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The Academies of Science towards the Future (**)

During the celebration of the Bicentennial of our Academy we have had a debate on "The Academies of Science toward the year 2000", which has been exhaustive and fruitful, rich in contributions of great interest, and which I shall analyze in my final report. In particular I shall deal briefly with the general problems that have come up in the discussions and I will try to answer the question as to what the Academies can do for the further development of the sciences in a society in rapid transformation.

The present Academies almost all date back to the 17th century, when they were established because of a need, felt by those who devoted themselves to scientific studies, to explain, discuss the results of research, and make them known through publications. In this function the Academies were for a long time a very effective and irreplaceable instrument of scientific progress. Nevertheless, their early function has been gradually decreasing in importance with the progress of scientific development. Science has acquired new dimensions through the Research Councils with their systematic and/or oriented research, through the universities — at first for the élite but today for the masses — the great specifically oriented institutions such as NASA, NIH, AAAS, etc., the regional and international scientific associations with hundreds of conventions, symposia and periodical publications, and hundreds of general and specialized scientific magazines. Publication today is done through specialized periodicals of scientific societies and also by private international publishers, who make possible a broad and rapid diffusion of the results of research.

However, the Academies have not stood still in these times and have undergone in varying degrees the influence of events which have taken place in their

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countries. Some of them have become active again after more or less long periods of silence, others have been transformed in their institutional aims, and still others are of recent formation.

One wonders, therefore, what is the present position of the Academies with regard to the authorities and public opinion in the various countries. In the Socialist countries the Academies of Science have the duties of super-universities and institutions for the planning and development of research as well as the coordination of research activities carried on outside the Academies. Even if the funds at their disposal represent, as we have heard, only 5% of the resources allocated to higher education and research, yet because of their tasks of great responsability they are solidly integrated with governments.

It seems to us that this very strength can be a source of weakness; for example, it can easily degenerate into that rigidity which has given rise in the past to the Lysenko phenomenon, which has detracted so much from the tradition and the image of Soviet science. In this regard it should be noted that the re-examination of their objectives every five years and their greater receptivity to cultural exchanges and to international scientific cooperation recently observed can have a favorable effect on the activity of such Academies.

The situation of the Academies in countries of the western world is very different. They do not generally have duties of coordinating and carrying on research, which are the task of the universities or the Research Councils. Their objectives are the promotion of scientific progress through various activities such as meetings, symposia, seminars, financing of scientific and research projects, scientific publications, awarding of prizes, the assessment of problems of outstanding scientific and cultural interest, etc.

Some of them, as we have learned here, have created ad hoc research institutions (for example, NFS, the Swedish Academy, Centro Linceo), which have developed a noteworthy activity of informing the public (for example, the National Academy of Sciences in Sweden) and have carried on activity for advanced studies for college instructors, e.g., with seminars on biological evolution (Lincei), or have contributed in international scientific cooperation (NASA, NFS, Royal Society, Nobel Prize Symposia, etc.); they have promoted the study of the Systems Science applied to world problems (e.g., National Academy of Sciences, Lincei); they have worked for the free circulation of scientists, etc. They safeguard the intellectual and spiritual values which represent the fruit of the creative activities carried on in the past, and they offer evidence of the historic importance of such a patrimony.

The authoritativeness and the prestige of the Academies are derived from the traditions of the past, from the by-laws and rules which they have freely given themselves, from the freedom of research by which they are inspired. The credibility of their acts was as essential condition to win the confidence of learned people and assume the role of cultural point of reference in the society in which they operate.

This is evidenced by the numerous foundations created by generous donors

to the Academies, foundations which aim to strengthen the traditional values and encourage and develop research projects, to encourage and reward talent, to put science at the service of humanity. However, Academies are substantially weak. They must daily win credibility and confidence from public opinion and guess what is expected of them. But their strength lies in this weakness. The need to be always on the alert mens a continuous effort toward cultural renewal, choice of priorities, promotional activities and the necessity to be always at the service of the community.

In the developing countries the Academies of Sciences have begun to develop their function in accordance with models similar to those of the industrial countries, with the aim to establish collaboration and scientific exchange.

The suggestions made by Dr. Chagas regarding what the Academies should be, i.e., not simply institutions of prestige but institutions receptive from the outset to the applications of science, if put into practice can stimulate the formation of new talents and avoid cultural colonialism.

Now if we consider more directly the function of the Academies in the western world, it is very clear that it is in the interest of the Academies that the universities operate effectively and with dignity up to the highest level, that the scientific associations, with their publications be efficient, that the Research Councils gain strength in activities of basic and oriented research.

