Rethinking the puzzles of the science-policy nexus: Boundary traffic, boundary work and the mutual transgression between STS and Policy Studies.

by

Robert Hoppe[i]

Twente University
Faculty of Public Administration and Public Policy
P.O. Box 217, 7500 AE Enschede, The Netherlands
Phone: +31 53 489 4684
Email r.hoppe@bsk.utwente.nl

Paper prepared for the EASST 2002 Conference, 'Responsibility under Uncertainty',York, 31 July– 3August.

[i] I am grateful to Willem Halffman for comments on a previous draft of this paper; and for generously allowing me to use passages from a co-authored text still in the making, W. Halffman & R. Hoppe, Rethinking Political Judgment and Science-Based Expertise: Research Protocol, Twente University, Enschede, 2002.

Introduction.

Any arbitrary selection of stories in the newspapers and the other media testifies to the troubled relationship between politics and science. Here are just a few examples, which easily could have been expanded in an endless list.

"Environmental institute lies and cheats" is the headline in one of the Netherlands' leading newspapers (*Trouw*, 20 January, 1999). The article reports on accusations of bad quality of research by the well-known Dutch National Institute for Health and the Environment (RIVM), aired by the senior statistician of its laboratory for soil and groundwater research , dr. ir. J.W. de Kwaadsteniet. He complains about imprecise data, lack of measurement and over-reliance on model-based calculations, and the lack of competition in Dutch science. MP's are 'shocked' and, under the spell of market-oriented thinking, demand independent "accountancy audits" on RIVM's future research products. The Minister of Environmental Affairs comes to the rescue of the RIVM; and succeeds in securing a 2 million pounds budget increase for more observation and measurement. Scientists respond in a series of op-eds, in which the RIVM's predicament is interpreted as symptomatic for modern science. They propose solutions that pretty much cover every nook and cranny of the contemporary epistemological debate. Meanwhile, the environmental movement keeps a very low profile on the issue; it dares not to take anybody's side. Although the RIVM denies internal problems and struggles, it steps up its measurements efforts, initiates more and faster peer reviews, and starts working on internal guidelines for dealing with uncertainty and communication with its knowledge-users (Van Ast, 2000; Van der Sluys et al., 2002).

Next consider a collection of stories about the continuing political controversy, *Whither Schiphol Airport*? For decades already, the Dutch government relies on bureaucratic and scientific expertise in airport policymaking. Yet, according to famous public administration scholar and policy consultant, Professor Roel In 't Veld, it is facing an imminent 'administrative catastrophe' on this issue (*NRC-Handelsblad*, October 3, 1998).

(1) Bureaucratic expertise is vested in the National Civil Aviation Bureau (Rijksluchtvaartdienst, RLD), which is a Directorate-General of the Ministry for Traffic and Water Management. According to a leading Dutch newspaper (*NRC-Handelsblad*, October 9, 1998), for many years the civil aviation industry, supposedly regulated by the RLD, offers RLD civil servants and their families very cheap tickets if they fly Royal Dutch Airlines (KLM). Green-Left leading MP Rosenmöller sharply interrogates the Minister. Yet, an RLD spokesperson was quoted, stating that "although their is the appearance of some dependence, it was never shown to influence our work." Is this evidence of a conflict of interests and possible agency capture?

(2) Scientific expertise is concentrated in the National Aviation and Aerospace Laboratory (Nationaal Lucht- en Ruimtevaart Laboratorium, NLR) in Amsterdam. Yet, confusion, incompleteness, conflicting evidence, and uncertainty about the quantitative bases of previous Cabinet-decisions has become so rampant, that the leading Labor MP, Mr. Melkert, publicly went on record as 'getting absolutely crazy' about the data input for political judgments and decisions. Surprisingly, a public hearing by parliament of the very same experts responsible for this 'mess' instantaneously but temporarily dampened the parliamentarian outcry. Does this mean that experts bungled their jobs? Or were experts blamed in an indirect political attack on a previous Liberal Party (VVD) Minister? Or did experts really clear up the 'mess', so that politicians were satisfied that they were 'on top' and the experts were 'on tap' again?

(3) Also for years already, community groups and the environmental movement, supported by court rulings, demand scientific evidence on the possible causal connection between nightly air traffic noise, sleep disturbances, and potentially harmful health effects, as a pre-condition for further political decisions on airport expansions. Experts of the Dutch national Health Council (Gezondheidsraad, Gr) judge that reliable evidence will take many years of costly research, but meanwhile support the judiciary's position on the basis of an appeal to the precautionary principle. An inconclusive British study on noise doses and health impacts of London's

Heathrow Airport suffices to stifle political debate and decision-making on the issue in The Netherlands (NLR, 1996). A large-scale and expensive international-comparative study on the health impact of large airports by the National Health Council (1999) only results in the recommendation of ongoing integrated health assessment as a basis for political decision-making on the further development of the civil aviation system. Does this mean that community protesters and the environmental movement have lost trust in Dutch health experts; is the legal system unable to redress the executive; do business interests dictate political authorities' judgment; or did health experts correctly point out a trans-scientific problem?

(4) In Fall 1996 an expert meeting on the Schiphol Mainport debate was called on the premises of the Faculty of Policy Sciences at Catholic University Nijmegen. Over forty researchers and policy analysts presented their studies. Almost all uncritically presupposed the validity of the 'twin goals' of the Schiphol Mainport governmental policies: economic growth through airport expansion and, simultaneously, substantial reduction of environmental damage and nuisance. They only disagreed on the alternatives for most effectively and efficiently realizing those twin goals. Only two studies dared question the feasibility of the twin goals, and discussed alternatives beyond the political consensus. Are scientific advisors like the piper who plays whatever tune called by government and business interests?

