SCIENCE
and the Federal Government

an article based on Dr. Smyth's address as retiring president of the American Physical Society, given at the annual meeting in New York, January 30, 1958

By H. D. Smyth

THE great achievement of Russian science in launching the first earth satellite has captured the imagination of men everywhere. In this country, the Russian success has had the effect of making us reappraise our national standing both in education and science. This reappraisal over the last three months has resulted in a flood of suggestions from private citizens and public groups for the remedy of our situation. Such an outpouring of American self-criticism is a healthy thing and seems to me the expression of a democracy which is fundamentally healthy.

Unfortunately too many of the suggestions now being made from public and private sources for the remedy of our evident limitation in education and science are merely stopgap suggestions. They are too often made without historical perspective and without any real understanding of the essential nature of education or the essential nature of science. Such suggestions are aimed at catching up with a momentary lead in Russian technology through the rapid expenditure of large amounts of money. But what ails our American society is not a lack of money but a confusion of ideals. Our society is healthy insofar as it is fluid and flexible, with ultimate power residing in the people. It is not healthy insofar as its values are shallow.

In our enthusiastic enjoyment of our material well-being we have been neglecting the deeper values of spiritual and intellectual vitality. The meaning of education and the life of the mind were better understood in the writing of such men as Thomas Jefferson one hundred and fifty years ago than they are today.

It was perhaps inevitable that these values were lost sight of in the century that followed Jefferson, when this continent had to be settled and industrialized by men of action rather than by men of thought. But today the only frontiers before us are those of the mind. I believe the American people are becoming aware of this and indeed are ahead of their political leaders in this awareness. That is why we should review the history of science in relation to government so as to understand better the nature of the problem before us and to learn from our American experience in this collaboration over the last century. Many of the questions we now discuss were debated by the founders of our government and have arisen repeatedly throughout our history. Issues that were confused one hundred and fifty years ago are still confused. One such issue arises from the dual nature of science itself.

Science like most other branches of knowledge fills two roles. Its principal object is an understanding of the natural world. By patience, by objective observation, by experiment and rational analysis, above all, by the cooperation of like-minded men, science has revealed to us the complexity and vastness of the universe, the basic orderliness manifested in an infinite variety and beauty, the awesome immutability of nature's laws extending through unimaginable ranges of time and space. This explosive extension of man's experience has enriched his mind and strengthened his spirit. Surely this is the noblest result of the three hundred years of modern science.

Inevitably, understanding of our environment has made it possible to improve our control of it. The origin of such control is prehistoric and has been extended continuously since prehistoric time, chiefly without the aid of science as we now know it. From the discovery of fire through the discovery of the steam engine and beyond, the development of technology, as we now call it, was largely empirical, independent of science. But during the last hundred years, and particularly during the last fifty years, the interplay between science and technology has increased so greatly that now both the methods and immediate objectives are indistinguishable, however distinct the basic motivation remains.

Although the interdependence of science and technology is now nearly universal it has been present for a long time in certain areas such as navigation and surveying. Sufficiently so that the confusion between science and technology now frequently encountered in our society is an issue that has a long if not particularly honorable history, going back to the founding of the republic.

Such confusion is perhaps more readily understood if we recognize that science per se, as well as technology, has profound effects on society. Even today our excitement over satellites and interspace travel arises not just from fear of military implications, but from admiration for a great achievement. This is one more example of the fantastic capacity men have for interesting themselves in ideas or ideals, often dedicating their lives to such abstractions.

It is strange how often political leaders ignore this peculiarity of man, and assume their constituents are interested only in their stomachs and their pocketbooks. Particularly is it strange in this country based ulti-

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mately on the ideals of Christianity and more immediately on the eighteenth-century philosophy of Locke and other interpreters of Newtonian physics.

THE end of the eighteenth century was a period of intellectual and political ferment. The great scientific discoveries of the seventeenth century had had time to spread through the intellectual community, to be interpreted by the philosophers, and to affect wide areas of thought. The accumulation of knowledge had not become too great to be mastered by amateurs. Benjamin Franklin was both a leading statesman and a scientist of distinction. Jefferson's political views were colored by his knowledge of science and his enthusiasm for it. These men did not separate science from other branches of knowledge. Nor did they distinguish between "pure" and applied science. All knowledge was their province and they were eager to disseminate knowledge both for the enlightenment of men's minds and for the improvement of their material conditions of life.

In this atmosphere it was natural that the framers of our constitution should be eager to invigorate the intellectual life of the new country which they were founding. In the constitutional convention there was a strong movement to authorize a national university to promote the arts and sciences.

