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TECHNOLOGY: BETWEEN SCIENCE AND MAN

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As its title suggests, our meeting is concerned with the mutual interactions between man and science. In the present paper it is argued that between these two factors there is a new and very important entity which should also be considered and examined. 'Man', 'science' and 'technology' are very abstract words whose meaning must be made clear when they are employed. The term 'man' here refers to persons and individuals as well as to societies composed of men and women. The word 'science' (in the singular) will cover in this paper the set of disciplines which are represented within our Pontifical Academy of Sciences. The word 'technology', a singular also, will cover a great variety of different forms of technology. It is important to make a clear distinction between sciences and technologies and between technologies and techniques.

Sciences conduct research to develop, for the benefit of mankind, knowledge about the world, the earth, matter, and living beings on the one hand, and knowledge to be applied by technologies and by industrial activities on the other.

Technologies involve everything that is needed to create and produce goods, tools, things, all of which are generally very complex and which give men and women as well as societies the possibility to improve their lives and to achieve sustainable development. Moreover, they contribute to the progress of sciences because of the new kinds of apparatus and materials they provide. They reach their goals by using various results and knowledge worked out by science and techniques, but also by taking account of many constraints such as economic and financial conditions, market opportunities, production delays, prices, social acceptance, aggressive competition and so on. A technique is a skilled method by which to realise a performance or an object.

Sciences and technologies are different. Their ambitions are not the same. Sciences through research try to *discover* knew knowledge; technologies try to *innovate* and create new products. Time does not play the same role in relation to both. Competition in sciences has nothing like the decisive importance it has in technologies. To be successful, a technological activity requires the co-ordination of many actors, usually the application of many scientific results and many techniques. Very often a scientific discovery has a single author.

Obviously, scientific results play a crucial role in the success of a technology. This is why very often technology is seen as belonging to science. This seems to be the case in the principal document issued by the 'World Conference on Science' which took place in Budapest last June entitled: 'Declaration on science and of the use of scientific knowledge'. This is also probably the case in the title of the present meeting. An attempt will be made to show that one must make the distinction if one wishes to analyse in some detail the relations between the sciences and society.

1. Science and Powers

Our century has seen the emergence and the boom of technologies as a result of powerful and often multinational enterprises whose goal is specifically to make themselves always better, always more efficient, always more attractive. Thanks to these enterprises, the advance and the expansion of technologies has played the leading role in the recent evolution of our societies. Elaborate discussion is not required to be convinced of this point: military power was stimulated by the two World Wars and by the Cold War; economic power, biomedical power, communications power – all three have been very strong during the last decades; and, of course, there is also political power. These powers are very beneficial to societies because they provide them with security, sources of wealth and energy, health, the possibility to travel easily to every part of the world; they free humankind from arduous work and give the public easy access to all cultural goods. As scientific knowledge is absolutely necessary for the development of technologies, science may be rightly credited with being responsible for a large number of these important results. But, conversely, with the expansion of technologies, these powers have also brought about environmental degradation and technological disasters. They have contributed to social and even international imbalance and exclusion. The public is beginning to be anxious and afraid. In addition, science is often seen as responsible for

these troubles and its image is negatively affected. That is what happens if one does not want to make a distinction between science and technology. In this situation, as the 'Declaration of Budapest' makes clear, the solution has to be found through a dialogue between the scientific community and decision-makers through democratic debate. An attempt must be made to show that to be realistic, such a statement requires a certain clarification and analysis of the respective roles of science and technology.

2. Science and the Progress of Knowledge

It is necessary to emphasise that the development of scientific knowledge during the last three centuries has tremendously enriched the culture of men and women; as well as the cultures of societies. Culture is what allows each person to understand himself, understand his relations with his environment and with other people, and his roots in the past generations, and to find, in this understanding, sources of fulfilment. The progress of knowledge is the result of fundamental research, research done just for the satisfaction of curiosity, which is, indeed, a fundamental character of the human spirit. *One must always stress the relevance of fundamental research for society*. Applied research is a necessary ingredient for improving technologies and these technologies are the weapons of the economic war between industrial companies and of very severe competition between arms factories. These powers try to attract the best scientists and to give financially interesting contracts to universities or to research establishments in order to stimulate the applied research that is useful for their programmes. This evolution is now so important that economists call the applied sciences developed for this improvement of technologies 'techno-sciences' and they affirm that all sciences are now becoming techno-sciences. Moreover, these companies try to patent the results of sciences which are useful to them, even sometimes results which are fundamental, and they then try to restrict the diffusion of the results. This is contrary to well established scientific tradition. This is specially true in the biomedical, in the biotechnological, and in particular in the genomic domains. Powerful firms often invest a considerable amount of money in these domains, thanks to the present policy on patents, against which scientists have not put up serious opposition. And the sums involved are far greater than is usually the case with public governmental institutions. The present economic system, which favours the creation of very powerful companies, will probably weaken fundamental research within the formal scientific sphere.

