

## SCIENTIFIC RESEARCH AND INDUSTRIAL PLANNING

## BRITISH ASSOCIATION CONFERENCE

IT might have been too much to expect that the two-day Conference on Scientific Research and Industrial Planning arranged by the Division for the Social and International Relations of Science of the British Association on December 7 and 8, and held at the London School of Hygiene and Tropical Medicine, should reach the exceptionally high level of the similar conference on industrial research last January; and the Conference was neither so well attended as might have been expected, nor did it receive the publicity in the daily Press that it deserved. The latter is the more important, because the Conference as a whole had a far wider appeal than its general title suggested. In fact some of the speakers—and by no means those who like Prof. M. Polanyi have consistently warned their fellow men of science of the dangers inherent in planning science—seemed concerned rather to take the plan out of planning, and the general theme of the Conference was essentially the human element in research: the research worker himself and the conditions which are most likely to stimulate creative work; the place of the human factor in production and the contribution which scientific research can render to efficiency.

These were the main *motifs* in the Conference, and planning appeared to be discussed chiefly in regard to how best the community could organise its resources to secure the right type of scientific worker in adequate numbers and in the most fruitful conditions, and similarly how production could be most effectively organised in the service of human needs. In opening the first session of the Conference, in which "Fundamental Research in relation to the Community" was considered, Sir Richard Gregory said that the title and general plan of the Conference had been decided before the application of atomic energy to the construction of the bomb was made known last August. Sir Richard pointed out that the main subjects of the four sessions of the Conference—fundamental research, planned research, economic aspects and the human factor—were all considered in the joint statement on atomic energy made by the President of the United States and the Prime Ministers of the United Kingdom and of Canada in November, and the emphasis on freedom of thought and expression as an axiom of scientific inquiry which is formally accepted in the statement was repeated in Prof. M. Polanyi's address on the social message of pure science.

In a challenging address, Prof. Polanyi did much more than utter a further warning against the dangers of totalitarianism to which the planning of science is exposed. In criticizing the thesis that the content of science is determined by social needs, Prof. Polanyi undoubtedly over-stated the case—though scarcely to the extent suggested by a later speaker in the discussion, of setting up his own Aunt Sallys to knock them down; his plea that the essence of science is the love of knowledge, and that the utility of knowledge is secondary, was dignified and sincere. He pleaded that science is entitled to public respect and support as a pursuit of knowledge and of knowledge alone. The claims of science are a part of the claims of all scholarship for respect and for academic independence and freedom, and men of science are

pledged to values more precious than material welfare. Moreover, Prof. Polanyi held that the world needs science to-day as an example of the good life, and he pleaded for the revival of international scientific life as a part of the restoration of reason and civilized human intercourse in Europe. He suggested that the United Nations should simply extend the privileges of diplomatic passage to men of science and scholars all over the world. With freedom to travel as they please through Europe, scientific men would restore within six months a close and intensive collaboration of all scientific workers in Europe, and weave once more a part of the destroyed European fabric.

Prof. Polanyi's vision of the wandering man of science restoring the broken unity of European civilization, with its call not merely to reassert the spirit of science and of scholarship but also to revive the spirit of reason and justice, gave dignity and purpose to an otherwise somewhat halting opening session.

Prof. J. W. Munro, who followed, did not seem quite sure of himself, and the chairman was equally at a loss to place the paper in relation to the theme of the session. The clue seems to be in the sentence with which Prof. Munro closed the account of his work on the fundamental problems of insect infestation, when he suggested that unless scientific men are free to follow their bent and study the problems that appeal to them, as he himself and Mr. Charles Elton had been, the scientific reserves for the attack on some of our urgent war problems would not have existed.

