A National Science Foundation and the Scientific Worker[1]

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WITH THE ATOMIC BOMB, science came of age in our civilization. It will now have, and must exercise, the right to vote. One would not have chosen as the setting for our coming-out party "the rockets' red glare" and "bombs bursting in air," but such drama—and tragedy—was perhaps essential to stir both scientists and public to a realization of the penetration of science and technology throughout modern society—in peace far more than in war, for creation far more than for destruction.

Scientists have been slow in this country to fill their legitimate place in human affairs. Many men were content to pursue their private quest for knowledge and eschewed any responsibility beyond their towered walls. The historical tradition has lingered on—from the time when science was a dilettante interest of some wealthy individuals able to humor their personal whims or to patronize others who served as court scientists, like court magicians or jesters or musicians.

Only as certain tangible and useful results of these esoteric experiments reappeared time and again did science find its way into the universities and into the lower schools; did society begin to support experiments on a significant scale; did the scientist and technologist receive requests for aid from industry and agriculture and the military. But, in the mind of the expert as well as of the community, he was still doing only his particular job of research or application. He was still, in the telling figure of Carl Minor, "in the kitchen." He was still, as Raymond Swing recently pointed out, conspicuously absent from the invited consultants to the delegations at the San Francisco Conference or from those meeting in London to set up an international education office. "Not a single prophet of the century ahead of us was even asked to advise the men of state." Parenthetically, Compton, Shapley, and other scientists have now gone to London; and on 7 November Archibald MacLeish announced that the United Nations Educational and Cultural Organization has become the United Nations Educational, Scientific, and Cultural Organization.

[1] Contributed to a panel discussion on "Research, Government, and You," sponsored by the American Association for the Advancement of Science and the Chicago branches of leading chemical organizations, 8 November 1945, Chicago, Illinois.

All this was slowly changing for, as the Moe report puts it, "Science cannot live by and unto itself alone." Science was reaching social maturity. Its war contribution, through the Office of Scientific Research and Development and allied organizations, was impressive. Dr. Bush was close to President Roosevelt, and plans for a government research foundation began to incubate. How they would have fared in Congress on their own merit we will never know. As Dr. Bush wrote, "The Government has only begun to utilize science in the nation's welfare. . . . Science has been in the wings. It should be brought to the center of the stage."

Well, the atomic bomb brought it there and spotlighted it, and Congress is at last tumbling over itself with proposals to nourish the roots of discovery, as in the Magnuson and Kilgore bills, and to stifle its flowering, as in the May-Johnson bill. Science is in politics now and is in to stay. There will be changes that scientific workers will like and some that they will not like. I am convinced that the good will far outweigh the bad, but, even if the reverse were true, the road science is taking and is to take has long been inevitable (e.g. *Science,* 1942, **95**, 309). Recent events have accelerated movement, not changed direction.

Let me remind you of some of the changes within science. True laissez-faire research is almost unknown even now. Scientific workers are professionals and require some employer to pay for their living and to supply their facilities. In industry it is taken for granted, except in rare cases, that the technologist works on assigned problems. In universities and a few other institutions freedom of research is the slogan. But is it the fact? Research costs ever more money, and few institutions indeed have an adequate and fluid fund to support it. Investigators seek additional aid—from industry, from foundations, from private donors—and deliberately or without awareness they tend to shape their research to tap the available sources. When the Rockefeller Foundation becomes interested in research in psychiatry, so do many investigators; when the National Foundation for Infantile Paralysis has millions to spend, articles on nerve and muscle degeneration multiply; and the Bowman Committee warns, in connection with research grants, that we "need to guard against control of science by

industry as well as against control of science by Government."

Further, with multiplying techniques and pyramiding knowledge, scientists have had to take refuge more and more in collaboration and team research. To ride the flood of literature, to master apparatus and methods based on far-flung branches of science, to turn out experimental findings at the ever-mounting tempo, the investigator needs help desperately. Abstracts, reviews, local bibliographers; secretaries, editorial assistants, draftsmen, photographers; machinists, glass blowers, animal caretakers; technicians and assistants; colleagues and collaborators—all these are needed to keep up with the Joneses in favored institutes. Quite aside from the war situation, what fraction of all our well-trained scientists is even now in a partly subordinated research position, as junior member of a team or lieutenant to a director?

Please do not misunderstand my not feeling too sad about this. I know as well as anyone the absolute indispensability of the imaginative insight and the freedom to exploit it. But I know also the ratio in time and effort between getting an idea and working it out. One first-rate creative scientist can keep dozens or hundreds of good men working at full effectiveness and maximum fertility, and, if human relationships are also fortunate, with complete personal satisfaction as well.

For all the pressure of immediate results, the sacrifice of personal research interests, the coordination from above, most scientists, I believe, were reasonably content in OSRD work, and many even under the additional strictures of work done directly with the armed forces. Science, like society itself, has become too large and too complex to remain completely individualistic.

The problems for the future are to find and to recognize true talent and leadership, to keep open the road to the top for all individuals possessing these qualities regardless of social status, and to maintain in scientists a greater concern for the good of the many than for selfish gain. These problems will become more pressing as more money, more power, and more prestige are attached to the scientific calling.

The present science bills, or any reasonable modification of them, will direct a great stream of financial support into the academic pools. In these bills emphasis is on basic rather than applied research, on aid to universities and like institutions rather than to industry or Government agencies—on recruiting young talent and subsidizing its full education. The amount of money under consideration is some fivefold the total annual expenditures made in the academic research field at the start of the war. Under this pressure many of the traditions and procedures which clothe the universities will burst their seams. Many unscholarly, aggressive entrepreneurs will be attracted by the odor of gravy.

