March/2001

52

ISSN: 1025-9384

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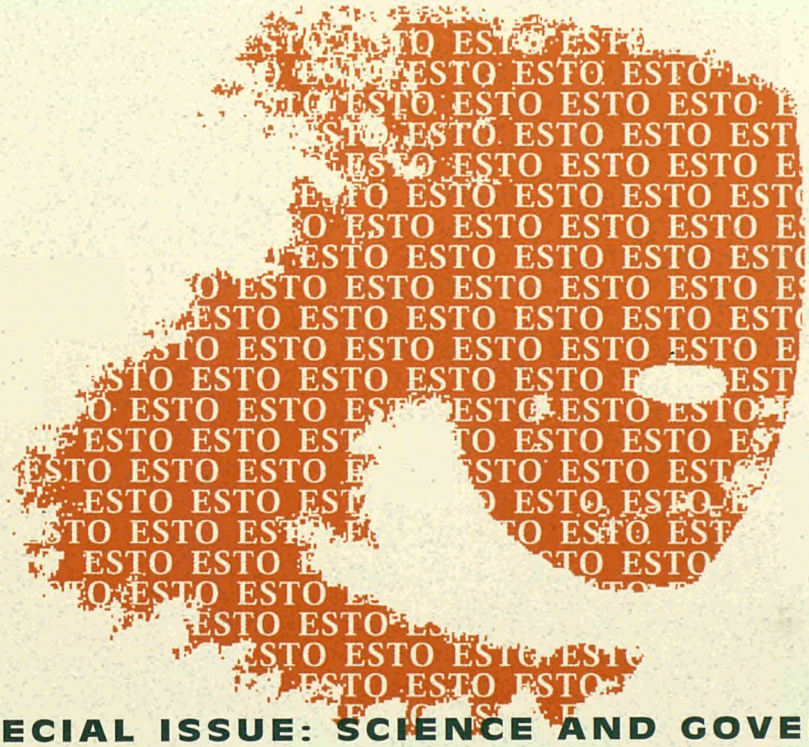
The IPTS REPORT

EDITED BY THE INSTITUTE FOR PROSPECTIVE TECHNOLOGICAL STUDIES (IPTS)
AND ISSUED IN COOPERATION WITH THE EUROPEAN S&T OBSERVATORY NETWORK



SPECIAL ISSUE: SCIENCE AND GOVERNANCE IN A KNOWLEDGE SOCIETY

EUROPEAN COMMISSION
Joint Research Centre

ENGLISH VERSION

ABOUT THE IPTS REPORT

The IPTS Report is produced on a monthly basis - ten issues a year to be precise, since there are no issues in January and August - by the Institute for Prospective Technological Studies (IPTS) of the Joint Research Centre (JRC) of the European Commission. The IPTS formally collaborates in the production of the IPTS Report with a group of prestigious European institutions, forming with IPTS the European Science and Technology Observatory (ESTO). It also benefits from contributions from other colleagues in the JRC.

The Report is produced simultaneously in four languages (English, French, German and Spanish) by the IPTS. The fact that it is not only available in several languages, but also largely prepared and produced on the Internet's World Wide Web, makes it quite an uncommon undertaking.

The Report publishes articles in numerous areas, maintaining a rough balance between them, and exploiting interdisciplinarity as far as possible. Articles are deemed prospectively relevant if they attempt to explore issues not yet on the policymaker's agenda (but projected to be there sooner or later), or underappreciated aspects of issues already on the policymaker's agenda. The multi-stage drafting and redrafting process, based on a series of interactive consultations with outside experts guarantees quality control.

The first, and possibly most significant indicator, of success is that the Report is being read. The issue 00 (December 1995) had a print run of 2000 copies, in what seemed an optimistic projection at the time. Since then, readership of the paper and electronic versions has far exceeded the 10,000 mark. Feedback, requests for subscriptions, as well as contributions, have come from policymaking (but also academic and private sector) circles not only from various parts of Europe but also from the US, Japan, Australia, Latin America, N. Africa, etc.

We shall continue to endeavour to find the best way of fulfilling the expectations of our quite diverse readership, avoiding oversimplification, as well as encyclopaedic reviews and the inaccessibility of academic journals. The key is to remind ourselves, as well as the readers, that we cannot be all things to all people, that it is important to carve our niche and continue optimally exploring and exploiting it, hoping to illuminate topics under a new, revealing light for the benefit of the readers, in order to prepare them for managing the challenges ahead.

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PUBLISHED BY THE EUROPEAN COMMISSION
Joint Research Centre
ISSN: 1025-9384
Catalogue Number GK-AA-01-002-EN-C
DEPOT LEGAL: SE-1937-95

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PRODUCTION
CINDOC-CSIC/L&H Spain

PRINT
Graesal

TRANSLATION
CINDOC-CSIC/L&H Spain

THE IPTS REPORT
is published in the first week of every month, except for the months of January and August. It is edited in English and is currently available at a price of 50 EURO per year, in four languages: English, French, German and Spanish.

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CONTENTS

EDITORIAL

Dimitris Kyriakou and Jaime Rojo, *IPTS*

Science and Technology (S/T) – and more generally technical progress – modulate the pace and even the direction of change in our societies. Governance, on the other hand, is all about decision-making with a view to managing this change, making it a friend, not a foe, in order to safeguard and promote people's wellbeing. Simply put "science and governance" is about the process of devising and controlling the mechanisms to allow science and decision-making in society to work together in ways that are effective, credible, accountable and transparent.

The articles in this special issue are based on the authors' presentations at the conference organized by the European Commission's Joint Research Centre (JRC) and Directorate General Research in Brussels on October 16-17, on the topic of science and governance. Recent tensions at international level over the use of depleted uranium, "mad cow disease", etc. which have been accompanied by apparently contradictory statements by scientists in different camps, are often perceived to reflect national bias or bickering across disciplinary lines. They make the need for a rethink of the science/technology and governance interaction all the more urgent, but no less difficult, for the benefit of governance as well as science.

The importance of a successful wedding of science and governance is manifold. On the one hand S/T plays a major role in driving social and economic change. Moreover, S/T is a pivotal input to the policy-making process: helping clarify the terms of the debate, the stakes, and the repercussions of the alternatives considered. It can help clear away unfounded assertions and reveal opponents' demonizations for what they are, allowing dialogue and debate to examine the foundations on which policy alternatives rest. By informing an intelligent debate and the eventual policy choices, S/T helps both governance and itself. Governance and the policy choices made are legitimated in an S/T-informed process so as to become more than the arbitrary selection resulting from power struggles, untamed by facts and cool-headed analysis. On the other hand, S/T escapes both the splendid isolation of the proverbial academic ivory tower, and the crippling image of a hired gun offering its services (and tailoring its verdict) to the highest bidder.

This has been an important issue for some time, and is becoming more so, fed by the increasingly central role scientific/technological considerations play in decision-making, as well as by a wave of popular mistrust of science and/or the means of delivering scientific input to policy. For instance in light of the relaunching of trade

negotiations, and of the inevitable tensions resulting from giving obligations stemming from WTO agreements priority over thematic agreements such as the recently signed biosafety protocol, it would seem to be an opportune moment to turn the spotlight on these issues and their implications.

The goal then in this context is to integrate sound science and sound governance, and to enhance their interface in a way that is accountable, transparent, thorough, impartial and credible, and which will help focus the policy debate on the merits of the proposed actions. Such integration will provide reference quality information and analyses, presenting in a distilled, user-friendly fashion what we know, what we do not know, and the extent of the uncertainties and risks involved in different alternatives.

If strengthening this integration of science and governance is necessary within one country, it becomes even more so when the international dimension of governance is concerned. Across borders there is no unique enforcer, no single government with a monopoly over the legitimate use of force. Hence when sovereign entities have to choose a course of action, persuasion and S/T-informed debate become even more important.

At an even more global level, the absence of an EU-level body acting as an interlocutor and coordinator meant missing an opportunity to nip in the bud what later became thorny EU-US trade problems related to S/T (e.g. approval of genetically modified food products in the US put through completely independently of European attitudes, and future obstacles to their commercialization in Europe).

Both in instances of intra-EU issues in which effective governance has to rely on S/T reference quality information, untainted by as much as the suspicion of possible partiality, as well as in cases of global issues involving the EU with non-EU states, an EU-level system must provide the means of providing EU-wide reference quality information.

Preparing the ground for such a scientific reference system involves more than merely providing advice; the system should engender trust and a sense of shared responsibility through the development of networks, and it should be firmly anchored institutionally. Moreover, it should ultimately combine, and strike a careful balance between, the role of translating relevant knowledge for policy-makers and stakeholders, identifying the common denominators underlying disparate viewpoints, and distilling out the essence of disagreements for subsequent analysis. The Commission's JRC can play a central, catalytic role in this process of building a system for scientific reference.

