NATIONAL SCIENCE FOUNDATION

The Year

of the

Earth Satellites

THE STATUS OF SCIENCE

AND EDUCATION

IN THE UNITED STATES

THE YEAR OF THE EARTH SATELLITES—THE STATUS OF SCIENCE AND EDUCATION IN THE UNITED STATES

Because of the manmade satellites now circling the earth, United States citizens recognize—perhaps with more clarity than ever before—the importance of science and its contribution to their welfare and security. The achievement which brought this about was the launching of the first satellite by the Soviets in October 1957, a feat of astonishing engineering prowess. Later launchings by both the United States and the U. S. S. R. culminated a period of increasing attention in the public press to scientific and technical accomplishments, including the harnessing of nuclear energy for power as well as weapons purposes and the worldwide exploration of the universe represented by the International Geophysical Year, of which the satellites are a part.

With increased awareness of the vital role of science also came the realization of the high state of Soviet science in many fields, a fact known and reported by United States scientists for many years. To the American public, however, the first launching became a symbol of competition between Russian and American science, and a sign that we had "lost" a "scientific race." To the extent that the symbol became identified with such a "race," it was erroneous and destructive—we did not think of the undertaking in these terms, but regarded it as a part of a cooperative international scientific undertaking, the International Geophysical Year. But to the extent that the symbol called attention to certain marked deficiencies in the environment in which our scientists operate, and pointed up the need for improvements in our scientific education and strengthening of our basic research, it was accurate and useful.

Quality of the Nation's Scientific Effort

The critical self-examination that followed showed that, in point of fact, United States science has during recent years been of the highest

quality. In general, our accomplishments in research have been second to none, and United States scientists as a group have continued to rank high in the estimation of their colleagues throughout the world. It was pointed out, for example, that from 1943 to 1956, United States scientists received 34 of the 67 Nobel Prizes awarded in physics, chemistry, and medicine and physiology.

This evaluation of domestic science also showed that the Nation has not been wholly unaware of the needs of its scientists. The growing proportion of Soviet young people being trained as scientists and engineers, as contrasted with our own, had received much publicity, as had the comparatively higher position with respect both to salaries and public esteem which is enjoyed by scientists in the U. S. S. R. Expenditures for research and development have been steadily increased by industry, by the Government, and by educational and nonprofit institutions of many types, although by far the greatest percentage of these expenditures is devoted to developmental work and applications engineering, rather than basic research. Establishment of the National Science Foundation in 1950 had been a major step in the attempt to correct the imbalance in this country insofar as the position of basic research was concerned.

Public discussions following the satellite launchings brought out once again the fact that Americans customarily think of science in terms of applied work, or engineering, despite the highly significant accomplishments of research workers in the areas of fundamental investigation. Nevertheless, the connection between basic and applied research, and the degree of dependence of the latter upon the former, has become increasingly clear during the past year. In addition, the continuing reduction of the "technological lag"—the time elapsing between publication of the results of fundamental research and utilization of those results in specific engineering applications—has become more apparent.

Finally, interest in the satellites and the inquiry into the status of science which they stimulated also brought to United States citizens a realization of the interrelationships of science and scientists throughout the world. Our rate of scientific progress is appreciably increased when the achievements of foreign scientists are made available to us. Similarly, the achievements of American scientists help scientists of other countries to move on to new research, the results of which are again available to our scientists as to all others. Scientific literature is circulating more freely and more translations are becoming available. International scientific conferences are increasingly benefiting from the

participation of scientists from more and more countries, including those behind the Iron Curtain. The U. S. S. R., for example, is maintaining one of the three world data centers of the International Geophysical Year and has taken an active and cooperative part in many other IGY programs. Despite the continuing difficulty which marks political relations between the United States and the Soviet Union, scientific relationships have improved substantially. If this interchange can continue, the world may well anticipate a measurably faster rate of scientific development in the future. The economy, health, and general welfare of mankind benefit from such international exchange of scientific accomplishment.

Condition of American Education

Review of the United States position which followed the launchings also necessarily included an analysis of the educational system which must produce the well-informed and highly competent men of science and public affairs required if our Nation is to retain its position of responsibility and leadership in world affairs. Although yesterday's less exacting requirements for trained manpower were satisfied by the graduates of our schools and colleges, thoughtful observers raised serious questions about the quality of today's educational system and its ability to meet tomorrow's increasing demands for thoroughly trained men and women.

