenditure from the current $40 million per year to an estimated $70 to $100 million [1] per year by 1962 (in terms of 1956 dollars). It includes an allowance for new construction, anticipated capital improvements, operation, and research associated with machines authorized.

Estimates are not projected beyond 1962 because of the rapid changes in accelerator technology. It is unlikely, however, that the pressure for increased expansion of effort in the field will continue indefinitely.

Question of Diversified Support

High-energy physics, like any other branch of science, will benefit from diversified support in the sense that several agencies, with somewhat different motivations, provide funds for construction, operation, and experimentation. In turn, the individual agencies will benefit from their direct contact with the work. Each agency has an important direct and specific interest in the science and technology of this field as well as a responsibility for maintaining the overall strength of this country in basic science. The scientific staff of each agency benefits by being associated with work in this field and the experience acquired will stimulate accomplishment in the other activities of the agency.

---

[1] This estimate is somewhat higher than that mentioned on p. 18 in view of the probable stimulation of the field by events that occurred after the latter estimate was made.

Of even greater importance is the fact that, in time of national emergency, the scientists engaged in research become immediately available to serve the country. Their work and experience will have prepared them for the kind of service most desperately needed at such a time.

Recommendations

In view of these facts the Panel recommended that:

1. The Government continue active support of high-energy physics, including the design, construction, and operation of and experimentation with high-energy accelerators.
2. The Department of Defense, the Atomic Energy Commission, and the National Science Foundation, which have important responsibilities for the promotion or utilization of science and technology, each engage directly in the support of high-energy physics; in particular, that the Department of Defense and the National Science Foundation extend their support in this field to maintain important positions.
3. Adequate support be given to existing research programs in this field.
4. Planning for the support of high-energy accelerators anticipate an annual rate of expenditure in this field of $60 to $90 million per year by 1962; this rate, large as it is in comparison with national nuclear research budgets of a few years ago, nevertheless is believed necessary to maintain a program adequate to our national needs.
5. The need for accelerators of a variety of characteristics be recognized. The most important parameters are energy, intensity, and kind of particle. In situations where a choice is to be made, it is usually better to extend the range of these important parameters than to increase the number of functionally similar accelerators.
6. Adequate support be given to research and development pointed toward new types of accelerators. It is especially recommended that efforts be made to continue to extend the energy limit.
7. No fixed general policy be made with regard to the location of new accelerators at individual universities, national laboratories, or other research establishments; but that each proposal be reviewed on its merits with due regard to the research that will be done, the stimulation to science, and the opportunities for training.

A PLAN TO ASSURE AN ADEQUATE SUPPLY OF MINERAL RESOURCES

The President's Materials Policy Commission (the Paley Commission), in its report published in 1952, examined the adequacy of materials to meet the needs of the free world in the years ahead. One of its recommendations was that the National Science Foundation should determine how an intensive program of basic scientific research and technical development can best be applied to assure an adequate supply of mineral resources. Accordingly, the Foundation appointed an Advisory Committee on Minerals Research, under the chairmanship of Dr. James A. Boyd, vice president of Kennecott Copper Corporation.

Background

Our economy and way of life depend in large measure on the production of energy and its application to the processing of raw materials. Basic to the maintenance of this economy is the assurance of adequate reserves of mineral resources to which we may turn as the deposits currently being mined are depleted and exhausted and as the ever-growing demand exceeds the capacity of existing operations. The quantity of most metals and mineral fuels used in the United States since the First World War exceeds the total used throughout the entire world in all of history preceding 1914.

Today we are faced with the unhappy prospect that the United States, the industrial leader of the world, is no longer self-sufficient in many of the basic mineral commodities. The demands of World War II and the postwar prosperity have used up some of our deposits and have made others woefully inadequate. We are therefore faced with the immediate and practical problem of how to maintain our minerals industries.

Foreign deposits and better technology in the exploitation of low-grade domestic deposits can only provide a temporary and partial solution. Foreign operations have their limitations even under relatively stable political conditions, let alone in times of emergency. In any event, the discovery and exploitation of foreign deposits provide only a temporary postponement of the need for finding new deposits. Likewise, improvements in our techniques for extracting mineral commodities from lower and lower grade deposits also help, but only temporarily because here too we are making use of known reserves, not adding vitally needed new ones.

The ultimate answer is the discovery of new and hitherto unsuspected sources of mineral wealth. Until recently this could safely be left to the prospector, but his range is becoming increasingly restricted by expanding population. He has practically worked himself out of a job, except in the relatively new uranium industry, by discovering virtually all of the deposits that can be found by visual and simple instrumental methods. Therefore, in the vital task of finding new deposits of both metallic and nonmetallic minerals, we must depend on modern science, for it is only by gaining a better understanding of these basic processes that we can hope to guide our search for the hidden and unsuspected deposits that we need.

More than 90 percent of our metallic wealth has come from a mere 1,000 square miles of territory. At the rate we are extracting minerals, we must make every conceivable effort to locate another thousand square miles of mineral wealth. It is not an academic question; it is an immediate practical problem on which our national survival may depend.

