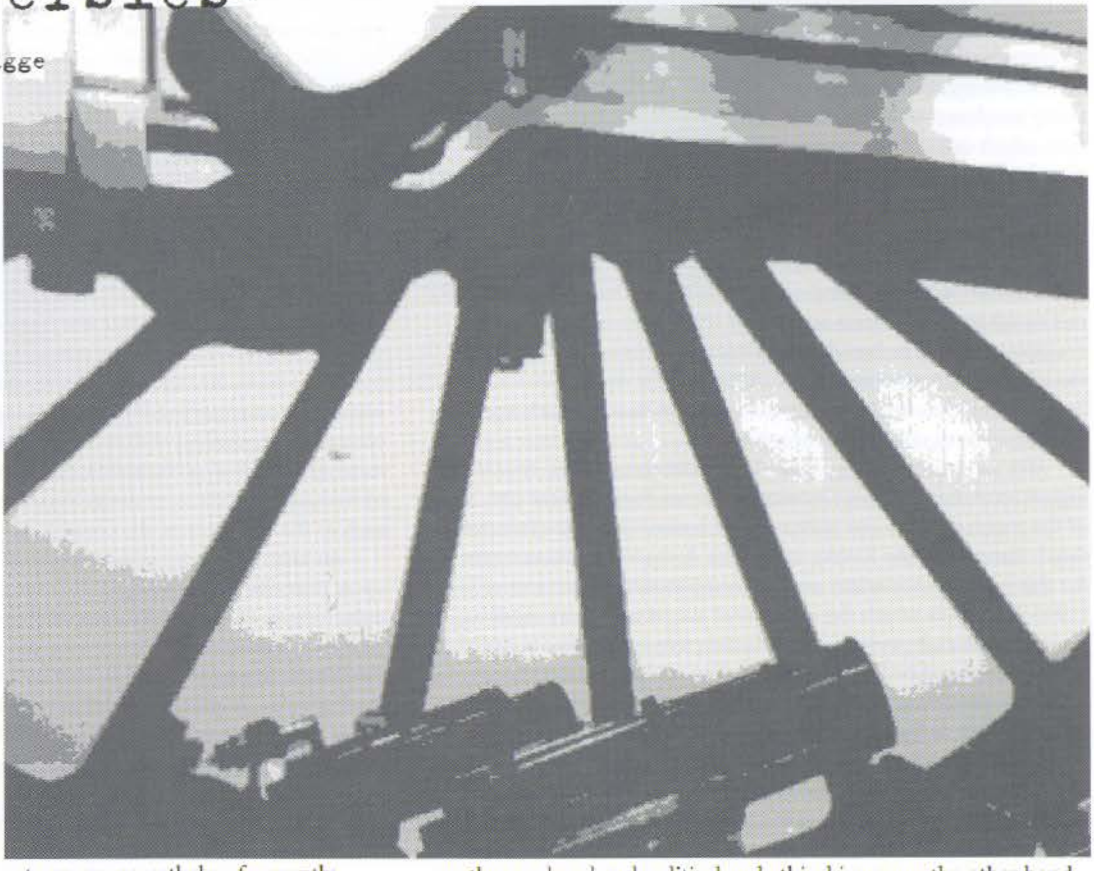
Boundary Work in Regulatory Controversies[1]

By Karl-Michael Nigge



Introduction

The regulation of technological risks is an area in which science and policy are generally linked in an inextricable fashion that Wynne aptly describes through the metaphor of the "regulatory jungle" (1992a). It involves a mixture of scientific, political and ethical issues, and due to the presence of scientific uncertainty on a significant scale, even the scientific issues cannot be answered by scientific means alone, but rely on policy considerations for their resolution. Seen from this perspective, controversies over technological risks come as no surprise.

Participants in these controversies, such as scientists, regulators or interest groups, nevertheless frequently attempt to draw clear boundaries between science and policy, which, in reality, do not exist. In general, such attempts to set up fences in the jungle are strategically motivated by the desire to allocate decision making authority in particular ways, or to attach legitimacy to decisions. If an issue can be depicted as science rather than policy, then the respective decision-making authority comes to rest with scientists rather than policy makers, and vice versa. Regardless of who makes decisions, attempts are frequently made to legitimize them by claiming that they are based on science.