Such a system could be structured on networks of centres of excellence, catalysed by the Commission, providing a common knowledge-base for S&T reference, and an interlocutor between actors and policy-makers. This would be a crucial step towards tackling the "science and governance" challenge. Moreover it should be seen in the context of, and will be enabled by, Commissioner Busquin's European Research Area initiative, and indeed may serve as a showcase of what this initiative can deliver, when the joining of forces in research that it enunciates takes hold.

To put it in a nutshell, the issue and relevance paragraphs applicable to this entire special issue would be as follows:

Issue: S/T is substantially responsible for driving change; it is a pivotal input to the policy-making process, and can help clarify the terms of the debate, the stakes, and the repercussions of the alternatives considered. Moreover, the pace of change in science and technology has made governments increasingly reliant on timely and accurate S/T advice. However, in recent years public trust has been eroded, particularly where scientists are not perceived as being sufficiently independent from government or other interest groups. Thus, the goal in this context is to integrate sound science and sound governance; to enhance the interface of science and governance in a way that is accountable, transparent, rigorous, impartial and credible; and in such a way as to help focus the policy debate on the merits of proposed actions. Such integration will provide reference quality information and analyses, presenting in a distilled, user-friendly fashion what we know, what we do not know, and the extent of the uncertainties and risks involved in different courses of action.

Relevance: The increasing weight of, and need for, input on scientific and technological considerations for decision-making, creates the need to achieve this in/by "reference quality", consensus-galvanizing ways/procedures that enjoy the full confidence of all concerned. Key to ensuring confidence is ensuring decisions are made in ways that are inclusive of as wide a range as possible of interests and opinions, that are open, transparent and able to handle uncertainty. This would benefit from the creation of an institutionally anchored, common scientific and technological reference system for Europe, making use of existing EU institutional anchors, such as existing Commission research institutions, and the enabling framework provided by Commissioner Busquin's European Research Area initiative.

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Towards a European Research Area

Philippe Busquin, *Member of the European Commission in charge of Research*

In offering me the opportunity to open the concluding session of the Conference "Science and governance", the organisers have conferred on me both an honour and a challenge. The difficulty of the task entrusted to me is due to several reasons: First of all, to the richness of the debates and the multiplicity of avenues opened by the various participants. Secondly, and on a deeper level, to the still very open-ended nature of deliberations on the topic of science and governance, a subject which is proving itself to be of ever greater importance at international and, more particularly, European level.

The problems involved are complex. Above all, it is necessary to bring a little clarity to the subject, while endeavouring to move beyond purely theoretical considerations and so to be as concrete as possible. I will try to do so by presenting some ideas on three points:

- The place of questions on "Science and governance" among the issues concerning governance in general;
- Their impact on research policies;
- The contribution of debate and initiatives in this field to the establishment of a new contract between science and society.

"Science and governance": a valuable example

My first reflection will take, to some extent, the form of a postulate:

The issues brought together under the heading "Science and governance" can be used as an example when considering issues of governance in general.

Governance comprises the new methods of administration of public affairs based on the interaction of the political authorities and "civil society": private actors, public organisations, and citizens' groups. This concept links both aspects relating to the quality of the decision-making process and citizens' participation in public affairs.

Why do science-related questions have here a "paradigmatic" character? I see several reasons:

- Firstly, science and technology are among the most powerful of all the forces shaping the way in which societies evolve.

  S/T is therefore a factor over which it is essential for society to exert genuine mastery;

- Secondly, the questions which arise in this field are particularly complex owing to their technical nature and to the knowledge needed to deal with them;

- Thirdly, the problem of the relationship between political and economic decision-makers, experts and citizens is particularly acute in this field, as is the issue of their respective responsibilities.

The issues brought together under the heading "Science and governance" can be used as an example when considering issues of governance in general

In other words, if we manage to establish (at European level in particular) satisfactory and effective relations between governance and scientific and technological progress, we will be able to do so, *a fortiori*, in the case of other important (though perhaps simpler) problems faced by society.

On the initiative of President Prodi, the Commission has begun deliberations on the topic of European governance, and this should lead to a White Paper on the subject between now and the summer of 2001.

The discussion focuses on the question of how to bring citizens closer to European realities, strengthen their participation in the debate and further decentralize certain aspects of the decision-making process.

The progress achieved in the specific field of "Science and governance" questions should significantly help us when analysing and drawing-up proposals, and also contribute to the debate launched by the White Paper.

Although involving citizens' groups in the various stages of the research endeavour is no guarantee that the results will be relevant to their needs, it is a step in the right direction

The principle of "sustainable development" has three dimensions: environmental sustainability, economic sustainability, and social sustainability

The impact on research policies

The second point that I want to stress is the impact of ideas on governance of science policy, more particularly ideas concerning research policies, which make up its central plank. I will give three illustrations of this, relating to three different aspects.

Societal involvement

The first aspect relates to the question of the involvement of society in the definition of research needs, the choices of research policy, and the monitoring of research activities.

I recently had the opportunity to take part in a meeting of the Presidents of the so called "External Advisory Groups", management structures associated with the implementation of the European research programmes. Representatives of industry and research of course figure among the members of these groups, along with representatives from various components of "civil society".

The involvement, at the various stages of the research endeavour, of patients' associations, transport users' groups, or consumer's organisations, for example, does not alone guarantee the relevance of the results obtained in relation to their needs. However, it can considerably help to bring this about. The spontaneous developments which have appeared in this regard have therefore to be encouraged and supported, at both national and European levels.

The organisation of research policies

The second aspect is the organisation of research policies.

These have to be endowed with structuring principles defined according to social goals and citizens' expectations.

An organising topic which can play this role in Europe is the aim set for the European Union by the Heads of State and of Government at the European Council of Lisbon: "to become the most competitive and dynamic knowledge economy in the world, capable of maintaining sustainable economic growth accompanied by enhanced social cohesion and quantitative and qualitative improvement in employment."

Another unifying theme is the idea of "sustainable development". The principle of "sustainable development" was formulated for the first time in 1984 in the United Nations Report entitled "Our common future". The questions which arise in relation to sustainable development include all the big problems affecting the planet as a whole, such

as climate change, ozone layer depletion, loss of biodiversity, etc.

However the principle of "sustainable development" actually has three dimensions: environmental sustainability, economic sustainability, and social sustainability, in a broad sense.

The Commission is currently engaged in an effort to provide an operational definition of this sustainability in the broad sense, at least to establish criteria for its application. Its results will be presented in a communication on the subject of "Sustainable Development".

Research and the precautionary principle

The third aspect is the question of safety and risk, more particularly that of the research needed to implement the "precautionary principle". Precaution is the equivalent for potential risks of prevention for actual risks.

It is a positive attitude, and the precautionary principle should not be understood as a precept for inaction: its role is precisely to force a decision to be made in the face of uncertainty.

It should be stressed that "zero risk" is a mirage, and absolute safety an illusion.

This does not prevent us from seeking to base decisions on the soundest and most regularly updated knowledge, so as to reduce this uncertainty as much as possible. The implementation of the precautionary principle will necessarily have important effects on the research agenda. We should see the appearance of a new category of research, which one could baptise "precautionary research". This will involve:

- Development of more precise and safer risk evaluation methods;
- Production and validation of the specific knowledge necessary to anticipate crises and to react when they occur, to support regulations and to monitor their application.

In the field of risk, as for the other aspects of science policy, it also seems essential to ensure that scientific opinion is given to decision-makers in a way that is genuinely transparent.

The rule should therefore be that the opinions of experts on questions of public interest are publicly accessible.

A new contract between science and society

These last remarks lead me to my third point. In what sense is this deliberation on the topic of science and governance politically and socially fundamental?

What is in view here can, I believe, be formulated in the following way. Research and technology play a key role in the economy and the knowledge society that the European Union has committed itself to building in Europe and at a European level. However scientific and technological progress also causes apprehensions, given its rapid pace, the risks that accompany it and its social consequences.

European citizens have somewhat the impression that this progress is not fully under control. Although they benefit more than ever from the fruits of this progress, they no longer feel the enthusiasm for the adventure of knowledge that was apparent just a few decades ago.

For a long time, a tacit contract existed between science and those who produce it, those who finance it, those who decide on its use and those who benefit from it.

The precautionary principle is a positive attitude, and it should not be understood as a precept for inaction: its role is precisely to force a decision to be made in the face of uncertainty

Research and technology play a key role in the economy and the knowledge society that the European Union has committed itself to building in Europe

The development of the scientific and technological endeavour and of its relationship with society makes it necessary to draw up a new contract between science and society, which should be explicitly stated and based on precise and accepted terms

Considering science and technology questions on a European level and acting at this level would enable Europe to contribute more effectively to the establishment of world-wide governance mechanisms in these fields

It is envisaged that the new Framework Programme will play a bigger role in structuring European research, facilitating and supporting the aim of better coordination of policies and research activities in Europe under the aegis of the "European Research Area"

The development of the scientific and technological endeavour and of its relationship with society makes it necessary to draw up a new contract between science and society, which should be explicitly stated and based on precise and accepted terms. This contract must be based on governance formulas bringing together all the stakeholders. These formulas will necessarily combine a stronger societal participation in the debate on the issues of research and the control of the research policies, together with the tried and tested mechanisms of representative democracies.

