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Organization of Science in the United Kingdom

There are significant differences as well as similarities between U.K. and U.S. national science patterns.

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In this article I shall not attempt to give a detailed picture of the organization of science in Britain but rather to sketch in some of the principal features of the British setup and to indicate the manner in which these differ from, or are similar to, the pattern in the United States.

In order to get our sights adjusted I should, perhaps, remind you that the population and area of the United States are about 3.3 times and 38 times, respectively, the population and area of the United Kingdom.

Unfortunately there are no authoritative up-to-date and comparable figures for expenditure on research and development in the two countries, but in 1957 expenditure in the United States was probably about $7 billion and in the United Kingdom, about £350 million. Each of these figures is very nearly 1.6 percent of the gross national product, and—although my figures are subject to correction—it is, I think, fairly clear that, on this basis, the scales of expenditure on research and development in the two countries are of the same order.

It is when we examine the sources of these vast sums that differences emerge. In the case of the United States, it is probable that about 50 percent of the total is government expenditure, whereas the corresponding figure for the United Kingdom is probably about 75 percent. Thus, government looms much larger in the United Kingdom science picture than it does here.

Now let us consider the United Kingdom picture in somewhat greater detail.

Industry. Although it can be deduced that expenditure on research and development by private industry is significantly less in the United Kingdom than in the United States, the pattern and objectives are much the same except in one important respect (the Research Associations), which I will refer to later.

Government. Here the organizational pictures differ from each other; Fig. 1 gives a highly simplified representation of the British organization.

Defense Research

The right-hand section of Fig. 1 represents defense research. Although defense research runs away with so much of the money, its organization and objectives are fairly obvious. Defense research is, of course, aimed primarily at satisfying the requirements of the defense departments; it is largely concentrated, as far as the Navy is concerned, in the hands of the Royal Naval Scientific Service (this is a civilian service), and as far as the Army and Air Force are concerned, in the Ministry of Supply, which is a civilian department set up during World War II to satisfy the requirements of the War Office and the Air Ministry.

A substantial amount of this defense work has important civil applications. Examples of this are the work of the National Institute of Oceanography, which is controlled by the Admiralty; the Royal Aircraft Establishment (the largest scientific establishment in the United Kingdom), which is controlled by the Ministry of Supply; and the Meteorological Office, which is controlled by the Air Ministry.

Civil Research before 1914

Although the association of government and science in the United Kingdom goes back for some hundreds of years, official interest in science before the present century was confined almost wholly to the direct requirements of the administration or the defense of the realm. Thus, in 1675, Charles II established the Royal Observatory at Greenwich, so that tables of the position of the moon and the fixed stars could be corrected "for the use of his seamen." The Geological Survey was founded in 1835, and the Meteorological Office, in 1854, but it was not until the closing years of the 19th century that the Government was made to realize that science had something to contribute to the general welfare of the nation.

This came about, at least in part, through the efforts of the British Association for the Advancement of Science, which asked itself why Germany was beginning to oust the United Kingdom as the foremost manufacturing nation in Europe and decided that one reason, at least, was that the German Government was supporting scientific work in such establishments as the Physikalische Technische Reichsanstalt. After some years of agitation and negotiation, a small grant of government money and Queen

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Victoria's agreement to the use of Bushy House were obtained to enable the Royal Society to found the National Physical Laboratory. This laboratory came into being on 1 January 1900 (and was, by the way, followed by the third great standards laboratory—your National Bureau of Standards—about 1½ years later).

(The British Association, which is our equivalent of the American Association for the Advancement of Science, has, by the way, during its 127 years of life, played an important part in keeping the country informed on the aims and achievements of science. Man has released vast forces of nature which he is still struggling to control. An understanding of these and of the possibility of using them for the benefit of mankind is necessary for every thinking person who wishes to understand the contemporary scene.)

Although the formal terms of reference of the National Physical Laboratory covered only the testing of instruments and materials, a strangely prophetic speech was made by the Prince of Wales (later King George V) in 1902, at the opening of the laboratory's then new engineering building, when he said:

"I believe that in the National Physical Laboratory we have the first instance of the State taking part in scientific research. The object of the scheme is, I understand, to bring scientific knowledge to bear practically upon our everyday industrial and commercial life, to break down the barrier between theory and practice, to effect a union between science and commerce."

