DIRECTOR'S STATEMENT

The attention and interest that continue to focus on science and technology give rise to the hope that substantial gains are being made in those areas that have become the subject of national concern.

A review of the current status of research and development and of education in the sciences provides little reason for relaxation of effort, however, and certainly none at all for complacency. Progress is being made, yes, but not of an order commensurate with the problems. Despite the vast amount of newspaper space that has been devoted to research and development, and despite the oft-repeated recitals of deficiencies in our educational system, one is obliged to wonder just how fully the American public is aware of the deeper implications in both these areas.

The strength of our economy, the adequacy of our defenses, the health and future of ourselves and our children depend to an increasing extent on the effectiveness of our research and development effort and on the number and quality of scientists and engineers which our educational system is providing. Two factors of overriding importance—the rapidly growing population of the United States and competitive conditions in the modern world—make it imperative that we be strong in science and technology.

So far as the international political situation is concerned, the most drastic changes are unlikely to affect this need. If the cold war continues indefinitely, requirements for scientific and technical personnel to devise and operate modern weapons systems will continue to be high. If the cold war should subside to the point of partial or complete disarmament, we should still find ourselves in active competition with other nations on economic and ideological grounds.

By 1985 the population of the United States will reach an estimated quarter-billion. This rapidly expanding population will require corresponding acceleration in the growth of our economy to meet the needs and demands of millions of additional citizens.

The United States, as well as other nations that enjoy highly developed science and technology, has a responsibility to help the developing nations to apply today's knowledge to the problems of underproduction, hunger, and disease.

From a still broader point of view, science has an important role to play in furthering international understanding and cooperation.

The International Geophysical Year demonstrated in a magnificent way that men of all nations can work together harmoniously to extend our knowledge of nature. That such efforts can also carry over into the political area was demonstrated in the Antarctic Treaty when, as an aftermath of the IGY, 12 nations agreed to reserve a major portion of the earth's surface as a great scientific laboratory. The establishment of the International Atomic Energy Agency under the United Nations and the two successful International Conferences on the Peaceful Uses of Atomic Energy bear witness to mankind's basic desire to use the new forces that science has discovered for the common good. Already steps have been taken, both by the United Nations and the international scientific community, looking to collaboration in outer space.

It is apparent that science, in addition to its progress as an academic subject, is increasingly an instrument of both national and international policy.

Against this background, then, let us examine recent accomplishments and problems in both education and research.

In education, the Federal Government has established forward-looking programs dealing primarily with teaching and education in mathematics, science, and engineering. It has done so by enlarging the programs of the National Science Foundation in scope and depth, and through the National Defense Education Act, administered by the Office of Education. It is noteworthy that this Act is not limited to science alone, but extends into such important matters as improved counseling and guidance of young students, scholarship loans for students at colleges and universities, special fellowships to graduate schools with emphasis upon the study of languages and of teaching, and provision for teaching equipment and facilities.

If, however, these initial accomplishments have led us to believe that now that we have taken some active steps all will be well, we are lapsing into a very dangerous attitude. Let us look at the facts. There is still an alarming dearth of trained teachers, especially for secondary schools, and no prospect that the requisite number will be forthcoming. Although active attention is being given to the importance of improving competence in teaching, there has been, on the whole, little accomplished toward the prime requisite of providing salaries that will enable the teaching profession to compete successfully with other careers. True, some excellent results have been accomplished here and there by a few forward-looking local communities and organizations. But as a nation we have not come to grips with the major problem. The cultivation and staffing of a professional group can be adequately realized only if the career is a rewarding one from the standpoint of salary, future, and

prestige, as well as the deeper satisfactions that go with the opportunity to serve. On these points one must acknowledge that progress is meager indeed.

