

THE DIRECTOR'S STATEMENT

This statement is the third I have contributed to the Annual Reports of the National Science Foundation since becoming its Director. In the first (covering fiscal year 1964), I took the opportunity to express some of my own convictions regarding the reasons for, and the appropriate extent of, the support given by the Federal Government to "research and development," calling attention to the wide spectrum and differing objectives of the various activities covered by that term. That statement emphasized the significance of basic research—its importance in the intellectual and cultural sense, its vital role in graduate science education, and its indispensability as the base for the growth of virtually all of modern technological development. It also discussed, briefly, the special role of the National Science Foundation in the support of basic research and science education at all levels, together with some of the problems faced by the Foundation as I then saw them.

The second statement (for fiscal year 1965) formed part of the Foundation's 15th Annual Report. For this reason, and because as the fiscal year ended an intensive review of the Foundation was being conducted by the Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics of the U.S. House of Representatives, the report discussed in some detail the Foundation's history, objectives, organization, and programs. Among other things, it pointed out the fact that the early and successful role played by the Foundation in the support of science education at all levels had been an important precedent for the current massive expansion of Federal support for general education. In particular, the pattern and methods of the Foundation's science education program had gone far toward allaying earlier fears that such support would, in some way, result in undesirable central control of the education process.

Together these statements constitute a fairly comprehensive although in no sense detailed, review of the Foundation's mission within the total framework of the national scientific enterprise, and of the means employed in carrying out that mission. Accordingly, the present statement will be

devoted primarily to the events of fiscal year 1966, as they affected or may affect the Foundation, and to the effects of those events, and of further objective analysis on the Foundation's goals and programs.

During the year certain developments affected the context of the Foundation's mission and the background against which its operations are conducted. These have involved both the mounting needs of the educational institutions and scientific communities to which the Foundation gives support, and public and official attitudes toward Federal support of science and its role in the pursuit of national goals. Many of these developments are the consequence of the phenomenal rate of growth of institutions of higher education and the increasing attention being paid by the public and its representatives in government to the vital importance of high-quality education; others relate to a general tightening of many aspects of the Federal budget, including the budget for basic research and science education, as a result of the war in Vietnam and other urgent demands upon the Federal treasury.

Some General Trends

The year saw a continuation of several general trends discussed in previous reports. Among the most important of these are:

1. Increasing interest in and activities on behalf of education by all sectors of society, in particular, the Federal Government. As they affect the Foundation, these involve: the improvement of science education at all levels; the impact of Federal science programs upon universities and colleges as institutions; and recognition of national and regional needs for assisting in the development of more first-class universities and colleges.

2. Increasingly greater recognition of the growing importance of science to national objectives and to the daily lives of our citizens. This recognition, together with substantial outlays of the Federal Government and other public bodies in support of scientific research and science education, has increased the desire of the general public and its representatives, both legislative and executive, to augment and improve the techniques by which scientific knowledge acquired through research can be turned to practical ends. Unfortunately, this understandable and praiseworthy desire is not always accompanied by an understanding of the fact that great caution must be practiced in this area lest attempts to mold basic science in the direction of immediate usefulness not only harm science itself but also, at least in the long run, thwart its every purpose.

3. Increasing concern in the Congress and elsewhere with the development of more effective and progressive Federal policies for science, including the organization of the executive branch with respect to its scientific programs.

The following sections will recount certain actions and proposals of the executive branch and the Congress affecting the Foundation, some of which have already resulted in tangible actions, others of which are still in course.

Policy Statement by the President Regarding Academic Science

On September 13, 1965, the President issued a policy directive to all Federal agencies for the purpose of clarifying and amplifying national objectives for Federal programs concerned with support of academic science. This directive took the form of a memorandum to heads of Federal departments and agencies entitled *Strengthening Academic Capability for Science Throughout the Country*. The formulation of the policy had its origins in discussions initiated by the Foundation within the Federal Council for Science and Technology. The memorandum, which was publicly released through a statement of the President laying great stress on the importance of science, points out that the strength of Government research and development programs and their ability to meet national needs depend on the total strength of the American educational system. It further states that research supported to further agency missions should be administered not only with a view toward producing specific results, but also with a view to strengthening academic research and educational capabilities in general. After defining the specific functions of the Federal agencies in this respect, the memorandum goes on to lay down the following guidelines:

“To the fullest extent compatible with their primary interests in specific fields of science, their basic statutes, and their needs for research results in high quality, all Federal agencies should act so as to:

- a. Encourage the maintenance of outstanding quality in science and science education in those universities where it exists;
- b. Provide research funds to academic institutions under conditions affording them the opportunity to improve and extend their programs for research and science education and to develop the potentialities for high quality research of groups and individuals, including capable younger faculty members;
- c. Contribute to the improvement of potentially strong universities through measures such as:
 - Giving consideration, where research capability of comparable quality exists, to awarding grants and contracts to institutions not now heavily engaged in Federal research programs;
 - Assisting such institutions or parts of institutions in strengthening themselves while performing research relevant to agency missions, by such means as establishing university-administered programs in specialized areas relevant to the missions of the agencies.”

