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SCIENCE AND GOVERNMENT

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THE term "science" is in some ways ambiguous and confusing: to some it merely connotes an area or field of study—science as distinguished from art or literature; to some it suggests a body of exact principles regarded as of fixed and unchanging character—called a science; to still others it means a particular method of analysis—the method of science. What we are really interested in should be the scientific spirit, which is an attitude of mind, rather than a field of inquiry, a body of principles or a particular method of analysis.

The objective, open-minded, scientific outlook is not restricted to natural phenomena or to any particular field of investigation, nor is there any single methodology or technique for scientific inquiry. There are as many different methods of observation, experimentation and analysis as there are divisions of science. Even a single research project may require the use of several methods. True scientists are alike only in their pursuit of the common purpose of deriving their conclusions from ascertained facts.

It is this scientific outlook, this scientific attitude, this scientific frame of mind with which we are concerned when considering the problems of modern government. If we are to conduct the greatest of all businesses, namely, that of government, with even a reasonable degree of proficiency, if we are to maintain a stable and efficient democratic, political system, it seems obvious that the effort must be increasingly animated by and permeated with the scientific spirit.

This is because of the preponderant, if not controlling, importance of government in the entire scheme of things.

SCIENCE, INVENTION, BUSINESS ORGANIZATION, ECONOMICS AND GOVERNMENT

The overwhelming importance of government requires amplification. The achievement of higher standards of living depends basically upon the combined influence of the following factors: (1) Natural and human resources; (2) scientific discoveries; (3) inventions; (4) engineering applications; (5) business organization and management; (6) the economic system; and (7) the governmental system. Scientists, inventors, engineers, business managers and professional students of economics and government are in final analysis cooperating in a common objective—that of increasing the capacity of the people to satisfy their wants.

Each of these groups naturally likes to think of itself as of primary importance; but the sanest conception is that each group is an essential part of a larger whole. Scientific discoveries would not yield practical results if we did not have invention; patented technological apparatus and devices would be impotent were it not for engineering applications to productive processes; engineering can function only in conjunction with a business enterprise which appraises the feasibility of new developments in relation to other factors of production and the potentialities of profit and loss; the individual business enterprise in turn will be thwarted if the economic system is defective; and the function of the economic system is in turn dependent upon the character of the governmental organization which has been developed.

As a result of a combination of developments, which can not here be summarized, these various factors came to work together so effectively as to give us a century or more of phenomenal progress. As we look foreward, continued advancement will depend upon the degree to which we can continue to make these interrelated parts of the complex society in which we live work effectively together.

I venture to suggest that the surest means of resolving the prevailing confusion of our time and of finding solutions to the baffling problems now confronting civilization lies in a reintegration of knowledge through the systematic study of the various fields of science conceived as a whole. This is the primary responsibility of the university, the very name of which denotes the universality of its interest. This is the only agency of sufficient breadth and scope to envisage and comprehend the problem as a whole. But the university can not succeed if it merely aspires to be universal in the sense of touching all fields. It must somehow integrate the various fields of knowledge.

SCIENCE IN GOVERNMENT

Is this greatest of all businesses—upon which every other business depends—conducted on scientific principles? As the job to be done grows in magnitude and complexity does it tend to become more or less scientific? What, if anything, can individual scientists or the scientific societies do to further the development of science in government?

It should be pointed out in the first place that government agencies—federal, state and local—have long recognized the importance of science and scientists. For more than a century the government has in one way or another fostered and actually conducted scientific work in various fields. This is well illustrated by the organization of such agencies as the U. S. Geological Survey and the Bureaus of Reclamation and Mines. In the fiscal year 1938 the federal government spent $8,940,000 on aviation service and development; $4,876,000 on the Bureau of Plant Industry; $2,875,000 on the Bureau of Engineering, and $2,214,000 on the Bureau of Entomology and Plant Quarantine. Other agencies devoted to scientific work, with expenditures running well beyond a million dollars, were the Forest Service, the Ordnance Department, the Bureau of Mines, the Soil Conservation Service, the Bureau of Animal Industry, the Bureau of Chemistry and Soils and the National Bureau of Standards. Surveys and maps in that year cost the federal government $11,185,000. In the field of social science and statistics expenditures ran to $18,552,000 for such bureaus as Census, Agricultural Economics, Foreign and Domestic Commerce, Labor Statistics, and such commissions as National Bituminous Coal and United States Tariff.

