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The IPTS REPORT

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SPECIAL ISSUE: SCIENCE & GOVERNANCE

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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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The IPTS Report Secretariat
IPTS, JRC Sevilla
World Trade Center
Isla de la Cartuja
E-41092 Sevilla, Spain
Tel: +34-95-448 82 97
Fax: +34-95-448 82 93
E-mail: ipts_secr@jrc.es
Web address: www.jrc.es/iptsreport/subscribe.html

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EDITORIAL

Dimitris Kyriakou and Giorgio Di Pietro, *IPTS*

Science and Technology (S/T) – and more generally technical progress – modulates 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" refers to the mechanisms, and the challenge of devising them, so as to allow science and the processes of decision-making in society to work together in ways that are effective, credible, accountable and transparent.

The articles in this special issue reflect the authors' presentations at the workshop organized by the Joint Research Centre (JRC) in Brussels on March 29-30, on the topic of science and governance. One of the ideas to emerge from the workshop was that a common system of S&T reference is indispensable for addressing the science and governance challenge. Such a system would be a commonly built, owned and used ensemble of organizations or actors linked together by a set of relations and procedures to provide the expertise and scientific support needed for the policy-making process.

Preparing the ground for such a scientific reference system involves more than mere provision of advice; the system should engender trust and a sense of shared responsibility through the development of networks, and it should be firmly anchored institutionally. It should also provide a scientific component to President Prodi's initiative on overall governance. The Commission's JRC can play a central, catalytic role in this process of building a system for scientific reference (note that these issues will be further explored in a conference the IPTS is due to hold in the autumn).

The challenges to be tackled by such a system include: the need to be as inclusive as possible when considering relevant information/analyses, without diluting the process to the point of being ineffective; preserving its independence and scientific character, but also promoting review, flexibility and avoiding all pretence of omniscience. It must deal not only with what we know but also with what we do not know, and even more vexingly, with what we do not know that we do not know. It should start by exploring who is doing what in this field in the systems existing in different parts of the world, and understand key- 'constitutional' as it were- underlying differences, such as different legal systems. It should entail a better relationship with the public and the media. It should ultimately combine in a careful balance the qualities of translator of relevant knowledge to policymakers and stakeholders, communicator of the common denominator of agreement across views and distiller/assessor of areas of disagreement.

The importance of a successful wedding of science and governance is manifold. On the one hand S/T is substantially responsible for driving change. Moreover, S/T is a pivotal input to the policy-making process: helping clarify the terms of the debate, the stakes, the repercussions of alternatives considered. It can help clear away unfounded assertions and reveal opponents' demonizations for what they are, and so allow 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 increasingly so, fed by the increasingly central role scientific/technological considerations play in decision-making, as well as by a wave of popular mistrust in 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 in assigning primacy to obligations stemming from WTO versus 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.

Without such an integration, debate can come to resemble a dialogue of the deaf, with prejudices and preconceptions determining positions, and where granting a point to the other side is akin to a religious conversion. Credibility and impartiality are crucial here: the sight of each side of the argument parading its own 'literati' (or perhaps 'digerati' in our digital age) from forum to forum is the fastest route to making audiences cynical and unwilling to entertain serious debate.

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, suasion and S/T-informed debate become even more important.

The recent intra-EU disputes over the importation of British beef, and the differing verdicts/recommendations of experts on different sides are a recent reminder that we are not immune to such problems within the EU. That case highlighted the importance of a permanent platform at an EU level commanding the trust of all parties (rather than an ad-hoc committee), able to provide reference quality information and drawing on, in an ongoing way, all the expertise accumulated at member-state level.

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 even the suspicion/semblance of possible partiality, as well as in cases of global issues involving the EU with non-EU states, an EU-level system is needed to provide the means to EU-wide reference quality information.

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 can be 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. 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 corresponding input on, scientific and technological considerations for decision-making, and the need to achieve this in/by 'reference quality', consensus-galvanizing ways/procedures that enjoy the full confidence of all concerned, makes indispensable the creation of an institutionally anchored, common scientific and technological reference system for Europe. Commissioner Busquin's European Research Area initiative provides the crucial enabling framework for addressing this inevitable challenge, through such a common reference system.

Contact

Dimitris Kyriakou, IPTS

Tel.: +34 95 448 82 98, fax: +34 95 448 83 26, e-mail: **Dimitris.Kyriakou@jrc.es**

Science Advice for Government Effectiveness: The Canadian Approach

Council of Science and Technology Advisors

Science and technology today have an impact on most core government functions, underscoring the importance of sound science advice as a key input to policy formulation

Introduction[1]

The emergence of the knowledge-based society has underscored the importance of sound science[2] advice as a key input to policy formulation both nationally and internationally. The pervasiveness of science and technology is such that they now impact most core government functions. The issues facing governments are increasingly complex and require decisions that have profound impacts on societies and economies. Many of these decisions involve risk assessments that arouse public concerns about their health, safety and long term well-being; others attempt to capitalize on the opportunities afforded by advancements in science and technology.

As we enter the 21st century, government decision making is also taking place in a highly dynamic environment. Government decisions taken in a federal context may involve federal-provincial considerations. Policies and decisions often need to take into account the diverse physical and social considerations that exist in Canada. In addition, there are increasing concerns regarding the accountability and liability of scientists and decision makers. Fuelled by increased access to information, there is heightened public interest in science-based issues and greater emphasis on active public involvement in decision making. At the same time there is greater public scepticism of science, government, industry, and the interactions among them. Greater science literacy and better communication of scientific uncertainty will increase the public's understanding of the capabilities and limitations of science.

This article addresses science advice. Clearly, decision making in government must consider a wide range of inputs and consult, as appropriate, advisors competent in other aspects of public policy (e.g. economics, public administration, social science, international affairs, etc.). Decision makers must exercise their legitimate role to weigh these multiple inputs and make choices. Science advice has an important role to play by contributing to government decisions which serve Canada's strategic interests and concerns in areas such as public health and safety, environmental protection, resource exploitation, wealth creation, innovation, and national security.

Desirable Outcomes

The Federal Government requires an effective science advisory process that leads to better government decisions, minimizes crises and unnecessary controversies, and capitalizes on opportunities. An effective advisory process brings sound science and the best science advice to bear on policy issues and ensures that:

- Ministers are confident that rigorous and objective assessment of all available information was made in providing the advice;
- the public and parliamentarians are confident that government is using science in the best interests of Canadians, and that science advice provided to decision makers is credible; and,

- Canada has an enhanced ability to influence international solutions to global problems.

Principles and Guidelines

The science advice principles and guidelines that follow reflect the evolving context for government decision making. Their adoption will lead to the desirable outcomes identified above. When implemented these guidelines should remain largely consistent across government departments with only a small number of exceptions. Departments should justify any changes needed to tailor them to individual departmental situations.

Early Identification

Decision makers need to be convinced of the importance of seeking science advice and recognize when science advice is needed. Departments need to anticipate, as early as possible, those issues (representing both challenges and opportunities) for which science advice will be required. A broad base of advice can lead to improvements in the timeliness of issue identification. Interdisciplinary, interdepartmental, and international cooperation should be in place to identify, frame, and address 'horizontal' issues.

Guidelines

- Decision makers need to cast a wide net (consulting internal, external[3], and international sources) to assist in the identification of issues requiring science advice.

- Decision makers need to communicate to scientists those policy areas requiring advice, and government scientists need to be able to recognize the connections between their research and potential policy issues.

- Departments need a sufficient and adaptable internal capacity to identify science issues and to assess, translate and communicate science for policy.

- Departments need to support and encourage their science and policy staffs to establish linkages with each other and with external and international sources.

- Departments need to maximize the use of expertise across government departments to identify and address 'horizontal' issues.

Inclusiveness

Advice should be drawn from a variety of scientific sources and from experts in many disciplines in order to capture the full diversity of scientific schools of thought and opinion. Inclusiveness enhances the debate and draws in scientific findings which may not otherwise be considered; sound science thrives on the competition of ideas facilitated by the open publication of data and analyses. The market for science advice is global and the growing body of science knowledge available internationally must be brought to bear on policy issues. Inclusiveness aids in achieving sound science advice by reducing the impact of conflicts of interest or biases that exist among advisors.

Guidelines

- Science input and advice needs to be sought from a wide range of sources; due weight needs to be given to the 'traditional knowledge' of local peoples; decision makers need to balance the multiple viewpoints received.

- While advice from external and international sources needs to be sought regularly, it is especially important to seek such advice in the following situations. Government also needs to consider engaging external, independent agencies to create advisory panels or to solicit advice in these circumstances:
  - the problem raises scientific questions that exceed the expertise of the in-house staff;

Input should be drawn from a variety of scientific sources and from experts in many disciplines in order to capture the full diversity of scientific schools of thought and opinion so as to enhance the debate and draw in scientific findings which may not otherwise be considered

- the issue is 'horizontal' or cuts across lines of jurisdiction within or among departments; there is significant scientific uncertainty; there is a range of scientific opinion; or,
- there are potentially significant implications for sensitive areas of public policy and where independent scientific analyses can strengthen public confidence.
- Decision makers need to be open to both solicited and unsolicited advice from external sources.

Sound Science and Science Advice

The public expects government to employ measures to ensure the quality, integrity, and objectivity of the science and the science advice it utilizes, and to ensure that science advice is considered seriously in decision making. Due diligence procedures for assuring quality and reliability, including scientific peer review, need to be built into the science advisory process. Where information is proprietary, external peer review needs to proceed with appropriate measures to maintain confidentiality. Science advisors need to contribute sound scientific information, unfiltered by other policy considerations. In developing policy, departments need to involve advisors in assessing the implications of various policy options.

The public expects government to employ measures to ensure the quality, integrity, and non-partisan nature of the science and the science advice it utilizes, and to ensure that science advice is considered seriously in decision making

Guidelines

- All advisory processes, including those involving traditional knowledge, need to be subject to due diligence. This should include rigorous internal and external review and assessment of all input, analyses, findings, and recommendations of advisors. The fact that information is proprietary should not preclude external review, although confidentiality of such information should be appropriately maintained.