(5) Scientific advisors of the Dutch Government's official think tank, the Scientific Council of the Government (Wetenschappelijke Raad voor het Regeringsbeleid, WRR) have recommended that every large infrastructural project, among them the Schiphol Mainport plans, requires a debate on (national) utility and necessity (WRR, 1994). Regarding Schiphol, this has exacerbated the argumentative deadlock between pro- and anti-expansionists. Dissatisfied by this unproductive political and public controversy, in 1997 the Cabinet organized an open and interactive policy-analytic debate between all the stakeholders on the Future of Dutch Civil Aviation Infrastructure (Toekomst Nederlandse Luchtvaart Infrastructuur, TNLI). Although discursive policy analysis clearly shows three more fruitful problem frames emerging from the TNLI policy exercise, and

'common sense' political judgment endorses the idea, Cabinet refrains from new problem structuring and agenda-setting on this very controversial issue (Van Eeten, 1999, 2000). Were WRR-experts premature in their recommendation? Or, alternatively, did Cabinet prudently ignore contrary expert advice by a lower-status expert with less access to political circles? Or was the Cabinet just caught between contradictory expert advises and acted on the spur of its own internal power struggles?

>From whatever perspective these examples are looked at, they show a troubled relationship between political judgment and science-based expertise. In the popular media three cliché images compete for interpretive hegemony. The business-as-usual political story is that, in spite of appearances to the contrary, politics is safely 'on top' and experts are still 'on tap'. The corresponding story told by proud scientists is that power-less but inventive scientists only 'speak truth to power'. But the examples mentioned as '*pars pro toto'* for the reality of the science/politics nexus cannot be illuminated, let alone explained by these front-office rhetorical strategies by politicians and scientists. There is plenty of room for a more cynical interpretation. It sees scientific advisers as following their own interests, unless better paid by other interests; and politicians as asking for advice only to support and legitimize their pre-formed political decisions. To the extent this cynical perspective gains ascendancy, politics and science loose credibility – not only for each other, but foremost in the eyes of the public at large. If we think the three clichés cloak a more complex reality, we should embark upon a quest for other, possibly better models of the science/politics nexus in our contemporary world.

That is exactly the purpose of this essay. Its major claim is that a transgression from the knowledge utilization strand of research in policy studies (KU-PS) into the field of science, technology and society (STS) will provide us with a number of more sophisticated images of

science/politics boundary traffic. These two interdisciplinary fields[1] claim to systematically study the relationship between politics and science. Moreover, they appear to have done so in mutually complementary ways. Peter Weingart (1983) claims that the development of the science-policy nexus since (at least) the Second World War can be described as a dialectical process of the *scientification* of politics or policy and the *politicization* of science. STS-studies can claim credit for showing the latter tendency (Cozzens & Woodhouse, 1995:551). STS-scholar Arie Rip (2001) nicely captured the gist of these findings and insights by calling for a '*political science of science'* as a logical next step in STS. On the other hand, Policy Studies, and particularly Policy Analysis, has in fact contributed to the scientization of politics (Fischer, 1990; Hoppe, 1999).

Since its inception in the early sixties, STS-oriented sociologists and anthropologists have studied the boundary work by scientists in labs and R&D work-sites. Later, the concepts was extended to other institutional spheres where boundary work by scientists was important; especially, the science-politics/policy nexus. Partially on that basis, STS-oriented epistemologists interested in the transmission and application of science in public policy have discovered the existence and relevance of numerous trans-scientific questions, emergent complexity, and post-normal science. In the process they have gained a much better understanding of how experts and science-advisors fit in complex political problem-solving efforts. Whereas Science and Technology Studies (STS) has developed epistemologically sophisticated tools to analyze science-in-society, it has had a difficult time to connect to ongoing societal debate and policy issues, often remaining remarkable naïve with respect to the policy game (Halffman 2002; Jasanoff, 1996) In addition, STS has remained largely invisible to neighbouring fields of social science, which often lightly discarded several decades of research as being relativist, contrived or excessively post-

[1] STS-related sciences range from the sociology of knowledge, sociology of science, (social) sciences concerned with technolgical development and innovation, any of the R&D-oriented and 'applied' sciences (e.g. biology, chemistry, physics, health and life sciences), to philosophy and history of science, and research on professions (cf. Edge, 1995). Among the PS-related sciences are policy science and analysis, political science, political philosophy, cognitive and decision sciences, 'applied' statistics, economics (cost-benefit analysis, welfare economics, public choice) and sociology (with lots of sub-fields), anthropology (esp. the cultural constructivists), (social) psychology, public administration, policy impact evaluation methodologists, knowledge utitlization research (cf. Dunn & Kelly, 1990).

modern. In recent years, political scientists and public policy analysts are becoming increasingly interested in STS. The combination seems almost too obvious: with the seemingly limitless growth of the role of experts and their knowledge in policy making, the refined tools and concepts of STS with respect to science and technology could be combined with theories of policy making and the operation of the state.

PS was actually launched a full decade earlier than STS, in the fifties, as a prophetic call (Lasswell and Lerner, 1951) to harness the (social) sciences for solving practical problems of public policy. PS scholars only gradually lost their technocratic and essentialist neo-positivist assumptions about what they saw as the application of science *in* policy, i.e. ways to provide science-based expertise in political decisions and policy controversies. In fact, the topic of the role of science *in* policy has been much more thoroughly and creatively studied by STS- than by PS-scholars[2]. By contrast, PS became much more sophisticated in science *of* policy, i.e. explaining policy change in the wider context of long term developments (demographic and economic shift, changes in institutional interdependencies), short term impacts (from public opinion, media reporting, and power shifts due to elections) on policy networks, changing political opportunity structures and distributions of resources and constraints, and policy domain-specific inter-actor dynamics. Re-combining at long last findings and insights from both science *in* and *of* policy, they became much more alert to interaction processes between policymakers and science-based experts (Fischer, 1990; Barker & Peters, 1993) in processes of policy-oriented learning (Morone & Woodhouse, 1986; Sabatier & Jenkins-Smith, 1993).

