THE DIRECTOR'S STATEMENT

One of the responsibilities of the National Science Foundation is the continuing study and analysis of the Nation's scientific research and development potential, including research facilities, scientific manpower, and education for science. A comprehensive program of studies based upon information from industry, Government, and nonprofit institutions was initiated some seven years ago. It is now possible to discern trends that shed light upon the current situation as well as being useful for long-range planning purposes. Indeed, on the basis of these and similar studies by industry and other agencies of the Government, the time appears ripe for the Federal Government to plan more effectively with respect to its interest, responsibility and participation in the future of the country's science and technology. At the same time, advantage is being taken of the opportunity to study more carefully the impact of science and technology upon the national economy.

Certain conclusions are clear. For the future, the principal concern lies in the field of education. This has been the subject of considerable discussion and some controversy. As a result, noteworthy progress has been made, especially in self study and improvement by schools, colleges, and other groups involved in general education. Much of the incentive and the pressure has come from the need to improve the teaching of science, but action has also extended to the teaching of modern languages and, in general, to the fundamental subjects of instruction.

There have been a perceptible tightening of standards and critical thought devoted to curricula and to the improvement of teacher training and course content. These efforts have been supported by the Federal Government and by interested organizations and local groups. The teaching profession, especially in secondary schools, has been the subject of sympathetic attention, and its prestige has undoubtedly improved. By and large, however, little progress has been made in providing adequate salaries and career prospects for secondary school teachers. We have still a long way to go.

In the area of scientific research and its extension into development and production there is a growing realization of the importance of continuity and proper apportionment of support through all stages, starting with basic research and extending through applied research, development, and production. However, it is still true that in spite of repeated emphasis upon the importance of basic research, support for this effort has only barely held its own in relation to the larger and seemingly more pressing problems of development. It has proved far more difficult to secure adequate support for basic progress in science than for the applications of science, because

of the seeming vagueness of the enterprise, especially when high-priority, costly practical goals have to be met. Vannevar Bush's pithy statement, "Applied research drives out basic", is constantly being verified. If the full potentialities of our society are to be realized, however, we must by all means insure that the frontiers of science are pushed forward energetically.

Although other shortcomings can be discerned in this whole chain, one outstanding fact has begun to emerge, namely, that our institutions of higher learning are in critical need of assistance, especially in their graduate schools and other professional training centers. The huge and mounting influx of students into our colleges and universities has focused attention upon the need for facilities for housing, classrooms and instruction. As these needs are met, maintenance funds must be provided. The recent report of the President's Science Advisory Committee, SCIENTIFIC PROGRESS, THE UNIVERSITIES AND THE FEDERAL GOVERNMENT, points out that research and education go hand in hand in the graduate schools of our universities; they should not be separated. Much of the present Government support to colleges and universities is earmarked for research, and particular research at that. Ways must be found to improve the environment for graduate student training, to give closer attention to the postdoctoral class, and to provide adequate and up-to-date research laboratories and equipment.

The natural habitat of basic research is the university. Although industry, Government, and independent research institutes do and should conduct basic research related to their objectives, it is the university that provides the freest and most independent environment for the progress of science.

Industry and Government have come fully to appreciate this role of the universities. In a very real sense they are the producers; industry and Government are the consumers. The latter look to the universities to train an adequate number of scientists and engineers through basic research. Government and industry also look to the universities for accurate, up-to-date research data and information, and novel ideas that may be explored through applied research. And finally, it is primarily to basic research that we must look for the occasional large breakthroughs in scientific thought that may revolutionize an era; the environment of universities is especially conducive to such events.

The needs of the universities at the present time are extremely critical. The widened gap between faculty and industrial salaries, in particular, militates against the universities in the retention of their most competent research faculty members and entices their most promising young Ph. D.'s. The graduate laboratories and research facilities of most universities are out of date and quite inadequate as compared with those of industry and Government. In many instances new buildings are required and, in practically all cases, renovation and extension of existing buildings and equipment.

In other respects the situation is even more disturbing. For a number of years an average of fewer than 50 percent of the competent research workers in our colleges and universities have been receiving adequate support for the problems they wish to undertake. For the past several years the national output of scientists and engineers with graduate degrees has remained substantially constant. Since the curve of national research and development effort continues to rise, the conclusion is easy to draw. We are now failing to meet the increasing demand for qualified professional scientists and engineers we require to achieve the research and development goals of the country, much less to meet world competition in modern technology.

To fill these needs by special national programs for each separate problem is only a partial answer. What is obviously needed is a source of funds that will enable a university to exercise initiative, judgment, and competence in meeting its own needs. Such uncommitted funds are now practically impossible to obtain in adequate amounts without Federal contribution. It is worthy of note that the two Federal agencies for which this type of general support in science is appropriate—namely, the National Science Foundation and the Department of Health, Education, and Welfare through its National Institutes of Health, have initiated modest programs of institutional grants to be used for scientific purposes as the head of the institution sees fit. These programs merit close attention. There is an opportunity here for the Federal Government to be of real service, provided adequate support can be furnished without violating the independence of the institution and without causing a withdrawal of other support from State, municipal, or private sources.

