ISSP
INSTITUT DE RECHERCHE SUR LA SCIENCE, LA SOCIÉTÉ ET LA POLITIQUE PUBLIQUE
INSTITUTE FOR SCIENCE, SOCIETY AND POLICY

Policy Brief Series
Science/Policy Interface
6
June 2014

A Map of the Interface Between Science & Policy

Marc Saner

University of Ottawa

(Edited version

First published January 2007 at the Council of Canadian Academies)

uOttawa

issp.uottawa.ca

Note from the Series Editor

This policy brief, part of a series by the Institute for Science, Society and Policy (ISSP) at the University of Ottawa, is supported by a SSHRC Public Outreach grant (#604-2011-0007). The goal of the series is to mobilize academic research beyond the walls of universities. The series is directed at public servants operating at the science/policy interface in Canada and abroad. It has been designed to bring forth some themes and findings in academic studies for the purpose of synthesis, knowledge transfer and discussion. This brief is the sixth in the series. It was previously issued in 2007 as a staff paper at Council of Canadian Academies. The ISSP also carries out adjacent activities on the topics covered in these briefs. We hope they will be well received and are looking forward to any feedback you may have. You may reach me directly at msaner@uottawa.ca.

Marc Saner
Director, ISSP

Titles in this Series

(1) (Policy Brief) Researchers are from Mars; Policymakers are from Venus: *Collaboration across the System* – by Matthew Gaudreau and Marc Saner
(2) (Policy Brief) From Many to One: *Integration of Knowledge and Values in Decision Making* – by Matthew Gaudreau and Marc Saner
(3) (Policy Brief) Dealing with Not Knowing: *Evaluating and Communicating Uncertainty at the Science/Policy Interface* – by Matthew Gaudreau, Michael Bordt and Marc Saner
(4) (Workshop Backgrounder) Making it Work: *Improving the Interface Between Scientists and Policy Makers: Management Incentives* – by Sasha Kebo and Marc Saner
(5) (Workshop Report) The Top Five Management Incentives for Improving the Interface Between Scientists and Policy Makers – by Michael Bordt and Marc Saner
(6) (Policy Brief) A Map of the Interface between Science and Policy by Marc Saner (update of a Staff Paper, Council of Canadian Academies, 2007)
(7) (Policy Brief) The Role And Responsibilities Of The Scientist In Public Policy by Bill Jarvis (republication of a Discussion Paper, Public Policy Forum, 1998; with permission of the Public Policy Forum and the Author)
(8) (Policy Brief) A Question of Balance: *New Approaches for Science Based Regulations* (republication of a Policy Brief, Public Policy Forum, 1998; with permission of the Public Policy Forum and the Author)

Please visit www.issp.uottawa.ca for PDF versions of these documents.

ISSP

About the Author

Marc Saner

Dr. Marc Saner is the inaugural Director of the Institute for Science, Society and Policy, and an Associate Professor in the University of Ottawa, Department of Geography. Prior to this appointment, he served as Executive Director, Regulatory Governance Initiative, School of Public Policy and Administration, at Carleton University, and Director of Assessments and Executive Vice-President of the Council of Canadian Academies. Previously, Dr. Saner was a Director at the Institute on Governance where he built the Ethics and Risk Management Sector and co-managed the Technology and Governance Program. His primary interest has been multi-disciplinary work at the intersection of science, ethics and governance. He holds a PhD in applied ecology from the University of Basel, Switzerland (1991) as well as an MA in applied ethics from Carleton University (1999). Dr. Saner publishes in peer-reviewed journals in the areas of technology ethics, bioethics, risk management, biotechnology and ecology and has been invited to speak at seminars, workshops and international conferences around the world.

Acknowledgments

Background work for this Policy Brief has been made possible through a contribution by the Professional Institute of the Public Service of Canada (PIPSC), the union of scientists working for the Government of Canada (www.pipsc.ca) to the Institute on Governance (www.iog.ca). I also thank Peter Nicholson, Council of Canadian Academies; Bruce Doern, Carleton University; Cornelius von Baeyer, Workplace Ethics Consultancy; Stephen Hare, Health Canada; and Gary Corbett, PIPSC, and Michael Bordt for comments on draft versions of this text.

Any errors and omissions are solely those of the authors.

Available for download at www.issp.uottawa.ca

uOttawa

ISSP

A Map of the Interface Between Science & Policy

Introduction

Scientists have been able to contribute to human understanding and technology at an exponential rate over the last three centuries. When praising the virtues of science, most commentators highlight the technical achievements that were engineered on the basis of scientific discoveries—antibiotics, electricity, or communication devices may be listed as examples.

Less frequently, commentators highlight the concept of the scientific methodology, and the resulting reproducibility of results, as an important achievement in itself. Yet, it is precisely the strength of this methodology that allows scientists to communicate and cooperate effectively across all nations, economic systems, ideologies, and religions–a truly remarkable development in the history of humankind.

