RESEARCH TECHNOLOGY and PUBLIC POLICY

The President of the United States addressed the Centennial Convocation of the National Academy of Sciences on October 22, 1963, in Washington, D. C. His remarks on that occasion are reproduced below.

By John F. Kennedy

IT is impressive to reflect that one hundred years ago, in the midst of a savage fraternal war, the United States Congress established a body devoted to the advancement of scientific research. The recognition then of the value of abstract science ran against the grain of our traditional preoccupation with technology and engineering.

You will remember de Tocqueville's famous chapter on why the Americans are more addicted to practical than to theoretical science; de Tocqueville concluded that, the more democratic a society, "the more will discoveries immediately applicable to productive industry confer gain, fame, and even power on their authors".

But if I were to name a single thing which points up the difference this century has made in the American attitude toward science, it would certainly be the wholehearted understanding today of the importance of pure science. We realize now that progress in technology depends on progress in theory; that the most abstract investigations can lead to the most concrete results, and that the vitality of a scientific community springs from its passion to answer science's most fundamental questions. I therefore greet this body with particular pleasure, for the range and depth of scientific achievement represented in this room constitutes the seedbed of our nation's future.

The last hundred years have seen a second great change—the change in the relationship between science and public policy. To this new relationship, your own academy has made a decisive contribution. For a century, the National Academy of Sciences has exemplified the partnership between scientists who accept the responsibilities that accompany freedom, and a government which encourages the increase of knowledge for the welfare of mankind. As a result in large part of the recommendations of this academy, the federal government enlarged its scientific activities through such agencies as the Geological Survey, the Weather Bureau, the Bureau of Standards, the Forest Service, and many others, but it took the First World War to bring science into central contact with governmental policy and it took the Second World War to make scientific counsel an indispensable function of government. The relationship between science and public policy is bound to be complex.

As the country had reason to note in recent weeks during the debate on the test-ban treaty, scientists do not always unite themselves on their recommendations to the makers of policy. This is only partly because of scientific disagreements. It is even more because the big issues so often go beyond the possibilities of exact scientific determination.

I know few significant questions of public policy which can safely be confided to computers. In the end, the hard decisions inescapably involve imponderables of intuition, prudence, and judgment.

In the last hundred years, science has thus emerged from a peripheral concern of government to an active partner. The instrumentalities devised in recent times have given this partnership continuity and force. The question in all our minds today is how science can best continue its service to the nation, to the people, to the world, in the years to come.

I would suggest that science is already moving to enlarge its influence in three general ways: in the interdisciplinary area, in the international area, and in the intercultural area. For science is the most powerful means we have for the unification of knowledge, and a main obligation of its future must be to deal with problems which cut across boundaries, whether boundaries between the sciences, boundaries between nations, or boundaries between man's scientific and his humane concerns.

As science, of necessity, becomes more involved with itself, so also, of necessity, it becomes more international. I am impressed to know of the 670 members of this academy, 163 were born in

other lands. The great scientific challenges transcend national frontiers and national prejudices. In a sense, this has always been true, for the language of science has always been universal and perhaps scientists have been the most international of all professions in their outlook, but the contemporary revolution in transport and communications has dramatically contributed to the internationalization of science, and one consequence has been the increase in organized international cooperation.

Every time you scientists make a major invention, we politicians have to invent a new institution to cope with it, and almost invariably these days and, happily, it must be an international institution. I am not just thinking of the fact that when you gentlemen figure out how to build a global satellite communications system we have to figure out a global organization to manage it. I am thinking as well that scientific advantage provided the rationale for the World Health Organization and the Food and Agricultural Organization; that splitting the atom led not only to a nuclear arms race, but to the establishment of the International Atomic Energy Agency; that the need for scientific exploration of Antarctica leads to an international treaty providing free access to the area without regard to territorial claims; that the scientific possibility of a World Weather Watch requires the attention of the World Meteorological Organization; that the exploration of oceans leads to the establishment of an Intergovernmental Oceanographic Commission.

Recent scientific advances have not only made international cooperation desirable, but they have made it essential. The ocean, the atmosphere, outer space, belong not to one nation or one ideology, but to all mankind, and as science carries out its tasks in the years ahead, it must enlist all its own disciplines, all nations prepared for the scientific quest, and all men capable of sympathizing with the scientific impulse.

Scientists alone can establish the objectives of their research, but society, in extending support to science, must take account of its own needs. As a layman, I can suggest only with diffidence what some of the major tasks might be on your scientific agenda, but I venture to mention certain areas which, from the viewpoint of the maker of policy, might deserve your special concern.

