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THE GOVERNMENT'S RESPONSIBILITIES IN SCIENCE[1]

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THE range of opportunity in science in this country is so great and the extent to which the government should undertake responsibility in this field involves such complex considerations that it is perhaps rash to undertake a discussion of the problem. Nevertheless, the problem is as important as it is complex and events of the last two years have conspired to focus on it the attention of several organized groups of scientists with the result that some aspects at least of the problem have been somewhat clarified. I will attempt, therefore, to give a brief sketch of the problem of the government's present responsibilities in science, together with some suggestions as to ways in which these responsibilities may profitably be extended as they have been developed through discussions in the Science Advisory Board and in conferences with many other agencies and individuals.

[1] Address given on March 16 at the initiation banquet of the Yale Chapter of Sigma Xi.

My own contact with this study dated from a radiogram from my assistant, received in the summer of 1933 while on the boat from Boston to Bangor, stating: "Word received that you have been appointed chairman of committee to reorganize Federal Government." Realizing that there was some major misunderstanding, I was naturally interested to learn what had really happened and found in the paper on the following day that the President had appointed a Science Advisory Board of scientists and engineers with authority "to appoint committees to deal with specific problems in the various departments."

This board now consists of fifteen men, including: Dr. Campbell, president of the National Academy of Sciences; Dr. Bowman, chairman of the National Research Council; Dr. Dunn, president of the J. G. White Engineering Corporation; Dr. Jewett, president of the Bell Telephone Laboratories; Dr. Kettering, president of the General Motors Research Corporation; Dr.

Leith, professor of geology at the University of Wisconsin; Dr. Merriam, president of the Carnegie Institution of Washington; Dr. Millikan, director of the Norman Bridge Laboratory of Physics, California Institute of Technology; Dr. Adams, professor of organic chemistry and president of the American Chemical Society; Dr. Flexner, director of the Rockefeller Institute for Medical Research; Dr. Jones, professor of plant pathology at the University of Wisconsin; Dr. Lillie, dean of the Division of the Biological Sciences of the University of Chicago; Dr. Rosenau, professor of preventive medicine and hygiene at the Harvard Medical School and professor of epidemiology at the Harvard School of Public Health; Dr. Parran, state commissioner of health of New York.

I discuss the work of this Science Advisory Board with some hesitation on two grounds. In the first place, your distinguished president, Dr. Angell, is reported in the press to have raised a question as to whether the services to government by members of educational institutions may not sometimes be of less public value than their regular services in their institutions. You have probably heard the remark attributed to President Nicholas Murray Butler in commenting on the large exodus of Columbia University professors to government posts: "Columbia's loss is the nation's loss." In the second place, there are those who feel that the efforts of well-meaning experts to assist the country, through their services to the government in these times of distress, have not all been well considered or successful. Some of them are unfortunately analogous to the attempt to relieve the darky who had swallowed a potato bug by administering to him a large dose of Paris green to kill the potato bug.

However these things may be, the Science Advisory Board has found certain directions of usefulness in a modest way, and through its consideration of problems of the scientific services of the government has formulated the broad outlines of a plan whereby the scientific forces of the country may be strengthened and put to work more effectively for the national welfare. Before discussing this plan it will be helpful first to see where the government now fits into the picture of scientific activities of the country.

The scientific services of the government are spread through forty federal bureaus, of which eighteen can be called primarily scientific. Although their operations involve only about half of one per cent. of the federal budget, their work is absolutely essential to the national welfare in agriculture, manufacture, commerce, health and safety.

Typical problems in the administration of these bureaus are: Is the organization adapted to the best fulfilment of its objectives? Are its objectives of distinct importance for the public welfare? Is its program planned with vision and keen appreciation of needs and opportunities? Are old projects dropped when their objectives have been attained? Is the personnel competent and alert? Is there proper coordination and cooperation with non-governmental agencies? Are the most up-to-date methods in use? Is there unwise duplication of effort? Should a given project be handled by a governmental bureau or left to non-governmental agencies? What is the best expert advice on a given problem of public interest?

Problems like these are always present and require constant attention if the government's scientific work is to be maintained on a plane of high efficiency. Disinterested and competent advice is desired on occasions by the secretaries of departments, and similar advice and help are useful to the chiefs of bureaus.