Parliaments, and above all, the European Parliament, have here a fundamental role to play.

Science and governance in the "European Research Area"

"Science and Governance" related questions have a European dimension which makes it necessary to approach them at this level.

It is easy to find illustrations of this: the recent "food crises" concerning mad cow disease or dioxin contamination; the debate concerning GMOs, in particular in food; differences in national sensitivity on subjects like research on embryos, cloning or energy policies, etc.

Considering these questions on a European level and acting at this level would also enable Europe to contribute more effectively to the establishment of world-wide governance mechanisms in the fields connected with science and technology.

These questions therefore constitute a very important aspect of the "European Research Area" project on which the European Union has been engaged since January. As part of the implementation of this project, the Commission will present in the weeks ahead a Communication on the topic of "Science, society and citizens". It will cover various aspects of the new contract between science and society to be established at European level, such as:

- The involvement of society in the research endeavour;
- The role of the economic, human and social sciences in this context;
- The position and role of women in research;
- The question of expertise, the research necessary for the implementation of the precautionary principle and the establishment of a European reference system in this field;
- The necessary reconciliation of ethical principles with the freedom of research;
- The ways in which a new dialogue can be instituted between science and society and scientific skills and understanding be developed among citizens.

The aim is to propose a frame of reference for the debate while formulating suggestions for action to be undertaken at European level.

These actions may be based on existing experience at European level and the initiatives taken by the Commission in this field, for example:

- The setting up of a high-level working party on Life Sciences regarding the question of communication with the public;
- The proposed creation of a "European Food Authority";
- The "Women and Science" action;
- The initiatives to promote the public understanding of science and to encourage young people's interest in research.

A part of these actions will be implemented by or with the support of the future Research Framework Programme, the guidelines for which were presented by the Commission on 4 October 2000.

It is envisaged that the new Framework Programme will play a bigger role in structuring European research, facilitating and supporting the aim of better coordination of policies and research activities in Europe under the aegis of the "European Research Area". This will also be the case in this individual field.

Conclusion

Finally, a few thoughts that I would like to share by way of an introduction to the conclusions of this debate.

I will finish by making a general comment. These conclusions can be no more than provisional as the range of questions covered under the heading "Science and Governance" is still broad and remains to be structured.

In this field where a great deal still remains to be invented, but where urgent questions are being asked, we have to prove our intent through action.

I believe and hope that this conference will represent an important milestone on the road before us.

Keywords

Precautionary principle, research policy, sustainable development, European Research Area, Sixth Framework Programme

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The Role of Experts in the Dialogue between Science and Society

Gilles Le Chatelier, *Head of the Office of the French Minister for Research*

The fields which cause greatest fear, and powerful, and at times even violent reactions, are often those which are perceived to have an irreversible effect on future generations

Although in many advanced industrial nations it may in the last decade have seemed at times that a rupture had occurred between the scientific community and the rest of society, most people now agree this impression to be no more than an error of perspective. In general, the public is not actively hostile to science, although the idea of progress undoubtedly no longer stands on the pedestal it occupied in the nineteenth century.

Nevertheless, what is true is the potential that some of the new fields science is exploring (biotechnology, information and communication technology, etc.), and the advances that have been made in them over the last twenty years, in conjunction with the persistence of their effects for both ways of life and the environment (nuclear power, blood transfusion, pesticides, artificial fertilizers, etc.), have for causing concern. One will no doubt have observed that the fields which cause greatest individual and collective fear, and powerful, and at times even violent reactions, are those which are perceived to have an irreversible effect on future generations in terms of their health and environment.

This has given rise to a more critical view of science as a whole and greater vigilance of both its current directions and expected future outcomes. At the same time the tools available to put this vigilance into effect seem increasingly inadequate. One need look no further than the growing demands for debate and the burgeoning number of cases fought in the courts over science and technology issues for evidence.

The scientific and technical field is bound by a new imperative, which encompasses but goes beyond the aims of internal regulation of research activity (ethical rules, mechanisms to avoid fraud, etc.) This imperative arises out of vague but urgent **calls for science and technology choices to be made in a more democratic way**. This applies in particular (though not exclusively) to the implementation of public policies, even if it were only, as Commissioner Philippe Busquin has so aptly written: "to restore to Europeans the means of re-establishing faith in the adventure of science and confidence in the progress that it generates".

The simultaneous development of a field of research (molecular biology) and a regulatory concept (the precautionary principle) is at the origin, if not of the existence, then at least of the greater emphasis placed on stakes whose ethical dimension is far from being the least important.

- On the one hand, if biotechnology fulfils the potential many scientists are predicting it to have, the world in which we live will be profoundly changed. This will affect

not only methods of production (agriculture, livestock-farming, medicines, etc.) but also of reproduction (genetic selection of embryos, cloning, etc.)

- On the other hand, this set of technologies is developing at a precise time in the history of our societies when although public opinion largely accepts that scientific progress is socially and economically valuable, its attitude is more critical than it has been in the past and the immediate results (acquiring of scientific knowledge followed by its application) are not always free of unintended consequences. Moreover, society has come to be more reluctant to take risks, to the extent that greater application is being made of the **precautionary principle**, which extends beyond the field of biotechnology to all areas of scientific and technical development.

This principle seems to be a reversal of the prevailing logic whereby society tended to allow scientific research the freedom to pursue its own path and only reacted when problems arose, and generally did so by applying risk management procedures. The precautionary principle, on the other hand, implies not waiting for possible problems to arise, but providing the means **upstream**, as soon as there is any doubt as to the innocuousness of the research being undertaken or the products developed, and seeks to predict the possible effects so as better to prevent them.

It was at one stage feared that this would lead to paralysis –uncertainty is a feature of all new developments in science; would it not lead to a ban on all research? However, the precautionary principle has given rise, both in France and in Europe as a whole, to numerous deliberations which, while not being totally without discord, seem to be bringing the majority of observers towards a common understanding, firstly that **precaution is not abstention**; i.e. that it does not imply abstaining on principle from starting out on new scientific and technical paths on the grounds that all novelty entails uncertainty. Rather, in practice, it entails a prior evaluation of possible adverse effects or unintended consequences, so as to shape research in such a way as to limit the scope of that uncertainty as far as possible. The general idea is therefore unambiguous: scientific developments are not unavoidably foisted upon society with their risks and benefits bundled together, it is possible to try to examine these risks in more detail upstream, before they are run, and then to follow their progress more closely to monitor their effects and thus their acceptability, their timeliness, etc. Precaution therefore re-establishes choice, making it possible to choose the path research takes and then, further downstream, choose the uses to which the results of that research are put. This represents a new approach bringing citizens, scientists and policy-makers together around a new "social contract" between science and society.

To make this a reality it is necessary to bridge the gulf between science and the public. Our citizens must be fully informed of both progress made by research in science and technology and the issues it raises so they are able to engage in debate with policy-makers.

This is an issue which is far from being limited to Europe and is one that is driven by more than just the precautionary principle. To a greater or lesser extent (and more or less clearly) it concerns countries at all levels of development and is complicated by some of the advances made by science and technology themselves. Roughly speaking, it affects all those countries that are participating in "globalization" and which therefore are undergoing:

- On the one hand, a sweeping away of the traditional traces of our individual and

One concern in the scientific community raised by the precautionary principle is that given the inevitable uncertainty of the outcomes of all scientific activity it would lead to paralysis and inaction

In practice the precautionary principle has meant a prior evaluation of possible effects and then shaping research in such a way as to limit this uncertainty as far as possible

The processes of globalization and European integration are creating confusion for citizens by undermining the traditional role of the nation state as the level at which S/T policy issues were resolved

collective identity by instruments conceived and controlled from outside our shared political, economic and cultural sphere.

- And on the other, the weakening of the structuring role of the social and political bodies, nation states in particular, which are responsible for embodying them and making them work.

Indeed, this weakening of the traditional and familiar interlocutors of opinion, the nation state in particular, caused by globalization, is blurring public opinion's perception of European integration.

Greater public familiarity with scientific thought is essential to rigorous and effective public debate. However, as well as education, the way in which information is propagated needs to be looked at

In other words, at precisely a time when the public has growing doubts about scientific and technical research, the social actor that it would traditionally turn to for answers, namely the state, is less able to answer, either because the globalization process has sidelined it, or because authority has moved to a European level, thus throwing public opinion into disarray.

