1999 Cecil Powell Memorial Lecture

"The 21st century will be the century of ethics"—according to the French president. Concerned about ethics, and how scientific academies play their role, Gérard Toulouse, gives his view

Gérard Toulouse, France

The Century of Evaluation

For this millennium lecture I will tell you what the 21st century will be the century of. I will draw some lessons from the recent Budapest Conference, whose full title was *World Conference on Science for the 21st Century: a new commitment.* From this large brain-storming event let me extract a few salient points: 3 points of consensus, 2 points of dissensus, and one underlying trend. There was a consensus on the importance of ethics in science, a consensus on the urgency to give women their place and a consensus on new opportunities for increased cooperation between natural and social sciences. There was a dissensus on intellectual property rights (patenting versus free access to basic knowledge); a dissensus on the relations between science and other forms of knowledge. One important factor at Budapest was the influence of the Third World Academy of Sciences (which was created 16 years ago by Abdus Salam and is based in Trieste). All this gives me motivation to discuss the genius and engineering of scientific institutions—a discussion which will involve historical and comparative perspectives, around Europe and beyond, about scholarly societies, science academies, associations for the advancement of science. And I'll talk about ethics, with emphasis on individual and collective responsibilities.

Two months ago in his Bastille Day speech the French president Jacques Chirac announced that the 21st century will be the century of ethics. I quote: "It is because the 20th century has been so contrasted, with an unbounded capacity for creation, and an equally boundless capacity for destruction, that the 21st century, drawing all lessons from the past, will be the century of ethics." Then, referring to the incipient permanent International Criminal Court, he added, "a message without ambiguity is now sent to the leaders all over the world who believe they can do anything sheltered behind state sovereignty". Of course, these statements were given in the context of the recent indictments of Augusto Pinochet and Slobodan Milosevic.

Now I'll tell you my own prediction: I believe that the 21st century will be the century of evaluation. Note that this is not at odds with Chirac's prophecy, because the word 'evaluation' contains the word 'value', which includes moral values but also others like economic values (costs, interests) and so on.

Let's begin with the ethics of science and John Ziman (who was to be the Cecil Powell lecturer in 1984 but withdrew): "Why must scientists become more ethically sensitive than they used to be?" Ziman's point is the following: "As their products become more tightly woven into the social fabric scientists are having to perform new roles in which ethical considerations can no longer be swept aside." Traditionally, university scientists were indifferent to the consequences of their work while industrial scientists were doing work whose consequences were considered too important to be left solely in their hands. But nowadays there is the formation of a new hybrid culture, with much more intimate mixing between these two categories of scientists. According to Ziman, "one of the virtues of the new mode of knowledge production is that it cannot brush its ethical problems under the carpet".

Here is a sketchy history of science ethics since the end of World War 2. In 1945 a double shock occurred with Hiroshima and the discovery of what had gone on in Auschwitz. Biologists and lawyers were quick to react. In 1955 came the Russell-Einstein manifesto (remember that Cecil Powell was one of the 11 signatories) and 2 years later, as a follow-up, the Pugwash Conferences for Science and World Affairs. In the seventies the actions took the form of moratoria, such as the non-proliferation treaty for nuclear weapons, or the Asilomar moratorium for genetic engineering. Then in the middle of the eighties a new double shock, with Chernobyl and the contaminated blood (and mad cow) affairs; these catastrophes stirred considerable emotion in our societies. Recently, ethical reflection has led to two universal declarations, focussing on science and technology: the declaration on the human genome and human rights, and the declaration on the responsibilities of present generations toward future generations. I should mention also the recent creation by Unesco of the World Commission for the Ethics of Scientific Knowledge and Technology (Comest), which started its activities last Spring.

We all know there is a universality to science. But what about ethics? To what extent can we speak about universal ethics? These questions were considered by the World Commission for Culture and Development which came up three years ago with the definition of five pillars of universal ethics: human rights and responsibilities, democracy and civil society, protection of minorities, resolution of conflicts through pacific means and fair negotiations, equity between generations. Now, in the context of the recent developments of international law, one may add a sixth pillar: action against impunity cultures (impunity of the more powerful, impunity of local tyrants, abuses of trust).

