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ORGANISATION OF SCIENTIFIC RESEARCH

IT has become increasingly clear in recent years that applied research and development are indispensable for the maintenance of reasonable standards of life in any nation—by developing new technologies in the service of humanity and in the service of the nation through new products, improved processes, higher outputs and improved health and welfare. The need to organise applied research and development work has always been obvious to industrial units, but the concept of a *national* organisation is new and in many countries is only now being attempted

There is no standard formula for the organisation of research. Differences in political and economic maturity in the stability and structure of industry demand that each country should devise its own form of national organisation. However, certain elements common to all countries are discernible, and these relate to the formulation of a national research policy, the nature and structure of research establishments, realisation of a wholesome research climate and finally, means and methods of administration and finance. It is therefore clear that the experience of other countries in such matters has a great deal to tell us how we can solve our own. In this connection the Report* of the Technical Assistance Missions set up by the Organisation for European Economic Co-operation (OEEC) to study the organisation of applied research in Western Europe and North America, contains a wealth of useful data and suggestions, which merits careful study. The following is a summary of some points of general interest in this report.

* *The Organisation of Applied Research in Europe, the United States and Canada:* Vol. I—A Comparitive Study, Vol. II—Applied Research in Europe, Vol. III—Applied Research in the United States and Canada. Published by the Organisation for European Economic Co-operation, Paris 16e, 1954. Price: 1.00, 2.00, 1.25 dollars respectively.

In all the countries visited by the Missions it has been observed that large and middle-sized industries themselves provide the applied research for their healthy growth, while the Government shoulders the responsibility not only of the research effort for defence, atomic energy and public health, but in great part finances also the institutions for the education of the research personnel, fundamental research, applied research in agriculture as also that of small industrial firms The importance of private endowments for research would seem to be diminishing, while industry and Government remain as the two great powers behind research.

In view of the complexity of research activities, every country visited has found it necessary to create bodies to supervise and co-ordinate such activities However, in only a few instances have these bodies given serious thought to the formulation of a national research policy in their fields of interest, taking into account the supply of scientific talent, the natural resources of the country and the needs of industry. It has therefore been suggested that from time to time the national research effort should be evaluated and guidance laid for future research. The result should not be a hard and fast set of executive orders, but rather a memorandum providing information and reasoned recommendations so that it might act as a stimulant to both administrators and research men.

It is a common saying that while Europe has excelled in fundamental research, the Americans have mastered the art of transforming scientific results into practical applications. By way of comment, the report observes that in general the research worker in the United States has undeniably a greater urge to produce practical results, while in Europe there are still some remnants of the old academic schools which pursue scientific research for the sake of pure science, and look down on scientists who do research for industry. However, a large volume of applied research *has* been carried on in Europe for some time now, just as there have been unsurpassed achievements in fundamental science in America It may well be that any difference in the emphasis placed on fundamental and applied research in various countries reflects a difference in temperament and philosophy, but the balance between the two is a delicate one for any country, and should be maintained at the point as which it yields the greatest return, whether it be to the Government or industry.

The spectrum of national research effort recommended by the Missions as likely to be most helpful is as follows :

(*a*) Universities should concentrate primarily on teaching and fundamental research ; but Institutes of Technology should include semi-technical and pilot scale work.

(*b*) Industry should (and in the larger concerns normally does) cover the whole field of applied research and development.

(c) Government research establishments, depending on the industrial responsibilities of Government Departments, should pursue their applied research to the point at which results can be applied or used for further development in industry, or to the point where reliable advice can be given to guide administrative action by Government Departments. It is assumed here that Government research establishments, where they exist, fulfil a national need in applied research which is not being met elsewhere.

(*d*) Co-operative research establishments, as they exist to serve branches of industry, should cover the whole range of industrial application in their particular field of interest.

(*e*) The field for sponsored research institutes is to be determined, after duly considering the capacity and efficiency with which industry and Government find it possible to cover their own requirements.

