Stimulating The National Research Effort

STIMULATING THE NATIONAL RESEARCH EFFORT

In *Strengthening American Science,** the President's Science Advisory Committee reported:

> It is apparent . . . that the Government exerts a powerful shaping influence on all U.S. science and technology. Not only the Nation's security but its long-term health and economic welfare, the excellence of its scientific life, and the quality of American higher education are now fatefully bound up with the care and thoughtfulness with which the Government supports research. If this support is halting and erratic, if it emphasizes mechanism and "hardware" to the neglect of fundamental understanding, if it lavishes money on a few popular fields and starves others of importance, if it fails to encourage exceptional men and exceptional programs, the net result could be an impoverished science and a second-rate technology.

How can the United States secure its science against impoverishment, prevent its technology from becoming second class during the final half of a century characterized by a scientific and technological revolution?

This Tenth Anniversary Annual Report of the National Science Foundation provides an opportunity for reviewing Foundation programs for promoting basic research and education in the sciences in the broader context of the Federal Government's response to this challenge.

The three factors which must be considered are:

1. Progress of research in science.
2. Development of the individual scientist.
3. The health and growth of the institutions (the environment) where science is taught and research performed.

Progress of Research in Science

Conduct of Basic Research

Basic research is an investment in knowledge. Since basic research is exploration into the unknown, the degree of success any single piece

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of research may achieve is uncertain. Support must therefore be planned and carried out over a wide range of subjects. Then, statistically, one may be assured of a high return in understanding and a new insight on a fair percentage of the work undertaken. In practice, one may even state with some confidence that the return on this small percentage far more than pays the cost of the entire investment. The analogy can be carried further. One should invest in daring projects that appear to have small chance of succeeding but a big payoff if they do. And there should be a fair proportion of standard gilt-edge projects that promise a small but reliable return. In this way, one can manage to advance knowledge across a wide range of fields, and yet follow an approach that is fiscally reasonable.

Some general understanding of the organizational pattern under which basic research is conducted in this country is essential if we are to resolve problems confronting basic research support today. According to National Science Foundation estimates for 1959–60, out of $12.5 billion total for research and development in the United States, about $1 billion (8 percent) supports basic research. It should be borne in mind that the latter amount covers many types of costs, including the operation of expensive research "tools," such as nuclear particle accelerators, research rockets, and radio telescopes. Of the total funds for basic research the Federal Government is the source of about half; industry gives slightly less than a third; and the universities and other nonprofit institutions contribute about one-fifth.

Another index to the relative proportion of effort among the principal sponsors of basic research is the number of scientists and engineers engaged in these activities. As is well known, many scientists and engineers combine research and development with other pursuits such as teaching or industrial production. If we simply add up the amount of time given to research and development activities by all our scientists and engineers, we find that this amounted in 1958–59 to the equivalent of about 340,000 full-time researchers, or about a third of the total number of persons who are scientists and engineers.

Of the 340,000 full-time equivalents in research and development, a little more than 30,000 are in basic research, or about 9 percent.

The primary source of support for uncovering new knowledge through basic scientific research is the Federal Government, and the primary source of manpower to perform the research is our institutions of higher learning. In fulfilling its commitment to stimulate progress in science, the U.S. Government is today supporting basic research in some 450 universities and research institutions in all 50 States, and in a dozen foreign countries as well.

A very compelling reason for the adequate support of basic research by Government is that such research helps to make possible the wise expenditure of funds for development—always many times costlier than fundamental studies. Sound investment of funds in basic research is the best way to uncover leads in all possible fields. From these leads, one can then select for future development those that appear to have the greatest potentialities.

Support Methods

In furthering the progress of research in science, the Foundation has consistently adhered to the following basic concept which it commends as a guide to the Federal Government and the Nation as a whole with respect to the support of basic research: No able scientist willing to undertake basic research should be precluded from doing so because of lack of financial support. Within such framework the Government invites research proposals from individuals or groups of scientists, submitted through their institutions. With the help of individual reviewers in the field involved and advisory panels whose members are chosen from among the Nation's top scientists and appointed by the agency to assist in the evaluation process, the Federal agency selects for support those proposals judged to have the greatest scientific merit.