The universality of the scientific method made it possible, and necessary, to establish an *International Council of Scientific Unions* in 1931 (ICSU). ICSU, now called the *International Council for Science*, formulates a "Principle of the Universality of Science" as follows:

> *The principle of the Universality of Science is fundamental to scientific progress. This principle embodies freedom of movement, association, expression and communication for scientists, as well as equitable access to data, information and research materials*[1].

We can derive from this quote that the universality of science causes scientists to share not only benefits but also challenges around the world. A current key challenge is expressed in the overall theme of ICSU's *Strategic Plan 2012-2017: Strengthening International Science for the Benefit of Society*:

> *The long-term ICSU vision is for a world where excellence in science is effectively translated into policy making and socio-economic development*[2].

The interest in the linkage between scientific knowledge and policy-making is shared by many national and international organizations. I will explore this linkage in its many manifestations—the interface of science and policy–with the goal to deepen the understanding of the challenges we are dealing with, in particular as they relate to scientists working for and with governments. The description of this lay of the land starts with the theoretical concepts (the view from the "stratosphere") and progressively moves towards practical aspects. It will be composed of (a) a description of the concepts underlying the science/policy interface, (b) the manifestation of the interface with a focus on broad functions within organizations, and (c) a simple classification of the diverse uses of government science and, thus, locations where the science/policy interface may have to be managed. As I move from the theoretical to the practical, I also move from observations that are applicable to any organizational context to those that are most

[1] From ICSU Statute No. 5 (see www.icsu.org/5_abouticsu/STATUTES.htm#5).
[2] ICSU Strategic Plan 2012-2017, p. 11. (see http://www.icsu.org/about-icsu/strategic-priorities/strategic-plan-2012-17).

applicable to the situation in the federal government of Canada. I am attempting, however, to provide a *map* rather than *directions* at all times—an analytic taxonomy rather than an argument.

Stratosphere: The Facts/Values Interface

The public association of philosophical analysis with stratospheric heights goes back a long way—at least to the time when Aristophanes portrayed Socrates in an unflattering way in the play *Clouds* (419 BC). However, by approaching the fundamental distinction between science and policy from a philosophical perspective it is possible to shed light on some of the underlying concepts and foundations. In the context of this brief, "policy" designates a basic statement of purpose and approach decided on by a governmental authority[3]. Good decisions require both *facts* and *values*—solid evidence (and, by extension, predictions) that are derived from scientific analysis and justified values that are derived from policy analysis. It is through the interaction of these variables that good decision-making is fostered.

Scottish philosopher David Hume (1711-1776), one of the most influential philosophers of all time, was first to describe what is now often called the "is/ought gap." He did not use the word "gap" himself, however. He simply complained that many authors seamlessly, without argument, move from descriptive clauses that contain the word "is" to prescriptive clauses that contain the word "ought". One can derive from Hume's complaint that it takes considerable precision and effort on the part of authors to connect two different kinds of discourses: the one over *what there is* (science) with the one over *what should be done* (policy). This is, perhaps, the purest expression of the interface between science and policy.

One contemporary manifestation of the is/ought gap is the on-going debate in academia between so-called "positivists" and "post-modernists." Simplified, the former adhere to a classic model of science that asserts the existence of more-or-less absolute facts on which science can progressively be built. The latter stress the importance of paradigms, values and power-relationships in the interpretation of science—a perspective that calls a simplistic concept of "fact" into question. The disagreement between these two academic camps manifests itself in practical terms because it informs the discussion over the allocation of government funds to the different academic faculties. A critique of the natural sciences in combination with analytic advances in the social sciences and humanities strengthens the argument that too much money goes to the former and not enough to the latter.

Government scientists and policy-makers should take from the academic debate mostly one thing: don't expect any consensus from academics on how to address the issues at the interface of science and policy—certainly don't expect a clear justification for the insulation of science from policy, or the segregation of scientists from policy-makers, arising from Hume's observation.

Increasingly, a critique of the natural sciences and technological disciplines from religious circles becomes relevant to the policy context. This is another form of the is/ought gap

[3] This definition is adopted from Bruce Doern (2001).

where the “ought side” is represented by reference to scriptures and faith. The inclusion of multiple, conflicting scriptures and expressions of faith increases a challenge that is already present in secular governments: policy development often requires long consultations on conflicting arguments.

Another, very important manifestation of the is/ought gap comes from the global trade context. Within the current World Trade Organization agreements it is permissible to reject unsafe products at the border (emphasising the aspects of a product that can be evaluated scientifically) but it is very difficult to reject products on ethical grounds. For example, the European moratorium on genetically engineered foods is based on an apparent risk issue and the precautionary principle—but not on ethics or cultural rejection (this case would deserve a discussion in itself, because the precautionary principle is located precisely on the wedge of the interface between facts and values). Another example is that the World Trade Organization has a hard time dealing with animal welfare issues—a nation may not “level the playing field” by means of import taxes if its own production of animals is more expensive due to more demanding domestic animal welfare regulations.