The rest of this essay on the mutual transgression of PS and STS for better understanding the science/politics nexus will unfold in the following steps. The second and third sections commence the quest for better models by comparing the (dis)similarities between Knowledge Utilization research in Policy Studies (KU-PS) and STS. The fourth section builds upon Wittrock's historical-institutional approach in constructing a property space for the systematic

distinction between different boundary traffic models. In the fifth section, each of the eight models found will be specified in terms of possible consequences for 'successful' or 'productive' boundary traffic. In the final section a tentative research agenda is proposed. We should try to discover the conditions under which some of these models may claim greater verisimilitude. As a by-product this may allow us to rethink the role of scientific expertise in policymaking and generate a model that guides experts and policymakers (and perhaps other stakeholders as well) in their day-to-day boundary work.

1. Policy science on knowledge utilization: unsuccessful scientization?

Policy studies is the study of the contents, processes and impacts of (public) policies in order to explain variations in policies (between policy domains, between countries) and policy change over time (in terms of direction and speed). Following Lasswell (1971), this scientific goal of PS is referred to as knowledge *of* policy. But PS has a practical knowledge interest as well. Policymakers and, in a democratic polity, citizens, also need to know how policy processes really come about. This demands optimal knowledge *of* policy. Policymakers who, in a welfare state tied to the rule of law, want to successfully cope with problems on the political agenda, should be able to mobilize the best available knowledge. This requires high-quality knowledge applied *in* policy. There is an obvious link between knowledge of and in policy: The more and better knowledge *of* policy, the easier it is to mobilize knowledge production for and application *in* policy. Lasswell expressed the interdependence between knowledge *of* and *in* policy by defining the policy analyst's operational task as focusing the attention of all those involved in policymaking so as to bring about their maximum rationality. Dror (1971:50) expressed the same ambition by constructing policy analysis as an additional (to normal applied social and management science) approach for the "systematic application of knowledge, structured rationality and organized creativity in the service of the self-conscious transformation of society."

[2] The knowledge utilization studies in the seventies to mid-eighties are a possible exception; the impact on and meaning of the

For the policy analyst this implied the development of two skills. One, for the sake of mobilizing the best available knowledge in policy, s/he should be able to mediate between several different scientific disciplines. Second, for the sake of optimizing the interdependence between science in and of policy, s/he should be able to mediate between theory and practice, between science and politics. Hence Dunn's (1994:84) formal definition of policy analysis as an applied social science discipline that uses multiple research methods in a context of argumentation, public debate and political struggle in order to create, critically evaluate, and communicate policy-relevant knowledge. Historically, the differentiation and successful institutionalization of policy studies in American and European universities can be interpreted as the scientization of the functions of knowledge organization, storage, dissemination and application in the knowledge system (Dunn & Holzner, 1988; Van de Graaf & Hoppe, 1989:29). Moreover, this scientization of hitherto 'un-scientized' functions of the knowledge system, by expressly including science *of* policy contents, processes and impacts, aimed to gear these functions to the political system. In that sense, Lasswell and Lerner's (1951) call for policy sciences prophetically anticipated a trend towards the *scientization of (democratic) politics* to become clearly visible only later.

Looking backwards, it is clear that policy science overburdened itself. Although Lasswell's interdependence thesis between knowledge *in* and *of* policy is logically impeccable (and ethically honorable), it proved to be too much for the newly conceived discipline to operate simultaneously on both fronts. Hence, something of a division of labor occurred between two types of policy studies. One part specialized in developing basic knowledge *of* policy contents, processes and impacts by embarking upon a research program around the key concept of 'stages in the policy process'. Another part, calling itself policy analysis, specialized in developing a toolbox of analytic techniques for the policy consultant engaged in producing science-based advice to administration and politics. In the process, both policy studies projects lost a serious, sustained empirical interest in the role of knowledge *in* policy. Both currents suffered from the

knowledge utilization literature for the development of policy studies since the mid-eighties is discussed in section two.

then current belief that the social sciences should emulate the hard sciences as much as possible, and hence succumbed to essentialist conceptions of science, especially (economic) deductivism, neo-positivism, and later - to its credit - Popper's critical rationalism (Hoppe, 1999). Especially the policy analysis part of policy studies, of course, had an interest in piggy-backing on the functional authority of capital-S science for policy/politics. At the price of a retreat from Lasswellian democratic and pragmatist ambitions in favor of inherent technocratic tendencies, policy analysis succeeded in institutionalizing itself both in the academic and administrative/political worlds.

The division of labor between 'stagists' and 'policy analysts' is far from absolute. Both currents keep an eye on each other, and from time to time cross-fertilization happens. One such wave of cross-fertilization, in the late seventies till the mid-eighties, is known as the era of knowledge utilization studies. In our interpretation, this period is of crucial importance to the recent history of policy studies - and certainly to the quest for models of boundary traffic between science and politics attempted here.

Under cognitive attacks from fellow (social) scientists and pragmatic criticism from administrators and politicians, policy analysts and evaluators[3] started asking themselves if their professional inquiry was really more useful than ordinary knowledge (Lindblom & Cohen, 1979). This sense of crisis spurred a wave of empirical investigations into the actual use of policy-analytic advice in political practice (Caplan, 1977; Bulmer, 1978; Weiss & Bucavalas, 1980). Evaluating the results of these studies, Weiss (1991) concludes that it became clear that the findings of policy analysis and policy (impact) evaluation studies, if they arrived in the political arena at all (a fair amount of *non-use* was reported), they arrived in fundamentally different ways.

Most policy analysts thought for quite some time that practice is best served through direct input of scientific data in decision-making: research today means decision help tomorrow.

Policy analysis inspired by deductivism/analycentrism, neopositivism and critical rationalism displays this character of *instrumental use* or *research as data*. Indeed, there is quite some policymaking that, among other inputs, depends on a continuing stream of routinely collected data. Holland Statistics'[4] regular surveys of economic trends are a good example. However, this very direct way of decision support through policy analysis appeared to occur only in a small minority of cases; especially when research outputs enabled policymakers to do better what they planned to do anyway.