This so-called "project method" of research support has a number of advantages. Properly interpreted, the plan is flexible and may be applied to narrowly defined problems in science or to broad areas. It enables the Government to move in freely with the support needed for promising and significant undertakings of current interest. It provides for a national program in the sciences, utilizes the advice of the scientists in each field, and is based upon the significance and merit of the research proposed and the competence of the investigators. Since each grant and contract requires the official indorsement of the investigator's institution, the plan has evolved with the concurrence of the Nation's universities and has had a most important indirect effect in helping to strengthen such institutions. In fact, such aid has often been of critical importance, particularly for the smaller schools.

With the increased sums available to it for support purposes, the Foundation is now able to make more grants of a broader type, often cutting across two or more departments of a university. For example, a grant awarded to the University of Pennsylvania will further research which applies concepts of chemistry and physics to the biological problem of regulation of metabolism within the cell. In another instance, scientists at the Massachusetts Institute of Technology will undertake a concerted attack upon the problem of the production and nature of

plasmas. Included are studies on gaseous electronics processes, plasma statics, magnetohydrodynamics of compressible and incompressible fluids, ionospheric physics, and some branches of astrophysics. This program is being supported by the Foundation with a 3-year grant.

Facilities for Research

Basic research today increasingly requires the use of large, complex, and expensive research tools. Although Government expenditures for research facilities since World War II have run into the hundreds of millions of dollars, for the most part these have been committed to practical research and hence have been available only to a small degree for purposes of basic research.

Traditionally, universities and other private research organizations have provided needed research tools from their own funds or from funds available from state or local sources. Now, however, the need for such major equipment as nuclear reactors, high-energy particle accelerators, high-speed computers, and radio and optical telescopes is too great to be met from such local resources or even from the combined resources of several institutions. If American science is to advance at a satisfactory rate, Federal support of needed facilities must be provided.

Each case must be judged on its individual merits. It is difficult to establish criteria that would be applicable in all cases. Factors to consider include the urgency of the need, the national significance of the development, the availability of trained personnel, and the degree and character of local backing. Recipient institutions are encouraged to participate financially to the extent possible. In some situations, the Federal Government must continue to supply funds for operating and maintenance, in addition to funds for construction.

International Participation

In a larger frame of reference, the progress of science has been measurably stimulated through participation of U.S. scientists in vast programs of international research with very substantial support by Government. An outstanding example is the brilliantly successful International Geophysical Year. Through a special committee established by the International Council of Scientific Unions (ICSU), a program encompassing the entire globe in 13 major fields of physics, together with extensive rocket and satellite programs, was undertaken, with the participation of 66 countries and supported on a world-wide scale by funds equivalent to many hundreds of millions of dollars. The IGY was successfully carried on without reference to political considerations, and demonstrated

that men of many different political persuasions are able to work together harmoniously for the advancement of knowledge.

Some aspects of the successful IGY are being continued under the program known as "International Geophysical Cooperation." Scientific studies are continuing in the Antarctic, in space science, in oceanographic research, and plans are being weighed for further studies in meteorology, geomagnetism, and other subjects. In programs already under way, Federal funds are being used to support special U.S. committees and their secretariats, under the National Academy of Sciences.

Continuing research programs in the Antarctic are being carried on by the 12 nations which participated in the IGY Antarctic program. General scientific recommendations for the area are made by the Special Committee on Antarctic Research (SCAR) of ICSU. The U.S. program is being developed, funded, and coordinated by the National Science Foundation. The Foundation looks primarily to the Committee on Polar Research of the National Academy of Sciences for program recommendations; NSF also considers proposals from qualified scientists interested in carrying out such research. The Foundation works with the Interdepartmental Committee on the Antarctic to coordinate the research activities of other agencies, such as the National Bureau of Standards, the Weather Bureau, and the Geological Survey, and provides them with funds for their participation in Antarctic research. Grants are also made to universities and various interested research organizations to complete the program of scientific activities in the Antarctic. To date, Congress has appropriated $10 million for this post-IGY program in the Antarctic.