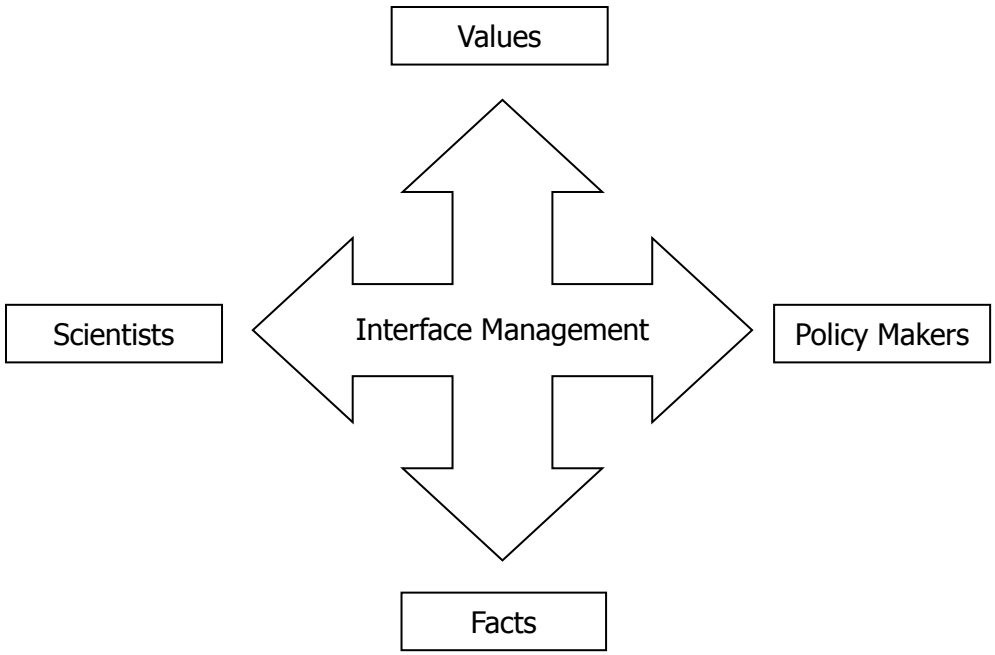
Staying on the “is” side of the is/ought spectrum has huge advantages for trade and regulation. Safety issues are easier defended in court than, say, animal welfare standards, and they move regulation in the direction of a lowest common denominator that suits the goal of the international harmonization of regulatory requirements. The fact that product safety assessments (the science part) are neither completely objective nor void of any form of judgement is the only fly in the ointment.

It should be clear without explanation that each and every rational decision is a combination of facts and values—a decision requires judgment. The agents of judgment are, of course, people, and this leads us to an entirely different interface—that between scientists and policy-makers.

Biosphere Part I: The Scientist/Policy-maker Interface

The interface between science and policy should not be confused with the interface between scientists and policy-makers (or implementers). The former are *concepts* and the latter are *functions* or professions. We are dealing, therefore, with at least two very different interfaces as the following **Figure 1** shows.

Figure 1: Two Different Types of Science/Policy Interface



Professional functions are associated with corresponding professional cultures. There are a number of differences between the cultures of scientists and policy-makers, respectively. These differences can be expressed, for example, in diverging value systems and workplace standards, the framing of issues and fundamental goals and, of course, language use. Each of these differences could be heightened to express a type of science/policy interface. **Table 1**, below, provides a list of manifestations of the science/policy interface and, more importantly, the interface between scientists and policy-makers. It should illustrate how manifold and multi-faceted the manifestation of this interface may be. It also shows that the worst case scenario—lack of understanding and mutual arrogance between scientists and policy-makers—has a solid foundation.

We should not be surprised that scientists and policy-makers often have difficulties communicating and cooperating. Their segregation may actively start during “frosh week” at universities and be used as a form of competitive incentive. From there, diverging metaphysical positions can easily develop. For example, a young scientist, exasperated by the points made by post-modernists or feminists may exclaim: “facts are not a matter of power”. On the other hand, someone in the liberal arts may be offended by the lack of limits observed in science and exclaim: “the worth of a person is not a matter of scientific evaluation.”

The lack of good communications among the faculties has already been lamented by C.P. Snow, in a 1959 lecture entitled *Two Cultures and the Scientific Revolution* (Snow, 1961) . Psychology Professor David Barash more recently commented on Snow's influential lecture and stated:

> *"And despite the proliferation of numerous centers and institutions for interdisciplinary study, I suggest that, if anything, academic cultures are less mutually interpenetrating now than in Snow's day, perhaps because institutionalization of bridge builders, serves, ironically, to marginalize them, and keep them out of the main academic thoroughfares. … Everyone claims to love boundary-busting scholarship, but virtually no one would advise a graduate student or even a faculty member lacking tenure to hitch his or her career to it."* (Barash, 2005)

All this is not surprising. What is surprising, however, is that we somehow expect the two sides to communicate and cooperate as soon as most of them enter the offices and boardrooms of industries and governments right after exiting the universities.