- Science advice needs to be supported by research and policy analysis
  - Decision makers need to ensure there are sufficient resources for supporting policy research and analysis to underpin the science advisory process.
  - Scientists need to have the flexibility to explore the range of conclusions and interpretations that the scientific findings might suggest.
  - A strong coupling needs to exist between the science advisors and the departmental policy and analytical support mechanisms.
  - Science advisors need to assist decision makers and science managers set research priorities and design an R&D base that will support future science-based decision making.

- Selection of advisors needs to:
  - be matched to the nature of the issue and the breadth of judgement required;
  - be balanced to reflect the diversity of opinions and to counter potential biases;
  - include at least some experts from other, not necessarily scientific, disciplines; and,
  - be regularly rotated, with replacements chosen to preserve balance of representation.

- Advice providers need to:
  - adhere to professional practice and conflict of interest guidelines;
  - clearly distinguish scientific fact and judgement from their personal views in formulating their advice; and
  - recognize the limits of science advice and the existence of other considerations in decision making.

- Departments need to:
  - ensure in-house expertise to assess and communicate science (whether generated internally or externally) to decision makers;
  - promote professional practices for those involved in the conduct, management and use of science[4];

- provide and enforce conflict of interest guidelines. Considerations include:
- advisors need to be required to declare any conflicts of interest prior to serving in an advisory capacity and to update such declarations throughout their term of service;
- while the responsibility for documenting and avoiding conflicts of interest should be placed on the advisor, decision makers need to have the ultimate responsibility for protecting against actual or perceived conflicts of interests.
- clearly document the science advice received and report back to the advice providers how decisions are made.

- Decision makers need to:
  - take care to separate scientific fact and judgement from personal views and judgements in formulating the questions to be addressed;
  - be conscious of possible biases in the advice providers and be alert to indications of bias in the advice received; and
  - involve science advisors in policy formulation, to help maintain the integrity of the advice throughout the decision making process.

Uncertainty and Risk

Science in public policy always contains some uncertainty and often a high degree of uncertainty which must be assessed, communicated, and managed. As such, it is important to consider adopting a risk management approach. In addition to hazards, uncertainty may include potential benefits or opportunities which should not be ignored. The goal of risk management is scientifically sound, cost-effective, integrated actions that reduce risks while taking into account social, cultural, ethical, political, and legal considerations.

Guidelines

- Departments require a clearly defined set of risk management guidelines, including how and when the precautionary principle[5] should be applied, in order to maintain confidence that a consistent and effective approach is being used across government.

- Science advisors need to ensure that scientific uncertainty is weighted fairly, is explicitly and fully identified in scientific results, and is communicated directly in plain language to decision makers; decision makers need to ensure that scientific uncertainty is given the appropriate weight in policy decisions.

- Science advisors and decision makers need to communicate to the public and stakeholders the degree and nature of scientific uncertainty and the risk management approach utilized in reaching decisions.

Openness

Democratic governments are expected to employ decision making processes that are transparent and open to stakeholders. Openness implies a clear articulation of how decisions are reached, policies are presented in open forums, and the public has access to the findings and advice of scientists as early as possible. It is essential that the public be aware of what the responsibility of government is in relation to the use of science. In addition, decision makers need to treat the science advisory function as an integral part of the management process. Effective relationships between decision makers and science advisors benefit from an understanding of their differing perspectives and approaches. Policy makers and advice providers need to communicate to ensure that policy makers are convinced the science advice is current and sound. In turn, advice providers need to be

Science in public policy always contains some uncertainty, which must be assessed, communicated, and managed. It is therefore important to consider adopting a risk management approach confident that their advice is considered seriously in decision making. Finally, there needs to be consultation with stakeholder groups and public discourse to ensure that public values are considered in formulating policy. Early and ongoing consultation both within government and with the public can mitigate greater negative debate and controversy when policies are announced.

Democratic governments are expected to employ decision making processes that are transparent and open to stakeholders; this implies a clear articulation of how decisions are reached, disclosure of findings, etc.

Guidelines

- Decision makers need to provide early warning of significant policy and regulatory initiatives to key interest groups, other governments or international organizations, as appropriate.

- Departments need to allow scientists freedom to pursue a broad base of inquiry and undertake widespread and thoughtful discussions. Departments need to make every effort to support and encourage scientists to publish their research findings and conclusions in external peer-reviewed publications. However, inevitably, circumstances will arise where the findings and conclusions will conflict with existing government policies. In these cases, departments need to review both the policies and all of the relevant scientific findings and advice in order to determine how to proceed.

- Departments need to publish and disseminate widely all scientific evidence and analysis (other than proprietary information) underlying policy decisions, and show how the science was taken into account in policy formulation.

- Decision makers need to explain how the advice they received was used and why the ultimate decision was made.

- Departments need to consider using public meetings to present policy; scientists need to have a leading role in explaining their advice and policy officials need to describe how the advice was secured and how the policies have been framed in light of the advice.

- The level of expected risk and controversy and the need for timely decisions should guide the nature and extent of consultation undertaken, with higher levels of risk and controversy demanding a greater degree of public consultation. Decision makers need to balance the need for timeliness in reaching decisions with the need for effective consultation.

Review

The principle of review includes two elements: 1) subsequent review of science-based decisions to determine whether recent advances in knowledge impact the science and science advice used to inform the decision, and 2) evaluation of the decision making process. Appropriate accountability mechanisms need to be in place to ensure that these principles and guidelines for sound science advice are followed.

Guidelines

- Departments need to institutionalize a follow-up process that includes, once decisions have been made, the provision of written responses to the findings and recommendations that emerged during the advisory process.

- Policy decisions need to be reviewed subsequently to determine whether recent advances in knowledge impact the science and science advice used to inform the decision. The period for review will depend on the state of the science (e.g. the level of uncertainty, rate of change in the scientific knowledge) and a maximum period before review should be identified at the time the decision is taken (e.g. establish a "best before" date).

- When asked to review past decisions, advisors should have access to all relevant information including previous analyses and official responses.

- Departments should capture best practices that emerge from the advisory process and feed these into their guidelines for use of science advice in the future.

Implementation

Implementing the principles and guidelines will help build public confidence in government decision making. Adherence to the principles and guidelines will also lead to better understanding of the contribution of science to departmental and government-wide missions and mandates[6]. A strategy for implementing the science advice principles and guidelines must include three elements: 1) promoting their adoption, 2) ensuring their adherence by individual departments and across government, and 3) monitoring their effectiveness. The following options are provided for consideration as part of an implementation strategy.

Promoting the Adoption of Science Advice Principles and Guidelines

- Identify the people who can assist departments adopt the principles and guidelines.

- Provide professional development/training to government decision makers and scientists to improve science communication and the use of science advice in policy making.

- Make all government departments? not just the science-based departments and agencies (SBDAs), aware of the principles and guidelines and encourage their use when dealing with science laden issues.

- Communicate the existence of the principles and guidelines to. stakeholders and the public, and publicise cases that illustrate best practice in the use of science advice.

- Consider creating a Parliamentary Committee tasked with the examination of science and technology issues. One of its functions could be oversight of the use of science advice in government decision making.

Ensuring Adherence and Accountability

- Provide a template or simple checklist to assist decision makers ensure they have adhered to the principles and guidelines.

- Require annexes to Cabinet documents and legislation that demonstrate adherence to the principles and guidelines and recommend science review procedures.

- Designate a "departmental champion" within each science-based department responsible for:
  - Guiding the implementation of the science advice principles and guidelines and ensuring the department's adherence;
  - Preparing an annual report of the department's measures which demonstrate adherence to the principles and guidelines; and
  - Sharing best practices with their counterparts in other SBDAs.

- Departments establish, through their Deputy Ministers, a mechanism to ensure that science advice is received and acted upon in a timely fashion in reaching government decisions.

- Identify a government-wide coordination and accountability mechanism (possibilities include the Committee of Senior Officials (COSO) S&T Committee, the Ethics Counsellor, etc.) responsible for:
  - "Championing" the principles and guidelines government-wide;

Appropriate accountability mechanisms need to be in place to ensure that science-based decisions are reviewed in the light of recent advances and the decision-making process is properly evaluated

- Ensuring the application of the principles and guidelines to 'horizontal' issues;
- Receiving the departmental annual reports and preparing a government-wide annual report on science advice (perhaps included as an annex to the Annual S&T Report);

Monitoring Effectiveness

- Assess the application of the principles and guidelines through:
  - Audit mechanisms;
  - Reports to a designated "oversight function" such as a parliamentary committee (e.g. the proposed new Science and Technology Committee or the Natural Resources and Government Operations Committee) or the Auditor General;
- Measure the success of the government science advice principles and guidelines through review by an external advisory body (such as departmental science advisory committees and CSTA).

Conclusion

The principles and guidelines contained in this article address how science advice should be sought and applied, but CSTA recognizes that the government must establish policies and make decisions when certainty does not exist and, at times, under extreme time constraints. The principles and guidelines espoused should not inhibit action, but rather guide action.

About the author
The **Council of Science and Technology Advisors** (CSTA) was established to provide the Cabinet Committee on Economic Union (CCEU) with external expert advice on internal federal government science and technology issues that require strategic attention. Recent government decisions in the areas of natural resources management (e.g. fish stocks) and public health and safety (e.g. the blood supply) have contributed to public concern regarding the ability of government to effectively address science-based issues.

Notes

1. This article is based on the report by the Council of Science and Technology Advisors dated 5 May 1999, which in turn draws heavily from the work of Sir Robert May (UK), David Beckler (US). Willie Smith (NZ) and others.
2. In this article "science" is defined broadly to include the natural, health, and social sciences, mathematics, engineering, and technology. "Science advice" is defined as value-added guidance deriving from scientific theories, data, findings, and conclusions provided to inform policy and regulatory decision making.
3. External sources include, for example, other government departments, provincial governments, academe, industry, professional societies, and other interested parties.
4. The report of the Best Practices Initiative, a joint effort led by Health Canada and the four natural resources related departments (NRCan, EC, AAFC, and DFO) on behalf of the ADMs Ad Hoc Committee on Science in Government, provides useful guidance in this regard. It presents a set of fundamental values, traits of key stakeholders, and best practices to ensure that federal government science is conducted credibly, managed effectively, and used wisely. Best practices are identified in the areas of organizational environment, accountability, science in decision making, review processes, and communications.
5. The 'precautionary principle' dictates that action to reduce risk should not await scientific certainty.
6. CSTA recognizes that implementing these principles and guidelines will make demands on the government's science-based departments. The government's capacity to undertake science required to inform decision making will be examined as part of CSTA's broader examination of the roles of the federal government as a performer of S&T and its capacity to deliver on those roles.

