

Research in the Modern State.*

THERE are few documents which present a more comprehensive picture of the manifold ways in which scientific research is applied, not only to industrial problems but also to the service of our daily needs, than the annual reports of the Department of Scientific and Industrial Research. All the major needs of the population are touched by the activities of the Department—food and clothing, air and water supply, heating and lighting, communications and transport, housing and building—in each of these spheres science is making important contributions, and promoting not material developments alone but also the solution of many problems which menace the national development and health. There is no department of State in which the beneficial influence of the Department of Scientific and Industrial Research is not felt, and it is probable that no proportion of the national income is more profitably spent than the comparatively small sum of £711,200 (gross) or £536,746 (net) which represents the expenditure of this Department for the year ending Mar. 31, 1930.

The report of the Department for the period, Aug. 1, 1929–July 31, 1930, which has recently been published, includes the short report of the Committee of the Privy Council, signed by Lord Parmoor, with the report of the Advisory Council and summaries of the work carried out by the National Physical Laboratory (representing the largest single item of expenditure, £205,301 gross, or £100,418 net), and the Chemical Research Laboratory, by the twenty research associations which are in receipt of grants, and under the direction of the various research boards. Appendices deal with the research boards, committees, and establishments of the department, finance, publications, and developments during the period in the organisation of industrial research in other parts of the British Empire. The extent to which scientific knowledge is now woven into the fabric of modern life is well indicated by the list of some forty-five research boards and committees and of the twenty research associations, to the support of which grants amounting to £70,931 were contributed during the year. The personnel of these committees comprises many of the most distinguished scientific workers in Great Britain, and much of the voluntary service they thus render receives little public recognition. As in the year under report, the results of scientific work are seldom spectacular, and even when a fundamental discovery has been made, years may elapse before it becomes a benefit to mankind. The absence of spectacular results from the present report, in fact, renders it a more valuable document from which to assess the immense normal contribution such work makes to our common wants.

In the course of a short article it is impossible even to catalogue the wide range of subjects coming within the province of the Department, and a few examples only will be selected to illustrate the intimate relationship of its work and our daily life. Even to outline the work of the research associations would carry us beyond our limits, and it must be sufficient to refer to the investigations being carried out by the British Non-Ferrous Metals Research Association on the effect of frost on the bursting of water pipes, which is to include pipes made of lead, the new lead alloys, copper and iron so far as they are used in domestic installations; and by the Research Association of British Paint, Colour, and Varnish Manufacturers on the durability of films of paint or varnish, etc. The tests carried out have already made it possible to obtain much valuable information regarding the probable performance of paint materials in use. The British Cotton Industry Research Association has successfully introduced a new antiseptic, 'Shirlan', to protect cloths exported to warm damp climates, and warps stored under damp conditions at home from the deleterious effects of mildew development. The British Launderers' Research Association has studied the laundering of rayon, and directs attention to the caution needed in finishing, for example, ironing, such fabrics; whilst the Wool Industries Research Association has reported the unexpected discovery that when sulphur dioxide and alkali are present in particular proportions they assume a phase of exceptional activity. By taking advantage of this active range a new, effective, and cheaper process of bleaching has been developed.

The increasing use of electricity for domestic purposes is not unaccompanied by dangers. Thus, while the necessity for earthing as a means of avoiding the danger of shock or mitigating its effect is generally acknowledged, the means for obtaining a 'satisfactory' earth have not been described, and wide variations exist in practice, some of which are hazardous and others unnecessarily expensive. This question, and also the elimination of fatigue failure in the overhead lines now widely used for the transmission of power at high voltages, are occupying the attention of the British Electrical and Allied Industries Research Association. By work of this kind, the consumer benefits through obtaining a better article, and in some cases also a cheaper article. The standard of living is thus being gradually raised as a result of the application of discovery to production. Research on the electric lamp, for example, has enabled the consumer to-day to obtain more than four times the light his grandfather could obtain for the same money.

