

SCIENCE AND DREAM

PAUL GERMAIN

For many years, I have been impressed by the following statement. Let me quote it in French: 'L'homme, cet arrière-neveu de limace qui inventa le calcul intégral et rêva de justice'.

I am not sure I am able to give an English translation which can imply what is meant by this French statement. Let me try: 'Man, the distant cousin of the slug, who invented integral calculus and dreamed of justice'.

It is found in a book entitled *La vie et ses problèmes* by Jean Rostand, a biologist who was very interested in ethics, published in 1940 by Flammarion. The phrase was put by Jean Hamburger, a former President of the French Academy of Sciences, just below the title of his book *Un jour, un homme*, published by Flammarion in 1981. I also quoted it in my paper 'La science interpellée', published in *La Vie des Sciences* in 1990. I found that, with a few simple words, it gave a good definition of man.

Man, which means here the human society, who invented integral calculus and dreamed of justice. He is a product of biological evolution, the descendant of animal ancestors.

Integral calculus: it is a mathematical concept which has many useful applications in various sciences. Mathematics is the language of Nature. Here, integral calculus means science.

Then, humanity appears as the result of a double historical process: a passive one – evolution – and an active one, the creation by man of his surroundings. These two processes are governed by 'causality'. That means that each element is produced as an effect of a previous one by a rational progression.

The final part of the sentence concerns a dream, a vision, a feeling, an expectation. It says that man is unduly hopeful of a better world, a world of peace, of equity, of purity, a realm of fairdealing. Here the dream is oriented by a 'finality'. A scientific concept, a scientific statement are strongly

established. They are always progressing. A dream, a vision are never certain, never permanent. They are fragile, delicate.

The purpose of this paper is to discuss if such a definition, which states that these two components, science and dream, are and must be present in what is man, is still always valid. I will present my comments in three points. The first one will recall the marvellous gifts of science to man. The second will briefly review the positions and attitudes of scientists about the dream. The last one deals with the new situation which is now encountered by the scientific community.

1. *The marvellous gifts of science to humanity*

Science provides models. In the most advanced disciplines, the models are theories. Starting from a few concepts or basic statements, they give the possibility to predict the properties of a large class of phenomena by a rational – often a mathematical – reasoning. For a given phenomenon, the results given by a theory have to be compared with those obtained by a direct experiment. The smaller are the differences, the better is the approximation given by the theory. Science is steadily improving the quality of the approximation and the domain of applicability of its models. What must be emphasized is the ‘objectivity’ of this knowledge. It means that it may be obtained by any scientist completely independently of his moral, religious, or political convictions. Then, science offers to people the vast domain of scientific knowledge which may be called ‘the world of agreement’, because any scientist, provided he applies the rules of a rational reasoning, reaches the same conclusion. This ‘objectivity’ is the main characteristic of a scientific model or theory which cannot be forgotten, as is often the case. As a consequence, it is not possible to derive from a scientific statement any moral or philosophical conclusion.

Science not only offers a large domain of the ‘world of agreement’ to those who want it, but also may offer every child an important contribution to the formation of his culture. This point is the theme of a recent book by my colleague Yves Quéré entitled *La science institutrice – Science as a primary-school teacher*. It explains and comments the successful operation ‘La main à la pâte’, launched with Georges Charpak and Pierre Léna, similar as far as I know to ‘Hands on’ in the United States. A child who receives such an education will never forget that science is a strong component of any culture and that it is an introduction to the ‘world of agreement’.

Thanks to science we know now that the universe and life have a history. These facts were not known two centuries ago and have been revealed by science. They provide a deep understanding of our human situation. It is so important that some people are prepared to say that science is the motor of human history.

The applications of sciences are the source of significant improvements in techniques – and, more recently, of technology – which have produced significant wealth and staple commodities for the benefit of society. They give humanity the possibility of acting directly on its future.

The above remarks are sufficient to show the marvellous gifts of science to society.

2. Scientists and the dream

Scientists are, of course, aware of the gifts provided by sciences and their applications to humanity. The actions of sciences are going in the same direction. They are ever more powerful. It is certain that science is a strong component of the essence of man. In appearance at least, it is not the same for the dream: beliefs and feelings don't show a similar evolution. It is not then surprising if scientists have various opinions and show different behaviours in relation to about the dream.