Contact

Kevin Keough, Council of Science and Technology Advisors Secretariat, S&T Strategy Directorate
Industry Canada
Tel.: +1 613 993 75 89, Fax: +1 613 996 78 87, e-mail: **csta.cest@ic.gc.ca**

Science and Governance: The Engagement of Stakeholders

Paul Johnston, *Greenpeace International*

The role and influence of science in the shaping of policy at international level has been recognized by Greenpeace International. Accordingly, the organization maintains a university based group of scientific researchers with expertise in a variety of disciplines. The role of this group is broadly to provide scientific support to Greenpeace in relation to its areas of interest. This takes the form both of instrumental analysis and of informational analysis and evaluation and, importantly, translating scientific information into terms more readily understood by those without a deep grounding in scientific and technical issues. The existence of this group, therefore, underlines the commitment that Greenpeace International has to ensuring that any position that it takes on an issue is well founded in scientific terms but is also comprehensible to a wide audience.

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Over the years, the activities carried out by the scientific personnel have given a unique insight into the desirability, and indeed the necessity, of stakeholder dialogue on environmental issues, while at the same time providing considerable experience of the attitudes of the public, industry and decision makers to scientific issues, particularly at the "science/policy interface".

In defining the relationship between science and governance, there is often a presumption that decisions can be based upon scientific information alone. Accordingly, there is often a failure to define the precise objectives of governance in any given situation. Before scientific advice can usefully be given it is a primary necessity to define the objectives of any proposed policy change or development. Questions as to whether the objective is national, regional or global need to answered. There is a need to define very specific time frames over which objectives are to be achieved and finally to identify whether the potential policy decision is related to planned, well structured change or to the management of an exigent situation.

It is only when the policy objectives have been defined in a structured way that it becomes possible to couch them in the form of questions for which attempts can be made to derive answers based upon scientific, technical or other knowledge. In many

As part of its commitment to ensuring that any position that it takes on an issue is well founded in scientific terms and is also comprehensible to a wide audience, Greenpeace International maintains a university based group of scientific researchers with expertise in a variety of disciplines

Scientific advice alone is an inadequate basis for decision-making: before such input can usefully be given it is a primary necessity to define the objectives and scope of any proposed policy change or development

Stakeholders need to be involved from an early stage in the definition of the problem and the associated policy objectives. The heterogeneity of stakeholder interests makes this a complex process

Public trust in science has been undermined by the perception that expertise is influenced by commercial pressures and that policy directions are decided by an elite

The use of the risk model to define environmental problems has often proved inadequate to ensure environmental protection

respects, the definition of policy goals will define the nature of the support required from other domains and the timeframe over which this will be required. Indeed, once the policy objectives have been adequately defined these can serve as the basis for interrogative evaluation on grounds other than the scientific and technical, including economic and societal issues. In all of this, it is important that the correct questions are asked. There have been too many instances in the past where the scientific research has been misdirected by a failure at the political level to frame the correct questions. As an obvious example, the question "how large is the problem?" will produce a very different set of answers (although perhaps with some overlap) to the question "how can this problem best be eliminated?"

Turning to the involvement of stakeholders in any given area of environmental debate, it is clear that such involvement is required from an early stage in the definition of the problem and the associated policy objectives. The engagement needs to be maintained through the process of gathering and evaluating the supporting information to be used through to policy formulation if the resulting decisions are to be seen ultimately as truly democratic. While stakeholder engagement may be seen in principle as a simple matter, in reality it is likely to be highly complex. Although the relationship between stakeholders, scientists and government can be seen as a triangular one, in reality the stakeholder element represents a heterogeneous grouping with interests and expertise ranging across a spectrum from environmental protection through to substantial commercial interests. There is a clear requirement, therefore, for any and all interests in the dialogue to be declared from the outset.

Disclosure is an important factor. At least in the public domain there is a perception that the environmental dialogue is driven largely by commercial interests, be it, for example on whaling or fisheries or agriculture, including chemical regulation and genetically modified organisms. Public trust in policy oriented science is currently at a very low ebb partly because of the perception that scientific expertise can be bought in the same way as any other commodity. The corollary to this is that such expertise is largely unavailable to resource-poor interest groups, thus magnifying cynicism about the environmental policy-making processes. Accordingly, if scientific input to these processes is to be seen as neutral there is a pressing need for the scientific community to be placed in a position to serve both sides of the debate free of constraints imposed by funding mechanisms.

Public trust in science is also compromised by a perception, arguably justified, that debate taking place in the scientific domain is largely the preserve of an elite and that the input of non-commercial interest groups, excluded in one way or another from this elite, plays only a very small part in formulation of final policy directions. It is vital that the interests of stakeholders are seen and recognized as an important input to the science/governance debate and that their input is given full consideration.

Perhaps the most corrosive impact upon public belief in science, however, has arisen from the use of the risk paradigm as a means of evaluating and managing environmental problems. It is widely perceived that risk assessment has largely failed (through its design) in providing adequate environmental protection. As a deeply reductionist approach, the paradigm has, in fact, been perceived for some years as a considerable impediment to the progress of environmental protection measures and disquiet with the paradigm continues to grow.

As an attempt to define environmental problems in terms originally developed as actuarial tools for the insurance industry, the risk paradigm has signally failed to deliver promised and desirable developments in environmental protection. Increasingly it is recognized that when operating in data-poor environments "what we don't know" and more importantly "what we don't know that we don't know" are considerable obstacles to progress. When considered alongside a scientific tendency to construe "absence of evidence" of an effect as "evidence of absence" of the effect it becomes clear that the risk paradigm is fundamentally flawed as an engine of environmental protection. Perhaps the most absurd example of this attempted reductionism is the use of the PEC/PNEC[1] ratio as an instrument of risk assessment in the EU. Effectively, in this case, single species toxicity tests are being used, without any underlying justification, as predictors of whole ecosystem impact and to define "acceptable" levels of pollution. This is widely, and correctly, viewed as a scientific nonsense. The failures of the risk paradigm are further exacerbated by the widespread definition of assessment techniques as "sound science". This term (although intrinsically meaningless) is seen as offensive and demeaning to a wide constituency of interest groups, including the many scientists whose work, though fully robust, is not designed to generate data suitable for input to a risk assessment framework.

Given the potentially wide range of failure modes of the risk assessment paradigm, it is unsurprising that the precautionary approach to environmental protection is progressively coming to underpin environmental decision making. A precautionary paradigm constitutes a fully scientific means whereby uncertainties can be explicitly defined, recognized and incorporated into environmental decision making, from the stage of problem recognition onwards. This contrasts with the "sound science" approach espoused by industry which demands absolute proof of deleterious effects before taking action. Portraying precaution as an emotional or subjective approach serves to widen the chasm of trust that already exists between the policy makers, their scientific advisors and the wider community.

Hence, whilst involvement of stakeholders in environmental policy-making must be regarded as a vital component of the overall process, it is also clear that for such involvement to be useful and effective changes need to be made at the science/policy interface to restore stakeholder trust. The principle of providing equal access to scientific expertise and the premise of a debate conducted in a manner not perceived as elitist are likely to contribute significantly. Overall, however, redefining science/policy interactions to accommodate the various areas of scientific uncertainty, indeterminacy and ignorance under a precautionary paradigm is undoubtedly the one element that will do more to restore a widespread trust in policy development than any other.

The "sound science" approach espoused by industry demands absolute proof of deleterious effects before taking action. Portraying the alternative, the precautionary paradigm, as an emotional or subjective approach serves to widen chasm of trust that already exists between the policy makers, their scientific advisors and the wider community

Note

1. Predicted Effect Concentration/Predicted No Effect Concentration.

Contact

Paul Johnston, Head, Science Unit, Greenpeace International
Greenpeace Research Laboratories, University of Exeter
Tel.: +31 205 23 62 28, fax: +31 205 23 62 00, e-mail: **p.johnston@exeter.ac.uk**

About the author

Paul Johnston obtained his PhD at the University of London (UK). In 1987 he established the research laboratories for Greenpeace International within the University of London, and has continued as principal scientist to the group since its move to the University of Exeter. Dr Johnston co-ordinates the research activities and represents the group at a national and international level.

Science and Governance: The US Experience

Prof. Sheila Jasanoff, ***Harvard University***

The EU has the advantage that it is currently in a formative stage where the relationship between science and governance has yet to be fully defined

A key fact about the relationship between Science and Governance in today's world is that the scientific establishment is being subjected to contradictory pulls and pushes. On the one hand, there is the widely accepted notion that science is a neutral space, so that, if we can justify policy in terms of science, then we need not worry any longer about politics. On the other, there is little agreement among different countries as to what constitutes good science, even among traditional political allies and partners. In addition, there is another deep contradiction that affects the use of science in governance: increasingly politicians seem to be relying on science as a way of bailing them out of political problems at the very moment when trust in those very same public officials seems, in many countries, to be declining.

As an example of these contradictory pressures take the recent speech given by the US Secretary of State at the annual meeting of the American Association for the Advancement of Science (the fact she spoke there illustrates that there is a parallel, high-level discussion going on in the US about the linkage between Science and Governance). Referring to the recently concluded international agreement on biosafety, the US Secretary of State stated that: "Science does not support the 'Frankenfood' fears of some, particularly outside the US, that biotech food or other products will harm human health. So it is unfortunate that unsubstantiated fears about biotech products exert a significant influence on the recently concluded biosafety protocol. We fought and succeeded in basing this agreement on good science". Shortly afterwards, the press reported the diminishing influence of the US Secretary of State. Indeed, one newspaper went so far as to claim that: "She has been largely unsuccessful in either getting control of her own building or of her own policy generally. She has in effect become the errand boy of foreign policy rather than the conceptualizer of it" (International Herald Tribune, March 2000)[1]. Thus, the US Secretary of State's speech congratulating the US policy establishment on good science should be interpreted in the light of press reports calling into question her own credibility.