The following three steps have been taken by the Federal Government to provide for itself disinterested and competent advice upon scientific matters:

(1) The National Academy of Sciences was established by an Act of Incorporation "enacted by the Senate and House of Representatives of the United States of America in Congress assembled," and approved by President Lincoln on March 3, 1863, said act specifying 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 paid from appropriations which may be made for the purpose," subject to the condition that "the Academy shall receive no compensation whatever for any service to the Government of the United States."

(2) The National Research Council was organized in 1916, at the request of President Wilson, by the National Academy of Sciences under its congressional charter, as a measure of national preparedness, and perpetuated by the National Academy of Sciences on April 29, 1919, at the President's further request, as expressed in Executive Order No. 2859. The National Research Council is, in a sense, an operating arm of the National Academy of Sciences and is permanently organized into divisions, with representatives from all major scientific bodies, to further the interests of science and technology within and without the government.

(3) The Science Advisory Board was created by President Roosevelt by Executive Order No. 6238, July 31, 1933 (supplemented by Executive Order No. 6725, May 28, 1934) "with authority, acting through the machinery and under the jurisdiction of the National Academy of Sciences and the National Research Council, to appoint committees to deal with specific

problems in the various departments," with terms of appointment to expire on July 31, 1935.

The appropriations for the scientific bureaus of the government have been greatly reduced since the affluent days just preceding the depression, by amounts ranging in some bureaus as high as 60 per cent. According to Mr. Ralph Ward the 1935 budget shows the following appropriations for scientific work:

10 bureaus in the Department of Agriculture	$38,276,000
5 bureaus in the Department of Commerce	11,522,000
2 bureaus in the Department of Interior	1,232,000
8 bureaus in the Navy Department	3,918,000
1 bureau in the Treasury Department	9,313,000
6 bureaus in the War Department	4,503,000
Nat'l Advisory Com. for Aeronautics	1,453,000
Smithsonian Institution	864,000

These figures include only expenditures for scientific work, except in the Department of Agriculture, where they include all appropriations to the bureaus, since it is difficult there to separate the scientific work from other activities.

Taking the appropriations which go definitely for science, it is found that only about .3 of one per cent. of the total budget of the Federal Government goes into scientific work. In comparison with the importance of scientific work to the country, this is certainly not a large proportion. One might well raise the question as to whether an increase in this amount might not bring advantages to the country which are large in comparison with those resulting from many of the other far larger expenditures.

It is interesting to consider these expenditures against the total background of expenditures for scientific work in the country from all sources. Mr. Watson Davis, editor of Science Service, has estimated the total national expenditure for work in science by government, industry, foundations and universities to be somewhat less than $100,000,000 per year. It is seen, therefore, that the Federal Government accounts for roughly half of the total national expenditure for science.

It is also interesting to consider the part played by the universities from the standpoint of expenditures for science. The U. S. Office of Education Pamphlet No. 58 gives the following statistics for the academic year 1934–1935: 81 publicly controlled universities and colleges, with a total budget of $81,774,000, reported $9,526,000 as appropriated for research work. The major portion of these appropriations were for agriculture. Of the 81 institutions here listed only 47 reported any appropriations for research. Of 219 privately controlled educational institutions with aggregate budgets of $57,600,000, practically all the research funds were reported by 16 of these institutions, and their aggregate expenditures for organized research were $1,627,000. It is evident from these figures that, important as research in educational institutions may be in developing new knowledge, their total expenditures for research are very much less than are the expenditures of the Federal Government for scientific work. It must be remembered of course that most of the government's expenditures for scientific work are not for research but rather for the accumulation of scientific and technical data or the administration of technical services.

It is of interest to note the part played by the philanthropic foundations in this whole program. Dr. Keppel, in an address at Brown University last year, stated that in 1931 the philanthropic foundations of the country distributed $54,000,000, of which about $10,000,000 were for encouragement of research, exclusive of the very important fields of medicine and public health. Taking two of the largest of these foundations as examples, we note that the Carnegie Corporation in 1933 made grants of $68,000 for scientific research in the United States, and its scientific agency, the Carnegie Institution of Washington, reported total expenses of $1,576,000. Similarly, the Rockefeller Foundation in 1933, out of total appropriations and expenditures of $14,754,000, made appropriations of $4,509,000 for the natural and medical sciences and public health.