Quality in the Nation's schools was observed to be what the community and its citizens made it. So long as students disdained difficult studies in English, foreign languages, science, and mathematics; so long as they were supported by parents who derogated learning and culture with contemptuous references to eggheads and longhairs; so long as citizens were reluctant to continue to vote the increased taxes needed to provide well-equipped schools and well-paid teachers—then so long did the quality of the educational system jog along over an improvised and bumpy road. In the years immediately ahead, schools and colleges will be deluged with applicants representing the generation born in the postwar period. They will be greeted by overworked and underpaid teachers, too hard-pressed to withstand the burden of trying to maintain high scholastic standards while, at the same time, trying to satisfy the demands of an age which requires that high-ability students be provided the training to which their talents entitle them.

For the National Science Foundation, policy lines were clear—un-

equivocally, the Foundation programs were concerned with improving science education, a prerequisite for raising the quality of scientific manpower. As a result, so coveted have become Foundation fellowships for men and women pursuing science training into the doctoral area that most candidates given honorable-mention ratings have asked that their names be publicized with the announced winners of fellowships—secure in the knowledge that other sources of support would regard them more favorably because of the acknowledged severity of standards applied by the Foundation. Similarly, Foundation-supported institutes (summer, academic-year, and in-service) for high school and college teachers of science and mathematics have won nationwide acclaim for their role in improving competence in subject matter training. Finally, the Foundation's support of curriculum-improvement studies in high school physics and mathematics (with plans for similar studies in chemistry and biology) promises to point the way to measurably improved quality of course content in several fields of science, focused as these studies are on fundamental, not filigreed, science instruction.

Complementing these programs of the National Science Foundation, which made a resolute attack on the science-manpower problem, were very substantial efforts extended by several private organizations. Groups such as the Ford Foundation and the Rockefeller Foundation supported broad-based programs designed to improve education in the United States; and the National Merit Scholarship program to recognize exceptional achievement at the high school level did much to publicize the need for high intellectual attainment, through the award of college scholarships. All in all, however, these efforts were confined largely to groups already aware of the problem. At the time of the satellite launchings, citizens generally had not become genuinely concerned with the pressing problem of identifying and training prospective scientists. With Sputnik in orbit, however, the Federal Government took quick action to improve the status of science and education in the United States.

President Eisenhower Alerts the Nation

In November of 1957, President Eisenhower made two major addresses to the Nation—"Science in National Security" and "Our Future Security"—in which he focused attention on the importance of science and technology to our security and of our failure to give high enough priority to scientific education and to the place of science in our national

life. He noted, as well, our failure to give priority, both public and private, to basic research.

At the same time, the President appointed Dr. James R. Killian, Jr., President of the Massachusetts Institute of Technology, as Special Assistant to the President for Science and Technology. A staff of scientific experts was also named as the President's Science Advisory Committee to work with Dr. Killian to provide the President with the very best advice the scientific community could supply.

Soon thereafter, in recognition of the impact of science on international policy and international policy on science, Dr. Wallace R. Brode was appointed Science Adviser to the Secretary of State. Dr. Brode is directing a reinvigorated program for sending science attachés to our embassies in those countries most scientifically advanced, to collect information and to advise our ambassadors on scientific matters.

Increased Support for Science by the Federal Government

In recognition of the importance of science and the vital interest of this country in space exploration, the Congress established special standing committees—in the House of Representatives, the Committee on Science and Astronautics; and in the Senate, the Committee on Astronautic and Space Sciences. These committees will permit far more effective congressional consideration of the increasing number of problems in these areas.

Actions taken by the Federal Government through the executive and legislative branches to improve our scientific position include:

1. *Increased Research Appropriations.*—Increased funds for research were given to the National Science Foundation for its basic research programs, to the Public Health Service for its programs of medical research, to the Atomic Energy Commission for its programs in atomic research, and to the Department of Defense.

2. *Establishment of a Space Agency.*—A major legislative achievement was the creation of an independent Federal agency to direct aeronautical and space research and activities, including the development and use of aeronautical and space vehicles. This agency has been designated as the National Aeronautics and Space Administration. Space activities will be coordinated and policy set at the highest level by the Aeronautics and Space Council composed of the President, the Secretaries of State and Defense, the Administrator of the NASA, the

Chairman of the Atomic Energy Commission, and a maximum of one additional Government and three additional non-Government members.