In reality it is necessary to **bring science back into the "Polis",** to reintegrate science with the sphere of public affairs and reintroduce it into the political debate that must exist in any democratic society on all the major issues affecting it. Our citizens wish to be to be involved in the debate on the applications of genome research, research on the human embryo and stem cells, on GMOs or on the fate of radioactive waste.

A European Academy of Science could make a contribution to clarifying a number of scientific and technical choices for community institutions and preparing for a broader debate at European level

Improved healthcare, nutrition and security are the issues and challenges that research confronts and in which citizens must become involved. If not, the democratic debate would be incomplete.

But, what paths should we follow to reach these goals?

The first seems to me to be quite clearly training. Just as one cannot hope to build lasting integration within Europe without a collective consciousness, built upon teaching a common history, geography and common civic instruction, equally one cannot achieve the participation of the public as a whole in the democratic debate on science, without strengthening the scientific and technological component of teaching everywhere in Europe. The elements of basic scientific knowledge have to become a part of what future generations come to consider general knowledge.

However, educating the public is a necessary precondition but not a sufficient one. It is also essential to work on the way the authorities distribute information, the role of the media, the way in which discussion forums are set up and run, etc.

Creating the conditions for democratic debate also rests on a prior reflection on the place and role of the **expert**, as has been highlighted by all the work carried out on the precautionary principle. In this regard the French proposal to institute a **European Academy of Science** is a contribution to clarifying a number of scientific and technical choices for community institutions and preparing for a broader debate at European level.

The stakes involved in achieving social acceptance for certain areas of scientific and technological progress are high. However, if this acceptance is not achieved the risk of some areas effectively being driven underground are considerable. Needless to say, these are matters of great economic importance. It was because of the crucial significance of these issues that the French presidency decided to hold a meeting (on 30 November to 1 December) of European ministers with responsibility for research, together with a number of their counterparts from Asian countries, on the occasion of the Sorbonne

colloquium entitled "Science and Society", to discuss these issues, issues which are also at the heart of this conference organized for today and tomorrow in Brussels by the Commission, and which is therefore an initiative we wholeheartedly support.

Keywords

Science and society, precautionary principle, globalization, European integration, European Academy of Sciences

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Science & Technology and the Public: a complex relationship

Umberto Colombo, *former Minister of Research,* Italy

Without improved technology it will be impossible to support the global population predicted for the 21st century or to attempt to reduce the intolerable gap between the world's rich and its poor

Introduction

There is no question as to the importance of science and technology for mankind. Indeed, the carrying capacity of our planet, that is the capability of the Earth to sustain human life, with all its needs in terms of energy, food and other resources, is a function of scientific progress and of the technological innovations that spring from it.

Ten thousand years ago, at the time of the first agricultural revolution, the planet could not feed and support more than five million inhabitants. Now there are six billion of us, and we expect world population to continue to increase before levelling off, hopefully, at a level of ten billion sometime within the 21st century. At our present level of technology, the world cannot possibly carry a population of ten billion. Nevertheless, this is the number we must aim at. At the same time, we must also allow for conspicuous economic growth, given the ethical imperative to reduce the current intolerable gap between North and South and between the rich and poor within every region. This means that more science, and more and better technology, are vitally necessary for the long-term survival of Mankind.

Over the last few decades the links between science and technology have become ever tighter, so that one can rightly speak nowadays of "scientific technology", while in parallel science has come depend more closely on the need for sophisticated and often costly technologies. Furthermore, to tackle the complex problems of our time, many of which are of a global nature, it is necessary to breakdown the traditional disciplinary fragmentation and to adopt an open-systems approach, with a strategic vision that avails itself of the most disparate elements of knowledge.

The connection between science and technology has grown more sophisticated and complex. It may happen that a fundamental scientific discovery meriting a Nobel Prize for its authors has technological connotations that lead to new revolutionary products or processes. It is appropriate here to quote the seminal work done by Bednorz and Müller in the 1980s on high temperature superconductors at the IBM Research Centre in Zürich (which, ironically, was recently closed). This work has started to find practical applications which are expected to diffuse greatly in the future. It may on the contrary happen that an applied research project leads to an outstanding scientific discovery. The example I have in mind is the detection of the 3-degree Kelvin cosmic background radiation made by Penzias and Wilson at the Bell labs in the course of a project aiming at improving radio telecommunication technology. This year's Nobel prizes in Physics and Chemistry

have been awarded to six scientists (three Americans, one Russian, one German and one Japanese) who pioneered work on materials for microelectronics, computers and photography: this could be the sign of a departure from the past, when Nobel Prizes were preferentially given for work leading to theoretical and abstract advances, which were rarely related to everyday life. I should also like to note here that, as Nathan Rosenberg has shown, there are many cases in which basic science follows practical applications: the transistor caused the development of solid state physics, just as, much earlier, it was the steam engine that led to the development of thermodynamics.

One can say that science and technology are going through a situation marked by a powerful ambivalence between, on the one hand, their recognition as the main motor of economic and social change, and on the other their apparent loss of that positive halo as the drivers of progress they once seemed to be. Moreover science and technology are increasingly subject to doubts, perplexity, and even downright rejection. Policy makers and the public at large now feel the need better to understand how scientific and technological research is carried out, if and when it is in tune with the needs and aspirations of society, or if it ends up by conditioning societal development, in the sense that, though it provides solutions which seem to tackle real problems in effective ways, people may feel they have lost control over whether they can accept them or not.

Science and technology are therefore perceived as being a sort of ideology, given the influence they have on the direction of development. One can understand why in democratic countries parliaments demand ever more insistently to take control over decisions on priorities in public research, bearing in mind the consequences –for example, in terms of economic growth or employment– of alternative strategic choices.

This will mean that scientists are going to have to get off their high horse and engage themselves much more than hitherto in explaining the value of the work they are doing for society. Even when their work is of a fundamental nature and has its main justification in contributing to the advancement of knowledge, scientists should nevertheless feel obliged to look into possible fall-outs that would benefit society by contributing to the advancement of technology and to the generation of employment.

While accountability, "value-for-money" criteria and close monitoring of projects may be useful in increasing the productivity of short-term oriented research, they may frustrate originality and lead to an environment that discourages break-through innovations. For this reason European governments and the Commission should allow some funds to bottom-up, high risk, high imagination proposals, and these proposals should be handled without time-consuming procedures that act as a drag on creativity and innovation.

Scientists should also establish guidelines for ethical behaviour. Assessments of research programmes should be widely disseminated. To ensure a fruitful debate with the involvement of the public, a number of conditions should be observed: scientists would have to refrain from taking up publicity-seeking attitudes; the media would have to adopt a code of ethics eliminating consciously biased information; furthermore, scientists and the media would have to work together in assisting the public and the policy-makers to grasp the true nature of each scientific issue.

Differences in the public response to stated research objectives will increasingly affect science and technology policy. Policy making must take the demands of society into account. This will reinforce the social acceptability of science, while making a contribution to the

The relationship between science and technology is becoming more complex. It is more common nowadays for technology to be science driven and for prestige to be attached to scientific work with immediate practical applications

Science and technology has come to be recognized as the motor of economic and social change, yet at the same time people have lost a sense of "progress" as something necessarily positive

The need for scientists to justify their work and accept closer scrutiny does, however, bring with it the risk of frustrating originality and discouraging break-through innovations

establishment of funding priorities. Though the criterion of public acceptance assumes an important role, policy should not centre on defending a project from attack; rather it should accept the necessity of demonstrating its value. This approach is much more democratic. As we know, society's "big list" is quite different from that of most professional scientists. It is dominated by issues linked to overpopulation –food security, water shortage, environmental issues, health concerns, migration. What contribution can science make to resolving them? The problem is extending awareness of the potential of science to benefit society beyond the currently narrow groups of experts and specialists so as to include the broader public and so enhance the ability of science to offer what people want.

Though the criterion of public acceptance plays an important role, policy should not centre on defending projects from attack; rather it should accept the necessity of demonstrating their value

Economic growth takes place best in a context of open competition, which stimulates mobility and innovation. Although this would be good for research, it may tend to privilege short-term, low-risk, applied research and technological development, rather than long-term, high-risk strategic research, not to mention fundamental scientific research. It is up to policy makers to fund universities and public research, in order to avoid the drying up of the sources of future innovation.

Neither companies nor countries can opt out of technological progress. To do so would be to undermine performance, and in the case of a country, to face rising unemployment and falling standards of living

The cost of research may be high, but the benefits to be derived –both real and measurable, and more uncertain but foreseeable in the longer-term– are altogether much higher. This can be easily demonstrated "*ad absurdum*" simply by reflecting on what would happen if a country –or even a company– decided to stop all research. Not only would its competitive position be eroded, in the case of a country, unemployment would rise rapidly (despite the common belief that unemployment is a consequence of technological progress). In the case of a company, profits would fall, as a result of fewer new, high value-added products to place on the market. A company's, or country's, backwardness in science and technology will inevitably undermine its overall performance.