It is of course extremely difficult to justify the accuracy of these figures because of the differences in manner of reporting, but certain general conclusions can safely be drawn. The Federal Government is by a very large margin the largest scientific agency in the country. The next largest single unit consists of the agricultural work of the land-grant colleges and universities. Excluding these the aggregate expenditures for scientific research by the universities of the country are comparable with the expenditures of the philanthropic foundations for these purposes. (As stated above, these conclusions are necessarily very rough. A major uncertainty lies in the definition of scientific work. If the expenditures of universities for *educational* work in science had been included, their position would of course appear much more prominently in the financial comparison).

With this general background showing the distribution of scientific work in the country, let me now turn to a description of some typical problems of the federal scientific services which have engaged the attention of the Science Advisory Board and its committees during the past two years.

The first problem submitted to the board was a request by the Secretary of Agriculture for a study of the U. S. Weather Bureau and recommendations for improving its service. There had long been recognition of economic and other advantages which would result if the accuracy of weather forecasting and of other meteorological data could be improved. The issue may have been forced by a critical survey and report of the Weather Bureau by a committee of the American Society of Civil Engineers and by the disaster to the airship *Akron*. The board's study of the Weather Bureau disclosed the enormous service to the public which this bureau has rendered per dollar of taxpayers' money which has gone into the service as a result of efficient organization and particularly because of the friendly contribution of services by an enormous number of voluntary meteorological observers organized by and cooperating with the Weather Bureau. It was evident, however, that a new technique of weather forecasting, based on "air mass analysis" and which originated in the Scandinavian countries, has proven to be superior to the older method now in use by the bureau which was based essentially on a systematic study of precedence in weather maps. The air mass analysis method is a three-dimensional rather than a two-dimensional study of the atmosphere and therefore involves the use of meteorological data taken at high altitudes as well as those taken on the surface of the ground. The atmosphere is like a huge ocean with cold currents coming down from the north, warm, humid currents flowing up from the region of the Caribbean, and a third current flowing in from the Pacific. These currents are like great rivers, or like the Gulf Stream, in the atmosphere, and follow more or less well-defined but continuing varying paths over the country. Storms and quick changes of temperature occur where they meet. Tests on the Atlantic Coast by the Massachusetts Institute of Technology, and on the Pacific Coast by the California Institute of Technology and some years of use by the military services have demonstrated the improved accuracy of this new method. While greater accuracy is valuable for all human activities which depend on the weather, and economically important, particularly in the handling and transportation of foodstuffs and live-stock, it is the requirements of modern commercial aviation which have rendered acute the problem of greater accuracy in weather forecasting.

We found that all the governmental agencies involved were anxious to cooperate in any movement which might improve the work of the Weather Bureau. The Army and the Navy offered to assign some of their airplanes, used in practice flying, for the purpose of taking up to high altitudes the self-recording meteorological instruments needed to secure the data on temperature, pressure and humidity, and to do this at strategically located stations over the country. The Bureau of Aeronautics in the Department of Commerce agreed to cooperate more closely with the Weather Bureau in unifying the communication system for transmitting meteorological data. The board therefore recommended the adoption of the air mass analysis method of forecasting, together with other important improvements, such as increasing from two to three, and if possible 4, the number of daily weather maps, the attaining of an increased amount of meteorological information from the region of the Caribbean Sea in which destructive hurricanes have their origin, and the closer inspection of meteorological stations.

These recommendations have been adopted and are being put into effect as rapidly as circumstances permit. The major difficulties to be overcome are, first, the retraining of personnel to use the new method, which will take a minimum of five years and which involves some knotty problems of internal administration, and second, some increase in the annual appropriations to the Weather Bureau, which can be unquestionably defended on the ground of large economic return to the country but which are difficult to obtain in these times of anxiety over federal expenditures, and which have not yet been granted by Congress.