Although we are now familiar with such ideas, they were quite revolutionary 57 years ago. From 1909 on, however, the Government assumed a wider responsibility for promoting and encouraging scientific research, and since that time the form and extent of government assistance have been adapted to meet the rapidly changing conditions in industry and education. Even so, the Government worked mainly through grants to committees and learned societies until the importance of scientific research was emphasized by the lessons of World War I.

General Coordination of Government Research

Before the emergence of cabinet government in the 18th century, the chief source of executive power in Great Britain was the Privy Council. The Privy Council Office still exists and is controlled by a senior cabinet member, the Lord President of the Council. When research councils were established they operated under committees of the Privy Council, and we have a situation in which the Lord President, who is, therefore, responsible to Parliament for the work of the research councils, has come to be regarded as having a general oversight of scientific matters.

At the end of World War II, the Government established an Advisory Council on Scientific Policy to advise the Lord President on his various scientific responsibilities. The Minister of Defence is advised by a parallel committee—the Defence Research Policy Committee—and some members are common to the two committees.

Civil Research after 1914

In 1916, the Department of Scientific and Industrial Research was established as a separate government department. Financial control of the National Physical Laboratory was transferred to this department, although the "management" of the laboratory's scientific work still remains the responsibility of the Royal Society. The Department of Scientific and Industrial Research now has 14 research stations (for example, Geological Survey, Road Research, and Radio Research) and is associated with the setting up and operation of 46 industrial Research Associations. It also administers an Overseas Liaison Division, which services the scientific attaché program. Hence, my administrative base is the Department of Scientific and Industrial Research, although I do not by any means spend the greater part of my time on matters of concern to that department.

The Department of Scientific and Industrial Research is a full department of state and operates directly under an executive council known as the Research Council. The department's senior officers are scientists, and all its secretaries (the title by which the permanent heads of most British Government departments are known) have, with the exception of the first, been eminent scientists such as Sir Henry Tizard and Sir Edward Appleton. There is no strict parallel to this department in the American scientific scene, although the National Science Foundation fulfills here many of the functions of the Department of Scientific and Industrial Research in the United Kingdom; however, the National Science Foundation does not run its own laboratories.

One factor in the operation of the department is of particular interest. It works on a quinquennial basis in regard to financial and staff allocations, because it is recognized that a year is now an insufficient period of time for the successful planning and completion of scientific work and for the manufacture of expensive research tools—for example, the National Physical Laboratory ship tank.

The Medical Research Council and the Agricultural Research Council were created in 1920 and 1931, respectively. These councils also operate laboratories, maintain research units at universities, and make research grants. They differ, however, from the Department of Scientific and Industrial Research in that they obtain their funds by grant-in-aid and not on a direct parliamentary vote. This means that the councils have considerable freedom within the limits of total funds made available and that they are not subject to direct departmental control.

Many of the executive departments of state have scientific advisers, and some operate their own laboratories—for example, the Post Office and the Home Office (the counterpart of the U.S. Department of the Interior).

Atomic Energy

Prior to 1957, the Lord President was also responsible to Parliament for atomic energy policy in general. In April 1957, the Lord President's responsibility was transferred, by Order in Council, to the Prime Minister. The development of new sources of energy for peaceful purposes is of the highest economic importance in the United Kingdom because of our lack of indigenous fuels.

Research on both civil and military applications of atomic energy is carried out in the main by the Atomic Energy Authority itself. The Authority, which was established as a public corporation by act of Parliament in 1954, has quasi-governmental status and is subject to broad but not day-to-day government control.

Thus we now have the following situation:

1) The Lord President, a senior member of the Cabinet, is responsible for the formulation and execution of government scientific policy; for the operation

of the three research councils responsible for agricultural, medical, and scientific and industrial research, respectively; and for operation of the nature conservancy program.

2) The Prime Minister has himself assumed responsibility to Parliament for atomic energy policy in general.

3) Other ministers have responsibility for the scientific establishments within their own departments.

4) The advice of the research councils is at the disposal of the executive departments, and there is close liaison between them, but the research councils are *not* subject to departmental control.

In view of suggestions, both in the United Kingdom and in the United States, favoring the setting up of ministries of science, a recent comment by Lord Halsbury regarding the United Kingdom is of interest. He stated that, since the cost of government science is small in relation both to its importance and to the over-all budget, there are good arguments for making it a part-time responsibility of a senior member of the cabinet rather than the whole-time responsibility of a junior member.

