Committee III
Interdisciplinary Approaches
to Development and
Modernization

DRAFT - 8/15/88
For Conference Distribution Only

THE GEOGRAPHICAL UNIFICATION OF THE SCIENCES: STRENGTHENING THE SCIENTIFIC INFRASTRUCTURE IN THE DEVELOPING COUNTRIES

by

Michael J. Moravcsik
Professor of Physics
Institute of Theoretical Science
University of Oregon
Eugene, Oregon

The Seventeenth International Conference on the Unity of the Sciences
Los Angeles, California November 24-27, 1988

Moravcsik
(Ali Com)

BACKGROUND AND OBJECTIVES

ICUS's aim, the unification of the sciences, is usually viewed in terms of a rapprochemant among various scientific disciplines, at the present quite separate and isolated from each other. As we will see, that aim will also be served by the content of my discussion. In addition, however, I want to interpret the word 'unification' also in another sense, namely in terms of geography.

The word 'science' here means only the natural sciences, and denotes an activity the product of which is knowledge about the world around us. This is distinct from 'technology' the product of which is a process, a patent, a prototype, a gadget. This discussion is not directly concerned with technology.

The basic facts speak for themselves. At the present time, about 95% of new science (in the natural sciences) is produced by a set of countries which together constitute only one-quarter of the world's population. The other three-quarters of humanity, for all practical purposes, does not participate at all in creating new scientific knowledge and understanding: They produce only the remaining 5%, which means that per capita they generate only about one-sixtieth as much science as the one-quarter.

We can therefore say that there is also a need for the geographical unification and universalization of science. It will be my objective in this discussion to give you a background for how this huge disparity came about, to outline some of the difficulties facing measures to redress this unbalance, and to propose specific projects that ICUS could undertake to further the aim of extending significant scientific activity over the whole world.

As I mentioned, the discussion also serves the disciplinary unification of the sciences, since most of the problems in science development and in the measures that can be taken to further science development cut through disciplinary boundaries and pertain to the characteristics of science and of scientific infrastructures which hold for any kind of scientific activity. Indeed, some of these problems are intimately related to the linkages of science with culture, and the embedding of science as a system into the overall life of the country. ICUS is therefore indeed in an excellent position to discuss these aspects of science and science building, in a much better position than many of the national, regional, and international organizations and agencies which often have a highly specialized, narrow, and culturally parochial approach to these problems. More about that presently.

In talking of science we are concerned with all the many various aims and objectives of science. They can be collected under three general headings: a) Science as an ingredient in technology which in turn is an ingredient in the material improvement of life; b) Science as a human aspiration in the 20th century; c) Science as an important influence on Man's view of the world and on Man's role in this world.

How did the above mentioned disparity come about? I can give some description of it but will not be able to give you a satisfactory explanation of it, since nobody knows enough to do so.

Interest in the natural world around us has been with us for a very long time, and traces of it can be found in most old cultures we know of. Inspite of this longstanding human preoccupation with what is now called science, the total amount of scientific knowledge which was available to us about 400 years ago is a tiny fraction (less than 1%) of what we know today. Essentially all of science that we have today was created in the last 400 years.

This scientific revolution in the last 400 years which created most of our scientific knowledge took place, for reasons which are much debated but not necessarily resolved, all within the "Western" cultural circle, meaning Europe and North America. At least it was entirely confined to that geographical area until about 100 years ago, when Japan began to get involved in it also. Toward the beginning of the present century the pursuoit of science on any significant scale began to spread to other non-European countries also, such as India and China, and activity also was evident in South American countries, among the part of the population of European origin.

The participation in science by an even larger circle of countries in Asia, Africa, and South America accelerated after the second world war, and by now virtually every country in the world proclaims as one of its aim the pursuit of science and the application thereof. The scale of this participation, however, remains still very modest, as was mentioned earlier.