Much more frequently research outputs through knowledge creep had an indirect and unintended function for policymakers as *conceptual use*, enlightenment, or *research as ideas*. Some studies by the Dutch government's official think tank, the Scientific Council for Governmental Policy, are nice examples. For science this meant both good and bad news. The bad news was that research findings were severed from their nuances and qualifications, and re-shaped as un-scientific, over-generalized, and popularized 'stories'. Of course, the good news was that scientific findings did sometimes focus political attention in the shape of new views, innovative problem definitions and policy alternatives.

Knowledge utilization studies also showed a fairly large number of cases where research output, as hypothesized by Lindblom as early as the sixties (Lindblom, 1965, 1968), was used as a political weapon legitimizing an already advocated political position, that is *tactical or selective use* of *research as (advocacy) argument*: "When this happens, not only are some of the data lost, as with research as ideas, but data are selectively lost. Those findings that favor 'the other hand', or weaken the power the argument, are sheared away in order to make the argument more persuasive" (Weiss, 1991:314). The only function of analysis is to legitimize an extant political judgment. A nice example was reported about the political interpretation of uncertainty in the

[3] Policy analysis is a toolbox of design methods and heuristics to arrive at plausible *ex ante* judgments on the qualities of alternative policy options. Policy evaluation is a collection of research methods and techniques for arriving at valid propositions about the causal links between an implemented policy and its impacts, usually goals-achievement, effectiveness and efficiency of policy instruments. Policy analysis and evaluation both serve the purpose of well-argued and well-researched expert advice for policymakers.

[4] The now partially privatized, former Central Census Bureau (Centraal Bureau voor de Statistiek, CBS).

RIVM's 2000 Environmental Audit (*Volkskrant*, September 16, 2000). The RIVM reported that, to its surprise, carbon dioxide emissions had decreased while the economy had boomed. Analysts could explain this finding only by appealing to irreducible uncertainty around what exactly happened to large buffers of oil and coal stored on Dutch soil. But politicians immediately jumped upon the 'fact' of decreasing emissions during exuberant economic growth in order to argue that their environmental policy had been 'successful'.

The cause for this disappointing state of affairs is sought in the gap, that is a number of incompatible characteristics of the research and policymaking communities (Caplan et al., 1975). For example, the policy world deals with complex real problems which do not allow complexity reduction along the disciplinary boundaries of science; the policy world is risk averse or even legally bound not to experiment, and looks for verification, whereas science is inherently interested in the new and unexpected, loves quasi-experimental evaluation designs, and looks for falsification; and in terms of time frames, policymakers want quick results for external administrative and political accountability where analysts need time for internal quality control(Henke, 2002: 3). Apart from the two worlds hypothesis, PS-KU literature has generated a lot of knowledge about contextual factors, issue-arena characteristics, linkage tools like dissemination procedures and organizational arrangements which all influence the amount and extent of knowledge utilization (Patton, 1997; Guba & Lincoln, 1989). Some even believe that the 'gap' metaphor should be replaced by that of the 'seamless web'; and hece propose that scientific input in policy should be made entirely dependent on the contingencies and erratic dynamics of the policy-making process (Van Eeten & Ten Heuvelhof, 1998; In 't Veld, 2000). Building on these insights policy analysts and evaluators nowadays have at their disposal "a cafetaria of answers to the question of what kinds of research are most apt to be used"(Weiss, 1999). But a great deal of this knowledge is contextual in ways insufficiently understood for a systematic 'toolkit'-like set of do's and don't's.

In summary, the main impression is that analysts and evaluators have but few degrees of freedom in the choice of role in policy-making. As data providers they aim at direct instrumental use, which is usually beyond their reach. If they succeed and their input is actually used, this normally depends on prior alignment between their work and political ambitions. As idea mongers, scientists are completely dependent on the media and other idea brokers and policy entrepreneurs; but this may leave them rather indifferent. As providers of argumentative ammunition, analysts are recruited by politicians and not the other way round.

Taking the PS-KU studies seriously, we get a rather depressing image of the scope and relevance of strategic science. But perhaps such an image is biased due to the immodest aspirations of PS' to contribute to the scientization of politics and policy-making as forms of collective instrumental action.

2. STS on the politicization of science and intensification boundary traffic

STS does not take knowledge use as its analytical point of departure, but rather the producer perspective. Particularly, STS-research tries to uncover the unexpected impact of social influences on apparently pure scientific laboratory research and more applied R&D activities. The STS perspective is exemplified in the role of the World Health Organization (WHO) as sponsor of research into the best typification varieties of HIV-viruses. Although one should be indifferent between molecular-biological or immunological classification techniques on scientific grounds, WHO's efficiency considerations in due course of time favored molecular-biological techniques because the results of both types of classification work could be stored in an existing molecular-biological database (De Bont, 2000).

Applying critical sociology, symbolic interactionism and ethnomethodology to the innermost workings of the laboratories (Latour, 1988; Knorr Cetina, 1995), STS-scholars have been able to punctuate some myths about science. The first such myth is the idealist image of science as producer of privileged, authoritative knowledge claims, supported by an ascetic

practice of Mertonian norms for proper scientific conduct (commonality or communism, universalism, disinterestedness, organized skepticism - CUDO's). These are just the outside, legitimizing veneer of scientific practices and successes. Using interpretive frames from Marxist science studies, conflict theory, interest theory, and social constructivism, a much more realistic, but to some over-cynical, perspective on science has been developed (Restivo, 1995). Scientists, like everyone else, are motivated by self interest, pride, profit, power and the anticipation of glory and public heroism. Instead of Mertonian CUDO-norms, contemporary scientists *de facto* behave as if science were proprietary, local, authoritarian, commissioned, and expert (Ziman, 1990 - PLACE). From Olympian heights of abstraction, curiosity-driven noble speculation, innovative but stringent experiments, and Humboldtian institutional autonomy, small-s science came down to earth as a social movement (Yearley, 1988:44ff) driven by local and practical, sometimes openly political interests, entrepreneurial, fiercely competitive, wildly speculative with an 'anything goes' methodology, and selling itself to government and big business in the race for financial resources.