Prof. C. D. Ellis was also concerned with the practical aspects of fundamental research in relation to the community, and in particular with the implications of the recent discoveries in atomic energy. Holding that progress can only be assured if we have an ever-widening basis of fundamental knowledge and that pure research must have first priority, he proceeded to review briefly the practical results of these new discoveries. The outstanding achievement is the development of the 'pile', which means that nuclear chemistry is possible on an industrial scale; and if the difficulties in the way of utilizing the heat liberated in the process can be overcome, industry will have an immense increase in freedom of location, for there will be no fundamental difficulty in producing power in quantity in any place sufficiently accessible for the ancillary machinery to be assembled. This, he believes, is an important aspect to be kept in mind in planning the utilization of the new discovery; but no great reduction in the cost of power is likely and the use of nuclear power in driving ships or automobiles is unlikely to replace existing means of propulsion. Supplies of uranium are no more unlimited than those of coal or oil, and Prof. Ellis thought that the greatest benefits to mankind arising from the new discoveries may well lie in the widespread availability of radioactive materials of all atomic weights and their use in therapeutics and in research as indicators and aids in tracing biological and physical processes.

Sir Richard Gregory, in opening the discussion, emphasized that the essential motive of men of science is the discovery of truth, and that science is to be

understood as systematic or organized knowledge in any field of human activity and not merely in the study of natural phenomena. Prof. A. G. Tansley, pointing out that fundamental research is not easily defined and that too much should not be made of the distinction between pure and applied research, the distinction depending rather on the subject than the method, stressed the importance of freedom and endowment: endowment of fundamental research should not be subject to control outside the ranks of scientific men themselves. He also referred to the demonstration in the war effort of the possibility of combining team-work and individuality.

Mr. Herbert Morrison, Lord President of the Council, who opened the afternoon session on "Planned Research", also stressed this element of freedom. The close working partnership between the Government, scientific men and industry which grew up during the War was indeed a partnership and not the regimentation that had proved disastrous in Germany. Science has a vital contribution to make to that increased productivity on which social progress and security depend. While we have no reason to be ashamed of our record in pure science, he thought that before the War we were not bold enough in applying the results; we must look to the development of whole industries. After suggesting that in regard to new knowledge we should attempt to free workers from economic handicaps and encourage them to pursue knowledge for its own sake, Mr. Morrison urged that in the wider field of applied science we should provide the right atmosphere and tools. We should provide the wide incentive of social purpose instead of the narrower though not irrelevant incentive of profitable exploitation. Priorities for development and application should be fixed in the public interest and in relation to the quickening of the general economic plan, within which scientific research would find its aims and inspiration, and in which national problems and public needs would be the guides and targets for the efforts of every section of the community. The educational policy of Britain must provide for the training of adequate numbers of scientific workers and of laboratory assistants, and besides providing adequate endowments for research we must encourage the employment of men of science in the Civil Service as well as in industry. Above all, in a world safe from war, planned research involves the fullest freedom for the exchange of ideas and results not only among scientific workers themselves but also between them and industry and Government.

In this reference to the importance of closer contact and better information services, Mr. Morrison pointed out that the committee he has recently appointed to consider the use and development of the scientific man-power and resources of Britain includes besides three men of science, an administrative Civil Servant, an economist and a business man.

Sir Edward Appleton, who followed Mr. Morrison, pointing out that planned science means deliberate and conscious planning for application, said that there are two aspects: the choice of objective, and the means by which it is to be achieved. The public is fully aware now of the social consequences which might come from scientific discovery, and he finds that young people, in consulting him regarding the choice of a career, are frequently determined by the probable social or political consequences of the work they are contemplating. Now that Government has

increasingly come to assume the positive function of ensuring that the right things are done, its function in planned research should be to secure a proper allocation of effort. Academic research which is solely concerned with the advancement of knowledge should be free from any conditions or effect of the by-products of that work, and any planning should merely ensure that enough money is available for the work to go forward. In industrial research, we are planning for practical objectives, but Sir Edward considers that the results obtained in the Department of Scientific and Industrial Research should be made available for all, and that we must take care to avoid short views in objective planning. He urged the importance of long-term objectives in fundamental research in the physical sciences. In conclusion he uttered a warning against the danger of putting scientific workers on too high a pedestal. The authority of science does not extend beyond its own sphere, and he is of opinion that scientific men should be careful to claim no special privileges and to avoid attempting to dictate how their results should be used.