To be brief, one may distinguish three main attitudes.

First, for some of them, the dream has no importance and therefore may be forgotten or even ignored in the progression of science and of its applications. Roughly speaking, they say that ethical considerations have not to be taken into account against innovations.

Second, others consider that, even if one cannot describe exactly the expectations and value of the dream, they are important for the development of humanity. But they think that they would be best achieved through the expansion of the scientific disciplines, especially by the emergence and the development of human and social sciences.

Finally, one finds the scientists who have no strong opinion about the possible dream of the society. As they don't know, they don't care about it. They consider that it is not their problem.

The reasons for these different choices among scientists are related to the source of the vitality of the scientific activity. One source lies in the personal feeling of scientists who, answering the question why they are scientists, say: for amusement, curiosity, pleasure, the satisfaction of discovering something new, to increase my knowledge, to participate in an

activity which may give people a better life. Many scientists of the 19th century or of the first half of the 20th century had this kind of reaction. They thought that teaching science or working in science were favourable to the 'dream of justice'. They were the heirs of the scientists and of the philosophers of the time of Enlightenment, who had such confidence in science that they thought that the dream would be achieved by way of expansion of the scientific progress. That is the theme of a book by Ernest Renan, *L'avenir de la science*, who wrote: 'It is not an exaggeration to say that in science may be found the future of man. Science alone is able to tell him what is his fate and how he can reach his goal'. Let me quote also Jean Perrin, a Nobel Laureate, who wrote more than fifty years ago, in the book *La science et l'espérance*: 'The progress of science will increase and thought will continuously broaden. The wealth and the power of humans will increase. And then, by a miracle, Humanity will enter a new age. The public has a deep faith in science, a little confused, but deep. He expects that science will bring a liberation and will make possible for everybody access to the pure joys of Arts and Thought'. Of course, nobody would make such a declaration today. But such a hope has not completely disappeared. It remains in what may be called 'the ideal of being a scientist'.

However precious might be this source of vitality of science, it is probably not the most important for explaining its remarkable progress. One of my colleagues, Jacques Blamont, wrote a big book – 940 pages – called *Le chiffre et le Songe* devoted to what he called 'the political history of scientific discoveries'. For him, the wish for knowledge is not the essential factor of this progress. He thinks that 'man' is a force who wants to build tools to go to a real elsewhere which is not the future brought by religion or metaphysics, a new Earth, a new sea, towards space in the direction of the stars. The whole book is a deepening description of important achievements. His thesis is that they are the result of a triple conjugation. First the prince – that may be a king, a dictator, a man with great power – let us say: the 'motor' of the operation. Second, a scientific institution which may mobilize scientists and engineers who have to work together. And then a few great scientists who may have new ideas. Two conditions are necessary to guarantee success: the 'motor' must have a clear vision of the goal of the operation and must be able to collect a large amount of money. No big science without a lot of money; no money spent in a big scientific achievement without a clear vision of the goal. The methods to follow, the measures to use, however drastic they may be, are secondary.

Jacques Blamont's book gives many examples to illustrate these statements. Let us mention quickly two of them, the first from ancient times, the second a recent example. The first: the expansion of science due to the Ptolemes is astonishing. It was possible only thanks to the exploitation of the gold mines of Nubia in which thousands of people – slaves, war prisoners and Greek citizens – were working in appalling conditions. The second concerns the building in Germany during the last war of a large quantity of new arms, V1 and V2 rockets to be launched on England in order to try to avoid defeat. Thousands of people taken from prisoner of war camps or from concentration camps were working as modern slaves, victims subjected to horrible treatment. But this terrible enterprise was effectively, from the scientific and technical point of view, a highly significant step towards the conquest of Space and the leaders were fascinated by this goal, maybe more so than by the success of this new weapon. Most of the scientists and engineers working on such big operations did not agree with the treatment imposed on the workers.

