in the acts creating the U. S. Department of Agriculture and the land-grant college. This, then, is the specific recommendation that I bring before this body —the restoration of the democratic relationship between the U. S. Department of Agriculture and the land-grant colleges and other departments and agencies of the Federal Government all along the line—as swiftly as possible in the post-war world.

FURTHER RECOMMENDATIONS

We should be looking ahead, also, to broadening the pattern of cooperation to include engineering research in the College of Engineering and also research in home economics. The Morrill Act, in addition to specifying the teaching of agriculture, also provides that mechanic arts shall be taught. The teaching of mechanic arts is just as dependent on research as agricultural teaching is, and research in this field is just as much a governmental function. It has always seemed to me that resident instruction in the mechanic arts should be supplemented with research in the same way the Hatch-Adams Act of 1887 supplements resident instruction in agriculture with research.

A study of the Morrill Act and the statements of Justin Morrill indicate that it was his intention as well as his associates' in Congress that equal opportunity and facilities in the field of agriculture and engineering should be available. This will not be the case until the same amount of federal funds are available for engineering research as are available for agriculture. We should work toward this end.

The demand for engineers at this time in war industries and in the armed services emphasizes the importance of this expansion at the present time. We are living in what has been called a technological machine age, and the war in which we are engaged is a highly mechanized war. Such conditions call for more highly trained engineers and indicate the need for increased research in this field.

Nutrition for human beings is a rapidly developing science. For many years we have been studying the nutritional habits of live stock, and at last I am glad to say we are getting around to the serious study of nutrition for our citizens. Certainly this should be one of our most important sciences since it is so vitally concerned with human welfare. There is much to be explored in this field. If we are concerned about money for research in agriculture and in engineering, we should be equally concerned about funds for research in this field of human welfare which we know as home economics.

The Agricultural Extension Service is carrying a very heavy load. This, of course, is the division of the college through which education in connection with all war programs is carried to the public—for scrap metal and salvage, for war bond and stamp sales, for essential food and fiber production goals, for price control and so on. A special committee has gone before the Bureau of the Budget to appeal for emergency funds for increased personnel to carry on these expanding programs. What this committee has accomplished remains to be seen. In any event, if the Agricultural Extension Service is to assume these increased war duties, increased Federal funds should be available.

There is no body of men and women anywhere in this country who are working with greater unity of purpose to win this war than the teaching, research and extension staffs of the land-grant colleges. They bring to our young men and women the right appreciation of the obligations which they have to our national life, and upon this appreciation the perpetuation of our democracy depends. In the democratic policy or pattern provided for in the Land-Grant College Act, and the act creating the U. S. Department of Agriculture, and the cooperative relationship between them during the past eighty years, the land-grant colleges have made a great contribution to the development of the nation's agriculture and industry. Their usefulness has continually increased. This relationship sets a pattern for all educational programs sponsored jointly by the Federal Government and the states. This relationship is essentially the democratic process in the development of educational programs for the masses of the people and is the basis of an enduring democracy and of democratic institutions.

THE FULLER UTILIZATION OF SCIENTIFIC RESOURCES FOR TOTAL WAR[1]

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To the scientific worker it is a matter of the gravest concern that the scientific resources of the nation are still far short of full mobilization for war. Scientists are involved in this war as are all people: their deepest interests as citizens, in common with all others, are threatened to their foundations. But they have a spe-

[1] Presented at a meeting of the New York Branch, American Association of Scientific Workers, New York, October 7, 1942.

cial interest in the war beyond the ordinary. Science has perfected the weapons of war, trained its immediate personnel and provided the means both for defense against it and for the repair of its ravages. Science operates in this war on the fighting front, in the factory, in the laboratory and also in the mind of the scientist. The skilful use of the weapons of war; the efficient production of the best weapons; the development of still better weapons; and the discovery of principles and techniques that underlie still further development—all these aspects of science are indispensable for total war. Weapons are not alone guns, tanks and planes. They are also ships, trucks, roads and bridges; they are food, clothing and shelter; they are vaccines and sulfonamide drugs; and—by no means least important—they are ideas. Total war demands all our resources for its successful prosecution. We are not yet waging total war; nor are we yet winning significant victories. Lack of full utilization of scientific resources is one phase only of a more general deficiency. It is an important phase, and one to which we, as scientific workers, can and must address ourselves with particular attention.

