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SCIENTIFIC AND INDUSTRIAL RESEARCH.—VI

WE have now completed our survey of the strategy and tactics of research in respect of the workers and organization required, and the broad objectives of programmes to serve the advance of science and the needs of the nation. We have now to view in conclusion, more from outside, the structure thus adumbrated; and to consider, not primarily the service to be rendered thus to the community, but the price that must be exacted from the community in order that such an organization may function effectively and render the services set forth. That support has two main aspects: financial and educational. Research in any field cannot be prosecuted effectively unless support is forthcoming on an adequate scale. Such support in turn is unlikely to be forthcoming unless the reasons for prosecuting research are adequately understood by the public; and once again, the case for research is unlikely to be presented effectively unless the possibilities are fully appreciated by the administrator, whether he be in Government service or in industry.

For our present purpose it is unnecessary to enlarge on the financial aspect. Estimates as to the cost of the programmes and of the organization involved are as yet incomplete or tentative. Many of the essential facts have yet to be determined, and even the programmes themselves to be outlined adequately. Sir Ernest Simon has estimated that the necessary expansion and development of the universities involves increasing the Exchequer grant to £4 millions in the first year after the War and successively to £8 millions in the fifth year, with capital grants on the scale of £20 millions over a period of ten years. The Parliamentary and Scientific Committee likewise visualizes an increase of the Treasury grant to six or seven million pounds, with at least £10 millions over the first five post-war years for capital expenditure, and the British Association Committee on Post-War University Education estimates this capital expenditure at £25 millions. The Association of Scientific Workers puts the total university expenditure at about £15 millions after five years and at £20 millions after ten years, most of which will have to come from the State; accordingly, it anticipates an increase in the annual Government grant to £9 millions after five and to £13½ millions after ten years.

This is only a part of the national research budget directly charged on the State, though, of course, a large part of the university expenditure is only indirectly for research purposes. Estimates as to the increased expenditure involved in the research directly financed by the State are fewer, and in any event are at present largely tentative in the absence of the essential surveys or broad programmes. The Parliamentary and Scientific Committee puts the desirable expenditure on coal research alone at "several millions" and on agricultural research at at least three millions per annum. In its statement "A Post-War Policy for Science", the Association of Scientific Workers puts

the cost to the State of the proposed increases at about £18 millions, of which £7 millions would be for industrial research (as against £3 millions pre-war), £6 millions for agricultural advisory services, six hundred thousand for agricultural research, £4 millions for medical research (in place of £2 millions before the War) and half a million for consumer research. Even this estimate takes no account of Colonial research, for which expenditure up to half a million a year has already been provided under the Colonial Development and Welfare Act of 1940, or of the social and economic research adumbrated in the Nuffield College statement and elsewhere.

It is sufficient, however, for the present purpose to note that expenditure ranging up to what might well approach £50 millions can scarcely be appropriated without widespread public understanding of its purposes and implications. It is most important that these calculations should be properly and exhaustively made and that the cost of expansion should be determined and apportioned. But it is even more important, as *The Economist* has pointed out, that in this process the right relation should be devised between the universities and public bodies, including local authorities as well as the central government. That can scarcely be secured unless on one hand the underlying issues are clearly understood by the local authorities, in Parliament and by the electorate, so that decisions are taken free from prejudice or the pressure of private or sectional interests; and on the other, the question of university research and finance is seen as part of, and in relation to, the wider question of the national research effort.

From this point of view, accordingly, it is all-important that in the comprehensive reconstruction of our education system, of which the Education Act embodies the first instalment, the system should be regarded as a whole, from the nursery school to the universities and adult education beyond the university stage. No matter how perfectly our research organization is designed to serve our strategy, embodies the correct tactics and executes the programmes planned, it will only be fully effective when it has the intelligent support of the body of the nation it serves. By this means alone can we be sure, as the history of the last twenty years shows, that no false economy or sudden demand for retrenchment will cripple the long-range plans which would bring immeasurable returns to the nation's balance sheet.

That point of view is clearly recognized by the Government. In admitting the Government's responsibility for giving a lead in this matter of research, the Lord President of the Council, Mr. Attlee, stated in the House of Commons debate that Government support for research must be backed not only by a readiness to use the results of that research, but also by public opinion and by the nation becoming more aware of the importance of science. Mr. Attlee regards the Education Act as an essential means of getting the nation scientifically minded, and stressed that there are three parties: the Government, industry and the general public. Our

research effort will not endure unless, as Mr. Attlee said, public opinion is behind it.

No body is doing more in this work of public education than the Parliamentary and Scientific Committee, and Mr. Attlee paid fitting tribute to that work. Such educational work must be carried on outside as well as inside Parliament, and all scientific workers have their own opportunities as well as responsibility for sharing in the task. The Colonial Research Committee, in its first annual report, makes a sound point in emphasizing the importance of actively associating the Colonial peoples, through their Governments, with the planning and guidance of research. This point has an even wider bearing, for it may well be that until we can secure, in Great Britain as well as in the Colonial territories, that the ordinary citizen is associated with the planning of research, at least to the extent of gaining some understanding of its bearing on his everyday life and welfare, we cannot expect the sustained support and endowment of research on the scale now needed.