Communication of Scientific Information

But whether he pursues his research in the frozen laboratory of the Antarctic or in the cloister of his own laboratory, the scientist wastes valuable hours if he is not familiar with the published results of research in his own field. Time saved for scientists in searching out what is already known is time they can actively spend on research. Improvement in the communication of scientific information is reflected in improved use of scientists' time—in effect, equivalent to an increase in the number of scientists available.

Axiomatic in the scientific community is the statement that no piece of research is complete until it is published. As the pace of scientific research accelerates and scientific publications multiply, it becomes increasingly difficult for a scientist to learn about and obtain access to everything that is published in this field. Accordingly, the Foundation is trying to make it easier for scientists to locate and acquire the published

results of research. The objective is to ensure that any U.S. scientist can obtain any item of unclassified scientific information he needs, no matter where it originates, and to develop improvements in the organization and availability of scientific information on behalf of all U.S. scientists.

Published results of scientific research are obtainable from many sources, private and public, at home and abroad. It is most important that significant scientific research publications, whether published in Great Britain, Sweden, Russia, or any other nation of the world, be identified, obtained, translated if necessary, and distributed to interested scientists in the United States. Similarly, unpublished reports from university laboratories, industry, and the Federal Government are an important medium of scientific communication. The Foundation attempts to make such reports more readily available. Additionally, it seeks to open new, and to keep open existing, channels of communication among scientists through partial support of scientific journals and reference aids and through the support of research directed toward more efficient organization, processing, and storing of information for rapid search.

Thus through vigorous support of meritorious research on both national and international fronts, through the provision of modern research facilities, and through improving communication among scientists, the Federal Government stimulates the progress of United States research. No other nation surpasses the United States in the scope and depth of its science. Since 1945, its scientists have been awarded more than half of all Nobel prizes in science—a not insignificant measure of the wisdom with which the Nation has pursued its policy toward encouraging science.

Development of the Individual Scientist

However meritorious the settled course of the Government's commitment to sustain and support the progress of research in science in these portentous years, trained manpower is required to convey it to fulfillment. As outlined in the foregoing section, Government seeks in a variety of meaningful ways to stimulate the progress and growth of scientific research. With equal vigor, it seeks to develop capable men and women who can be depended upon by the Nation to attain the goals of its scientific endeavor. At issue, therefore, is the competence of students, scholars, and teachers.

The manpower needed to carry forward the science of tomorrow is in today's classrooms across the Nation. Questions of moment are:

What is being taught? Who is doing the teaching? What are the opportunities for those who graduate? Satisfactory answers to these questions need urgently to be found if we are to meet fully our science-manpower requirements at this midcentury point in the scientific revolution. A panel of the Nation's foremost scientists and educators who serve the Federal Government did supply forthright answers to these questions, concluding that:

> . . . Americans should attach greater value to intellectual excellence.
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> . . . Every school and college should reexamine its curriculum to make sure that in every aspect it is giving adequate challenge to the intellectual capacities of its students.
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> . . . We should do far more than we are now doing to enhance the prestige of the teacher and to provide him with more effective support in his efforts to improve the effectiveness of his teaching.
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> . . . We should move much further in the direction of adapting our educational programs to the widely varying competence of students, and seek especially to meet the needs of the most gifted students.
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> . . . We should improve our scientific education at all levels, attempting to give better understanding of science to the nonscientist as well as to discover and stimulate more individuals who have the talents to become scientists and engineers.
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> . . . To attain these ends we conclude that four major areas need specific and urgent attention throughout our educational system:
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> (1) the curriculum and the content of courses,
> (2) the quality and effectiveness of teachers,
> (3) the recognition and encouragement of students, and
> (4) the development of intellectual leadership.**

Fellowships in Science

These objectives characterize the commitment of the Federal Government in its efforts to provide means for developing the numbers and kinds of well trained scientists required by industry, education, and Government. The Foundation's fellowship program, oldest of all Foundation-supported programs, is typical of the kind of support provided by other agencies of Government. It offers aid to graduate students, teachers, and advanced scholars in science, mathematics, engineering,

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** From Education for the Age of Science, a statement by the President's Science Advisory Committee, May 1959.

and certain social sciences, according to plans designed to meet the educational needs of individuals. It was inaugurated in 1952 by the predoctoral and regular postdoctoral programs with a budget of $1.4 million—almost half the Foundation's appropriation for that year.

