

SCIENCES AND SCIENTISTS AT THE BEGINNING OF THE TWENTY-FIRST CENTURY*

PAUL GERMAIN

INTRODUCTION

Let us recall first three recent international events which show that the situation of sciences and scientists is significantly changing:

1 – *The World Conference on Science*, Budapest 26 June-1 July 1999 organised by ICSU and UNESCO. Nearly 1,800 participants from 155 countries took part.

The *Declaration on Science and the Use of Scientific Knowledge, the Agenda of Framework for Action*, and other documents were published in a special issue of *Science International*, the bulletin of ICSU (ISSN 1011-6257, September 1999, 27 pages).

The Pontifical Academy of Sciences was represented by Nicola Cabibbo, the President, Marcelo Sánchez Sorondo, the Chancellor, and myself .

2 – *The Conference of Academies*, Tokyo, May 2000, on ‘*Transition of Sustainability in the 21st Century*’ organised by the IAP – the Inter-Academy Panel on International Issues.

A *Statement* on the subject of the conference was adopted and signed by sixty-three Academies of Sciences (including our own Academy) after a critical examination of it by these Academies.

Our colleague Peter Raven represented our Academy at this important meeting.

* This is a proposed declaration drawn up by Prof. P. Germain, Academician and Councillor of the Pontifical Academy of Sciences, which the Council of the Academy decided to publish in the Proceedings of the Jubilee Session.

3 – *Organization of cooperation between Academies of Sciences.*

During and after this Tokyo Conference, the cooperation between the Academies of Sciences was greatly reorganised.

a) The IAP

Prior to the Tokyo Conference this was a friendly association of eighty-two Academies which did not have any formal defined procedure. But, in Japan in May 2000 a provisional executive committee was elected with two co-chairs – Yves Quéré (France) and Eduardo Krieger (Brazil). The IAP Secretariat is chaired by Mohammed Hassan (TWAS) in Trieste. This committee held its first meeting in France on 6-8 July 2000. The Statutes are presently at the stage of adoption. I hope that the Pontifical Academy of Sciences will decide to apply for membership as soon as possible.

b) The IAC-Inter Academy Council

This is something like a 'working force' which will carry out studies for international organisations such as the World Bank and committees connected with UNO (the United Nations). It is chaired by two countries, and these countries at the present time are the USA and India. The Secretariat is in the Netherlands. The Board has fifteen members. One of the co-chairs of the IAP attends the meetings of the IAC Board.

These three events are very important. They show that the situation of sciences and scientists in relation to society is undergoing a major change.

The first and traditional task of the sciences and scientists remains, of course, the development of our knowledge in all the scientific disciplines. At the international level, the ICSU is the organisation which stimulates this progress and promotes the necessary cooperation.

The second task is rather new. It requires a 'New Commitment'. As was written in the 'Declaration of Science and the Use of Scientific Knowledge' of Budapest: 'The sciences should be at the service of humanity as a whole and should contribute to providing every one with a deeper understanding of nature and society, a better quality of life and a sustainable and healthy environment for present and future generations'.

For this second task, the Academies of Sciences seem ready to play an important role and this is why they have recently created new tools with which to face this new duty *together with the IAP and the IAC.*

To describe what is implied in this new task the following three lines of thought will be analysed:

- I. Science as a necessary basis of technology
- II. Science at the heart of culture
- III. Science, a fundamental goal of education

I. SCIENCE AS A NECESSARY BASIS OF TECHNOLOGY

A dialogue between science and its application has always existed. But it has become more effective in recent decades thanks to large institutions and companies which have organised networks of scientific results and technical achievements in order to offer goods, products, possibilities, and many improvements in living conditions, in a most effective way. One such network is called a technology.

I.1 *The beneficial consequences*

We may mention just a few by way of example:

- equipment and consumer goods produced by industry;
- agricultural and food products produced by biotechnology;
- health produced by biomedical technology;
- travel and means of transport produced by the aeronautical and aerospace industries;
- instant communications produced by the telephone, television, and Internet;
- the maintenance of peace and security by the defence industries.

All these advances in technology have been very beneficial for people. Their material existence has been greatly improved. They live longer and have better health. They can enjoy a very rich cultural life.

I.2 *The current problems faced by society*

But these forms of technology have also had other consequences, which can cause serious problems to society. They are partly due to, or increased by, the main goal of companies whose chief concern is the money that their shareholders will receive. Let us briefly describe some of these problems.