It may be helpful to simplify and re-state the basic problem that has been outlined so far:

Decisions = facts + values

Culture = facts *vs.* values

The cultural gap between scientists and policy-makers has a real cost because good policies require a solid factual foundation—and this requires some cooperation between the two sides. Both sides should have an interest in a functioning interface, the scientists because they want meaningful jobs and the policy-makers because they need the figures and predictions that only science can produce.

Table 1: A Catalogue of the Multiple Facets of the Science/Policy Interface[4]

Science	Policy
Concepts & Foundations	
Understanding the world	Managing the world
"Is" (facts)—Description	"Is" combined with "ought" (values)—Prescription
Reductionism	Holism
Truth and reproducibility	Rightness and practicality
Uncertainty is a fact of life	Deciding "Yes" or "No" is the goal
Methods & Perspectives	
Problem oriented	Service oriented
Clientele diffuse, diverse or not present	Clientele specific, immediate, and insistent
Investigation	Justification
Experiment and observation	Dialogue and judgment
Inquiry and discovery	Imagination and mission
Precision and selection towards the truth	Reconciliation of viewpoints and compromise
Replication asserts independence from context	Context-specific, situational solutions desired
"Know what and how"	"Know why and whether"
Risk: "right answer, but wrong question"	Risk: "unsupported answer to the right question"
Absolutism in the concept of truth	Absolutism in ethical concepts
Inequality is a scientific observation	Equality is moral goal
Sharing within a world-wide network	Focus on domestic interests
Very open to external expertise	External input is evaluated as "an agenda"
Long-term focus or open-ended	Time horizons are often fixed (e.g., next election)
Resources are almost never sufficient	Resource needs can often be defined
Failure and risk accepted	Failure and risk intolerable
Toward Ignorance & Mutual Arrogance	
Scientists, engineers … are first segregated in universities from … lawyers, historians, philosophers	
Use technical terminology and jargon	Use socio-economic and political jargon
Praise innovation	Are weary of innovation
Often underestimate the complexity of policy-making	Often overestimate the precision of science
… and then thrown back together in the workplace …	
Derogative term: "lab coats, techies"	Derogative term: "policy wonks"
Favourite statements about the other side: "They should learn some science and statistics"; "They ignore the hard evidence"; "Over there, they don't appreciate our value"	Favourite statements about the other side: "They should learn about the process and context"; "They think they are the high priests of truth"; "Over there, they always want more resources"
The world of progress	**The world of power**

[4] This table has been combined from multiple sources including the report by the Canadian Centre for Management development et al. (2002) and the insightful papers by Tom A. Brzustowski (2000); Bill Jarvis (1998); and G.A. Bradshaw & J.G. Borchers (2000). Note that the paper by Bill Jarvis has been republished as Brief #7 in this series.

Biosphere Part II: The Game

A particularly vexing challenge in the management of the science/policy interface is the following. On the one hand, it is important that facts are unbiased and, therefore, generated without political interference. It seems best that the scientists do not know what the most desired answer to a factual question would be—they should provide the truth, be that answer liked or dreaded. On the other hand, it is important that scientists have a chance to clarify the question if necessary, discuss the scope of an assessment and to assert that their answer is fully understood by the policy-makers. This results in a dilemma. If the scientists and the policy-makers are physically segregated then this minimizes political interference and, therefore, results in a clean interface between facts and values. However, only if the scientists and policy-makers are able to freely communicate, can we be sure that questions, scope and answers are clear and understood. What we therefore need to engineer is an interface with both of the following features:

Clear	*separation*	of	facts	&	values
Open	*communication*	between	scientists	&	policy-makers

A concrete manifestation of this dilemma arises in the context of safety regulations. The dilemma is manifest in the different approaches to risk management suggested by two different reports of the National Research Council of the U.S. National Academies. In their 1983 “Red Book” (National Research Council (US). Committee on the Institutional Means for Assessment of Risks to Public Health, 1983) a conceptual distinction between the assessment of risk (the descriptive step; the gathering of facts) and the management of risk (the prescriptive step; the decision-making step) was advocated. This conceptual distinction can be interpreted as an argument for the segregation of scientists and decision-makers. The purpose of this segregation is to ensure that the scientists carrying out the technical assessment of risk are protected from inappropriate policy influences originating from the decision-makers.

In the 1994 “Blue Book” (National Research Council (US). Committee on Risk Assessment of Hazardous Air Pollutants, 1994), however, the authors explain that the Red Book’s separation should neither imply that there should be no policy judgment when evaluating science, nor that the assessors of risk may not be guided when it comes to the type of information collected, analyzed, or presented. As a consequence, a dialogue between scientists and decision-makers is meaningful.

The 1983 Red Book was a major influence on the product assessment approach promoted in the World Trade Organization. As a consequence, it has entered basic agreements and legislations and its concepts persist, particularly in regulatory departments. However, a more integrative approach to risk management, as emphasized in the 1994 Blue Book is also very common, particularly in the financial sector. Therefore, both schools of thought—highlighting the value of separation or communication, respectively—are now pervasive and risk management suffers from conceptual and

semantic confusion among and within organizations[5]. In other words, improvements in the management of the science/policy interface would be directly applicable to the risk management context and, in particular, to the design of integrated risk management systems across organizations.

