SATURDAY, APRIL 21, 1923.

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Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters should be addressed to the Publishers.
Editorial communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.

Science and Government Administration.

SENSE, experience, humility, and imagination may teach one the need of advice: but some understanding of the subject is required to know whom to ask for advice and how to ask him; and still more to select advice, apply it, and act on it. In scientific matters this receptiveness of the recipient is an essential condition, otherwise the adviser is merely pouring water upon a flat plate; it bounces off, yet the plate shines and glories in its wetness.

In view of the supremely scientific character of modern war, can we say that the Army Council, Board of Admiralty, and Air Force Council possess the *sine qua non* for asking, selecting, applying, and acting on scientific advice in relation to the myriad problems of their occupation? These administrative bodies are called upon to foresee the wants of war and to make purchases and initiate researches for their fulfilment. They should, therefore, not only know what is wanted, but also understand what can be obtained. In the restricted sense of this use of the word "want" Julius Cæsar did not *want* electric light. He would have had to be even more remarkable than he was to want it, and then he could not have described the want effectively to any listener.

It is quite common for the lay public to be too unacquainted with what it can get to form a clear idea of its requirements—the man who tries to install central heating, or drains, without architect or builder will understand what is here meant. Luckily most people have sufficient knowledge of the subject and feeling of humility to determine them to go to the architect—that is because central heating and drains are everyday things. The lay public did not want railways—it did not know how to want them; it did not want automobiles until some years of education had been applied, and, coming nearer to our subject, the Army and Navy did not want aeroplanes until long after they were shown them. We are not making an accusation, but merely giving examples to show that the human faculty of wanting is a function of knowing what can be evolved, that is, education; and of imagining to what uses that provision can be extended, that is, vision.

There is the reciprocal of this also in "*not*-wanting." Ask any young officer at random if he wants the Finance Member of the Army Council; facetiously, but not without disclosing a true feeling, he will reply that "he has no use for him." With fairly precise analogy, if it were to be suggested to any member of the three councils named that a man of distinguished scientific attainments is wanted on these councils, he would with equal conviction, equal error, and possibly with equal facetiousness say, they "have no use for him" . . . "they have their advisers."

Suppose that there rises to the top at rare intervals a scientific admiral, "M.G.O.," or "Member for Supply and Research," it still remains the fact that in the absence of provision for securing by the law of the land that there *shall* be a man of wide scientific attainments on those councils, we cannot depend that, when a problem arises in council, its possible relation to science will be automatically and early considered. In many cases science will not be thought to touch the matter at all—and no attempt be made to get such advice. Unless there be some one, with full rights of membership, to probe into what can "per impossibile" be got from science, it is no comfort to know that there exist outside the Council advisers of great skill—since they would not be consulted—nay, they could not be consulted owing to the difficulty for the inexpert to pose the question even if he suspects the want.

A strong case can be made out for a scientific member of council—present at the fountain-head of war policy—at the place where the large problems arise, just as there is, at present, a finance member of council. The analogy of the finance member is apt because the public mind is far more financially sensitive and sane than scientifically acute and trained. Indeed, these councils themselves are almost certainly more awake to finance than they are to science. Is there not a House of Commons and a Press with money sense and taxation sensitiveness? But there is no similar power behind the scientific aspects of the case. It is not worth while to pose the false dilemma: which won the war, money or science? But it may be said that it is no use thinking the nation can safeguard its money if it does not safeguard its science. The awareness in money matters of the public due to its daily preoccupations, its annual state accountancy, etc., has ensured for money a representative at headquarters, but science has nothing of the kind.

No doubt the appeal of science would be better appreciated if it were expressed on terms of money. As an illustration of this the following episode is worth relating. The war council of a certain State was in session. A grave question had to be settled: advisers were outside the sacred chamber whence a member of council emerged, and, taking aside a man of science of European reputation who was in attendance and in the employ of that Army, propounded a question. As happens in such cases the inquiry sounded like: "How far is it from Somaliland to Good Friday?" so that the reply (and who has not gone through this ordeal!) began by hypothecating the alternative possible meanings and an inquiry as to which was intended. "I am not here to be interrogated but to be answered," was the reply inspired by a very proper fear of disclosing a clue to the secret policy in contemplation. The representative of science then gave an elementary lecture in which he reserved with dramatic instinct the essence of his reply for the climax. Before that was reached, however, the august member had excused himself and returned to his colleagues—fortified as a schoolboy would be for the reading of Plato by a knowledge of his subject limited to the alphabet. In the sequel some millions (not of marks) were expended on the scheme, which, however, was unfruitful.

Events and actions of this kind can be avoided only if the following principles are borne in mind:

(1) It is difficult even to ask for scientific advice so as to get it—unless the inquirer has scientific training.

(2) After asking for advice it cannot be taken without scientific training.

(3) When advice is taken it cannot be made effective without scientific training.

(4) However scientifically competent a man may be, he cannot advise on a case without knowing *à fond* how the problem arose and when, what qualifies it, and what alternatives might be employed to bye-pass the difficulty while still arriving at the goal.