Interest in the federal government as a sponsor of learning did not die with the Constitution. In the early years of the republic various efforts continued which were aimed at the establishment of a national university, a national observatory, and what not. These early efforts culminated in John Quincy Adams' vigorous support of such a proposal, support which was politically unpopular and contributed to his downfall. No serious attempt has since been made to establish a national university. The scientific activities which now distinguish the federal government have grown up in a variety of ways, sometimes almost surreptitiously, like the Naval Observatory, sometimes as the result of obvious need, like the Coast and Geodetic Survey, often as the result of the ability of one or two individuals who both recognized a need and were able to devise a way of meeting it.

In spite of the absence of a general center of research and education in Washington, circumstances gradually forced the government into scientific activities. Even the expedition of Lewis and Clark had both scientific and political objectives as Jefferson made clear (though to be sure he varied his emphasis depending on his audience). The specimens that they brought back needed a home and the information they acquired needed to be disseminated. Later exploring expeditions for the most part in our own west, but sometimes far across the seas, raised the same questions. The early answers to these questions were fragmentary and unsatisfactory.

A later expedition, that of Major Long in 1819 to the headwaters of the Arkansas, turned over its botanical collection to Dr. John Torrey in New York who then used his own library and collections to aid him in describing the new material. This procedure was not unlike the present cooperation between the government and private institutions to promote scientific research.

Other situations now familiar to us were foreshadowed in this early period. For instance, Jefferson, speaking of the importance of federal support of science and the arts, says "a public institution can alone supply those sciences which though rarely called for are yet necessary to complete the circle, all the parts of which contribute to the improvement of the country and some of them to its preservation." Does this not sound like the arguments we have all made for federal support of research in general and the construction of big accelerators in particular?

And at a lower and more mundane level, listen to Mr. Hassler's plea for freedom from detailed financial control. He said "the subjection of my expenditures to the control of a final account would subject my whole existence . . . to the control of the accounting officers . . . who by their absence from the work itself cannot have any idea of its incidences." This was in President Madison's time and Hassler was a Swiss of experience and ability who was supposed to set up a coast survey. More successful than many of us, Hassler persuaded President Madison to accede to most of his demands. You will not be surprised to hear that his success was shortlived. He made the mistake of being too thorough, too scientific and therefore too slow in producing tangible results. Also, he failed to keep in touch with Congress. So after a few years an

economy measure was passed in 1818 providing that only military or naval officers could be employed by the survey. After all, they were already on the payroll.

After languishing futilely for fourteen years until 1832, the survey was restored by a revision of the law and Hassler brought back as its head. His troubles were by no means over, yet he was at last able to establish the survey on sound principles and stayed with it until his death in 1843. During all this period and for many years thereafter the Coast Survey was considered an ad hoc affair. Its job was to map our coasts and then go out of existence. This "temporary" character interfered somewhat with the quality of its work but not with its life. It survives still as the Coast and Geodetic Survey in the Department of Commerce with its duties redefined by the Act of August 6, 1947. I cite it as a typical government scientific bureau with limited objectives, and a tradition of carrying out its duties faithfully and adequately.

But obviously neither the Coast Survey nor the various exploring expeditions sent out by the federal government approached in generality of purpose the kinds of scientific institutions envisioned by such men as Jefferson and John Quincy Adams. Such an institution resulted not from the wisdom of either the Congress or the executives, but from the curious last will and testament of James Smithson, bastard son of the first Duke of Northumberland.

About the time that John Quincy Adams was endeavoring to persuade the Congress to establish something in the nature of a national university, James Smithson, a man of some accomplishments in the field of chemistry and other sciences, a member of the Royal Society, and a resident of Paris, drew up a will in which he made the provision "in the case of the death of my third nephew . . . I then bequeath the whole of my property to the United States of America to found at Washington under the name of the Smithsonian Institution an establishment for the increase and diffusion of knowledge among men." Smithson died in 1829, by 1836 his other heirs had died, and the question came before Congress as to whether his bequest should be accepted. After considerable debate the bequest was accepted by a vote of 31 to 7. The legacy was delivered in New York in the form of 105 960 golden sovereigns. But ten years elapsed before Congress could agree on how the money should be used. In 1846 Congress finally set up an establishment consisting of the President, the Vice President, the Cabinet, Chief Justice, and the mayor of Washington to receive the money. The same bill also set up a Board of Regents which is in fact the governing body. It consists of the Chief Justice, the Vice President, 3 members of the Senate, 3 members of the House of Representatives, and 4 private citizens.

Although this organization is cumbersome and artificial it does have the advantage of removing the Smithsonian Institution from the direct control of either the Congress or the executive department, and thereby at least reduces the political pressures on it. But more important than the nature of the organization was the choice of the first secretary of the institution, in effect, the Director.

Joseph Henry (1797–1878). After a brilliant career as a research physicist and professor of natural philosophy at Albany Academy and at the College of New Jersey (now Princeton University), he was appointed to head the new Smithsonian Institution in 1846.