Dr. C. F. Goodeve, speaking on planning and organizing research, suggested that the first lesson of the War is that proper planning and direction of background and applied research are essential: practically the whole of the technical advances of the War were made under a system of extensive planning and direction. Next, he suggested, we have learnt that a research organization must be such that it can seek out and ascertain accurately the objectives in the given field of activity, and inspire every man in the organisation with their importance. As a corollary of our war experience here, Dr. Goodeve pointed out that scientific workers will require full knowledge of the economic and commercial aspects of their work. Next comes the importance of the right degree of collaboration with the user. Such collaboration both clarifies the objective and eases the problem of utilizing the results of research, but it is essential that the user should understand what is involved. Dr. Goodeve then referred to the question of team-work, the organisation of which is a major task of a research director. There must also be a balance between background research and development, and priorities should be determined not merely on the strength of a particular need but also on the prospects of meeting that need in the required time.

Dr. E. F. Armstrong had prepared a paper on "Planned Research in the Building Industry", which was read for him. Reviewing the special problems encountered in an industry like building, which is largely based on traditional practice, Dr. Armstrong indicated the way in which research on building requirements, materials and structures and on the industry itself, covering human efficiency and social surveys and laboratory studies involved in the functional aspects of buildings, is already being planned to solve one of the most fundamental problems of our age—the synthesis of suitable building for a modern civilization. Sir William Larke, who opened the discussion, commented on the need for the widest and most efficient organisation for ensuring the prompt application of the results of research throughout the industrial economy of Britain. He would build on to the Department of Scientific and Industrial Research a national council widely representative of scientific and industrial interests and empowered to promote and finance through existing organisations, or under its own direction, research into fundamental problems



which have far-reaching effects on the economic life of the country and the standards of life, but which could not be solved so quickly by any one country acting alone. Such a national council might delegate detailed responsibility for international collaboration to appropriate existing bodies, but would endeavour to expand and develop existing research facilities and establish new research organisations where facilities are not available; and it would provide a central national source of information and inspiration relating to research which is badly needed. We must above all get away from the contemptuous attitude to research. Dr. P. Dunsheath referred to the danger of over-developing ideas, but his remarks on planning as affected by human personality linked the second session with the third and fourth, dealing with the economic aspects of research and with the human factor, respectively, but in both of which the human aspects were almost equally prominent.

Lieut.-Colonel Urwick's inspiring chairmanship quickly opened up the wider horizons at the morning session on December 8 in his opening remarks, when he pointed out that the economist and the engineer have both much to learn from each other, and that we need to pay much more attention to the principle of balance in industrial and in social organisation. Scientific knowledge is badly out of balance with an appreciation of the importance of applying such knowledge to the solution of social and economic problems, and the scientific worker, the administrator and the financier should come together in assisting the Government to solve some of the problems of society and to achieve an integration of authority and responsibility in which all could share. Prof. P. Sargant Florence, dealing with the economic stages involved in the transmutation of ideas into products, argued that scientific research can be applied to such stages just as in the natural sciences, and that such research can similarly be developed at the universities, in scientific institutions and in industry itself. The chart of the contribution of the human sciences to production problems with which Prof. Florence illustrated his paper shows how unevenly such efforts have been distributed, although scientific methods have been already applied in each of the four groups of problems he distinguished, namely, industrial economics, production engineering, industrial psychology and production management. A body of knowledge is in fact being accumulated, which should be pooled for the benefit of all producers; and which when organised sufficiently to generalize and interpret deserves teaching at the university level. This is a vital factor in laying the foundation stone for higher standards of leadership in industry and commerce; and Prof. Florence linked this further call for higher standards of industrial management with a plea for more published pooled research in production engineering and management, in which Great Britain lags behind. Such problems must be tackled in a scientific spirit and by scientific methods, for their scientific handling is an essential factor in furthering national efficiency in getting into large-scale production, upon which an increased export trade and improved standards of living depend.