Right now the EU enjoys a distinct advantage over the US from the point of view of science and governance. The rapid changes the EU is currently undergoing are constitutional changes through which the Union is being formed. Moreover, these constitutional changes are taking place not only at EU level but also in several Member States- although without an explicit constitutional convention, and without the coming together of people who have drafted explicit constitutional documents. When the US Constitution was written, nobody thought that it was important to say very much about science (famously, science is not mentioned as such in the Constitution). There was a notion that the products of science should be protected, and scientific ingenuity rewarded, but nothing was said about the relationship between science and the State. This was not because people thought it was unimportant, but rather because people thought they understood quite well what the relationship between science and government ought to be. The US was born out of a philosophy of upholding enlightenment views and values. People accepted that the government should promote certain kinds of sciences that were useful to public policy (activities that have to do with mapping, measuring, standardizing, etc.); these attitudes led later in the 19th century to the founding of the influential National Academy of Sciences.

By contrast, the EU stands at a point where it is possible to rethink the constitutional relationship between science and governance on the basis of understandings of science that have matured very considerably over 200 years-since, for instance, France or the US wrote the constitutions under which they are governed. One of the things we have come to recognize during this time is that the old model of the relationship between science and public policy (captured in the phrase "speaking truth to power") is no longer very useful. It has become apparent that "truth" is often a contested commodity and that it is attained through processes that we need to understand better. It has also become clear that power and truth do not necessarily occupy completely different domains. Power is often involved in the processes of making scientific truth. Thus, when "truth is speaking to power," it may well be that one particular form of power is speaking to another. This profound recognition should affect the institutions through which we link scientific knowledge to public policy.

In the US, although the Constitution does not explicitly mention the relationship between science and government, a great deal of policy learning about the role of science has taken place over the last 50 years. Out of this process, a complex set of institutional arrangements and networks has evolved to address many of the questions facing policy-makers and the administration. In particular, although the US public policy establishment often acts as if it still believes in speaking truth to power (the Secretary of State's comment that "we fought and succeeded in basing this agreement on good science" is a classic formulation of this viewpoint), in reality US institutional practices work according to very different premises. For instance, hardly any science-based policy decision is completely irreversible. Science may speak to power, and public policy may result, but US institutional structures are set up in a way that makes it possible for contradictory opinions from different sources to be expressed, and even, sometimes, for lay opinions to win out against the views of establishment experts.

As in other countries, many areas such as food safety, nuclear power, and chemical pesticides are regulated in the US. But we know that a regulated industry or substance is never 100 per cent safe. It may cause damage or injuries that were not foreseen at the time that it was regulated. In the US legal system, regulation does not usually protect manufacturers against lawsuits. Thus, a regulated drug may have been pronounced safe by the Food and Drug Administration, but if it subsequently harms someone, the victim can sue the company that manufactured the drug and potentially win compensation.

In general, public opinion in the United States is optimistic about new discoveries and new technologies (including genetically modified foods), but it could be argued that one institutional feature which supports this optimism is the availability of various options for redress. Although the authorities may be taking a risk when approving something like genetically modified foods, confidence in the system is maintained by the fact that, if something does go wrong, it will be possible for injured parties to get

The old model of the relationship between science and public policy in which science "speaks truth to power" is no longer sufficient in descriptive or prescriptive terms

One important feature of the regulatory system in the US is the fact that it does not rule out subsequent action in the courts if things go wrong

Endowing the concept of "good science" with policy-relevant meaning involves action in the political field compensation through the courts. This is not necessarily an institutional arrangement that would work well in the EU or in its individual Member States. The point is simply that the ability of a US public official to invoke the idea of good science rests on the US political system's having developed, over more than 200 years of history, a set of institutional arrangements that enable people to understand what is meant by "good science" and to challenge any assertions that they do not really believe to be good science.

This kind of elaborate institutional framework for underpinning public confidence in science should be the goal of any new governmental body that seeks to achieve what we might call good science. In short, work needs to be done in the *political* field in order to endow the idea of good science with meaning. It is this work that I think has to undertaken at European level.

One lesson from the US experience is that it would be a mistake for the JRC, or any other central EU scientific organization, to see itself as a kind of sovereign expert authority that can unproblematically deliver truth to power. There are other possible roles for scientific units such as the JRC. One would be to act as a common denominator that takes what is available in the Member States and applies an averaging process so as to produce a kind of minimum standard that everybody accept. Another role would be that of mediator.

To conclude, I have suggested that citizens believe in their state's claims of good science only if scientific claims are supported by good and robust forms of politics. If this is the case, then one promising role for a European authority would be to act as a kind of translation agent among different approaches to the politics of science. Such a body could make available to Member States a deeper understanding of how confidence in science and technology is achieved, or is not achieved, in different national contexts. This might involve identifying what we could call "best practices" for linking science to government. It is worth bearing in mind that if the US offers a model for relatively robust democracy, then that robustness has been obtained by keeping science very close to people's control-by allowing generalist courts, for instance, to pass on issues of great complexity, such as the antitrust suit against Microsoft, and to resist the technocratic tendencies that one can also see in the US. As US politicians become impatient for more efficient ways of resolving controversies, they may turn away from exactly the kind of wide-ranging engagement between science and citizens which has been a key source of strength for American democracy. This is a path the EU might do well not to follow.

About the author

Sheila Jasanoff is Professor of Science and Public Policy at Harvard University's John F. Kennedy School of Government. She has written widely on the relationship of law, science, and politics in democratic societies, with a particular focus on the regulation of hazardous technologies in Europe and the US. She is also known for her role in developing the interdisciplinary field of science and technology studies and investigating its implications for law and public policy.

Note

1. The author would like to underline that this is a quotation from an interview in a newspaper and not a statement of her own views.

Contact

Sheila Jasanoff, Harvard University, John F. Kennedy School of Government
Tel.: +1 617 495-79 02 , e-mail: **sheila _jasanoff@harvard.edu**

The Governance of Research

Guy Paillotin, *INRA*

The elegance of the notion of governance should not lead us to forget that managing the relationship between science and politics is still a very delicate task. Although not denying the right of politicians to intervene in the definition of the overall balance of research or to request specific research to support a specific decision, researchers refuse to accept that their work be guided by short-term political considerations. Rather, curiosity is, and should be, the main driving force behind their activity. Nevertheless, the responsibility of the manager of an agency or organization is not limited only to evaluating the quality of the researchers under his management. This would imply an illusory and naïve denial of the social dimension of research.

To escape this apparent contradiction, it is important that one should not reduce the question of the governance of research to a simple tête-à-tête between the policy-maker and the scientist, but rather introduce a third party into this dual relationship, namely the citizen and his demands, which are increasingly independent from the strictly political approach. Having done this, the idea is not so much to respond to the demands of policy-makers as to expand scientists' curiosity about new questions, which are often of a social nature, but which are not inaccessible to the rational demands of research. These questions are linked to the concept of sustainable development and include issues such as how to ensure the overall creation of wealth without causing exclusion; how to combine globalization and differentiation; how to ensure public health; how to preserve the environment, ensure the sustainability of natural resources -and particularly water- and recycle our waste in an acceptable way; and how to develop the citizenship of each inhabitant of our planet.

In order to induce scientists to expand their curiosity on regarding these societal questions it is necessary to substantially modify the content of the "traditional" disciplines, or at least to allow the possibility of their coming together in new ways. This is what has been done at INRA (Institut National de la Recherche Agronomique) and in many of its counterpart institutions throughout the world. This restructuring groups together the subjects of agronomy, soil sciences, and bioclimatology around environmental questions; links animal pathology to the essential question of human health; integrates approaches to the issue of protecting cultures; means economists take into account questions of local development; and analyses of consumer behaviour, etc.

In making this choice of a direct relationship with citizens' demands, we have found that we have taken on new responsibilities, independent from those assumed by politicians. Additionally, INRA has developed its prospective approaches on the basis of a lengthy consultation with economic and social actors; it has made a rule of alerting government on points where its level of information appeared to be substantially higher than that of politicians (BSE, GMOs, etc.), it has an ethics and precautionary committee to enable it to perform its responsibilities to citizens better; and it

Although curiosity is, and should be, the main driving force behind scientific research, the citizen's needs need to be taken into account in scientific work

To cover citizen's needs it is necessary to expand scientific curiosity to take in these issues. This may often entail altering the boundaries and content of 'traditional' disciplines communicates directly with the media on subjects judged to be of importance to our fellow citizens.

Since the time when a consensus was achieved on this, and the networks of co-responsibility on common fields were organized at European level (following the example that we initiated in the agronomy field), the European Union has been interested in linking the governance of research with the institutions that manage it on a day-to-day basis. The case of BSE (bovine spongiform encephalopathy) is in this sense highly instructive, as at the time the crisis began, what was lacking was the existence of a conventional agreement between European institutions on the research to be carried out, whilst an informal agreement between research teams did perhaps in fact exist.

Engaging directly with citizens' concerns means taking on new responsibilities independent from those of politicians and can involve direct communication, including the appropriate use of the media on subjects of importance to public welfare

Finally, from the time where it was a matter of expanding the curiosity of scientists to take in new questions, it has been appropriate, so as to take in the universal nature of science, to give an international projection to our too exclusively European approaches. After all, the development of models of supply and demand for foodstuffs or fuels, the growth of these models and their climatic impacts, taking exclusion into consideration, etc. are universal issues. And this universality is an intrinsic part of their scientific nature. In view of this fact we have always sought to give an international character to our activities and look into experience foreign to our own endeavours, as this international projection adds value to the choices we make in the governance of science field.