Scientific Civil Service

So much for the organization in Government. Now, what about the people who do its scientific work? In the main, this falls to the Scientific Civil Service. Although scientists have been employed in the civil service for many years (I myself have been a scientist in the civil service for 30 years), the Scientific Civil Service, as such, came into being only in 1946. It was created so that reasonable uniformity in standards of qualification, performance of work, promotion prospects, and so on could be achieved. Re-

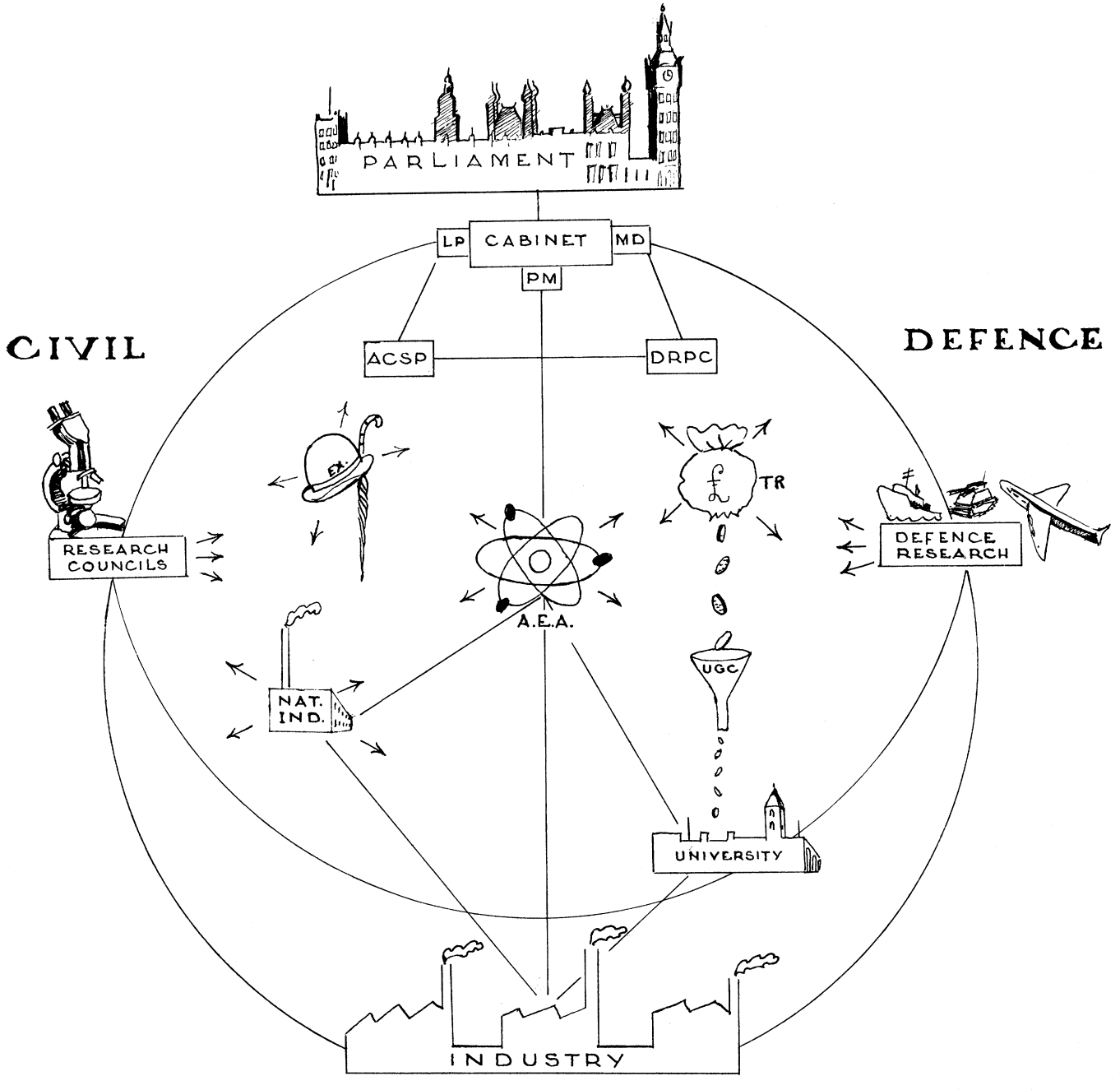

Fig. 1. British governmental organization for scientific research. ACSP, Advisory Council on Scientific Policy; A.E.A., Atomic Energy Authority; DRPC, Defence Research Policy Committee; EX., Executive departments; LP, Lord President of the Council; MD, Minister of Defence; NAT. IND., Nationalized Industries; PM, Prime Minister; TR, Treasury; UGC, University Grants Committee.

cruitment to established posts is through the Civil Service Commission's Scientific Branch, which acts as a recruitment and qualifying agency but does not, as does its counterpart in the United States (I believe), deal with rates of pay and conditions of service. These are the province of the Treasury in the United Kingdom.