In this paper, I will discuss the concept of 'boundary work,' which refers to such strategically motivated definitions of boundaries between science and policy (Gieryn, 1983, 1995; Jasanoff, 1987 and 1990). Underlying the concept of boundary work is a distinction between a substantive role of science in policy or regulatory decision-making reflects the extent to which certain questions relevant in those contexts can be answered by scientific means, such as methods, data and theories, and according to scientific quality standards. In contrast, the notion of a strategic role of science in regulation or policy-making refers to the extent to which certain characteristics, i.e., objectivity, are attributed to science in order to provide legitimization for decisions which are claimed to be based on scientific findings.

Regarding the question of how substantive and strategic uses of science relate to each other in cases where science is brought to bear upon policy or regulatory decision-making, I generally propose that science has a substantive role to play, which is, however, significantly limited due to the presence of scientific uncertainties as well as due to the intricate connection between scientific issues on the one hand and political and ethical issues on the other hand. Compared to its generally limited substantive role, science is nevertheless frequently used as a strategic resource to attach legitimacy and authority to regulatory or policy decisions.

The concept of boundary work, which will be discussed in detail in section 3, is associated with the latter, strategic use of science. Since it can only be understood in relation to the limitations of the substantive role of science in regulatory or policy decision-making, a brief account of the general character of those limitations will first be presented in section 2.

Limitations of the Substantive Role of Science

Limitations in the substantive role of science in regulatory or policy decision making are linked to two main reasons: the existence of scientific uncertainty and the fact that, in many cases, the issues relevant to a decision are not scientific in nature alone, but are tied to political or ethical issues.

Funtowicz and Ravetz (1993) distinguish between three different regimes for the substantive role of science as an input for political or regulatory decision making, based on a model which considers the two dimensions of scientific uncertainty and decision stakes[2]. In the order of rising decision stakes *and* rising uncertainty, they denote these three regimes as *applied science, professional consultancy*, and *post-normal science*. Each of these three regimes is characterized by a particular kind of scientific uncertainty, namely *technical, methodological* and *epistemological* uncertainty.

Technical uncertainty typically involves a statistical spread in measurement data, due to either random fluctuations in the mea-

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sured physical phenomena themselves or to inaccuracies of the instruments used to measure data or controll a process. In terms of the management of uncertainty, technical uncertainties can be dealt with by well-known statistical techniques of data processing. Technical uncertainties are characteristic for the realm of *applied science* (Funtowicz and Ravetz, 1993:745). Results of applied science, be they some piece of knowledge or some technological artifact constructed on the basis of that knowledge, can typically be expected to be reproducible.

Climbing up the scale of uncertainty, *methodological* uncertainty involves problems with the reliability of theories or information, which can only be managed on the level of personal professional judgment. This situation is typically encountered in situations of "professional consultancy" (Funtowicz and Ravetz, 1993:747) such as medicine or engineering. Professional consultancy generally deals with situations that have a more unique character, i.e., compared to applied science, when reproducibility of results might be more difficult to achieve (Funtowicz and Ravetz, 1993:749). In medicine, for example, this may be because theoretical consensus is lacking about the relavant factors related to the causation of a certain disease, or because an illness might be caused by various factors which are difficult to isolate or control in a specific case.

Yet another, more severe kind of uncertainty on the epistemological level characterizes the scientific issues revolving around "any of the problems of major technological hazards or large-scale pollution" (Funtowicz and Ravetz, 1993:750). A characteristic example for this level of uncertainty are the "completeness uncertainties" (1993:744), from which the widespread use of computer models typically suffers. In this case, only incomplete knowledge is available about the natural or technological system under consideration, such that important parts of the interactions within the system may be completely unknown.