Thus, laboratory politics extended into the political domain. But it would be wrong to attribute this just to science's institutional self-interest in finances and public acclaim. To the extent scientists were successful in producing authoritative cosmopolitan (not truly universal, Rip, 1997:625) knowledge claims and upholding them in their translation into successful large technological projects (frequently in war-related fields, like the famous Manhattan project which produced the A-bomb), they were invited by politicians and administrators as useful advisers. Thereby politics paradoxically contributed to its own scientization; and politics at least co-created a public climate in which scientists have to display PLACE-ethos for strategic science to flourish.

A second myth punctuated by STS research is that of science as ivory tower. At first, till the early seventies, it looked like the science-politics nexus would be just mutually beneficial. The institutional 'covenant' between the two spheres, aptly named "*Science, the Endless Frontier*" (Rip, 1997) meant a high degree of institutional autonomy, lots of resources, and privileged access to

political decision-making through advisory positions for science. Politics, impressed by and grateful for science's contribution to the war effort, rested content in expecting the same high pay-offs of scientific research for civilian purposes. As these promises turned out to be empty or merely disappointing, science's cognitive authority waned, and politics gradually revised the covenant by tightening its conditions for financial support and scientific autonomy. The new inter-institutional contract between science and politics is now called "*Strategic Science*". On the one hand, politics forces criteria of relevance on scientists, which clearly indicates the politicization of science; on the other hand, "(s)cientists have internalized the pressure for relevance, but at the same time have captured it for their own purposes by claiming a division of labor. Typical stories emphasize strategic research as the hero at the core of one or more 'innovation chains' where the switch from open-ended research to implementation would occur" (Rip,1997:631). This, of course, points towards the continued scientization of politics.

In spite of the fact that numerous studies of public and political controversies showed that science-advisors in the political arena behave pretty much like any other self-interested political actor (Nelkin, 1995), science somehow managed to maintain its functional cognitive authority for politics. To explain this paradox between continued functional cognitive authority and PLACE-type behavior by scientists, the concept of *boundary work* is very useful: "…no explanation for the cultural authority of science could be found … without succumbing to the essentialism of Popper, Merton, or Kuhn[5]. Instead, attention shifts to representations of scientific practice and knowledge in situations where answers to the question, 'What is science?' move from tacit assumption to explicit articulation. *The task of demarcating science and non-science is reassigned from analysts to people in society* (italics rh), and…focuses on episodes of 'boundary-work'… Boundary-work occurs as people contend for, legitimate, or challenge the authority of science - and the credibility, prestige, power, and material resources that attend such a privileged position.

[5] In section one it was shown that this is exactly the state of affairs concerning science *in* policy that characterized policy studies for too long.

…Crucially, the 'essential features' of science are provisional and contextual *results* of successful boundary-work, not determinants of who wins" (Gieryn, 1995:405-406).

Gieryn therefore analyses what arguments actors use to stake out claims about what should and should not be considered science, in light of how actors want to conquer professional 'jurisdictions' for science or complementary activities. Gieryn has used this approach to analyse how biologists and judges tried to define science in ways to exclude creationism and hence keep creationism out of American high school curricula (Gieryn, Bevins et al. 1985)), or attempts to define agricultural practices of compost making as a science and hence claim a position in the research system (Gieryn 1999). Hence Gieryn's notion of boundary work refers to the negotiated nature of what is considered science and what not, in order to study how actors (manage to) carve out a domain of cognitive authority of their science.

Of course, one domain in which scientists have to guard their cognitive authority is their role as scientific advisors in the boundary traffic with policymakers and politicians. The best-known research into institutional and organizational arrangements and practices of boundary work between science and politics, policy and bureaucracy is Sheila Jasanoff's *The Fifth Branch* (1990). The most important implication of this type of research is that the controversy about the desirability or undesirability of strategic science may divest itself of categorical rejection or approval. By the careful distinction between research science, mandated science, and regulatory science, Jasanoff shows that empirically informed evaluative research into the functions and meanings of strategic science is feasible. This type of research may generate new insights into the conditions under which strategic science, without sacrificing scientific standards set by peers for certifiable truth, may also arrive at *serviceable truths* for better policy. Yet, STS research has generally remained agnostcc about about its normative implications and potential prescriptive application.[6]

[6] Trying to save science from too much cynicism, and attempting to preserve its functional authority to politics/policy, some pragmatic epistemologists have moved beyond the futile quest for crystal clear demarcation criteria to rules for 'good' scientific practice in the context of boundary work at the science-politics nexus. They try to spell out the rules for 'postnormal science'

Taking stock

Let me briefly take stock of the findings at this mid-way stage of my exploration. In politics and the media three clichés of the science-politics/policy nexus vie for hegemony: politics keeps science in place (primacy for politics); simple but inventive scientists speak truth to power (science as hero); and, the symbiosis of politics and science only serves their institutional self-interests (cynical view). In search of tenable counter-images I explored two interdisciplinary fields which claim to systematically study boundary traffic between science and politics, namely STS and KU-PS. Summarizing the results, I would say we arrive at the image of an argumentative 'pin-ball machine'. Due to the regime of strategic science we find rather dense traffic between the institutional domains of politics/policy and science. One important implication is that it has become untenable to assume that only politics unilaterally poses research questions at science. Because of the ascendancy of the PLACE-ethos among scientists, science targets politics, whether on request or on its own initiative, with its insights and research proposals. Entrepreneurial scientists have become smart salesmen for their academic lore and know their ways around the corridors of power. Yet, although the worlds of science and politics have been drawing closer than in the past, they have not converged into a seamless web. Scientists keep accusing politicians of asking the wrong questions and under-using their precious insights. *Vice versa*, politicians and policymakers keep telling scientists that they produce usable knowledge too little and too late.