The problems of modern society have been amply dealt with in these last few days, and it seems clear that science and technology in the future will have an ever-increasing role in their solution: energy, protection of the natural environment, food and world hunger, desertification, fertility and productivity of the land, discovering and encouraging new talents, and also the moral problems of every scientist when faced with the wrong use of new discoveries. Not all these problems should be treated on the academic level, but one cannot be indifferent and be a simple spectator when confronted by them. In particular it could be the role of the Academies to deal with certain problems which are not limited to specialists, and because of their interdisciplinarity and universality they can assume the character of permanent value.

A first problem concerns the physical protection of the biosphere and thus the man-environment relationship, the survival of humanity and therefore world hunger, the quality of life and the dignity of man, as well as the relationship between the individual and society. We are all familiar with the problem of environment because it belongs to all, it is protected by no one. One activity of the Academies of Science could be the issuing of periodical reports regarding the quality and the use of the environment by man (acid rain, carbon dioxide, stratospheric ozone, the use of the seas, fishing, etc.).

In order to face with knowledge the years to come, the Academies could, with the help of experts, carry on studies regarding short-term national and international objectives, thus providing possible fields for political action, especially with regard to energy, biotechnologies, natural resources, new fields and the science of systems applied to social problems.

To solve the problem of world hunger, it will not be enough to increase the cultivated areas; it will be necessary to make use of science and technology to combat erosion and desertification, to increase productivity and to transform natural resources into goods and services. The solution of the problems of the Third World will require financial help, but especially the availability of local technicians and scientists. The Academies can promote and support adequate programs of scientific and technical cooperation with the Academies of these countries for the formation of experts and the elimination of obstacles to cooperation.

The exchange of scientists between countries governed by different ideologies is the best contribution which the Academies of Science can make to promote the coexistence of different ways of life and cultures. Science, says Werner Heisenberg in his book "Physics and Politics", is the most effective instrument to establish the first bond between different cultural traditions.

Thus it will become always more and more important to seek methods that can promote economic and social equilibria, which are bound to be upset with the increase of population. This research too could be one of the tasks of the Academies of Science in the coming years.

In addition to all this there is a preliminary problem which touches closely the academic world, and that is the relationship between public opinion and science and the applications of science.

It might be said that all the applications of science are today under discussion and to a great degree conditioned by the impact of society on science — not vice versa. The public requests that technological innovation should not be technical in the narrow sense but that it should be directed toward sastisfying social needs. The impact of public opinion, and consequently the degree of knowledge that the authorities have regarding the social function of science and technology, will determine the objectives of the activity of the Academies and make their activity timely and effective.

Harvey Brooks in a recent report prepared for the OCDE (H. Brooks, "Science and Technology for the '80s") tries to show the intrinsic vulnerability of a purely technological society and points out that a suspicious and cautious attitude, even an antagonism toward the applications of science, makes public opinion a social force in scientific policy. Among the fields foreseeably more important in the coming years, i.e., new materials, new areas, new sources of energy, biotechnology and information processing, the last three will, according to Brooks, be found to be in the eye of the storm.

Data processing regarding the economic and social structures has already begun; man can greatly develop his creativity, but the assimilation of this new technological revolution will constitute one of the most heated arguments of the political and social debate of the future and may even increase social tensions. In order to involve "participation" as an instrument to attenuate such tensions, there must be complete, accurate information, not ideologically influenced, on the real possibilities of science.

In other words, it is necessary to create public opinion that is informed and aware of the problems. It must be shown that there are problems which science cannot yet solve and things which technology cannot yet accomplish. We cannot, for example, guarantee zero level concentrations of pollution, or produce technological options without risk. We can attenuate the damage through recycling, or conversion of waste matter into less toxic or more manageable materials, we can plan special combustion plants, but the decision must be accepted by the public; and the Academies, which are centers of thought, can give their scientific contribution to the formation of public opinion by thus filling a need which becomes always greater because of the aggressiveness of the mass media.

In order to create a society capable of evaluating objectively the impact of science on society, one must begin with the school. Einstein in 1955 affirmed: "I think that the problem of atomic energy must be discussed in every newspaper, in the churches, in the schools, in peivate conversations, so that the real importance of the problem is clear in the mind and in the hearts of all men". Yesterday the Pope reminded us of the study made by the Pontifical Academy of Sciences to show that science and medicine cannot offer any remedy for the destruction caused by an atomic bombardment of a town. It is necessary that the Academies take the initiative to introduce these concepts in the educational programs of secondary schools. Moreover, the school is essential for the formation of citizens, and thus of government leaders who are aware of the social functions of science.