Science and technology policy needs to optimize the use of resources in a similar way to how "megaprojects" are nowadays increasingly planned as exercises in broad international cooperation, so as to avoid duplication and pool human resources and capital

International collaboration in science and technology is currently taking place both on a European level, and at times with a wider participation, particularly in such fields as high energy physics, nuclear fusion, space research, astronomy, ocean research, molecular biology, global climate and so forth. Some of these require the construction of big facilities and entail large-scale investment in expensive installations and equipment. Others call for large-scale, cooperative, multi-disciplinary research and rely as much on small and medium-sized instruments as on large ones. Science "megaprojects" now are increasingly planned as exercises in broad international cooperation, so as to avoid duplication and optimize the use of human resources and capital. Support is also needed at the national level for basic and applied research projects that may be less grandiose but often bring more immediate benefits. What is required, then, is a science and technology policy better designed to optimise the application of financial and human resources toward achieving goals of true benefit to society.

It is worth reiterating that European governments need to increase their support for fundamental research by devoting a sizeable percentage of science and technology funding to it. Support for basic research could also be given by those industrial enterprises operating at the cutting edge of scientific technology. In those countries where industry is strong and able to finance most of its own R&D activity, it is appropriate for governments to concentrate on supporting fundamental research. Where, on the other hand, the industrial fabric is still weak and fragile, governments may have to play a bigger role in promoting industrial research and technological development. Furthermore, considering that small and medium sized businesses (SMEs) are the backbone of the

economy, governments should ensure that adequate mechanisms exist to transfer advanced technologies to these SMEs, and to link the demand for the innovation that emerges from them to the supply of research results, usually obtained in academia or state-run research institutions.

Europe should be ready to invest more in science and technology, and the private sector should be encouraged to take the lead. Fundamental research must continue to rely essentially on public funds at the national level, while long-term, strategic research should increasingly be planned at the European Union level. The Framework Programme of the European Union is already performing this task to a certain extent. While it is true that the Framework Programme accounts for only five per cent of total public R&D expenditure in Europe, its catalytic effect in orienting the research strategies of member countries should not be underestimated. This influence will increase as the concept of ERA (European Research Area) is more systematically taken into account, and also as a consequence of the on-going trend toward a greater concentration in the directions of strategic research supported by the Commission.

Finally, it is encouraging that Commissioner Busquin, in his first communication introducing the concept of a European Research Area, placed particular emphasis on technology foresight. As an exercise, technology foresight is long term and taking a holistic view of the "problematique". That is, it does not rely on (or merely comprise) specific predictions or forecasts, indicators and behaviour patterns. Rather, it takes all these factors, and more, into account in the context of a commitment to reduce the imbalances affecting modern society. It is therefore a search for solutions, a response to identified societal need which itself is called upon to provide inspiration and orientation for science and technology. Technology foresight and the public acceptance of science and technology have one major aspect in common: the social dimension of science and technology, as an inspiration for research and as a justification for funding. These are key instruments with which to improve the decision-making process and contribute to the governance of our institutions.

Although the Framework Programme accounts for only a tiny fraction of R&D spending in Europe, its role as a catalyst for research strategies in the member states should not be underestimated

Keywords
Social acceptance of science, research priorities, foresight

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Science and Governance: the US example

John Brademas, *New York University*

Policy makers shaping legislation to address a particular problem often find themselves faced not with a political barrier – i.e. that what they want to do is politically difficult or dangerous – but rather with a knowledge barrier

The Carnegie Commission in the US seeks to give recommendations on how the Federal government and the governments of the 50 states can best make S/T policy decisions

Introduction[1]

I count it an honour to have been invited by Dr. Dimitris Kyriakou, the outstanding young scientist from the Institute for Prospective Technological Studies, in Seville, of the Joint Research Centre of the European Commission, to take part in this conference on "Science and Governance in a Knowledge Society: The Challenge for Europe".

During my years in the US Congress, again and again, in shaping legislation to address a particular problem, I found myself faced not with a **political** barrier – was what I wanted to do politically difficult or politically dangerous? – but rather with a **knowledge** one. For instance, what was the most intelligent, rational, effective approach to, let's say, providing Federal funds to the 50 states and to local school systems for the education of handicapped children receiving inadequate schooling or none at all?

Policymakers often find themselves facing such knowledge barriers. President Lyndon Johnson used to summarize the challenge legislators face with the aphorism: "My problem is not **doing** what is right; it's **knowing** what is right".

The role of science and technology (S&T) in helping the policymaker deal with this challenge is key, and this applies in Europe, at both the state as well as the EU level. The birth and growth of the European Union are events of extraordinary significance, and although, as the dramatic events in Yugoslavia, the Danish vote on the euro and the hostility on the part of some political leaders to the idea of an integrated Europe all illustrate, the development of a united Europe has, not surprisingly, been fitful and uneven, there can be no question that a genuinely European community now exists and is not likely to disappear. Thus it is entirely logical that Europe should seek to coordinate its efforts on Science and Technology policy at European level and seek to enhance productive interactions between the EU and national levels.

In the United States, the Carnegie Commission on Science, Technology and Government, is a body that directs its efforts not to producing proposals for substantive government policy for science and technology but rather to recommendations for how the Federal government, as well as the governments of the 50 states, could more wisely and effectively make decisions for S&T policy and for dealing with public policy issues with scientific and technological implications. The Carnegie Commission was created on the initiative of the Carnegie Corporation of New York, and its 22 members included former President Jimmy Carter, two Nobel Laureates –Joshua Lederberg, who with William T. Golden, co-chaired the Commission, and Robert Solow– and two former Science Advisors to Presidents

Kennedy, Nixon and Ford. The commission's work confronted an issue which is now being faced by efforts to coordinate scientific research policy-making in the EU and its member states.

In Europe, when seeking to understand the issues involving science and governance in the knowledge society, the report of the Commission's Independent Expert Panel, chaired by Jóan Majó provides useful insight.[2] The Majó report calls for "a radical upgrading of the policies and policy mechanisms to ensure that scientific and technological advances continue to underpin economic progress", and warns that Europe can fall "further behind other economic areas over the next decade. Looking from the scientific community, the fear of Europe losing its place as a centre of excellence for the creation of knowledge, I am convinced," writes Majó, in his introduction to the report, "that both threats are the same".[3]

Of course, the political systems of the United States and the European Union are very different and, therefore, methods of making S&T policy in the US are not readily applicable or necessarily appropriate for the European Union and its member-states. Nonetheless, as both the EU and US are modern democratic, industrial societies, they can no doubt learn a great deal from one another.

A recent article in Science[4] reported that: "Disaffection with the European Union's... flagship research effort has found a sympathetic ear in the program's upper echelons. Last week the EU's top two research officials said they are pushing for big changes in the successor to Europe's 5-year, $17 billion Fifth Framework Programme for Research, including stronger efforts to coordinate research across the continent and to support innovative projects".

The Science article goes on to note Research Commissioner Philippe Busquin's September 14th speech to the European Parliament promising that Framework 6, to begin in 2003, will "play a bigger role in coordinating European research", and cites the recent prediction of Research Directorate's new Director-General, Achilleas Mitsos, that Framework 6 will seek to "link the different national and European Community research programmes in a more strategic way".

The Carnegie Commission on Science, Technology and Government, referred to above, published nearly two dozen reports, and although they appeared a few years ago, they are nevertheless still worth reviewing.

The American separation of powers system means that elected members of the United States Senate and House of Representatives can exert a powerful influence on the direction of American S&T policy. However, political arrangements in Europe may mean that parliamentarians may not exercise commensurate power. Nonetheless, we are perhaps seeing European MPs become more and more important in decision-making processes and so some of the recommendations of the Carnegie Commission report on Congress may prove increasingly relevant for them.

Two of the Commission's main recommendations to Congress were firstly for it to improve both the quality and timeliness of advice it receives by making greater use of informal advisory groups, meetings and conferences, and secondly for it to establish a bipartisan Science & Technology Study Conference to analyse issues as needed and encourage communications across the myriad congressional committees and subcommittees that deal with S&T.

It also proposed the creation of a Center for Science, Technology and Congress to provide briefings on major S&T issues before Congress. A proposal which has since been implemented by the

The 6th Framework Plan will play a bigger role in coordinating European research and seek to link national and European Community research programmes in a more strategic way

The US political system allows parliamentarians more direct control over S&T policy than is usually the case in Europe

One of the Commission's main recommendations to Congress was for it to improve both the quality and timeliness of advice it receives by making greater use of informal advisory groups, meetings and conferences

The Carnegie Commission has sought to involve scientists and engineers more actively in policy-making and has urged Federal agencies, academic institutions, corporations and professional societies to encourage such involvement

Executive Branch officials, either elected or career civil servants, do not necessarily have a monopoly on wisdom. Parliamentarians may also make valuable contributions to policy

American Association for the Advancement of Science. As one of its activities the Center publishes a periodical report on relevant legislation called "Science and Technology in Congress."