The grand total for research expenditures in that year from the regular funds of the Treasury amounted to $77,443,000. The number of scientists in the employ of the federal government was more than 40,000 in 1939. In war-time, of course, it is very much larger.

The government has also recognized the importance of using the scientific resources of agencies outside the government. Mention need only be made of the National Academy of Sciences, the National Research Council and the Social Science Research Council.

SCIENTIFIC RESEARCH INTO GOVERNMENT OPERATIONS

The discussion which we have just concluded has related to the actual conduct of scientific research by the government and to the use of scientifically trained men by the government in connection with its manifold problems. Attention must now be called to the fact that there has also been no small amount of scientific research with respect to the operations of government itself.

The federal government has from time to time sought or availed itself of the aid of scientific experts in the field of public administration. For example, the Government Research division of the Brookings Institution was responsible for the establishment and the early development of the budget system of the United States government. In innumerable cases this institution has been called upon both by committees of Congress and by government departments for advice and counsel with respect to both administrative and economic problems. Other scientific agencies have also made studies of federal government operations, and the counsel of individual scholars has been sought very frequently.

Similarly, state and municipal governments have been availing themselves increasingly of the services of trained students of public administration. The Brookings Institution has made comprehensive surveys of the administrative organization of some seven states. Other scientific groups in this field have made many studies of state, and especially of local, government problems. Twenty-nine states now maintain fully staffed legislative reference services to obtain information regarding the subject-matter of proposed laws and to assist in the drafting of bills. Eight states have organized legislative councils to study problems of government in the interim between sessions of the legislature. While these are composed of members of the legislature they usually have permanent staffs to make studies of matters which will be the subject of legislation at the next session.

The organization in 1907 of the New York Bureau of Municipal Research marked the beginning of systematic study of city government administration. At the present time there are over 200 agencies devoted to research in the broad field of government. Of these eight are national in scope, 57 conduct state-wide activities, and 140 are concerned with purely local problems. In addition, 29 universities and colleges maintain separate departments devoted to administration and government. Most of these agencies receive their funds from private sources.

From the factual information which has here been presented it is evident that our governments have not been unaware of the existence of science and scientists. Enormous sums of money are annually spent by the government in fostering scientific research; the government departments and bureaus are manned by an abundance of personnel with excellent scientific training; and extensive use is made by government of scientific agencies. At the same time many agencies have been devoting themselves to the scientific study of government operations.

And yet it is unfortunately true that major governmental policies appear to be formulated and administered with little regard to the scientific point of view. In our darker moods it almost seems as though science were ignored entirely.

Sources of Weakness

The failure of the government to make more effective use of science in policy determination is attributable chiefly to shortcomings in the organization of our governmental and political system.

In the first place, a large proportion of the scientists employed by the government are specialists in particular bureaus or agencies and are in no wise concerned with policy formulation. They are simply "doing their scientific work," much as individuals in universities and industrial research laboratories carry out their favored projects. In the departments or agencies which are more directly concerned with policy the scientist's is not the determining voice. Policy determination lies chiefly with the overhead administrators, who are nearly always political appointees.

Even in cases where the scientist has a part in the formulation of a department's or bureau's policy the result which can be achieved is limited by the lack of coordination with other departments. No means exists whereby a scientifically determined policy in one department can be articulated with the policies of other departments. In other words, there is no means whereby groups of scientists in the government can collaborate in the working out of an integrated program.

It should be recorded here that scientists in the government are all too often interested chiefly in the maintenance of their particular jobs and their organizational set-up. Through their bureau chiefs they lobby for the continuation and expansion of their work, and they steadfastly resist reorganizations which might adversely affect their particular interests. Moreover, all too few research projects conducted within the government have any terminal dates. They continue year after year, the results often growing thinner and thinner, although there is no reduction in the amount of money and personnel utilized.