That task of education cannot be carried out without the wholehearted support and co-operation of scientific workers themselves, on whose shoulders much of the work of exposition and interpretation must necessarily fall. This is particularly true in respect of the special task of educating the administrator as to the potentialities of scientific research. We may indeed hope that further attention to the training of the administrator and manager, as part of our programme of educational reform, will explode the superstition that business and administration cannot be taught in a university, and demonstrate that a university can provide those whose profession is to be industry or business with a three-years discipline in the fundamentals of the problems they will meet in their professional career. Thus we may ultimately provide both industry and Government departments alike with administrators having sufficient scientific background to appreciate the scientific factors in the problems confronting them, and to discharge more adequately and imaginatively such functions as decisions upon research needs and priorities—a long-range task. The immediate problem is that of educating the present generation of administrators, who carry the responsibilities for the decisions that will permit or warp the post-war expansion of research. As Dr. D. R. Pye suggested recently to the London Institute of World Affairs, the primary responsibility of the universities to industry is to supply the qualified men and women, able executives with trained minds and initiative, capable of seizing upon and developing a new idea or a promising new process.

The concern with which the medical profession has viewed the Government proposals for a State medical service is at bottom due to distrust of the administrator. The weaknesses of the Civil servant as summarized in the recent report on "The Training of Civil Servants" . . . "over-devotion to precedent; remoteness from the rest of the community, inaccessibility and faulty handling of the general public; lack of initiative and imagination; ineffective organ-

ization and misuse of manpower; procrastination and unwillingness to take responsibility or to give decisions" . . . may be exaggerated, but undoubtedly exist, and Prof. H. J. Laski is right when he says that the control of research is often in the hands of men with no serious acquaintance with the possibilities of either natural or social sciences. If this situation is to be rectified, the tendency to departmentalism checked, means found for securing that Government departments are aware of the relevance of achievements of scientific men in other countries, and a more youthful outlook and representation achieved in the direction of the relations between the Government and science, scientific workers must translate their concern for professional and intellectual freedom into a sense of social responsibility which issues in both individual and in corporate action.

Dr. D. W. Hill, in his recent book "The Impact and Value of Science", has put his finger on the weak spot: "Until they have learned to express themselves, scientists will continue to be wallflowers at the world's quickstep". The faults are not all on one side. The indifference and even scorn with which scientific workers have treated this task of exposition is every bit as serious as the defects of the administrator already mentioned. As Dr. Hill says, scientific men must learn to write and to speak so that people will listen to them, and will understand and appreciate their efforts. In place of the isolationist and sometimes arrogant attitude to the administrator, scientific workers must adopt a sympathetic and co-operative attitude: they must seek to help, not to dictate. The task of intelligence calls for tact and sympathy and for imagination on both sides. The man of science as well as the administrator needs to be sensitive to opinion.

These factors are as important in the running of our research organization and in the functioning of its information services as lubrication in running a machine, and especially so in dealing with the present situation, when we cannot wait for a reformed educational system to provide us with improved types of experienced administrators. There is, however, another aspect in which educational reform is important to our plans for the expansion of research. The Association of Scientific Workers has pointed to the need for increasing the supply of laboratory technicians in order that we may make full use of even the existing numbers of trained scientific workers. Equally important is the supply of technicians in industry, and no plans for the expansion of applied research which take no account of the facilities for technical education can be expected to fructify.

The dependence of Great Britain's post-war plans on the provision made for technical education has been repeatedly emphasized of late. It is recognized, as the Nuffield College paper points out, that the management of a firm should include men with a sound knowledge of basic scientific principles and methods. The Government and the public should be similarly equipped. Thus, in the long run, the general need is for a spread through the educational system of a sound knowledge of basic scientific principles and method. Sir George Schuster urged in the House

of Commons the need for a very great increase in the number of scientifically trained workers and for a very rapid development of all forms of scientific and technical education; and the Government educational programme was strongly criticized from this point of view in the House of Lords. The report of the London Chamber of Commerce on Scientific Industrial Research also recognized the importance of this question of technical education and urged the allocation of a far larger sum for the development of technical colleges than the £100,000 envisaged in the White Paper on Educational Reconstruction. Similarly, the report of the Parliamentary and Scientific Committee directs attention to the need for a great expansion in technical education, for reconsidering the position of the technical institutions with reference to the universities, and to the value of the large number of technical personnel now in the Forces, if suitably trained, on demobilization.

There is a further point stressed in this same report, as well as in that of the London Chamber of Commerce, which has frequently been overlooked. It is essential to find some means of restoring the status of the craftsman or artisan and technician, both in the laboratory and in the works. When all has been said about the necessity for further provision for technical training of the skilled workers and craftsmen which industry will require in growing numbers, to remedy the present inadequate provision for this purpose will not by itself be enough. There is an important body of industrial opinion which holds that the provision of technical education in Great Britain is inadequate and defective primarily because the country undervalues the man who works with his hands, and regards him as socially inferior to the office or professional worker.

