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ORGANIZATION OF AMERICAN SCIENTISTS FOR THE WAR[1]

By Dr. KARL T. COMPTON

PRESIDENT, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

INTRODUCTION

IN ordinary times any American scientist would deem it a distinguished honor to be nominated as the Pilgrim Trust lecturer. In these extraordinary times the significance of this lectureship is enhanced by the fact that American and British scientists are working hand in hand, not only to advance science as an important aspect of man's culture, but now especially as a powerful tool for the preservation of our opportunities for continued life, liberty and pursuit of happiness. Consequently, when Sir Henry Tizard transmitted your invitation for me to deliver this lecture I accepted the invitation with profound appreciation and humility.

There were also two personal aspects of this invitation which aroused in me a sentimental reaction. The establishment of the Pilgrim Trust lectures was announced to the Royal Society by your late colleague, Sir William Bragg, in his presidential address at the anniversary meeting of the society in 1937. Not only has Sir William Bragg, together with his distinguished son, been an inspiration to my generation of American physicists, but it happens that he delivered the address at the graduation exercises of the Massachusetts Institute of Technology on the occasion of my inauguration as president of that institution in 1930. I recall very vividly his remarks on that occasion and my feeling that his presence was an inspiration to me at that time when, with considerable trepidation and regret I moved from the research laboratory into an administrative office.

In that address Sir William traced the development of modern institutions for technical instruction and drew his illustrations from the lives and work of

[1] Pilgrim Trust Lecture, under the auspices of the Royal Society of London, London, May 20, 1943.

Count Rumford, Thomas Bernard and Michael Faraday. Permit me to read several excerpts from Sir William's address.

A school of technology is an expression of the wish to gather together the growing knowledge of nature, of natural materials and laws, and to make that knowledge of service to mankind. . . . Where and when did this movement begin?

It is not of great antiquity. Perhaps the seventeenth century includes its first recognizable appearance, marked by the new-found delight in careful experimental examination of the world. The Royal Society of London was founded in the troubled times of conflict between King and Parliament: where we read the account of the early proceedings of the society we are reminded of boys let out of school, running quickly to brook and hedgerow to examine the extraordinarily interesting things to be found there at every turn. A very important account of the methods of ventilating mines in Belgium comes next to the careful description of some animal monstrosity such as a calf with more than the proper allowance of heads or legs. The professor of astronomy at Oxford writes on the use of incubators in Egypt. Early discussions on tide prediction, then a very important matter because the old harbors did not easily accommodate the large boats wanted for the American trade, lie side by side with a disquisition on a remarkable set of teeth and pertinent references to the properties of sugar. The hodge-podge is readily understandable. The infant was beginning to notice and ask questions. . . . We can well be amused at all this, remembering that the infant has now become a very sturdy youth: and that the proceedings of these early fellows of the Royal Society were only the first results of the new regard for natural knowledge.

Sir William then proceeded in most interesting fashion to sketch the significant facts in the life, work and social viewpoint of Count Rumford and Thomas Bernard, and pointed out that the wealth of Bernard and the stimulation given by Benjamin Thompson, both of them men who spent their early lives within a few miles of my home in Massachusetts, led to the establishment of your Royal Institution.

Then, after drawing lessons from the life of Michael Faraday, Sir William concluded with these words.

Science was not merely a collection of inventions to be applied by the rich for the comfort of the poor. It was a glorious purpose to be shared by all mankind. We must try to understand the world in which we live, for our own enjoyment, for the training of our minds, for the enrichment of our souls' contemplation, for the means whereby we may help each other.

It is in this spirit that we may try to do our work. It is true of course that we must work for ourselves; instructors have to earn their living and students must come to learn how to earn theirs. As the world is made it must be so, but also the world is so made that the vision of its wonder and of the delight of mutual service and the happy task of exploring the one to help us in achieving the other, can light our lives for us as the sunshine lights the earth.

As we think of the noble ideals which Count Rumford, Thomas Bernard and Michael Faraday held for science as that which "can light our lives for us as the sunshine lights the earth," it is a grim and discouraging contrast to see the scientists of the world engaged to-day in developing new instrumentalities for destruction or other instrumentalities for protection against the destruction which would be wrought upon us by the engines of war of our enemies. The fact that this is so is a grim reminder that our skill in statemanship and our art and ethics of Christian living have not kept pace with our ideals. We have no alternative now but to apply our knowledge of science in every aspect to serve us in our struggle for survival and to preserve for us that opportunity for which our race has struggled throughout the centuries—the opportunity to live and work in peace and freedom.

