One of the statutory responsibilities of the National Science Foundation is "to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences." To a considerable extent the development of such national policy is reflected directly in the programs of the National Science Foundation, notably in its support of basic research and training in science and in aiding the teaching of science. Full accounts of the development of these Foundation programs are contained in the previous six Annual Reports of the National Science Foundation to the Congress.

With increasing awareness on the part of the Federal Government and the country of the importance of national policy for science, it is appropriate to consider what one means by a "national policy" for science and to explain what such policy is.

What is science? The body of science represents the accumulated knowledge concerning the world we live in and how it operates. Increases in this body of knowledge are made by research, which is the active search to increase our understanding of nature. It is continually tested by observation and by experiment, and continually enlarged in detail, and in overall design. As science grows in scope and complexity, years of study and practice are required to perform modern research.

A traditional "policy" exists among workers in science that is as old as science itself. It is really a combination of a philosophy of science—the scientists' attitude toward their field—plus a tacit code of behavior both for the individual scientist and for his relation to his colleagues. Although a scientist would be startled and probably amused at calling this "policy," no policy for science that ignores or violates it can be tenable.

But what is this philosophy or policy concerning science? Briefly and in oversimplified form it is this. Science is man's attempt at an objective view of our universe. It is not based upon opinions, even of the world's leaders in science, but upon observations and experimental demonstrations that any compe-

tent individual can verify for himself. Each new scientific finding, even by a Nobel prize winner, is challenged and subjected to critical examination and test by others in the same field. The process is thoroughly democratic. In fact, scientific research has always been, in this sense, a "free enterprise" system. Any adequately trained research scientist may and does make his own contributions to science, which may be large or small. In fact, this is the research scientist's goal—to make an original contribution to his field of science. Note, this is an individual matter—he makes his own decision where and how to explore. Since he is a specialist, the importance and feasibility of what he wants to do and the significance of his final results can only be properly appraised and evaluated by his peers—his scientific colleagues in the same field. Now in order to attempt an original piece of work it is necessary for him to know about all other research in his special field—past, present, and planned—as far as possible. Since he and his fellow scientists are in the same boat, all strive to maintain contact with one another, directly if possible, and otherwise at conferences, by correspondence, and through papers published in the scientific journals.

What is the significance of the scientific method in terms of a national policy for basic research? It is that no agency, governmental or otherwise, can rationally attempt to formulate what individual scientists should do, and still less how they should do it. No scientific society would think of doing such a thing for its members. The scientists themselves know best what can be done and how to go about it. A national policy in pure science must, therefore, be an enlightened one—it must find out what scientists consider important to do and to see that they have the means to do it. This means wholehearted approval of providing support for competent basic research wherever needed, and in particular for the capital facilities which science needs in such fields as nuclear research, radio astronomy, and the scientific exploration of outer space. A national policy should also assist scientists by the dissemination of research reports, by providing opportunity for conferences, travel to scientific meetings, and by helping them to renew research study and personal communication with other scientists, both at home and abroad.

But, one may ask, what of the priorities of different sciences? Are not some more important than others? To this, science itself can make only one answer. No field of science should be excluded from encouragement and support. The capital discoveries in science may occur in any field. History is convincing upon this point. In fact, the more novel and far-reaching the discovery, the less one can predict where it may occur. How could one foretell the discovery of magnetism, X-rays, helium, or cosmic rays in advance, before knowing of their existence? By very definition, what lies in the unknown cannot be foretold. It was a biologist who first discovered an electric current and the principle of an electric battery. It was a physician who first formulated the broad principle of the conservation of energy—one of the major laws of physics. The only distinctions that can be made as to relative values are in terms of contributions to understanding of our world, generality of findings, techniques available, current rates of progress, available skilled manpower, and occasionally neglected or overemphasized special areas, when so identified by the scientists themselves. This is science's own answer to the matter of priority.