Noteworthy as well is House Concurrent Resolution 332, expressing the sense of Congress that the United States should strive for international agreements banning the use of outer space for military purposes and providing for joint exploration of outer space and the amicable settlement of international disputes arising therefrom.

3. *Improved Working Conditions for Government Scientific Programs.*—Strengthening the Federal Government's own research effort was another considerable achievement. Physical scientists and engineers employed by the Government were given salary increases. Recruitment for junior scientific and technical positions was authorized at a higher salary level. Scientific and engineering personnel were made eligible to receive further training and education at Government expense. Newly appointed scientists and engineers traveling to their first post of duty now receive travel expenses not heretofore granted.

4. *High-level Coordination of Research and Engineering Activities in the Department of Defense.*—The position of Director of Research and Engineering was established within the Department of Defense, with rank above the Assistant Secretaries of Defense and power to manage projects of interservice character without the necessity of following the military chain of command of any of the services. Furthermore, the Department of Defense issued a significant directive stressing the importance of basic research.

5. *Other Legislative Actions.*—(a) The National Science Foundation was directed to begin a program of study, research, and evaluation in the field of weather modification; (b) Federal agencies were authorized to use certain foreign funds, acquired by this country in connection with agriculture surplus programs, for scientific activities overseas including collection and translation of foreign science literature; and (c) authorization to make grants, as well as contracts, was provided for Federal agencies engaged in contracting for basic research by educational and other nonprofit institutions. These agencies were also enabled to vest, with the institution, title to equipment procured from research funds.

Federal Activity in the Field of Education

1. *President's Special Education Message to the Congress.*—In January 1958, President Eisenhower forwarded to Congress a special educa-

tion message containing recommendations for "certain emergency Federal actions to encourage and assist greater effort in specific areas of national concern." He said, "Because of the growing importance of science and technology, we must necessarily give special—but by no means exclusive—attention to education in science and engineering."

He recommended a fivefold increase in the appropriation for the scientific education activities of the National Science Foundation because they are regarded "as among the most significant contributions currently being made to the improvement of science education in the United States."

Also submitted were recommendations for additional temporary Federal programs to strengthen general education and to strengthen science education in our State and local school systems. These programs were to be conducted by the Department of Health, Education, and Welfare.

2. *Congressional Response.*—Probably the first action taken to improve existing conditions was the early passage of a supplemental appropriation to the National Science Foundation of approximately $9 million permitting immediate expansion of existing programs designed to improve science education. This included the award of additional fellowships and attendance of additional high school science teachers at summer institutes.

The 1959 appropriation for National Science Foundation educational programs was increased more than 300 percent to approximately $60 million, thus allowing wide expansion of existing programs and the initiation of new programs.

However, the principal congressional action in the field of education was the National Defense Education Act of 1958, which constituted the first general Federal aid-to-education legislation since the Morrell Act of 1862. At the same time the act reaffirmed the principle that State and local communities have primary educational responsibility including that for supporting science and language study and for encouraging high academic standards as being in the national interest.

This act provided, among other things, for loans to students to enable them to attend college; for the award of graduate fellowships; for matching grants to the States for guidance and counseling activities in the high school and for vocational programs for training highly skilled technicians requiring scientific knowledge; and for contracts with colleges for conducting foreign language institutes for elementary and secondary schoolteachers. Major administrative responsibility for

carrying out the provisions of this statute was assigned to the Department of Health, Education, and Welfare.

The act also created a Science Information Service in the National Science Foundation to develop new and improved methods for making scientific information more readily available, thus endorsing a recommendation of the President's Science Advisory Committee. In this way, Congress emphasized the importance of the information programs presently being carried on by the Foundation pursuant to the 1950 act establishing the Foundation.

Recommendations of the Scientific Community

In March of 1958, the American Association for the Advancement of Science convened a Parliament of Science of more than 100 prominent scientists and public leaders. One of their key conclusions was that Government support of scientific research should not be centralized in a single Department of Science.

Among their other conclusions were:

1. Optimal progress in science requires increased support for basic research.

2. As funds for support of science increase, plans and procedures for administering the national scientific effort become increasingly important and national scientific policy bears closer scrutiny.