As new needs have become apparent, additional programs have been added: in 1956, the senior postdoctoral program; in 1957, the science faculty program; in 1959, the cooperative graduate, teaching assistants, and secondary school teachers programs. By the end of fiscal year 1960, approximately $43 million will have been used for support of graduate students, teachers, and advanced scholars through these seven fellowship programs. After awards have been made for 1960, an approximate total of 13,000 graduate students and advanced scholars in science, mathematics, and engineering will have received awards, from among about 50,000 applications.

It should be noted, also, that the high standards of selection for Foundation fellowships have resulted in wide-spread interest in the applicants, with the result that many of the unsuccessful applicants for Foundation fellowships have received awards from other sources. This is particularly true in the case of applicants included in the honorable mention lists published by the Foundation each year.

The fellowship programs are productive methods for encouraging the college graduate to continue his education into, through, and beyond the graduate level of competence in science. Measures were needed as well to stimulate the enthusiasms of youth toward careers in science. Early in its history the Foundation, charged with responsibilities for scientific education policy as well as science policy, began to look closely into the training of scientists and engineers in the United States. It was an era when shortages in these professions were becoming severe. Newspaper and journal articles of the day reflected the growing anxiety about the Nation's chances of providing both for its immediate needs and for its anticipated growth in needs during the next few decades.

Science Teacher Training

It became clear to the Foundation that substantial support of scientific education programs was required in order that scientific progress and continued technological superiority might be assured. The immediate objectives would be to stimulate more young people to take up science, and beyond that to enable their teachers to improve themselves in the subjects they were teaching so that they could better stimulate their students.

An experimental program of institutes for teachers of science was therefore begun by the Foundation in fiscal year 1953, apparently the

first such effort ever sponsored by the Federal Government. It was an immediate success, and has been expanded each succeeding year.

This marked the beginning of a shift in national policy. Heretofore, the Federal Government's stake in education was never felt to be substantial enough to justify such direct action in the field of teacher training. The NSF experiment, coming at a time of great national need, paved the way for realization that the Federal Government does indeed have a stake in ensuring that the Nation's teachers are well educated so that, in turn, their students—the oncoming generation—will be trained to meet the demands of their civilization.

At the same time, the traditional place of State and local governments as managers of their educational systems was carefully preserved, through the NSF system of support to locally initiated projects rather than through establishment by the Federal Government of its own educational operations.

Other Government agencies followed this lead in establishing institute programs. Thus, the Foundation sponsored during one year—jointly with the Atomic Energy Commission—two institutes in nuclear engineering for college teachers; the AEC later obtained authority and funds for this type of program, and took over the sponsorship of these and several similar institutes.

The Foundation initiated, as well, certain special projects in science education designed: (1) to supplement the secondary school students' classroom training in science by introducing lectures by visiting scientists, supporting programs of State academies of science, and providing summer research training for students of special ability and aptitude; (2) to provide opportunities for undergraduate students in science, mathematics, and engineering to obtain experience in research laboratories, and to assist teachers by supporting conferences and special academic-year programs and programs of research participation; and (3) through programs of public understanding of science, to improve citizen understanding of the role of basic research and its fundamental relationship to progress in engineering and technology.

Support of teacher training became national policy in 1958. President Eisenhower, in a special education message to Congress, pointed out that programs of the National Science Foundation "have come to be recognized by the educational and scientific communities as among the most significant contributions currently being made to the improvement of science education in the United States." His message recommended a fivefold increase in appropriations for Foundation educational activities; of the five objectives he listed, three—improvement of subject-matter knowledge of science and mathematics teachers, improvement of

course content, and encouragement of science as a career—represented new fields of endeavor for the Federal Government, fields which had already been the subjects of "pilot experimentation" by the Foundation.