The significance of this Presidential statement is that it directs the various agencies to take proper cognizance of the importance to the national welfare of strengthening the scientific capabilities of the whole academic community—especially, though by no means exclusively, those

institutions not now among the foremost rank—in ways compatible with the specific needs of the mission-oriented agencies, and with the national need to advance the frontiers of science on as broad a front as possible. It should not be construed, as has sometimes been done, as being directed primarily at widening institutional and geographic distribution of Federal research funds without regard to quality.

Committee on Academic Science and Engineering

In direct sequence to the President's memorandum was the establishment of the Committee on Academic Science and Engineering (CASE) under the aegis of the Federal Council for Science and Technology. Chaired by the Director of the National Science Foundation, the Committee includes representatives of all major Federal agencies that support scientific research and education at academic institutions. During the fiscal year CASE initiated several important coordinating actions among these agencies.

As a result of one of these, it is now possible for the first time to measure the extent of the total Federal financial contribution to the research and other scientific activities of the Nation's institutions of higher learning, and to relate these to the general purposes for which the funds were expended. In this program, data collected by the individual departments and agencies are forwarded to the National Science Foundation which compiles, tabulates, and analyzes them to give a Government-wide picture. This information is highly useful for general planning purposes and for evaluating the need to expand or alter existing programs, or to introduce new ones. It also provides a pool of reliable data for use in preparing factual information to meet the various needs of Congress. One report, covering fiscal year 1965, has been published. Others will be issued as they are completed.

Other CASE projects initiated during the year include a planning study directed toward achieving greater uniformity among the agencies in their policies for administering programs in support of facility construction at academic institutions, including, hopefully, reasonable standardization of application forms to be used by institutions in requesting such support. Another action was the establishment of a standing panel with responsibility for seeking methods to achieve better interagency cooperation with respect to institutional development.

It is hoped that these and other projects, together with concerted actions resulting from discussions within the Committee itself, can go far toward alleviating many of the difficulties now encountered by academic institutions in dealing with the Federal Government as a result of differing policies and administrative practices among the various agencies.

Strengthening Institutional Capabilities in Science

The United States is growing so fast and our national needs are mounting at such an accelerated pace that we must expand the institutional base for scientific research and education to maintain our present rate of technological advance. For this reason the Foundation has devoted a progressively increasing part of its budget to what are called institutional programs, both to strengthen the scientific capabilities of a broad spectrum of colleges and universities and, increasingly, to build up those not now quite in the very first rank.

Thus in fiscal year 1960, the Foundation reached the conclusion that the educational institutions of the country required special assistance in improving and enlarging their scientific laboratories. It therefore launched the "Graduate Science Facilities Program." During fiscal year 1966 grants under this program were made to 47 institutions in a total sum of approximately \$25 million.

In the following year the Foundation undertook a program known as "Institutional Grants for Science" to provide the institutions participating in Foundation research-oriented programs with some funds awarded on a formula basis for general support of their scientific programs rather than for specific projects approved by the Foundation. The formula, using total research grants as a base, is tapered to favor the less well-supported institutions. During fiscal year 1966, Institutional Grants for Science were awarded to 401 universities and colleges in a total amount of \$14.5 million.

More recently the Foundation has placed greater stress on efforts to upgrade the quality of a limited number of institutions with a demonstrated potential for advancement. As a first step, in fiscal year 1965, the Foundation initiated the "Science Development Program" designed to help universities possessing recognized strength, but not now among the 20 or so of highest quality, to markedly improve their scientific programs over a fairly broad front. In fiscal year 1965, the Foundation made Science Development grants to 9 additional universities, bringing the total for the 2 years to 17 institutions, which received a total of almost \$64 million.