We are warned from all sides that time is too short, and the teaching method for science, especially in the secondary schools, is not always adequate; and science is neglected in favor of other disciplines of a literary and philosophical nature. At that age it might be better to teach a little more about scientific observations and methodologies, even if this means sacrificing to some degree a long-standing tradition. A debate on this problem at the level of the Academies of Sciences would be most opportune.

To conclude, one might ask why is it necessary that the Academies increase their participation in the needs of the social community. The answer lies in the awareness that the years around 2000 will be crucial for humanity, that the problems of coexistence today have already reached planetary dimensions. The mass media create mirages, illusions of comfort which cannot be satisfied and therefore frustrations and hatreds result. If we add to this the skyrocketing increase in population, there results an increase in the disequilibria and the difficulty in managing them.

Even if the material problems in these fields are solved, there remain the different ideological approaches which can lead to dangerous temptations. And the power which man has at his disposal is too great in relation to the margin of safety within which he can freely move.

The Academies represent islands of wisdom and centers of thought, and they can, through intensified exchange of ideas and studies of national and international objectives, find solutions which do not excessively limit the freedom of choice,

but leave the greatest number of options open for future generations. Besides, interventions at the social level have become more and more frequent: from the Nobel Prize for Peace, which the Norwegian Academy of Sciences has been awarding since 1901, to the activities mentioned in these last few days, and up to the appeal of the Pontifical Academy for peace (1982).

We must therefore operate both more intensively and more extensively. The methods will vary according to each case, always with due regard to credibility and not doing what others are able to do better than we can. For example, ways of conferring with public opinion are: in Great Britain — the British Association for the Advancement of Science; in USA — the American Association for the Advancement of Science; in Italy — the Società Italiana per il Progresso delle Scienze; etc.

I would like to conclude with the hope that the Academies of Sciences, while continuing to attest to the progress of science with their traditional activities, will also function as an authoritative forum of cultural synthesis through scientific progress and social objectives, acting also as a body where they are not already doing so, in the great problems of modern society in sectors coherent with their own traditions, with the maturity and the force of tradition which confers on them the function of a cultural and scientific conscience of society, and with the innovator's spirit which Marsilio Ficino adopted for the Academies of his time: "*Per litteras in se ipsis pariunt*".

DISCUSSION

BADRAN

Thank you, Professor Caglioti. Really the floor is open for any question or discussion, but I would like very much to thank Professor Caglioti for his most illustrative talk and the feeling that academies should take the position of an organ that puts spotlights on areas of hope for the betterment of the people. Naturally we have been talking about the formula of the developing countries, whether socialistic or capitalistic, trying to plan systems of the government or working, as free thinkers, to promote industry and investment in the capitalistic world. Naturally the problems of the developing world, looked at this morning and this afternoon, vary from promotion of intelligence or artificial intelligence to genetic engineering, to space engineering and technology, to remote sensing and so on, but still the world is suffering from great disasters which Academicians should look upon: fellow men living in the Third World sometimes suffer from the phenomena of hunger, of unemployment, of immigration, both internal and external — these three phenomena are real hazards to the developing world. I feel that fellow men in the developed world should consider the situation of hunger and thirst. Three hundred million human beings either deprived of water or having unpotable water; six hundred million people are suffering from under-nourishment; cancer is sweeping over the world; other situations are more awkward to be reflected as a result of hazards of advancement of sciences. Academicians or academics of sciences are the only situations where mankind can take a little deep breath and think where he is going and where others are going.

We feel in the developed world that Dr. Press has forgotten a fourth category besides his three equations which he mentioned between the western world and the eastern world and between the United States and others. I feel he should have mentioned a fourth category. What is the relation between the developing countries and each other? Because they are nearer to their own problems and they themselves can be classified as countries which have already found their way towards development. India, Brazil, South Korea and other countries can be considered in this category. Others are trying hard but obstacles: the absence of peace, lack of economic stability, lack of utilization of the available manpower, all of these constitute a real obstacle to the progress of the solution of their own problems. Others are lost on the road of consumption and of imagination — they are building towers in the air. So we feel that in such a meeting of great academicians as yourselves in this most holy place, the library — the library for a scientist is the most holy place — and in the presence of an Academy aged 200 years, I think we have to have a little moment of deep breathtaking and try to see where we are going. Are Academies to be linked completely to governments, or are they going to oppose

governments? I feel that by no means should they oppose government, and whether in the western world or in the eastern world, if the Academies are not sponsored or helped or activated by government support and government push, they can encounter great difficulties and failure.