The same message recommended extension of the institute principle to foreign languages and counselling, under the sponsorship of the Office of Education.

Legislation embodying the presidential proposals was passed by the Congress in the National Defense Education Act of 1958. A milestone in Federal recognition of the problems of education, it is the national expression of policies earlier given impetus and substance by the pioneering programs of the National Science Foundation in science education.

Curriculum Improvement

A second major Foundation policy move in the field of science education came with the inauguration of projects designed specifically to improve science curricula within the Nation's schools. It was recognized early in the Foundation's history that, too often, science courses were being taught on the basis of outmoded textbooks and obsolete theories. Although teachers and school administrations had tried to keep up with rapidly evolving scientific disciplines, there existed no systematic channels through which they could learn of these changes in a manner designed to enable them to incorporate the knowledge into their classroom situations.

The Foundation also recognized that it was in the national interest to involve broadly based groups in action programs to remedy this problem. The problem had been identified; further discussion would not contribute to a solution unless the groups concerned were committed to produce specific materials useful to the classrooms at various levels.

Similarly, the NSF has scrupulously maintained the principle that, although classroom materials might be produced with the aid of the Federal Government, the Government has no control whatsoever over the content of these materials nor over their distribution. This remains in the hands of the scientists. The Government has no mechanism to "sell" the materials produced; the aim is merely to make available classroom materials that, if they are indeed better, will sell themselves to the schools needing them.

The Health and Growth of Institutions—Environment of Teaching and Research

Although the settled course of Federal aid to science and the scientist may hopefully continue along the constructive patterns outlined above, it needs underpinning in resolving a problem that has been paid relatively

little attention—support for educational institutions to enable them to develop their own capabilities in science and engineering.

Institutions have benefited substantially from Government support of research projects and from awards, such as fellowships, to individuals, but they have received little aid of a sufficiently general type to enable them to carry out their own plans for growth in science and engineering and to maintain a proper balance between these activities and others in which they engage. The needs are great: Graduate research laboratories require modernization in terms of buildings, equipment, and space; the salary scale in many institutions urgently needs adjustment upward; there is an acute and a continuing shortage of maintenance and operating funds; in the secondary schools the salary scale is also low. Although some progress is being made, much still remains to be done.

The Federal Government's policy with respect to the problems of the institutions is to point out the needs and to emphasize the importance of satisfying those needs—to the extent possible and in accordance with American traditions—from State and private sources. But it is also the responsibility of the Federal Government to exercise leadership in meeting this problem. The inadequacy of resources available to our educational institutions is a national problem which the Federal Government must help to meet.

Another problem is the growing need to evaluate and dispose of competing claims by those who support special areas of basic research declared to be critical. Atmospheric physics, oceanography, meteorology, and seismology are examples of areas which in recent years have been found to lack adequate support, trained personnel, facilities, and equipment. Different techniques may be required for handling such problem areas, but these special problems should not obscure the need for comprehensive support of basic research in all fields of science.

Support Should Emphasize Basic Research

The university is the traditional home of basic research. Ideally, it is here that the so-called uncommitted investigator, in an atmosphere of academic freedom, can pursue his individual researches without reference to practical objectives. In recent years, however, the universities have been subjected to new pressures in the form of the Government's need for a wide variety of so-called "contract research." Both the scientific community and the Federal Government have expressed concern lest outside demands for the solution of pressing practical problems jeopardize the university's traditional role of education and free research. The Foundation found it desirable to make a special study of the situa-

tion—"Government-University Relationships in Federally Sponsored Scientific Research and Development." This study notes that:

> In certain specialized fields, such as engineering, agriculture, and medicine, applied research is frequently closely related to educational objectives. Federal support of applied research projects in these fields appears to present no fundamental problem in terms of interference with the traditional functions of colleges and universities. However, with such exceptions noted, . . . Federal agencies [should] consider other alternatives before establishing large-scale applied research and development projects (particularly those concerned with development and testing) within institutions of higher learning. Such alternatives would include: (a) Federal laboratories; (b) industrial or other private laboratories; and (c) research centers organizationally separated from the institution proper.