Looking ahead to the needs of the future, the Foundation is now giving attention to those universities which generally do not yet have the general strength required to excel on a broad front but which, nevertheless, have areas of strength with the potential for attaining high quality. Once attained, such areas of high quality not only will contribute to the vigor of American science but also can form the nucleus for broader development of the respective institutions in the future. During fiscal year 1966, therefore, planning was instituted for a new "Departmental Science Development Program" intended to help institutions already engaged in research and graduate education raise a selected science department or

interdisciplinary area to a new and higher level of quality. These grants, which will be for a 3-year period and for a maximum of \$0.6 million each, have been funded in a total amount of \$15 million for fiscal year 1967.

With the same concern for the future, the Foundation has developed a program aimed at improving the total science enterprise of predominantly undergraduate institutions, with primary emphasis on upgrading their instructional programs. This "College Science Improvement Program" is being funded at a \$10 million level in fiscal year 1967. We have also continued our "Undergraduate Instructional Scientific Equipment Program" aimed at helping to equip the teaching laboratories of our colleges and universities with up-to-date apparatus.

In making awards under these programs (other than Institutional Grants for Science) the Foundation has been continuously mindful of the desirability of avoiding undue geographic concentration. Our hope is that these programs will help assure that eventually institutions of the very first class will be found throughout the country. While working towards this end, however, we must of course continue to support—through project, equipment, and facility grants—the institutions which today set the standard for excellence in scientific research and education and on which our present and future strength so heavily depend.

The President's statement of September 1965 has, of course, added a new impetus and sense of urgency to all of these programs.

Review of the National Science Foundation by the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics

As mentioned earlier, during the latter half of fiscal year 1965, under the chairmanship of Rep. Emilio Q. Daddario, the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics began an intensive review of the National Science Foundation, its objectives, its policies, its programs, and its organization—with the stated purpose of evaluating the effectiveness with which the Foundation was carrying out the purposes of the act by which it was established, of reassessing its role in the light of present circumstances, of making appropriate recommendations to improve its organization and operations, and, if need be, of framing new legislation aimed at achieving these improvements.

Following several months of study by the subcommittee, including lengthy hearings held in June, July, and August 1965, the subcommittee on December 30, 1965, submitted to the chairman of the Committee on Science and Astronautics, a detailed and penetrating report of its findings and recommendations. This report was committed, on February 1, 1966, to the Committee of the Whole House on the State of the Union and ordered to be printed. Although the report speaks, of course, for itself, it seems worthwhile to recount here its principal features.

The main thrust of the report was that on the whole the Foundation has performed its functions well, but that with changing times the growing national importance of science and hence of science education, the greater reliance of Federal programs on science, and changes in the interests and requirements of mission-oriented agencies, the role of the Foundation should be expanded, its internal responsibilities redefined, and its staff organization strengthened. In addition to emphasizing that the Foundation should continue to expand its current programs of support of basic research and science education, the House subcommittee report recommended or suggested attention to the following:

1. That the Foundation, and especially the National Science Board, play a greater role in recommending national science policy, particularly as it concerns basic science and science education, and that the Foundation's responsibilities in this area in relation to the Office of Science and Technology and the President's Science Advisory Committee be clarified. In order to enable the Board to perform the expanded role proposed for it, the report recommended that it be relieved of much responsibility for day-to-day operations of the Foundation and that the responsibilities of the Director be increased accordingly. Briefly put, the concept suggested is that, instead of the Board largely confining itself to being "the Board of the National Science Foundation," it become a National Science Board in the broad sense of that term. The report also recommended that the Foundation staff expand its activities directed at the accumulation of statistics and data, and at the conduct and support of studies bearing on national science policy. Finally, the report recommended that the Board be made responsible for producing an annual report on the state of basic science in the United States—both an accounting and a plan of action for the future.

2. That the Foundation place increasing emphasis on its role as a "balance wheel" in Federal support of basic research and in responsibility for the general health of science, including providing adequate support to programs and disciplines which tend to be bypassed or insufficiently supported by mission-oriented agencies in the light of their specific objectives (e.g., stellar astronomy, systematic biology, pure mathematics). Further, that for this and other reasons the Foundation play a more active role in the administration of its programs and endeavor to discover means of assigning priorities to research areas in the various scientific fields covered by it and other agencies.

3. That the Foundation give considerably greater emphasis to the social sciences and that, in the process, attention be paid to the important role they can play in the development of solutions for the problems of society.

4. That the Foundation take more cognizance of pressing national needs in problem areas of society where solutions or assistance can be accelerated through the help of science; that it endeavor to assist in

the pursuit of such solutions, including the stimulation of studies employing an integrated, interdisciplinary ("systems-type") approach, and that as part of this effort it be authorized to support applied research under appropriate circumstances.