Another great and essential scientific service of the Federal Government is the National Bureau of Standards, through which are maintained those scientific and technical standards which form the very basis of modern manufacturing methods, as well as of scientific and technical work generally. A peculiarly acute problem faces the Bureau of Standards because of the following situation, which is over and above the problem of decreased budgets which has faced the scientific services generally.

Because of the nature of the Bureau of Standards, it has been found to serve a useful purpose in setting the specifications for the purchase of all kinds of materials by federal agencies, such as army blankets, trucks for the Post Office Department, thermometers for the Veterans' Hospitals and thousands of similar items. Having set these specifications, it is then necessary for the government to test its purchased materials to find out whether they meet the specifications, and here again the Bureau of Standards has been found the most convenient, and in fact, the only government agency set up to make such tests. Consequently, a very large portion of the work of the bureau has come to be the testing of purchased materials for other branches of the government, although this work was not contemplated or provided for in the organic act which created the bureau. As a matter of fact, nearly half of the budget of the Bureau of Standards is required to carry on such work.

When the severe reductions in appropriations to government bureaus were made for the purpose of balancing the federal budget, the total appropriations to the bureau were cut nearly 50 per cent. It was impossible, however, for the bureau to reduce its expenditures for these government testing services because the government was continuing to purchase materials even on an increased scale. The fact that the bureau has had to continue this work undiminished has resulted in its crowding out of a large portion of the proper work of the bureau for which it was originally established, and this work, as a matter of fact, has had to be reduced at least 70 per cent. The problem of the Bureau of Standards has therefore been one of the most severe of any of the federal bureaus.

Three agencies have combined to make a joint study of this situation, the Science Advisory Board, the Visiting Committee of the Bureau of Standards, which was set up by Act of Congress, and the Committee of the Bureau of Standards of the Business Advisory and Planning Council of the Department of Commerce. This joint committee has made a detailed study of the activities and problems of the bureau and has recommended that certain activities be dropped, that others be transferred to non-governmental agencies where possible, that others be reduced for the time being and that still others be pushed forward and extended. Many of these recommendations have not been made because reduction or curtailment was desirable, but simply because curtailments *had* to be made somewhere because of the budget reduction.

The Secretary of the Interior asked the advice of the Science Advisory Board as to whether the Geological Survey and the Bureau of Mines should be combined or retained as separate bureaus. A study of the situation led to the recommendation that the bureaus should be maintained separately, though with minor readjustments of functions. There were two primary reasons for this recommendation, one that the objective and methods of the two bureaus were quite different, and the other that it would be difficult if not impossible to find one director for the combined services who would be sufficiently acquainted and sympathetic with both of them to prevent one or the other suffering from lack of leadership. At the same time the study disclosed a woeful inadequacy of statistical information in regard to minerals generally, and this at a time when such information is most urgently needed for the administration of the codes, of regulation of production and of tariffs and reciprocal trade agreements. It was therefore recommended that the agencies charged with collecting mineral statistics, which were spread over four bureaus in different departments, should be consolidated into one bureau of mineral economics and statistics. I am glad to say that these recommendations also have been adopted.

The Federal Coordinator of Transportation requested the Science Advisory Board to appoint a committee to cooperate with a committee of railroad presidents, for the purpose of finding out whether the railroads are making as effective use as possible of modern scientific and technical developments and to formulate a plan whereby the railroads may make as effective use as possible of such developments. This joint committee of leading railroad presidents and distinguished directors of industrial research has rendered its report in which broad policies for guiding and coordinating research work for the railroads were laid down. The results of this report are being crystallized in the newly formed Division of Planning and Research of the Association of American Railroads. There is no doubt but that the opportunities here are great and that the railroads are disposed to make every effort to utilize modern technology as effectively as possible, and it is perhaps fair to say that it is the human element in the situation, namely, the difficulty in finding properly qualified men to take charge of this work, which will be the limiting factor in the rate at which this program will be made effective.

