The Cultural Values of Science

Plenary Session 8-11 November 2002 – Research in the natural sciences has brought mankind many forms of enlightenment with regard to natural laws. The knowledge which has been acquired through such research has been, and is still, useful for numerous practical and technological applications which help to facilitate the daily lives of human beings, including their health and wealth. Acquired scientific knowledge also 'modulates' our world-view, our deeper understanding of what nature (both the inanimate and the living world) is and how it functions. The internalised world-view greatly influences man's multiple relations with his environment. This is true both of technological development and the psychological and sociological aspects of human behaviour. Indeed, the history of scientific discoveries and their impact on our world-view and on technological progress is closely bound up with the history of our civilisation. It could be the aim of the proposed debate at the Plenary Session to collect case studies and to propose general conclusions on the obvious cultural values of science in a broad context, both as regards the evolution of our world-view and the evolution of the opportunities and possibilities of our lives.

Many of the contributions could be made by Academicians but the programme might be complemented by papers and comments given by a few invited speakers who are experts in the field. This debate could represent a contribution of the Academy to the follow-up to the World Conference on Science held in Budapest in 1999 and more specifically to the subject of the renewal of the social contract between science and society. The Academy might possibly aim to draw up an appropriate statement and a set of recommendations on the basis of the conclusions reached during this Plenary Session.

Werner Arber

Introduction
The First Homes of Science

All anthropologists agree that culture should be seen as a set of learned ways of behaving and adapting as opposed to inherited patterns of behaviour or instincts. Aristotle writes: 'While the other animals live by impressions and memories, and have but a small share of experience, the human race lives also by art and reasoning' (*Metaph*. 980 b 21). Culture is a typical characteristic of man who is not rigidly guided by determining laws which establish him within a given horizon. On the contrary, he is a self-interpreting animal, a self-made man. He never ceases to express himself and to give himself a name, and this development, at the centre of which is to be found man's freedom, is called 'culture', which is different from nature. When did culture experience the transition to science? If by science we mean the sophisticated arts of mathematics, aesthetics, architecture, metallurgy, and the written documents that describe such disciplines and their philosophical significance, then it is possible to describe ancient Egypt, China and Greece as the first homes of science. The wonders that Plato and Aristotle perceived as the starting point for engaging in philosophical thought are still applicable to the knowledge of children and adults, and to science itself, only that science makes the subject of

these wonders move from the outside to the inside of things and is dedicated to the discovery of new laws, at the same time answering old questions and raising new ones.

The Scientific Revolution

Perhaps the most important event in European culture during the sixteenth and seventeenth centuries, which indeed gave rise to the modern age, was the so-called 'scientific revolution'. The wish to obtain in all the sciences (astronomy, physics, chemistry, biology) the same kind of rigorous demonstration that was to be found in mathematics, led the first modern scientists to apply mathematics to the study of nature. They dedicated attention to those aspects that could be measured. Given that mathematical hypotheses did not in themselves ensure a direct correspondence with reality, these modern scientists tried to verify such hypotheses not only by simple observations which could at times be deceptive (e.g., the perception that the earth is stationary) but also by more precise instruments (the telescope, the microscope, and others, which were constantly being improved), and above all by experiments, that is to say attempts to reproduce phenomena in more rigorous and controlled conditions. The synthesis of these two procedures, i.e. mathematical demonstration applied to nature on the one hand, and experimentation on the other, was the experimental-mathematical method. Matter, indeed, because of its quantity, could demonstrate its intelligibility through mathematical calculations that expressed themselves in relationships of a formal identity of reality in an abstract way. For example, two cells and two elephants, because they were each two in number, were the same in their 'twoness'. But in reality things do not exist equally, not even individuals of the same species. Therefore, contemporary science affirms the plurality and differences of physical forces (mass, energy, space, time, nuclear and sub-nuclear electric charges) and the plurality of life energies (cells, chromosomes, genes, the genetic code, the teleomatic structure) in living things. Today, macrophysics and microbiology seem to be moving towards an awareness that quality is in a dialectic relationship with quantity and vice versa, although on the physical level they are co-existent.