In conclusion, looking at the opinions of scientists, one sees that in general there is no direct connexion between their attachment to science and their view about the dream of the society. Extreme positions may be found, some thinking that the dream will follow the progress of science, others that the dream should not be taken into account if it were to slow down the progress of scientific achievements. In this last case, which was exceptional, the dream could have been affected by the progress of science.

3. Science and Society. A new situation today?

In this last section, the aim is not to analyse the complex relations between sciences and societies. A few flashes only will be presented in order to see if the phrase I have chosen to comment on this paper is still relevant. Today refers to the few decades – 1 or 2 – before and after the starting point of the millennium.

Sciences today appear mainly through what is called 'technosciences', which are complex and elaborate assemblies of scientific and technical elements, results and methods, built up in order to produce special goods, machines or equipment. The above description of the system which produces scientific discoveries proposed by Jacques Blamont is appropriate to explain how technosciences may be implemented. Among the great variety of technosciences, three main kinds of 'motor' may be mentioned according to the type of goals they are looking for.

First: 'the military motor' whose goal is to strengthen political power – in general of a country – and to assure the safety of its citizens. It is a very important one for which many scientists and engineers are working. It has to support an army, a lot of officers and soldiers, and to give them the best arms they need. These equipments demand a large armaments industry. The budget devoted to these activities is very high. After the USSR collapsed, the possibility of a decrease in this large amount of investment was expected. But unfortunately that is not happening owing to recent events and especially the necessity to face the threat of terrorism.

Second is 'the economic motor'. This too requires great numbers of scientists and engineers working in industrial enterprises and companies to produce goods and services. Some of them are highly important and very powerful. They need a lot of money. They are in general private and belong to the shareholders. If they are successful, the value of the share is high and the number of the shares may be increased.

The third: 'the biomedical motor' is more recent but its importance is steadily and rapidly increasing. Its principal technosciences belong either to pharmacology or to biotechnology. The first deal with chemistry for producing goods for living beings; the second are special technosciences using living materials or even living beings. One does find in this motor category, big companies working like classical companies with shareholders and patents, but also some laboratories. The latter may receive some public subsidies but also many gifts and donations of varying size, from people who are ready to help medical research to hasten the progress of discoveries for curing frequent and serious diseases like, for instance, cancer or Alzheimer.

The technosciences developed by these three motors receive big support and a lot of money from those able to take advantage of what they may offer, meaning people of the advanced countries and especially their rich citizens. These technosciences need to take up a large proportion of the whole of scientific activity, which causes a significant change between fundamental research devoted to knowledge and applications. Moreover the dream of society and also the public's confidence in science may be affected by their development. Consequently, the relations between science and society may require serious attention.

The evolution of societies depends greatly on the development of communications which makes the world what is often called 'a global village'. Everybody, everywhere, is aware of what happens in the rest of the world, and particularly so of all the modern facilities which are at the disposal of the people living in countries where they can take advantage of scien-

tific and technical development for improving their individual cultural and social life. The people of the developing countries wish, of course, to be able to enjoy the same advantages for themselves and for their children. Their claim gives rise to worldwide meetings and demonstrations for expressing their expectations. Among these, the conferences organized by the United Nations on major issues of long-time global significance such as environment, population growth or social features including poverty deserve to be mentioned. Many academies of the world were invited to send contributions. A little later, an informal network of academies of sciences, the InterAcademy Panel on International Issues (IAP) was formed to facilitate further collaboration. IAP invited academies to develop their thoughts on the long-term quality of life of all people and also of the poor countries of the world which urgently require an increase in availability of consumption of some essential resources.

Important initiatives took place at the turning point of the century. First, ICSU and UNESCO organized the worldwide conference on Sciences and Societies in Budapest in June 1999, giving the opportunity to nearly 200 nations to express their views. The representatives of the developing countries told of how much they need and expect the help of Science in order to enable them to face their vital problems. Secondly, a year later, IAP called a meeting in Tokyo devoted to a preliminary study of the most important points science and technology might achieve in order to move the world globally to a sustainable way of life. It seems to me that the purposes of these initiatives are part of the new dream which may be proposed to 'man', to humanity. That is, to work in order to extend to all people of the world, in the long-term, the gifts which have so far been given to the citizens of the advanced countries – food, health, energy, education – and at the same time, the possibility of building and increasing their own capacity to participate in this action by developing their own level in science and in technology. It is an ideal of solidarity and equity. To make this dream a reality will obviously take a lot of time and strong convictions, in order to overcome the difficulties and the obstacles. It is clear, in particular, that the long-term improvement in the situation of the poor countries will not be possible without important change in the consumption patterns of the richer countries.