The second difficulty is more or less inherent in the varied character of our representative government. Laws are made by Congress and congressmen represent the people of their districts. Our system as a practical matter operates on the conception that congressmen are the mouthpieces of their constituents, not the brains thereof. Because of this and the added fact that reelection is a pressing problem, it is difficult for congressmen to take a genuinely national point of view with respect to many types of legislative measures.

This fundamental shortcoming is in some degree mitigated by the system of standing committees where legislative measures are formulated. These standing committees as a rule undoubtedly consider their problems from a much broader point of view than can the individual congressman. But they are nevertheless subject to pressures from their own constituents and they of course recognize that the recommendations of the committee must meet the approval of Congress as a whole. Hence they may refrain from recommendations which they would like to see incorporated because of the knowledge that the temper of the country and of Congress is hostile.

The prevailing philosophy has been that if we follow the "will of the people" we will not go far wrong. But even when the people of the various sections of the United States are well informed a majority vote recorded through their elected representatives will not necessarily yield a scientific result. Suppose, for example, an omnibus waterway bill is before Congress, a bill which authorizes expenditures on harbors, canals, rivers and creeks located in 40 states. The people of each of these states may well be for this bill because of the local benefits conferred, whereas the representatives of the other states might well be against it. The bill would carry not because either group had looked at the problem of waterway expenditures from the standpoint of the most economical type of national transportation, but simply because those who stood to get some local aid from the federal treasury outnumbered the others.

A very wise candidate for the presidency long ago refused to take a stand on the tariff because, he said, the tariff is a local issue. What he meant was that no section of the country looked at the tariff from a national point of view. The people of each section were for it or against it depending on how they thought it might affect their particular regions.

To guard against a faulty impression, let me now add that in numerous fields, and I think increasingly as the years pass, congressional committees, with the aid of scientifically trained personnel, are giving attention to the broader national implications of policies. But so long as they are subject to pressures which arise from the self-interests of local constituencies there will be very real limits to the extent to which an over-all objective scientific point of view can be obtained.

There remains to be considered the factors which influence the most powerful agency in the formulation of national policies, namely, the presidency. The President has at his command the scientific resources of all the various scientific bureaus and agencies. At the present time he also has an extensive personnel that is under the immediate direction of the Executive Office. Moreover, he is privileged to call upon the services of scientific groups and individuals who are not directly connected with the government.

A president may use the findings of scientific agencies in a truly scientific way—for the purpose of developing the soundest possible national policies. Or he may use these resources for the purpose of support for policies which have been predetermined by political considerations. As the primary seat of power, the President is in a position to exert pressure throughout the administrative personnel of the government. The scientific personnel in government departments may assemble the data required with true scientific objectivity; but they are usually debarred from interpreting the meaning of the data or formulating conclusions to be drawn therefrom. This, as previously indicated, is the function of the bureau chief who is nearly always a part of the political hierarchy. In short, scientific men can be scientific up to a point; and the point beyond which they can not go is usually the vitally important point.

The President occupies a much more detached position than do the members of Congress, especially of the House of Representatives. As the representative of all the people he is able to think more nearly in national terms. But the President is head of his party and he must be constantly looking forward to the reaction of the public to the party's policies. Before he is well seated consideration must be given to the biennial elections of the House—because it is necessary to maintain control in the House. Very soon he must be thinking of re-election for a second term, or at any rate to the maintenance of the party in power. For these reasons he can not overlook the bearing of legislation upon particular states because it is commonly essential that certain key states be carried by the party. So long as we have a party system dependent for its perpetuation upon the goodwill of the people, popular reaction to national policies will play a role of great importance, and popular opinion is not synonymous with scientific opinion.