The other point is the relation between education and scientific development. Education is the field to breed brains and hands that can work in science. Academies should work in that direction, to support and to invite and to promote educational capabilities and facilities by their means and by government advice, so that they can really be of use for future development. The generation that sprouted in the field of freedom of thought is coming to an end. The world is under control now. Brains are washed by so many external influences. The generation which is present in this room has developed in a world of free thought. Nowadays the world is not, to my mind, is not so free as it had been, but it can be governed to a certain extent in the coming decades by mass media, by influences of greediness and political envy. So we should, as free thinkers, find a solution for the coming generation, because we are now thinking for the year 2000. What are we going to leave to the coming generation in the year 2000? Is the Academy the responsible body, as many of the Excellencies suggested who have discussed problems today and yesterday? Is the medium to promote new disciplines? or is it the university's responsibility, or is it both? Should it be only the advisory body in areas where science can be cultivated? Because Academies, by definition, are a problem-solving area, whether it be problems of development or problems of innovation. So the areas of cultivation of manpower and of promotion of thought really exist in universities. Are we going to depend on Academies to initiate new centers of excellence, or shall we just suggest? This is another point that again needs some thought. Should Academies be linked to the body that advises for policy making regarding academic and scientific and technological progress? Or is it to be left to planners, to a government planning system, to make decisions? And what is the role of Academies in such a corner of grave importance? Can we as academicians ask the government or the governments that export billions of pounds and dollars' worth to allocate a small sector of the benefit or to raise the prices a little in order to supply the developing world with means of developing indigenously their capabilities or to raise the standard of living through problem-solving research? Finally, can we together initiate an international magazine from such a forum which is of great importance in the history of the world, a little magazine which can be contributed to by all members of states or different countries, and can it be translated into all languages in their land and distributed to scientists and to the public? All these are ideas which really may add a little to the wealth of knowledge that has been discussed this morning and this afternoon and well prospected in the great talk of Professor Caglioti. These are the points which came to my mind, after this very long journey of pleasure, hearing great scientists in this room. And now the floor is open for your discussion.

HUXLEY

Professor Caglioti said, I think quite rightly, that Academies should do those things which they can do better than other organizations, and I wanted to raise the question of how this relates to what Frank Press was saying, in particular about help to developing countries. In Britain we give aid to developing countries partly through the British Council on academic and cultural

matters, through a branch of our Foreign Office known as the ODA, the Overseas Development Administration, and also through our large subscriptions to the United Nations organization. Now I do not know to what extent there are parallels to the British Council and our Overseas Development Administration in the United States, and is it because equivalents of those organizations do not exist that the National Academy of Sciences has undertaken these very excellent initiatives? And I wonder if it is part of American policy to carry out aid more by bilateral arrangements than through multilateral arrangements through the United Nations, where of course parallel initiatives exist. So I really wanted to raise this question of what is the best way of doing what we all want to do in a situation where each country has a number of parallel ways in which these things can be done. I wonder particularly whether Frank Press or Professor Bernhard can give special reasons why this kind of aid should be given through Academies rather than other organizations of the kind that I have mentioned.

MALONE

Mr. Chairman, Dr. Press had to leave and although I am no longer Foreign Secretary of the Academy, some four years of experience there perhaps qualify me to address the important question raised by Sir Andrew Huxley and our answer is an unequivocal yes, there are things that a body of scientists can do that complement the activities of — in our country — the Agency for International Development, and so on. I think one of the lessons that came out of the late and lamented UNCSTD conference in Austria was that much more is needed than the movement of capital from developed to developing countries. That is important, but of equal importance is the development of indigenous scientific competence, the infrastructure which permits these countries to select from alternative technologies to generate their own, and this process, we feel, is most successfully carried out by scientists themselves. This is why we involved several thousand of our scientists in working individually with scientists in the developing countries. We think that there are many ways — there is no one answer — but we have ascertained, and the response that we get to our publications, the requests that we get for our scientists to come to developing countries encouraged us to believe that this is a unique function which in our country the Agency for International Development (AID) does not feel it can carry out.

With respect to the second question, multilateral versus bilateral aid, we think both are necessary. I am perfectly delighted that we have been able to persuade our Agency for International Development to channel some funds through our National Academy into the International Foundation for Science in Stockholm, which Professor Bernhard described so eloquently. In my view, that is one of the most effective brain drain reversing multilateral activities in the world. And we participate in that as an indication of our belief in the importance of both the multilateral and bilateral activities. I hope this answers Sir Andrew's questions. Perhaps Professor Bernhard might like to elaborate.