Since the Tokyo meeting this action has made a good start. IAP has the benefit of a good organization and now has eighty-five academies as members. A programme of four important topics has been adopted, including in particular Science education and Capacity building. Moreover,

another working structure of fifteen academies, the InterAcademy Council (IAC), has been more recently created inside IAP, with the mission of carrying out studies and making reports for international organizations like the United Nations or the World Bank.

Conclusion

The statement recalled at the beginning of this paper which implies that science and dream must be present in man, that is in the human society, seems still to be valid, despite the fantastic changes and humanity's new conditions of life. But the relations of science and society inside this new complex man are modified. The gifts given by science, and in particular by technosciences, have to be understood and appreciated by the public and their dangers avoided. They must also be made available, at least in the long-term, to every nation of the world. It appears that in order to hope to achieve these difficult goals, the academies of sciences have a more important role than in the past. It is not surprising if one agrees with the statement of one former President of the French Académie des Sciences: an academy of sciences is the conscience of the scientific world, and, more than this, the scientific conscience of the world.

DISCUSSION ON THE PAPER BY GERMAIN

ZICHICHI: I enjoyed very much this fantastic contribution of optimism centred on science. We should do our best to transform these dreams into reality. I've only one point where I cannot say that I agree with what you said: where you say man is a product of biological evolution. Science is not the product of biological evolution, it's the incredible evolution of culture in terms of the logic of nature. The species that we belong to is not characterised by biological evolution; what distinguishes us from all other forms of living matter is not biological evolution, it's cultural evolution. How many millions of years would we have had to wait for our eyes to be able by biological evolution to see New York on television, and how many billion years would we have had to wait to fly at the speed of a jet? So, what distinguishes us is cultural evolution: language, logic and science.

GERMAIN: Of course, but I want to comment on a statement of Jean Rostand on man: 'l'homme, l'arrière petit-neveu de la limace'. I think this is a good way to tell people that if they are here it is because we have had a lot of years, as you say, with all the steps of evolution. I will not say that man is only this thing, but I said this as a comment to the sentence by Jean Rostand.

LE DOUARIN: I would like to make a small remark to Professor Germain. You emphasised that science and the progress of science now relies essentially upon large groups of people, big operations involving a lot of money and personnel. Don't you think that there is still room for small groups of individuals and perhaps even isolated individuals with very creative minds?

GERMAIN: First of all I don't say that all scientific progress is the work of techno-science, but a large part of it.

LE DOUARIN: You seem to say on page 7 that in the future the progress of science will be based on extremely large forces which is true, but perhaps this is not the only way to find new ways and new avenues.

GERMAIN: No, of course that's not my hope. I tried to give a description, and I can quote economists and sociologists who say that science has no importance, it is only techno-science which has the power to change the fate of humanity. And of course I'm very anxious to develop what I've called the ideal of being a scientist, I've repeated this view this morning, and you know that we in France, and I think in other countries as well, are noticing that not very many young people dedicate themselves to science. When they see the sort of style of some companies in the United States, they think that Europe will follow sooner or later. Of course an economy with big companies, even the biomedical, is very different from what they want. What they like is astronomy, astrophysics, mathematics and theoretical physics, because there is no application, no direct industrial application. The ideals of science may still be a source, a good source of what they dream. If the scientific community uses its tools, the IAP, the IAC, I'm pretty sure that young people will be persuaded to act. We have to be convinced of the future of science.