Let's return to the ethics of science with the physicist Sidney Drell: "I have always felt that the scientific community has a special responsibility to be alert to the implications and practical uses of our progress."

"Though it need not be fulfiled by each individual scientist, this is a moral obligation of the community as a whole..."—A very important issue about the relative share of responsibilities between individuals and communities.

Drell reminds us of the saga of Andrei Sakharov "who in 1948 was drawn to work on the development of the Soviet hydrogen bomb by his judgment that the world would be safer with a socialist bomb to balance the capitalist bomb". But later on Sakharov became disillusioned with Soviet leaders and eventually "turned into an energetic, outspoken, courageous dissident and opponent of a continuing nuclear arms build up of mindless proportions. Can we or should we make a judgment that Sakharov was wrong in 1948 and right in the 1960s?" Finally, let me turn Drell's conclusions into further questions: What is the best conduct for a scientist? What can one expect from colleagues? What should one request from others and from oneself?

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The life of Sakharov raises 2 questions. The Soviet science establishment was unwilling to better protect Sakharov—why? All that Sakharov ever said about caring for the environment, the need for democracy, and respect for human rights was basically sound, even common sense, yet he was not listened to.

The collapse of the Soviet Union entailed the collapse of the scientific establishment—why? The obvious diagnosis is that the scientific establishment was too close to power and too distant from civil society. But on second thoughts, one may go even further and advance the thesis that "the Soviet Union lived by science and perished by science". Here are listed some arguments.

The ideology of the regime was 'scientific materialism', sectarian with respect to other forms of knowledge; its highest glory was reached in the fifties and sixties with nuclear and space technosciences; there were too many physicists by a factor of two or three; its incapacity to adapt to new technologies: information technologies, biotechnologies; the huge damage it caused to the environment.

During the last decade third world countries have been drawing lessons from the collapse of science in the second world. The Soviet model no longer appears as a smart shortcut to catch up. One week before the Budapest Conference an article was published in *Nature*, written by two South-East Asian colleagues: "Scientific societies are deeply embedded in Western culture. These non-governmental organizations—professional bodies with altruistic objectives—have worked selflessly to promote the public understanding of science... The Western experience shows that scientific societies in developing countries have much to contribute to nation building."

Clearly, the most dynamic scholarly society in physics is the American Physical Society which has been celebrating its centennial this year. Last year the APS president was asked: "How has society evolved in terms of how it interprets its mission over the last 100 years?" The answer of Andrew Sessler was: "Over the years the APS has evolved into a society with a social conscience." In 1972 the Forum on Physics and Society was created, followed by the Panel on Public Affairs, the Committee on the International Freedom of Scientists, committees on women, minorities, physics planning, applications, careers. "So we've evolved from an organization concerned only with physics to an organization concerned about the social impact of physics, and finally to an organization concerned about the civil and human rights of physicists in this and other countries, as well as employment opportunities for physicists."

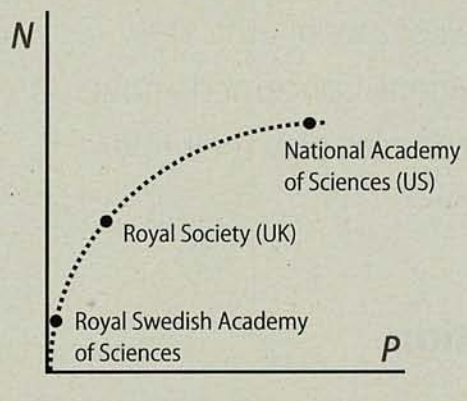

Fig 1 Number of members *N* against country population *P* for three sciences academies

$$N = f \times (T_2 - T_1)$$

N **number of members**
f **flux of incoming members**
T_2 **average age at death**
T_1 **average age at election**

One of the first initiatives of the APS Forum on Physics and Society was to create the Leo Szilard Lectureship Award "for physics in the public interest". That was done in 1974, one year before the first Cecil Powell memorial lecture. Note that Leo Szilard (1898-1964) was the elder of Cecil Powell (1903-1969) by exactly 5 years.