This is not surprizing. The establishment of a strong indigenous scientific infrastructure in a country is a complex and slow process. If we take the now scientifically leading countries as typical, the process takes several hundred years. It is most likely that the now developing countries will be able to complete the process considerably faster, but even so, the typical time scale should be regarded as at the very least 50 years. The purpose of cooperation with these countries is therefore not to bring about miracles in three or five years, but to assist these countries to cut down on the duration of decades by a few years and to assure that the infrastructure built there is of the highest quality.

Let me now turn to the discussion of some of the main defects of the existing efforts on the part of the scientifically advanced countries to cooperate with the developing countries in the evolution of science in the latter countries.

Science in those countries has two quite different aspects the promotion of each of which to a significant extent clashes with the promotion of the other. First, those countries have many very prominent and conspicuous already existing problems in the solution of which science must play a significant role. These problems are in agriculture, in health, in industrial production, in transportation, in organization and management, and in innumerable other material and concrete areas. If one wants to achieve quick and optimal results in remedying such problems, the best procedure is clear: The research and development needed for the remedies should be carried out in the advanced countries with personnel from those countries, since there the expertise and the facilities are readily available to do so. The results of such research and development should then be taken to the country where it is to be applied, this transfer being carried out by experts of the advanced countries who are much more familiar with the results, and be then applied and implemented by these experts, perhaps with the auxiliary assistance of some local people. If the application is sociologically or culturally as simple as building a dam, providing an energy supply, delivering a vaccine, evolving a new variety of seed, or designing a tool of "appropriate technology", the above outlined method can achieve considerable success in a short time. The green revolution or the presumed eradication of small pox may serve as examples.

The trouble with this approach is that that it leaves the country which is being helped no better off to handle the next problem. Nothing in the above process gives the country a better capability to solve its own problems. When the next problem arises, the solution must again come from abroad. The second of the functions of science, that of making the country selfreliant, less dependent, and more able to make its own decisions through the strengthening of the local infrastructure has not been served.

One can understand why not: In the impatience of wanting to remedy the conspicuous existing problems as quickly as possible, the long and delicate task of building the local capability of doing so was cast aside. As the old saying goes, we provided fish but did not teach how to fish.

It is natural that governmental and international organizations should behave this way. They have political reasons for wanting quick and visible results, and their personnel has the background appropriate for this which usually is quite different from the background needed to assist infrastructure building.

It should be mentioned that infrastructure building includes assuring a general societal acceptance and understanding of science. This cultural element in science building is one ICUS is particularly close to in its activities.

This is precisely the reason why ICUS has a role to play. By the very nature of ICUS it is well suited for redressing the balance and for addressing itself to this other, infrastructure-building task. In it there are many opportunities for activities which require subtle expertise to spot and to shape in the most effective way, and these activities can be carried out with relatively modest resources. It is in the area of infrastructure building that ICUS has, as the economists would say, a comparative advantage vis a vis the large, massive, heavy, and straightforward agencies and organizations.

OBSTACLES IN THE PATH OF INFRASTRUCTURE BUILDING

Having defined the problem area in an overall sense, we are now ready to discuss some of the difficulties in building the scientific infrastructures in developing countries.

The first aspect to note is that this building process is replete with vicious circles. The aim is to establish a system in which the various aspects and functions of science are all productive and interlinked. As such a system is evolved, we often find that A is weak because B has not been sufficiently developed, and B has this deficiency because it does not have the support of A.

A few examples may be helpful.

Science teaching may be on a rote-learning basis and lacking in functionality because the science teachers have not had the opportunity to acquire personal experience in doing science, which in turn may be due to they themselves having been taught science in a non-functional way. Similarly, their students will be handicapped in doing science and therefore the science teaching by these students will also lack in functionality.

Scientists may have difficulty undertaking scientific research successfully because the provisions for pursuing science are weak and inappropriate. This is partly caused by not having good managers of science, and there are no such managers of science because the scientists have not had the opportunity to learn about science management through personal experience in scientific research.