It is important to note here that a large body of literature debunks the myth that risk assessors and other applied scientists are able to achieve objectivity in an absolute sense. To pick just one example, Daniel Sarewitz states in his paper *How Science Makes Environmental Controversies Worse*: "Even the most apparently apolitical, disinterested scientist may, by virtue of disciplinary orientation, view the world in a way that is more amenable to some value systems than others. That is, disciplinary perspective itself can be viewed as a sort of conflict." (Sarewitz, 2004) The viewpoint of Sarewitz (and many others) implies the need for a greater focus on dialogue (Blue Book), rather than greater focus on objectivity (Red Book).

Within and outside of a risk management framework, the science/policy game can be played from three different positions (see **Figure 2**):

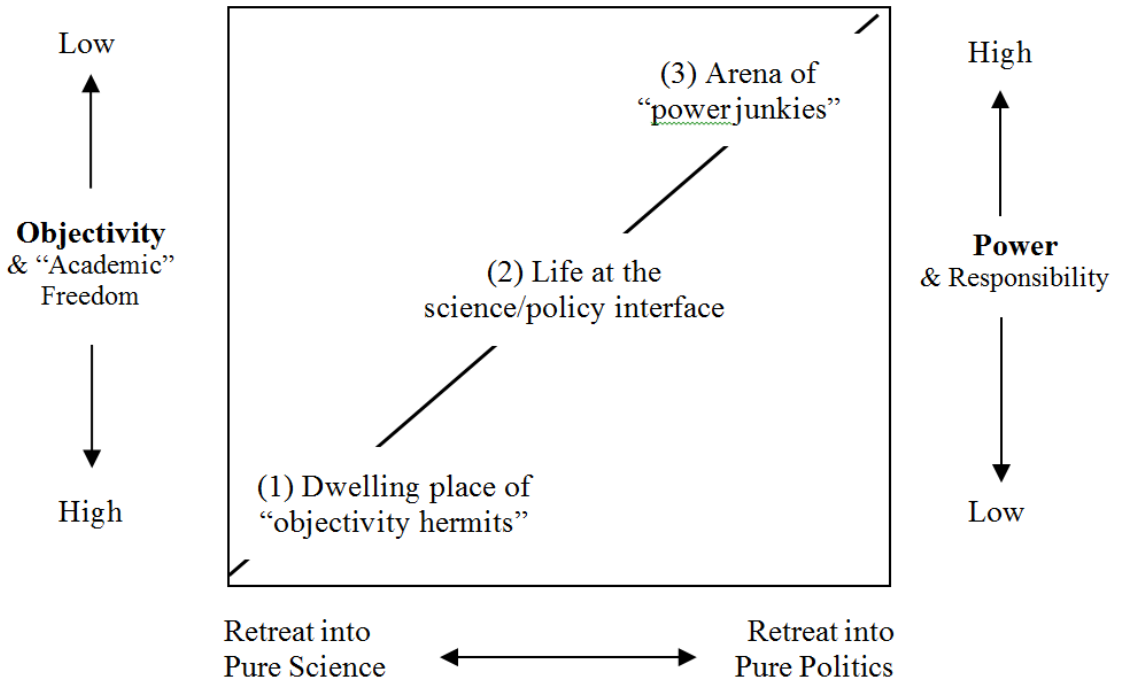
(1) Retreat into the world of pure science (the dwelling place of "objectivity hermits"):
- *Kick:* "Academic" freedom (as far as government work permits it), the pursuit of truth, and the participation in a world-wide community of science.
- *Safety Bonus:* Protection from politics and the "horrors of metaphysics."
- *Healthy Condition:* "The division of labour in government makes sense."
- *Borderline Condition:* "Many more managers should be scientists and policy should be made by using the scientific method."
- *Pathological Condition:* "I don't care anymore what the wonks do."

(2) Living at the science/policy interface:
- *Kick:* This is where the challenge is and this is where big gains can be made.
- *Safety Bonus:* None.

(3) Retreat into the world of pure politics (the arena of "power junkies"):
- *Kick:* The proximity to both power and important issues here and now.
- *Safety Bonus:* Protection from the complexity of technical knowledge and the "horrors of mathematics."
- *Healthy Condition:* "The division of labour in government makes sense."
- *Borderline Condition:* "Scientists are incapable of explaining anything clearly."
- *Pathological Condition:* "I am not going to listen to little technicians."

[5] For additional details see the *Information Brief on International Risk Management Standards,* available at http://cstpr.colorado.edu/students/envs_5120/saner_2005.pdf.

Figure 2: Three Locations Where the Science/Policy Game Is Played by Individuals



Playing the Game Fairly—The division of labour,[6] if well managed, will provide the benefits of professionalism in both science and policy-making. It will also provide the important benefit that decision-makers will have a clear sense of what the facts are and where the value judgments were made—both "objectivity hermits" and "power junkies" have important roles if the roles at the interface of science and policy are managed well. Some willingness to enter the science/policy interface is required, however, so that the posing of technical questions and the delivery of technical answers functions with all the attention these difficult transactions demand. It is, perhaps, unfortunate that life at the science/policy interface, where two alien cultures meet, often leads to greater risk and discomfort than retreat into pure science or politics, respectively.