Last year, which was the centennial of Szilard, the APS decided to provide a new impulse to this Award by funding lectures given to younger physicists. For the benefit of young european physicists, let me recommend a delightful book of Szilard, which in retrospect appears to be pioneering in many issues in the ethics of science, *The Voice of the Dolphins* (1961). Moreover, this book is full of wit, imagination, and makes quite pleasant reading.

Now let's turn from scholarly societies to science academies. National science academies may be classified into two broad categories: functional academies, which are healthy, and fossil academies, which are sick. *Figure* 1 displays data for three healthy academies: the Royal Swedish Academy of Sciences, the Royal Society (UK) and the National Academy of Sciences (US), in a plot of *N* (number of members) versus *P* (country population). Why is the curve convex? Well, national science academies should be representative of the country's population, but also of world science as a whole with its many disciplines. The interplay between these two constraints leads to a curve, which is neither a straight line from the origin nor a constant but something in between.

In a quasi-stationary regime, the number of members *N* may be written as the product of the annual incoming flux *f* of newly elected members, by the average academician life span *T* (namely the difference between death and election ages, $T_2 - T_1$). It is easy to check that this approximate formula accounts well for the data concerning the Royal Society and the NAS. Note that for functional, adaptive academies, *N* tends to grow with time because *f* tends to increase, death age T_2 increases also, while the average election age T_1 should *not* increase. Otherwise a decoupling occurs with modern science and with society. Such decoupling catastrophe indeed occurs for microcanonical (*N* fixed) academies where the conditions of *N* fixed, with *f* and T_2 increasing, imply that T_1 must necessarily shoot up.

This catastrophic process has been neatly documented by our physicist colleague Alfred Kastler over more than 3 centuries for the French Académie des Sciences (*figure* 2). Observe that in the middle of the 19th century, when science became a productive force in society with faster growth, the election age begins to climb irresistibly. The conservation of privileges leads to a numerus clausus, and this is the crucial factor distinguishing fossil from functional academies: the average age of elected members increases so that an older generation rules.

In contrast, in the statutes of the UK's Royal Society there is the key article 89: "Of the Restraint of Dividends to Fellows. The Society shall not, and by its laws may not, make any dividend, gift, division, or bonus unto or between any of its members." The absence of financial privileges is the key to openness and adaptability. The amusing paradox here is that Robert Hooke in 1663 said that "the business and design of the RS is to improve the knowledge of natural things...not meddling with morals". But it turns out that the capacity of the RS to fulfil its purpose has

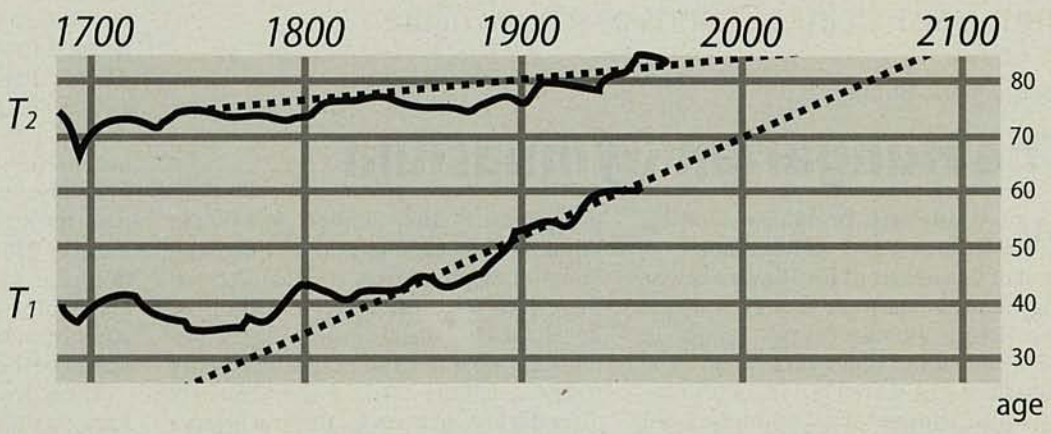

Fig 2 Old dogs rule: The average age of members of the French Académie des Sciences. Note that T_1 is the average age at election and that this increases over time—the Academy gradually becomes less and less representative of the younger generation and of society as a whole

been crucially dependent on this ethical rule. Thus, far from being an obstacle to efficiency, ethics proved here to be essential for it.