- The management of non-renewable resources, for instance oil, gas, and minerals;
- the deterioration of biodiversity, in particular the diminution in the number of species (plants, insects, animals) and the areas devoted to forests;
- the deterioration of the environment due to pollution, the greenhouse effect, the increase in world temperature, and the modification of the climate;
- the exhaustion of resources brought about by population growth (food, water, energy);
- the dangers of nuclear arms or the risks of accidents in nuclear power plants;
- the social and ethical problems produced by excessively rapid technological evolution.

1.3 The need for scientific expertise

Governments and political authorities encounter difficulties in analysing the reasons behind these situations and in discussing what can be done to overcome them. It is a natural step to ask the scientific community to help them to understand causes and to tell them what can be done in order to avoid these negative consequences. That is precisely the role of scientific expertise.

Scientific expertise must be seen in a more positive light by the scientific community. At the present time the provision of scientific expertise is one of that community's major tasks. Publications and journals devoted to this kind of scientific work should exist. Scientific experts must be independent of the authority which asks them for expertise. They must investigate all the possibilities which are available and not report only on that which obtains the majority preference among the members of the committees of experts – committees which should be composed of scientists representative of all the various scientific disciplines.

It may happen that they recommend further research into a problem. Some of the questions which have been listed above require the constant application of expertise.

Lastly, we should strongly remind decision-makers that it is their duty to ask for expertise on matters where science and technology are competent and can consequently provide useful information.

II. SCIENCE AT THE HEART OF CULTURE

Despite the fact that the production and justification of scientific results are

independent of philosophical, political, ethical, and religious considerations, the development of scientific knowledge has many cultural consequences.

II.1 *Views of the world more realistic*

– The *geocentric* view of the world was replaced by a *heliocentric* view which appeared immediately after the emergence of modern science.

– In the nineteenth century *the history of life* and of living beings was described by *evolution*.

– In the twentieth century it was discovered that the Laplacian view of the world based on *Newton's mechanics*, with its notions of absolute time and absolute space, and which was thought for more than two hundred years to be an accurate description of the world, was only a very good approximation to Albert Einstein's conception. His theories of *relativity* gave rise to perceptions of new relations between space and time, and between matter and energy.

– Progress in astrophysics led us to see that the *universe*, like life, has a *history*. It is in expansion and we have begun to investigate its billions of galaxies, stars, and planets.

– Physics discovered that matter, energy, and radiations appear to be the work of elementary particles ruled by quantum mechanics for which at this level the usual concepts of causality, locality and separability lose their relevance, and in such a way that their universal character may be questioned.

– Biology has indisputably reached the status of being a science of chemistry, with the discovery of the double helix, DNA, the genetic code, and the genome, which, indeed, has already been completely mapped.

Further demonstrations of our understanding and mastering of the world can be easily described. Let us mention two examples: the possible complexity of the behaviour of dynamic systems known as deterministic chaos which may prevent us from making long-term predictions, and the domestication of electronics which has given rise to the fantastic possibilities – which are steadily increasing – of communications.

II.2 *The temptations of a totalitarian claim*

This fantastic history has very often given rise to “ideologisation” – the belief that scientific results have a “metaphysical implication” and that they provide the only valid knowledge. This was especially the case during the nineteenth century and in particular during its last decades when many

people believed that scientific development would continue to produce similar progress in the field of human and social problems.

Such a view was too optimistic. International and social problems are not solved by scientific development. On the contrary: the wars of the twentieth century were terrible as a consequence of the progress of science.

This progress has also shown that our various forms of science can build astounding models of the “real” world, but it has also shown that these are models which can always be improved. We are grateful that today we have a better understanding of what science is and what it may continue to tell us. We encounter too much disenchantment today. We still have much to learn by studying phenomena because they still have much to offer us. Yet we should not ask them things they cannot tell us.

II.3 *The role of scientific knowledge within human knowledge*

Scientific knowledge has played, and will continue to play, a very important role within human knowledge. But it cannot claim to replace or supplant other sources of knowledge. Two may be mentioned here:

– *The human, social and economic sciences.* These are more recent and have been produced by mankind through a critical analysis of facts, taking account, when possible, of the results of the natural sciences. They are concerned almost exclusively with the past and the present, and their techniques and results are often coloured by the cultural context of their authors.

– *The “humanities”.* Human thought has a long history which goes back several centuries before our present era. From thought emerged man’s knowledge and our present-day sciences. But all these sciences cannot exhaust the wealth of this thought which is the basis and the source of our perception of human dignity, our personality, in which is to be found most of our foundations and aspirations.

II.4 *Science and ethics*

Scientific activity and results have to be integrated into the culture of the society in which, and for which, the scientists are working, but without forgetting about the ethical principles of science.