5. That the Foundation pay greater attention and give more support to increasing the total scientific capabilities of academic institutions as such, while continuing to support specific research and education projects within those institutions. That all feasible support be given to the development of additional first-class universities and colleges and that programs for this purpose be administered with due regard to the needs of all regions of the country.

6. That the Foundation plays a more active role internationally and that its authority to engage in activities to this end be broadened.

During fiscal year 1966, Representative Daddario introduced, and the House passed, a bill to provide the necessary legislative authorization to carry out the suggestions of the report. The bill expired with the final adjournment of the 89th Congress.

Developments Relating to the Environment

During fiscal year 1966 there were a number of developments indicating widespread interest among the scientific community and the executive and congressional branches of the Government in the application of science to new areas of both opportunity and danger in relation to our environment. Early in the fiscal year the President's Science Advisory Committee issued a comprehensive report entitled *Restoring the Quality of our Environment*, calling attention to, analyzing, and recommending measures against the degradation of many aspects of our environment as a result of pollution of the air, water, and land that are brought about largely through activities resulting from our technological advances.

Recommendations were made with respect to such activities as the use of pesticides; industrial and urban pollution of the rivers and estuaries; pollution of the atmosphere by the products of combustion from fuels used in industrial processes, heating, automobiles, and airplanes; and so forth. The recommendations include: (a) taking steps to exert greater control over the activities creating these undesirable effects, and (b) acceleration of research and development directed toward both better understanding of the effects of the various pollutants and seeking alternatives to the types of activities that result in their creation or discharge. The President has instructed each agency to give special attention to this report and to make recommendations concerning steps that it could take leading toward solution of the problems.

Special attention was devoted during the year to research and development directed at greater exploitation of the potentialities inherent in modification of the atmosphere (weather modification) and in marine resources.

Weather and climate modification has been of increasing interest to the Congress and the public, largely because of potential benefits to agriculture and to water supplies through the augmentation of precipitation, but the prospect has also excited concern because of possible hazards to the farmer and city dweller resulting from unforeseen climatic change and other possible side effects. As a result, Congress and the public have been urging more attention to weather modification techniques. In 1966, two reports on weather and climate modification were issued, one by the National Academy of Sciences that thoroughly reviewed the state of our knowledge regarding the possibilities of modifying weather or climate, and one by a Special Commission of the Foundation that made a comprehensive review of the subject in the light of the scientific findings of the Academy Report.

These reports reevaluated the technology of weather modification and noted that it had now reached a point where rational programs could be initiated. In particular the evidence seems strong that small increases in rainfall can be induced by artificial means under certain atmospheric conditions, and that substantial increases might be induced under particularly favorable circumstances. The reports reflected concern about inadvertent modification of the atmosphere (pollution) and uttered strong words of warning over the social, ecological, and legal implications of deliberate weather modification activities, stressing the need for careful controls and careful evaluation of effects outside the immediate area of experimentation.

Both reports expressed the belief that the current \$7.2 million level for weather and climate modification activities, divided among five Government agencies, was quite inadequate to cover both research and field operations and that the sum ought to be increased to levels above \$30 million by 1970. They also recommended increases in funds for support of the more basic aspects of atmospheric science and for developing a better understanding of weather and climate on a global scale. A strong case was made for greater exploitation of computers in the entire field of atmospheric science. The Commission report recommended that an agency other than the Foundation take central responsibility for the development of operational techniques for weather modification.

Congress in turn proposed legislation designed to improve the effort and reallocate research and operational authority. During the fiscal year, two bills were introduced in the Congress aimed at reorganizing the program by clarifying the responsibilities of each Federal agency, including the Foundation. One of these (S. 2916, introduced by Senator Magnuson), which was later passed by the Senate, would, among other things, shift the data collection responsibilities of the National Science Foundation to the Department of Commerce. Both bills expired with the adjournment of the 89th Congress.

There was also a sharp upsurge in public and congressional interest in oceanography during fiscal year 1966. In June 1966 the Panel on Oceanography of the President's Science Advisory Committee issued a comprehensive report entitled *Effective Use of the Sea*, which recommended an expanded oceanographic research effort by the Federal Government, including particular attention toward developing the resources of the seas, especially the food resources. It also recommended the formation of a new agency, combining the marine activities of several existing civilian agencies, to lead the way in the development of marine resources.