One of the possible cures for the depression which has frequently been suggested is the creation of new industries, and the Secretary of Commerce has requested his Business Advisory and Planning Council and the Science Advisory Board to cooperate in recommending to him a program to this end. The assignment is a difficult one, for new industries are like babies—they need shelter and nourishment, which they take in the form of patent protection, financing and chance of reasonable profits. But, before all, they need to be born, and their parents are science and invention. Neither laws nor committees nor juggling acts can perform the necessary first step of conception. Also, like babies, new industries require time for growth. It is therefore evident that consideration of this problem involves stimulation of scientific research and engineering development, requires opportunities for financing and for the making of profits, which are rendered somewhat difficult under some of the more recent legislation, and requires a degree of patent protection which is difficult under our present system which is staggering along and almost swamped by the complexity of modern developments in the patent fields of types which were not contemplated when the patent law was originally drawn.

To cope with this situation the Science Advisory Board is making certain recommendations of government assistance in the stimulation of scientific work generally, and is submitting recommendations for certain modifications in patent procedure which should greatly improve the present situation without changing the general structure of patents. Some of the situations which these recommendations are designed to meet are the following.

The load on the Patent Office, from the enormous number of applications to patent all things from the trivial to the important, is such that adequate examination of prior art is impossible. For this reason the assurance of a patent does not now carry with it the proper validity and, in fact, I am told that over 65 per cent. of all patents which come up for litigation are declared invalid by the courts. The situation is so bad that it has come to be said that a patent is simply an invitation to sue.

A second difficulty lies in the time and expense and doubtful outcome of patent litigation. The expense has become so great that some large organizations are seriously questioning whether or not their research organizations are an economic gain or loss, and others are avoiding patents and seeking security in secrecy.

A third difficulty lies in the complexity of modern inventions, whereby a single product may involve a large number of different patents often held by different individuals. If any one of these individuals refuses to grant license under his patent, he may entirely block production of the product. It is this situation which has forced organizations to seek to acquire complicated patent monopolies which in turn have not been looked upon with favor by the courts. The situation is well-nigh an impossible one in its present form.

Through wide consultation and correspondence, a general consensus of opinion has been found in support of certain remedies for these situations, and these will soon be submitted to the secretary as a partial answer to his request for a plan for the stimulation of new industries.

One of the most far-reaching services of the government is its work in surveying and mapping. An accurate map of the United States is a prerequisite of all types of construction and planning. The standard map of the United States is less than half completed, and until the work is finished millions of dollars will be wasted in temporary and uncoordinated surveys which are found necessary by municipalities or states or construction agencies to handle their particular jobs. We are the only progressive nation in the world whose country has not been adequately surveyed and mapped.

There are more than twenty bureaus in the government which have mapping activities. The question has frequently been raised, "Should not these be consolidated?" This question has been investigated by the Science Advisory Board at the request of the Director of the Budget and a report with recommendations has been submitted to him. Among the interesting considerations are the following.

In some bureaus the production of maps is not a major objective, but maps are produced and used only as tools in the attainment of some other objective. In the case of other bureaus, however, the sole purpose of the bureau is to produce maps. As a basic principle it may be suggested that the tools should not be taken away from the people who need to use them. In other words, the subsidiary mapping services should not be consolidated into a federal bureau. On the other hand, a strong argument for efficiency can be made for the consolidation of those services whose sole objective is the production of maps. This argument is based upon efficient use of personnel the year round, elimination of duplication and uniform adoption of the most modern and efficient methods. On the other hand, there may be good reasons for the maintenance of separate units in several cases. For example, in the military services, military necessity or secrecy or the maintenance of a staff under immediate military control may be important factors.

This question has been frequently discussed by previous commissions and before Congress, and there are amusing illustrations of arguments pro and con which have been invented to impress Congress without adequate basis of fact. From the standpoint of national efficiency it is highly important that some action should be taken, but any action which involves the transfer of established bureaus meets with a type of opposition which is politically difficult to overcome. We very much hope that the present effort may meet with a degree of success which has been denied the more than a dozen previous efforts which have been made to effect an improvement in this field.