Many gifted young people hesitate today to embark on a scientific career because of the severe patenting conditions and the realities of harsh competition, rather than being attracted by the fight against the unknown in order to satisfy their own curiosity. The scientific community has to be cautious if it wants to preserve and maintain strong fundamental research. The challenge which presents itself here concerns the scientific creativity of humankind.

3. Scientific Expertise and the Practice of Democracy

We have seen that the technologies which are utilised and applied by biomedical or economic firms may be often very beneficial for the public, but they may also often cause difficulties and problems for nature and society. The political power may want to – and must in cases of doubt – receive advice when it has to take decisions concerning a special technology. It has to know what the causes are of its drawbacks or its dangers, what its consequences may be in the long term, whether it is better to ban it, and under what conditions it may be accepted. When scientific knowledge plays an important role in a technology, some scientists can be called in to take part in a committee which gives advice to the decision-makers. Engineers, economists, medical doctors, social scientists, and other suitable scientific experts, could also belong to this kind of committee. The questions that such a committee would have to answer are called today 'ethical questions'. Things are easy if these questions can be answered through the application of moral principles that are recognised by the great majority of people, such as human rights or human dignity. But things are more difficult for these experts in situations where the decision has long-term consequences and where ethical approaches are different. The political power may be tempted to influence the committee to give it answers which would enable it to justify its decision with reference to the recommendations of the committee. In such a case two drawbacks would exist. First, the experts would extend beyond their domain of competence. Second, they would impede the practice of democracy. What is called for is an instrument by which experts on 'spiritual, cultural, philosophical and religious values' could be added to the committee, in line with the recommendation of point 3-2 of the 'Introductory Note to the Science Agenda – Framework for Action', one of the documents adopted by the Budapest Conference. This 'Note' also argues that 'an open dialogue needs to be maintained with these values, and that it is necessary to recognise the many ethical frameworks in the civili-

sations around the world'. It is a pity that the principal document of the conference, the 'Declaration on Science', did not follow this recommendation. Of course such a project would be difficult to implement. But one must try. Some attempts at consensus have been made

4. Science for Development

Obviously enough, progress in technologies, and in biotechnology in particular, may be very useful for developing countries. The documents issued by the Budapest Conference provide good analyses and good recommendations. One may simply stress here that the scientific community has to meet the needs and the expectations of these developing countries. It must be careful, and must avoid the temptations offered by big firms which are more interested in the money they may earn than in social acceptance by the local populations. Methods which are good for developed nations are not necessarily the best ones for helping poor countries. During the last three days of the Budapest meeting each delegation had the possibility of giving a short address (6 minutes) to the conference. The confidence felt by the poor countries that science could solve the difficulties of their situations was very impressive. I interpreted these contributions as an appeal to more advanced scientific communities for help. I want to hope that this appeal will meet with success. The Academies of Science provided a first response a few years ago with their creation of a new institution – 'the Inter-Academy Panel on International Issues' (IAP). It is a pity that during the meeting in Budapest and in the documents issued by the conference neither the existence of the IAP nor the 'Tokyo-IAP 2000' meeting which will take place next May were mentioned. These are two recent and new initiatives which deserve to be encouraged.

Conclusion

'Science for the Twenty-First Century – A New Commitment' was the title of the Budapest meeting. With its 1800 delegates from 155 countries, it was a major success. The documents which were adopted contain many useful analyses and recommendations. What has to be new for science in the twenty-first century? What should be the new commitments of scientists?

For me, Budapest 1999 was an extraordinary occasion to re-appreciate the assignments for scientific activity. I think that two principal assignments may be proposed. The first one, the traditional one, always and for-

ever, is the progress of knowledge in relation to the unknown. It has to be protected. The international body to take care of this goal is the ICSU. The second one, which is very new, is to work in favour of the harmonious and sustainable development of all the countries of the planet by ensuring that the results and the values of sciences and techniques are integrated into the culture of each individual country and that the inequalities between and within these countries are reduced. This is a new duty for scientific activity. Academies and universities are the places where this can be worked out. At the international level, the IAP, a new institution, it is to be hoped, will take care of this new responsibility.

This implies an important mutation in the behaviour of the scientific community in the advanced countries as well as in developing countries. Thus will require new forms of solidarity and fraternity between and among all the scientists of the world.