Mr. F. E. Smith, of Imperial Chemical Industries, Ltd., who followed, based his remarks on the view of research as the process of gaining knowledge in a systematic manner by the study of phenomena or by the examination and correlation of existing data, and further that the economics of research can only be considered in relation to human life. Mr. Smith

suggested that industrial research is of two main types: that directed to maintaining the competitive position of the firm in its established products, and that directed to the development of new products. He referred to the neglect of scientific research and method on both the technical and human sides in distribution and other important non-manufacturing industries. Research on a proper scale is essential for efficient working; but it is important that it should be properly directed and its results should be properly applied. Here endorsing Dr. Goodeve's observations on the overlap between fundamental, background and development research, Mr. Smith emphasized that we need a better balance between research into the physical and into the humanistic sciences, and that fundamental research should not be shut off. We must encourage the diffusion of scientific knowledge by the interchange of scientific workers between industry, the Department of Scientific and Industrial Research and other Departments and the universities, as well as by more effective organisation of information services. Industry, besides its research staff, requires many more men who are qualified by education and training to appreciate the value and place of research and development, production and user departments in their respective fields, if we are to overcome the lag in the application of new knowledge which has sometimes characterized Great Britain.

Prof. M. L. Oliphant said that the scientific worker was jolted out of his 'ivory tower' before and during the War, and referred particularly to the necessity of obtaining scientific equipment for fundamental research from abroad owing to lack of enterprise in Britain. He made a vigorous appeal for a more adventurous spirit. Britain's ability to throw up great scientific workers is one of her biggest assets; but there is at present grave danger that excessive caution may lead to the centre of research and development shifting to other countries. Deploring the existence of short-term views, he urged that it is impossible to direct scientific energies; the universities should endeavour to get the research spirit into applied science and build up the proper background of science for the production engineer, and leave him to apply it. Dr. Rosin said that insufficient attention is paid to the fundamental principle of research—the proper definition of a problem. The achievements of research in the War were obtained in complete disregard of the common concept of economic research: the determining factors were man-power and materials, not finance. Prof. J. D. Bernal commented on the need for integration, and on the possibilities of infiltration of scientific ideas into our thought. Social, rather than economic, objectives are required. He criticized defects in the British patent system and referred to the importance of developments in industrial psychology particularly with reference to training. Summing up, Lieut.-Colonel Urwick pointed out that the management of research has two main aspects: the relations between research and management, and research into management itself. We need a partnership on equal terms between the research worker and the administrator. Fundamentally, the economic aspect of research is a problem in thinking. The obstacles are essentially human obstacles, and by right thinking they could be overcome.

The morning session thus led smoothly to the final session on December 8, over which Dr. Raymond Priestley presided. Dr. Priestley, viewing the problem

in relation to the discovery and education of research workers, said that in regard to the outstanding first-class man the problem of securing the best use of the nation's resources involves seeing that he gets to the top quickly and in the right place, and he looked for at least a couple of dozen centres of learning and research with internationally recognized schools in several fields. More of our outstanding men should also be attracted to our research institutes and industrial research laboratories. For the great majority, who represent the second class of research worker, we need more postgraduate studentships and research fellowships and freer circulation between university laboratories and research organisations in government and industry, and franker and more frequent discussion and pooling of results. Finally, we need much more adequate provision of technical assistants of all kinds, with better conditions of service and prospects of promotion. This is at present one of the universities' weak spots, as has indeed been emphasized in reports on the universities and research. In conclusion, Dr. Priestley said that he would like to see imported into the education of the man of science at a fairly late stage some element which would force him to think about and study the history of the world in which he lives.