It has been very difficult to secure an unbiased opinion regarding the economic possibilities of mineral development in the region of Boulder Dam with the utilization of the electric power there developed. Perhaps because of the great industrial and political interests involved, the Science Advisory Board was called upon as a disinterested body to make a survey and report on this matter. This work was carried out in three steps: first, a factual survey by the Geological Survey of the extent, grade and accessibility of the mineral deposits within reach of electric power of the Boulder Dam; second, a determination of the cost of production of the various products obtainable from these mineral deposits; and third, a consideration of such economic features as transportation costs to the point of demand and the effect of such production on similar industries in other localities. The result of this study has been the publication by the Department of the Interior of a factual analysis from which can be selected those products which can profitably be developed and those other products whose development at the present time would be economically impossible or undesirable in competition with other sources of supply.

The Department of Agriculture carries on more scientific work than any of the other departments. This work is found in about ten out of the eighteen bureaus of the department. Many of these bureaus are almost independent organizations and there is a considerable amount of duplication of effort and of facilities. Some of this duplication is necessary to the efficient performance of work, while in other cases a more effective coordination would undoubtedly be advantageous. The Secretary of Agriculture requested the Science Advisory Board to give particular attention to the Bureau of Chemistry and Soils in its relation to the chemical work of other bureaus. It has sometimes been suggested that all chemical work of the government should be concentrated in one comprehensive bureau of chemistry. On the other hand, it is pointed out that chemistry is frequently a tool which is needed by a worker in some other field where the objective is not primarily chemical in nature. It is obviously a very difficult matter to ascertain that most effective degree of consolidation or the best type of coordination of such work. A distinguished committee has been giving attention to this problem, bringing in the benefit of the best industrial experience as well as expert knowledge of chemistry. This committee has found certain difficulties which are peculiar to the government organization and which probably preclude an ideal solution to the problem. In view, however, of the millions of dollars which are spent on research in this department, it is decidedly to the public interest to see that this work is being done with the maximum effectiveness, and the officials of the department are cooperating with the committee in an effort to find a solution which will be as nearly ideal as possible and at the same time practicable within the limitations of government operation.

These illustrations, taken from the varied activities of the Science Advisory Board, will show something of the interest as well as the complexity of the government's work in the varied fields of science. Beyond these particular services attached to existing bureaus, there lies, however, an immense field of government responsibility in which science plays or may play a prominent part, and I would next comment briefly upon the opportunities and responsibilities which the government may have in this larger field.

There are important national problems like insanity, crime, public works, unemployment, excess agricultural production, land use and power utilization, which are of great concern to government but for which the responsibility extends beyond the jurisdiction of governmental bureaus to states, municipalities and to the people as a whole. They involve considerations of care, relief, control and management which are the subject of governmental action involving enormous expenditures. They are the concern of the social scientists in order that this care, relief, control and management may be wisely conceived and administered. But they should also be the concern of the natural scientists in two main aspects: first, to ascertain the facts which are susceptible of scientific observation or measurement, in order to supply social scientists and government with data essential to their activities; second, to alleviate or cure the difficulties where this is possible by applications of science, as illustrated below.

The magnitude of the purely economic aspect of these problems is realized by very few people. In the case of mental illness alone, approximately 20 per cent. of the state budgets goes to care of the mentally diseased. Past experience and present knowledge both indicate that science will probably succeed in alleviating or partially curing all these difficulties if given adequate time and opportunity. It is obviously in the public interest, therefore, that this opportunity should be given and that this should be done as rapidly as the scientists themselves are able to handle the opportunity. As an investment for the future, or an insurance against future expenditures, and at the same time as a social obligation, the government has a great responsibility in seeing to it that work along these lines is pushed as vigorously as possible. The Science Advisory Board is prepared to cooperate with other agencies in pointing out this responsibility and urging that the government accept it.

If time permitted it would be possible to analyze these problems in greater detail and to submit specific programs for work in pure and applied science whose social value is unquestioned and which can be laid out with some degree of assurance on the basis of present knowledge. I would simply mention, by way of illustration, such matters as tropical diseases, long-range weather forecasting, development of new and improved uses of electric power, discovery of new uses for agricultural products, elimination of specific hazards in navigation, etc.

It is interesting and somewhat disheartening to note that our country, with all its boasted progressiveness, has paid less official attention to science as a means of combatting our present difficulties than any of the other great powers.

