SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. 33 APRIL 1967 No. 4

ROYAL SOCIETY CONFERENCE OF COMMONWEALTH SCIENTISTS

OXFORD, 7—11 APRIL 1967

THE Royal Society Conference of Commonwealth Scientists was held, in Merton College, Oxford from 7–11 April 1967. The Conference was attended by some 80 representatives from 25 countries of the Commonwealth of whom about 40 to 45 were from overseas. It was a pleasant, instructive, and in many ways an exciting experience to have participated in this conference. My colleagues from India were Dr. Atma Ram, Dr. V. R. Khanolkar, and Professor T. R. Seshadri, who presided over the session on Universities and Scientific Education.

I had attended the Royal Society Empire Scientific Conference held in 1946 which was organised on a much larger scale. Meetings were held over a period of four weeks, of which one week each was spent in Oxford and Cambridge and two weeks in London. The Oxford Conference was much smaller in size. Most of the delegates to the Conference in 1946 were selected at government level. In the present conference particular care was taken to have representatives from scientific academies and societies or universities; I believe there were no government delegates from overseas.

Residential accommodation and meals were provided for the participants in Merton College which gave opportunities to get acquainted with one another. Discussions took place in a small hall in the same college in a very informal way with frank exchange of views and criticisms. The only semi-formal function was the opening of the Conference on 7 April with a reception and dinner attended by His Royal Highness The Duke of Edinburgh. "The general themes of the conference were introduced in speeches by His Royal Highness and by Professor P. M. S. Blackett, C.H., President of the Royal Society."*

The Conference sessions began with review statements on the Royal Society's activities in the Commonwealth, existing schemes for Commonwealth scientific interchange, the work of the intergovernmental Commonwealth agencies. "Other sessions were devoted to Universities and Scientific Education, Scientific Policy and Organization, Problems of Aid and Commonwealth Co-operation in Research Projects."

Comments and observations from the representatives of the African countries were particularly interesting and instructive. Evidently great importance was being attached to the progress of science and technology in the newly independent countries.

There was a great deal of variation in conditions relating to scientific research and organisations and in facilities for science education in different countries. U.K. was the most advanced country; Australia, Canada and New Zealand also were highly developed. India and Pakistan with a history of nearly 200 years of scientific activities and a large number of scientific organisations, universities and teaching institutions at various levels, occupied a middle position. Some of the smaller Commonwealth countries had fairly good facilities; many other countries were in a relatively early stage of development.

In spite of the great diversity in the stage of development of science and technology it was clear that there were many common problems and difficulties. Views expressed at the Conference indicated that even in U.K., with its long tradition of independent scientific

* Quoted passages are taken from the Royal Society Press Release of 11 April 1967.

societies, universities and higher educational institutions, the establishment of numerous governmental scientific agencies in recent years had not been entirely beneficial to the advancement of science and technology. Continuing reference was made, especially from the less advanced countries, to difficulties created by the administrative machinery of government which often delayed decisions and led to much waste of effort and resources resulting in frustration among scientific workers. It was felt that until the administrative officers in government begin to have a proper appreciation of science and scientific research progress would be very slow in the less developed countries. An urgent task is to promote the scientific outlook among the general public and among those who make political and administrative decisions.

The Press Release noted :-

"The important independent role of Royal Societies and Academies working alongside governmental science organisations was stressed. These societies and academies in the Commonwealth vary from the long established to the recently founded, and some countries do not yet have them."

"The value of national Science Councils as instruments for the co-ordination of scientific effort and in the distribution of funds was emphasized."

Another important feature was the emphasis laid on the need of orienting research and development to economic growth. The Press Release stated :-

"The Conference devoted a major part of its deliberations to the problems of developing countries and urged that scientists in these countries should be more concerned in the economic development of their countries. It was considered important that scientific and technological knowledge should be directed to local problems, the solution of which seems likely to lead to practical benefits. In the phrase of Dr. Atma Ram, Director General of the Department of Scientific and Industrial Research, India, it is more important to have technological competence than to strive after technological independence. The importance of agricultural science was stressed and in this connexion it was suggested that a Commonwealth Agricultural Conference should be held."