– Scientific work requires freedom of thought and expression and, more generally, everything that is required by human rights.

– The ethics of science imply that every scientist obeys a code of “good behaviour” of a deontological nature.

– There is no frontier to scientific knowledge. But the scientific community must not forget that the progress of science and its application must always respect human dignity and benefit the whole of mankind, each country of the world and future generations, and work to reduce inequalities.

– Scientific expertise is often provided by committees of ethics which have to be rigorously controlled, in which scientists can use their own expertise. But in many cases, in the case of very serious problems which are of great importance for the dignity of the person, or for the future of humanity, one must prevent scientific experts from dealing with positions or questions which are the proper concern of the decision-making bodies of a democracy.

Meeting such a requirement is not easy. One can appoint a multi-disciplinary committee and add a few people working with scientists who can represent non-scientists. One can also organise debates, especially between those various schools of belief or opinion which are very concerned with the destiny of man, in such a way that they can exchange and compare their positions.

III. SCIENCE, A FUNDAMENTAL GOAL OF EDUCATION

The scientific community has always been concerned with the education of future scientists (researchers, lecturers, engineers, doctors). But in the present context of the new commitment of science and technology within society a far more important involvement in education of a broad public is of primary importance in order to make the actions which have been analysed in the two preceding sections more effective.

III.1 *A paradoxical and even dangerous situation*

Science and technology are, without any doubt, the “motor” of our rapidly changing world. The recent new developments described in section II. 1, and the new problems faced by society, are factors which bring out the truth of this statement. But at a more simple level the same may be said of the experience of daily life. People are surrounded by the products of technology which make their lives easy, interesting, and fruitful, although sometimes also tiring. Their world is largely shaped by science. Nonetheless, in

most cases, they have no idea of why this is so. That is something which remains mysterious. They do not understand science and, what is even more serious, they think that they will never understand it. From this point of view, they are scientifically illiterate.

That is not a satisfactory situation. Firstly, because access to knowledge, especially to that knowledge which shapes our lives, is an important component of the human being and human dignity. Secondly, because it produces a number of people who feel that they are excluded from society. Such a feeling of exclusion must be avoided. Lastly, because it prevents the sound working of democracy. As has already been observed above, such an exercise is necessary in order for the right decisions to be taken on questions which may affect the future of humanity.

III.2 Who will be involved in this great education project?

The answer is simple: everybody. Children in elementary schools, teenagers in high schools, students in universities, future teachers and lecturers, and the general public as well. The idea is to promote different kinds of initiatives and experiences in order to spread knowledge about the progress and results of the world of science. In elementary schools, for example, interesting initiatives have already been taken: in the United States of America there is the “Hands On” project, in France there is “La Main à la Pate”, and similar initiatives have been promoted in China. The aim is to provide children with the opportunity to engage in a practical experience, to discover something, and to report their results. This is a complete educational exercise. It shows children what a scientific achievement is, irrespective of the position of their parents within society, their nationality, or their political ideas. In short, it tells them what scientific research really involves at a practical level.

III.3 Who will be the actors in this project?

Of course, in the front line, there will be scientists. Not only those who teach in departments devoted to the preparation of future teachers and lecturers, but also scientists, researchers, lecturers and engineers who could draw up new teaching methods well suited to a specific public, new paths by which to make people participate in new knowledge. But also scientists from other disciplines, from the history and philosophy of science for example, and – why not? – scholars from other branches of knowledge. One

may also think of scientific journalists or experts in public communications – active in radio and TV in particular. And of course there are all the possibilities opened up by the use of the “Web”. In general, all those people who are ready to take part in this great education project form the broad scientific community, which works for the integration of the achievements of science into the culture of every society and of humanity as a whole.

CONCLUSION

We are living in curious times, in a contemporary world which is like a train equipped with a very powerful engine. Scientists are the engineers who have built the engine, who are most able to master it, and, consequently, who are able to master the train itself. The people sitting in the train are happy to be in it but they are also very concerned about what might happen. The duty of the scientific community is to understand their fears and their questions, and to make the journey as comfortable as possible. That, today, is the new task of this community, and one which this message has tried to analyse.

Some scientists and philosophers think that humanity is today undergoing a dramatic period which is unprecedented in history – with the exception of when our ancestors found out how to use seeds and thereby engage in agriculture or how to domesticate animals and set them to work. At that time it was impossible to foresee what would happen in the future. At the beginning of the third millennium are we not perhaps in a similar situation?

We may also bring to mind that wonderful work of science-fiction by Aldous Huxley, “Brave New World”, which was published in 1932. Are we now entering this new world?