To remedy a perverted social attitude is a matter that lies outside the field of education, in the limited sense of that term, and while the scientific worker will urge the importance of adequate provision for the technical training of the craftsman as bearing vitally on industrial efficiency and the effectiveness of our research organization, he cannot fail to note that here again he must accept some responsibility for attempting to reverse that attitude. More might undoubtedly be done by the example of professional associations, and the scientific worker is prone to overlook the influence that his own personal conduct and attitude may have on his fellow citizens and workers. Social attitudes may be reversed less by propaganda than by the quiet pervasive influence of conduct determined by principles firmly held and resolutely but sympathetically and sincerely explained.

It is not only the general public and the administrator who in such ways as these must be educated to understand the needs and possibilities of the situation in order to enable our research organization to function effectively. Reports from the Department of Scientific and Industrial Research have repeatedly stressed the need for more publicity in industry, and for the education of industry, in order to make the work of the research associations, for example, effective. It has become an important function of some research associations to secure the translation of their

results into terms which are easily assimilable by the industry. The task of public relations has acquired a special significance in this respect for securing that industry is research-minded, and both the report of the London Chamber of Commerce and that of the Industrial Research Committee of the Federation of British Industries have directed attention to this point.

The London Chamber of Commerce urges that chambers of commerce, trade associations and industrial federations should give attention to this question of publicity generally, providing information and advice as to the steps to be taken by firms to get specific research done for them and to utilize the research facilities available. It also suggests that the B.B.C., the Press and the cinema should be used to stimulate interest in scientific work and to interpret the results of that work when applied to industry. That was to be one of the functions of the co-ordinating secretariat for industrial research suggested by Dr. P. Dunsheath, and it is one of the main functions of the bureau of industrial research suggested by the Federation of British Industries. This bureau, though supported financially by research associations, independent research laboratories, Government research establishments, universities and others, would be entirely objective in its activities. Among its suggested activities are the publication of a year-book, in which could be included a short description of the achievements of British research and of the facilities available for the prosecution of research, and educational publicity on research.

In addition to advisory functions on research problems, the Federation of British Industries' Committee visualizes such a bureau as possibly creating a liaison between research workers in similar or related fields. Its existence would in the opinion of the Committee increase the research-mindedness of British industry and foster a greater national sense of the importance of the subject and its influence in maintaining national prosperity and well-being. It might indeed assist in imparting to those responsible for management in large or small firms a scientific approach and understanding of their problems, and encourage a readiness to give a high place in business affairs to the claims of scientific research; though it can never absolve us from the responsibility already indicated of thinking in terms not only of supplying industry with adequate staffs of experienced research workers but also with managements capable of co-operating fruitfully with them.

The importance of establishing some new machinery for such purposes and of providing adequately for the organization of information or intelligence services is clear, but it must not be forgotten that organization by itself is not enough. We have already outlined the kind of organization which may be required to serve the broad strategy of research and to execute the programmes which may be planned to serve the national needs. We have stressed the need for keeping that organization flexible and sensitive, for development in accordance with the experience of the past, for avoiding compartmentalism or departmentalism; and that in our planning the

first attention must be given to the supply of the right personnel.

In this matter of securing adequate and sustained support of research and the effective utilization of its results, the question of personnel again comes before organization, but with a different emphasis. Success in such publicity and educational work depends largely on those who carry it on, and here the scientific worker must always have a large, and at the start a major, responsibility. Educational reform is a slow process, and the full effects are only felt after a period of years. The immediate task of educating the general public, the administrator and industry as to what is involved must be done largely by them or not at all; and if it is not done, our plans for the expansion and development of research are unlikely to go forward.

Scientific workers will not knowingly neglect their responsibilities, great or small, in such matters as the strategy, the planning or the execution of research. There are signs of an increasing concern with questions of tactics and that the professional associations may take wider and more public-spirited views on some of the problems calling for corporate action, to which in the past they have been indifferent. But the majority of scientific workers have scarcely realized the crucial importance of this task of interpretation and exposition involved in the education of the public, which must proceed step by step as our plans for scientific research are developed.

Research organization may be perfectly designed to serve the purposes of our strategy; research programmes may be comprehensive and well co-ordinated; but no excellence of administration or tactics can eliminate the dependence of success or failure on the human element. The research worker, too, does not work in a vacuum. He has relations with the Government or administration, with fellow scientific men in other branches of knowledge, with his fellow citizens in industry and elsewhere. Organization can only provide the means for co-operation, but without the determination or desire to co-operate and some sympathetic understanding of other points of view, organization will not function.

The adequate organization and planning of research involves a great partnership in which the scientific man, whether he be research worker or administrator or expositor, must take his place with those engaged in Departments of State, in industry and in a real sense the general public. The special responsibilities which fall on men of science in formulating strategy or planning programmes, in criticizing constructively the strategy, tactics or organization of research, as well as for the actual prosecution of research, must not lead them to overlook this further responsibility. The prosecution and organization of research can in fact only yield their full results when this task of interpretation and exposition—of educating public opinion as to what is required—is discharged with vision, imagination and persistent resolution, and in a spirit of public service which matches the devotion which scientific workers instinctively bring to the quest for truth in the laboratory.