Playing Dirty, Part I—"I make the decision but you will take the fall." Problems arise when the division of labour is not managed well. For example, a policy-maker may play the game unfairly by assigning blame for a wrong decision to a scientist (who was not present during the decision-making process) although the decision was the result of the complex balancing of interests rather than incorrect scientific data. One could call this a violation of the ethical doctrine that power must be matched with accountability.

Playing Dirty, Part II—"You need my expertise and I know how to manipulate you." An unfair game play on the part of scientist would arise if the scientific data presented is exaggerated for ideological reasons or reasons outside of the agreed scope of an

[6] It may be of anecdotal interest that Adam Smith, who described the benefits of the division of labour in his *Wealth of Nations*, was a close friend of David Hume. The ethical frameworks of both Adam Smith and David Hume would deserve close consideration in the context at hand. Smith, for example, was worried that the division of labour could result in ethical and sociological problems.

assessment. For example, a scientist who carries out a safety assessment may exaggerate the potential hazard of a product because he believes that the company behind the product demonstrates unfair business practices, something clearly outside of the scope of a safety assessment. One could call this a violation of the ethical doctrine that public servants must "speak truth to power."

It is important to note that the designation of "scientist" or "policy-maker" is not always straightforward. A scientist may become a policy-maker later in the career, for example. Sometimes, a single person will function as a scientist and as a policy-maker. Nevertheless, decisions remain composites of facts and values and an awareness of the difference between the technical and policy-making functions will facilitate good decision making.

We may further want to note that within "policy-makers" (**Figure 1**) there is another, similar boundary, namely the separation between the public service and the politicians. This separation works the same way—the public service (including policy-makers) may be asked to work like "technicians" and, based on our Westminster model, only the electorate should make value-judgements. Although this concept of separation cannot be implemented in an absolute way, it remains the basis for the accountability system of the Government of Canada. To take this train of thought to its logical conclusion, one could also observe yet another science/policy interface between politicians and the public in those cases where parties or governments leave the value judgments to the voters (e.g., referenda).

The example of safety regulation discussed above is only one, albeit very important component of government work where the science/policy interface is important. To appreciate the full complexity, we have to look at the playground of the science/policy interface—the "bureau-sphere."

Bureau-sphere: The Playground for the Science/Policy Interface

Where in government does the science/policy interface emerge? To answer this question we have to look at the breadth of science in government. Drawing on the work of its Council of Science and Technology Advisors (CSTA), the Government of Canada presented the following four core S&T roles in the 2005 report *In the Service of Canadians: A Framework for Federal Science and Technology*:[7]

- Support for decision making, policy development and regulation
- Development and management of federal and international standards
- Support for health, safety and security, and environmental needs
- Enabling economic and social development

While this list describes the key functions well, it does not relate closely to the issues at the science/policy interface and, in particular, to the terminology used in **Table 1**. The map presented here requires a classification that separates those science-related activities in government that pose different challenges at the science/policy interface. In the following, a simple classification is developed in two steps.

[7] The four roles are described on pages 6 and 7 of *In the Service of Canadians: A Framework for Federal Science and Technology* that is available at http://publications.gc.ca/collections/Collection/Iu4-66-2005E.pdf).

The logic underlying the classification is presented in **Figure 3**. The differentiation of scientific activities that are directed toward *external* use, from those that remain *internal* is meaningful because the policy environments are different. For the same reason, activities that are directed at controlling products and processes (*"stop"* function) should be differentiated from those that are directed at producing novel ideas and products (*"go"* function).

Figure 4 maps different uses of science in government, as well as the issue of the workplace quality of scientists, onto this simple classification—not precisely but approximately. In their entirety, these activities form the "playground" for the science/policy interface within government. Each of the elements detailed below and included in **Figure 4** produces its own array of issues at the science/policy interface (conceptual, cultural, or with respect to the arrangement of organizational functions) and each is governed by a set of government policies and management approaches (these polices should not be confused with "science policy" that is more narrowly defined). The last two (i.e., science for outreach and justification) feed most clearly into policy development:

- *Science for innovation* (e.g., basic research)
- *Science for commercialization* (e.g., applied research, promoting economic and social development)
- *Workplace quality and role of scientists* (e.g., management issues, ethical issues)
- *Science for investigation* (e.g., mapping, statistics, analysis, model building, evaluation)
- *Science for safety assessment* (e.g., regulation, pre-market assessments)
- *Science for operations and enforcement* (e.g., standards setting, monitoring, quality controls, policing, safety checks)
- *Science for outreach* (e.g., science communication, risk communication, museums)
- *Science for justification* (e.g., policy development, decision making, foresight, priority setting)