Russia, seeing what science has done in raising the standard of living in other countries—especially in our own country—is centering her whole economic program on science. She has used, as the central feature of this program, the Academy of Science, founded by Peter the Great. Under this have been established more than two hundred great research institutes for work in pure science and engineering. Her annual appropriations for these institutes are reported to be larger than any other items in her budget—even the military and defense item.[2] Many of her scientific laboratories rank among the best-equipped laboratories in the world at the present time. Though short of trained workers, they are already turning out some first-class work, and a well-considered program of selecting and training research workers has been instituted.

Great Britain also has taken decisive steps to utilize science for social and economic improvement, despite the fact that she was harder hit than we by the war, her unemployment crisis came sooner, her taxes are higher. She has called her leading scientific men to advise her privy council on scientific and technical policies, through three advisory councils composed of Britain's most noted scientists. It is on advice of these councils that the programs and budgets of the government's scientific bureaus are determined. The government, furthermore, appropriates about a million pounds annually, to be used for research. On advice of the advisory council, appropriations are made to governmental scientific bureaus and grants for research are made to educational institutions and scientific societies; also for research fellowships, and for support of industrial research by trade associations, provided these associations match the grants with similar contributions from their own funds. In this latter way, programs of research have been inaugurated in twenty-one of the most important industrial associations.

Italy has mobilized her research facilities in a broad-scale effort to rehabilitate her economic position, and to counteract her deficiency in raw materials through application of her "brain power" to the most effective use of what she has. The government has appropriated large sums for the better equipment of university research laboratories and all work in these institutions and in governmental laboratories is supervised by a National Research Council. Furthermore, no governmental financial assistance is given to industries unless this Research Council certifies that the industry maintains a progressive policy of research and development.[3]

Until recently Germany led the world in her sustained efforts to maintain a strong economic position through scientific research, notably in the fields of chemistry and metallurgy. Every one knows the success of this policy, until it was largely wrecked by other circumstances. Her scientific strength, however, is still probably Germany's strongest economic asset.

Japan, for years, has been bending every effort to introduce western technology into her industrial procedures. Begun as a policy of copying technical processes and products which had been developed elsewhere, it was accompanied by an intensive program of scientific education of her own scholars. She is now in a position to lead as well as to follow in scientific work of high quality, and this is bearing fruit in her industrial position.

Compare this picture with that of our own country. As soon as we got into trouble we cut our governmental expenditures for scientific work *more* severely than those of any other government activity. We gave no consideration either to unemployed scientists or to the public value of their work in our emergency measures for relief of unemployment or for economic rehabilitation. And yet we have prided ourselves as being the most advanced nation on earth!

The truth is that we have been fortunate enough to have great natural resources, which we have exploited riotously; we have had a pioneering spirit which has bred some great inventors; this same pioneering spirit has developed some industrial giants who have plunged into big things and have brought "quantity production" into operation; we have been blessed with a few great philanthropists whose altruistic vision has led them generously to support scientific work and other activities for human welfare in universities and other private institutions. But, as a people and therefore as reflected in our national policies, we have been more lucky than intelligent. Now that we are no longer able to thrive on the unrestricted exploitation of the gifts of nature, it is imperative that we take steps to utilize our resources more intelligently and effectively, and this means scientific research on an increasing scale.

In conclusion, it seems to me that what is needed is a bilateral program for putting science to work for the national welfare. There is needed on the one side the cooperation of the scientists of the country generally, to assist the government in putting the work of its scientific bureaus on a scale of maximum efficiency and value. There is needed on the other hand a new type of government leadership whereby the scientific men of the country may be brought together to make an intelligent and coordinated attack on the great problems which are facing the country at those points at which science may offer hope of alleviation or solution.

Under these circumstances it seems to me certain that scientists will have to play an even more important rôle in the future than in the past. The problems to be solved are more complex, greater intelligence is

[2] Report by Dr. Julius F. Hecker, of Moscow University, who was sent to the United States to arrange for a system of exchange research professorships between the United States and the U. S. S. R.

[3] Report by Mr. Maurice Holland, director of the Division of Engineering and Industrial Research of the National Research Council, following his recent study of conditions in Italy.

needed in handling them, the scientific approach rather than the political or opportunistic approach is demanded. Whether directly in the government service or indirectly in universities or industries of the country, there is no doubt but that men of the type found in the Society of Sigma Xi will find ample scope for their best efforts and in those efforts they will find careers of usefulness and of satisfaction.