BERNHARD

Well, Dr. Malone has given the reply to the second question. I will refer to the first one about what an Academy can do besides, shall we say, the routine organizations. In Sweden we have the Swedish International Development

Association, SIDA, which of course gives a lot of money to various projects in the developing countries. However, in certain cases the Academy has been asked by this organization to give advice; in other cases also to channel the money since the Academy is regarded as the organization which could make the scientific assessment. So we have various categories, but there are cases actually when we are asked to channel the money since we have the capacity of making this assessment that is needed from the scientists.

BERGE

Thank you very much, Mr. Chairman. First of all I would like to apologize to the President in his absence for my lateness to this meeting, but I had to recover from a rather busy meeting in Cambridge, and in spite of the rewards of that meeting, it was still necessary that I take a little rest. Secondly, I would like to add my congratulations to those which might have been already expressed, congratulations which are well deserved, to the Italian Academy for their 200th anniversary. We are all aware of the contributions which Italian scientists have made to the progress of science, and this is not really the forum to recount them. We have here people who are already aware of these contributions and if we were in a more general forum it might be necessary to recount them. It is sufficient to say only that, as I believe most of the organizations represented here are Academies, I should bring congratulations from the rest of the ICSU family, that is, the scientific unions and the scientific associates and the national associates. So my congratulations there.

Next I would like to address myself to a couple of other issues which have come up. I know we are looking to the future, but one has to take a little step back in order to get a good perspective for the future. We have talked about the relationship between the industrialized countries and the less developed countries in relation to the Academies and what they can do. I think that as a family the Academies, together with the Scientific Unions, have pledged to promote international scientists for the benefit of mankind. Now we are all aware that in this international cooperation we do not have the full participation of all concerned, and so the question arises: Can we really say that we are promoting truly international science? Now without the participation, the full participation of major parts of the world, I do not believe that we can answer that question in the affirmative, and it is therefore necessary that we make all possible efforts among academies, among the scientific unions, to promote truly international science by providing the less developed countries with the means whereby they can really participate in this international endeavor. The problems that some of the developing countries encounter are quite enormous. In some cases the brain drain is a quite minor thing because you do not in very many cases have a scientific community that can participate in the sort of work that we are talking about, and we need to build up this infrastructure and direct our efforts in such a way that the work becomes self-sustaining after a while. Otherwise we just keep on making several inputs, and the developing countries will be asking for more. I think we should always look to the future with a certain amount of confidence that our efforts will lead to a true take-off in that direction. And in this particular respect, the work of our Committee on Science and Technology and programs such as we have launched with UNESCO such as the International Biosciences network, which are really aimed at developing a network of institutions and persons who can communicate and work

together on common problems and stay in their own countries, these are all very important.

Now, to look further to the future, I think in some parts of the world we can talk about credibility, we can talk about lack of contact with the rest of the community. There is a certain amount of talk in certain parts of the world about elitism, referring particularly to bodies like academies. And I think it is important that as we look to the future we should make a clear distinction between elitism and leadership. The two are related, but I think I need not go into that except just to raise the point, because I think that through leadership we can do a lot which we cannot do by ourselves.

The question was raised about whether we should widen the scope of the academies to include other disciplines. I conducted a survey recently and I addressed the question to various members of the ICSU family and there was more or less unanimity — there were one or two exceptions who believed that we should not really widen our scope that much because if we incorporate all of the applied sciences and all of the social sciences, then, they asked, who will speak for the basic sciences? What they said was that we should cooperate closely with the applied scientists and with the social scientists, otherwise we lose our identity and we shall then not be able to do what we can do best.

Now again on the question of credibility, I think our relations with society are important. Our relations depend on communication, and we must be able to communicate, not just with non-scientists and with governments and with decision makers; we must communicate with each other. We must think in future, as we have a crystallization of various specializations in different disciplines, of how we talk to one another, because we shall come to a stage where we have a meeting of an Academy and one person will speak and maybe only two others will understand and the rest of the 40 or 400 will be completely in the dark. These are matters to which I think we need to give some thought.

Now, as to the support of science generally, both national and international, I think we are seriously in danger of losing on that front, because the increase in the resources that have been made available to science, both nationally and internationally, basic science that is, can be said to be decreasing somewhat, and this is an area where I believe the Academies, through appropriate means, can exert some influence on the various sources of finance, and also recruitment of people, personnel who would normally be going to other areas, so that they help to keep science. Finally I will just say that there will always be frontiers of science or as some people say, frontiers of ignorance. And all of us must make sure that we have all the best tools available for pushing this frontier in the right direction. Thank you very much, Mr. Chairman.