Although the 'pin-ball machine' image refutes, enriches and qualifies the three dominant cliché-images, the results are still rather poor. The working consensus can be summarized in four rather abstract theses (Hisschemöller et al., 2001:13-15):

- The *subjectivity* thesis holds that scientific and professional knowledge, however well warranted on logical and empirical grounds, remains subjectively construed by individual

(Funtowicz & Ravetz, 1993; Van der Sluys, 1997). For an interpretation of some Dutch initiatives in environmental policy as experiments in post-normal science, see Hisschemöller et al., 2001: 437-470.

and collective actors. These subjective constructions are products of competing sets of organized assumptions, standards, or criteria to assess knowledge claims.

- The *corrigibility* thesis holds that scientific and practical knowledge, whether directed towards understanding or action, may be improved in processes which have variously been called empirical and conceptual problem solving (Laudan), rational consensus formation (Habermas), epistemological evolution (Campbell) or reflective learning (Schön).
- The thesis of *sociality* holdt that the production, transfer, and utilization of scientific and practical knowledge are social processes. There is ample evidence that the structure of social arrangements, societies, governments, communities, organizations and sciences affects the production, transfer and utilization of knowledge.
- The *complexity* thesis holds that what Holzner & Marx (1979; MacRae & Whitaker, 1997) have called the knowledge system is a socially constrained configuration of highly interrelated and interdependent knowledge functions ranging from knowledge mandating and knowledge production to knowledge distribution and knowledge utilization. The complexity thesis punctuates the importance of viewing knowledge-related functions and their products as interdependent systems of elements with properties that are at one subjective, corrigible and social.

To get a sharper, less abstract image, we need more differentiated models of boundary traffic or transactions between science and politics/policy. It is amazing that such models only exist in rudimentary form, even after so many years of STS and PS-KU research (cf. Wittrock, 1991). Let alone that we have a detailed empirical understanding the conditions under which some of these models may lay claim to greater verisimilitude and, more prescriptively, suggest mechanisms for creative and productive boundary traffic. Like for ordinary people, it is obviously very difficult for science and politics to confront realities about your own beliefs and conduct.

4. Towards an approach and a property space for the construction of models for boundary traffic

Let me first try to sharpen what I mean exactly by *boundary traffic* between science and politics. Three decades of research on the use of expertise in policy making has convincingly shown that traditional recipes for organizing the division of labor between experts and policy makers have some major drawbacks. The traditional one-directional model is one in which science produces objective knowledge that needs to be translated into a format ('applied knowledge') that policy makers can use. What social science research on expertise has shown is that this unilinear model does not even begin to represent the complexities of the mutual construction of science and policy: the ways in which policy selectively stimulates certain forms of knowledge at the expense of others; the ways in which scientists do not just provide instrumental knowledge that policy makers use to achieve their goals, but also define problems, suggest and help to define policy goals, structure trajectories for solutions for policy problems; the ways in which political strategies can be wrapped in the cloak of scientific objectivity, or the subtle interplay between finding solutions for defined problems or redefining problems to fit found solutions.

As an alternative to the traditional model of "expertise as applied objective science", policy analysts and particularly researchers from Science and Technology Studies (STS) have suggested that the problematic division of labor between scientific experts and policy makers should be acknowledged. They have argued that the traditional model should be replaced with one that stresses the more pragmatic nature of expertise for policy (hence the demystification of absolute, 'objective science'); that acknowledges the normative or political contents of scientific policy advice; and that fully takes into account co-construction of science and policy, in order to come to a 'more democratic' model for the organization of expertise.

However, what this research has also shown, but is acknowledged only recently, is that the alternative recipes for the organization of the division of labor between experts and policy

makers are not universally valid and in fact also suffer from a number of drawbacks. For example, complex participative alternatives for the organization of expertise can be used as a policy stalling tactic or struggle extensively with the representation of unorganized or even uninterested actors that may nevertheless have stakes or relevant knowledge. In other words, we are increasingly aware that there may not be one single best model for the organization of the division of labor between experts and policy makers. This sets the stage for the main research objective: provide insight into which models for the organization of the science/policy boundary may be better under specific conditions. From this objective spring a number of specific research questions: What forms does the division of labor between experts and policy-makers take in each of the cases? Under which conditions do these forms operate? In addition, this also leads to the question: what constitutes a "better" model? In this essay I will be concerned only with the first question.

Contrary to the user-focused approach of KU-PS and the producer-oriented approach in STS, the focus here is on the transactions between science and politics/policy, and on different views of the relationship between these two institutional domains and its consequences for the nature and outcomes of the transactions. First, contrary to for example Gieryn, I will not be looking for variable definitions of science. I am looking for variable types of perspectives on *the division of labor* between science and politics. The types distinguished in the following typology describe the (desired) roles of scientists-as-experts and how they should relate to (non-scientific) policy makers. Definitions of what is and is not science, or how science is to be distinguished from politics, are part of this, but only one part and not the core of the project (as in Gieryn's case). Apart from the way actors *demarcate* science and politics, the models also describe how actors (want to) *coordinate* science and politics. Thus, what I am after is not a typology of boundary *work*. Rather, the typology of variable divisions of labor presents what Gieryn would consider the outcome of the *work*: the cartographies, the discourses. Each of the types are sets of conceptions about the division of labor between science and politics: they claim

to be systematized versions of how actors conceive of the division of labor between science and politics, conceptions that can be mobilized in boundary work (in more or less consistent ways).[7] As such, these discourses can be mobilized as resources in actual episodes of boundary work. They are *repertoires* (Bal 1999; Hoppe & Huijs, 2002) used to settle boundary disputes. Evidently, some actors have preferences for some repertoires. The risk in making a typology of outcomes, of the cartographies themselves, is that the richness of boundary work, the contingencies and the flux of shifting boundaries and conflicting accounts of boundaries, may get lost (which is the essential reason why one would want to use the term 'work'). What the 'rethinking' project therefore does have in common with Gieryn is the attempt to avoid essentialism: there is not one best way to organize science/policy boundaries, as there is no stable definition of science or politics, nor a fixed set of rules about the most desirable division of labor between experts and policy makers.