Sir Arthur Fleming's paper discussed from the industrial point of view the functions with which the research worker has to deal. He regards the function of research itself in industry as the achievement of the utmost efficiency in the industrial transformation of raw materials into finished products; and he urged that it is essential that in every manufacturing concern there should be an officer who could assimilate, interpret and apply, as it became available, the scientific knowledge appropriate to his concern's field of industry. The industrial research worker requires to know a good deal about the economics of the problem, the limitations to manufacturing processes and something of industrial administration and markets. Judgment and courage are involved in regard to the introduction of new tools, processes or materials; and the human factor is also important in the education of public opinion, where interest awakened during the War should be developed to ensure that a strong and healthy public opinion encourages the application of scientific research in all services affecting the public.

Mr. Alec Rodger, senior psychologist at the Admiralty, dealing with the contribution of the industrial psychologist to industrial reconstruction, pointed out that the psychologist in general suffers somewhat from misunderstanding and from lack of official recognition. Industrial psychologists are also very scarce—there are only about thirty among the fellows and associates of the British Psychological Society, and we should aim at increasing this number to at least 120 during the next five years. Training facilities are also extremely poor. He would like to see the National Institute of Industrial Psychology become a live centre of postgraduate training linked closely with the University of London, and making its contribution to the training of personnel managers, employment officers, careers masters and others. Moreover, the industrial psychologist is inevitably an advocate and agent of scientific management, and Mr. Rodger thinks he cannot make his maximum contribution to social and economic life until a full employment policy is implemented and we have a planned wage structure for the whole of industry. That contribution during the next two or three

decades would best be made if industrial psychologists concentrated on the problems of vocational guidance and personnel selection methods of training and the design and lay-out of equipment.

Mr. J. T. Kendall, discussing the education and training of the research worker, suggested that more attention might be given to the needs and weaknesses of the men and women to be trained, and referred to such ideas as postgraduate or refresher courses and increased migration between the academic and industrial world as important in bridging the gulf which sometimes develops in Great Britain between pure and applied research. With regard to the basic psychology of research, he pleaded that place should be found in the training of the research worker for some instruction in the art of thinking, and that any training in technology for the applied scientific worker should be deferred to the postgraduate stage. He also urged the need for a broad general education designed to fit the scientific worker to take an active interest in everyday affairs. This clearly should be given largely at school, where specialization should be avoided; but in part it must come from informal education. To increase substantially the number of first-class men of science, we must aim at a general increase in the level of education and standard of living of the nation. Prof. Bernal referred to the importance of freedom. Creative activities and original thinking cannot be carried out under compulsion, and he pleaded for the association of those who believe in planning with those who feel most strongly about the freedom of science. It should be possible to use people largely to solve the problems in which they are interested and which they wish to solve. Referring to the value of the method of discussion and organised collaboration demonstrated in war research, he emphasized that the organisation of science must be democratic, and one object in our organisation must be the selection or determination of priorities. On this point Mr. J. A. Lauwerys, observing that personnel constitutes a bottleneck in the expansion of research, referred to the relation of teaching to the output of scientific workers, and emphasized the need for seeing that the release and training of teachers is handled as a priority of the first order.

The concern regarding the future use of atomic energy which had been manifested throughout the Conference, from Sir Richard Gregory's opening speech and particularly in the addresses of Prof. C. D. Ellis and Prof. M. L. Oliphant, found expression in a resolution approving the statement of President Truman, Mr. Attlee and Mr. MacKenzie King, which was passed at the end of this final session. The resolution, affirming the belief of the Conference that the statement "should receive the support of the scientific world as indicating the true approach to the problems of developing the beneficial applications of atomic energy and other scientific achievements on the one hand, and, on the other, of preventing their destructive uses", requested the Council of the British Association "to consider the desirability of forwarding a communication to H.M. Government in this sense, and of using any other opportunity within the scope of the Association to support the ideals implicit in the statement". Sir Richard Gregory, in moving the resolution, stressed the indispensable condition of full freedom for science and the impossibility of stopping the advance of knowledge; and he urged that the scientific worker, as a citizen, desires only peaceful and productive issues to his discoveries.