The question of preserving the basic research functions of our universities is fundamental. So long as our universities are not able to obtain adequate funds to support normal activities, they may be tempted to supplement regular budgets, and possibly in so doing, to undertake projects and programs to meet needs other than strictly scientific and educational. This means that teachers and experienced research investigators needed for the guidance and training of future scientists may be diverted to urgent practical problems or away from a specialty of their free choice.

Rise of New Types of Research Organizations

It should be noted, also, that the years since the war have marked the rise of new organizational forms for the furtherance of basic research. These include Federal contract research centers, such as the national laboratories, of which Los Alamos, Argonne, and Brookhaven are major examples, which are managed by a university, a group of universities, or an industrial concern under contract to the Federal Government. In general they are engaged in both basic and applied research, where considerations of both cost and security have dictated that the work be carried on under direct Government sponsorship.

More recently, groups of universities have begun to collaborate in similar fashion to conduct basic research in other fields. In the field of astronomy, for example, the Foundation is supporting two major projects—the radio astronomy facility being constructed and operated at Green Bank, W. Va., by Associated Universities, Inc.; and the optical astronomy facility on Kitt Peak, Tucson, Ariz., being constructed and operated by the Association of Universities for Research in Astronomy,

Inc. A recent group to enter the field is the University Committee for Atmospheric Research, organized by a group of 14 universities.

It is clear that certain broad fields, such as astronomy, atmospheric research, oceanography, materials, and space research, lend themselves well to cooperative effort. It is practically certain that the expanding horizon of research in this country will dictate the organization of new forms of research activity here. In the first place, there will continue to be pressures for an organized attack upon any critical, practical problem, of either basic or applied science, such as that which currently obtains with respect to materials. Whether these needs can best be met by establishing special centers for the purpose, or whether coordinated programs should be set up in more decentralized fashion, will be matters for consideration in each case. In the second place, the voice of science itself will come increasingly to be heard demanding support for highly significant areas of science, mainly basic.

Group or Individual Support?

A word of caution is in order here. We must, of course, be alert to future trends and do justice to concerted efforts in science, but we must also be alert to the weaknesses as well as the strengths inherent in massive and concentrated effort. Are we likely, for example, to overemphasize group activity at the expense of the individual researcher? Certainly history indicates that capital discoveries can usually be attributed to a single person or a few individuals, although it is quickly admitted that their particular contributions may be only the climax of a host of prior smaller research contributions. Those who are familiar with group activities will probably agree, if they are candid, that the tendency of the group is to be conservative although powerful. In dedication to its objective, it reacts rather conservatively to radical ideas or subject matter lying on the periphery of its main activity. Furthermore, an organized group tends toward a singleness of purpose and of method which by its very nature is apt to ignore ideas from outside.

The large research center introduces another quite serious problem. A unique bulwark of university research is admittedly the close association between graduate faculty and graduate students. How can a specialized research center or facility effectively collaborate with university research and graduate education—if within the university, it tends to monopolize attention; if remote from the university, it suffers from inaccessibility? Although an organized group can mount a vigorous attack against broad and complex research problems, support must not be withheld from individuals and smaller groups who may approach the subject from other disciplines or other points of view. It is important

to achieve a desirable balance between group and individual effort, certainly in basic research; neither has sole merit.

Urgent Laboratory Needs

Today, outstanding needs exist that are not being met. Chief among these is the need for new or renovated laboratories, for research and teaching equipment and facilities, and, in certain fields, for costly modern research installations. Accordingly, the Foundation has recently embarked on a small experimental program designed to furnish funds for these purposes on a matching basis—that is, the Foundation furnishes half of the funds and the institution furnishes the other half. On top of this is the ever-mounting cost of maintenance. The situation appears to call for general aid to U.S. universities patterned somewhat after that provided universities in the United Kingdom by the University Grants Committee. In any event, the question arises of direct subsidy to educational institutions in order to increase the overall strength of their departments and to provide greater flexibility in their administration.