Total war demands the utmost efficiency in leadership from above, and alike in cooperation from below. Neither the leadership nor the people by themselves can hope to achieve victory except by working wholeheartedly together and by both demanding and permitting the fullest possible utilization of the potentialities on both sides. Neither can be deficient without impairing the efficiency of the other.

As a member of the American Association of Scientific Workers and an active worker in the War Effort Committee of its New York branch, I should like to speak for the "people" in science. I urge them to cooperate whole-heartedly in the war effort; and I urge the leadership in science to demand and to permit that whole-hearted cooperation. I offer constructive suggestions as to ways and means, based on the experiences of the association.

The American Association of Scientific Workers has been increasingly concerned with the problem of complete utilization of scientific resources in the war effort, especially from the standpoint of facilitating and encouraging volunteer work by individual scientists and local groups. Although small in scale and more fruitful up to the present in promise than in accomplishment, our activity has convinced us both of the need for work of this kind and of the practicability of our approach. Extension of such activity on a larger scale will, we feel sure, bring concrete results that will exert a very appreciable influence on the total war effort.

The association has endeavored to present the problem of the utilization of scientific resources as a basis for action. Communications on the subject have been published;[2] and a memorandum submitted to the National Academy of Sciences on July 30 suggested means whereby the academy and other leading scientific bodies might aid directly in solving the problem.

What is the current extent of failure to utilize our resources of science? More precisely, what proportion of our total scientific man-hours and equipment-hours is being unused or used for non-essential or non-contributory purposes—for "business as usual"? Unfortunately, in the absence of adequate statistical data, no such precise formulation is yet possible. Compilation of these data is badly needed. It is nevertheless possible to define the problem from the experience of the association with sufficient clarity for the present purpose.

Certain fields of science are being very largely utilized for war purposes. Workers in the physical and mathematical sciences, engineers, and physicians, dentists and veterinarians have been absorbed into the war effort so rapidly that shortages in these fields on the home front are actually becoming critical. Such shortages, especially of physicians, may depend in part upon an aggravation of previously existing faults of distribution, and may therefore reflect the problem of efficient utilization as much as that of simple conversion of personnel from peacetime to wartime work. In these fields, at all events, the chief problems appear to be those of most effective utilization of the limited resources that are available, and of maintenance of the supply of trained personnel by accelerated education. These are the front-line sciences; their need for the war effort is most immediately apparent.

Among chemists, on the other hand, our experience shows more "business as usual" than we have any right to tolerate. Chemists contribute to both the physical-engineering and the medical front lines. Their importance, in chemical warfare itself, in the development and improvement of synthetic and substitute materials such as rubber and of therapeutic agents and other biological products, needs no extended emphasis. As might be expected, more complete use has been found in war work for physical chemists than for those in other categories. There should be room in the war effort, however, for competent chemists of all kinds. There is no doubt that not all competent chemists are being so used.

The medical sciences seem to be still further behind the goal of full utilization. These sciences, including physiology, biochemistry and bacteriology, are to medicine what production, development and invention are to ordnance. They are being utilized under the effective leadership of the Committee on Medical Re-

[2] (a) J. E. Hawkins, SCIENCE, 95: 2472, 507–508, May 15, 1942; (b) C. Behre, H. Grundfest and E. A. Kabat, *ibid.*, 96: 2479, 16, July 3, 1942; (c) H. Grundfest, *ibid.*, 96: 2492, 318–319, October 2, 1942.

search, one of the two major subdivisions of the government's Office of Scientific Research and Development. Many problems in important fields have been allocated and are being worked on, including means for control of many infectious diseases, the handling of war injuries and burns, the causes and control of shock, the storage and preservation of blood and the use of blood substitutes, and the control of nutritional deficiencies. In medical schools, moreover, scientific workers, who are nearly always teachers as well, have been given less time for research in the accelerated program of teaching. There are nevertheless many competent medical scientists who have time for research and who have not yet been utilized for war work. Their research continues on a "business as usual" basis, rarely by choice, but because the CMR has not reached them with problems, and because they themselves have not known how to find war work.