To some the easy answer to the problem of efficiency in government is simply to elect better and abler men—for both congressional and administrative offices. In so far as this can be achieved it would of course be helpful; but the able, objective, scientific man may rightly feel that the opportunity under all the circumstances is not an engaging one. The scientific man does not make a good mouthpiece. He likes to think for himself. And since he is constrained by the facts, he is not likely to be the most effective type of campaign orator.

The general conclusion to which this discussion leads is that there is no easy road to efficiency in government. All of us—scientists, business men and lay public—must take an active and continuous interest in government—federal, state and local. We must inform ourselves on the issues involved in succeeding campaigns. We must elect honest, public-spirited and able servants. We must if possible make public office-holding—all along the line—a high calling, a worthy and rewarding career for any one. But this can not be fully accomplished until the federal government is so organized as to permit and foster thinking on the part of our representatives in terms of the national welfare as a whole rather than in terms of sectional and local special interests.

WARTIME CHEMICALS FROM NATURAL GAS. II

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With the number of research men in the field of synthetic rubber, with expenditures of millions of dollars yearly, one can feel confident that synthetic rubber tires will evolve with a life of at least 100,000 miles or, expressed another way, the tires may well outlive the motor car.

As far as the author is concerned, synthetic rubber in the United States is here to stay and will be a permanent industry during the next peace period. With the fall of Singapore our greatest source of natural rubber was cut off. Natural rubber (December, 1941) cost about 22 cents per pound. The price ranged through the years from 3.5 cents to over one dollar per pound. It can be stated that synthetic rubber in mass production will cost less than 15 cents a pound.

Does this mean that natural rubber will not have its uses? As far as tires are concerned, it will not have the dominating position it has held heretofore. One may be certain that as good as synthetic rubber is to-day, it will be far surpassed by that yet to come. The properties of the rubber desired will be under close chemical control based upon the high purity of the components started with, catalyst and precise conditions to yield the finished product. Natural rubbers vary widely in properties, due to many factors. Producers of natural rubber depend upon the life cycle of the rubber tree, climatic and soil conditions, while the chemically produced rubber will have the exact properties for which its structure and use was designed. Natural rubber contains a number of unknown components, whereas synthetic rubber has one, two or three components of known characteristics.

Natural gas is an important source of high explosives. Natural gas in some parts of the country is being cracked into hydrogen, which is combined with the nitrogen from the air, producing synthetic ammonia. The ammonia is readily oxidized with air into nitric acid. Combination of the ammonia and nitric acid produces ammonium nitrate.

In World War I the maximum toluene production was at the rate of 15,000,000 gallons a year, and practically all came from coal carbonization plants to derive coke for steel making, with toluene as a by-product. The toluene production in World War II from coal carbonization is at the rate of over 25,000,000 gallons a year. According to published reports the demand for toluene is from 250 to 300,000,000 gallons a year—the difference between the volume of toluene from coal and the total demand will come from petroleum, *i.e.,* ten to twelve times as much from petroleum. In comparing the two wars the increased demand for toluene is from sixteen to twenty times. On a T.N.T. basis World War I called for 150,000,000 pounds, whereas the present war calls for 3,000,000,000 pounds a year. Benzene is readily converted into carbolic acid or phenol through chlorination and hydrolysis. Combine the phenol with nitric acid and pictric acid is the result, a high explosive, and when synthetic ammonia reacts with picric acid, ammonia picrate is formed, another high-grade explosive. The ammonium picrate is relatively stable, but when picric acid is used, it reacts readily with iron to form iron picrate, a very unstable compound that has a habit of exploding when least expected. That is what happened in a number of plants in World War I.

Many natural gases contain hydrogen sulfide, which when oxidized with air is converted to sulfuric acid necessary in so many arts, particularly high explosives. A number of commercial units are producing sulfuric acid based on hydrogen sulfide or elemental sulfur produced from natural gas as a starting material. So we have sulfuric and nitric acid, both produced from natural gases, raw materials necessary for high explosives needed in this present war, some of which are on a scale over twenty times that of World War I.

An important substance in war is glycerine for the production of trinitroglycerine, the commonest form of which is dynamite. The main source of glycerine has been in the splitting of fats to glycerine and fatty