Joseph Henry, America's leading physicist, had been a professor at Princeton since 1832. While there, he had continued the great work on the basic principles of electricity and magnetism begun while he was at the Albany Academy. At this time Henry was in his late 40's and at the peak of his scientific career. It was with the greatest reluctance that he accepted the appointment as secretary of the Smithsonian since he recognized the probability that his researches in physics would be brought to an end. It is apparent that he made the change from sense of duty which was very strong in him. Fortunately, in the history of our country there have been many instances like this, where men sacrificed their personal inclinations and professional ambitions to serve the country. Joseph Henry was neither the first nor the last. As in similar cases it is impossible to judge whether his contributions might have been greater had he continued to work as a scientist. But there is no doubt that during his 30 years in Washington, as secretary of the Smithsonian, as a founder and finally president of the National Academy, and as occupied in other activities, he rendered service to the people of this country such as few men are privileged to give.

Without pursuing further Joseph Henry's career, or the history of the Smithsonian, we can emphasize the importance of setting up an institution under govern-

ment auspices but semiautonomous, which recognizes the general importance of knowledge and of the research and publication activities which keep such knowledge viable.

RETURNING to the development of the various scientific activities more directly related to the government, we can only mention some of the services that grew up between 1840 and the First World War. During the period of expansion and settlement in the west before and after the Civil War, a series of exploring expeditions were followed by more detailed surveys. There were, for example, a series of very thorough surveys made in connection with proposals for transcontinental railroads. These activities were undertaken by various branches of the government, or by individuals with government support. It was apparent that not only topographical surveys but surveys of natural resources, water supplies, etc., were desirable. Finally, as the result of Major Powell's activities the United States Geological Survey was set up in 1879 by a rider attached to an appropriation bill.

The federal scientific establishment as we know it now was essentially completed in the early years of the present century with the exception of the National Science Foundation and the Atomic Energy Commission. For example, the Weather Bureau was founded in 1890, the National Bureau of Standards in 1901, the Bureau of Mines in 1910, the National Advisory Committee for Aeronautics in 1915. Of course research in agriculture had been under way for many years, particularly stimulated by the establishment of the land grant colleges after the Civil War; and a certain amount of work in medicine under the aegis of the Army or Navy had started at an early date and flourished particularly in the last half of the 19th century. The Public Health Service was founded around the turn of the century.

In reviewing the relations between science and the federal government during the 19th century I have made no mention of military technology. Members of the armed services had played important roles in various exploring expeditions from the time of Lewis and Clark onward. Sometimes these expeditions were purely military, sometimes they depended only secondarily on the Army or Navy for support, but the most common pattern was a combination of military command, supplies and equipment with civilian scientists attached to the group as experts. Many individual officers of the army and navy showed considerable talent in matters scientific and made contributions to the growth of science when opportunity offered. Besides individual interest, much was contributed by certain branches of the services like the Army Topographical Engineers, the Army Medical Corps, and the various Navy bureaus concerned with navigation. Where friction developed as it frequently did, it usually arose from personal peculiarities or ambitions. What we now call the organization man does not seem to have been common in the nineteenth century, even in the armed services.

In basic military technology, weapons, ships, and the like, advances during the 19th century and even up to World War I depended more on invention than on science. It was only during World War I that the closing of the gap between science and technology began to bring science into direct relation with weapons.

I need not review the familiar story of science in World War II. The atomic bomb, radar, the proximity fuse, and many other developments established science, or at least applied science, as essential to military technology. Since the end of the war the Department of Defense and the Atomic Energy Commission have spent large amounts of money to keep our military technology up to date. The importance of basic research has even been recognized though not always very clearly.

AT present we are engaged in a reappraisal of our efforts. Are they good enough? If not, why not and what should we do? I believe that members of this society have a special responsibility in considering our problems. For that reason I have tried, however sketchily, to give you some historical perspective. I now would like to review our present needs.

We need to improve our weapons, to keep our industrial technology up to date, and to support the basic science that now lies so close behind most technology. As Joseph Henry said in 1870, "The great object is to facilitate in every way the promotion of science, and especially the fostering of original research, and enlarging the bounds of human thought. It is a matter of surprise that the idea is not more generally understood by statesmen and legislators that modern civilization stands upon science including the knowledge of the forces of nature, and the modes in which they become the agents of man."

Such measures are necessary for our survival, they are bulwarks of defense against outside attack. I wish I could believe that we needed nothing more. But should we not also be concerned about whether we deserve to survive? We are proud of our traditions. What are we doing to enrich them? We accept the ideals of the founders of our country. What are we doing to attain them? Of what use is freedom of thought if we do not think?