Third, I will not try to construct these cartographies empirically. I start off with a cartography, eight maps of science/policy boundaries, based on theory. The origins of the conceptions in the typology are not found directly in conceptions of actors involved (experts, policy makers), but among philosophers and social scientists (mostly public policy scientists). These analysts have reflected upon the relation between science and politics, perhaps as found in the conceptions of actors *or in the actual division of labor between experts and policy makers*. Making a cartography directly based on actors' conceptions would imply a systematic analysis of their discourse, contents analysis, or a questionnaire followed by a factor analysis of conceptions. The implicit claim in the following typology is that it catches the clusters of conceptions that live among actors involved in science/policy boundary. Testing this empirically might be an interesting but very specific endeavour.

[7] Based on a cursory of definition of boundary work by historian of science Steve Shapin, Halffman has suggested the following definition of boundary work which appears to be more consistent with the approach followed here: Boundary work defines a practice in contrast with other practices, protects it from unwanted participants and interference, while attempting to prescribe proper ways of behaviour for participants and non participants (demarcation); at the same time, boundary work defines proper ways for interaction between these practices and makes such interaction possible and conceivable (coordination). ((Halffman

After clarifying my intentions and objectives in the construction of a typology of the variable conceptions of a division of labor (or boundary traffic) between science and politics/policy, we may proceed with the construction of a 'logic' or, more precisely, a property space for such types. I propose to construct the typology along the axes of 'primacy' and 'societal logic'.

The first axis is well known from Jürgen Habermas' work and concerns *relative primacy* in terms of control and authority of one over the other. Habermas conceives of this dimension as a three-valued continuum. On one end of the continuum, the relationship science-politics is called *technocratic* when science dominates or displaces politics. In this view politicians and civil servants are fully dependent on the ways scientific procedures, techniques and thinking impact on them. Political goals and the choice of means are both dictated and determined by the *Sachzwänge* inherent in the powers of technology. Political reasoning and judgment degenerate into *ex post facto* legitimization for scientific insights and methods. From a democratic point of view, the technocratic stance is considered politically objectionable, if not taboo. On the opposite side of the continuum, the relationship is *decisionist* when representatives of political bodies have the first and the last say. In this view, what is politically desirable and acceptable steers the functioning of science and technology in society. They can merely provide alternative means for politically set goals. Science and technology provide instrumental knowledge; politics decides on its use or non-use. Evidently, the cliché image of politics on top and experts on tap is rooted in the democratic correctness of the decisionist position. In the middle of the continuum we find a third, *pragmatist* model of politics and science as countervailing powers in equilibrium; their boundary traffic may be conceived of as dialogue or debate. Science and technology not only provide instrumental knowledge; they also critically reflect on the choice of goals. *Vice versa*, politics does not limit itself to choice of values and goals; but attempts to critically influence science's contributions. The heroic academic self-image of 'speaking truth to power' is, of course, inspired by this

2002), based on (Shapin 1992). Boundary work thus tends to have two sides to it:: a demarcation (separating two practices or

pragmatist or dialogical model, but blended with a dash of technocracy. But quite a few politicians adhere to this model of science and politics as countervailing powers, which they see as necessary condition for spirited and creative public debate (cf. the now Dutch prime-minister, mr. Balkenende, in Rathenau Institute, 1998:50).

More recently Swedish sociologist Björn Wittrock (1991:338) drew attention to a second dimension, which he called the presupposed convergence or divergence between the *modus operandi* and operational codes of science and politics. Historically, the sharp distinction between science and politics as different and separated social domains and institutions emerged since the Enlightenment in the course of what sociologists analyze as the development of high modernity. Insisting on divergent operational codes confirms and reproduces this functional differentiation. Science and politics are considered two incompatible ways of life, whose relational logic is Either/Or. The two worlds or cultures or communities hypothesis in PS-KU research finds its roots in this functionalist 'cage model' of society (Halffman, 2002:23-26). Somewhat blurry boundaries between science and politics look much more tolerable from a relational logic of Both/And. In this view, no matter how different their operational codes, science and politics are supposed to eventually serve the same societal functions: the creation of consensus and the fight against chaos as preconditions for social cooperation and collective action (Schmutzer, 1994:366; Ezrahi, 1990). Politics generates consensus in society through social and rhetorical means. Science achieves the same through the tacit consensus and action coordination brought about through technology's black boxing and the 'grey boxes' of social innovations, socio-technical networks, legal rules, and the models and intervention techniques developed in economics and the social sciences. The functional differentiation of science and politics is viewed as an historical contingency, to be problematized in the contemporary world of late or rather, reflexive modernity. The focus is not on reproduction and continuation of functional difference and binary codes. Rather, one should directs one's attention to problems of functional re-integration,

groups) and a coordination side (defining how the two are to relate to each other).

productive reciprocity and meaningful communication – in a word, well-organized boundary work.

Where the dimension of relative primacy has found its way into daily political and scientific discourse, the second dimension of divergent or convergent functional logics has remained rather inarticulate or latent. It is a tacit attitude or predisposition permeating the practice of boundary work between science and politics; or a taken for granted assumption punctuating one's public lip service to the technocratic, decisionist or pragmatist forms. For example, Gieryn's and even Jasanoff's use of the concept of boundary work is informed by a divergent functional logic, whereas those who advocate a seamless web-like harmonious interaction between science and politics in the co-construction of a negotiated, eventually shared truth presuppose a convergent societal logic (Van Eeten & Ten Heuvelhof, 1998). An analysis of discourses by practitioners of boundary work showed that, in spite of a clear majority in favor of pragmatist models, there was no consensus at all about ways of managing and organizing pragmatist dialogue.(Hoppe & Huijs, 2002).

In Figure 1 I have indicated the eight models that appear identifiable from the academic literature. Contrary to Wittrock, whose listing of models I merely follow, I have not conceived of the convergence-divergence axis as a two-valued, but as a three-valued typology. I believe that this actually renders Wittrock's analysis more adequately. Also, the fact that some of the cells in the property space remain empty, allows for greater empirical richness and variety stil to be discovered through research than Wittrock's conceptualization.