If, however, the intent of the scientists who planned the National Science Foundation and of the legislators who are creating it is realized in the character of the administrative machinery, organization, and personnel, we may expect the inevitable readjustments to be salutary.[2] More, and more able, students will be recruited into science; but the cream of talent must not be skimmed from other areas of human enterprise, especially in the social sciences. More, and more desirable, research posts will open up to these students when their training is adequate; but relatively fewer will work on their own and at individual programs. Scientific discoveries will be increased in number and develop more rapidly; but the really great imaginative leaps in understanding will be of hardly greater frequency. The men and institutions and activities associated with research will be in the spotlight and under far greater social pressures and will have to make sacrifices to meet them. Perhaps, even, as Bernal suggested in his *Social function of science,* research teams will come to include publicists, promoters, lawyers, and other nonscientific members.

As science outgrows its cloistered walls and becomes a full-fledged participant in the hurly-burly of society, it must meet both responsibilities and opportunities. Scientists must be trained appropriately. They must learn in college, preferably as a part of a liberal education program, a minimum beyond their professional courses, including sufficient social science to cover the external relationships of science. They, or some of them, must learn the methods and skills of popular adult education. As the Moe Committee wrote, "It will not be sufficient, if science is to remain healthy in root and branch, merely to develop a large number of scientists and to provide them with the support necessary for their investigations. There is also the necessity of creating a better understanding of science in our national life, so that public approval and support for the future development of science will be forthcoming."

Scientific workers will find themselves forming more closely-knit and extensive groups, not primarily devoted to the exchange of technical knowledge. These groups, like the national American Association of Scientific Workers or the local Chicago Technical Societies Council, or, more and more, the American Association for the Advancement of Science itself, will be concerned with the interrelations of sciences,

[2] This paper was written before the public statements of the Committee supporting the Bush Report. It was not intended as approval of any specific bill before Congress. My own belief is that several improvements are possible in drafting a final bill.

and especially with the external relations of science as a whole.

These groups will in time become action groups, attempting to influence public opinion and Government decisions in order to protect research from debasement and restriction and to extend the beneficial influence of research results and methods. After becoming strong and active, these groups will be in grave danger of forgetting their social obligations, of existing to serve the personal ends of their members and officers. This tragedy has happened often enough, in business, in labor, in agriculture, and even in the professions. If it should ever become the habit of scientists, I assure you, fellow scientific workers, we will be judged and treated accordingly by the society of which we are a part.

Alliance of Industry and Scientific Research in Great Britain

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THE LIFE AND WORK of the universities impinge upon the activities of industry in a variety of ways. New industrial products and processes frequently will be found to have germinated in the investigations carried out in the university research laboratories. Industry looks to the universities for provision of graduates for its technical, research, and, in some instances, high administrative positions. There are also indirect consequences of the dissemination of knowledge and culture from the centers of learning. These have their effect upon public and industrial opinion and national policy, which in turn may affect, by legislation or otherwise, industrial practice and progress.

In Britain since the end of the war there has been searching consideration of whether industry has been making its maximum contribution to the well-being of British universities and how it could benefit more fully from their activities. In the ensuing discussion, special attention has been devoted to scientific and industrial research.

There are many schemes now in hand in Britain for the expansion of pure and applied research in industry, cooperative research laboratories, and the universities. At the time of writing, however, many of the scientists, technicians, and research workers who have devoted their whole energies to World War II have not yet returned to their peacetime activities, and these have by no means reached fruition. This is an interim report, therefore, on some of the plans so far announced for a more intimate relationship between British industry and the universities with regard to scientific research. These plans are intended not only to assist in harnessing the work and results of universities to industrial needs without interfering with, or prejudicing in any way, the independence or integrity of the university spirit, but also to develop and maintain closer contacts between research workers in different environments.

The British universities, twelve in number, are renowned for the contribution they have made to the advancement and dissemination of learning. Few countries offer so rich a variety of facilities for access to the highest forms of education. In the sphere of science British universities have occupied themselves very considerably with investigations of a fundamental kind at the outer boundaries of man's knowledge of nature.

Although, in the long run, social and industrial advance is largely dependent on this extension of knowledge of the material universe, the whole spirit and atmosphere of university research is single-minded concern with the acquisition of knowledge for its own sake. The fundamental research carried out at the universities has fed and inspired the research undertaken in industrial laboratories, which has, in turn, irrigated the fields of industry. For instance, the first successful experiments in splitting the atom were carried out by Lord Rutherford at Manchester University and subsequently at the Cavendish Laboratories in Cambridge before World War I, and the theories then propounded by him on atomic structure have now been confirmed in practice by the atomic bomb.

Despite the fact that the universities are, rather naturally, a little remote from industry, there have grown up in the past a certain number of close contacts of great mutual benefit. For instance, collective research in the British glass industry is carried out in a special department of Sheffield University; at Leeds University a department deals with coal, coke, and gas research and another with textiles; at Birmingham will be found an experimental coal mine and oil-boring equipment. Furthermore, certain of the provincial universities contain technological departments serving the industries of the locality. There are also a number of recognized technical experts on university staffs who act as consultants to industry, and they and their laboratories, by bringing their experience to bear on industrial problems, have been of assistance in their solution.