this effort is an extremely good example of both the needs and opportunities for international collaboration. As a result of this experience, Dr. Needham is convinced that similar international collaboration would be just as much needed and appreciated in all relatively undeveloped countries.

The men of science of this and most other industrial countries have been occupied in the last six years largely with the important tasks of war, and have engaged in international collaboration for that purpose. In this they have learned both of the unity of the natural and social sciences and that of all peoples of the world. The problems of peace can start from this experience, but there is no question of applying it in a mechanical way. Much research and discussion must take place before a complete and effective system of united world scientific collaboration can be built up. This is now of particular importance in the light of the Soviet Government's expressed view that the full organization of cultural and scientific activities should await the setting up of the United Nations Economic and Social Council. It is to be hoped that in a few months time this will have occurred and that both the natural and social sciences will find their place in an all-inclusive international organization.

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# THE PLACE OF SCIENCE AND INTERNATIONAL SCIENTIFIC CO-OPERATION IN POST-WAR WORLD ORGANIZATION

By Dr. JOSEPH NEEDHAM, F.R.S.

MY experience during the past two years in China in organizing and directing scientific and technical co-operation between China and the United Kingdom has led me to devote much thought to post-war international scientific co-operation. The present memorandum, sketched out in Chicago and Washington in March 1945 and completed in Chungking in May 1945, does not necessarily represent the views of any organization, but are my own views.

In the past, in times of peace, men of science themselves organized periodical international congresses for each science; and for certain branches of science (though not for all) there were successful international unions, or permanent bureaux, able to deal with day-to-day co-operation. These unions were federalized in an International Council of Scientific Unions, which, however, was not as successful as it might have been, due to the lack of an adequate secretariat. The International Council was associated with the League's International Institute of Intellectual Co-operation, but this itself was imperfect.

In war-time all these international agencies have gone into a state of suspended animation. Under the exigencies of war, the United Nations set up in each others' capitals science co-operation offices to deal with the emergency exchange of scientific and technical information bearing on military affairs. Most of these offices, such as the British Commonwealth Scientific Office in Washington; the United States Scientific Mission in London (under the Office of Scientific Research and Development); the French Scientific Missions in London and Montreal, in general much more efficiently run than anything known to international science in peace-time, deal to the extent of some 85 per cent with war science But in one case (the British Scientific Office in Chung king) a condition more similar to what might pertain in peace-time is found. These science co-operation offices differ from pre-war international scientific co-operation mainly in that they have adequate funds, secretariat and mechanical aids; and are not confined to any one science, but have to promote general scientific co-operation between the countries which they link. They are, therefore, rather a new departure; and point the way for the future.

The pre-war international scientific unions were thus limited as to subject-matter; the bilateral science co-operation offices are limited as to national scope. What we need to-day is fundamentally an attempt to combine the methods which science has spontaneously worked out for itself in terms of peace, with those which the nations have had to work out under the stress of war. None of the machinery ought to be scrapped. The problem is to weld it into a satisfactory functioning system.

In the future, there are two other types of international scientific intercourse which may grow up. One is the further extension into the scientific field of the bilateral cultural goodwill organizations (such as the British Council, Cultural Division of the State Department, etc.). The other is the appointment of scientific attachés in the principal embassies, a measure which the continuing interchange of information on war science will almost certainly necessitate. While there is much to be said for both these methods, I feel that these methods are not fitted to play the major part, though they may well play a valuable minor part, in the international exchange of so basically international an activity as science. Now is the time to attempt the establishment of an International Science Co-operation Service in which a supra-national loyalty would be possible, as it was in the case of the most successful League agencies.

In general, it may be said that there is a universal desire among men of science to see better international scientific contacts after the War. The dependence of all modern world civilization on applied science must find its expression in the sphere of international relations. This desire is more strongly expressed, however, the further one goes away from the great scientific and industrial centres of Europe and the United States. The picture of world science looks very different when seen from Rumania, Peru, Java, Siam or China.