Figure 3: A Basic Classification Scheme for Scientific Activities in Government

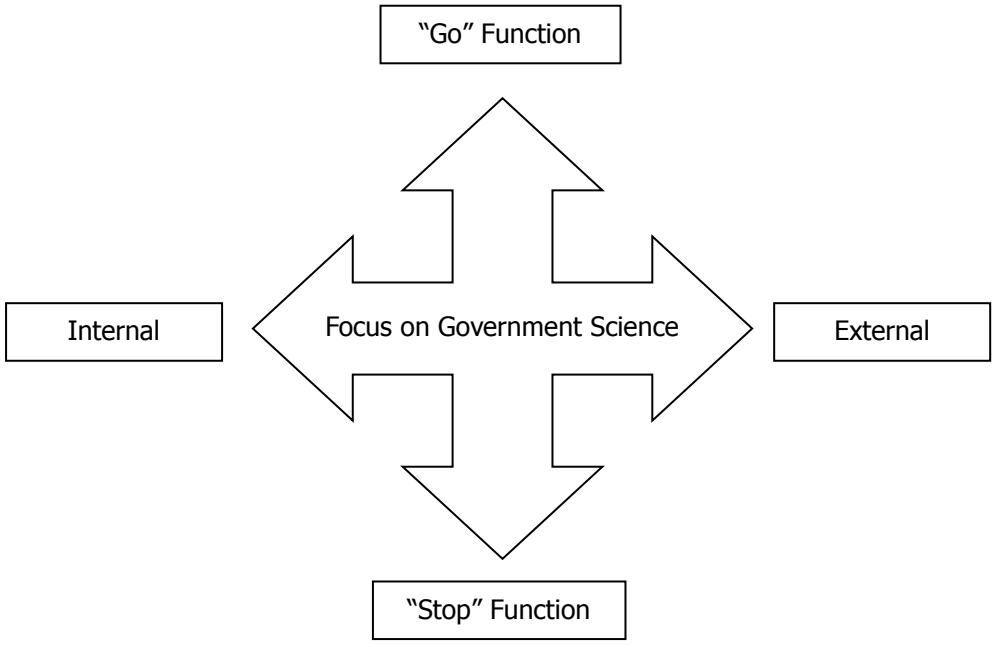
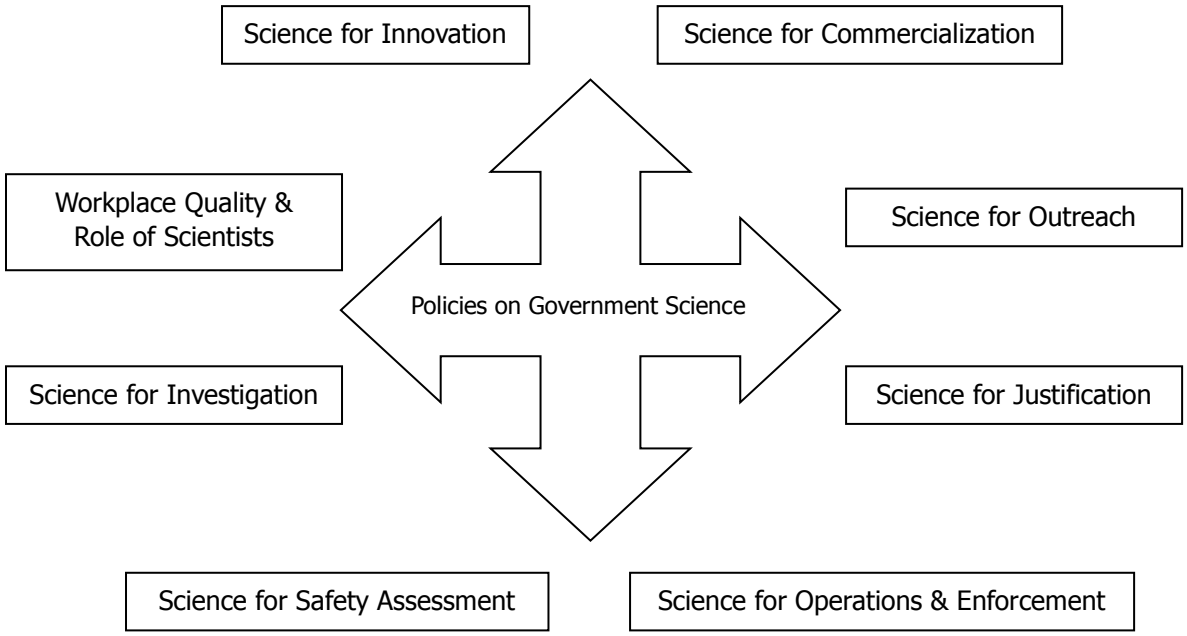


Figure 4: Key Scientific Activities in Government (mapped onto the classification in Figure 3)



Ground Zero: Take-home Messages

The key points made in this brief are:

- There are conceptual reasons why science and policy are fundamentally different (the is/ought gap).
- There are cultural reasons why scientists and policy-makers find it difficult to communicate (**Table 1**).
- There are benefits to some players if the linkages between science and policy remain weak (**Figure 2**).
- The manifestations of the science/policy interface in government are manifold (**Table 1** and **Figure 4**).