Surely the degraded state of our educational system is a reflection of indifference of our people to the things of the mind. Apparently we no longer believe that the attainment of knowledge makes individuals and societies happier and stronger, that the exercise of minds is as rewarding as the exercise of muscles. Science itself is built on such faith. In a society that denies this belief science will not continue to flourish. If we wish, we may train scientists for defense just as we used to breed horses for the cavalry. The long-range efficacy of such a measure is questionable. For the long run we must strengthen our whole intellectual and educational fabric.

It is easy to make these general statements about our situation and our objectives. It is much harder to make specific suggestions. I feel I must attempt to

do so. My suggestions are limited by my own experience. In making them I have tried to review in my own mind what changes would have improved the various scientific projects sponsored by the federal government, with which I have been familiar during the past eighteen years.

I find the difficulties which have impeded progress in the work I know fall into four general categories: confusion as to goals, inadequate funds, red tape, and secrecy with its attendant atmosphere of fear and suspicion. The first two difficulties were almost entirely absent during the war in the Manhattan District Project. Furthermore, the red tape was minimal, and secrecy was so obviously necessary as to be acceptable though unpleasant. So by experience I know that the present situation can be improved.

Often confusion as to specific goals is related to confusion as to national objectives. In developing weapons or weapons systems it is important to know what kind of war is anticipated. In planning a nuclear power program we need to know what weight to give to the "atoms for peace" program. Even in basic scientific research which by definition has only the general goal of increased knowledge it is still desirable to know what level of support can be expected over a period of years.

In the matter of funds total appropriations for research and development over the past ten years have been generous. Of course more could have been used and recently there have been signs of serious limitations. But it is my impression that the hand-to-mouth methods of financing, the continual uncertainty as to the future, even uncertainty as to the next few weeks, has been more serious than the over-all amounts of money eventually available. Assured long-range financial support would greatly strengthen our research and development program.

Part of this financial difficulty is legal, part purely organizational. It is not clear why a government contract takes so long to negotiate and has to be approved by so many superposed layers of government officials. The elaborate structure of bureaucracy supposedly intended to insure honesty and efficiency causes incredible delays and inefficiency. We cannot afford to squander the time of scientists and others as we now do. We need more delegation of authority, more trust in the integrity of men both inside and outside the government.

I have cited secrecy as the fourth hindrance to rapid progress. To some extent I believe it fosters the kind of red tape I have mentioned. If operations cannot be carried out openly it is natural to emphasize internal controls. In an atmosphere where a man may be pilloried as disloyal when he makes a mistake in judgment, he will hesitate to take responsibility. The worst consequences of secrecy are intangible. It creates an atmosphere of suspicion and fear. It is inimical to the need of a democracy to be informed. It is hostile to the spirit of science. Secrecy is like a drug habit. Breaking away from it induces nervousness and hallucinations. Sticking to it maintains a false glow of security. It should be limited to data of military importance, not extended to research that might conceivably, ten or twenty years from now, have some slight military utility.

TO summarize my recommendations for improvement of the scientific work supported by the federal government, I urge a clearer definition of goals, greater delegation of authority, more sustained financial support, and less secrecy.

In addition to these suggestions, which certainly are not new, we must go beyond the present activities of the federal government to strengthen science throughout the country. As an interim measure, scientific scholarships, federal aid to schools, and similar measures are desirable. In the long run it would be far healthier to have support at the state and local level. What we need is a strong secondary-school system with well-educated, well-paid teachers in all subjects. What we need is a rigorous curriculum. What we need are strong universities with well-paid faculties competent for teaching and research. Such needs should not be met solely by federal appropriations.

In our relations with foreign countries we must make it possible for men to talk together of their common interest regardless of their political affiliations. We must conquer the fear that a visitor from a communist country will corrupt us. How absurd it is that we cannot have international scientific conferences in this country without limiting attendance to those considered politically pure, regardless of their scientific attainments. How can we hope for friendly relations with people with whom we refuse to talk?

Science is a part of the whole structure of knowledge and thought that we have inherited from western Europe. For the past hundred years we have been so busy settling a continent and building our industry that we have continued to depend heavily on western Europe for new ideas and knowledge even in the field of science. Partly by luck, partly by adherence to ideals of freedom and individual liberty, we have become a rich nation. We now find ourselves in a world transformed by the applications of science, a world where society faces opportunities undreamed of fifty years ago, opportunities for good and for disaster. We wish to rise to our responsibilities for leadership, our chance for greatness. To succeed we must have knowledge of the world of nature, the province of science, and knowledge of the world of man and his institutions which is outside the province of science. We must learn to think and we must have the knowledge and discipline that makes thought productive.

We need a conviction throughout the country that the increase and diffusion of knowledge among men is a purpose we should support with thought, effort, and even financial sacrifice. This is an ideal we once cherished. We still render it lip service. We must make it once more a vital and active part of our national creed.