It is often thought that in science everyone knows everyone else, and can, therefore, easily get in touch when any problem arises which calls for it. But this is not the case in the greater part of the world. A Venezuelan economic entomologist may have a problem very similar to that of a Chinese economic entomologist; but the difficulties of their coming into touch are enormous. A Rumanian organic chemist may need a few grams of a substance only being produced in India or Canada; but if he only knows his own language it will not be so easy to get it. The Australian workers on alunite needed for years the publications of the Chinese National Academy on the same subject; but were never able to get them until an exchange was arranged through the British Scientific Office in Chungking.

Allied to what may be called this 'periphery principle' of concentrating the help of an International Science Co-operation Service where it is most needed, that is, to the scientific men isolated around the periphery of the 'bright zone', is the

complementary principle of not interfering too much within the 'bright zone'. It would obviously be absurd for any international funds to be spent in communicating between people in the United Kingdom and the United States, for example, who are quite well able to communicate with each other. The International Science Co-operation Service should be directed, and indeed limited, to doing those things in international scientific co-operation which are not being done, and cannot be done, by any other channels.

The problem before an International Science Co-operation Service (or, what we are now coming to, a scientific section of a United Nations Educational and Cultural Organisation) is to steer clear of two extremes. The spontaneously arising scientific organizations before the War too often made the mistake of thinking that the battle was won when the organization was once written down on paper, and eminent men of science in different countries had accepted high positions in it. On the other hand, if care is not taken to select the right personnel, the other extreme of undue bureaucratism will kill the organization. The former danger may be avoided if adequate office management is assured, and the latter will not arise if men of science themselves fully participate.

## The United Nations Educational and Cultural Organisation

While these discussions about an International Science Co-operation Service had been proceeding in the scientific world, planning had been going on for the establishment of a United Nations Educational and Cultural Organisation. Draft proposals for such an organization have been published by H.M. Stationery Office for the Conference of Allied Ministers of Education, and are being discussed by the United Nations Educational and Cultural Conference at present being held in London.

In my opinion it is desirable that the word 'science' appears in the actual title of the Organisation. This is essential, since the co-operation of men of science throughout the world is necessary. Many of them are not much concerned with teaching, since they may be in governmental or industrial laboratories; and the word 'culture' does not have in all countries the wide connotation that it has in the United States. Men of science in many countries would be likely to feel that an organization entitled only 'educational and cultural' had little to do with them. Hence I suggest that the full title of the Organisation should be United Nations Educational, Scientific and Cultural Organisation. The word 'cultural' could be assumed to take sufficient care of the humanities and the arts.

I am deeply convinced of the importance of the Organisation's name. I feel that from the psychological point of view, the avoidance of prejudice, etc., names matter enormously. The League's International Institute of Intellectual Co-operation was hindered by the lack of a good 'selling' name, and also lack of any arts of modern publicity to put it across to the intellectual world.

'Applied science' as well as 'pure science' should be written in the Organisation's constitution. If this is not done there might conceivably be a tendency later on to confine the work of the United Nations Educational and Cultural Organisation to matters of pure science without any technological aspect or bearings on the life and needs of the peoples. But pure and applied science can never be separated.

The scientific division of the Organisation should be to:

(1) Promote international scientific co-operation in all its aspects.

This general aim covers all the rest. The United Nations Educational and Cultural Organisation would not be restricted to any one group of sciences. It should also be thought of in connexion with the 'periphery principle' already mentioned.

(2) Organize and assist the better exchange of scientific information and research services between men of science and their organizations in the different countries.

While in the future there may be many opportunities for the exchange of confidential technical information between various countries, there is an enormous field of work to be done in seeing that the information actually published by government scientific organizations reaches those who need it both near and far. Moreover, the availability of scientific journals, especially the more specialized ones, throughout the world, is very restricted, and there is great need for an agency which could help isolated scientific workers with microfilmed or double-contact-printed excerpts from the literature.

