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Knowledge and Action.

JUST sixty years ago, Prof. T. H. Huxley, in a lecture on technical education, delivered to aid the Working Man's Club and Institute Union, used the significant phrase, "The great end of life is not knowledge but action". He went on to say that most people only need such knowledge as can be assimilated and organised into a basis for action, and that undigested learning is not only of no service to the individual or society, but also may be injurious. It was in the same lecture that Huxley, referring to the cost of education, made the oft-quoted statement, "I weigh my words when I say that if the nation could purchase a potential Watt, or Davy, or Faraday, at the cost of a hundred thousand pounds down, he would be dirt cheap at the money. It is a mere commonplace and everyday piece of knowledge, that what these three men did has produced untold millions of wealth, in the narrowest economical sense of the word."

Huxley's aphorism, and his application of it to profitable industry, provide an appropriate text for a short address to business men not alone in Nottingham but in any part of the world. In this country, however, we should be particularly proud of the international effects of the work of our own scientific and inventive citizens. We cannot too often remind the world that it was James Watt who transformed an imperfect pumping engine into an efficient and powerful working instrument for the use of steam power in industry everywhere; and he accomplished this by the combination of genius with scientific study and mechanical ingenuity. Every locomotive in the world originated in the applications of steam engines to railways by Trevithick and George Stephenson; and most of the steam turbines in use for marine propulsion, in power stations, and for various industrial purposes, are of the type designed and developed by Sir Charles Parsons, who brought about as great a revolution in the generation of power both ashore and afloat, as did Watt about a century earlier. When, in addition to the steam engine, the steam locomotive, and the steam turbine, in use in every civilised country, it is realised also that every electric dynamo owes its existence to Michael Faraday's discovery of the means of creating electric currents by the expenditure of mechanical energy, we may be pardoned for our pride in these contributions of our own countrymen to progressive industry all over the world.

Most of the inventions associated with the industrial revolution which began in the latter part of the eighteenth century were products of the workshop and mechanical ingenuity and depended little upon the discovery of scientific principles in the laboratory. Since then, however, creative science has not only given rise to many practical applications and new inventions, but has added greatly to human comfort and welfare. From Faraday's discoveries at the Royal Institution, London, has developed the vast engineering industry, which in the light, power, and traction companies, electro-chemical plant and the companies manufacturing electrical equipment and apparatus, provides employment for millions of workers. The radio industry is similarly the outcome of the scientific researches of Maxwell and Hertz on the properties of electric waves; and to Marconi belongs the credit of developing laboratory experiments into a system of communication through the ether. He was an engineer with vision, who put knowledge into action, and on that account his name is rightly associated with the commerical development of wireless telegraphy, and not because of his scientific contributions to the subject. As he himself acknowledged at the beginning of this century, "The experimental proof of Hertz, thirteen years ago, of the identity of light and electricity, and the knowledge of how to produce, and how to detect, these ether-waves, the existence of which had been so far unknown, made possible wireless telegraphy."

To foresee the possibilities of a discovery, to transform a laboratory experiment into the mechanical plant of a large works, or to apply it to the needs of ordinary life, requires aptitudes not commonly possessed by the scientific investigator. The engineer usually has such practical purposes in mind: discoveries are to him things to be used and not ends in themselves, as they are to the man of science. The two types of mind are, however, complementary to each other, and both are essential if knowledge is to be linked to action. Light itself is not made manifest until it comes into contact with matter; similarly, scientific knowledge has to be reflected in social service—intellectual or material—before its existence is recognised.

It may be said, therefore, that knowledge, like energy, is the power of doing work, and it only becomes effective when it is released. On the mechanical side, the potentialities of science are continually being made kinetic in inventions which add to human comfort and power; and these applications have revolutionised social and economic conditions. Industrial changes have been so great and rapid that it is no wonder that social instability exists everywhere. Our national leaders and administrators need wide knowledge and keen foresight to enable them to make the most effective use of the technical forces which are shaping the conditions of modern life. The scientific worker and technologist usually have their attention concentrated so closely upon their own particular subjects that they are indifferent to the social effects of their own activities.