Contact
Guy Paillotin, INRA
Tel.: +33 142 75 90 00, fax: +33 147 05 99 66, e-mail: **Guy.Paillotin@paris.inra.fr**

About the author
Guy Paillotin has a degree from the Ecole Polytechnique and the Ecole des Mines de Paris and a Ph.D. from Paris XII University. He was deputy administrator of the Atomic Energy Commission (France) from 1989 to 1992, President of INRA (Institut national de la recherche agronomique) and of CIRAD (Centre de cooperation international en recherche agronomique pour le développement) from 1991 to 1999.

An Agenda for 21st Century Science: Science and Governance

Martin Apple, *President of the Council of Scientific Society Presidents*

Different systems can learn in similar ways

The US Political System differs greatly from that of the EU. Whereas the US System is heavily influenced by individual campaign contributions, is a system of conflict management, and can be redirected by grass roots concerns; the EU, in contrast, requires more conflict avoidance, and is structured so its systems of influence and points of decision are different. A further difference is that American states are not sovereign nations each with their own language. Therefore it is often inappropriate to apply US experience directly to the EU case. On the other hand, we are all facing the same common interest groups–trade unions, professional groups, citizen concerns on the environment, health, and the like.

One path the JRC may wish to examine is defining itself into systems whereby key activities are linked to results which are measured and evaluated, which are in turn linked to reaching into an idea pool of how to improve the way things are done, which is linked to improving what is being done, and so on, so as to form a helix that improves with each turn around the cycle. Such Learning Systems provide important ways to achieve a lot more in less time and with more strategic direction of resources.

Scientific collaboration between Europe and the US creates value

Over the last fifty years an impressive range of major scientific and technological advances have taken place. These have included the development of vaccines, the discovery of antibiotics, *in vitro* fertilization, superconductors, heart transplants, to name but a few (see Table 1). These advances were made by collaborations going beyond national boundaries between scientists working in both the public and private sectors.

What is more remarkable, is that only one human life-span ago none of these were conceivable. They are not simple projections from the past or forecasts from prior events and trends. In its own way each of these breakthroughs was a revolution. Throughout the history of science, scientists have caused -often abrupt- social change, and they often do so inadvertently.

The differences between the political systems in the US and the EU preclude the direct application of US experience to the European case

As new knowledge is discovered, and foundational research impacts others around us, we create and alter the future and how everyone around us perceives it. Our research regularly leads to changes unimagined by our institutions struggling to adjust to them. It is therefore the obligation of scientists to routinely assist the public in anticipating these social changes, to prevent constant resistance and backlashes. There are a number of things that can be done to make this process smoother:

Science has always brought about social changes. Scientists need to routinely assist the public in anticipating these social changes, to prevent constant resistance and backlash

- Establish direction, a vision of the future and strategies for achieving that vision. This needs to be a vision that is imaginable, desirable, feasible, and clear.

- Create a sense of urgency that moves decision timetables ahead.

Table 1. Prominent scientific breakthroughs in the last 50 years

*developed polio vaccine,	*first synthesized hormones,
*discovered antibiotics,	*cracked a "universal" genetic code,
*conceived a baby in a test tube,	*"saw" an atom for the first time,
*verified continental drift,	*conducted electricity without resistance,
*defined every gene in an animal,	*grew creatures in boiling water,
*stored an encyclopedia on a credit card,	*cloned an adult animal,
*made human insulin in a bacterium,	*flew a jet across an ocean in 1 hr,
*invented the transistor,	*found evidence of extraterrestrial life,
*walked on the moon,	*transplanted hearts from the dead to the living,
*invented the digital computer,	*transplanted genes into food sources,
*invented the Internet,	*duplicated the sun's sustained fusion reaction,
*discovered lasers and NMR and made into medical lifesavers,	*first synthesized effective new medicines for treating them mental illness,
*understood the organization of units that construct subatomic particles,	*watched the fall of empires on live colour TV in real time,
*saw humans live far from earth in a constructed space station,	*and thousands of other revolutions that changed our lives forever.

Since the end of the cold war it has been necessary to create a new social contract for research. This new social contract means the scientific establishment has to communicate its values clearly and in a way that people can understand its benefits

- Align people through words and deeds so coalitions understand and accept strategies
- Motivate and inspire coalitions to overcome barriers and obstacles towards the vision.
- Empower broad based action by really encouraging risk taking, non-traditional ideas and actions, and by changing whole systems.

The rise of scientific influence in the US government probably stems largely from the impact of security threats over the last fifty years to a greater extent than other issues, although the science community in the post-cold war era is now getting more politically involved in other ways. However, on both sides of the Atlantic there are similar interests contending for advantages: business and trade, professional, trade unions, territorial and public interest, consumer, environmental, social etc. The US-CSSP (Council for Scientific Society Presidents) has discussed and defined what may become the new driving forces in the future and these will form the basis of a new "social contract" model.

The 21st century social contract for research

Since the key stimulus for science development in the US was essentially military conflicts (the second world war and primarily the cold war) which created a situation in which funding for science was readily available if research proposals had potential defence applications. Since the end of the cold war it has been necessary to create a new social contract for research. This new social contract means the scientific establishment has to communicate its values clearly and in a way that people can understand: e.g. how research saves life, improves our environment, ensures our security, creates new jobs, etc. These are the issues that people listen to and pay attention to. But important to the future of all of them is our top priority to increase research investment and ensure we have a trained research workforce with which to meet the growing demands of the future. This workforce serves not only as the foundation of researchers of the future but often also as the leaders and effective creative problem solvers in every type of institution or enterprise. This workforce will arise out of the mathematics and science literacy we will develop in our 21st Century student population. Most of our populations have only a basic grasp of the mathematics they need for their daily lives and their education has not equipped them with the skills they need to solve problems or adjust to the pace of the ongoing revolution, for example, taking place in life sciences. As the demands become more complex, the crisis will escalate.

Examples of new engines that can help drive the international future of science investment

As we create our future, the major value creations for science that could become the engines driving future development of science in the first third of the 21st Century could include:

- New understandings, new enlightenment and new sciences from fundamental scientific discovery;
- Ensuring the biosphere is sustainable and all human interventions improve or maintain healthy ecosystems;
- Entirely new models of lifelong learning systems that emphasize creative problem solving and thinking skills;
- Engines of economic development and leadership, many of which may not even be conceivable yet, just as those that we created the last century were not conceivable generations earlier.
- Healthy populations worldwide, both physically and mentally, via accessible and affordable preventive care systems, new science and new technology.
- Worldwide energy autonomy of individual city/village units in a way that is safe, affordable and sufficient.

These points form the basis of a potential framework for our future. The challenge is to for the scientific establishment to meet them.

Some non-traditional next steps to help build the role of science

Two important practical steps to help enable the challenges described above to be met would be to improve access to finance for innovative start-ups and to set up a council linking universities, government and industry.

- Establishing a new type European investment bank, a hybrid between the current model of an investment bank and the current model of a venture capital firm. This will not only serve to provide "smart" capital, but also be a "school" of capacity-building for high-tech high-growth companies that will both demand new science and increase economic growth.
  - All of its founders could be the men and women of Europe who have retired from a high tech business venture which they personally founded, with enough capital to provide e.g. one million euros each in founding capital to the "euro-vc bank."
  - The new euro-vc bank could raise many times its founding capital on the current major capital markets of Europe.
  - The euro-vc bank could bundle its investments and loans into units of five start-up companies at a time, to lower the risk of investing and ensure its return on almost every investment

A scientifically trained workforce is essential not just to meet the growing demands of the research establishment but, in an increasingly technical world, it is needed to provide the leaders and effective creative problem solvers in every type of institution or enterprise

Two important practical steps to help meet the challenges of the coming decades would be to improve access to finance for innovative start-ups and to set up a council linking universities, government and industry

- The euro-vc bank founders could be members of the boards of directors of the start-up companies.

- Establishing a European university-government-industry leader council, a network that specifically and regularly addresses and acts upon whatever it determines to be the necessary key steps to enhance the value of each of its components.
  - The organization and operation should be meritocratic, allowing ideas to be debated openly and accepted or dismissed on merit alone.
  - The power of this group would derive from its being an organized network of decision-makers who can meet often and make immediately productive decisions for the groups they lead without channelling them through any other organization.
  - Whatever they decide on any issue should be benchmarked for its measurable effects and the regularly measured results provided as soon as possible to all the others. The outcome of this would be a learning network, (i.e. one that rapidly learns how to improve all of its decisions). These results could become a valuable input to public policy and European legislation, after the trio of groups had determined the merit of a policy.
  - Its university component should emphasize research centres, its industry component should emphasize R&D-intensive and/or high job-growth industries, and the government components should offer action-oriented leadership.

About the author
Dr. Martin Apple is president of the Council of Scientific Society Presidents, whose presidents represent a combined 150 disciplines of science and over 1 million scientists. He has served on the faculty of the University of California and been president of several high-tech, high-growth companies. He has received over 20 major recognitions and awards, and was the founder of one of the important areas of genetic engineering.

Contact
Martin Apple, PhD, President, Council of Scientific Society Presidents
Tel.: +1 202 872 44 52, fax: +1 202 872 40 79, e-mail: **cssp@acs.org**

Enhancing Dialogue between Science and Governance

Manfred Popp, ***President of Vorstand Forschungszentrum Karlsruhe***

Discussion of the relationship between science and governance tends to be mostly influenced by our experience from the past, including particularly crises such as BSE, Chernobyl or other environmental disasters. Nevertheless, it is also important to discuss the issue of science and governance in a wider framework placing more emphasis on the future. The importance of the relationship between science and governance is, after all, not just the role science can play in remedying crises and disasters, but the fact that science has a powerful influence on the shape of the future. Therefore, from the policy-makers' viewpoint, science is a means for moulding that future. And this is what makes the dialogue between science and politics so much more important and demanding.

The dialogue between science and politics is made difficult, however, by the fact that the roles of the two spheres differ greatly. The democratic principle that underpins politics cannot meaningfully be applied to science, which is more concerned with objective measures of the truth of a hypothesis than its broad acceptance. Apart from the conceptual difficulties of dialogue, treatment of it tends to focus only on one side of it. A lot tends to be said about scientific advice to politics but less consideration is given to political influence on science. This should, of course, not be interpreted as meaning that we need political influence on science in general; there are certain areas in science which function better autonomously. These are curiosity-driven research and basic research, for instance, which should be treated as an independent matter for the scientific establishment to decide according to scientific criteria alone. And there is a second group, namely innovation-driven research, most of which is industrial research; this of course also needs to be autonomous and free of unnecessary influence from government.