Then the system of exchanging reprints, universally used among men of science and most valuable in itself, is very incomplete and unsatisfactory. It needs to be supplemented by other means, especially microfilms, double-contact prints, photostats, etc. If there were, under International Science Co-operation Service, some central stockpile where reprints could accumulate, the work of scientific workers throughout the world would be considerably assisted and much time saved.

In the field of research services, great help could be rendered by arranging for the wider use of special apparatus only available at certain places. It will be a long time before every centre has an electron microscope, a cyclotron, equipment for cutting thin rock-sections, or an ultracentrifuge. In all such work, very often the International Science Co-operation Service of the United Nations Educational and Cultural Organisation would only need to put men of science in different countries in touch with each other.

(3) Work out a plan for the restoration of scientific facilities in the liberated countries.

(4) Work out a plan for the provision of German and Japanese reparations in the form of scientific apparatus and research chemicals.

(5) Work out a plan for the utilization of such surplus war material and equipment as would be suitable for use in scientific research, and its transfer to the more scientifically backward countries.

(6) Assist in maintaining contact between government organizations concerned with science, pure and applied, when necessary; and advise governmental and diplomatic personnel on scientific matters, when desired.

It is probable that government organizations concerned with science in the major countries can communicate with each other quite satisfactorily without the good offices of any new international organization. But is this equally the case between the forestry service of a Balkan country, let us say, and the economic entomology bureau of one of the smaller States in South America? The diplomatic representation of the smaller Powers abroad can never be expected to be elaborate enough to handle all such technical inquiries. There is thus a large scope for

an International Science Co-operation Service which would know no limitations of language or geography.

Again, if scientific attachés are appointed in the embassies of the larger Powers, competent advisers will be available to the diplomatic staffs. That this is most desirable would be readily admitted by all of them. But the smaller Powers can scarcely be expected to appoint such advisers, owing to lack of sufficient personnel. There is much, therefore, for the International Science Co-operation Service to do in this direction, and its supra-national character would render it all the better qualified to do it.

(7) Assist the free flow of essential research apparatus, chemicals and equipment across national boundaries.

A helping hand might be very useful, especially in the matter of customs duties and procedures. The International Science Co-operation Service could press, for example, for increased facilities for movements of apparatus, at least in the medical sciences. It would also do everything possible to encourage the production of scientific apparatus by local initiative from materials locally available. The Committee on *Scientific Equipment of the Conference of Allied* Ministers of Education has already emphasized these points.

(8) Assist the free flow of scientific books, periodicals, microfilms, manuscripts for publication, translations, abstracts, etc., across national boundaries, and especially between world regions of widely different linguistic pattern, for example, those of the ideographic and alphabetic languages.

(9) Assist the free flow of men of science coming and going across national boundaries, whether for periods of study or research, or for congresses, conferences and the like.

Here the International Science Co-operation Service would have to work in close contact with the continuation committees of the great international congresses, for example, those of physics, zoology and geology, usually triennial, and the smaller special conferences which have grown up in special subjects, for example, the Annual Conference on Differentiation and Growth. The more complete the return to normal after the War in matters of travel, passports, and the like, the less need there will be for an International Science Co-operation Service of the United Nations Educational and Cultural Organisation to exert any special influence in the direction of assisting the movements of men of science. But even if this return successfully takes place, there will be room for a long time to come for financial and other assistance to competent men of science to travel.

Allied to this is the helping hand which International Science Co-operation Service could give in the preparation of all kinds of scientific expeditions in zoology, astronomy, etc.

Then again, there are particularly interesting parts of the world which are unable themselves to finance the investigation of their natural products. The International Science Co-operation Service could help, either by financing the necessary investigations or by bringing the need to the notice of the existing world financing foundations.