It must be accepted that a genuine and thorough scientific training is not compatible with the multifarious changes of duty, changes of locality, changes of personnel, etc., essential to naval, military, and air force training. The development of a versatile, more or less uniformly trained force requires a *rota* of occupations by which officers and men, at stated periods of two or three years, are moved on to the various forms or classes which constitute the war school we call the Army, Navy, and Air Force. It is an accepted principle that no fighting man must become an indispensable expert; his loss would be too severe a discomfiture—his *ipse dixit* too formidable a threat to authority—his specialised training, and the unexpected bye-paths into which the laws of Nature would lead him, too incompatible with the whole principle of a versatile force of obedient and capable units united by a sedulously cultivated esprit de corps.

This is sound policy, and its acceptance leads to the conclusion that the scientific member of council cannot, any more than the finance member, be one of the routine organisation as we know it. We need scarcely plead here, after the War, that there is not, in a man of distinguished scientific attainments, any inherent unworthiness to be entrusted with State secrets. There is nothing peculiar about a suitably selected major-general that makes him a more acceptable recipient of such secrets than an equally well-chosen man of science. Nor yet is administrative ability incompatible with the widest range of scientific attainments.

The present-day divorce between the science which must infuse the war machine and the men who administer it is *not* of all time. Of old, as now, transport,

communications, weapons, archery, etc., involved a knowledge of man's endurance, food consumption, horses, shoe leather, the elastic qualities of yew, the flight path of arrows, and the like, but then, unlike to-day, every member of the governing staff was easily an adept in these matters, competent to select and profit by any expert specialisation—when for a spell generals commanded the fleet they were soon discovered not to be adept and the sea was entrusted to those who were. In both cases it was unnecessary to provide a seat on the council for the astrologer, alchemist, or magician of the time. To-day, however, all this is changed.

It is not to be expected that even a carefully chosen and widely informed scientific member of council can know ballistics, meteorology, chemistry, metallurgy, the thermodynamics of the petrol engine, the intricacies of sound detection, or of wireless procedures, the stability of ships, the phugoids of aeroplanes, the rotary derivatives of their equations of motion, etc.; but given a really sound scientific representative none of these subjects is to him what most of them are to the Army Council, Admiralty, and Air Force Council—at the best, jargon: at the worst, stupidity. Such a man would and could seek advice, because he knows enough of the problem and of the outlook of science to see that it was wanted. He could take advice because he would know enough to sift it, test it, select it, and present it for consideration to a council with the real purpose and personalities of which he would be acquainted.

How can we make such a need be felt by the war machine, which is certainly not asking our advice about it? Only by public opinion; and clearly this is difficult. Scientific opinion deserves better regard and esteem than it gets, and it suffers this loss because of the quite unreasonable contempt with which it views the operations of politicians. The world of science abstains from making its voice heard in the only way it can be heard, through the megaphone of the politician, by reason of the pressure of its organisation. It has itself no organisation. Some of the wiser men, who lifted their heads from the absorbing interest of their own grindstones, did in fact form a Conjoint Board of Scientific Societies, which died a month ago. This body comprised the leading Institutions and Societies in the British Isles concerned with pure and applied science. It might have leavened the lump, and reminded the technical world that it is an organic part of modern social organisation. Let us hope, as taxpayers, if from no higher motive, that science and technology may yet form a federation to promote recognition of their significance in the affairs of the State.

MERVYN O'GORMAN.

The Structure of the Atom.

The Theory of Spectra and Atomic Constitution: Three Essays. By Prof. Niels Bohr. Pp. x+126. (Cambridge: At the University Press, 1922.) 7*s.* 6*d.* net.

THE beautiful conception which inspires and co-ordinates practically the whole of modern atomic physics is the atomic model of Rutherford and Bohr. Its essential feature—the nucleus—was first put forward by Rutherford in 1911 on the basis of experiments on the scattering of α-particles. So convincing is this model that after only twelve years it is known no longer as "the atomic model of Rutherford and Bohr," but is simply taken for granted as "the atom." In this development, moreover, the ideas of Bohr have played such a dominating part that it is of the greatest importance that the three essays of this volume should be accessible in English, as well as in the original Danish and German, to the widest circle of readers. We welcome most heartily their opportune appearance.

When a theory such as the present is expounded semi-historically by its principal creator, a critical account of the theory itself is scarcely the function of a review. Such a critical discussion could be nothing less than an exhaustive survey of the whole tendencies of modern physics. It is perhaps a less impossible—certainly a more relevant—task to attempt to bring to notice the various stages of the theory represented by the three essays in this book, in the hope that some faint reflections of their beauty and convincingness may be conveyed to those whose studies are directed elsewhere.

Some preliminary remarks of a general nature may not be out of place. Though the theory itself finds a place for much advanced mathematical analysis and demands the development of new and more powerful weapons than those yet available, in the hands of Bohr it is never an abstraction divorced from contact with physical realities. Rather he succeeds in bringing it ever into closer contact, and expounds it in these essays in a simple non-mathematical way which should be capable of being followed by any one who is prepared to accept the mathematical theorems on which the work is necessarily based. The mathematician will desire to look further into the foundations and will be rewarded. But those who are not mathematicians need not for that reason fall short of full conviction. It is unavoidable to speak of the theory, in description or exposition, as "explaining" certain facts of experience. But the theory is non-mechanical—in fact, is nowadays identical with the quantum theory—and "explanation" by the theory cannot mean explanation in the classical sense. Explanation of a fact can mean no more than its correlation with and co-ordination among an existing