Among the subdivisions of biological science other than those directly contributory to medicine the problem of utilization is evidently still more serious. Biologists and agricultural scientists have no central government agency like the CMR, with money to spend and power to initiate and coordinate war research. They recognize the need for work on such problems as the new or improved production and conservation of natural materials like foods, fiber, forest products and rubber, and the ecology of animal and insect agents and carriers of disease. By and large they have not been able to initiate intensive study of these problems. As individuals they are still largely unused in the war effort, clearly not because of any lack of willingness on their part, but because the means for their conversion from a peacetime to a wartime basis have not yet been found or made available.

These are the broad outlines of the problem. Science is basic to the war effort. A vast amount of scientific research and development work has been and is being allocated, implemented and coordinated under the leadership of the OSRD and through its two major committees, the National Defense Research Committee (for physical sciences) and the Committee on Medical Research, cooperating through the National Research Council with many subcommittees for individual fields. It implies no serious criticism of this leadership to point out that its efforts to date afford no basis for complacency. Many of our scientific resources have not yet been utilized. We can not afford to waste any of them in total war. It can not be seriously argued that all the really important problems have been assigned or that all the really competent scientists have been absorbed into war work. This would be complacency at its worst, equivalent to the view, now seldom expressed, that the Army and Navy will fight the war for us, and the people may rest. The people have too much at stake to rest while they can help. Unused scientific resources are unconscionable in total war.

Leadership alone, however competent, is not enough; and if it were to attempt to work alone, without exploring and opening all possible avenues for cooperation from below, it would be shirking an indispensable part of its duty. The OSRD and its supporting agencies can not be expected to envisage all possible scientific war work, or to reach down to every scientific worker and find the proper job for him, without requiring, or at least encouraging, each individual worker to find his own place and to help others to do likewise. Fortunately the manner in which the OSRD operates includes provision for just such individual volunteer effort. Any responsible scientific worker can formulate a war project and submit it as an application for a contract to the OSRD or to one of its subcommittees. If the application is approved a contract is granted, and funds for assisting personnel and for equipment and supplies are made available for the work. This provision for volunteer effort, however, has not been widely publicized, and does not seem to have been put into practice on an extensive scale. Its usefulness has been impaired by the requirement of secrecy imposed on war research by the military authorities. Because much current research remains unpublished, scientific workers fully conversant with the literature in their fields may be unable to determine whether a given problem is already being investigated, and through fear of useless duplication may fail to apply for an important contract. We do not question the need for secrecy in many war research problems; but our experience suggests that secrecy regulations have not been adequately clarified, and that in many instances the restrictions in practice are much more severe than either the regulations or the needs require.

Recent experiences of a group of bacteriologists in New York indicate some of the means that are waiting to be used to encourage and facilitate volunteer scientific activity. This group was organized through the efforts of the New York branch of the association, as an outgrowth of the experience of its war effort committee, and is now an autonomous body. Its purpose is to consider aspects of bacteriology and related sciences that are of current war importance, and from open discussions to formulate war research projects that can be undertaken by members of the group after approval by the OSRD. A meeting held September 23 for discussion of vaccines against enteric infections was attended by more than two hundred bacteriologists, immunologists, pathologists and biochemists. Two invited speakers presented complementary aspects of the subject. During more than an hour of discussion from the floor after the presentations, seven problems in the field were suggested. A repre-

sentative of the Army Medical School who attended the meeting by invitation offered the facilities of his laboratories for cooperation on several of the problems, and pointed out that one of them was currently being investigated. The other six were then allocated to committees of volunteers from among those present for separate detailed consideration with a view to preparation of OSRD contract applications.