Basic Conclusions of the Committee

The Foundation's Advisory Committee on Minerals Research, through its various subcommittees, reached the following three basic conclusions:

1. A large volume of new, coordinated research must be done in geology, geochemistry, and geophysics if the task of mineral exploration is to be pursued scientifically.
2. The ultimate volume, distribution, and character of the new research can be determined more intelligently if all published and unpublished data on mining districts are restudied and synthesized so as to avoid duplication of work already done and omission of basic studies that have never been attempted.
3. The program is so comprehensive that every existing agency, private and public, currently engaged in minerals research must be encouraged to continue, and a new research agency should be created to stimulate, coordinate, and assimilate fundamental studies and to disseminate the results of research activities bearing on mineral exploration and discovery.

Minerals Research Institute

The Advisory Committee recommended the establishment of a Minerals Research Institute, supported by the mining industry, which would conduct and sponsor basic research in the fields of earth science related to the formation of mineral deposits. The discovery and research that could lead to exploitation of any new mineral deposits should be the mining industry's business, because this industry will be a direct beneficiary of the research. The committee recommended, therefore, that the proposed institute should be supported and maintained largely by the mining companies.

The establishment of such an institute is being actively explored by the minerals industries.

PROPOSAL TO ESTABLISH A GEOPHYSICAL INSTITUTE IN HAWAII

By joint resolution of the 84th Congress, the National Science Foundation was authorized and directed to make a study of the feasibility and desirability of using Federal funds for constructing and equipping a geophysical institute in the Territory of Hawaii.[1] A special 10-man advisory committee under the chairmanship of Dr. E. A. Eckhardt was appointed to aid the Foundation's study. The committee's conclusions served as a basis for the Foundation's report to Congress which was submitted on May 1, 1957.

In summary, the Foundation believes that there are good scientific and related geographic and educational reasons for establishing a geophysical institute as a part of the University of Hawaii. However, the Federal Government should obligate funds only if assurance is provided that (1) the research potential of the supporting science departments of chemistry, physics, mathematics, and geology will be adequate to operate the institute at maximum efficiency; and (2) continuing local support will be of sufficient magnitude to guarantee successful operation.

The Foundation further recommended that, if established, funds for the geophysical institute should come out of a special congressional appropriation and should not be part of the Foundation's regular budget.

---

[1] Public Law 909, 84th Cong., ch. 685, 2d sess., H. J. Res. 643, approved August 1, 1956.

RESEARCH RESULTS OF GOVERNMENT-SUPPORTED SYNTHETIC RUBBER PROGRAM (1942–55) MADE AVAILABLE TO THE PUBLIC

On July 1, 1955, the research and development functions of the Federal Facilities Corporation concerned with synthetic rubber were transferred to the Foundation.[1] With this transfer came a large body of technical and scientific information in the form of progress reports and project completion reports from contractors—both universities and plant operators—involved in this program up to the time of disposal of the manufacturing plants (1942–55).

The Foundation determined, after a review of the situation, that it was in the national interest to make available to the public all of this information which was acquired through the expenditure of Federal funds.

Accordingly the Foundation during the past year completed the transfer of all research and development reports dealing with synthetic rubber to the Office of Technical Services of the Department of Commerce. OTS, through its usual procedures, has made it possible for any interested firm, organization, or person to purchase copies of these reports from the Library of Congress for the years 1949 to 1955. If the demand warrants it, earlier reports will be made available.

[1] NSF 6th Annual Report, pp. 28–30.

UNITED STATES PARTICIPATION IN THE BRUSSELS UNIVERSAL AND INTERNATIONAL EXHIBITION OF 1958

The National Science Foundation, at the request of the Department of State, is coordinating the United States program for the International Science Section of the Brussels Universal and International Exhibition of 1958. Sixteen nations are contributing to the science exhibition.

In essence, the Foundation is (a) funding the United States program with money transferred from the Department of State; (b) administering the program under the United States Commissioner General, Howard S. Cullman; (c) providing such assistance as the scientists may need in the preparation of exhibits; and (d) furnishing all logistical support.

The United States program is expected to consist of more than 60 exhibits. These exhibits will become an integral part of the International Science Sector which is divided into four classes—the atom, the molecule, the crystal, and the living cell. Four advisory committees of prominent American scientists (one for each class) have been appointed by the Department of State to assist the National Science Foundation in determining the scientific content of the exhibits.

The Belgians plan that the International Science Pavilion will include a 600-seat theater in which a continuous film summarizing the whole exhibit field from human biological phenomena to atomic physics will be shown. "The Unity of Science" is the central theme of the film.

Following this film there will be a popular exhibit section—planned for a wide audience—where the visitor will be able to watch actual experiments and demonstrations depicted in the film. A large area will be set aside for each of the four exhibit classes. Here scientific ideas will be demonstrated in as varied and animated a way as possible. Arrangements will be made for lecture demonstrations by prominent scientists and the showing of short scientific films illustrating certain specific theories.

A science library and a mural dealing with historical aspects of science will complete the pavilion.

Thus, the organizers of the pavilion hope to satisfy the varying tastes of a very wide audience at different levels of knowledge.