RICŒUR: Oui, je dois dire que je ne suis pas très heureux avec le mot rêve, dream, surtout que dans votre papier le complément de mon rêve a disparu, justice. Je n'ai plus jamais rencontré le mot justice. Alors, cette lacune fait que le mot rêve a perdu sa force, et avec lui le calcul intégral, puisque la totalité des projets scientifiques s'est trouvée absorbée et, si je peux dire, colonisée par trois facteurs de... comment dirais-je? Un véritable hold-up sur l'esprit scientifique, parce que les trois moteurs que vous avez cités, le moteur militaire, le moteur économique, le moteur biomédical, ce sont des rêves de puissance... Et donc la justice a disparu, ce qui peut-être impliquait que le mot rêve lui-même n'était pas adéquat, parce que ce qui manquait c'était le mot exigence, et là nous ne sommes plus dans le rêve, et nous sommes plus forts contre la captation des trois projets de puissance. Moi, j'ai l'impression d'avoir plus de respect pour la science que ce que vous en décrivez.

GERMAIN: Oui, ce que j'ai visé c'était une des formes actuelles du développement scientifique, pas seulement développement technique, mais une forme qui mobilise beaucoup d'hommes, beaucoup de scientifiques. Si

nous nous plaignons de plus avoir assez d'étudiants qui font des sciences, si on regarde de plus près, comme je l'ai dit, l'astronomie, les sciences de l'idéal que j'ai cultivé toute ma vie ne souffrent pas. Quelles sont celles alors où il y a beaucoup de monde? C'est toutes les sciences techniques. C'est la physique, la physique pure, par exemple, qui a des difficultés. Monsieur Ricœur, je voudrais me défendre sur le rêve. Au début, j'ai dit ce que j'entendais: une vision, un sentiment, une attente, une espérance d'un meilleur monde, un monde de paix, d'équité, de pureté, un royaume de fraternité, voilà ce que j'entendais par le rêve... Je ne vais plus reprendre tout cela, mais pour moi quand je parle du rêve dans la suite c'est cela.

MENON: My comment is really not directed towards the speaker, but the Council and in particular the President of the Academy, because I agree with the concluding sentences of Professor Germain when he says that the Academies of Sciences have a more important role to play today than they did in the past. He says that one former President of the French Academy of Sciences has said: 'An Academy of Sciences is the conscience of the scientific world, and more than this, the scientific conscience of the world'. I agree with that, in which case we have to discuss in what way we can actually perform this task of being the scientific conscience of the world. It is hardly enough for us to discuss issues amongst ourselves. We've had many meetings of great value. Last time it was on education. Before that it was on science and development. We have discussed the question of genetically modified organisms and many such other issues. But, somehow, we have to get it across to society at large, to the world. There are many issues facing society today. The question of basic human needs and of meeting them, the question of the economic divide, the digital divide, aspects such as AIDS and many other diseases – one can list a whole range of them. I think it is important that as an Academy, and particularly the Council, for discussions in the Academy, should look at these issues from the viewpoint also of putting these across to society. This may not be the view of everyone. But if it is, how can we perform that role meaningfully?

GERMAIN: I'm sure you know about the IAP, InterAcademy Panel on international issues which started in Tokyo, May 2000. The two co-presidents are Yves Quéré and Edward Krieger. They now have ninety Academies, most of them from, of course, developing countries. They will have their next meeting in Madrid next year, and they have a programme

with four topics: one is education, one is food, one is water, I don't remember exactly, health; four good topics. They are not very strong Academies, you know, most of them are recent; they meet and they can say what they want. The IAC has fifteen Academies or so, it was born after the IAP. It is an organisation which hopes to obtain studies and reports from the World Bank, from the United Nations, and the leading man of the IAC is the President of the US International Academy of Science, Bruce Alberts. I attended a meeting of this organisation last July in Paris, and it was about what they would like to do, we are a few people who agree, and Quéré has been very active. But we are few. I would like the world community to know about this organisation.

CABIBBO: I'll be brief. I think the question posed by Professor Menon is very relevant. We devoted a special meeting to that, which was a closed session where the Academicians discussed the future activities of the Academy. You certainly know that this Academy has nothing to be ashamed of in that respect. I mean, the Academy has always been very active on these subjects. So, if you have a specific proposal, we will be happy to implement it with enthusiasm. I should also point out that the Academy is a member of the InterAcademy Panel which was created to discuss these very interesting problems.