There are three main classes in the Scientific Civil Service, and many specialist classes. The three main classes are as follows: Scientific Officer—the initiators; Experimental Officer—the doers; and Assistant (Scientific)—the helpers.

The over-all numerical ratios of members of these classes in the service is approximately 1:2:1. Promotion is by merit, and in the Scientific Officer class it can either be up the organizational ladder, so that the scientist assumes greater responsibility for the work of others as he progresses, or it can be up the "merit" ladder so that he can achieve high rank purely on his excellence as an individual scientist. In my view, this is one of the most significant developments in the employment of scientists in the postwar era.

This three-tier structure parallels the structure of the General United Kingdom Civil Service, with its three main classes: administrative, executive, and clerical. In Britain the administrator is the person who makes policy; the executive is the person who carries it out. You will see from this that we use the term *executive* somewhat differently from you.

The difference between the British structure and American two-tier structure is probably more apparent than real, but up to the present, in any case, the Scientific Civil Service has steadfastly maintained that possession of university degrees is not of itself an open-sesame to the Scientific Officer class. In my last laboratory, some 30 percent of the experimental class had university degrees, and many more had other professional qualifications.

Industrial Research

Public authorities. A group warranting brief consideration is that of the public corporations, such as the British Broadcasting Corporation, which are subject to broad but not day-to-day control by the Government. The nationalized industries, such as the Coal Board and the Transport Commission, are in the same position. All of these organizations carry out research themselves and maintain close liaison with the research councils and departmental research organizations. The special case of the Atomic Energy Authority was referred to earlier.

Research Associations. A feature of British research is the part played by Government in cooperative industrial research. There are 46 of these autonomous organizations of industrial firms which carry out research of concern to the participating industries. Their establishment is voluntary in the sense that the initial proposal must come from industry itself. They are governed by their own councils, the members of which are drawn mainly from the industry concerned. The councils are advised by research committees in the preparation of their research programs. They have a combined income of about £7 million, about one-quarter of which is contributed by the Government through the Industrial Grants Committee of the Department of Scientific and Industrial Research. Curiously enough, the large corporations which spend large sums on scientific research are also, in general, strong supporters of the Research Associations, whereas it was originally thought that these associations would be of use mainly to small firms unable to carry out their own research.

Sponsored research. Sponsored research organizations of the pattern and size of certain American organizations do not exist in the United Kingdom, although there are three small units, one of which is an offshoot of an American organization. The United Kingdom, however, just like the United States, is rich in independent organizations which finance or carry out research—for example, the British Empire Cancer Foundation, the Lister Institute, and the Nuffield Foundation.

University Research

The most important source of fundamental research in the United Kingdom is the universities. About 70 percent of their income comes from government sources, and this money is administered through the University Grants Committee on a quinquennial basis. The members of this committee are appointed by the Chancellor of the Exchequer from persons with experience of university administration and education. The committee receives its money as a grant-in-aid and is responsible for allocating it to the universities. This system ensures academic freedom, since there is no direct departmental control of the distribution of the funds.

Research is also supported in the universities by the research councils (scientific and industrial; agricultural; and medical) and by industrial organizations which provide research fellowships and occasionally endow chairs.

All research funds are administered so as to interfere as little as possible with academic freedom. There is relatively little contract research in British universities, and my own experience has been that any proposal which might even appear to curb this freedom meets with immediate and effective opposition from the faculties.

Learned Societies

No picture of the British research setup is complete without mention of the learned societies, the foremost of which is the Royal Society. In 1663, Hooke (of "Hooke's Law" fame) wrote that the society's business was "To improve the knowledge of all natural things, and all Useful Arts, Manufactures, Mechanick Practices, Engines and Inventions by Experiment (not meddling with Divinity, Metaphysics, Moralls, Politicks, Grammar, Rhetoric or Logick)." The society is independent of state control, but its advice on scientific matters is often sought by the Government. It also administers various research funds derived from government and other sources.

There are many other scientific organizations which should be mentioned in any reasonably complete account of the British scientific scene. They are, however, so numerous that to name them would make this article read like a directory.