"It was agreed that more total aid was needed but that it must be more selective and more closely co-ordinated by the recipients than hitherto; it should be directed towards projects of high development value and not merely of prestige value. In frank discussion of the problems of aid various improvements were suggested including the greater use of non-governmental channels, the use of advice by Royal Societies and Academies in the choice of experts and the need for the continued servicing of equipment and the training of technicians."

Much emphasis was given to the important role of universities in less advanced countries in providing training for science teachers and research workers to develop and maintain a self-sustaining scientific community. The Press Release noted :-

"Scientific research at these universities should be mainly in applied sciences relating to local problems and conditions. Such research can be good training, and useful work, even if simple, carries its own prestige. Close contact is desirable between university laboratories and governmental scientific institutions. No competent scientist should be out of touch with the young. When postgraduate students from universities in developing countries study abroad, the nature of the research problems should be so chosen as to relate to their home conditions and be appropriate for their return after training abroad. The value of examiners from abroad and 'twinning' arrangements between science departments in a developing and a developed country was warmly appreciated and extension of such arrangements was recommended. It was agreed to examine the possibility of instituting schemes for visiting associateships to leading centres of research in different parts of the Commonwealth. Such associateships would involve intermittent residence over a period at the selected centre of research, on condition that the holder would return to teach in his own country. Several speakers regretted that scholarships for undergraduates from developing countries tenable in the United Kingdom and other developed countries tended to cream off the best students from local universities. The use of aid from Canada to provide scholarships for West Indians tenable in the University of the West Indies was warmly applauded."

"Arising out of discussions on co-operation in scientific expeditions scientists from developing countries were urged to encourage expeditions to study their own countries and to establish and maintain national museums. The association of schoolboys and other young people with such expeditions was recommended."

"In a session devoted to Commonwealth co-operation in international research projects leading scientists from the Commonwealth reviewed progress in oceanography and fisheries, the International Biological Programme, space

research, Antarctic research, geology and geophysics and in medicine."

"It was agreed that exchange visits between Royal Societies and Academies should be encouraged, and it was suggested that another conference of this kind and also more specialized conferences should be held at appropriate intervals."

Some Comments and Observations

I may refer to some of the points which I mentioned during brief interventions at the Oxford Conference, and also make some general observations. I am in complete agreement with the policy of relating research and development to economic growth, and giving very high priority to developmental projects which are likely to lead to practical results in a short period. I stressed that at the same time it is also necessary to give equally high priority to certain special types of basic research which have clearly formulated objectives and which are also likely to lead to results of practical value in a short time. I cited two examples.

By the end of the first World War, Sir John Russell, at that time Director of the Rothamstead Experimental Station, Harpenden, Herts, found that current methods of agricultural field trials were entirely inadequate. He created a post for Ronald A. Fisher, a young mathematical statistician, to study this problem. In about three years, Fisher developed the method of "the design of experiments" which increased, by a factor of ten, the discriminating power of agricultural field trials for comparing the yield per acre of different varieties of crops or the effect on the yield of crops of different doses or different kinds of manurials. The design of experiments supplied a powerful tool not only for agricultural field trials but also for experiments in industry, medicine, engineering, and other natural and social sciences.

Metallurgists in U.S.S.R. had discovered about the middle of the 1930's that the injection of oxygen at a certain stage of the manufacture of steel could increase very appreciably the yield of steel. The question was whether a sufficiently low cost source of oxygen could be found to make the process economic. A distinguished physicist, Pietr Kapitza, took up the problem and found a satisfactory solution which led to a higher output of steel by about 30 or 35 per cent in comparison with the output without the injection of oxygen.

There is also need of promoting open-end basic research, that is, research without any sharply formulated practical objectives. In the developing countries such research can be best undertaken in association with the training of research personnel especially in universities and higher technological institutions. The size of such units would be small consisting of a scientist or two or up to five or six professional workers. The cost of each unit would be comparatively low because there would not be any need of using much hardware or engineering works as in the case of industrial development projects. To be of any real value the quality of research must be very high and must be assessed according to international standards.

The number of persons capable of undertaking, or supplying guidance for basic research of this type would be very small in every country. The proportion of persons of such ability was recently estimated to be of the order of five per cent of the number of scientists engaged in research and development (R & D) in the United States which in 1962 or 1963 had about 100,000 full-time equivalent scientific workers; or adjusting for part-time research workers, may be, about 120,000 individuals. On this basis, the number of persons capable of undertaking or guiding really high quality basic research would be five or six thousand in a population of, say, 180 millions in the U.S.A.