As the second personal note, let me lay claim to scientific kinship with your body as one who might be called a scientific grandchild of another one of your late leaders, Sir Joseph Thomson. We in America affectionately called him "J.J.," as I understand you also did in England, and we look upon him as the progenitor of that tribe of physicists who interested themselves in the conduction of electricity through gases. Taking him as the founder of that tribe, one of the second generation, your Sir Owen Richardson, was my guide and inspiration during my graduate student years at Princeton University. For his sake I am sorry that I did not turn out to be a more productive pupil, but the interests and satisfactions I have had in the field of research I owe more to him than to any other man.

As you know, we in America have two principal scientific societies which are broadly representative of all the fields of science and which are rather parallel to two of your principal scientific bodies, the Royal Society of London and the British Association for Advancement of Science.

Dr. Frank B. Jewett, president of our National Academy of Sciences, has asked me to deliver his personal message to the president of the Royal Society of London, Sir Henry Dale, and in addition he requested me to express to you the admiration which is felt by the members of the National Academy of Sciences for the magnificent manner in which the scientists of Great Britain have thrown the whole weight of their energies and abilities to master the innumerable technical problems arising in this war. He wanted me to assure you that in so far as we can do likewise, we in America are making a sincere effort to handle our similar problems and cooperatively to supplement the great work which you are doing.

Dr. Isaiah Bowman, last month elected president of the American Association for the Advancement of Science, also gave me a message of greeting to British scientists from which I quote as follows:

> Now that the war has advanced to the stage at which we begin to talk of post-war plans, we feel more than ever the need for collaboration between Great Britain and the United States. While there is no such thing as an Anglo-American bloc in world politics there is such a thing as close comradeship in the fight for principles. This comradeship we feel whenever we deal with the leaders of Britain and whatever the field of interest.
>
> I venture to predict that, whatever difficulties may arise, we shall find that comradeship and agreement upon principles will ever mark our future relations. This belief is based upon our widely recognized common responsibility for the peace and safety of mankind in the years after the war. If England is being changed by the war the United States is changing just as rapidly. Once our President was able to report on "the state of the Union," as our Constitution provides, almost without touching on foreign affairs. Two world wars have changed both the tenor and the scope of such messages. The state of the Union now includes the state of the world.
>
> This conception of the state of the Union lays new obligations upon us all. The scientist can no longer report on the state of the sciences. He must report on the impact of science upon society. He must make use of the qualities of mind that science fosters in dealing rationally with the terrible waste in vital resources that war imposes upon the human species. We may hope that the day will soon come when every mature man and woman will feel himself responsible for the state of the Union and act responsibly in that sector of our common life committed to his care, no matter how small the sector may be, no matter how humble.
>
> We say these things while recalling again how great an inheritance they represent from the unfolding political life of Great Britain. No one can speak of liberty and political responsibility and community enterprise without echoing truths that were discovered by centuries of experiment and experience on the part of rulers and ruled in the English political system. Thus, no matter where one starts in estimating future problems and future responsibilities, one ends by recognizing the special bond between America and Britain, by acknowledging the rich inheritance that has been responsible for so many strong elements in American life, and by elevating the comradeship that we both feel and need.

And now I come to the subject of my address. I have chosen to speak on a subject pertinent to the war, to describe to you the manner in which American scientists have organized to make their contribution to the same cause which has mobilized your efforts. In so doing, I trust that I shall be within the spirit, if not the letter, of Sir William's directive for these lectures. For he said, "Such lectures would associate workers in a common task," and surely our common task right now is to direct our scientific resources for victory.

In these days, when numbers of scientists are crossing the Atlantic in both directions on special missions, a better understanding of each other's organizations may be practically helpful. For I frankly confess sympathy with one of your number who recently told me that he found the American organization of interrelated scientific groups a bit complicated. I can only draw cold comfort from the fact that, complicated as it is, the scientific organization is far simpler than that of our governmental departments and bureaus generally. But that is another story.