Lack of familiarity with scientific matters has been an important factor in the crumbling away of our social structure under the stress of economic disaster, but we can stabilise the new social pattern by securing that action is related to knowledge. We are living in a period of great industrial and other material changes, the consequences of which can scarcely yet be predicted by the technical man, let alone be visualised by the average administrator. Equally, we are at the beginning of a new era of biological knowledge with new possibilities of physical and mental health, if our resources are planned intelligently with the object of satisfying real human needs.

It scarcely needs scientific authority to establish the principle that right nutrition, especially in early life, profoundly affects the well-being and social value of every individual member of a community. Much attention has been given in recent years to the determination of the essential constituents of a satisfactory diet, and the ascertainment of the financial resources of the general human population of this country to purchase such foods. Economists showed long ago, by records of family expenditure, that increases in income are associated with an increasing amount spent on food. What has been revealed by investigations carried out in recent years is that rising income, associated with increased consumption of milk, eggs, fruit, and a few other food-stuffs, goes hand in hand with decreased death-rate, better growth of children, greater adult stature, and much improved general health. On the other hand, it has been established that physique becomes worse, and disease more prevalent, as family income falls.

The results of investigations carried out by Sir John Orr and his staff at the Rowett Institute, Aberdeen, indicate that as many as twenty million, or nearly one-half, of the population of Great Britain would have their health improved by an increased consumption of the more expensive food-stuffs such as fruit, vegetables, milk and animal products, while examinations of family food budgets and family incomes show that price is the limiting factor for the consumption of these things. In a very large proportion of the population, the income per head is less than that considered sufficient by scientific inquiry for the maintenance of optimum health. If consumption were increased to a level at which every member of the community had a diet adequate for health, there would be room for a considerable expansion of agriculture in this country even without decreasing imports.

The unfulfilled needs of the people of Great Britain for essential food-stuffs are assessed at £100,000,000 a year as a minimum, and at double that value to maintain a standard of perfect nutrition.

Scientific studies of nutrition, with their social implications, and in relation to agriculture, have raised world-wide problems. A year ago an International Committee of Physiologists appointed by the League of Nations reported on the kind of diet which would be fully adequate for health. The standard given by this Committee is at present reached only by the wealthier half of the population of Great Britain and by an even smaller proportion in many other countries. The final Report of a Committee of the League on the Relation of Nutrition to Health, Agriculture, and Economic Policy, published a few days ago, is the most authoritative and suggestive survey of the subject that has yet appeared and provides a convincing case for relating knowledge to action. "Millions of people in all parts of the globe", the Report states, "are either suffering from inadequate physical development or from disease due to malnutrition, or are living in a state of subnormal health which could be improved if they consumed more or different food. That this situation can exist in a world in which agricultural resources are so abundant and the arts of agriculture have been so improved that supply frequently tends to outstrip effective demand remains an outstanding challenge to constructive statesmanship and international co-operation."

These conclusions are obviously closely related to the national campaign to raise the general standard of physical fitness, and especially that of the young. Fitness can never be obtained by physical measures alone, be they educational or recreative: adequate nourishment is an essential factor in its attainment. Malnutrition is the root cause of poor physique, and increased attention to sports or physical training can never mitigate the ill-effects of a bad diet.

The measures recently instituted for improving the physical health of the people of Great Britain involve, therefore, the element of nutrition. The question of the physical condition of the community cannot be studied or handled as a whole on scientific lines unless all the relevant factors are taken into consideration at the same time. It is desirable, therefore, that national provision for physical training should be co-ordinated with measures for improving national health in a scheme conceived on wide and generous lines. No citizen or young person should be prevented by inadequate nourishment due to lack of means from benefiting by the opportunities provided to improve national physique.