It is sometimes said that our major problems would be solved if only the Federal Government would go the whole way and subsidize or underwrite fully the research and training needs of our colleges and universities, thus obviating the need for project grants, equipment and training grants, and other special-purpose funding. It is true that this type of support would simplify university problems and provide the fullest opportunity for a university to grow and develop. It is also true that this type of support has been avoided hitherto, in the hope that universities may not have to become too dependent upon the Federal Government for support of research and research training.

However, now that the Federal Government is initiating a modest program of this type, it is important to call attention to the fact that the provision of uncommitted funds to universities, although admittedly important and hitherto neglected, does not directly accomplish quite the same thing as support by research project. What it does, under wise management and high competence, is to maximize the growth and independence of the institution and its contribution to research and education. On the other hand, the present form of research support in general use by the Federal Government offers the best opportunity to advance the progress of science, as

determined and recommended in each field by the country's leading scientists and engineers. It is also the system best adapted for the accomplishment of specific research of which Government agencies or the Nation may stand in need. These are not, of course, mutually exclusive; the most effective policy would incorporate adequate support of both kinds, with a proper balance between the two.

Support of basic research should be regarded as a form of investment, from which the returns in trained manpower are assured and research returns of definite value to the economy are statistically certain. Indeed, these dividends more than pay for the entire investment.

In addition to the physical needs of our colleges and universities, another problem is now before us—the need for special attention to what may be called "critical areas of science." These may be fields which at a given time show promise of highly significant contributions to the progress of science or to the furtherance of some important application, or both. Current examples are atmospheric physics, oceanography, and high-energy physics. Methods of identifying and dealing with such critical areas as they arise must be improved. The Foundation believes, however, that special attention to critical areas should be superposed upon general support of basic research across the board.

Another and newer kind of critical area is distinguished primarily by the high cost of the research equipment. Typical are high-energy particle accelerators in physics and the rockets and satellites required in space research programs. This problem is especially acute because of the difficult choice that confronts us: the lack of specific evidence as to the nature and importance of the research findings weighed against the prospect of no progress whatever unless the attempt is made. Clearly critical areas requiring very large and costly installations or equipment must be subject to special scrutiny which includes more than scientific justification alone.

So far as the overall progress of science is concerned, it is most important that basic research should proceed according to the judgment of the active research scientists. Each competent researcher is the best judge of the nature and aim of his own research. The whole purpose of the basic research investigator is to make an original contribution to his field of science. He must, therefore, keep fully informed regarding its status and the work of others. Because of this strong motivation, basic research has a "built-in" coordination. This can best be fostered by measures designed to improve communication among scientists. The national effort in basic science would only be weakened by central planning and direction in substantive content.

In development, the situation is quite different. Here the amounts of money are generally large, the precise objectives to be met are known, and the undertaking requires a considerable outlay of effort in manpower and facilities, as well as funds. Planning is essential, notably with respect to the current validity of the objective, the degree to which the proposed

development would meet this objective, and above all, the feasibility of the particular development contemplated. An organization engaged in development has the clear responsibility to pay careful and thorough attention to the planning and management of its development programs. It should provide for sufficient basic and applied research to enable it to plan and carry out its developmental programs most effectively. It should also employ such modern techniques as systems analysis and operations research to improve its planning and decision-making.

A final thought: As applied to the internal affairs of an industrial nation, science and technology have reasonably clear aims. These include national defense, improved health and welfare, full employment, and a high standard of living. In addition to these obvious and relatively well understood aims, however, there is a much deeper significance, especially in the pursuit of science itself. If the noblest ideals and goals of man have meaning, then religion, philosophy, poetry, literature, the arts, and scholarly activities are important considerations. Over the long haul these have played a fundamental role in the progress of man, perhaps the most fundamental of all. Science has provided mankind new vistas and new understanding both of his environment and of himself. Science has discovered and done much to perfect the so-called "scientific method," a technique that has helped to build a solid and enduring structure of knowledge. We should do well to recognize this aspect of science, for history suggests that the nation that ignores the contributions of scholarly, artistic, and philosophical pursuits to human progress is not capable of lasting leadership.

As the nations of the world work toward a better understanding of their relations, science, as defined by these broader considerations, offers great opportunity for collaboration in the attainment of common goals. Indeed, it may offer the most effective approach to the achievement of peace and justice which we can take at the present time. And we should remind ourselves that as man acquires more and more control over his environment and becomes increasingly able to draw upon nature's resources, it will require the combined wisdom of all mankind to make wise use of these powers.

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