3. Scientists must have maximum freedom to communicate with each other and with the public in order that science may progress most effectively and may be most widely used for improving human welfare.

4. As citizens, scientists must ponder the social consequences of their findings and must inform the public of the consequences they foresee.

5. The primary goal of education is the intellectual development of the individual.

What Remains To Be Done

In his Oklahoma address of November 14, 1957, on "Our Future Security," President Eisenhower not only stressed the importance of insuring high-quality instruction in science and engineering and the early identification and encouragement of science and engineering students, but he also emphasized the "long-term concern for even greater concentration on basic research—the kind that unlocks the secrets of

nature and prepares the way for such great breakthroughs as atomic fission, electronics, and antibiotics."

While pointing out the fact that "at present our basic research, compared with any other country's, is considerably greater in quantity and certainly equal in quality," he warned of the "fast rate of increase of the Soviet effort and their obvious determination to concentrate heavily on basic research. The world will witness future discoveries even more startling than that of nuclear fission. The question is: Will we be the ones to make them?"

Basic Research—A National Resource

One month before the President's Oklahoma address, the Director of the National Science Foundation, on October 15, 1957, transmitted to the President the report of the Foundation, *Basic Research—A National Resource*. In his letter of transmittal, the Director said:

> The report will, I believe, be informative and should prove helpful toward bringing about a fuller understanding concerning the desirable balance between applications of science to defense, health, and the economy on the one hand, and basic research activity—the "defense in depth" for our whole technology—on the other.

This report contained recommendations designed to improve the status of fundamental research in the United States—recommendations of far-reaching nature which warrant reemphasis here. Briefly, they are:

1. Government agencies should significantly increase the support of basic research (including facilities) and of training for research, as well as ensuring that support is rendered on a continuing stable basis.
2. State Governments, with Federal assistance, should increase their support of basic research and of graduate education at State universities.
3. Federal grants and contracts for research and research training should continue to carry a minimum of restrictions on the freedom of the scientist and of his institution.
4. Methods should be devised for increasing philanthropic gifts for basic research, with no restrictions as to their use.
5. Industry should be encouraged to conduct more basic research in its own laboratories.
6. Scientists working for industry should be encouraged, both by their firms and by scientific journals, to publish their research.
7. Closer and better relationships should be developed between mem-

bers of Congress and scientists, in view of their respective responsibilities to each other and to the American people.

Implicit in these recommendations is the strongly held conviction of the scientific community and of the National Science Foundation that the Federal Government must not exercise centralized control over science. Increased Federal support does not carry with it the license to direct the research, or to set the policies, scientific or otherwise, of the institutions receiving support. Each needs the other, but they must remain separate. Otherwise, our research institutions and our scientists might well begin to feel an erosion of the intellectual freedom which is their bulwark and our shield. For the educational and sociological barriers which are today set in the way of science, we cannot substitute legislative and administrative chains because, as we are finding out, limitations upon our scientists are limitations upon all of us.

It is important to understand the reasons for this policy. The first is that intellectual freedom is a cardinal principle of democracy. The second, related to and underlying the first, is that intellectual freedom constitutes the great strength of a true democracy. Creativeness, originality, and accomplishment are at a maximum when left to individual initiative and enthusiasm.

The goal of our scientific effort and indeed all our efforts must be quality—quality in native ability, quality in training, and quality in performance.

Quality in native ability we have in abundance, latent among our youth, from all walks of life. But we must identify these young people early, give them every encouragement and opportunity to develop their aptitudes to the fullest, whatever these may be, for their own future and for the future of our society.

Quality in training for these young people we must insist upon. This means superior teaching and superior teachers, together with the equipment and materials they should have.

Quality in performance in science and technology requires that we push forward the frontiers of science with all the vigor at our command. This means full support, both financial and moral, to our competent basic research scientists and engineers for their needs. This includes the construction of essential though costly capital installations, such as those required for nuclear physics, astronomy, oceanography, and the exploration of outer space.

The role of the Federal Government then is to encourage and assist efforts such as these. There is a final ingredient, however, without which effective results cannot be achieved, namely an understanding

and a determination on the part of our people to achieve them, and a pride in intellectual, as well as material accomplishment. When all is said and done, in the modern competitive world as in the past, it is the determination and perseverance of a people toward its national goals and toward international cooperation which alone can bring about realization of the hopes of mankind.