PEACE-TIME ORGANIZATION OF SCIENTISTS IN THE UNITED STATES

Let me first give an over-all picture of the scientific and technical organizations of the United States as they exist in peace-time. After this brief review I shall pass to a discussion of the special scientific organizations for war, which is the subject of more particular interest to us at this time.

The scientific and engineering work in the United States may be discussed under three categories: first, the agencies of the Federal Government, exclusive of the Armed Services; second, the agencies within the Armed Services; and third, the non-governmental agencies.

Federal Bureaus. The scientific services of the Federal Government in peace-time are spread through about 40 federal bureaus, of which 18 can be called primarily scientific. Their operations involve only about half of one per cent. of the total peace-time federal budget, but their work is of course absolutely essential to the national welfare in agriculture, manufacture, commerce, health and safety. The personnel of all these bureaus operates under the Civil Service.

From point of view of size of personnel and budget, the scientific services under the Department of Agriculture stand first in the list. Probably these scientific establishments, however, are not as well known generally as those of some of the other departments because their research work is quite largely spread through a great number of agricultural experimental stations distributed throughout the various states of the union and operated cooperatively between the Federal Government and the States. Most of the bureaus in Washington are primarily of an administrative character, but there are several which also conduct centralized research, as, for example, the Bureau of Chemistry and Soils and the Food and Drug Administration. Until recently the U. S. Weather Bureau operated under the Department of Agriculture, but a few years ago it was transferred to the Department of Commerce, largely because the requirements of air transportation had taken the lead in demanding more accurate and refined methods of weather forecasting than those which had served reasonably well in the past to provide for the needs of agriculture.

Many of you will probably recognize some of the more important of these governmental scientific bureaus, as, for example, the National Bureau of Standards under the Department of Commerce, the Geological Survey, the Bureau of Mines and the Bureau of Mineral Statistics and Economics under the Department of the Interior, and the National Institute of Health under the U. S. Public Health Service.

Of particular interest because of its unique character is the National Advisory Committee for Aeronautics, which was established during the last war and which operates three great research establishments. Until recently the work of the NACA was centered in the aerodynamical research program at Langley Field, Virginia. Several years ago there was added another aerodynamical research establishment named the "Ames Laboratory" at Moffett Field, in California, and quite recently still another large research and development establishment for aircraft engines in Cleveland, Ohio. Also, under the NACA, there are currently some 80 research projects being carried on at universities under contract. This obviates unnecessary duplication of facilities in a government laboratory and maintains a group of university scientists and engineers in close contact with the problems of aeronautical research.

The administration of this organization is also unique among our federal scientific agencies in that its controlling body is a committee which serves without salary and has been composed of men of such high character and distinction as to render it completely free from political influence. This committee is provided with representation from the most interested branches of the Army, Navy and governmental departments, but the chairman and the majority control reside in a body of citizen scientists appointed by the President who, in practice, has followed the recommendations of the chairman in appointments to fill vacancies. The present chairman of the NACA is Professor J. C. Hunsaker, head of the departments of mechanical and aeronautical engineering at the Massachusetts Institute of Technology, and incidentally, while a very young man, the designer of the first American airplane to fly the Atlantic.

Turning now to the United States Armed Services, I can best describe their research and development work as principally a cooperative effort between the services themselves and American industrial companies, with occasional participation from the research laboratories of the technological and educational institutions.

Army. Each branch of the Army contains a technical division under which operate laboratories or arsenals in which a certain amount of research and development work is carried on but whose activities consist for the most part of testing and proving new war materials or equipment. Thus the technical staffs in the various branches of the Army and Navy have the threefold duty of planning and coordinating an extensive program of research and development carried on in the industrial laboratories, of organizing and conducting research programs in their own establishments, and of carrying on the extensive operations of proving and testing which result in the acceptance of new devices and the drafting of specifications for production orders.

Among the principal Army establishments in which such work is centered, I would mention particularly those falling under the Ordnance Department, the Signal Corps, the Chemical Warfare Service and the Army Air Forces. The Ordnance Department operates a great proving ground at Aberdeen, at which is centered most of the proving and testing of ordnance and research on ballistics for arms of all types. In addition it operates five principal arsenals. The Watertown Arsenal is concerned principally with the manufacture of mounts for large caliber guns and is the principal center for research and technical service in the field of metallurgy. The Picatinny Arsenal is devoted to the testing of explosives and the design and operation of pilot plants as guides to the industrial producers. The Rock Island Arsenal carries on research and development in the field of oils and lubricants. The Frankford Arsenal supplements the Aberdeen Proving Ground as a testing and a development center for small arms. The Tank Arsenal in Detroit is the center for the design and testing of tanks.