Two significant pieces of legislation relating to marine resources were enacted during the second session of the 89th Congress. The Marine Resources and Engineering Act of 1966 (Public Law 89-454), enacted in June, established the National Council on Marine Resources and Engineering Development, chaired by the Vice President and including in its membership a number of department and other agency heads, among them the Director of the Foundation. The Council is charged with making recommendations to the President for the improved utilization of marine resources. The act also created a Commission of distinguished citizens and governmental representatives from the Congress and the executive branch to prepare a report making recommendations to the Council.

Later in the session, Congress enacted the National Sea Grant College and Program Act (Public Law 89-688), introduced by Senator Pell, authorizing and directing the Foundation to support programs of education, of research and development, and of advisory services directed towards improving the Nation's capabilities for exploiting the resources of the seas. The act authorizes expenditures of \$5 million in fiscal year 1967 and \$15 million in fiscal year 1968. The implementation of this program should provide a major stimulus to a concerted attack on problems related to exploitation of the marine environment.

National Academy of Sciences Reports on Specific Fields of Science

At the same time that much public attention is being focused on the applications of science, the material advances that they make possible, and the problems that are created by technology, careful study is also being given to the objectives, the progress, the promise, and the needs of the underlying fundamental sciences that are so vital to material progress and well-being, as well as forming an integral part of our intellectual, cultural, and educational growth. Of great importance in this area is a series of studies of broad scientific fields being conducted by the National Academy of Sciences under its Committee on Science and Public Policy. During the fiscal year, five such studies, all financially supported in whole or in part by the Foundation, were completed. Four of these concerned

particular areas of basic research. The fifth studied the role of computers in all fields of science and engineering. In each case the report was the result of a careful study conducted by a committee of specialists—drawn from the Academy membership and other sources—which devoted many months or even years to its deliberations.

The recommendations of three of the basic science reports covered, within their respective fields, the whole range of needs from the support of the conduct of research to the requirements for large instruments. These reports are:

Chemistry: Opportunities and Needs (committee chaired by Dr. F. H. Westheimer of Harvard University).

Physics: Survey and Outlook (committee chaired by Dr. George Pake of the Washington University of St. Louis).

Plant Science: Now and in the Coming Decade (committee chaired by Dr. Kenneth V. Thimann of Harvard University).

In addition to analyzing past and potential progress in the scientific sense, relating the importance of that progress to practical advances in the achievement of national goals, each report pointed out the important role of university-based research and the essentiality of increasing financial support, not only to advancement in the field but to the education of the rapidly increasing number of students needed and being trained.

A fourth report, *Ground-based Astronomy—a 10-Year Program*, though equally broad in its study of the field, limited its recommendations to the need over the next 10 years for additional major telescopes and other instrumentation. This report, prepared by a committee under the chairmanship of Dr. Albert E. Whitford of the University of California, recommended three large optical telescopes in the 150- to 200-inch class,* at least one to be placed in the Southern Hemisphere; two 300-foot steerable radio telescopes; one or more large radio telescope arrays; and various smaller instruments of both varieties, primarily for individual universities. In addition, it advocated studies directed at even larger telescopes.

The fifth report, *Digital Computer Needs in Universities and Colleges*, analyzed the rapidly growing needs of academic institutions for digital computers to be used in all fields of science and engineering. This report, prepared by a committee under the chairmanship of Dr. J. Barkley Rosser of the University of Wisconsin, recommended among other things that greatly increased support be given for computing activities—including both advances in the techniques of utilization and facilities for actual use—and for markedly expanding the number of undergraduate students trained annually in the use of computers.

With the exception of the one on plant sciences, which was issued late in the fiscal year, each of the above reports has been studied by an inter-agency panel created to evaluate the report and recommend courses of

*The 150-inch telescope, already underway for the Foundation's Kitt Peak National Observatory, is one of these three.

action for the Federal Government. Each is chaired by the National Science Foundation. Although not all panels have completed their reports, each has found itself in substantial agreement with the findings of the corresponding Academy committee as to the significance of, and need for, additional support to the respective fields, although, in view of limitations on resources, they do not all recommend the full measure of support suggested by the NAS committees.

In addition to studying the NAS recommendations for new telescopes, the panel considering the astronomy report also analyzed the financial needs for the support of the conduct of astronomical research at all observatories, and made recommendations with respect to total needs. Following a subsequent review and recommendations by the National Science Board, the Chairman of the Federal Council for Science and Technology designated the Foundation as the principal agent within the Government for ground-based astronomical research.