On the manpower side, the equivalent of about one-fourth of our scientists and engineers are engaged in research and development. This pool of talent is critical in two ways: Its size puts a certain limit to the research and development effort we attempt, and its competence determines the effectiveness of our undertakings. Significant increase in the size of this pool and improvement in its quality are a long-range operation. We must remember, too, that there is a definite limit on the extent to which we can forecast the special skills and the fields that will be important for the future. Who could have predicted even 10 years ago the current interest in and need for scientists and engineers for space exploration? At the rapid pace at which modern technology evolves, our problem is how to provide available manpower reserves competent to deal with any and all important technological developments and who have the knowledge and versatility to follow future changes and new undertakings.

These considerations clearly indicate what our manpower policy must be: We must endeavor to identify talented students and to provide those with aptitude for science and engineering the opportunity for training in these professions. Furthermore, this training should concentrate upon basic aspects of science and engineering, because only in this way can the individual hope to cope effectively with new developments. Both teaching and research must be taken into account—quite possibly the former may be the more important.

In terms of our educational system as a whole, an immediate problem—and a very troublesome one—is how we can place proper emphasis on the sciences and engineering and at the same time do justice to other disciplines. Engineers and scientists are a minority group; their expressions of concern and foreboding are sometimes interpreted as special pleading. However, we must bear in mind that they are in position to appraise our technological effort and to estimate our potentialities. Let us remind ourselves of the following: (*a*) elementary instruction in the sciences has suffered in comparison with other subjects; (*b*) science and technology depend critically upon the number and competence of the scientists and engineers we train; (*c*) if we are to improve our general education system, it is more feasible and expeditious to begin in a critical special area than to attempt to do the whole job at once.

With respect to scientific research—and especially development—considerable progress has been made; these are areas where we have been aware of specific needs. During the past year there have

been notable achievements in space exploration, in ballistic missiles and rocketry, and in radio astronomy—to cite but a few examples—and provision is being planned for needed facilities in such important areas as environmental biology and oceanography. The immediate practical limiting factor in our research and development activities turns out to be largely an economic one: How much can we afford to spend in terms of money as well as of manpower? How can we maximize our research and development effort? Since our security and economic strength are directly dependent upon its progress and vigor, these questions are crucial.

Certainly one answer is that we cannot afford to economize by reducing the level of support for research, particularly for basic research. The United States is currently spending more than $10 billion annually for research and development: less than 8 percent of this goes for basic research. Yet our progress in *basic* research largely determines the possibilities for development.

The potentialities of science for useful application cannot be predetermined; they depend upon the efforts of individual investigators or coherent groups. In general their findings cannot be predicted. By curtailing basic research activities all we succeed in doing is to blindfold ourselves for the future. Furthermore, the more thorough the basic research the more effective is the engineering development of required items. A democracy has a unique advantage in the strength and variety of its basic research. But to realize this advantage it must provide full support. Moreover, we do not yet appreciate the fact that by allotting to a given project only 90 percent of the funds required we may limit the effort to only 50-percent effectiveness.

There are those who seem to feel that both money and manpower problems could be solved very simply by curtailing the support of science generally and of basic research in particular. If scientists were slowed down or prevented from coming up with so many intriguing ideas for new developments, then there would be manpower and money enough to go around. All that would be necessary would be to determine in advance what items were desirable and then to proceed with their development on the basis of exactly predetermined budgets. Nothing could be more fallacious. In the first place, the output of basic research provides the up-to-date information and data essential to modern development. This stockpile must not be reduced or the quality of our developments will suffer. Secondly, such a philosophy encourages premature development, that is, development without adequate basic research background and justification—a highly wasteful and extravagant practice. Finally, curtailing basic research means shutting the door on

possible major discoveries or breakthroughs on which one might have capitalized in really important ways.

Progress in basic research depends directly upon the number and effectiveness of scientists and engineers. Because research experience is an essential part of advanced training, their competence, in turn, is directly related to the quantity and quality of basic research conducted in the graduate schools of our universities. In other words, this is a continuous "feedback" process in which input and output are mutually dependent and equally important. It is absolutely necessary, therefore, that our universities have adequate funds for basic research.