As a complement to these proposals, the Committee directed some recommendations to the scientific and engineering communities. For example, it urged expanding a programme under which recent university graduates with advanced degrees in science or engineering serve on staffs of Congressional Committees or of individual Members for a period of one year. It has also sought to involve scientists and engineers more actively in policy-making and has urged Federal agencies, academic institutions, corporations and professional societies to encourage such involvement. Furthermore, it has pressed the National Academy of Sciences complex to communicate more regularly, and deeply, with Members of Congress and their staffs.

Whereas the first report of the Carnegie Committee on Congress dealt with expert advice from outside Congress, its second study focused on the analysis and advice Congress received from the four congressional support agencies: the Office of Technology Assessment, Congressional Research Service of the Library of Congress, General Accounting Office and Congressional Budget Office. Apart from sharply criticizing the Republican-controlled Congress for short-sightedly eliminating the Office of Technology Assessment, the Committee urged enhancing the capacity of all the congressional support agencies to advise Congress on science and technology issues.

Individual philanthropy can also play an important role in linking the scientific and political establishments. For example, through a recent gift of $60 million from an American philanthropist, John Kluge, the Library of Congress is establishing a panel of senior scholars–to include a chair in technology and society–in residence at the Library to serve as an intellectual bridge to Members of Congress. According to James H. Billington, the Librarian of Congress, the gift will "bring some of the world's leading thinkers to the Library...both to maker greater use of the world's greatest collection of human knowledge and to make their wisdom continuously accessible to the world's most important lawmakers. We want this...gift to enrich the linkage between ideas and action, thinkers and doers."

The role of a legislative body in determining S&T policy is worth highlighting for two reasons. Firstly, Executive Branch officials, either elected or career civil servants, do not necessarily have a monopoly on wisdom. Parliamentarians may also make valuable contributions to policy. Secondly, for science and technology to be adequately financed, particularly by governments, public support is essential, and elected parliamentarians are experts in generating such support.

With respect to the role of the Executive Branch in making science policy, a report recently published by the National Academy of Sciences, National Academy of Engineering and the Institute of Medicine, entitled "Science and Technology in the National Interest" is worth mentioning. The thrust of this report is that the nation needs "the judgement and skills of its most qualified scientists and engineers in key government positions and that to recruit these leaders, including some from key sectors of the new economy, the President and Congress must smooth the path and reduce the barriers to government service". Moreover, no doubt the European Union and its member-states also face the challenge of finding first-class scientists and engineers for critical government positions.

When discussing the principal actors that affect science policy in the United States it is also necessary to mention the third branch of government in the US Constitutional firmament,

the judiciary. The Carnegie Commission also produced some reports on the role of courts in handling cases in which S&T issues loomed large. The Microsoft case, for example, immediately comes to mind.

A major result of the Carnegie Commission's Task Force on the Judiciary was the creation of a Judicial Reference Manual on Scientific Evidence, the second edition of which has just been published. The manual sets forth protocols created by judges and members of the S&T community in areas most frequently encountered in litigation.

The foregoing remarks refer to the situation in the United States, but there are no doubt useful parallels that can be drawn which may make the example fruitful when designing structures and mechanisms of governance for dealing with science and technology policy. There are of course many areas which have not been touched upon here that are nonetheless relevant and worthy of consideration. Perhaps the best way to summarize them is simply to list some characteristics of the system of basic scientific research in the United States, although there will be differences as well as similarities.

The points listed below are chiefly drawn from a report[5] by the Committee for Economic Development (CED).

- Basic research in science and engineering is essential to economic growth (true in both the US and Europe).
- The most important American institutions for conducting basic research are the nation's 200 major research universities.
- The Federal government has long been the most important source of financial support for basic research, and Federal support for training graduate students is indispensable.
- Scientific merit, based on peer review, should be the basis for allocating Federal research monies; in general, individuals rather than institutions should be supported.
- Publicly-funded basic research is critical to private sector innovation, and basic researchers work in the expectation that their efforts will be relevant to industrial application. Indeed, industry is increasingly involved in collaboration with, and sponsorship of, university-based researchers.
- If the United States is to enjoy an adequate supply of young researchers, more and more attention must be given to improving science and mathematics teaching in our elementary and secondary schools.
- Finally, American researchers should increase their collaboration with basic researchers in other countries.

On this last point it is worth noting the warning recently given by Torsten Wiesel, president emeritus of Rockefeller University and Secretary General of the Human Frontier Science Program, that too few young biomedical researchers from the United States are studying in laboratories in other countries. The US must, says Wiesel, "promote and maintain research networks and training across national boundaries"[6].

A further subject European Union policy-makers would do well to address is that of developing Europe-wide policies to stimulate philanthropic contributions from individuals, business and private foundations to institutions of culture, learning, science and health.

Allow me to make a final point: As Europe and the United States are, through NATO and in other ways, joined to assure our common security and

European Union policy-makers should address the question of developing Europe-wide policies to stimulate philanthropic contributions from individuals, business and private foundations to institutions of culture, learning, science and health

protect our common commitment to free and democratic societies; and as Europe and the United States represent, despite inevitable tensions and disputes, major markets for each other's goods and services, it seems to me imperative that leaders of the academic, business, political and scientific institutions of Europe and the United States find still more effective ways of working together.

About the Author

Dr **John Brademas** is President Emeritus of New York University, Chairman of the President's Committee on the Arts and Humanities under former president Bill Clinton, and a former member of the United States Congress. He chairs the National Endowment for Democracy, a non-governmental organization working to promote democracy. He was also chairman of the Committee on Science, Technology and Congress of the US Carnegie Commission on Science, Technology and Governance.

Keywords

Science and governance, Carnegie Commission, philanthropic contributions

Notes

1. This article is based on the address given by Dr John Brademas at the Conference on *Science and Governance in a Knowledge Society,* held in Brussels in October 2000.
2. Jóan Majó, Five Year Assessment of The European Research and Technological Development Programmes, 1995-1999. July 2000.
3. Ibid., p.1.
4. Science, *Research Behemoth Slated for Overhaul*, September 22, 2000, pp. 2019-20.
5. America's Basic Research: Prosperity through Recovery prepared by the Committee for Economic Development (CED), 1998.
6. Torsten Wiesel, *Balancing Biomedicine's Postdoc Exchange Rate*, Science, August 11, 2000, p.867.

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Bringing Science into Governance

Sir Robert May, *the Royal Society*, UK

Introduction

Today's pace of advance in scientific understanding increasingly presents challenges for the ages-old dialogue between policy makers and the public. This trend is likely to continue, and therefore I very much welcome the consideration of "Science and Governance" that this conference and its distinguished contributors signify. If we are to benefit from scientific advance, we need wide and open discussion about possible worries and unintended consequences, in ways which command public confidence and trust.

In particular, I thank Mr. Allgeier and Mr. Mitsos for inviting me to join this round-table discussion, and the JRC for arranging this event. I think this conference comes at a particularly opportune time.

The Commission's European Research Area initiative has not only highlighted the increasing importance of research and technology as drivers for competitiveness, growth and employment, but also brought to the fore the need to ensure we make the best use of scientific expertise when taking decisions. The forthcoming Commission White Paper on Governance, which will explore the issues of scientific evidence and advice in the broad context of EU governance, will be a crucial next milestone.

The Challenge

Advances in science and technology, especially those emerging from a new understanding of the molecular basis of life, have happened so rapidly that governments the world over have been caught unawares, first by the possibilities of the technology itself and secondly by the public's reaction. They have been left scrambling to make policies in a context of scientific uncertainty and vociferous public opinion.

Advances in science and technology have taken place so quickly in recent times that governments have often been caught unawares by both the technology and the public reaction to it

In recent years, in Britain in particular, trust and confidence has been eroded with respect to a number of scientific issues, of which BSE is the most notable example. Other European countries have had similar experiences.

Distrust for the new is not a recent phenomenon. In the past, it manifested itself in more draconian terms. Some 400 years ago Giordano Bruno was burnt at the stake for propagating Copernican theories and Galileo was forced to recant his beliefs. These, however, were the reactions of the establishment. An example of a more populist reaction, and one which would be recognisable today, was that to the introduction of cowpox vaccination against smallpox about 200 years ago. Proposals for mass vaccination in England were met with violent protests and the establishment of an Anti-Vaccine Society.