In the Signal Corps the technical division is divided into three principal branches: the Ground Signal Branch, the Electronics Branch and the Aircraft Radio Branch. The research, development and testing work carried on under the Signal Corps is divided principally between the signal laboratories at Fort Monmouth, Camp Evans, Camp Coles, Eatontown and Toms River. The Signal Corps also maintains a large cooperative establishment working with the Army Air Forces at its principal center, Wright Field.

Until quite recently the research and development work of the Chemical Warfare Service was centered in its great Edgewood Arsenal. As the threat of war came closer, however, a few years ago, and since a very large portion of the facilities at the Edgewood Arsenal are taken up by production, the Chemical Warfare Service established a subsidiary research laboratory and took over for this purpose the newly erected Chemical Engineering Laboratory of the Massachusetts Institute of Technology.

Despite the great expansion of the Army Air Forces, this service has continued to concentrate its research, development and testing activities at its huge establishment at Wright Field in Ohio. There are of course many other centers at which extended service testing goes on, or at which new equipment is installed in aircraft, but Wright Field remains the headquarters for the research and development work of the Army Air Forces.

The coordination among all these various technical services of the Army is maintained by two types of agency. Within each branch of the Army is a board which has general supervision over technical matters within that branch. Examples are the Coast Artillery Board and the Army Engineers Board. When a project has been approved by one of these boards it is next passed upon by the appropriate Technical Committee, composed of members of this branch of the service, and other branches which may be concerned with the project. If this technical committee also approves the project it goes as a recommendation to the general staff which presumably issues the appropriate directive.

Mention should be made also of the Army Medical Corps, within which a significant amount of research is conducted under the general supervision of the Surgeon General of the Army.

Navy. The Naval Observatory and the Hydrographic Office, which are under the Chief of Naval Operations, have obvious functions in research and development work. The Marine Corps does some research, but naturally depends to a large extent on the Army and the various Bureaus of the Navy. All the Bureaus of the Navy Department, Ships, Ordnance, Aeronautics, Naval Personnel, Supplies and Accounts, Medicine and Surgery, Yards and Docks, do research and development work, though naturally the materiel bureaus conduct the greatest volume.

All research work of the Navy Department is tied together through the office of the Coordinator of Research and Development, which office also arranges coordination with the Army, with other government departments and with the numerous civilian agencies which I will mention later.

Under the Bureau of Ships the Naval Research Laboratory near Washington is a center for all matters of fundamental research, including radio, electronics, chemical warfare defense, etc. The David W. Taylor Model Basin, also near Washington, is the primary station for research and development of ship structures, propeller and hull design. The Naval Boiler and Turbine Laboratory at Philadelphia is concerned with all matters of boiler research, testing and design, including fuel, composition, quality and nature of boiler fuels, ceramics, etc., and also for research, test and development of main propulsion turbines. The U. S. Naval Engineering Experiment Station at Annapolis, Md., is assigned all problems of research, test and development of mechanical equipment in ships other than main propulsion, and it also has a well-equipped Diesel engine laboratory. The principal metallurgical laboratory for the Bureau of Ships is also located at the Engineering Experiment Station. In New York there is located the Materials Test Laboratory, which handles all matters of research, test and development of electrical materials and equipment, acoustical equipment, optical and navigational material and equipment, plastics and allied materials. There are rubber and paint laboratories at Mare Island, California, and an inspection test laboratory in Pittsburgh, Pa., where line production methods for chemical analyses are set up which permit a capacity of about 5,000 chemical analyses per week with a minimum of personnel and equipment. In addition to the above each Navy Yard is equipped with an industrial laboratory to serve the purposes of the Yards. It has been found possible to place specialized problems in some of these laboratories such as the development of chain and rope in the Boston Navy Yard. The assignment and progress, as well as general administration of all research, development and test work, is carried out by the Bureau of Ships in Washington in order most fully and effectively to coordinate all work and to collect, apply and distribute the results.

Under the Bureau of Ordnance there are the Dahlgren Proving Ground, the Naval Gun Factory at Washington, whose research department includes the Naval Ordnance Laboratory, the Naval Powder Factory near Washington and the Newport Torpedo Station. In addition there are establishments devoted to mines, counter-mines, nets and the like.