OBITUARY

JOHN JAMES RICKARD MACLEOD

JOHN JAMES RICKARD MACLEOD, M.B., Ch.B., D.Sc. (University of Toronto 1923, University of Pennsylvania 1928, Jefferson Medical College 1928), LL.D. (University of Aberdeen 1924 and Western Reserve 1928), D.P.H. (Camb.), F.R.S., F.R.S. (Can.), was a son of the manse, born at Cluny, near Dunkeld, Scotland, in 1876, a son of the Reverend Robert Macleod. He was educated at Aberdeen Grammar School, Marischal College, Aberdeen and Cambridge University.

After a short period of postgraduate study on the Continent and in London, like many another Scot, he migrated to the United States. At the early age of 27 years, he was appointed professor of physiology at Western Reserve University, Cleveland, Ohio.

Here he established for himself a reputation as a teacher of physiology and an investigator in the field of carbohydrate metabolism, which attracted the attention of the authorities in Toronto. In 1918 Professor Macleod was appointed to the chair of physiology at the University of Toronto, where he remained till 1927. He took a keen and deep interest in medical education and was instrumental in the establishment of the six-year course in medicine at the university here.

Soon, his laboratory attracted a group of young workers in physiology. It was due to Professor Macleod's established reputation as an authority in carbohydrate metabolism that Dr. Banting, now Sir Frederick, came to Toronto to consult him and to pursue his investigations on the pancreas with the assistance of C. H. Best, then a young assistant, who eventually succeeded Professor Macleod as professor of physiology at the University of Toronto. These investigations led to the brilliant and important discovery of insulin by Dr. Banting and Mr. Best.

With the aid of Dr. J. B. Collip the first stages of purification of insulin were undertaken and arrangements made for its commercial production. For the final purification, a large group of workers contributed, including Professor P. A. Shaffer, of Washington University, St. Louis, and Professor J. J. Abel, of the Johns Hopkins University, Baltimore.

In recognition of this very important discovery, Dr. Banting and Professor Macleod were awarded jointly the Nobel Prize, the former sharing the award with Dr. Best and the latter with Dr. Collip.

In 1927 Professor Macleod returned to his alma mater as Regius professor of physiology, an honor which he himself valued greatly. At the time of his death he was chairman of the department of research in the Rowatt Institute of the University of Aberdeen.

Many outstanding honors were accorded him from universities and scientific bodies in Canada, the United States and Great Britain, and he was the author of numerous books of physiology and biochemistry. Among such honors was the fellowship of the Royal Society, presidency of the American Physiological Society in 1922, the Royal Canadian Institute in 1925, fellow of the Royal Society of Canada, honorary fellow of the Academy of Medicine, Toronto, foreign associate fellow of the College of Physicians of Philadelphia, and corresponding member of the Medical Chirurgical Society of Bologne and of the K. Deutsche Akad. Natur-Forscher zu Halle. He was the winner of the Cameron Prize at the University of Edinburgh in 1923, and was a member of the American Physiological Society, the Society for Experimental Biology and Medicine, the Society of Biological Chemistry, the Association of American Physicians, the American Association for the Advancement of Science, the London Physiological Society and the Biochemical Society.

He is survived by his widow, Mary McWalters. He had no children.

VELYIEN E. HENDERSON
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RECENT DEATHS

ERNEST B. SKINNER, professor emeritus of mathematics, for forty-two years a member of the faculty of the University of Wisconsin, died on April 3. He was seventy-one years old.

PROFESSOR THOMAS CRAMER HOPKINS, until his retirement in 1931 head of the department of geology at Syracuse University for thirty-one years, died on April 3 at seventy-three years of age.

Nature reports the death of Dr. B. M. Wilson, professor of mathematics in University College, Dundee, formerly lecturer in pure mathematics in the University of Liverpool, on March 18 at the age of thirty-eight years, and of Major-General Sir Richard M. Ruck, of the Royal Engineers, known for his scientific work in submarine mining and chairman of the council of the Royal Aeronautical Society from 1912 to 1919, on March 18, aged eighty-three years.