First, I would suggest the question of the conservation and development of our natural resources. In a recent speech to the General Assembly of the United Nations, I proposed a world-wide program to protect land and water, forests and wildlife, to combat exhaustion and erosion, to stop the contamination of water and air by industrial as well as nuclear pollution, and to provide for the steady renewal and expansion of the natural bases of life.

Malthus argued a century and a half ago that man, by using up all of his available resources, would forever press on the limits of subsistence, thus condemning humanity to an indefinite future of misery and poverty. We can now begin to hope and, I believe, know that Malthus was expressing not a law of nature, but merely the limitation then of scientific and social wisdom. The truth or falsity of his prediction will depend now, with the tools we have, on our own actions, now and in the years to come.

The earth can be an abundant mother to all of the people that will be born in the coming years if we learn to use her with skill and wisdom, to heal her wounds, replenish her vitality, and utilize her potentialities. And the necessity is now urgent and world wide, for few nations embarked on the adventure of development have the resources to sustain an ever-growing population and a rising standard of living. The United Nations has designated this the Decade of Development. We all stand committed to make this agreeable hope a reality. This seems to me the greatest challenge to science in our times, to use the world's resources, to expand life and hope for the world's inhabitants. While these are essentially applied problems, they required guidance and support from basic science.

I solicit your help, and I particularly solicit your help in meeting a problem of universal concern—the supply of food to the multiplying mouths of a multiplying world. Abundance depends now on the application of sound biological analysis to the problems of agriculture. If all the knowledge that we now have were systematically applied to all the countries of the world, the world could greatly improve its performance in the low-yield areas, but this would not be enough, and the long-term answer to inadequate food production, which brings misery with it, must lie in new research and new experimentation, and the successful use of new knowledge will require close cooperation with other nations.

Already a beginning has been made. I think of the work in other countries, of the Rockefeller and Ford Foundations, and the creation by the OAS of the Inter-American Institute of Agricultural Sciences in Costa Rica. I look forward eventually to the establishment of a series of international agricultural research institutes on a

regional basis throughout the developing world. I can imagine nothing more unwise than to hoard our knowledge and not disseminate it and develop the means of disseminating it throughout the globe.

Second, I would call your attention to a related problem; that is, the understanding and use of the resources of the sea. I recently sent to Congress a plan for a national attack on the oceans of the world, calling for the expenditure of more than $2 billion over the next ten years. This plan is the culmination of three years' effort by the Inter-Agency Committee on Oceanography, and it results from recommendations made by the National Academy.

Our goal is to investigate the world ocean, its boundaries, its properties, its processes. To a surprising extent, the sea has remained a mystery. Ten thousand fleets still sweep over it in vain. We know less of the oceans at our feet, where we came from, than we do of the sky above our heads. It is time to change this, to use to the full our powerful new instruments of oceanic exploration, to drive back the frontiers of the unknown in the waters which encircle our globe.

I can imagine no field among all those which are so exciting today than this great effort which our country and others will carry on in the years to come. We need this knowledge for its own sake. We want to know what is under the sea, and we need it to consider its bearings on our security, and on the world's social and economic needs. It has been estimated, for example, that the yield of food from the seas could be increased five or ten times through better knowledge of marine biology, and some day we will seed and weed and harvest the ocean. Here, again, the job can best be done by the nations of the world working together in international institutions.

As all men breathe the same air, so a storm along Cape Cod may well begin off the shores of Japan. The world ocean is also indivisible, and events in one part of the great sea have astonishing effects in remote places.

International scientific cooperation is indispensable if human knowledge of the ocean is to keep pace with human needs.

Third, there is the atmosphere itself, the atmosphere in which we live and breathe and which makes life on this planet possible. Scientists have studied the atmosphere for many decades, but its problems continue to defy us. The reasons for our limited progress are obvious. Weather cannot be easily reproduced and observed in the laboratory. It must, therefore, be studied in all of its violence wherever it has its way. Here, as in oceanography, new scientific tools have become available. With modern computers, rockets, and satellites, the time is ripe to harness a variety of disciplines for a concerted attack. And even more than oceanography, the atmospheric sciences require worldwide observation and, hence, international cooperation.

Some of our most successful international efforts have involved the study of the atmosphere. We all know that the World Meteorological Organization has been effective in this field. It is now developing a world-wide weather system to which nations the world over can make their contributions. Such cooperative undertakings can challenge the world's best efforts for decades to come.

Fourth, I would mention a problem which I know has greatly concerned many of you. That is our responsibility to control the effects of our own scientific experiments, for, as science investigates the natural environment, it also modifies it, and that modification may have incalculable consequences for evil as well as for good.