But there is, of course, another and completely different question, namely: In what ways can science best serve the Nation and all mankind? Here a wholly different set of criteria apply. This question involves an appraisal of the Nation's needs and a matching of progress in the fields of science to national and human needs. For the service of science to the Nation, or to mankind, is almost exclusively a practical matter and therefore concerns the *applications* that can be made from scientific discoveries and scientific principles. This is the primary business of applied research, and after applied research has pointed the way, engineering development takes over to prepare for production or other economic application. This whole sequence properly goes under the name of *technology*. We note that applied research has to start from the basic facts of science, and engineering; therefore, the more advanced our basic research, the more advanced can be our technology.

The needs of any nation can be described in terms of fundamental human needs and wants. These are represented by such broad essentials as food, health, defense, transportation, housing,

communication, and, above all in the modern age, available power and water. The countries of the world differ little in their fundamental needs; there are great differences in the degree to which they have been able to apply modern technology to the satisfaction of those needs. The United States and other industrial nations are of course most nearly similar in this respect. Our standard of living is commonly considered to represent the extent to which we are satisfying those needs. By the same token, the standard of living we wish to attain is regarded as a measure of priority of future needs. It is one of the responsibilities of the Federal Government to see that these broad needs are met, to the extent that this has to be centrally done. Therefore, Federal departments and agencies have been set up whose primary purposes are to do what is necessary to meet this responsibility.

Government departments, such as Defense, Commerce, Interior, Labor, and Health, Education and Welfare, therefore, have responsibilities for science and technology in their respective areas. These agencies have had to develop and support appropriate technology as an aid in accomplishing their missions; but by and large they are active in science only as necessary to provide the background for that technology. Thus the Department of Defense is concerned with military weapons and devices of warfare and supports science underlying the corresponding fields of technology. Most Government departments and agencies have had considerable experience in these matters and have specialized in knowledge of the relation of science and technology to their overall missions. It would be neither logical nor feasible, therefore, to establish a Department of Science and Technology with overall supervision of these activities. Such a department could at best be only an administrative department superposed on existing ones, with confusion and frustration resulting in the operation of each separate department.

Federal activities in science proper do, however, have a common element, namely, basic research. This is true because its findings may be useful in many and unexpected directions. It is logical and reasonable that a Federal agency, such as the National Science Foundation, which keeps itself informed of the basic research activities of the Federal agencies, should exercise an appropriate degree of coordination among them and be in the

position to take the lead with respect to common programs of the Federal Government in the various sciences.

Now, the present policy of the Federal Government with respect to technology among its own agencies is simply that each agency has responsibility for what it does in technology that is directly related to its mission.

It is also the policy of the Federal Government to permit and encourage each to conduct and support basic research in fields of science related to its mission and, of course, to conduct and support applied research aimed at solving its techonological problems. Both policies are set forth in Executive Order 10521 issued by the President in 1954.

In addition to the research conducted in its own laboratories, the Federal Government supports basic research in institutions throughout the country. In order to achieve its objectives, the Federal Government must utilize the highest available research competence in science in the country wherever this can be found. Consequently, Federal departments and agencies should and do have authority to support basic science in colleges and universities, at research institutes, and at research laboratories as appropriate. This is accomplished through a selection of applications for support of basic research that are received by the Federal research offices, and also, where appropriate, by enlistment of research scientists to work on pressing agency problems.

In addition to purely practical considerations, however, the Federal Government recognizes that progress in pure science is fundamental not only to the strength and welfare of the Nation, but to its intellectual growth as well. Congress demonstrated this conviction when it established the National Science Foundation in 1950 to support basic research comprehensively throughout the country so that science would go forward actively on all fronts.

Policy on the part of the National Science Foundation is simply to support high-quality research by competent scientists in all fields, taking into account support by other agencies. The Foundation has also in view the distribution of support among fields of science and among various types of institutions. It like-

wise considers such factors as geographical distribution and due consideration of promising young research investigators.