Activities of this kind could well be set up elsewhere and in other fields of science. They require only that a small group of persons in the field undertake the work of organization and the responsibility of seeing their work through to a fruitful conclusion. They should be encouraged, if not actively aided, by the scientific leadership of the country. Secrecy regulations are an obstacle to their progress, but not an insurmountable one. The details of many researches are necessarily secret, but the subject as a whole can generally be discussed openly without departing from the spirit of the regulations, and the gaps that require investigation can be indicated or sought by those in attendance. Cooperation such as the bacteriologists' group has received from informed persons who can help to eliminate duplication and to encourage useful projects is of the greatest value, and can probably be obtained with less difficulty than may be imagined.

There is encouraging evidence that this kind of volunteer activity meets a real need, both of the many individual scientific workers who are eager to participate in war research and will cooperate gladly in such an undertaking, and of those charged with the leadership of science in the war effort, who will recognize here a means to relieve themselves of part of their great responsibility, and to insure the more perfect fulfilment of the enormous task that has been assigned to them.

The fuller utilization of scientific resources implies more than research and more than the activities of scientific personnel. What of scientific work other than research? And what of the full utilization of scientific facilities, equipment and materials? The association has considered aspects of both questions.

Scientific workers who lack the facilities or the qualifications for war research can find work on the home front that makes use of their special skills, and which therefore can not be done by others not so qualified. They can aid in the training of civilian defense workers, or participate directly in local civilian defense organizations as gas detection experts, medical assistants or engineers for control or rehabilitation in disaster areas after enemy attack. They can prepare directions and help to institute precautions for storage or disposal of potentially dangerous materials in laboratories, factories and homes. Many scientists as individuals are now active in such work. The New York branch of the association is currently projecting plans for the more wide-spread utilization of scientific workers in such activities.

Scientists can also be of service by preparing pamphlets or books embodying popularizations of scientific data for the use of civilian defense workers and for education and morale-building among the armed forces. The Boston-Cambridge branch of the association has prepared a popular book on "Science from Shipboard" which is soon to be published by the Red Cross for distribution to soldiers aboard transports. Other branches are planning analogous books and pamphlets.

Sooner or later scientists will need to be concerned with problems that result from shortages of trained personnel on the home front. Aside from those means for overcoming shortages by rapid replacement through accelerated and improved education, means for substitution may also be available. A committee of the New York branch of the association has surveyed this problem as it affects the shortage of medical personnel in hospitals, and has considered the possibilities for substitution of technicians to perform many of the duties customarily undertaken by interns. Similar shortages may be expected to develop in civilian engineering activity, and may be met in part by parallel substitutions. Shortages of physicists, both in college teaching and in research, might be alleviated by substitution of workers in biology, chemistry and geology who have the necessary qualifications.[2c]

Another activity in which volunteer scientific effort can be used to good advantage to supplement centralized leadership is that of ensuring the full utilization of scientific facilities, equipment and materials. Shortages of metals and rubber and the conversion of industry to war production are rapidly making many types of apparatus unobtainable, and there are indications that other materials, such as certain organic chemical reagents, may soon disappear from the market. Critical shortages are bound to develop in some laboratories, while others either have the required equipment without using it or have the facilities for its production or synthesis. The National Registry of Rare Chemicals, maintained under the auspices of the Armour Foundation, grew directly out of the efforts of the Chicago branch of the association, and has become an important step toward the alleviation of one type of shortage, with a present listing of over three thousand items. A committee of the New York branch, cooperating with the committee designated for the purpose by the National Research Council, is now preparing local registries both of unused scientific equipment and of the need for unobtainable articles, as a basis for the necessary exchanges, perhaps by a "lend-lease" arrangement. This local effort, following and expanding plans

worked out by the Purdue branch of the association, is expected to provide a background of experience for a much more wide-spread survey that may soon become essential.