There is one committee, however, which, as far as I know, has no parallel in this country. This is the Parliamentary and Scientific Committee. This committee consists of members of both Houses of Parliament, of all parties, who are interested in scientific matters and also of leading scientists and technologists. The committee meets to discuss science and scientific matters and thus helps to maintain in the legislature a body of informed opinion on these matters.

General Comments

I have tried to give a picture of the main elements of scientific organization in Great Britain. It is a picture which

is changing in detail from year to year to meet the changing requirements and the ever-increasing importance of science in all aspects of national life.

A great—perhaps too great—proportion of our scientific effort is devoted to fundamental research. This is due to many causes, one of which is the educational system, which tends in science to produce rather narrow specialists. In our secondary schools we do not give one-year courses in such subjects as biology but prefer, from age 11 on, to rely on a three-year course in general science followed by continuous courses for the next four years in major branches of science. Students intending to go to a university normally take the Advanced Certificate of Education in three subjects at age 18.

In this connection it is interesting to note that in 1957 more students sat for this examination in physics, chemistry, and mathematics (in that order) than in any other subjects and that nearly 20 percent of all students took physics.

This concentration on few subjects continues in the universities, which are staffed in the main by people chosen for their skill in basic research rather than for their skill in teaching, and the universities do relatively little sponsored work.

Efforts are now being made in several British universities to broaden the educational basis, and my personal view is that there is much to be said for the system about halfway between your system and ours.

Finally, our social structure is such that attainment in pure science appears to attract greater social status than attainment in technology—we revere our eggheads! On the other hand, we have a great need for application of science, and the Government is now taking great pains to increase the output of technologists—not in the main, be it noted, in the universities but in technical colleges and special Colleges of Advanced Technology (these grant diplomas but not the traditional university degrees).

On the government side we have a senior cabinet minister broadly responsible for much of the basic civil research. This minister is advised by a scientific policy committee which has some common membership with the corresponding committee which advises the Minister of Defence. We appear, therefore, to have a somewhat more closely coordinated system than exists in the United States. On the civil side research is mainly under the direction of scientists who are not subject to control by executive departments. We also allocate public money for basic research on a five-year basis, so as to give greater stability to our efforts.

This situation looks satisfactory but is by no means perfect and is not without its critics, who complain that no means exist either for formulating or for securing a coordinated national policy of research. Our educational system also comes in for criticism, especially from the point of view of lack of breadth in the education of scientists.

Again, although there is considerable direct cooperation in research between Government and industry, especially in the Research Associations, we do not appear, as a nation, to match up to the United States in practical application of the results. This is not wholly the fault of the scientists but is due also to economic and other factors.

Being a smaller and more closely knit country, we pay rather less respect than you do to the possession of formal qualifications. We tend to pay for ability and experience even though the latter may not have led to the gaining of higher degrees. We may, however, be changing somewhat in this respect.

Our government administrative processes seem on the whole to be more flexible than yours, and this difference stems no doubt, in the main, from our very different parliamentary systems. In yours, the executive and the legislature may not always see eye to eye. In ours, the Cabinet represents the majority party in Parliament. It also possibly stems from the traditional reluctance of British administrators to specify and define more closely than is absolutely necessary. (You have a written constitution—we haven't). However, when all is said and done, our outlook and aims are much the same as yours. Cooperation between American and British science is close, and I regard it as one of my principal objectives in my capacity as scientific attaché here to improve and extend this cooperation in every way possible.

There is an old saying that "comparisons are odious," and in making comparisons I have not been trying to show that the methods of one country are in general superior to those of the other. It is fairly evident that we can each learn from the other and that in at least one important instance—that of education—a midway course would be of advantage to each of us. Some of the differences are more apparent than real. I have on many occasions been present at discussions between British and American scientists about their difficulties and hopes when it would have been very difficult for a man from Mars to tell which were British and which American!

Probably in no other major field of human endeavor is it so necessary to consider the individual and to try to fit the organization to the men rather than the men to the organization.

Organization and administration in science are a means to an end, and in conclusion, therefore, I would like to quote a British scientist and our leading humorous journal.

The scientist, Sir Ben Lockspeiser, a former secretary of the Department of Scientific and Industrial Research, said at the end of a lecture, "Let me therefore conclude by underlining the importance of good administration, but by reminding you also that administration in science will not, of itself, produce a single new idea and without new ideas science would cease to exist."

The journal is *Punch,* which 22 years ago said, "The greatest of all research problems is the people who do the research."