An interesting proposal has been made by Dr. F. W. Went of the organization of temporary research groups in specific topics. Some of the more important investigators of a certain controversial subject would be brought together for a period of some months in one laboratory, during which time each would demonstrate the experiments on which he bases his own conclusions, and also work with the methods and materials of some of his opponents. As examples, twelve investigators hold fourteen different theories of bud inhibition, each man concentrating on a different aspect and using a different experimental plant; and there are no less than ten mutually contradictory theories of translocation of carbohydrates in plants. The expenses of such research gatherings, and the arrangements for them, could properly be undertaken by United Nations Educational and Cultural Organisation.

(10) Promote plans of international collaboration in research.

This, of course, overlaps with the last heading. It would require close contact with the international scientific unions, which in the case of such sciences as astronomy, geophysics, geodesy and radio physics have been in the past, and no doubt will again be in the future, outstandingly successful. The United Nations Educational and Cultural Organisation would also encourage the setting up of such unions in sciences which have not previously had them. It would also encourage the activities of such essential organizations as the International Committee on Zoological Nomenclature.

(11) Support all international activities of the various national academies of science.

This simply emphasizes the desirability of working in close co-operation with such bodies as the Royal Society, the Paris Academy of Sciences, the U.S. National Academy of Sciences, the Academy of Sciences of Moscow, etc.

(12) Assist the work of other international organizations, such as the United Nations Food and Agriculture Organisation, the International Labour Office, the International Health Organisation, the United Nations Relief and Rehabilitation Administration, etc., in scientific questions.

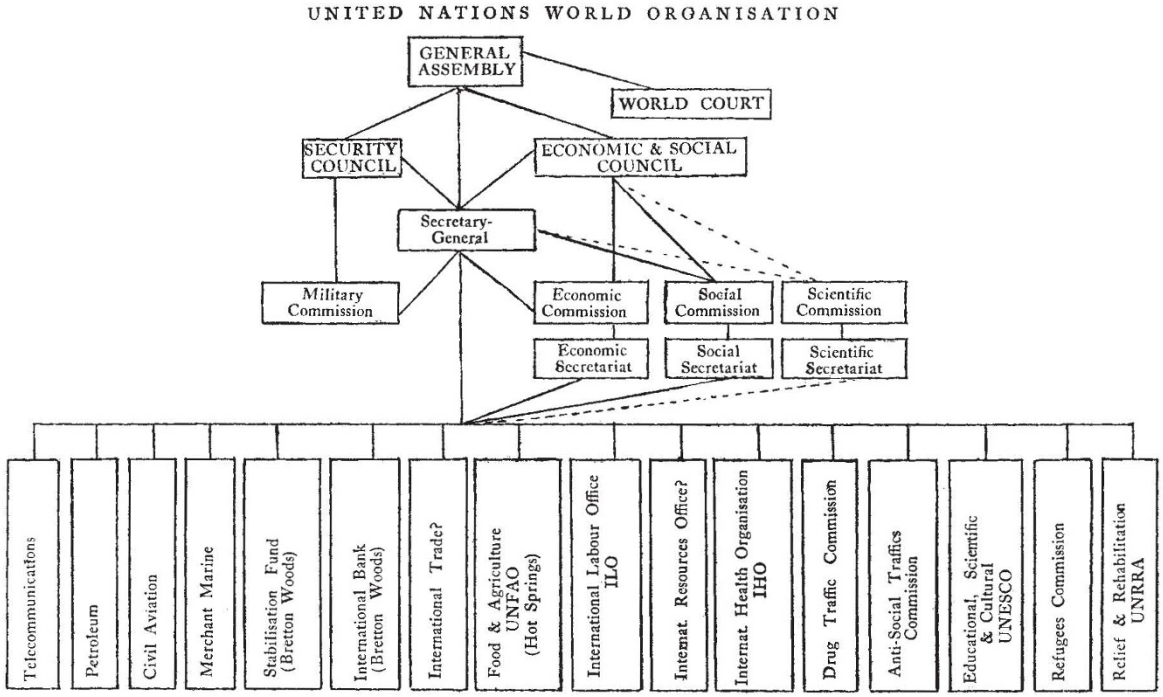
At first sight this seems to need no comment since the means of mutual assistance would grow up naturally between these bodies. But mention may be made here of certain bodies which may play a very important part in world science without being international in the widest sense. Thus the British Commonwealth, now the War is practically over, will almost certainly possess a science co-operation service of its own, with a central secretariat in London and permanent offices in all the other capitals, for example, Delhi, Canberra, Ottawa, etc. This would be a federation within a federation, and its existence would enormously lighten the work of scientific co-operation since the British Commonwealth could be treated as one unit. The United States and U.S.S.R. do not present such problems on account of their territorial contiguity and unity.