National fitness thus involves not only provision for industrial progress, but also for the maintenance of healthy growth in the life of the individual and of the community. The degrading social consequences of the industrial revolution, and of the attitude of labour to mechanical inventions, were due to the neglect of these human factors. Both rightly or wrongly, science has been blamed for much of the wastage of life which has been brought about by the rapid applications of scientific knowledge to purposes of peace and of war. Men of science are, however, citizens as well as scientific workers; and they are beginning to realise their special responsibilities for securing that the fruits of scientific knowledge are used for human welfare. They can no longer remain indifferent to the social consequences of discovery and invention, or be silent while they are blamed for increasing powers of production of food supplies, providing means of superseding manual labour by machines and discovering substances which can be used for destructive purposes. It would be a betrayal of the scientific movement if scientific workers failed to play an active part in solving the social problems which their contributions to natural knowledge have created.

The view that the sole function of science is the discovery and study of natural facts and principles without regard to the social implications of the knowledge gained, can no longer be maintained. It is being widely realised that science cannot be divorced from ethics or rightly absolve itself from the human responsibilities in the application of its discoveries to destructive purposes in war or economic disturbances in times of peace. Men of science can no longer stand aside from the social and political questions involved in the structure which has been built up from the materials provided by them, and which their discoveries may be used to destroy. It is their duty to assist in the establishment of a rational and harmonious social order out of the welter of human conflict into which the world has been thrown through the release of uncontrolled sources of industrial production and of lethal weapons.

In the consideration of the social aspects of science, scientific workers must be capable of appreciating the non-technical problems involved, as well as the scientific and technical issues, if they are to make an effective contribution to the scientific control of civilisation. They must, first of all, promote the extension of the application of scientific method to the consideration of social, economic and political questions, so that accurate knowledge may be obtained upon which sound conclusions may be based and progressive policies or programmes established. The task of securing action upon the facts is scarcely one for scientific workers as such; though it is their responsibility as individual private citizens to do all in their power to secure the appropriate action. They have, however, a further public duty which they cannot lightly evade; and that is the task of awakening public opinion to the grave danger incurred in the neglect to take action along the lines indicated by the results of impartial and scientific inquiry. The British Association is assisting to this end at its meetings by the discussions and papers bearing upon the relation between the advance of science and the life of the community.

RICHARD A. GREGORY.

Address given at a luncheon of Nottingham City Business Club on Friday, September 3rd, 1937, in connection with the Annual Meeting of the British Association.

Henry Edward Armstrong.

H. E. ARMSTRONG, a striking personality in chemistry, striking alike for independent-mindedness as for the relentless fervour with which he expounded the results of his labours, passed away on July 13, at the age of ninety (*b.* May 6, 1848). His was a vigorous and active life, and even a week before his death, he is reported to have corrected the proof of a scientific contribution "Ammonolatry—The Life Element", appearing in *Nature* (July 24, 1937), representing "the final expression of the frank and critical views which he held upon the training of chemists and subjects of research". As a critic he was unsparing and provocative, and this he perhaps owed to his illustrious professor, Kolbe. Voluminous and versatile were his contributions to chemistry, which included the studies on structure of naphthalenes, structure of camphor and mechanism of chemical changes. His work on the nature and mode of action of enzymes, in which among others his son E. F. Armstrong collaborated, is to be found recorded in the 23 papers appearing in the *Proceedings of the Royal Society*. He was associated with numerous educational and agricultural bodies. His favourite hobby was field geology and he was fond of open country and frequent travel. Among his associates, mention may be made of Kipping, Lowry and Forster. He was essentially an individualist and was "somewhat arrogant and extreme perhaps in his denunciations", but was a kind hearted gentleman whose "devotion to chemistry was the master passion of his life". In this connection, *Chemistry and Industry* (July 17, 1937) observes "We venture to think that for a long time, whenever old or middle-aged chemists meet they will think of him with affectionate remembrance and regret that there is no one left who can do so much to give life and vigour to chemical discussion, instruct and to divert chemists and enliven their minds.... Other men will make notable advances in the science of chemistry and invent processes of value to industry; others will advocate the proper place for chemistry in our national life. We doubt whether a chemist with so sure a judgement on many chemical matters will again invent a new waist coat of many colours, invent a familiar nick-name for a scientific journal and do so much to brighten our chemical outlook."