The work of the Fuel Research Board is of outstanding importance, whether for industrial or domestic purposes, and on this work a gross sum of £95,305 was expended. Some account of the investigations conducted by the Board has recently

* Department of Scientific and Industrial Research. Report for the Year 1929–30. (Cmd. 3789.) Pp. 224. (London: H.M. Stationery Office, 1931.) 3s. 6d. net.

appeared in NATURE (Mar. 7, p. 386), and the results of the study of low temperature carbonisation have led to the formation of a Low Temperature Coal Distillers' Association. This work is linked up with the investigation of the tar oils produced as by-products which is being carried out by the Chemical Research Laboratory, Teddington. The main object of the low temperature carbonisation process—the production of a satisfactory smokeless fuel—can only be achieved if the by-products can find a suitable market, and it is accordingly worthy of note that 'Bakelite' and 'Novalak' resins have been successfully prepared from phenolic fractions of this low temperature tar, whilst interesting results have also been obtained at Teddington in cracking, hydrogenation, and syntheses from the same tar.

A closely related problem is that of atmospheric pollution, and the investigations of the research committee dealing with this have now reached an advanced stage. Improved methods of obtaining information on atmospheric pollution are being elaborated, including methods for the determination of sulphur in the atmosphere, the approximate total sunlight received, and the lateral distribution of atmospheric impurity from a centre of pollution under different weather conditions.

The importance of preventing water pollution was particularly demonstrated during the dry summer of 1929, and has stimulated interest in the work of the Water Pollution Research Board. A comprehensive scientific survey of the Tees as a typical river flowing through an industrial centre has been undertaken, and already the general changes in the composition of the river water and in the fauna and flora of the river from source to mouth at different times of the year and under different conditions of rainfall and tide, have been ascertained. The very serious pollution occasioned by effluent from beet sugar factories has received special attention, and investigations carried out in co-operation with the industry have shown that there are practical methods by which such excessive pollution can be avoided. Another investigation in which the Chemical Research Laboratory is also participating is concerned with the difficulties caused by the corrosive action on iron mains and the plumbo-solvency of certain waters.

The work of the Food Investigation Board entailed a gross expenditure of £38,531, or £14,237 net, with a further £9736 on the extension of the Low Temperature Research Station at Cambridge—figures which seem infinitesimal in regard to the importance to the nation of the successful preservation, storage, and transport of fruit, vegetables, meat, and fish. The extension at Cambridge will accelerate the work on meat, in which important scientific and practical results have already been achieved in relation to freezing of gelatin gels and to the factors responsible for loss in 'bloom' or the freshly killed appearance of lamb. Work on the scientific basis of the curing of meat is providing a rational explanation of the customs of the curing industry, which are at present empirical and obscure.

The characteristic English breakfast has received special attention, for the programme of work has included large-scale investigations on the storage of frozen bacon and on the factors involved in control of the cold storage of eggs. During the year, construction of the new station at East Malling has advanced sufficiently to permit research on the storage of fruit on a semi-commercial scale, and a report has been published which should facilitate the elimination of wastage in fruit transport and storage, and another on the optimum temperatures and atmospheres for use in the gas storage of fruit, which has led to a remarkably successful method in one of the large commercial stores.

Research on the preservation of fish by cold, the smoking of fish, and the bacteriology of fish preservation has been commenced at the Surrey research station. This work has been supplemented by work carried out at sea in the steam drifter *City of Edinburgh* and by the Forest Products Research Laboratory, which has undertaken an investigation of the chemistry of wood smoke.

Much important work carried out by the Forest Products Research Board is concerned not merely with the development of the forestry resources of the Empire, but also with timber preservation and methods of preventing dry-rot or attack by the 'death-watch' beetle or other insect pests. Such work like that on the seasoning or creosoting of larch poles to prevent the serious wastage by longitudinal splitting is obviously related to the use of timber in building or constructional work, and in this field the Building Research Board is making a steady advance. Factors involved in weathering, the composition and properties of cement, the stresses and strength of constructional materials such as concrete, earth-pressure, and the fatigue of materials, have received systematic investigation. An experimental house has been used to correlate the heat requirements with weather conditions so as to obtain maximum efficiency from the point of view of the user.

The work of the Illumination Research Committee is also closely connected with housing problems, as is that of a joint committee of the Fuel and Building Research Boards on Heating and Ventilation. The former has directed investigations at the National Physical Laboratory on the effect of window size, colour, and reflection from walls and ceilings on the illumination of rooms, the effect of distribution and colour of various systems of lighting on clerical work, as well as investigations on street lighting and glare.

The latter represents only one of the ways in which the work of the Department impinges on the important field of transport. The establishment of a locomotive experimental station for tests and general research on locomotives, the testing of ship forms and propellers carried out in the William Froude National Tank, and the establishment of a second tank for research on ship design, resistance, and propulsion, etc., the aerodynamics research at the National Physical Laboratory, and the investigation of the Fuel Research Board on the

causes of fires on steamships in bunkers and cargo coal, are sufficient evidence of the important contributions made in every field of transport, without enumerating the metallurgical research or the important engineering investigations carried out at the National Physical Laboratory.