Distrust for the new is not a recent phenomenon and despite appearances there is little evidence that people distrust science or scientists in general

But even today the evidence does not support the conclusion that people distrust science or

In an effort to counter public distrust, many governments and scientific institutions have sought to promote public understanding of science. But greater understanding has not automatically led to broader acceptance

With a view to broadening consultation and increasing the openness with which decisions are taken, some countries have begun to publish guidelines for tackling scientific issues

Some of the areas guidelines need to cover are the need for the early identification of issues, including a wide range of inputs, dealing with uncertainty, ensuring transparency and openness and ongoing review of decisions in the light of further advances

scientists in general. According to recent studies from a range of countries the majority of people think that science and technology were making our lives healthier, easier and more comfortable. Studies of this type have been carried out in the USA (1997; 87% agreed), New Zealand (1997; 85%), Japan (1995; 51%), UK (2000; 67%) and the recent Eurobarometer indicates that similar levels of support exist across the member states of the EU (at least for technologies other than nuclear energy and genetic engineering).

Recent studies in the UK also indicate that scientists who are seen to be "independent" (e.g. university professors) are among the most trusted sources of advice on a number of difficult issues, including BSE and pollution. They certainly scored better than journalists, businessmen and politicians.

At the same time less than 50% of people in the UK and New Zealand thought that the benefits of science were greater than the harmful effects. Furthermore, these studies indicate that people in the UK have much less trust in scientists when they are labelled as "Government scientists".

In an effort to counter these elements of distrust, many governments and scientific institutions have put in place public understanding of science programmes. But naive expectations that if only the public understood more science they would find it more acceptable have not been justified. Detailed surveys such as the 1992 Eurobarometer show that those countries whose citizens score highest on quizzes about scientific facts and methods also are more likely to worry about the unintended consequences of new technologies. I think this is how it should be! The more we understand the nature of scientific enquiry and its applications, the more we understand that although on balance the results have greatly improved our lives, there can be adverse unintended consequences (for example, climate change, loss of biodiversity). Responding to public concerns is not only right on philosophical grounds, but I think it holds the promise of helping us avoid unintended adverse consequences from well intentioned actions in the future.

Guidelines for Science Advice in Policy Making

We need to move forward to a world where we consult widely, and where decisions are taken openly. We must recognise, however, that this has a cost, and that it may be difficult and uncomfortable at times.

Some countries, including the UK, have published guidance on how scientific issues should be tackled. The Canadian example is of particular interest as their Federal Government has to take account of the interests of the different Provinces. Their guidelines, which are set out in a 1999 report from their Council of Science and Technology Advisers, are an excellent example of the way ahead. They focus on the following key areas:

Early identification of issues. Decision makers need to anticipate the issues for which science advice will be required. They need to cast their net widely, consulting internal, external and international sources, to assist in this identification.

Inclusiveness. Advice should be drawn from a wide variety of scientific sources and from experts in many disciplines to capture the full diversity of scientific thought and opinion.

Sound science and science advice. There must be procedures for ensuring the quality, integrity and objectivity of the science, and to ensure that scientific advice is considered seriously in decision making.

Uncertainty and risk. There should be a risk management approach, with regulatory bodies having clearly defined approaches to risk management, knowing when a precautionary approach

should be applied, and ensuring that uncertainty is weighted fairly and communicated effectively. (The "Precautionary Principle" itself, unfortunately, is rapidly coming to mean all things to all people, and in some of its more simplistic manifestations runs the risk of becoming a recipe for paralysis).

Transparency and openness. These two are not the same. Transparency implies a clear articulation of how decisions are reached and that policies are presented in open fora, with the public having access to the findings and advice of scientists as early as possible. This should allow the public to reassure themselves that decisions have been taken in their interests and allow failures in analysis to be challenged. Openness, however, implies allowing interested parties to be included in the decision making process through consultation. In this way new policies can take account, from the outset, of the attitudes and values held by the public.

Review. There should be subsequent review of science-based decisions to determine whether recent advances in knowledge have had an impact on the science and scientific advice underlying the decisions.

Finally there should be strategies for ensuring the guidelines themselves are implemented by those who are supposed to operate them, and for monitoring their effectiveness.

Of course, the great majority of scientific advice needed by policy-makers is routine. It involves thoroughly understood scientific issues, and the decision path has been generally agreed. It is the remaining minority of advice with which we need particularly to concern ourselves. These are the cases were scientific advice is needed on questions which go beyond the boundaries of current understanding.

In such cases there is greatest need for the very highest calibre of scientific advice, from people with a demonstrated capacity to think in original and lateral ways. Here, there is no decision path laid out and the little evidence that is available is of variable quality and relevance.

Where these difficult scientific cases arise, we must resist the temptation to obtain advice through a closed coterie of officials. We should draw on established scientists without creating new layers of bureaucracy. We should also, where appropriate, engage some people with expertise outside the area under examination, to make sure that a sufficiently wide range of viewpoints is brought to bear. How are we going to do this at the European or at the International level?

The answer is to make use of existing bodies which are capable of seeking out the relevant scientists and scientific expertise and bringing them together. We already have a potential network of academies which are in a position to recommend excellent scientists from around Europe: national bodies such as the Royal Society (London), the Academie des Sciences (Paris), Accademia Nazionale dei Lincei and the Deutsche Forschungsgemeinschaft as well as the Academia Europaea.

There are existing precedents for such a network approach: at a *global level* we have the Inter-Academies Panel on International Issues which through the Inter-Academies Council is developing a group to look at just these difficult global issues; and at a *European level* we have organisations such as ALLEA (the All European Academies) or Euro-CASE, the European Council of Applied Sciences and Engineering. Euro-CASE is an organisation of academies of applied sciences and engineering from seventeen different European countries. This provides independent and balanced advice on technological issues with a clear European dimension. We should look at these models and see how they could be adapted to meet our needs.

The quality scientific input is particularly important on issues which go beyond the current boundaries of understanding. Here it is important to get a wide range of viewpoints from experts who are not perceived to be a part of a closed coterie

One way of bringing in scientific expertise from outside government circles is to use existing bodies such as the national academies and, at international level, the networks to which they belong

At European level, a similar role in facilitating information on science and technology matters is envisaged for the JRC, whereby it could serve as the link between EU bodies and the network of academies

But what role might there be here for our hosts today, the Joint Research Centre (JRC)? In looking at the future work of the JRC, the High Level Panel, Chaired by Viscount Davignon, recently recommended that "... a primary function [of the JRC] should be to ***facilitate*** the gathering and fair assessment of information on science and technology matters to inform the EU institutions on the current state of knowledge on a given scientific subject.". Under this scenario, it is clear that the JRC could, where appropriate, provide an important link between the EU's institutional customers and a network of academies.

But our basic aim must be kept clearly in view at all times. It is to seek advice on key and difficult issues from the very best scientists, as identified by their established peer organisations, with the minimum of bureaucratic apparatus.

Envoi

In conclusion, scientific progress during the 20th Century has made life better, but has had some unintended consequences. In the 21st Century this pattern is, I think, likely to intensify, especially as we learn more about the molecular machinery of life itself. All this adds up to great challenges for policy makers.

Scientific understanding, or scientific uncertainties, mediate and constrain the dialogue between the policy makers and the public. But in many important issues – both of safety and of ethics – science alone rarely gives unarguable answers. As Brecht wrote in his play on the Life of Galileo "The chief aim of science is not to open a door to infinite wisdom, but to set a limit to infinite error."

There are no easy solutions. Dialogue with citizens plays a part but only a part. We need to have mechanisms in place to ensure best use is being made of the scientific expertise we have available. And we have to change the culture of those who would prefer to make the decisions behind closed doors. Only by being inclusive, open and transparent can we hope to earn the confidence of a modern public.

About the author

Sir **Robert May** is President-elect of the Royal Society, London, and holds Professorships in the Department of Zoology, Oxford University and Imperial College, London. Previously he was Chief Scientific Adviser to the UK Government and Head of the UK Office of Science and Technology. Before that he was Class of 1877 Professor of Zoology at Princeton University and Professor of Physics at Sydney University. Trained as a theoretical physicist/ applied mathematician, for the past 25 years he has studied various aspects of the way populations and communities are structured and how they respond to change.

Keywords

European Research Area, precautionary principle, science academies

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The Changing Relationship between Science, Technology and Governance

Jean-Marie Cadiou, *Director of the IPTS*

It is a great pleasure for me to be able to take part in the opening of this conference, in the organization of which the Institute for Prospective Technological Studies, as part of the JRC, has played an active role. I am glad that so many of you have been able to attend, from both the European Union, and the candidate countries for accession, and yet further afield from America and Asia.

In recent years the relationship between science, technology and governance has undergone a qualitative change, to the extent that some people are calling it a "paradigm shift".

Increasingly often, **public decision-makers, and in particular elected representatives, turn to scientists for answers to questions on potential risks**. However, the paradox is that scientists, experts, and specialists, seem less and less in a position to answer with certainty the questions raised.