It may be assumed, as a first approximation, that talent for high quality research is distributed at random among the nationals of different countries of the world. The number of persons actually available for research would depend on the catchment area, that is, that part of the population which would have access to education at the university level. Compared with the advanced countries, the proportion of the population having access to higher education would be very small in the poorer countries. The number of persons qualified to undertake or guide basic research of high quality would be therefore extremely small in the early stages of economic growth.

It follows from the above considerations that even the poorer countries can afford the expenditure required for basic research of high quality. The real limiting factor is the lack of men with the required ability. Professor P. M. S. Blackett had stated a simple principle long ago, that every scientist of ability should be provided with as much funds as he can spend usefully.

Apart from scarcity of talent, the most serious difficulty is identifying whatever talent may be available at any given time. It is only scientists of high calibre who would be able to identify talented scientific workers. So long as the number of research scientists

of high ability is small the probability of successfully identifying talent would also be small. As the number of high calibre scientists increases the possibility of recognising talent would also increase. There would be therefore something like a feed-back mechanism in the building up of high quality research.

At the Oxford Conference attention was drawn on more than one occasion to the complex relation between the volume of research and development and the rate of economic growth. One participant placed great emphasis on the fact that there was very little expenditure on research and development during a long period of fast economic growth in the U.S.A. The implication possibly was that some of the newly independent countries may perhaps get on quite well without investing much in research and development. This would be true only up to a point.

It would be definitely wise for the poorer countries to start at the end of production and acquire technical skill through the use of imported machinery and technology. An increasing use of such standard methods as Statistical Quality Control (SQC) would be of great and immediate value in maintaining a high quality of manufactured products and in reducing the cost of production which would promote exports.

I have also strongly advocated the construction of machinery which would be at first faithful copies of imported machinery or equipment. To make a good copy would be an effective way of acquiring technical skill. Gradually, in the very process of copying, improvements would be continually made to suit local needs, conditions, and the domestic supply of raw or semi-processed materials. Development would thus start in connexion with production; also problems which cannot be solved on the spot would be handed over for applied research.

The apparent lack of a direct connexion between the current expenditure on R & D and the current rate of economic growth can be explained very easily as a short term effect in an oscillating economy. There is a clear analogy with capital accumulation. There can scarcely be any doubt that the level of economic production in different countries is determined by the volume of fixed investments in the form of machinery, transport, roads, and other economic infra-structure. Taking the long-term view there is a definite relation between the volume of fixed assets and the national income.

Economists usually use the 'capital coefficient', defined as the value of the capital divided by the current income, as a measure of the relationship between capital and income. The value of the capital would change slowly but the current production may increase very much during periods of boom production when the capital coefficient would be small. When production decreases during periods of slack or recession the capital coefficient would be large. Also, if the economy happens to become stagnant then the marginal value of the capital coefficient may become very high. This is the reason why for a very long time, until about 1952 or 1953, the capital coefficient was out of favour with economists because their attention had been focussed on the short-term fluctuations of the economy rather than on the long-term rate of growth.

The availability of research scientists of high calibre, and of facilities in the form of scientific equipment, accommodation, and services for research and development, play a very similar role to capital investment in respect of economic growth. The stock of research scientists and physical facilities in different countries have a definite relation with the level of economic production and the long term rate of growth. There may not be however any clear relation between the current expenditure on R and D and the current rate of growth of the economy.

In the less advanced countries the building up of an adequate infrastructure for research and development in the form of research personnel and physical facilities would be a much harder task than the accumulation of capital for physical production. Also, the maturing period for science would be at least a generation of about 30 years or roughly twice as long as the period of maturing of basic industries like the manufacture of heavy machinery, metals and energy.

The U.S.A. accumulated its capital both of hardware and of science and technology through heavy borrowings from Europe and with free export of its own commodities. Even then the United States was a debtor country up to the first World War. The inflow of scientists continued between the two wars, and increased very rapidly in the 1930's. It was only about 30 or 35 years ago that the United States became self-sustaining in research and development and could start expanding rapidly its science and technology.

The task of building up science, technology and industry would be much more difficult in the less advanced countries at the present time, because of the steep tariff barriers against their exports together with a heavy premium on the inflow of scientific and technological talent to the advanced countries especially to the United States.

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