The character of epistemological uncertainties van be illustrated for the case of predictions of global climate change by means of computer models. In this case, completeness uncertainties currently exist, for example, around possible feedback mechanisms, i.e., effects of changes in climate, caused in part by changes in the atmospheric concentration of Carbon-Dioxide (CO2), on the atmospheric CO2 concentration itself. More specifically, increased temperatures generally lead to increased rates of photosynthesis and hence more storage of carbon in plants, which could provide a negative feedback mechanism. On the other hand, carbon stored in soils is released with increasing temperatures, which could lead to a positive feedback. Such possible feedback mechanisms have, however, not yet been fully incorporated into climate models (IPCC 1994:56-57).

In addition to natural systems, "man-made" technological systems can also be sufficiently complex to pose the problem of incompleteness uncertainties for their analysis, e.g., in terms of safety. One of the problems for the consideration of accident probabilities in nuclear power plants, for example, is that, even though the composition of the system (in the sense of hardware) might be known in all details, incompleteness uncertainties with respect to the *pathways of accident scenarios* cannot be excluded (Perrow, 1984).

Scientific uncertainties are thus one factor that limits the substantive role of science for regulatory or policy decisions. However, they do not necessarily render scientific knowledge entirely useless for the purposes of decision-making. An example of how science can provide substantive inputs into policy making, even though those inputs may not be conclusive according to the traditional quality standards of research science, is provided by the case of ozone depletion through chlorofluorocarbons (CFCs).

In 1974, Mario Molina and Sherwood Rowland, two American chemical scientists, published their hypothesis which argued that CFCs, which had been shown to have reached the stratosphere, would destroy the ozone layer[3]. This hypothesis was based on the observation of chemical reactions in the laboratory under conditions that simulated those present in the stratosphere. Based on this hypothesis, the Congress of the United States later authorized the Environmental Protection Agency to ban the use of CFCs as propellants. This policy consensus was based on less than conclusive scientific evidence, given that direct experimental evidence of stratospheric ozone depletion was missing at that time (Weiss, 1993:230).

The missing direct evidence for ozone depletion was later provided by a group of British scientists and NASA, by the discovery of the Antarctic ozone hole, a major factor in bringing about the Montréal Protocol on the phase out of CFCs. At the same time, however, this experimental evidence could not be explained by the theoretical models of the day, such that the *causes* of the ozone hole were not firmly established at the time of the international political agreement on the Montréal Protocol (Weiss, 1993:231-6).

Litfin concludes that in order for scientific knowledge to have a substantive influence on the international negotiations leading to the Montréal Protocol, and its subsequent revisions, it needed to be framed in particular ways, so as to suggest precautionary action – namely, by emphasizing the fact of rising stratospheric CFC concentrations regardless of their ozone destroying effects. Furthermore, the political acceptability of this particular, value laden way of framing scientific knowledge depended on contextual factors, such as the discovery of the ozone hole (1994:187).

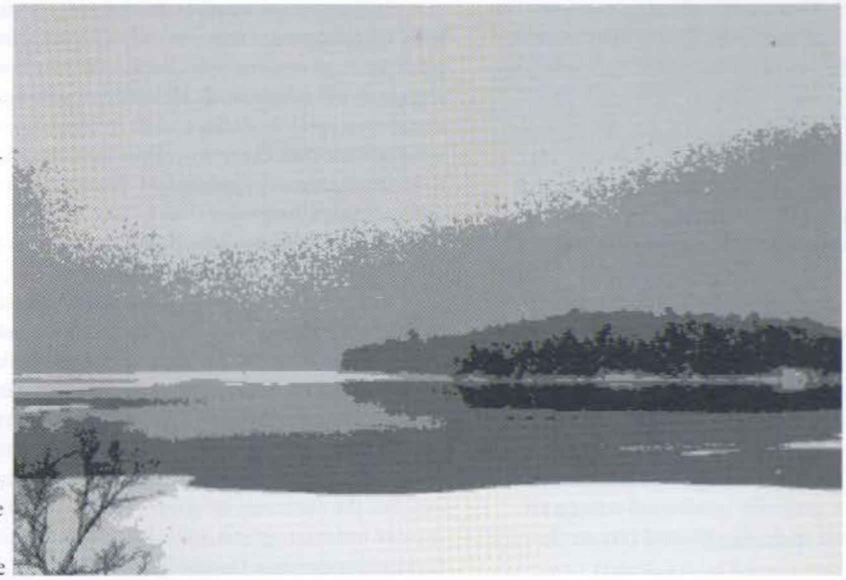
In cases where policy or regulatory decision making touches upon scientific issues, such as environmental policy or regulation of technologies, controversies associated with disagreement among various scientific experts frequently emerge. In such controversies, the substantive role of science may be further limited when a smaller or larger part of the debates surround political or ethical issues rather than scientific ones. Examples of such political or ethical issues include questions of equity regarding the societal distribution of risks and benefits, the weighing of risks against benefits, and the allocation of the burden of proof.