In addition to the Academy report on computers, which emphasized the utilization of such equipment for research, a panel of the President's Science Advisory Committee has been studying specifically their growing usefulness in the field of education. Although this panel has not yet issued its report, its discussions and other mounting evidence show that this type of use will undergo phenomenal growth during the next several years. As a result of both developments, the Foundation is formulating plans to increase markedly its support of computer facilities and activities at universities and colleges with particular emphasis on the development of facilities, techniques, and curricula in the field of education. Our thinking in this whole area is being carefully coordinated with that of the Executive Office, the Office of Education, and other interested agencies.

All the reports alluded to are the result of careful and comprehensive studies by distinguished and competent groups. Each has presented a convincing case for the importance of, the progress in, and the future promise for its field of interest. Each has well expressed the need for substantial increases in support, especially in the academic institutions. They will greatly influence Federal activities in their respective fields for some years to come, although limitations on total resources may well prevent full implementation of the recommendations.

The Committee on Science and Public Policy of the Academy has already initiated, or is planning, studies in other fields of science (including the social sciences) which will eventually provide full coverage of all fields. The new National Academy of Engineering is planning similar studies in its fields of interest.

Some Aspects of Research

It is clear that one of the foremost concerns regarding science on the part of the general public and its representatives in Government is that

the fruits of science be utilized to the maximum extent in improving the welfare and comfort of mankind. Specific evidence of this concern is provided by many actions of the Congress, including the legislation mentioned earlier relating to marine resources and weather modification and the most significant programmatic provision of Mr. Daddario's bill, namely, that the Foundation be authorized to support applied research at academic and other nonprofit institutions and, when so directed by the President, to support through other appropriate organizations applied research relevant to national problems involving the public interest.

This is an appropriate concern. The growth of our economy and, indeed, the future of our civilization are now dependent upon ever-increasing knowledge and understanding gained through scientific research, and a fruitful and expanding technology based on that knowledge and understanding. Problems of society arising from such conditions of modern life as urbanization; pollution of water, earth, and atmosphere; rising population here and abroad; the failure of the global food supply to keep up with this population increase; and the dwindling of natural resources, including fresh water and fuel, present such obstacles and in some cases threats to the future of civilized society that we must marshal every available resource to create an environment in which a better life will be possible for both this and future generations. To add to the complexity, it has become evident that many of the most pressing problems arising out of these conditions can no longer be dealt with on a piecemeal basis employing fragmented approaches, but must be attacked by a broad systems-type approach which will draw upon and unite in one common effort all of the intellectual disciplines—including the natural and the social sciences and the humanities—that can fruitfully contribute.

To make satisfactory progress, it is essential that science and technology be in appropriate balance and of reciprocal benefit to each other. New knowledge developed from basic research should be used fully in the shortest time possible to benefit mankind. Conversely, new developments in applied science and technology have a great deal to contribute to basic research by providing insights into better instrumentation, improved methodology, and new areas of exploration. As the one agency of the Federal Government dedicated to the health and welfare of science as a whole, the National Science Foundation has an important role to play in this interface—in helping to link progress in basic research to the goals and concerns of applied science and technology, and vice versa. Within this context the authority to support applied research, especially in the universities, would, in my opinion, provide a significant addition to the Foundation's powers—one which in time would redound to the benefit of both basic research and the national welfare. Even limited support of this nature—and for the time being, at least, I believe it should be relatively limited—would provide opportunities for scientists and engi-

needs, especially the latter, to pursue promising leads resulting from basic research into the applied field. It would eliminate the present restrictions which, except in a few special areas, prevent competent individuals from applying for Foundation funds to undertake applied research, however promising it may appear, and would thus eliminate some undoubted distortion of the programs within departments or schools of engineering. Equally important, it would give advanced engineering students wider scope of opportunity during their formative period, and in general would help broaden the education process. Finally, the support of some applied research would give to the Foundation itself a better understanding of the mechanisms of transfer of knowledge reciprocally between science and technology.

But in pursuing these worthy goals, we must all, including—indeed especially—the Foundation, exert the utmost caution lest in our desire to increase the usefulness of science we impair its own essential progress and hence defeat our very ends. An ever-increasing fund of new knowledge is indispensable to the growth of applied science and technology, as well as to our intellectual and cultural progress. Knowledge implies understanding as well as information. In science this understanding is developed by combining the results of many individual experiments and theoretical deductions to arrive at a combined and general whole, just as the effect of a picture results from its total composition and cannot be achieved from isolated bits of painted canvas. In turn, it is the understanding derived from this process that makes possible the planning and carrying out of further advances into new areas. It is the creative scientist, following the dictates of his own curiosity and intellect, with a driving urge to understand, who makes these advances possible. Even the great discoveries, the broad and brilliant generalizations—such as Einstein's Relativity Theory that is so necessary to our understanding of atomic and nuclear structure, or the fundamental understanding of the structure of solids that made possible the transistor—are not made in isolation, but build upon foundations laid by numerous experimental and theoretical investigations carried out by predecessors and contemporaries of the men who make the spectacular breakthroughs.