Direct financial assistance to academic departments or institutions raises a serious policy question: Should the Federal Government break precedent and provide direct aid to higher education in the fields of science? Can this be done without danger of loss of independence of the institutions supported? Can this be done wisely and acceptably by selective support in the manner of the current research support, or should it be done universally according to some suitable formula? Presumably, an obvious safeguard would be the provision for matching funds. Then there is the complicating factor of two primary classes of institutions: public and private. Despite the difficulties, however, it is quite clear that the needs are real and urgent. The responsibility of the Federal Government is to learn the facts, point out the problem and its urgency, and see that effective action is taken. This means consideration both of ways to assist State and private sources to meet the need (through such measures as revision of the tax structure), and of ways and means to provide some degree of direct support.

In Summary

Federal Government support of basic research and education in the sciences has clearly demonstrated its vitality and flexibility. In its broad attack on the degenerative and crippling diseases that afflict mankind; in its development and exploitation of nuclear energy for peaceful purposes; in its support of basic research unrelated to practical objectives, the Government effort has contributed to the general welfare. In doing

so, it has not encroached directly upon the independence of individual scientists and groups supported. Federal support of research at colleges and universities exists in various forms ranging from the very narrow to the very broad. The operations of current forms of support are continually studied with a view to adopting modifications and alternatives which would improve the environment for basic research and which at the same time would not be subject to abuse. All forms of support, both narrow and broad, have their place in the general pattern of Federal support. In the Foundation, we feel that each agency should use those forms best suited to particular needs at a particular time and should be free to vary the general pattern whenever desirable.

U.S. Research Strong

Research in the United States is inherently strong and versatile and, in comparison with other countries, is especially strong in industry-related programs. A nationwide program in support of basic research by the Federal Government has been established, aimed at progress in science along lines laid down by the scientists themselves. This program includes, as an important component, basic research in support of areas of research and development underlying the missions of individual Federal agencies. Basic research is also conducted vigorously by a number of leading industries, many of which provide support to universities and other research establishments chiefly in areas of interest to them. Colleges and universities continue to constitute the principal centers of basic research activity.

The evidence is, however, that basic research in the United States should be more strongly supported at colleges and universities in order to strengthen our future technology through progress made on the frontiers of science, in order to retain highly competent staff, and to assure high quality training of a great number of young scientists and engineers.

Government Organized for the Job

The Federal Government is now better prepared than ever before for the consideration of such matters because, in addition to the interested departments and agencies, there is the new Federal Council for Science and Technology, recently established by the President; the Special Assistant to the President for Science and Technology, in the White House; and the very active President's Science Advisory Committee.

Responsibilities for science matters in the Federal Government can be described as follows: With respect to the role of the Federal Government in the support of basic research, the National Science Foundation

with its National Science Board is primarily responsible for dealing with policy concerning Federal support of basic research throughout the country. On matters of policy coordination and future planning among Federal agencies, the Federal Council for Science and Technology makes recommendations to the President. The President's Science Advisory Committee, drawn from non-Government scientists and engineers, considers overall scientific and technological matters in relation to Government policy, with special reference to national security. The presence in the White House of the Special Assistant to the President for Science and Technology makes available to the President at all times advice and counsel on a wide range of scientific and technical affairs.

Potential Not Realized

In spite of the growth and strength of Federal programs in research and development and the assets that have been described, the potential of the country in science and technology is far from being realized. The element most requiring attention is a greater degree of support throughout the country for basic research and for the education and training of scientists and engineers. To realize our full potential in basic research, there must be widespread public recognition, understanding, and appreciation of the importance of intellectual and scholarly activity, and the pursuit of excellence in all fields of intellectual endeavor.

The fact remains that, in this country especially, we have not yet reached the point where we can step forth boldly and justify basic research in terms of its important objective, namely, the pursuit of knowledge for its own sake—as typified by the work of Galileo, Newton, Maxwell, Faraday, Henry, Darwin, Gibbs, and Einstein. Until we are willing to acknowledge and indeed proclaim the importance of purely intellectual and spiritual goals, we shall never realize the full advantages of basic research. If this point of view is correct, public attitudes must change to ensure United States science of high quality.