The extraordinary acceleration of the pace of discoveries (genetics is a case in point), and **of their application** in fields which affect everyone (health, food), have meant there is less and less room for manoeuvre regarding the potential risks, and the **areas of uncertainty are growing.**

The **"precautionary principle"** was developed in response to this type of situation of uncertainty. This conference will, I imagine, discuss it in depth. But uncertainty is something which affects all actors:

- **public concerns** about the ethical implications of advances in the life sciences and the impact of information technology on their privacy;
- **concerns of consumers and NGOs** about food, the environment, and their effects on health (there often seems to be less public reluctance to accept the use of genetic techniques in medicine than in agriculture);
- **concerns relayed by the media;**
- **concerns of scientists** sometimes drawn in personally through the scientific impact of their work outside the bounds of scientific research;
- the **uncertainty of public decision-makers**
  - often called upon to act, to make urgent decisions and to answer the sometimes contradictory requests of the public and the questions of the media:
  - or, alternatively, alerted by scientists to problems still far from the public eye.

In this regard, I am struck by the lag which sometimes exists between:

- the moment when a problem appears and
- the moment when the necessary decisions can be taken.

Obviously, it is difficult for those in positions of responsibility to take decisions until the public

Increasingly often, public decision-makers, and in particular elected representatives, turn to scientists for answers to questions on potential risks

It is difficult for those in positions of responsibility to take decisions until the public becomes aware of a problem

A well thought out prospective approach should help public decision-makers to deal in a timely way with the problems of tomorrow, instead of being forced to react to the problems of yesterday

Competition law needs to be reviewed to make sure it is still suited to a world where new technologies increasingly dominate the economy

becomes aware of a problem, and there are still many obstacles to reforming a system or modifying established procedures. However, the fact is that with the ever increasing rate of technological change, and the complexity and seriousness of the reforms to be carried out, by the time decisions are taken, they often address problems which either no longer exist or have changed.

I believe that to improve the situation, two objectives should be pursued: better advanced warning, and better discussion, and this conference can make a contribution to these aspects:

Better advanced warning

Advanced warning is a fundamental axis of the relationship between Science and Governance.

A well thought out prospective approach should help public decision-makers to deal in a timely way with the problems of tomorrow, instead of being forced to react to the problems of yesterday.

For its part the IPTS has launched the "Futures Project" which is analysing the major factors driving change in Europe up to 2010, be they technological, environmental, institutional, demographic, societal. For example, it is looking at the effect of demographic ageing on our economies in terms of the future of retirement provision, and also for that of employment in Europe, since, in the absence of qualified manpower in the new technology sectors, we may fail to meet the requirements for 1.6 million jobs in 2002, and that will cost Europe 100 billion Euros a year.

Another, though no doubt somewhat different example is that of globalization. Driven by the new technologies, and the global market concentration they bring in their wake, this affects the relationship between science, technology, the economy and society.

The speed of technological progress, which is particularly striking in information technology, calls into question our traditional ways of seeing and of acting. To begin with, it can render certain **regulatory tools**, such as the rules on competition, or anti-trust legislation, ineffective.

The Microsoft lawsuit in the United States is an example of this race between the law and the economy in a field of high technology affecting consumer's rights.

I think that it would be good to reflect on our tools regarding **competition**, to check that they are still suited to a world where the spread of technological development is overturning the traditional economy.

Better advanced warning, but also fuller discussion

To make progress towards a richer and more sustained dialogue between all actors it is necessary to focus on:

- **Responsibility of scientists**, who need to open up more to dialogue with society;
- **Responsibilities of industry** of which more transparency is asked;
- **Responsibility of citizens** who, with the aid of the public authorities, should at the same time deepen their scientific knowledge and become involved in the debate, along with NGOs;
- **Responsibility of policy makers** who:
  - Have to create conditions favourable to precautionary research and set up a scientific and technical reference system at European level;
  - Have to create the framework for a democratic debate which is as rich and lively as possible.
- **Responsibility of the media**: given the media's key role in the machinery of democracy.

In my view, the media should fulfil a different (three-part) function–not only to act as the observers

as they have always tended to in the past, but also to act as key intermediaries between science and governance, as they have more recently started to become:

- They have obviously to warn of potential risks, which they do as a matter of course;
- But they also need to inform public opinion by giving it the full diversity of points of view and analyses, while drawing on reliable sources, and avoiding sensationalism. For this they need suitable reference tools.
- And finally, they need to raise public awareness of the importance of topics which are not yet on the political agenda, nor on that of the newspapers, i.e. topics of which neither policy makers nor citizens are yet aware, despite their medium and long term importance.

In fact we would welcome journalists taking a fuller part in debates, and for them to be involved as participants, not just as witnesses or regulators.

And therefore to conclude, I hope that this Conference will enable us to make progress in these two areas, namely:

- How to anticipate events better, and for this reason within the framework of the European Space of Research, how to develop the necessary expertise and reference networks more effectively.
- Creating the tools to allow dialogue between the various actors concerned, within their roles, with a view to encouraging better and more rapid decision-making.

The media has an important role to play as intermediaries between science and governance, in addition to its traditional role in raising the alarm over potential risks

Keywords

Science and governance, role of media, public participation

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ABOUT THE JRC

The Joint Research Centre (JRC), one of the Directorates General of the European Commission, carries out research and provides technical know-how in support of European Union (EU) policies. Its status as a Commission service, which guarantees independence from private or national interest, is crucial for pursuing this role.

The JRC implements its mission through specific research programmes decided by the Council upon advice from the European Parliament falling under the European Union Framework Programmes for research and technological development. The work is funded by the Budget of the European Union with additional funding from associated countries. The work of the JRC includes customer-driven scientific and technical services for specific Community policies, such as those on the environment, agriculture or nuclear safety. It is involved in competitive activities in order to validate its expertise and increase its know-how in core competencies. Its guiding line is that of "adding value" where appropriate, rather than competing directly with establishments in the Member States.

The JRC has eight institutes, located on five separate sites, in Belgium, Germany, Italy, the Netherlands and Spain. Each has its own focus of expertise.

The Institutes are:

- The Institute for Reference Materials and Measurements (IRMM)
- The Institute for Transuranium Elements (ITU)
- The Institute for Advanced Materials (IAM)
- The Institute for Systems, Informatics and Safety (ISIS)
- The Environment Institute (EI)
- The Space Applications Institute (EI)
- The Institute for Health and Consumer Protection (IHCP)
- The Institute for Prospective Technological Studies (IPTS)

Further information can be found on the JRC web site:
www.jrc.cec.eu.int

ABOUT THE IPTS

The Institute for Prospective Technological Studies (IPTS) is one of the eight institutes making up the Joint Research Centre (JRC) of the European Commission. It was established in Seville, Spain, in September 1994.

The mission of the Institute is to provide techno-economic analysis support to European decision-makers, by monitoring and analysing Science & Technology related developments, their cross-sectoral impact, their inter-relationship in the socio-economic context and future policy implications and to present this information in a timely and integrated way.

The IPTS is a unique public advisory body, independent from special national or commercial interests, closely associated with the EU policy-making process. In fact, most of the work undertaken by the IPTS is in response to direct requests from (or takes the form of long-term policy support on behalf of) the European Commission Directorate Generals, or European Parliament Committees. The IPTS also does work for Member States' governmental, academic or industrial organizations, though this represents a minor share of its total activities.

Although particular emphasis is placed on key Science and Technology fields, especially those that have a driving role and even the potential to reshape our society, important efforts are devoted to improving the understanding of the complex interactions between technology, economy and society. Indeed, the impact of technology on society and, conversely, the way technological development is driven by societal changes, are highly relevant themes within the European decision-making context.

The inter-disciplinary prospective approach adopted by the Institute is intended to provide European decision-makers with a deeper understanding of the emerging S/T issues, and it complements the activities undertaken by other Joint Research Centres institutes.

The IPTS collects information about technological developments and their application in Europe and the world, analyses this information and transmits it in an accessible form to European decision-makers. This is implemented in three sectors of activity:

- Technologies for Sustainable Development
- Life Sciences / Information and Communication Technologies
- Technology, Employment, Competitiveness and Society

In order to implement its mission, the Institute develops appropriate contacts, awareness and skills for anticipating and following the agenda of the policy decision-makers. In addition to its own resources, the IPTS makes use of external Advisory Groups and operates a Network of European Institutes working in similar areas. These networking activities enable the IPTS to draw on a large pool of available expertise, while allowing a continuous process of external peer-review of the in-house activities.

The IPTS Report is published in the first week of every month, except for the months of January and August. It is edited in English and is currently available at a price of 50 EURO per year in four languages: English, French, German and Spanish.

S.P.S.01.02

GK-AA-01-002-EN-C

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