It is a fallacy to suppose that these advances in fundamental knowledge will necessarily follow by allowing immediately practical requirements to determine the direction that their pursuit should take. Indeed, they are more likely to suffer as a result. In scientific research there are many possible branches along the paths of inquiry. The most promising branch from a practical standpoint is not necessarily that which will lead to greatest understanding. The scientist impelled by fundamental curiosity should be encouraged and supported in following the latter path, just as others, who desire to do so, should be supported in following the former.

Thus, it is important that basic research—taken here to mean research in which the search for an understanding of nature and her laws, of man and his environment, is the primary objective—continue to be given adequate support, and that the purpose of this support be to assist the scientists in their never-ending quest for scientific truth, without externally imposed restrictions.

This is not meant to say that, even in the support of basic research, the practical need for knowledge should not be one of the criteria in determining relative emphasis among various broad fields, provided competent scientists are available and there is sufficient promise that progress can be made; rather, it is meant to say that, in the process, great care must be taken that other fields of scientific promise also be given adequate support whether or not practical, applicable knowledge is readily foreseeable. Neither is it meant to say that the *uses* to which we put the fruits of science should not be guided by practical needs. Differential levels of support guided by practical goals and, in some instances, even political controls imposed for the public welfare are appropriate and necessary in applying the results of fundamental science. It is in the pursuit of fundamental knowledge and understanding—the search for truth—that science must be untrammelled.

The National Science Foundation was brought into being largely to assure recognition and support by the Federal Government of the essential place of undirected basic research and of science education in the national scientific effort. The same needs that created the Foundation are even greater today, for an ever-expanding base of scientific innovation and discovery and an ever-increasing pool of scientists and engineers are necessary to preserve the rate of technological advance. For this reason the Foundation, in carrying out its present and any future roles assigned to it for the support of applied research, will always be vigilant in safeguarding its mission to encourage and support basic research.

In carrying out this mission, the Foundation will continue to recognize that research has unusual importance in the context of education, especially graduate education. In addition to the results achieved and to the intellectual stimulus given to the faculty, research is an essential element in the training of advanced students, both because it serves as an apprenticeship for some and because, importantly, it arouses and cultivates in all a spirit of inquiry which will both enrich their lives and enhance their usefulness, whether their ultimate careers be in teaching, research, development, or even other spheres. For it is this spirit of inquiry, of striving always to learn more, that has made for progress in the world, whether it be in science, the humanities, the arts, the technical skills, exploration, or almost any other of man's pursuits.

In recognition of the importance of basic research, the Foundation last year secured an increase of about one-third (from approximately \$120 million to \$160 million) in funds available for the support of basic

research projects, almost entirely at educational institutions. This increase, approved by the executive branch and the Congress during a period of stringen budgetary economy, demonstrates the importance attached by all parts of Government to science in general and to the need for a growing basic research effort in particular. That it was the vehicle for this increase is tangible evidence of the Foundation's importance as a "balance wheel" in Federal support for science, particularly in periods when defense and other considerations may cause leveling-off in funds available to other agencies for support of basic research.

Organization

During fiscal year 1966, several changes occurred in the membership and organization of the National Science Board, in the internal organization of the Foundation, and in the number and terms of reference of the Foundation's major advisory committees.

Ten appointments were made by the President to the National Science Board—two to fill unexpired terms and eight as a result of the normal expiration of the terms of one-third of the Board members. At the annual meeting in May 1966 (one of seven 2-day Board meetings held during the fiscal year) Philip Handler, James B. Duke Professor, and Chairman, Department of Biochemistry, Duke University, was elected Chairman and Ralph W. Tyler, Director, Center for Advanced Study in the Behavioral Sciences, Stanford, Calif., was elected Vice Chairman.