Under the Bureau of Aeronautics there is the Naval Aircraft Factory in Philadelphia, the Cedar Point Flight Testing Field near Washington and the Aircraft Armament Laboratory and Testing Field at Hampton Roads.

Research in medicine and surgery is directed by the Research Division of the Bureau of Medicine and Surgery, using many facilities but largely those of the U. S. Naval Medical Research Institute at Bethesda near Washington and the Medical Research Laboratories at Pensacola and New London.

Civilian Agencies. I pass now to the non-governmental scientific organizations in the United States, most of whose members are attached to the staffs of some 600 colleges, universities and engineering schools, some 2,000 industrial research laboratories and other specialized research institutes. Do not be alarmed when I begin by saying that these comprise well over one hundred nationally recognized scientific and engineering societies, exclusive of the social sciences. Of these, only a few are general in scope in the sense that they cover broadly the entire field of science. Largest of these is the American Association for the Advancement of Science, a close parallel to your British Association, with a direct membership of about 24,000 and an indirect aggregate membership of about a million through the 187 associated and affiliated societies. Of a more exclusive character and without the affiliated and associated societies are the American Philosophical Society and the American Academy of Arts and Sciences.

Unique among the scientific organizations of the United States is the National Academy of Sciences.

In March, 1863, during a crisis of our Civil War, Congress established the National Academy of Sciences and President Lincoln signed the Act of Incorporation. This act specified that "the Academy shall, whenever called upon by any department of the government, investigate, examine, experiment and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments and reports to be made from appropriations which may be made for the purpose." There was also the provision in the charter that, except for the actual expenses of these activities, neither the academy nor any member of the academy is entitled to receive any compensation whatsoever for such services. Although the membership is legally limited to 450, the actual membership in the academy has never exceeded its present enrolment of 350.

Outside of its services in war-times, perhaps the most noteworthy public service by the academy was its geological and engineering investigation of the slides which at one time threatened to prevent the successful consummation of the Panama Canal. However, the utilization of the academy by the government has been rather "spotty." Under some administrations the academy has been used rather extensively and in other administrations has been more or less forgotten by the government. In this respect I believe that your Royal Society has had a more consistent role of usefulness.

One inevitable characteristic of this type of organization, in which membership is considered to be the highest scientific honor of the country, is that membership, like scientific recognition, is likely to come to a man after he has passed the peak of activity in his scientific career. For this reason the academy has been able to perform an excellent function of the "scientific elder statesmen" variety. It has zealously kept itself free from all types of political influence. Its ideals have been unselfish service, integrity and scientific competence. Frequently, however, probably in the great majority of cases, when a very active research program has to be undertaken, many of the personnel best adapted for the particular job are not found within the membership of the academy.

During the last world war in Europe, but before the United States had become a participant, President Wilson by executive order requested the National Academy of Sciences to establish the National Research Council as a measure of national preparedness. This organization operated so usefully during the war that after its termination, in April, 1919, the National Research Council was perpetuated by the National Academy of Sciences at the express request of President Wilson.

This National Research Council is organized into nine permanent divisions covering the various fields of scientific research and of scientific administration. These divisions are composed of appointed members and also of representatives from many of the scientific and engineering societies and branches of the government. Because of this wide representation the National Research Council is a most effective agency for finding just the right persons to do any specific scientific job.

During the present war the National Academy and the National Research Council have been called upon to perform many important services, some of an advisory character and some involving the placing of contracts for research and development work in various laboratories.

Among the nearly 200 committees operating under the National Research Council, the following are typical of those concerned with the war: Aviation Medicine, War Metallurgy, Passive Protection Against Bombing, War Use of Research Facilities, Tin Smelting and Reclamation, Clothing, Shock and Transfusions, Treatment of Gas Casualties, Wartime Diet and Selection and Training of Service Personnel. *(To be concluded)*

OBITUARY

HENRY SEELY WHITE
1861–1943

HENRY SEELY WHITE, distinguished mathematician and professor emeritus at Vassar College, died on his eighty-second birthday, May 20, 1943, at his home on Overlook Road, Poughkeepsie.

Professor White's early years were spent in Cazenovia, N. Y., where his father, Professor Aaron