As a result of the limitations of the substantive role of science in providing a basis for policies or regulatory decisions, decision making in fields such as health, safety of technological systems or the environment, in which scientific inputs are often required or desirable, is characterized by a complex mixture of 'facts' and 'values,' such that it is often not clear where science ends and where policy begins.

Science which is brought to bear upon regulation or policy making, due to its close intertwining with policy, assumes characteristics that distinguish it from science in the context of research. Funtowicz and Ravetz (1993), based on their more philosophical analysis, suggest the term 'post-normal science' to emphasize these different characteristics, such as high uncertainties, value-ladenness and decision stakes. In keeping with the sociological and political science literature about science-based regulation, however, I will employ the terms 'mandated science' (Salter, 1988) or 'regulatory science' (Rushefsky, 1986) to distinguish science in the context of regulatory or policy decision-making from 'pure' or 'research science'.

Boundary Work and the Strategic Use of Science

In striking contrast to the above consideration of the limited substantive role that science can play in the resolution of regulatory or policy controversies, science nevertheless plays an enormous strategic role in these controversies. This is generally the case because of the high legitimacy appeal of scientific arguments, or simply because scientific arguments are the only ones which are legally allowed to be put forward, such as in a court case or within certain regulatory proceedings (Wynne, 1980: 183-4; Jasanoff, 1991:44).



In order to attach the legitimacy appeal associated with science to activities which are a complex mixture of scientific and political or ethical considerations, participants in controversies frequently employ rhetorical strategies to define their arguments or activities as belonging to the realm of science. Jasanoff points to the outstanding relevance that rhetorical struggles over the cognitive authority attached to science have in the field of regulatory science, where science and policy inevitably become interwoven, and analyzes such struggles in terms of the concept of "boundary work" (1990:14). Jasanoff's analysis of regulatory controversies in the United States will be discussed in detail later.

The concept of boundary work was introduced by Thomas Gieryn (1983, 1995), who defined boundary work of scientist's as:

> *their attribution of selected characteristics to the institution of science (i.e., to its practitioners, methods, stock of knowledge, values and work organization) for purposes of constructing a social boundary that distinguishes some intellectual activities as "non-science" (1983:782).*

One of the examples which Gieryn uses to illustrate the concept of boundary work is the demarcation of science from religion and mechanical engineering in Victorian England. Demarcating science was supposed to demonstrate the superiority of science, at a time when both religion and engineering presented obstacles to the expansion of scientific authority and resources. Subsequent to the publication of Darwin's *The Origin of the Species* in 1859, the intellectual authority associated with long-standing religious beliefs was an obstacle to the acceptance of scientific explanations of natural phenomena. Mechanical engineers, on the other hand, claimed that technological progress was achieved not due to, but in detachment of, scientific research, such that financial support for science and scientific education would appear without purpose (1983:784-5).

In public speeches and popular writings, John Tyndall, a professor at the Royal Institution in London, distinguished science from religion through characteristics such as the practical usefulness of science in bringing about technological progress, its empirical basis, its underlying skeptical attitude, and the objectivity of scientific knowledge (Gieryn, 1983:785-86). When distinguishing science from mechanical engineering, however, Tyndall attributed to science such elements as systematic experimentation and theoretical orientation and, furthermore, emphasized that the development of scientific knowledge precedes its technical application. Science seeks truth as an end in itself, thereby fostering intellectual discipline and epitomizing human culture. Interestingly, these attributes are in part incompatible with those that were used to characterize science as different from religion (1983:786-7).