In the past, the problem of conservation has been mainly the problem of human waste of natural resources, of their destruction, but science has the power for the first time in history now to undertake experiments with premeditation which can irreversibly alter our biological and physical environment on a global scale. The problem is difficult, because it is hard to know in advance whether the cumulative effects of a particular experiment will help or harm mankind. In the case of nuclear testing, the world is satisfied that radioactive contamination involves unnecessary risks, and we are all heartened that more than one hundred nations have joined to outlaw testing in environments where the effects most directly threaten mankind.

In other fields we may be less sure. We must, for example, balance the gains of weather modification against the hazards of protracted drought or storm.

The government has the clear responsibility to weigh the importance of large-scale experiments to the advance of knowledge or to national security against the possibility of adverse and destructive effects. The scientific community must assist the government in arriving at rational judgments and interpreting these issues to the public. To deal with this problem, we have worked out formal procedures within the government to assure expert review before potentially risky experiments are undertaken, and we will make every effort to

publish the data needed to permit open examination and discussion of proposed experiments by the scientific community before they are authorized.

If science is to press ahead in the four fields that I have mentioned, if it is to continue to grow in effectiveness and productivity, our society must provide scientific inquiry the necessary means of sustenance. We must, in short, support it. Military and space needs, for example, offer little justification for much work in what Joseph Henry called abstract science. Though such fundamental inquiry is essential to the future technological vitality of industry and government alike, it is usually more difficult to comprehend than applied activity, and, as a consequence, often seems harder to justify to the Congress, to the executive branch, and to the people.

But if basic research is to be properly regarded, it must be better understood. I ask you to reflect on this problem and on the means by which, in the years to come, our society can assure continuing backing to fundamental research in the life sciences, the physical sciences, the social sciences, our natural resources, on agriculture, on protection against pollution and erosion. Together, the scientific community, the government, industry, and education must work out the way to nourish American science in all its power and vitality. Even this year we have already seen in the first actions of the House of Representatives some failure of support for important areas of research which must depend on the national government. I am hopeful that the Senate of the United States will restore these funds. Of course, what it needs is a wider understanding by the country as a whole of the value of this work which has been so sustained by so many of you.

I would not close, however, on a gloomy note, for ours is a century of scientific conquest and scientific triumph. If scientific discovery has not been an unalloyed blessing, if it has conferred on mankind the power not only to create, but also to annihilate, it has at the same time provided humanity with a supreme challenge and a supreme testing. If the challenge and the testing are too much for humanity, then we are all doomed, but I believe that the future can be bright, and I believe it can be certain. Man is still the master of his own fate, and I believe that the power of science and the responsibility of science have offered mankind a new opportunity not only for intellectual growth, but for moral discipline, not only for the acquisition of knowledge but for the strengthening of our nerve and our will.

We are bound to grope for a time as we grapple with problems without precedent in human history, but wisdom is the child of experience. In the years since man unlocked the power stored within the atom, the world has made progress, halting but effective, towards bringing that power under human control. The challenge, in short, may be our salvation. As we begin to master the potentialities of modern science we move toward a new era in which science can fulfill its creative promise and help bring into existence the happiest society the world has ever known.

I express my appreciation to all of you for what you have done in your respective disciplines in the field of science, and the contribution which those disciplines have made to the welfare of our country, and in the great sense, to the welfare of all mankind.

I can imagine no period in the long history of the world where it would be more exciting and rewarding than in the field today of scientific exploration. I recognize with each door that we unlock we see perhaps ten doors that we never knew existed and, therefore, we have to keep working forward, but with all of the tools now at our command, with all the areas of knowledge which are waiting to be opened up, I think that never in the short history of this academy or in the far longer history of science has the time been brighter, the need been greater for the cooperation between those of us who work in government and those of you who may work in far-distant laboratories on subjects almost wholly unrelated to the problems we now face in 1963. I hope that that cooperation will remain intimate and that it will remain beneficial to both science and to the people as a whole.

Science has made all of our lives so much easier and happier in the last thirty years. I hope that the people of the United States will continue to sustain all of you in your work and make it possible for us to encourage other gifted young men and women to move into these high fields which require so much from them and which has so much to give to all of our people. So the need is very great. Even though some of your experiments may not bring fruition right away, I hope that they will be carried out immediately.

It reminds us of what the great French Marshal Lyautey once said to his gardener: "Plant a tree tomorrow." And the gardener said, "It won't bear fruit for a hundred years." "In that case," Lyautey said to the gardener, "plant it this afternoon." That is how I feel about your work.