and especially with the external relations of science as a whole.

These groups will in time become action groups, attempting to influence public opinion and Government decisions in order to protect research from debasement and restriction and to extend the beneficial influence of research results and methods. After becoming strong and active, these groups will be in grave danger of forgetting their social obligations, of existing to serve the personal ends of their members and officers. This tragedy has happened often enough, in business, in labor, in agriculture, and even in the professions. If it should ever become the habit of scientists, I assure you, fellow scientific workers, we will be judged and treated accordingly by the society of which we are a part.

Alliance of Industry and Scientific Research in Great Britain

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THE LIFE AND WORK of the universities impinge upon the activities of industry in a variety of ways. New industrial products and processes frequently will be found to have germinated in the investigations carried out in the university research laboratories. Industry looks to the universities for provision of graduates for its technical, research, and, in some instances, high administrative positions. There are also indirect consequences of the dissemination of knowledge and culture from the centers of learning. These have their effect upon public and industrial opinion and national policy, which in turn may affect, by legislation or otherwise, industrial practice and progress.

In Britain since the end of the war there has been searching consideration of whether industry has been making its maximum contribution to the well-being of British universities and how it could benefit more fully from their activities. In the ensuing discussion, special attention has been devoted to scientific and industrial research.

There are many schemes now in hand in Britain for the expansion of pure and applied research in industry, cooperative research laboratories, and the universities. At the time of writing, however, many of the scientists, technicians, and research workers who have devoted their whole energies to World War II have not yet returned to their peacetime activities, and these have by no means reached fruition. This is an interim report, therefore, on some of the plans so far announced for a more intimate relationship between British industry and the universities with regard to scientific research. These plans are intended not only to assist in harnessing the work and results of universities to industrial needs without interfering with, or prejudicing in any way, the independence or integrity of the university spirit, but also to develop and maintain closer contacts between research workers in different environments.

The British universities, twelve in number, are renowned for the contribution they have made to the advancement and dissemination of learning. Few countries offer so rich a variety of facilities for access to the highest forms of education. In the sphere of science British universities have occupied themselves very considerably with investigations of a fundamental kind at the outer boundaries of man's knowledge of nature.

Although, in the long run, social and industrial advance is largely dependent on this extension of knowledge of the material universe, the whole spirit and atmosphere of university research is single-minded concern with the acquisition of knowledge for its own sake. The fundamental research carried out at the universities has fed and inspired the research undertaken in industrial laboratories, which has, in turn, irrigated the fields of industry. For instance, the first successful experiments in splitting the atom were carried out by Lord Rutherford at Manchester University and subsequently at the Cavendish Laboratories in Cambridge before World War I, and the theories then propounded by him on atomic structure have now been confirmed in practice by the atomic bomb.

Despite the fact that the universities are, rather naturally, a little remote from industry, there have grown up in the past a certain number of close contacts of great mutual benefit. For instance, collective research in the British glass industry is carried out in a special department of Sheffield University; at Leeds University a department deals with coal, coke, and gas research and another with textiles; at Birmingham will be found an experimental coal mine and oil-boring equipment. Furthermore, certain of the provincial universities contain technological departments serving the industries of the locality. There are also a number of recognized technical experts on university staffs who act as consultants to industry, and they and their laboratories, by bringing their experience to bear on industrial problems, have been of assistance in their solution.

Accounts now being given of the great scientific achievements of World War II show that a good deal of the fundamental work on which these were based and, during the last three or four years much of the applied work also, has been carried out in the laboratories of the universities. For instance, research on radar was undertaken at Bristol, at Birmingham (where the first magnetron valve was designed), at Cambridge, and at Nottingham Universities.

Recent reports of the Association of Scientific Workers and the Association of University Teachers have attempted to define the proper place of industrial research in the universities. Both organizations agree that departments of applied science should be fostered at the universities, but that in the normal way industrial development work should be carried out elsewhere. They believe that the war, as well as making abundantly clear the close connection between pure and applied research, has revealed the inadequacy of the intercourse between academic scientists and their industrial colleagues. They recommend closer contact and collaboration between industrial, governmental, and university laboratories and, where practicable, interchange of members of research staffs.

The endowments now being offered to universities by industry, in addition to being of great assistance to the work of the universities, contain within themselves an element of enlightened self-interest. One of the most important of these is the offer by the directors of Imperial Chemical Industries of eighty senior fellowships averaging 600 pounds a year each to universities in Britain (twelve each to Oxford, Cambridge, and London; eight each to Glasgow, Edinburgh, Manchester, Birmingham, and Liverpool; and four to Durham), to strengthen scientific research in physics, chemistry, and applied sciences, such as metallurgy and engineering. The administration of the scheme, which will operate for an initial period of seven years, rests wholly with the universities, which will select and appoint the fellows.

Birmingham University, in the center of the nonferrous metals and light engineering industries, has received an offer from Messrs. Joseph Lucas (motor and electrical equipment engineers) to endow two-year postgraduate courses in production engineering at a cost of 112,000 pounds, and a further 10,000 pounds has been offered to grant bursaries to needy engineering students. The University is considering also the establishment of industrial metallurgy laboratories, including a special chair of industrial metallurgy, to be endowed by sections of the nonferrous metals industry.

Most famous of the British cooperative industrial research laboratories, the Shirley Institute, which covers cotton, rayon, and silk textiles, has just announced that it is offering scholarships and fellowships at British universities to train in fundamental research methods young science graduates who subsequently will attain managerial positions in cotton mills.