In addition to the need for basic and innovation-driven research, a further motivation for scientific work is precautionary research. Precautionary research leads to the production of knowledge or solutions for the future. This is research which is intended to be a tool for governments to help them master the problems of the future and to maintain their societies' position in the face of future global competition. This type of precautionary research possibly overlaps with some curiosity-driven research, such as in the case of climatology, for instance. Or, on the other hand, it can very often be close to innovation-driven research, such as in some areas of energy research. Nevertheless, this type of research tends to differ from other areas in that its urgency requires scientists to be prepared to react to the government's research needs. They therefore have a reduced freedom of action compared with scientists working in autonomous fields of pure science or in industrial development.

Scientific organizations conducting precautionary research must develop an appropriate structure in order to respond efficiently to the needs of society and government. And it is also important to note that precautionary research is, by its very nature, interdisciplinary and problem-oriented rather than

Discussion of the relationship between science and governance needs to consider the importance of science as a shaping influence on the future and not just its role in tackling crises

In addition to the need for basic and innovation-driven research, a further motivation for scientific work is precautionary research, which aims to provide knowledge or solutions for the future

The problems that science and technology will have to address in the future will be complex, often making the scientific approach complex too

One important goal is to avoid politics having too direct an influence over science, while ensuring responsiveness by scientific community to society's future demands

About the author
Manfred Popp
is Chairman of the Board of Directors, Karlsruhe Research Center and is an Honorary Professor at Darmstadt Technical University. He has a Ph.D. in nuclear physics and during his career as a research scientist and lecturer he has worked at Bonn University, Weizmann Institute of Science, Rehovot/Israel, the Hesse Ministry for Environment and Reactor Safety and Federal Ministry for Research and Technology, Bonn.

being focused on specific scientific fields. The future problems that science and technology have to address are necessarily complex, so the scientific approach to deal with them also has to be complex. This makes it necessary to organize science in such a way that it can properly respond to the scale of the problem, and this is something which often cannot be left to science's own self-organizational principles and processes. Instead, it calls for an organizational structure, it needs interaction with the government, and it needs an institutional framework. This cannot be done on a project-by-project basis; it has to rely on a continuous dialogue between science and governance and this demands an institutional framework, continuity and an appropriate structure for dialogue.

In Germany the approach taken has been to set up large science centres (sometimes comprising existing institutions which are still working on their original fields, although sometimes this has involved a considerable change of direction of the work) whose domain is this type of precautionary research. Work has also been reorganized into six major research areas, of which at least three (environment, health and nuclear energy) have a precautionary character. These organizational reforms are also accompanied by a shift in funding from an institutional approach to a programme-oriented one. This means that all the institutions wanting to participate in a given programme will find themselves competing for funds. Although institutions themselves may find this situation more difficult, it should improve the quality of the programme results and ensure they match future needs more closely. This is a very important move and one which will also change the type of interaction between governance and science in this field. However, as these changes potentially make science less independent from political pressures, to avoid too direct a political influence, overall management has been charged to a committee of scientists, industrialists and civil servants. The goal is to avoid politics having too direct an influence over science while ensuring responsiveness to society's future demands of the scientific community.

Turning now to the question of how these issues can be handled within the European Union, national structures clearly differ from one European country to another. What is needed is an institutional network that can act as the as a basis for the dialogue between those involved in science and governance. This institutional network would of course have the Joint Research Centre (JRC) as its centrepiece. However, the Framework Programme approach does not seem to be the optimal way of developing an active process of continuous dialogue between policy and science. Shaping the future really needs a more continuous and reliable programme and framework. This fact could make it necessary to redefine the role of institutions in this field and possibly set up new institutions to fill existing gaps.

Like other research institutions the JRC needs to adapt to play its evolving role as a central catalyst. To meet the new challenges a number of institutional networks need to be set up in Europe, and these should ideally be programme oriented, as it is the outcome that matters, not which particular institutions are involved. Moreover, the problem needs to be addressed that where networks do exist, they tend to respond to the needs of research areas that are no longer high on the list of priorities, such as nuclear power. There currently seem to be many other areas which are important for European policy, such as agriculture, energy, climatology and health-care, that may be under-represented by existing networks.

Contact
Prof. Dr. Manfred Popp, President of Vorstand Forschungszentrum Karlsruhe
Tel.: +49 724 782 20 00, fax: +49 724 782 61 23, e-mail: **manfred.popp@vorstand.fzd.de**

Scientific Input and National Boundaries

Mäns Lönnroth, *MISTRA,* Sweden

When policy-makers ask for scientific advice they tend to ask people they know. If they do not personally know experts, they usually ask scientists from their own country. Rarely, if ever, do they go across national borders of their own accord. However, small countries, which are less well equipped with the full range of resources are in some respects more reliant on science. In some respects their need to reinforce their arguments by the use of commonly agreed rules and procedures in order to exert international influence is greater than that of larger countries, which have been noted to be somewhat more discretionary in their approach. Science, in particular natural science, offers such a set of rules, and thus small countries are particularly dependent on good and, therefore, agreed science as a tool of persuasion. For example, the Scandinavian countries relied on establishing internationally agreed science on acidification in order to convince policy-makers elsewhere, particularly in the UK, of the need for action. Since UK policy-makers primarily would listen to UK scientists, it was important to establish direct research programmes on acidification bringing together countries on both sides of the North Sea.

This is true not only of the science of acid rain but also of climate change, chemical safety and so on. The problem is though that in some countries science is more advanced or there is a broader range of expertise than in others. Moreover, although not necessarily linked to this observation, international scientific contacts tend to cluster along well worn paths. Language plays an important role here. Some one hundred years ago Swedish scientists generally spoke German. Now they generally speak English and only rarely German, and even less often do they speak French.

But language is not the only factor. It would seem that Swedish climatologists, for instance, tend to regard US climate science as the most advanced, followed by Germany and the UK. Climate science is very unevenly spread not only around the globe but also around Europe. This obviously risks creating and consolidating gaps in perception and attitudes.

Small countries are often particularly reliant on agreed science as it gives them better negotiating leverage internationally

Toxicology and eco-toxicology offer another example. Again, Swedish experts on chemicals safety traditionally tend to look to North America, including Canada, for contacts. Among the EU members, the Netherlands appears to be particularly important together with the UK and Germany.

There are probably several reasons for this. One is that only the US, perhaps, is large enough to excel in most fields. Another is that conditions actually differ between countries. The concentration of toxic chemicals tends to be higher in the Baltic Sea and the Great Lakes and possibly in the Rhine estuary and the Wadden Sea than in the open Atlantic or even the North Sea or the Mediterranean.

International links in science are uneven, and are influenced by language and custom more than geography

In general, the mental distance between Scandinavia and the Pacific across the Atlantic and the Rocky Mountains appear to be much shorter than the mental distance between Scandinavia and the Mediterranean across the Alps. When Swedish scientists travel abroad on scholarships, some 50% go to the US, some 10% to the UK and some 5% to

Canada and Australia. The share that goes to Germany and France is less than 5%. Japan hardly exists in the statistics. This is an obvious problem for Swedish science, and it is to be hoped that EU membership will change this.

Nevertheless, this pattern highlights a problem for policy-making in the EU and there is an obvious need to create a level playing field for scientific understanding, where nationality becomes increasingly irrelevant and scientific quality the sole guiding light. The JRC perhaps has a role to play here.

Risk perception is a mix of science and politics. Countries may well differ on the extent to which they are willing to accept risks even if their respective scientists agree on the magnitudes of the risks in question

To give an indication of the importance of this, the internal market has to be founded not only on law and regulations but also on a common understanding of the potential and of the limitation of science to provide the answers that supra-national regulators need. It would therefore be of value to create a European wide (in the broadest sense, rather than EU-wide) nation-by-nation bench marking of those scientific disciplines that are par1icularly 'important for the efficient operation of the internal market.

The internal market, when regulating the balance between highly complex scientific arguments on the one hand and market power on the other, has yet to prove itself as a legitimate institution in the eyes of the different European publics. The recent fracas of BSE and dioxin contamination illustrates the point. Another complicating factor is that countries may well differ on the extent to which they are willing to accept risks even if their respective scientists agree on the magnitudes of the risks in question. Risk perception is a mix of science and politics.

The internal market is an attractive concept, but nations differ with respect to risk perception, scientific standards as well as regulatory traditions when it comes to balancing different interests between e.g. health and industry. This is no easy legacy to overcome, although one could imaging that bench-marking might be a way forward -here as well as in so many other areas. But we should remember that it is not only harmonization that drives progress -differences do as well.

About the author
Mäns Lönnroth
is director of MISTRA, a Swedish environment research foundation which has the task to fund strategic environment research aimed at contributing to resolving environmental problems. Prior to this he was state secretary at the Ministry of Environment in Sweden for five years. During most of the 1980s he was a political adviser to the then Prime Minister.

Contact

Mäns Lönnroth, MISTRA
Tel.: +46 87 91 10 23, fax: +46 87 91 10 29, e-mail: **m.lonnroth@mistra-research.se**

Coordinating European Science and Governance

César Nombela Cano, *President of CSIC*

For most developed countries the importance of scientific and technological research for economic and social development is self-evident. Every day we can perceive the contribution that advances in knowledge have made to the development and well being of our citizens. In the 21st century knowledge will almost certainly influence daily life in our society more profoundly than ever before.

Europe's contribution to this knowledge-based society has been extremely important in the past and continues to be so today. The scientific output of the European Union in the period 1993-1997 accounts for 35% of global scientific output. This is comparable to that of the United States (37.4%) and four times more than that of Japan (8.7%). The revolution caused by new scientific and technological discoveries is affecting all aspects of life. These may give rise to changes in our ethical perception of problems and the emergence of conflicts that require legal solutions.