The Impact of Modern Science

For this reason, modern science has been one of the most important factors in the evolution of our civilized world for at least three centuries. Indeed, it cannot be doubted that scientific knowledge has led to remarkable innovations that have been of great benefit to humankind. Life expectancy has increased strikingly, and cures have been discovered for many diseases; agricultural output has risen significantly in many parts of the world to meet growing population needs; technological developments and the use of new energy sources have created the opportunity to free humankind from manual labour; and technologies based on new methods of communication, information handling and computation have brought unprecedented opportunities and challenges for the scientific endeavour as well as for society as a whole.

Science and Values

The question whether the values by which 'improvement' is measured should come from outside or inside science (or a combination of both), that is to say whether they are purely scientific or philosophical, ethical, political, religious, etc. (or a mixture of the first and some or all of the rest), is a subject of primary importance in the contemporary debate. The determination of the character of an action with reference to the predicates of 'good', 'values' and 'obligatory', which represented a radical break with everything that had gone before, began for the first time in history with the tradition of thought generated by David Hume. For this tradition, one cannot derive an 'ought' from an 'is' and there can be no direct step from one to the other. Put in more contemporary terminology, no set of descriptive statements can entail an evaluative statement. Thus Bertrand Russell concluded 'that, while it is true that science cannot decide questions of value, that is because they cannot be intellectually decided at all, and lie outside the realm of truth and falsehood. Whatever knowledge is attainable, must be attained by scientific methods; and what science cannot discover, mankind cannot know' (*Religion and Science*, OUP, 1961, p. 243).

The Rejection of Ethical Neutrality

The rejection of ethical neutrality and the problem of the justifiability and objectivity of value judgements began to manifest themselves, under the impact of the circumstances of the time, after the end of the Second World War, when it appeared clear, as Russell was to write, that it was no longer possible to place on the same level a discussion of the goodness or otherwise of oysters and a discussion of the rightness or otherwise of torturing Jews. After what has been termed the capital sin of science, the atomic bomb, and the arrival of the greenhouse effect (which scientists are the first to recognise and strongly condemn) the most serious problem to emerge today is the relationship between the science of nature, in itself perhaps neutral in relation to values (in Max Weber's view 'without values', value-neutral and ethically neutral), and its freedom to engage in research, with all that this implies for the morally and socially relevant responsibility of science itself. This responsibility, which in the first instance concerns the technical and economic application of scientific results, also regards the planning and implementation, linked to both technical and economic assumptions, of research programmes.

Emerging Questions

There thus emerges first of all the strictly theoretical question of the relationship between what is and what ought to be, and the question of the relationship between ontology, deontology and teleology, or between scientific rationality and ethical rationality; and secondly, the question of how to compensate for the powerlessness of the responsibility attributable to individuals who become effective only within the context of institutions which themselves should be transformed so that science may do good. As is often observed, science is one of the very few human activities where errors are systematically criticised and fairly often, in time, corrected. This is why we can say that in science we frequently learn from our mistakes, and why we can speak clearly and sensibly about making progress. Naturally enough, the Pontifical Academy of Sciences, which has studied this subject on many other previous occasions, cannot but take part in this debate, and this plenary session seeks to make a contribution to its positive development.

The new horizons generated by globalisation, a process which has acted to reduce the distances of time and space (in part because of the impact of science itself), cannot neglect the question of the sustainable development of the whole world but in particular of developing countries. Let us not tolerate the existence of a knowledge divide, in addition to an unacceptable economic divide which also includes a 'digital divide'. For, unlike the possession of material goods, knowledge, science, and values, when shared, grow and develop. Aristotle argued that it was a principal task of the wise man to expound what he knows to others (*Metaph*. 982 a 14). Today, in a world which is increasingly globalised and where communication travels almost at the speed of light, it is the task, more than ever before, of wise men not only to engage in research but also to teach, to advise, and to orientate.

The Aims of the Deliberations of the Plenary Session

To provide examples of the progress of knowledge acquired by scientists during the course of the twentieth century in the various scientific disciplines; to observe that an expansion in knowledge in itself has an incontestable value for humankind: universality; an increase in life opportunities; and a strengthening of the bases of human dignity; to uphold the wish to share these cultural values with all our fellow citizens and with all the peoples of the world; to secure democratic agreement about the principles and values to be applied to experiments required by research and to the critical assessment of the consequences of research.

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Conference booklet