The linkage between science and technology may be weak because technologists in the country are more used to imitating foreign technology than to create their own on the basis of interaction with local scientists. Such an interaction is lacking in part because there is no precedent for such an interaction producing a productive technological results.

The contact between scientists and decision makers in policy may be weak because the decision makers lack the understanding of science to be able to benefit from such interaction. They lack this background because science is weak in the country and hence does not have much of an impact on the education and outlook of the decision maker. As a result, science remains weak.

The detrimental effect of such vicious circles is especoially strongly noticable with regard to interdisciplinary areas of science, since there many components have to work in unison to assure success.

These are but a few of the many examples one can find for such vicious circles, for such feed-back loops in the evolution of science in the Third World. Recognizing and analyzing them is a very important function of anybody wanting to acquire a deep understanding of science development and who wishes to be able to design action to promote such science development.

Let me now turn to the second aspect of science development that constitutes an obstacle in the path of the fast development of science in the developing countries.

This second aspect is the recognition that there are certain elements in science development that cannot be carried out from the outside but need to be instituted and established by the indigenous scientific community itself. In contrast, there are also areas in science development which can be assisted from the outside, in some of which such outside cooperation can in fact be of major and decisive importance.

This recognition is important for the proper design of cooperative projects with the developing countries. These projects should concentrate on those areas where such cooperation can have the greatest possibilities and greatest leverage. To illustrate this, I will briefly outline two such major areas.

The first one is education and manpower development. All through history education for a new kind of activity needed to be obtained in those geographical locations which were pioneers in such activities. In the middle ages, in Europe, people desiring to be learned scholars flocked to the great universities of Northern Italy which at that time carried the torch of learning. In the beginning of the 20th century, when the United States aspired to become an important country in science, the American students all went to Germany and other Western European countries to learn, since it was there that such advanced education was to be had.

Today the students desiring to become scientists go, in large numbers, to some of the countries which are now advanced in science, to obtain graduate-level education. There are well over 100,000 such students studying science and technology in the United States alone, and proportionately large numbers of students can also be found in universities in Germany, France, and other European countries. The numbers of such students who go to Japan to get their advanced education is also growing.

In this area of science education for students from the developing countries, there are many aspects which need improvement, and this problem area is therefore an excellent one to concentrate on for those in the scientifically advanced countries who wish to promote science development.

A second large area which can also be significantly influenced from the outside is communication. In order for science to be pursued successfully and to be linked successfully with other activities in the country, scientists need to communicate with other scientists, with technologists, with educators, with governmental decision makers, and with the population at large. An especially fruitful area for attention is the involvement of scientists from the developing countries in the worldwide communication network among scientists. This network is almost completely under the influence of the scientists themselves, and hence they, by themselves, without having to rely on governmental schemes or giant bureaucracies, can institute changes and measures that assure that the scientists in the developing countries are fully included into this network.

I have, on various previous occasions, analyzed these two areas in detail and suggested measures which could aid science development. Some of these have even been implemented, but much more remains to be done.

It is, however, perhaps not very functional to simply enumerate all the problems and their suggested solutions. It may be more effective to concentrate on a few specific measures that is within the capability of ICUS, so that we can agree on a concrete and easily attainable agenda for action. I want to do just that in the remainder of my discussion.

PROJECTS FOR ICUS

In designing programs for an organization, it is useful first to list the strengths and weaknesses of that organization compared to other organization also active in the same field, so that one can concentrate on programs which take maximal advantage of the special advantages the organization has.

ICUS has an impressive array of strengths when it comes to be effective in cooperating with developing countries in science development. It has as its goal the unification of sciences which is complete harmony with science development. It has a tradition of internationalism and hence has good access to individuals from many countries. It can operate non-bureaucratically, which means that it can make decisions quickly and can see to it that formal considerations to not impede the essence of the activities. It has a tradition in organizing meetings and in communication also through books and other written modes of communication. It has been able to enlist the cooperation of a large number of highly respected scientists, and therefore has access to seasoned judgement on what are the key problems in science development and what activities would be the most effective in resolving those problems.