It seems desirable not only to understand but to improve on the status quo, judging from the existence of the on-going, international, drawn-out, and quite intense debate on the topic. From the point of view of a manager in the public service, a number of issues related to the key points above require particular attention:

- How to organize teams to simultaneously accomplish a clear separation of facts and values when informing decision-makers and an on-going open communication between scientists and policymakers?
- How to manage the problem of diverging cultures proactively and successfully?
- How to create incentives for people to enter (and play fairly at) the science/policy interface?
- How to adapt to the specific issues around each of the many different manifestations of the science/policy interface? (Each of the facets listed in **Table 1** could arise at each of the scientific activities in **Figure 4** resulting in very many different manifestations).

The purpose of this brief is to provide a map, rather than directions. Nevertheless, the analytic taxonomy presented here suggests three conclusions. First, the diversity of interfaces and the complexity of the issues suggest that we should think about each issue contextually rather than attempting to solve “the problem of the science/policy interface” overall—the consideration of specific contexts is required to decide on the most effective type of dialogue or behavioural incentive. It is certainly quite misleading to suggest that we are dealing with a single interface or a single key issue.

Second, it is important to think of the facts/values continuum as a sliding scale on which individuals may move back or forth. Sometimes, scientists move towards the “values pole” and, thus require policy skills, other times policy-makers move towards the “facts pole” and, thus require some of the cultural traits on the left side of **Table 1** (one can think of a non-partisan, highly efficient policy shop as a fairly “technical” operation). As a result, the ideal of a non-partisan public service that provides quality advice to elected decision-makers requires public servants who can navigate the interface with great skill.

Third, it is valuable to reflect not only on solutions but also on the prevention of the issues described above under "Biosphere." Most scientists and policy-makers are university-trained and it is likely that the origin of the process of cultural divergence is located in the relatively brief period between high school and the professional workplace. Universities may be aware that they are the overseers (or even promoters) of this short and fateful process but it is not clear that they currently have an incentive to effect change.

The report *Creating Common Purpose: The Integration of Science and Policy in Canada's Public Service*[8] recommends concrete actions to remedy some of the issues presented here—much would be gained, in my opinion, if they were implemented. The importance of dialogue towards mutual understanding is a key element of these recommendations.

I conclude this brief with a word of consolation for scientists with a longing for policy impact: you are definitely not alone. Even people with close ties to the policy-making arena (such as ethicists, or scholars in the social sciences and humanities) and, as stated earlier, even the policy-makers in the public service are fighting for policy impact. The world of power is a competitive place.

[8] Action items are summarized on page "X" of *Creating Common Purpose: The Integration of Science and Policy in Canada's Public Service*, available at http://publications.gc.ca/collections/Collection/SC94-91-2002E.pdf).

REFERENCES

Barash, D. P. (2005). CP snow: Bridging the two-cultures divide. *The Chronicle Review, 52*(14), B10.

Bradshaw, G. A., & Borchers, J. G. (2000). Uncertainty as information: Narrowing the science-policy gap. *Ecology and Society, 41*(1), 7.

Brzustowski, T. A. (2000). The role of science in public policy: Some observations. In A. M. a. K. Herzberg I. (Ed.), *Statistics, science and public policy IV. The two cultures?* (pp. 107-118). Kingston, Ontario: Queen's University.

Canadian Centre for Management Development, May, A., & Wren, L. S. (2002). *Creating common purpose [electronic resource]: The integration of science and policy in Canada's public service.* Canadian Centre for Management Development.

Doern, B. (2001). *Science and technology advice in policy – A pilot course prepared for Natural Resources Canada and Environment Canada.* Unpublished manuscript.

Jarvis, B. (1998). *The role and responsibilities of the scientist in public policy: A discussion paper on science and government.* Ottawa: Public Policy Forum.

National Research Council (US). Committee on Risk Assessment of Hazardous Air Pollutants. (1994). *Science and judgment in risk assessment.* National Academy Press.

National Research Council (US). Committee on the Institutional Means for Assessment of Risks to Public Health. (1983). *Risk assessment in the federal government: Managing the process.* National Academy Press.

Sarewitz, D. (2004). How science makes environmental controversies worse. *Environmental Science and Policy, 7*, 385-403.

Snow, C. P. (1961). *The two cultures and the scientific revolution* (7th ed.). London: Cambridge University Press.

The Institute for Science, Society and Policy

The Institute for Science, Society and Policy offers a unique, holistic approach to understanding the social implications of science and technology. We're interested in how to use these different perspectives to inform science and technology policy.

Centered at the University of Ottawa, the ISSP carries out research, teaching and public outreach on the relationship between society and science, innovation and technology.

Institute for Science, Society and Policy
Desmarais Building, 10th Floor
55 Laurier Ave. East,
Ottawa, Ontario, Canada
K1N 6N5

Address inquiries and comments to:
issp@uottawa.ca

uOttawa

issp.uottawa.ca