In another field of communications, the Radio Research Board is making contributions which affect the millions of homes where broadcasting is received, while dental research, the production of insecticides for the destruction of the cocoa moth, the production of new drugs, and the discovery of the efficiency of borax—boric acid mixtures for the fireproofing of fabrics—and investigations on the action of sunlight on cotton, which have revealed the deleterious effect of small traces of iron, are all that can be mentioned of the activities of the Fabrics Research Board.

Similar work is being carried out in Canada, Australia, New Zealand, South Africa, and in certain fields, notably in that of the transport of fruit and on the investigation of Empire timbers, much has already been done to secure co-operation between the mother country and the Dominions overseas. Even the above brief survey should make it sufficiently clear that the work of the Department of Scientific and Industrial Research is a vital factor in the prosperity of the British Empire, and upon its wise direction and active prosecution depend in large measure our prospects of restoring our industries to full vigour, exploiting to the full such natural advantages as we possess, and, by increased efficiency where we now possess no such advantages, recovering something of the position we formerly held amongst the industrial nations of the world.

Physical and Mental Development of Children.

IN spite of the assiduity with which the growing child has been studied within recent years, it cannot be said that we know very much about him. But what we do know, and know with any degree of scientific certainty, is set forth in the Report of the Consultative Committee on the Primary School* recently issued. The Committee, indeed, has spared no pains in securing the most trustworthy information at present available. It has interviewed eighty-nine witnesses; it has read a staggering number of memoranda; it has examined with special care all evidence which can claim scientific validity. Hence it has treated with special respect the opinions of physiologists and psychologists. Indeed, much of what is said in the body of the Report about the development of the child is based on two memoranda which are printed in full in the appendix. The first is by Prof. H. A. Harris on the physical development of the child, and the second by Prof. Cyril Burt on the mental development of the child.

Prof. Burt's memorandum will be dealt with first. It may be said at once that it is wholly admirable. It sets forth with great clearness, and with no small measure of charm, all that is certainly known about the psychology of the child of primary school age—all that would receive the unqualified support of the author's fellow psychologists in Europe and America. It indicates the views that have survived; and these views show how far we have moved within the last thirty years.

Thirty years ago, the orthodox creed was largely based on biology. The belief of what happened in the mind was mixed up with a belief of what happened in the body and in its remote progenitors. It was believed that in the growing child certain instincts and interests and powers remained virtually dormant up to a given age, and then suddenly woke up and became insistently active. Their maturation was almost as sudden as their birth. Thus definite layers of mental life were laid down and consolidated, and, on top of these, new layers

were superimposed. First came the mastery of the physical senses, then the control of the muscular system (including the muscles of speech), which give rise to walking, dancing, talking, and constructing things with the fingers. Then came the development of memory, and finally the emergence of a capacity to reason.

Mixed up with this stratification theory, as Prof. Burt calls it, is the recapitulation theory, which states that the development of the child tends to reproduce in rapid and abbreviated form the evolution of the race. He goes through the cave-dwelling period, the savage period, and the barbarian period. He is at various times in the hunting stage, the nomadic stage, the agricultural stage, the craft stage, and what not.

We no longer hold these views—not in their original form at any rate. The stratification theory is discredited by the fact that experiment has exploded the old doctrine of distinct faculties, such as memory and reason; and the recapitulation theory is discredited by the failure to find evidence for the transmission of personally acquired characters. There is no more reason to think that the son of a potter inherits the aptitudes and interests of a potter (apart, that is, from the influences of his immediate environment) than there is for believing that the son of a mathematician will know the differential calculus by the light of Nature. Indeed, these old beliefs have been shattered through their failure to fit in with the facts of the mental life which have been disclosed by direct observation and experiment. For the method of direct study is essentially the modern method.

This is an important point of methodology. The child's mind is studied, not by studying his body, his brain, or his pedigree, but by the simple and obvious method of studying the thing itself. The facts to be observed and explained are mental facts. Real progress in the study of mental development may be said to have begun when the psychologist resolutely turned a blind eye to the alluring theories of the physiologist or the

* "The Primary School." (London: H.M. Stationery Office, 1931.) 2s. 6d. net.