In the field of agriculture, what is essentially a British Commonwealth science co-operation service has led an extremely successful existence since 1929, under the name of the Imperial Agricultural Bureaux.

(13) Combine into branches of one organization, if feasible, the smaller international scientific bodies already existing.

## A Scientific Commission and Secretariat

In all the foregoing discussion, it has been assumed that the principal place for science in the international scheme would be the United Nations Educational and Cultural Organisation. But although this body has seemed the obvious home for an International Science Co-operation




Service, it must be remembered that a considerable number of men of science will be working with the other functional organizations, such as the envisaged Radio Communications Organisation, the Civil Aviation Board, the Food and Agriculture Organisation, the Petroleum Board, the International Health Organisation and the Drug Traffic Commission.

Another proposal, of great importance, therefore deserves discussion. The services which science could render to world organization are so substantial, and at the same time so unpredictable, that it might be desirable to introduce a scientific body at a higher level than any one of the functional organizations.

Let us look for a moment at the Dumbarton Oaks proposals (see accompanying diagram). From the General Assembly there will stem on one hand the Security Council for military and political matters (five great Powers *ex officio* and six elected governments). This will not immediately concern us further. On the other hand, there will stem the Economic and Social Advisory Council (eighteen governments elected freely by the Assembly). This Council is to have an Economic Commission and a Social Commission with their respective secretariats "and such other Commissions as may be necessary". Why should it not also have a Scientific Commission and a Scientific Secretariat ?

## A World Conference of Science

There can be no doubt that among those concerned with government and international relations there is a general desire to see science well represented, and in a manner satisfactory to its representatives. The various proposals in this memorandum are brought forward as an aid to discussion. Others have been, and will be, forthcoming. There is available much carefully thought-out material embodying useful experience in crystallizing the structure of international organizations. But nothing authoritative can be obtained without a world conference of science, organized along the same lines as Bretton Woods, Hot Springs and Dumbarton Oaks. This should be called together as soon as possible. Only in this way can the voice of world science clearly indicate its wishes and aspirations with regard to the organization of the International Science Co-operation Service and the United Nations Educational and Cultural Organisation.

## Summary

(1) An International Science Co-operation Service has been proposed. It is shown that there are immense tasks to be undertaken for the benefit of humanity through the rapid expansion and dissemination of knowledge, by such an organization.

(2) The United Nations Educational and Cultural Organisation now being planned could embody the machinery proposed above, subject to certain conditions being met. A formulation of the tasks before any science division of the United Nations Educational and Cultural Organisation is given.

(3) Science has so much to offer to world organization that it would be highly desirable if it were represented at the higher, or conciliar, level, as well as at the lower, or functional organization, level. A proposal is made for a Scientific Commission to take its place, with its corresponding secretariat, side by side with the Economic and Social Commissions and their secretariats, in assisting the work of the Economic and Social Advisory Council. This arrangement would provide a means for correlating the entire scientific work of the whole world organization, and affording means of contact between the men of science in the various functional organizations.

(4) In order to ensure that all arrangements made shall be to the greatest benefit of world science, and hence to the welfare of the peoples, it is necessary that a world conference of men of science and their organizations should be called to assemble at some convenient place as soon as possible.