The report has much to say on the conditions which contribute to the creation of a proper research climate A good research organisation must combine proper management and effective research programmes with an adequate reserve of "scientific capital". This capital is usually composed of individual creative scientists with no administrative abilities, whose talent must be properly harnessed. Considerable care should be taken in recruiting staff to ensure that they are suited to the requirements of the research programme and remuneration should be related to scientific value rather than administrative or practical ability. There should be reasonable parity in the salaries of professional, technical, teaching and research staff. Last, but not the least, it is necessary to create public interest in scientific research. Such an interest, especially in applied research, would appear to be fairly widespread in most

countries, but there were many instances where such interest had not penetrated deeply enough into Government and the industrial circles to initiate active national programmes or convey the real importance of research. This state of affairs should be given serious consideration by appropriate bodies and especially by the scientists themselves. The report observes that people in authority cannot always be blamed for lack of understanding, as they are not specialists and cannot be expected spontaneously to realise all the possibilities of science and technology. In this connection, while it is reasonable for scientists to use a language of their own when discussing problems between themselves, it is at least equally important that they should contrive to make themselves understood by the layman as regards their plans, working methods and results. The popularisation of science should be an integral part of the organisation of research. A great deal about how to conduct such a campaign for the better understanding of research can be learnt from institutions such as the American Chemical Society.

Many of the suggestions put forward by the Missions are directly applicable to our country in its present state of rapid scientific and industrial progress. It is to be hoped that the matter will be taken up for full consideration by those who share the responsibility of shaping the industrial future of our nation.

NOBEL PRIZE FOR PHYSICS, 1954

THE prize this year is shared by Professor Max Born and Professor Walther Bothe. Professor Max Born is well known for his researches in various branches of theoretical physics. He was among the pioneers who developed the new quantum mechanics in the 1920's, the basic ideas of which have had a profound influence on the progress of physics ever since. More recently, he has made significant contributions towards the unification of the theories of matter and field, and of relativity and quantum theory. During the last few years he has contributed a number of articles on the philosophical foundations of quantum mechanics. Prof. Born has been deeply interested in crystal physics, and is the author of a number of books on this subject. In addition, he has published a large number of books on atomic physics, quantum mechanics and theory of liquids and also semi-popular accounts of modern physics and its philosophy.

Professor Born was in India for short period in 1936, after which he accepted the Tait Chair of Natural Philosophy in the University of Edinburgh. He retired from this position only last year.* He is now seventy-one.

Professor Bothe, who is sixty-three, is a specialist in the field of X-rays and electron physics. His early work was mainly concerned wtih the scattering of X-rays and the photo-electrons ejected from matter by X-rays. Together with Geiger, he performed the celebrated experiment on recoil electrons in the Compton effect, and proved definitely that one quantum of X-ray interacts with a single electron in this effect. This paved the way for the further development of the quantum theory of radiation.

Prof. Bothe was associated with W. Kolhorster in a discovery made in 1929, which led to a new and valuable method for the study of cosmic rays. They found that a ray which passed through two Geiger counters in succession was likely to discharge both of them. By suitable arrangements of counters it was possible to define more or less accurately the path followed by individual cosmic rays. A year later, with H. Becker, Bothe was responsible for the first experimental observations in a sequence of discoveries which culminated in the recognition by Sir James Chadwick in 1932 of the neutron as a fundamental particle.

During the years 1939 to 1945, Professor Bothe was engaged in the official atomic research programme in Germany, after which he returned to academic life as Professor of Physics in the Heidelberg University. He has continued his interest in electron physics, although of late he has been specially interested in its applications to cosmic rays and nuclear physics. Amongst other publications, Professor Bothe has to his credit two articles in the *Handbuch der Physik* dealing with the Transmission of Electrons through Matter and the Absorption and Scattering of X-rays.

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* A review of the "Festschrift" presented to him on this occasion appears elsewhere in this issue.