Gieryn concludes that, while the rhetorical style of attributing certain characteristics to science in order to demonstrate its superiority over other intellectual activities is common to these and other examples, the specific characteristics attributed to science nevertheless vary according to the obstacles to be overcome and the goals that are pursued (1983:792).

Sheila Jasanoff (1987, 1990), in her analyses of contemporary cases of controversies around the regulation of chemical substances by various federal agencies in the United States, found that boundary work, in the form of definitions of allegedly clear cut boundaries in the gray zones between science and policy, is a rhetorical strategy frequently used in these controversies not only by scientists, but also by regulators and interest groups (1990:14, 236).

Boundary work is often associated with the creation of new linguistic labels or with subtle shifts in the meaning of existing notions (Jasanoff, 1987:199). In the context of regulatory disputes, new labels such as 'science policy', or the complimentary notions of 'risk assessment' and 'risk management' are created to define the boundaries between science and policy in a way favorable to those who use and interpret these labels. For similar purposes, existing notions, such as the term 'peer review', are taken from their familiar contexts and introduced into the realm of regulatory science (Jasanoff, 1987:199).

The notion of 'science policy' was introduced by a legal scholar, Thomas McGarity (1979), and subsequently gained considerable currency in regulatory debates. Science policy denotes issues which require a mixture of scientific and policy deliberations for their resolution. In this sense, the notion of science policy is similar to the term 'trans-science,' which was coined by Alvin Weinberg (1972) to denote questions to which science cannot provide conclusive answers. In contrast to 'trans-science', however, which essentially leaves open who should decide upon such issues, the term 'science policy' has the further connotation that regulatory science is a particular field of policy and hence falls under the decision-making authority of administrators, politicians or the public (Jasanoff, 1987:204-205).

This idea and the way it was implemented by several regulatory agencies in the United States met with considerable criticism from industry, however. In response, methodologies of risk assessment were developed which were supposed to provide a scientific basis for regulatory decisions. In what provides for 'classical' examples of boundary work, the gray zone between science and regulation was frequently divided into the supposedly clear-cut territories of 'risk assessment' and 'risk management'. The former was to be carried out by scientists according to the quality standards of research science and the latter was to be left to regulators or policy makers.

Despite their powerful appeal, these attempts at a separation of science from policy have not gained unanimous support. The contrasting view, which points to the numerous elements of uncertainty and subjective judgment in risk assessment which render most steps of risk assessment a mixture of science and policy, has also gained many supporters. According to that view, risk assessment and risk management cannot be separated (Jasanoff, 1987:209-213)[4].

Somewhat less obviously, demands for 'peer review' in regulatory science can serve a similar purpose of boundary work, appealling to the notion that regulatory science could fulfill the same standards of quality controls as research science, where the concept of 'peer review' was derived. While peer review is problematic in research science, it poses further problems in the context of

PHOTO: JERRY VALEN DEMARCO, KENNISIS LAKE, ONTARIO regulatory science. For example, how are peers selected, and how does the purpose of their review and the structuring of the process affect their review, given the higher decision stakes and the more irreversible character of regulatory decisions (Jasanoff, 1987:218-219)?

The notion of peer review in research science has its origins in the review of scientific papers in order to determine whether they are suitable for publication in a scientific journal. When a paper is submitted to a journal, the editor of the journal typically selects between one and three scientific peers of the author, who review the paper and provide the editor with comments as to whether it is suitable for publication. The ideal of peer review is that it occurs objectively, according to well established, impersonal criteria for the validity of scientific findings (Jasanoff, 1990:63).

Despite the existence of criticisms of peer review in research science, there is broad agreement among scientists that, by and large, the process of peer review of scientific publications works reasonably well (Jasanoff, 1985:21). Even though it is not considered to be fail-safe, peer review is generally considered among scientists as the best possible method of quality control (Jasanoff, 1990:69).

Nevertheless, peer review of scientific publications does have its problems in practice. For example, the selection of the peer reviewers of a scientific paper by journal editors as well as deliberations by the editors themselves can have a significant influence on the outcome of peer review. Editors can often anticipate the kind of comments they will receive on a paper if they select certain scientists as reviewers. Furthermore, journal editors themselves generally have certain discretionary powers in deciding whether or not to publish a paper, giving consideration to aspects such as its novelty, its likely audiences and its political relevance (Jasanoff, 1990:67-68).