The problem is therefore a fundamental one for the construction of a future Europe founded on common ideas, ethical criteria and legal solutions. International cooperation within Europe is necessary in order to provide a sound scientific reference system that will help the construction of Europe by giving advice. This should cover the following topics:

- The rapid detection of advances in knowledge whose consequences may affect European society.
- The detection of risks and a rapid reaction to emergencies, based on sound scientific knowledge.
- Prospective studies that will help to determine the future needs of the European scientific and technological system.
- Examination of the possible positive and negative impacts of scientific progress.
- The recommendation to governments of legal solutions that may be considered necessary in each case.

The question now is how to organize European science in order to give this advice to European policy-makers and to support the adaptation of European policy to a changing social landscape by means of a sound system of reference. Another topic to be addressed is how to bring European science into contact with public opinion so as to counteract possible irresponsible campaigning that may influence public opinion against relevant technological achievements.

There are some short- or medium-term actions that may be undertaken to contribute towards the organization of this reference system in Europe linking different member States.

Among short-term actions, the networking of centres with different cultural backgrounds seems to be an important choice as an instrument for the creation of a common European science and technology reference system. This networking should be not only between centres that will contribute their expert advice on specific topics or concentrate on carrying out multinational prospective studies, but also between centres with different backgrounds that could develop the

One key problem in the age of the knowledge-based society is the construction of a future Europe founded on common ideas, ethical criteria and legal solutions

The question now is how to organize European science in order to advise European policy-makers and to support the adaptation of European policy to a changing social landscape by means of a sound system of reference

Networking centres with different cultural backgrounds is an important instrument for the creation of a common European science and technology reference system

Another important action would be to establish a European-wide data bank of experts and skills in the European Centres so as to allow the rapid mobilization of human resources in the event of a crisis

experimental basis for establishing new technologies and standards and for risk assessment.

The need for expert advice and prospective studies makes networking essential because of the different cultural backgrounds in Europe. Multilateral cooperation and decentralization would help make it possible to reach solutions acceptable to all EU countries.

Networking of research centres offers the additional advantage of reaching the critical mass necessary, which may be out of reach of individual countries either because the cost of funding is too high or because multidisciplinary research is needed. In the latter case the inclusion of research groups from several countries would ensure the presence of the best European research groups in the field concerned, which would take into account varying circumstances and thus optimize activity and create real European added value.

Another important action that could be taken on a short- or medium-term basis is to establish a European-wide data bank of experts and skills in the European Centres. This will allow the rapid mobilization of the human resources available in Europe when an emergency arises or a risk for European society that has to be urgently addressed. This action would require reaching a common standard of excellence for science and technology probably through the creation of a European scientific and technological evaluation system.

On a long-term basis, an important action could be to intensity the scientific education of young people. This is a matter of importance for the future construction of the knowledge-based society, promoting interaction between the scientific and technological system, European society and those responsible for political decisions in Europe. It is essential that society becomes aware of the essential role of science and technology in the development of countries and in the well-being of their citizens if it is to understand the political decisions leading to the allocation of economic and human resources. It is also crucial to instil the concepts of science and technology into the cultural milieu of the people who have to make political decisions. I therefore support the idea of organizing European-wide events that help make educators more aware of this issue.

The European Commission is ideally placed to coordinate these actions. The Joint Research Centre could play a pivotal role in such coordination by acting as the intermediary between the European Commission, the research organizations and European society. The Joint Research Centre has developed the skills and the know-how needed to play this coordinating role, while the European Commission should be the body to address the Union's policy-makers.

European research Organizations, like the CSIC, should participate in the co-ordination, their role being to advice on topics related with their main research objectives and skills. The CSIC has also an important experience in networking. Examples of that are:

- its significant participation in the European Union Framework Programmes;
- its activity in networks with third countries mostly Latin-American; and
- its important bilateral cooperation with European Union and East European countries.

These activities together with its presence in all the autonomous regions of Spain contribute to reinforce its possible role in the European scientific reference system.

About the author

César Nombela Cano, has been president the Higher Council for Scientific Research (CSIC) since1996. After obtaining his doctorate from the University of Salamanca he worked at New York University, the Roche Molecular Biology Institute (New Jersey, USA) and the University of Nottingham before joining the Microbiology Department at the Complutense University, Madrid. He has been president of the Sociedad Española de Microbiología (SEM), the Federation of European Microbiological Societies (FEMS) the Consejo Nacional de Especialidades Farmacéuticas. He is editor of the journal Microbiology and president of the Fundación Carmen y Severo Ochoa.

Contact

Prof. César Nombela Cano, President of the Consejo Superior de Investigaciones Científicas (CSIC), Spain
Tel.: +34 91 585 50 54, fax: +34 91 585 50 53, e-mail: **Nombela@orgc.csic.es**

Ensuring Stakeholder Involvement

Guy J. Martens, *UNICE*

The recent Commission communication "Towards a European Research area" states that: "policy options and decisions must be based on more solid scientific knowledge and a full and proper understanding of the economic and social aspects surrounding the problems in question." Policy options and decisions are translated into regulations; industry is not against regulations per se provided they are appropriate, based on the best current knowledge and do not distort competition by placing a greater regulatory burden on local firms than on their competitors abroad.

To achieve the Commission's stated objectives in terms of policy options and decisions based on sound scientific advice, the real stakeholders often have to be involved before the need to legislate arises. In fact they should become involved as soon as a potential problem can be identified, and ideally before the problem as such materializes. The way in which the problem of the ozone layer has been tackled by the collaboration of industry, the scientific community and the authorities is an example of good practice in this respect.

The Montreal Protocol, published in 1987, is an example of what should be done as it includes a periodic revision process that takes into account the progress of scientific knowledge. This process has been implemented in practice, and the most recent scientific assessment of the World Meteorological Organization (June 98), on which the UN protocol is based, concludes that the appropriate measures have been taken.

Another example of the need for the early involvement of all stakeholders, including the consumers, is the creation of pan-European and even global standards. Taking the lead in the definition of standards constitutes a tool for competitiveness, as demonstrated, for instance, by the European success story of industry standards for mobile phones.

The JRC has an important function in this context, not only in a "European Bureau of Standards" role, but by being the catalyst of a European network of pre- and co-normative research.

As political options and decisions by the authorities are supposed to reflect the opinions of the citizens, they need to be provided with clear, unbiased and objective information as a pre-requisite to their ability to exercise their democratic rights in a proper way. The question of how to communicate with and consult the general public is a huge issue that can involve fundamental legislation, and even sometimes the constitution, in Member States.

The problem of providing a scientific reference base that is acceptable to the scientific community and understood by the public actually starts with the scientific education of the young in order to enable them, as future citizens, to understand the real problems and make informed choices

The problem of providing a scientific reference base that is acceptable to the scientific community and understood by the public actually starts with the scientific education of the young in order to enable them, as future citizens, to understand the real problems and make informed choices. The role of teachers is important but not exclusive: scientists must also learn to "popularize" their knowledge; industry needs to communicate and the media has to replace sensationalism by scientific objectivity, including uncertainty.

On the subject of assigning each stakeholder his task, Lord Porter and Prof. Fischli's conclusions to the recently published IUPAC (International Union of Pure and Applied Chemistry) White Book on Chlorine state that: "There is no way that humans can foresee all the consequences of their actions... The only sure foundation for security in this technological world is to have a science base which is continually asking whatever questions seem interesting and is always there to advise and to act when the need emerges."

Thus, it is the responsibility of the scientific community to develop this science base, of the media to help inform the public in an comprehensible and unbiased way, of public authorities to make the relevant decisions on the basis of sound science and not as a result of knee-jerk reactions, and of industry to act responsibly, endorsing product stewardship and responsible care. This is just as true for all other human activities as it is for chlorine and its chemistry.

About the author
Dr. **Guy J. Martens** graduated in chemistry at the Free University of Brussels where he received his Ph.D. in physical chemistry in 1961. He has spent most of his career in R&D for a chemical multinational and now chairs the R&D commissions of the Belgian Federation of Enterprises, the Belgian Federation of the Chemical Industry, and the RTD Working Group of the Union of Industrial and Employer's Confederations of Europe (UNICE). He was a member of the Steering Committee of the Industrial R&D Advisory Committee of the European Commission (IRDAC). He is Vice-Chairman of the National Committee of Chemistry of the Belgian Academy and has taught R&D management in several Belgian universities.

Contact
Dr. Guy J. Martens, UNICE
Tel.: +32 22 64 27 58, fax: +32 22 64 27 90, e-mail: **guy.martens@solvay.com**

“Visions” in Co-Evolution: A Japanese Perspective on Science and Governance

Chihiro Watanabe, *Tokyo Institute of Technology*

Introduction

Before “the lost decade” of the 1990s, Japan, despite many handicaps, achieved a rapid enhancement of its technology and productivity levels. Much of the credit for this lies with industry's vigorous efforts to invest in R&D, which lead to the creation of a complex “virtuous cycle” with technology enhancing socio-economic development. This success is widely attributed to an effective system of governance based on a combination of industry efforts and government policy support for them.

In this policy system, the “Visions” concept played a fundamental role. This approach provided a vehicle for synchronizing possible, expected and preferred futures by perceiving future directions, identifying long-term goals, creating consensus, instilling confidence, and establishing the respective sharing of responsibilities among the broad sectors concerned. In Japan, this approach proved to be a vehicle for effective governance by creating the conditions for a virtuous cycle in which technological progress and socio-economic development reinforced one another.

Characteristics of Visions

The main defining characteristics of a “Vision” in the context of science and governance in Japan are the following:

- It is a concrete blueprint rather than a philosophical or a general picture.
- It maintains consistency and close interaction with general industrial policy.
- It is neither a plan nor a simple prediction. It is a public administration technology for shaping the future.
- The future to be shaped is not limited to only expected futures, possible futures or preferred futures but brings together all three.
- Outcomes are promptly responded to through policy implementation in which contributors to the formulation of the “Vision” are given broad participation.

The success of “Visions” as a tool for governance rests upon a number of factors:

- Visions are formulated from a total comprehensive system perspective.
- Vision issues are given further consideration by experts in the fields in question.
- Visions are joint products resulting through cooperation and open discussion between government and representatives from a broad spectrum.
- Prompt policy reaction in such a way as establishing national R&D programmes has been implemented in response to recommendations raised in Visions.
- Contributors to Visions have been given the opportunity to participate in R&D consortia and to conduct the R&D which they proposed.