Compared to some international organizations such as United Nations agencies which have at their annual disposal hundreds of millions of dollars, or compared to national foreign aid agencies like the Agency for International Development which control annually billions of dollars, ICUS's financial resources are much more modest. This, however, by no means represents a constraint on what ICUS can contribute to science development. On the contrary, it might be a blessing, since there are innumerable situations pertaining to science development in which there are latent resources in the international scientific community which are potentially available but are unutilized, and there are also corresponding needs on the part of the developing countries, presently unsatisfied. In such situations only a small bridging project is needed to connect the latent resources to the needs so that the natural flow of benefits can begin. To spot such situations and to design the appropriate program for the bridge requires, most of the time, only very modest financial resources, coupled with in-depth perception of the situation and with some imagination and enterprizing spirit to experiment with solutions.

It is beyond the confines of my present discussion to give a full account of these opportunities. My first specific proposal for ICUS, however, aims at exploring these opportunities more systematically by the formation of a permanent council within ICUS to deal with these issues and to advise ICUS on new activities in this area. This Council for Science Development (CSD) should consist of 6-8 appropriately selected people who would function continuously, even in between ICUS meetings. Its main aim would be to design activities and projects for ICUS in the area of science development, that is, in the area of cooperation with developing countries in their efforts to build their own scientific infrastructures. At each ICUS meeting, and perhaps even more often than that, CSD would report to ICUS as a whole and propose particular projects. These projects could be designed in such a way that volunteers from ICUS's circle of friends and collaborators would play leading roles in the implementation of these projects.

Even while CSD is established, I would like to propose three projects for ICUS which seem to fit very well into what ICUS is doing already and hence could be implemented very easily.

1. Science students from the developing countries at ICUS meetings.

There are over 100,000 students from the developing countries in the sciences and engineering now being educated at universities in the United States. These students receive, in general, a good education as judged by the narrow technicalities of their fields. For being effective after they return to their respective countries, however, they would need exposure to broader aspects of science also, exactly those aspects which form many of the topics of sessions at ICUS meetings. I propose, therefore, that ICUS invite to each of its annual meetings a small group (perhaps ten) students from developing countries who are now receiving education in the sciences at American universities. The selection of these students could be made through those scientists in the American scientific community who maintain close contact with the education of these 'foreign' students. The only reciprocal action ICUS should request from these students would be the submission, shortly after the meeting, of a ten-page report on the particular events at the meeting that the student found especially interesting and useful, and on whatever critique of the meeting the student would like to submit.

2. Sessions at ICUS meetings devoted to practical problems in science policy in the developing countries.

I propose that at one of its annual meetings ICUS devote a set of sessions to a discussion of practical aspects of science policy for developing countries. Invitations to attend this session would be extended to, say, 20 science managers presently active in various developing countries. The discussion would not deal with generalities and abstractions, but instead with very specific, practical aspects of science policy, such as, a) How one can enhance contact between scoience and technology in developing countries; b) How one can enhance the understanding of the role of science on the part of political decision makers in a developing country; c) How one can help the problem of absence of spare parts and repair facilities of scientific equipment in developing countries; d) How one can establish a substantive evaluation system for the assessment of past, present, and future science in the developing countries; etc. etc.

3. A practical book on the practical aspects of science and technology policy in developing countries.

Somewhat parallel with the second proposal, ICUS would commission a book dealing with such practical aspects of science and technology policy, written by appropriately selected people experienced in the problems of science development. The book would then be distributed widely in developing countries and among national and international agencies dealing with cooperation in science development.

Each of these three projects is modest in size, easy and quick to implement, and yet would be effective in contributing to a particular aspect of science development. It would be an exciting new facet of the already multidimensional set of ICUS activities if these proposals were acted upon soon.