In practice, this policy on the part of the National Science Foundation and indeed all Federal agencies consists of the encouragement of proposals from any competent scientist or group of scientists in the country. With the advice of expert consultants, the agency then makes a selection from among these proposals on the basis of the scientific merit of the research, the competence and experience of the research personnel, the endorsement of their institution, and relative importance of the field of research in question. The proposals selected then receive support in the form of a grant or contract to the institution on behalf of the persons wishing to do the research. Generally speaking, the grant or contract provides funds for equipment, materials, and personal services required for the job.

Coordination is achieved through a system whereby all agencies keep one another informed regarding their interests, the proposals they have received, and action taken on the latter.

This procedure enables the Federal Government to follow the lead of the scientists in the country in determining what research should be supported. The result is a truly national policy for the encouragement of science. Most important of all, it is consisent with the best tradition in research as outlined earlier, and permits, to a maximum degree, the freedom and independent action in the choice and conduct of research that are so necessary to the progress of science.

It should be noted that Federal policy with respect to the support of science has, in general, drawn the line at providing unrestricted research funds for institutions or departments of such institutions. This policy has been deliberate, and subject to constant review and appraisal. It rests upon two major considerations: In the first place, it is endorsed by the great majority of the country's scientists as being in the best interest of progress in science. In the second place, to provide unrestricted funds for research to educational institutions or their science departments would be a strong precedent for direct Federal aid to higher education. Although the policy of support by scientific project has been criticized by some university administrators and

scientists, majority opinion still holds it to be satisfactory. The question should, however, remain open. It is important to make certain, before any change is made, that direct support by the Federal Government to educational institutions in some manner other than by projects would be a wiser move, since a new policy, once inaugurated, would be hard to reverse.

In general this outlines present overall policy in Federal support of research in the basic sciences. There are some exceptions, chief of which is the longstanding Federal program in support of agriculture, which provides matching support to institutions. A more recent exception is in limited aid to institutions for medical research and there are some other important special cases where, as a rule, applied research and development predominate rather than basic research.

As the importance and significance of scientific research increases, the fundamental question arises: In what direction and to what degree should the Federal Government extend its support for science? To what extent should it increase its direct research activity in its own laboratories? Should it set up one or more federally operated general research laboratories in science? A still more fundamental question is the extent to which the Federal Government should provide support for education and training in science. At present this is limited to national fellowships of various kinds, summer institutes for science teachers, and a few graduate school projects for year-long training of high school science teachers, plus some programs for training in special critical fields. Our traditional policy has been to avoid Federal aid to education (an important exception being the Morrell Act, which provides aid to the land-grant colleges), and to leave the support of education to the States, the local communities, and to private sources. Now that our future, and indeed that of all nations, clearly depends critically upon the strength of our science and technology, can we still maintain this "hands-off" principle on the part of the Federal Government?

Our schools and colleges are badly in need of modern science laboratories and laboratory, demonstration, and research equipment. Most important of all, we need more trained scientists

and engineers in many special fields, and especially very many more competent, fully trained teachers of science, notably in our secondary schools. Undoubtedly, by a determined campaign, we can accomplish these ends in our traditional way, but how soon? The process is usually a lengthy one, and there is no time to be lost. Therefore, the pressing question is how quickly can our people act to accomplish these things? It is the clear duty of the Federal Government to point out what needs to be done and to take prompt steps to encourage and actively to assist—to the extent necessary—all who now have these responsibilities. Hopefully, plans may be evolved whereby the Federal Government provides temporary emergency aid only. In any event, the overriding urgency of prompt, effective, and permanent measures is fully apparent.

In all these matters it is of utmost importance that any steps taken in support of science should have the understanding and the backing of the people of the country. Our citizens must be able to understand and appraise the urgency of the national situation and to take and to urge effective action. Under our system it is not possible for the Federal Government to take adequate steps to strengthen our science education and our research unless these measures have the wholehearted support of our citizens.

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