Proposals to apply the process of peer review to regulatory science derive their convincing appeal from the underlying assumption that there are no differences between regulatory and research science. As Jasanoff points out, however, regulatory science differs in several aspects from research science in such a way that the problems that exist with peer review even in the case of research science are significantly exacerbated when attempts are made to apply peer review to regulatory science (1990:76-83).

As may be recalled, one difference between research and regulatory science lies in the fact that regulatory science tends to involve higher uncertainties. The issues relevant to decision making are often located at the margins of existing knowledge, driven by what would be desirable to know for the purposes of decision making, rather than by what can be known or suitably investigated on the basis of existing knowledge and methods. The other main difference is that the stakes in regulatory science are typically much higher than in research science. For both reasons, the danger that peer review might lead to biased results is significantly higher in regulatory science than in research science. This problem is compounded by the fact that time plays a critical role in regulatory decisions. While errors in peer reviews of scientific publications may be corrected later on, corrections to regulatory decisions, once taken, are not easily made (1990:79-82).

While variations in the practice of peer review occur in the case of scientific publications (Jasanoff, 1990:64), the above problems raised by the application of peer review to regulatory science convey crucial significance to the question of how such peer review procedures would be organized in detail, such as the selection of the peer reviewers and the openness of the process. Proposals of 'peer review', in the context of regulatory science, appealling to a supposedly well defined meaning and unproblematic character of peer review, represent, instead, instances of boundary work. The gray zone of the intertwining of science and policy in mandated science is simply subsumed under the realm of "pure" science for certain strategic purposes.

In discussing boundary work in regulatory controversies, then, it becomes apparent that not only scientists, but also other participants in these controversies, such as regulators and interest groups, engage in boundary work. Generally speaking, the motivation of actors to employ boundary work in regulatory controversies is to enlarge their own control over the decision making process, and/or to attach legitimacy to claims or decisions. This can be pursued in different ways, however.

As far as regulators or policy makers are concerned, they can either declare a certain range of issues in the gray zone between science and policy as 'science policy' in order to claim that it is ultimately within their responsibility to make decisions regarding those issues. Alternatively, they might also consider it advantageous to declare the same issues as 'science', as long as more or less informal arrangements can be found between regulatory agencies and their scientific advisory bodies. Doing so allows the agencies to effectively retain some influence over these issues, while, at the same time, attaches the authority of 'science' to the outcome in order to make it more resistant against attempts at deconstruction under conditions of controversy (Jasanoff, 1987:212).

As to scientists, their general motivation to engage in boundary work is to preserve the cognitive authority and integrity of science, and to prevent the deconstruction of scientific 'facts' which typically occurs in the more or less adversarial settings of regulatory disputes, from proceeding into the realm of 'pure' science (Jasanoff, 1987:224). Scientists can hereby pursue two fundamentally different strategies. They can, following Weinberg (1972), separate areas of maximum conflict and scientific uncertainty from science itself and attach new labels, such as 'trans-science', to them in order to emphasize their difference from 'pure' science. This strategy, however, leaves it open to whom the authority to make decisions in these gray zones between science and policy should accrue, and according to what procedures these decisions should be made (Jasanoff, 1987:224). This strategy, therefore, minimizes the influence of scientists in regulatory decisions.

Alternatively, scientists can attempt to maximize the influence of science by means of overemphasizing the extent to which scientific consensus actually exists, and thus attempt to 'sell' certain positions as being backed by science which, in reality, emerge from a mixture of scientific and policy considerations (Jasanoff, 1987:225).

In addition to scientists and regulatory agencies, whose motivation for engaging in boundary work is usually an attempt to acquire direct control over the decision making process, other participants in regulatory controversies, who might not have the opportunity for such direct control, such as interest or advocacy groups, also engage in boundary work in order to influence the decision making process according to their own interests. As Jasanoff suggests, since the outcome of a decision making process often depends on the way the authority to make the decision is allocated, it makes sense for them to attempt to take control away from those actors whose decisions are deemed to be less favorable (1987:224).