Beyond the goal of full utilization of scientific resources, in terms of the full-time employment in war work of all available personnel and materials, lies the problem of the most efficient utilization of these resources. Men and machines capable of more important war work than that being done may have to be converted further from the less to the more urgent tasks. One aspect of this problem has been mentioned in relation to the current shortage of physicians. Ultimately, as the exigencies imposed by total war become more and more apparent, and as the need for outright conversion of all science to war purposes is made inescapable, it may become imperative that all scientific activity be centralized and coordinated by a single government agency. A bill (S.2721) with essentially this purpose was introduced by Senator Kilgore on August 17, and has been referred to the Senate Committee on Military Affairs. The bill provides for a single government authority to survey, mobilize and coordinate all technological personnel and facilities of the nation for a maximum war effort. Certain changes in it appear desirable, particularly to remove its ambiguity with respect to the medical and biological sciences, and to insure continuity of the functions and adequate coordination of government agencies which now exist for the utilization of scientific resources.[3] It behooves all scientific workers to study this bill closely, since it affects their interests directly and embodies sweeping changes in their peacetime habits of life. If the "Office of Technological Mobilization" called for in the bill, or an analogous centralized government office of science, ever becomes a reality, the basis laid by expanded volunteer scientific work as outlined in this paper will take its place alongside the OSRD, the National Roster, and other official and semi-official government agencies as invaluable experience and as mechanisms in actual operation that may be expected to fit into the new centralized scheme with a minimum of alteration. All these efforts have their place in promoting the full utilization of scientific resources for total war. Volunteer effort, stimulated and guided from above, is not the least of them, and merits more attention as an essential part of this process of conversion of science to war than has heretofore been accorded to it.

SCIENTIFIC EVENTS

DEATHS AND MEMORIALS

DR. ARTHUR P. HONESS, professor of mineralogy and petrology at the Pennsylvania State College, died on October 17, at the age of fifty-five years.

DR. FRANZ C. SCHMELKES, assistant director of research of Wallace and Tiernan Company, Inc., manufacturers of pharmaceutical products and water-purifying apparatus, died on December 11. He was forty-three years old.

DR. MAX HARRISON DEMOREST, until recently instructor in geology at Wesleyan University, known for his researches in glaciology, according to information received from the War Department, died on November 30 in Greenland, where he was serving as a specialist with the rank of First Lieutenant at a remote military outpost. He was thirty-two years old.

PROFESSOR WILMOT V. METCALF died on November 21, at the age of eighty-two years. He had taught chemistry and physics at Whitman College, Carleton College, Fisk University and Berea College. His training included a bachelor's and master's degree at Oberlin College, the doctorate from Johns Hopkins, a year's post-doctorate study at Wurzburg and two years at Leipzig. In 1917, after persistent but unsuccessful efforts to enlist at the age of fifty-seven years, he volunteered for service with an ambulance unit and served for a time in France, paying all his own expenses. Later he served with the Army Y.M.C.A., his special interest being in personally delivering Y.M.C.A. supplies to the boys in the front-line trenches. Professor Metcalf's professional field was physical chemistry. Early in life he became interested in the philosophy of science. He was studying zealously in that field at the time of his death, having maintained a wide correspondence on the subject and contributed a number of papers to scientific and philosophical magazines in recent years. Professor Metcalf was the older brother of Maynard M. Metcalf, the zoologist, who died in 1940.—LLOYD W. TAYLOR.

A CORRESPONDENT writes: Robert Peele, who died at his home in New York City on December 8, in his eighty-fifth year, had been emeritus professor of mining of Columbia University since 1925 and a member of its staff since 1892. A graduate of the School of Mines with the class of 1883, after ten years of varied professional experience in the United States and South America, he was appointed adjunct professor in 1892

[3] Since this paper was presented, another bill has been introduced by Representative Tolan and by Senators Kilgore and Pepper. The Tolan-Kilgore bill embraces provisions similar to those of the original Kilgore bill, but as part of a broad program for total mobilization of the nation's manpower and resources. The modifications in the Kilgore bill referred to above have been largely included in the newer bill.