To fill unexpired terms ending in 1970, the President appointed Mary I. Bunting, President of Radcliffe College (a biologist) and Harvey Picker, President, Picker X-Ray Corporation (an engineer). For the eight full-term vacancies expiring in 1972, the President late in the fiscal year renominated Robert S. Morison, Professor of Biology, and Director, Division of Biological Sciences, Cornell University and E. R. Piore, Vice President and Chief Scientist, International Business Machines Corporation (a physicist), each of whom had been filling unexpired terms on the Board, and nominated as new members: *

Clifford M. Hardin.....	Chancellor, University of Nebraska (agricultural economist).
Charles F. Jones.....	President, Humble Oil & Refining Co. (chemical engineer).
Thomas F. Jones, Jr.....	President, University of South Carolina (electrical engineer).
Joseph M. Reynolds.....	Vice President for Research, Louisiana State University (physicist).

*All eight persons were unanimously confirmed by the Senate on July 25, 1966 and formally appointed by the President on July 27, 1966.

Athelstan F. Spilhaus----- Professor, School of Physics, University of Minnesota (meteorologist and oceanographer).

Richard H. Sullivan----- then President of Reed College and now President, Association of American Colleges (educator).

The National Science Board made several changes in its method of operation during the year. The functions of the Executive Committee were restated to include responsibility for: acting for the National Science Board on nonpolicy matters during intervals between Board meetings; serving as the Committee on the Budget; coordinating the activities of the other committees of the Board; considering legislative proposals and participating, when appropriate, in congressional hearings directly bearing on the mission of the Foundation.

In addition, as a step towards enhancing its ability to concentrate on major problems and issues of policy, the National Science Board, late in the fiscal year, restructured its standing committees as follows: Committee I was assigned cognizance over the research and science information activities of the Foundation. Committee II was assigned responsibility for institutional relations, including the impact of Foundation programs on institutions. (This committee also has cognizance over the Foundation's international activities.) Committee III was charged with surveillance of all the educational activities of the Foundation.

The Board's Science Development Program Committee, established at the end of fiscal year 1965, was in fiscal year 1966 renamed as the Committee on Science Development Awards. This committee has been of inestimable value to the Board and the Director in reviewing and furnishing advice on general criteria for the Science Development Program. It has also been of great assistance to the Director in reviewing proposals for science development grants. Since the purpose of this program is to assist in raising a few promising institutions, as rapidly as feasible, to the level of excellence attained by our truly outstanding institutions, our leading universities are not eligible to participate. The affiliations of the members of this committee are with institutions, including industrial organizations, not expected to participate in the program.

The major change in staff organization was the creation of a new Division of Environmental Sciences, incorporating the Atmospheric Sciences and Earth Sciences Sections—both by transfer from the Division of Mathematical and Physical Sciences—and the Office of Antarctic Programs, which had not previously been within a divisional structure. The former Head of the Office of Antarctic Programs, Dr. Thomas O. Jones, became Director of the new division and also Special Assistant to the Director for Antarctic Affairs, in view of the special nature of the latter activity.

The National Science Foundation Act of 1950, as amended and as modified by Reorganization Plan No. 2 of 1962, provided that there be for each division of the Foundation a "divisional committee" appointed by the Board and directed to "make recommendations to and to advise and consult with the Director with respect to matters relating to the programs of its division." With the growth in the number of divisions over the years, and the various interrelations between their activities, a more flexible arrangement was needed, so these committees were abolished by Reorganization Plan No. 5 of 1965.* In their place there has been established a system of functional "advisory committees" appointed by the Director in consultation with the Board under his general authority to appoint consultants. Although each advisory committee has as its focal point a division or group of divisions, each has been requested to take cognizance of all activities bearing on its field of interest throughout the Foundation. Each committee has also been asked to maintain awareness of the activities and points of view of the other committees. Staff responsibility for supporting the activities of the advisory committees, and promoting coordination between them, is lodged with the appropriate associate directors of the Foundation, who delegate to their division directors such of these responsibilities as they deem appropriate.

Each advisory committee has been asked to prepare a written annual report to the Director, including such comments, recommendations, and questions as desired, and each advisory committee chairman makes an oral presentation before the National Science Board annually. In addition, from time to time the advisory committees may make recommendations on specific topics to the Director, to the cognizant Associate Director, or on occasion to the appropriate Division Director. The greater scope given to these committees under the new arrangement has already broadened their overall view of the problems with which the Foundation is concerned and consequently enhances the value of their advice to the Foundation. The advisory committees are listed, together with their membership, in appendix A.

The above is intended to offer a few observations highlighting several significant policy and administrative matters and concerns and reflecting some of the views of the Director. The substance of the Foundation's scientific and educational programs is set forth in the body of the report which follows.

LELAND J. HAWORTH

*No change was made in the status of the Science Information Council established in 1958 by Public Law 85-864.