Two illustrations of the practical way in which industry is attempting to overcome the serious shortage of chemical engineers revealed during the war years are the offer by the Shell group of oil companies to endow Cambridge University with 420,400 pounds to establish a school of chemical engineering, and the benefaction from the firm of Courtaulds to the Department of Chemical Technology of the Imperial College of Science, London, calculated to yield an income of 3,000 pounds a year in perpetuity, which will cover, among other needs, the establishment of a new chair of chemical engineering.

In order to ensure a more efficient and frequent interchange of scientific workers between industry and the universities, the London Midland and Scottish Railway Company (one of Britain's four main-line railways) has proposed, after consultation with the University Committee of Vice-Chancellors, that members of its research staff be appointed each year to do fundamental research in the university laboratories. It is hoped that the universities will invite these temporary workers in their laboratories to occupy part of their time in teaching. The universities, in turn, will be invited to send members of their staffs to work in the London Midland and Scottish Railway research laboratory at Derby, for agreed periods of about six months or a year, on applied aspects of fundamental problems in which they happen to be interested. These individuals would enjoy access to all the departments of the railway and would thus have the opportunity of seeing how the results of research are applied in large-scale railway development. The Railway Company's research laboratory is staffed by seventy university graduates and has sections dealing with engineering, metallurgy, chemistry, physics, paints, and textiles.

The Company is prepared to bear the bulk of the cost of this scheme, including the salaries and adequate allowances of both the railway and university research workers involved in the interchange. The Company hopes that the scheme will operate flexibly and on a multilateral basis rather than on a system of what might be termed "barter"; for example, one of the railway men might be sent to the engineering research staff at Cambridge, while the railway itself took a man working in that field from an institution such as Glasgow or Manchester University.

Significant among recent developments is the establishment of the Manchester Joint Research Council. This Council, sponsored jointly by Manchester Uni-

versity and the Manchester Chamber of Commerce, will assist in securing the effective application of the results of scientific research in industry, particularly in the northwestern part of England, where cotton and heavy engineering are the most important industries. An information service has been created which aims not so much at furnishing scientific answers to the problems submitted but at placing the inquirer in touch with the organization best able to deal with the particular subject. Regular meetings of the Council are now held in the Manchester area, and the scientists and the facilities at Manchester University and Manchester College of Technology will be available, where appropriate, to industrial firms in the region. A similar scheme is now being instituted at Leeds.

Finally, university research into the functioning of financial and business institutions in Britain and elsewhere, and the economic conditions affecting them, is being encouraged by the fellowships and grants awarded by the Houblon Norman Fund, sponsored by the Bank of England.

It will have been observed that, in the development of these links between the universities and industry, there is no suggestion that the former should sacrifice their academic integrity, or be guided as to policy by industry, or, except in special circumstances, should put themselves at the disposal of industrial organizations. It cannot be doubted that in the long run the national well-being will be served by these schemes, and others which, no doubt, will follow, for interknitting more closely knowledge and manufacture.

Wartime Research in Malaria

The Board for the Coordination of Malarial Studies

AN EXTENSIVE PROGRAM of research in the chemotherapy of malaria has been developed during the last four years through the efforts of a large group of university investigators sponsored and supported by the Committee on Medical Research of the Office of Scientific Research and Development. This program, integrated with that of cooperating industrial firms, is closely coordinated with malarial investigations in the Army, Navy, and U. S. Public Health Service through the Board for the Coordination of Malarial Studies. The functions of the Board are administered through facilities of the National Research Council provided by a contract between the National Academy of Sciences and the OSRD.

Useful knowledge has been accumulated on the biology of various malarial parasites, on their biochemical requirements, and on their behavior in different hosts. Studies on immunity in the avian infections have yielded information on the cross-immunization which obtains with different species of parasites. The immune response of human subjects to malarial antigen has not shown promise, either in the prevention or modification of the disease or in the production of complement-fixing antibodies which might be useful in differentiating between a latent infection and a cure in *vivax* malaria.

The studies in the chemotherapy of malaria have involved the screening of over fourteen thousand compounds for various types of antimalarial activities in various avian infections, a study of the toxicology and pharmacology of many of these compounds in laboratory animals, and a study of the potentialities of about eighty in human malarias due to parasites of domestic and exotic origin. In the course of these investigations, the chemical and pharmaceutical industries have responded generously to requests for both small and large quantities of material for animal and clinical studies.

The net result of these investigations has been the discovery of antimalarial activity in compounds derived from a variety of structural types, and a clear definition of the problems involved in the suppression and cure of malaria. In addition, certain investigations have progressed to the point where the results have been of definite value in the treatment of malaria. The practical advances emanating from the program can be summarized in brief as follows:

(1) *The development of better methods for the use of quinacrine (atabrine) in the suppression and treatment of malaria, which led to the demonstration that this compound is superior to quinine.*[1] The development of an accurate specific method for the determination of the small amounts of quinacrine in plasma permitted the collection of information on the pharmacology of this drug in experimental animals and man, upon which was based a rational usage of the drug.

(2) *The development of compounds superior to quinacrine.* Among these are several members of the 4-aminoquinoline series. In this group, SN 7618,[2] *7-chloro-4-(4-diethylamino-1-methylbutylamino)quino-*

[1] Statement of the Board for the Coordination of Malarial Studies. *J. Amer. med. Ass.*, 1944, **125**, 977.

[2] The Survey number, designated SN, identifies a drug in the records of the Survey of Antimalarial Drugs.