One important role of scientific societies is to protect whistleblowers. In his 1995 Nobel Peace Prize speech Joseph Rotblat said: "Whistleblowing should become part of the scientific ethos." Indeed, there is a continuity in the process of emergence of truth (inside science) and the process of emergence of awareness (in the relations between science and society). If whistleblowers are silenced then inertia prevails and catastrophes cannot be prevented.

At this point, let me draw an instructive parallel between two famous figures whose destinies have been linked to the two major confrontations of the last half-century: East-West with Andrei Sakharov, South-North with Abdus Salam.

Sakharov was elected early, at 32 years, as a member of the Soviet Academy, but he was not efficiently protected and his warnings were not heeded to; finally a double collapse occurred, for Soviet Union and for science. Salam was elected also at an early age, 33, as a fellow of the Royal Society. Note that Salam was Pakistani, nevertheless he was elected as a fellow and not a foreign associate—this is a remarkable peculiarity of the Royal Society that British nationality is not required in order to become a fellow. Five years after his election Salam was in a position to create the International Centre for Theoretical Physics in Trieste, and later on the Third World Academy of Sciences, and other worthy institutions. During three decades Abdus Salam was a forceful voice and a constructive champion in favour of the South.

Whistleblowing is not reserved to the famous and glorious, and the American Association for the Advancement of Science (AAAS) has created a Prize for Scientific Freedom and Responsibility in order to provide recognition and support for courageous individuals. Here are 2 examples.

The Challenger disaster. We all know about Richard Feynman's analysis of the O-rings *after* the disaster, but apparently there were warnings *before* which were not listened to.

Nuclear waste—the case of a whistleblower who was subjected to "a career-destroying combination of harassment, bureaucratic manoeuvring, politicking and physical threat", with subsequent loss of job.

Coming back to Europe, 2 years ago a scandal of fraud and misconduct was disclosed in Germany, the Herrmann-Brach affair. As a consequence the German Research Council and the Max-Planck Institute set up an international Commission on Professional Self Regulation in Science, which produced 16 recommendations. Here is a selection of three of those recommendations.

Proper evaluation—quality versus quantity; learned societies should promote good scientific practice; and the end of "honourary authorship" in scientific publications. I hope that all 16 recommendations will soon become European standards.

In conclusion let me try to give an answer to Drell's questions, about individual and collective responsibilities. Not everyone is expected to become a hero, yet every scientist should see to it that scientific institutions and societies provide adequate evaluation and protection for those who take risks in advancing disturbing truths.

Rationality relates effects to their true causes. This is relevant in the realm of natural sciences, and also in the realm of human responsibility.

Impunity behind state sovereignty is no longer acceptable for politicians; impunity behind value-free science will no longer be acceptable for scientists. This moves away from ancient fatalities, and fatalism.

Let me end with Rammal's hope. Rammal was a student of mine. He was born in Beirut. He came to France for his university studies and did most of his scientific work in Grenoble. His family background, and early brilliance, were similar to Salam's. He died before the age of 40, three years after a heart transplant. In his last message to me, after many years of Lebanese civil war, he wrote: "One hope alone: that human intelligence will take over."

This hope has now become European, because the Rammal Medal is in the process of becoming the first distinction sponsored by Euroscience. Euroscience is a new association, which has the ambition of becoming the European counterpart to the American Association for the Advancement of Science.

In line with Rammal's hope let me formulate a pragmatic wish, the wish that the European Physical Society will draw inspiration from the best of APS, its openness and dynamism, its affirmative actions, and that Euroscience will equally emulate AAAS in its clever, intelligent initiatives.

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