In Japan “Visions” has proved to be a vehicle for effective governance by creating the conditions for a virtuous cycle in which technological progress and socio-economic development reinforced one another

Industrial Technology and Governance in Japan

Japan's ratio of governmental R&D support to overall industry R&D investment is just 3% (1997).

Despite a limited financial role, MITI (Japan's Ministry of International Trade & Industry), which is responsible for industrial technology policy, has developed other governance systems which allow it to play a leading role in the stimulation of industry R&D

In the 1990s it became harder to synchronize the views of the future of government and industry as they no longer shared the same expectations and preferences

This ratio is extremely small compared to 15% in the USA (1998), 24% in Germany (1997), 13% in France (1995) and 10% in the UK (1997). This observation implies the ability of Japan's R&D policy system to effectively stimulate industry R&D with only limited financial resources. Despite a limited financial role, MITI (Japan's Ministry of International Trade & Industry), which is responsible for industrial technology policy, has developed other governance systems which permit it to play a leading role in the stimulation of industry R&D.

The role of MITI in the 1960s, 70s and 80s

A report on science and governing issues published in 1963 by the advisory council to the Minister of MITI became Japan's first so-called "Vision", and in response, MITI established the Large-Scale R&D Project in 1966. This programme focused on strategic R&D initiated by R&D consortia run on government initiative, and laid the groundwork for MITI's long-lasting national R&D programme.

In line with the direction indicated by the first "Vision", Japan achieved rapid economic growth led by the heavy and chemical industries. However, such highly energy-intensive industries led to serious pollution problems which necessitated a re-examination of industrial policy. MITI's Vision for the 1970s was formulated after a re-examination. The basic policy orientation of this Vision aimed to change Japan's industrial structure into a more knowledge-intensive and less energy- and resource-dependent one.

Following the two energy crises in the 70s, the appreciation of the yen, and subsequent economic stagnation, MITI's Vision for the 1980s was formulated in 1980 postulating a "creative knowledge-intensive industrial structure."

It is clear that MITI's "Visions" programme in the 1960s, 1970s and 1980s played an important role in shaping the respective decades. However, a new structural wave emerged in Japan's science and technology in the late 1980s which confronted traditional governance with a new challenge.

Governance at a Turning Point: MITI's Vision for the 1990s

In the 1990s governance moved into uncharted waters. MITI's Vision for the 1990s stressed the new way in which Japan's industrial technology could satisfy new questions at a time when economic growth was slowing. At this point in time it was harder to synchronize the views of the future of government and industry as they no longer shared the same expectations and preferences.

In order to respond to these new circumstances, MITI decided to change its earlier strategy of creating new programmes. Instead, in 1993 it consolidated existing national R&D programmes into two comprehensive programmes:

- The "Industrial Science and Technology Frontier Program", and
- The "New Sunshine Program".

A Vision for the Year 2010: The Inter-Ministerial Action Programme

MITI's intensive efforts to consolidate existing national R&D programmes rather than create new ones were seen as an appropriate response to national demand concerning Japan's industrial technology at a time when the expectations and preferences of government and industry regarding the future no longer coincided as before.

Unfortunately, at the time this was taking place, Japan's economy and its industrial technology had to face the impacts an economic bubble, which started in 1987 and burst in 1991. Ironically, these impacts again required MITI and its "Vision" to develop a survival strategy for Japan to counter them. Thus, MITI's council of minister shaped the future of emerging industry towards the year 2010 in November 1996 by identifying the fifteen industries as being strategically important. This was the outcome of the synchronization of expected futures, possible futures, and preferred futures.

This is something like a "Vision" for the Year 2010. However, contrary to MITI's preceding "Visions", this time an integrated approach involving not only MITI, but also the other relevant ministries, was necessary. Therefore, this "Vision" was endorsed at the Cabinet meeting in May 1997 as a "Nation's Action Program for Economic Restructuring and Creation of New Industries". Consequently, interministerial efforts for the implementation of actions proposed by the "Vision" have been strengthened. This demonstrated new directions for the formulation and implementation of "Visions" under a new paradigm.

Joint Conference on Relevant Advisory Councils on Domestic Measures Addressing Global Warming

Another issue to emerge in the 1990s was global warning, the complexity of which called for an interdisciplinary approach. With responsibility as a chair country of COP3, Prime Minister Hashimoto established the Joint Conference on Relevant Advisory Councils in August 1997.

Following this strong initiative, representatives from nine advisory councils in relevant ministries were appointed to bring this inter-ministerial issue together in a single forum. On the basis of its intensive and extensive works the Joint Conference succeeded in adopting a report outlining the basic direction of policies and measures to be undertaken by the Japanese government. This was the first time that representatives of advisory councils in different ministries had met to discuss an issue of this kind in a single forum. Given the complexity of the global warming issue, it would have been difficult to arrive at policies rapidly without the Prime Minister's intervention.

Industrial Competitiveness Council and the National Strategy of Industrial Technology

Japan now faces a new situation in which, on the one hand, the role of "Visions" has become more significant, yet on the other the traditional approach to "Visions" is no longer appropriate as a mechanism for unifying the country's diverse national interests. This makes a stronger top down initiative to integrate diversified vectors in a single consolidated direction indispensable for total system coordination.

Facing these circumstances, similar to former Prime Minister Hashimoto's initiative on global warming, Prime Minister Obuchi undertook strong initiatives to improve Japanese industry's international competitiveness by organizing the Industrial Competitiveness Council in March 1999. The Council consists of all the Ministers from relevant departments together with the chairmen of leading firms.

At its June 1999 meeting, the Council decided to establish the National Strategy of Industrial Technology and Competitiveness for 16 industrial sectors, and a draft strategy was summarized in December 1999. In this draft, strategies were devised to enhance linkages between universities and industry. In addition, this plan proposes measures to stimulate universities (rather than industry) to take the lead in disseminating innovative technologies in the marketplace. This is considered one of the litmus tests for governance of science and technology under the new paradigm. Under this new paradigm the effectiveness of "Visions" as a vehicle for governance rests on the following eight Cs:

(i) Communication, (ii) Concentration, (iii) Coordination, (iv) Consensus, (v) Commitment, (vi) Comprehensive, (vii) Concrete, and (viii) Consortia.

In order to achieve a vision for 2010 not only MITI, but also the other relevant ministries, were involved

In 1999 ministers and company chairmen met to establish a national strategy for technology and competitiveness in 16 industrial sectors

Japan's socio-economic situation has reduced the traditional role of MITI's "Visions"

Today, the main challenges are to improve assimilation capacity, build stronger linkages between university and industry, encourage IT diffusion and capture the momentum of the digital revolution

In addition, a ninth C, (ix) Credibility, should be added, and efforts in Japan over the last four decades have consistently sought to instil this.

Limits of "Visions"

In contrast to their significant contributions for the 1960s, 1970s and 1980s the traditional role of MITI's "Visions" is declining. Discrepancies between the direction postulated by MITI's "Vision" for the l990s and socio-economic performance and policy options increased in the later half of the l990s. This is due to the situation faced by Japan in the l990s, characterized by low, zero or negative economic growth, globalization and the diversification of nation's interests. Under these conditions the old approach is less effective, indeed may result in a vicious cycle between stagnated industrial R&D and economic stagnation. This process is exacerbated by the increasing complexity of science and technology.

Unlike the case in earlier decades, an inter-ministerial joint approach and strong top-down initiative by the Prime Minister have become "necessary tools" to overcome these limits, which in turn threaten to distort the original concept of "Visions" as an autonomous vehicle, and the model on which its role for effective governance has so far depended.

Deterioration of Assimilation Capacity

Another important factor not to be overlooked is the deterioration of industry's assimilation capacity (the ability to utilize spillover technology). Consortia are essential components in realizing the goals of "Visions" and an important inducement for consortia is to stimulate cross sectoral, inter-firm, and inter-technology spillovers. Effective utilization of the benefit of this spillover depends on the assimilation capacity. Japan enjoyed the considerable assimilation capacity during the 1980s, which was considered a critical component of its high-tech miracle in the 1980s. However, while the comparative advantages of Japan's assimilation capacity (as "Just in time system" (JIT) and "Total quality control" (TQC) have become internationally universal assets), comparative disadvantages (such as rigidity and reduced flexibility due to the life-long employment and seniority system) have become more apparent. This trend undermines the benefit of consortia and so has resulted in the decreasing function of traditional "Visions".

Implications for Science and Governance

In the l990s, Japan's economy had clearly changed from that of the preceding decades. Up to this point success can be attributed to sophisticated governance of science and technology encouraging the formation of a virtuous cycle between technological development and socio-economic development. Initially, "Visions" played an important role in this process as a vehicle for effective governance. However, in the harsher climate of the 1990s the traditional approach has had to be rethought.

Among the measures urgently required is the recreation of the virtuous cycle between the function of "Visions" and other associated policy instruments, including the national R&D programme and consortia. A stronger interdisciplinary approach based on inter-ministerial and Prime Ministerial initiatives could be timely triggers for this restructuring, provided they do not undermine the autonomy of the "Visions" concept.

Today, the main challenges are to improve assimilation capacity, build stronger linkages between university and industry, encourage IT diffusion and capture the momentum of the digital revolution.

About the author
Chihiro Watanabe
is a Professor at the Dept. of Industrial Engineering & Management, Tokyo Institute of Technology, and a Senior Advisor to the Director on Technology, Intl. Institute for Applied Systems Analysis (IIASA).

Contact
Prof. Chihiro Watanabe, Tokyo Institute of Technology
Tel.: +81 35 734 22 48, fax: +81 35 734 22 52, e-mail: **Chihiro@me.titech.ac.jp**

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.

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The European Science and Technology Observatory Network (ESTO):
IPTS - JRC - European Commission
W.T.C., Isla de la Cartuja s/n, E-41092, Sevilla, Spain
tel.: +34-95-448 82 97; fax: +34-95-448 82 93; e-mail: ipts_secr@jrc.es

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