In the American context, for example, industry tends to see the regulatory agencies such as the Environmental Protection Agency (EPA) as captives of environmental interests. In an attempt to undermine the discretionary power of the agencies, industry has thus argued that the 'scientific' component (risk assessment) should be separated from the 'policy' component (risk management) of regulatory decisions. They also argue that the 'quality' of the 'scientific' component should be assured by means of 'peer review' by scientists external to the agencies. The underlying assumption was that review by external scientists would generally lead to decisions which are more favorable to the interests of industry (Jasanoff, 1987:220, 226).

Calls for peer review in regulatory science are not limited to industry, however. Depending on the circumstances, a call for peer review might as well emerge from public advocacy groups. This happened at one point in the controversy over the carcinogenicity of formaldehyde in the United States, when a decision by John Todhunter, a leading staff member of the EPA, to interpret the experimental data on the carcinogenicity of formaldehyde in a particular way ran counter to the previous practices of the EPA. Notably, the meaning that public interest groups and some politicians attached to 'peer review' in this case was that of internal review by agency staff, as opposed to review by external scientific experts. This internal peer review would likely have resulted in a reversal of Todhunter's decision (Jasanoff, 1987:221).

Moreover, this example illustrates that the rhetorical struggles between actors in a controversy can also take the form of attaching different meanings to the same notion, as opposed to attaching different labels to the same activity. These shifts in meaning of a term are particularly likely to occur for terms that are new in the regulatory arena, such as 'peer review' (Jasanoff, 1987:223).

Summary

For science, which stands in a context of regulatory or policy decision making, two different roles can be distinguished. The substantive role of science, i.e., the extent to which questions relevant to such decisions can be answered by scientific means and according to scientific quality standards, is generally limited due to the existence of scientific uncertainty, and the fact that, in many cases, the relevant issues are not only scientific, but often tied to political or ethical issues. Accordingly, in science based regulatory decision making, science and policy considerations are typically interwoven in a mixture that cannot easily be separated into pure constituents.

In this situation, despite its generally limited substantive role, science nevertheless frequently plays an important strategic role. Labels such as 'risk assessment' or 'peer review' are frequently attached to activities in the gray zone between science and policy in order to suggest that they are purely scientific in character. This is done in order to confer decision making authority to scientists, or in order to attach the "legitimacy" appeal of science to decisions that have been taken by either scientists or regulators. Alternatively, hybrid science/policy activities can also be subsumed under labels such as 'science policy', which place more emphasis on their political character, in order to shift decision making authority towards regulators or policy makers.

Generally speaking, different actors in regulatory controversies, such as scientists, regulators or interest groups, may wish to define boundaries in the gray One between science and policy according to their own interests, in order to enlarge their own control over the decision making process, or at least to take control away from those actors whose decisions are deemed to be less favorable. The concept of boundary work denotes such strategically motivated definitions of the boundaries between science and policy.

Notes

1 This paper is a modified version of chapters 1 and 2 of my Major Paper entitled, "Seismotectonic Boundary Work: A Case Study of Seismic Hazard Assessment in the Regulation of Nuclear Energy in Canada", in which I examine phenomena of boundary work for two cases of regulatory decision making related to an ongoing debate among scientitsts over the assessment of earthquake hazards for the sites of the Pickering and Darlington Nuclear Generating Stations east of Toronto.

2 While Funtowicz and Ravetz largely assume that these two dimensions are independent from each other, Wynne (1992b:116) argues that they are dependent in the sense that all three kinds of uncertainty are always present, and that they are brought up in regulatory or policy controversies to varying degrees depending on the decision stakes and on the particular goals that actors in such controversies pursue. In this sense, Funtowicz and Ravetz assume a more essentialist position regarding the existence of various kinds of scientific uncertainty, while Wynne emphasizes the social construction of uncertainty. A detailed discussion of these arguments is beyond the scope of this section.

3 Rowland and Molina received the Nobel Prize for Chemistry in 1995 for their work on stratospheric ozone depletion.

4 Based on the arguments provided in section 2, I support the latter position.

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Karl-Michael Nigge is a graduate student in the Faculty of Environmental Studies at York University.