In recent years, for example, the need has arisen for such capital facilities as nuclear accelerators and reactors, optical and radio telescopes, electronic computers, and oceanographic research equipment. The Federal Government must play a leading role in furnishing these, provided the need is urgent and clearly in the national interest, and provided, also, the necessary funds cannot be raised from other sources. Recipient institutions must expect to participate in the funding to the extent possible.

The inadequacy of college and university laboratories has prompted the initiation of Federal programs, on a matching funds basis—for the re-equipping, remodeling, and expansion of existing laboratory facilities.

And—most importantly, perhaps—the need is recognized for providing our academic institutions with flexible funds through some form of institutional grant to supplement current support of research projects. The purpose of such grants is to provide support for general scientific research and research training functions of the institution without reference to the specific activities to be undertaken with the grant funds.

Clearly, however, the national budget cannot support without limit all the research and development that may seem desirable. Since more than 90 percent of the overall effort goes into applied research and development, appreciable savings can be realized only through greater economy and efficiency in developmental work. This means careful examination and selection of the applications of science to be undertaken.

This priorities problem is by no means new, either to industry or government. The technical industries, especially, have developed considerable competence in dealing with it by such modern methods as systems analysis and operations research. Both techniques warrant further study and more intensive application.

In the selection process a new and serious consideration arises from the magnitude of the effort required, in money and in manpower, in special fields of technology, and indeed in certain areas of pure science, which limits the national effort to a relatively few installations. One need

only mention such developments as ballistic missiles, space craft, computing centers, and commercial power reactors; and in science, high-energy particle accelerators, powerful radio astronomy installations, and supersonic research facilities. The establishment of priorities among these pressing and costly needs is a fundamental question for the Government. It is typical of the type of problems under study and review by the Federal Council on Science and Technology, which was established last year.

If it is determined that a majority of such enterprises must be pursued, then the whole problem of selection extends beyond the areas of technology and becomes a matter of concern to the Nation as a whole. The Director of the Central Intelligence Agency reminds us that:

> The major thrust of Soviet economic development and its high technological skills and resources are directed toward specialized industrial, military, and national power goals. A major thrust of our economy is directed into the production of the consumer type goods and services which add little to the sinews of our national strength. Hence, neither the size of our respective gross national products nor of our respective industrial productions is a true yard stick of our relative national power positions.
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> The uses to which economic resources are directed largely determine the measure of national power.

Thus, we are called upon to consider priorities in our national life in a way that has probably never before been so necessary except during war. It is incumbent upon the Federal Government and leaders throughout the country to make clear to the people that we shall have to pay careful attention to our national goals and then make optimum use of existing resources—manpower and material—in achieving them. Other Western nations early realized that they could not afford to support research in each of the big new fields opening up, and so they have made a choice, or pooled their resources of talent and manpower in a variety of international scientific organizations.

Actually, as a people, we are past masters of the art of winning public acceptance. Our high standards of living are the result of our ability to develop and produce consumer goods. American industry has abundant experience and competence in (*a*) ascertaining consumer demand; (*b*) meeting the demand; (*c*) creating the demand where it does not exist. As one looks around, one finds that some of the best talent in the country is occupied in developing and meeting artificially created consumer demands. Obviously, the methods of influencing the American public in its choice of priorities for spending are familiar ones. But who, then, can or should engage in a similar effort to bring the public into a realization of national needs? And how is this to be done? If

the importance of better education and training and the intelligent selection of national priorities were to become matters of serious concern to each citizen, there is no doubt that successful action would follow.

The steps that need to be taken are of such magnitude and involve so many different groups that we must have recourse to democracy's main strength—the will of the people, based on understanding. Such an undertaking requires the active assistance of many public-spirited groups and organizations, each doing its bit to bring out the facts, the significance of the issues involved, and the type of action required.

Backed by an informed body of public opinion and reinforced by a full measure of State and local effort, the Federal Government would then have a clear mandate to develop a national program. On the basis of what we have done in the past, such a goal does not seem impossible of attainment. One thing is certain, however; if we lag we shall have periodic reminders in the form of notable advances by other nations.

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