FIGURE 1 HERE

Each of the models will be briefly elaborated. Attention will focus on six aspects or facets of boundary work that were identified as crucial for the success or failure of expert advice by Woodhouse and Nieusma (1997): (1) dealing with normative issues, (2) with divergent, potentially

Table 1: Models of Boundary Traffic at the Science-Policy/Politics Nexus (Wittrock/Hoppe version) Adapted from Henke, 2002

		primacy for science	*balanced (somehow)*		*primacy for policy/politics*
			primacy for science	*primacy for policy/politics*	
divergent functions		**Enlightenment Model** (research as idea; trickle-down theory of knowledge use or 'knowledge creep')			**Classical Bureaucratic Model** (research as data; recruitment and internal training theory of knowledge use)
Roughly analogous functions	*Modest form of divergent functions*		**Dispositional or Discourse Coalition Model** (research as argument; discourse-structuration and institutionalization concept of knowledge use)	**Adversarial Model** (research-and-analysis-as-intellectual-ammunition theory of knowledge use)	
	Modest form of convergent functions		**Policy Learning Model** (policies as hypotheses, policy implementation as social experiments)	**Problem Coping Model** (community of inquirers as political role model; incrementalist views of knowledge use)	
Convergent functions		**Technocratic Model** (scientists as power-holders and/or conceptual 'brainwashers')			**Engineering Model** (research as 'social' technology; external recruitment and mobilization model of knowledge use)

conflicting types of knowledge (between disciplines, with lay knowledge), (3) with uncertainty, (4) with institutional nexus, (5) with possibilities for policy-oriented learning, and (6) with the creation, maintenance and erosion of mutual trust between science and politics.

5. Models of boundary work and traffic.

I first discuss models of clear primacy, an Either/Or situation. Due to their relative black-and-white character they enjoy a lot of popularity even among scholars and politicy-makers with views more qualified than the media clich'es.

5.1. Models presupposing the primacy of science.

The *enlightenment model* emphasizes the separation between politics and science (divergence) and unambiguously opts for the primacy of science. Science leads to the gradual progress of objective knowledge of truth. It is an activity very different from politics, which regards values, interests and subjective judgments and decisions on collective action. Independent and curiosity-driven science creates new insights, concepts, hypotheses and technical instruments. New knowledge slowly trickles down towards the political and administrative domains. This is a process of knowledge creep (Weiss); scientific knowledge penetrates the political realm always with very considerable time delay; and politicians and policymakers never quite understand the how and why of the new scientific knowledge which infiltrates their thoughts and decisions. In that sense, science is crucial for progress! Politicians may walk in darkness and scientists in broad daylight, but owing to science journalists and popularizing scholars the political horizon sometimes dawns. However, a vital element of the enlightenment model is that scientists reject any responsibility for the transfer, dissemination and application of their newly created knowledge. It is up to the politicians, administrators and civil servants to use or neglect the fruits of science. Supposedly, the enlightenment model had a good deal of reality value from 1850 till

around 1930, when the scientific disciplines organized themselves in research universities with high autonomy.

In the enlightenment model *normative issues* are left to politics. Not necessarily because scholars do not deal with values – they do, if only because most scientific disciplines are organized around small utopias (Ezrahi, 1984) --, but because scholars lack theoretical and methodological tools for rational internal and external debate on values. It is politics' intrinsic function to deal with normative questions. Potential *conflicts between different types of knowledge* within science are pacified by respecting disciplinary boundaries. In fact, they function as conflict avoidance mechanisms. On the other hand, lay knowledge is unanimously labeled as inferior. Strict disciplinary boundaries also help in making different ways of dealing with *uncertainty* anathema between scientific disciplines. For some disciplines uncertainty is merely an error term to be reduced through more and better research; for others uncertainty is about human ignorance or perennial dilemmas of human existence. But in practice scholars deal with uncertainty in the same way as with values; it is left to politics to decide how to deal with (scientific) uncertainties.

Because in the enlightenment models the tasks and responsibilities of science and politics are depicted as completely different, the *institutional environment* lacks any degree of organization and firmness. In fact, contacts are largely spontaneous and *ad hoc*. They certainly are very restricted; 'unknown, unloved' applies here as much as elsewhere, because scholars usually detest politics. Generally speaking, mutual *distrust* governs relationships; although this does not exclude personal relations of trust and stable contacts between scholars and politicians – never between science and politics as collectivities. *Policy-oriented learning* in the sense of deliberate strategies among policymakers to make the most of combining their practical experience and scientific knowledge is unheard of. Spontaneous learning happens only by accident.

The relationship between economics and economic policymaking in the nineteen twenties and thirties probably is an example of how the enlightenment model works. At the time, debate about economic policies is highly politicized, but scientifically fragmented with very diverse

theoretical inputs. Keynes remarked about this situation that any prominent politician, in matters of economic policy, was in fact the disciple of some out-dated economist, like Ricardo, Smith, or Marx.

The *technocracy model*, like the enlightenment model, stresses the primacy of science in its relationship to politics. However, contrary to the enlightenment model, technocrats believe in strong convergence between science and politics. Since their societal functions are essentially the same, there can be no theoretical or methodical objections against scientists or scientifically trained persons as administrators or central policymakers on vital positions of power in the administrative and political apparatus. In the radical but naïve version of technocracy scientists replace politicians. In a less radical and more sophisticated variation scientists act as conceptual 'brainwashers': techno-science and experts hold *de facto* power in the day-to-day business of administration and politics – not because they occupy formal positions of power, but because scientific knowledge and its corresponding technical-practical tools have colonized the administrative and political worlds (Winner, 1977; Fischer, 1990). Depoliticization is key in technocratic policy-making; "Good policy is spoiled by politics" is the technocrat's adage.

The way science deals with *values* usually is definitionist or emotivist (Van de Graaf & Hoppe, 1996:131-157; Swierstra, 2000). In the definitionist way, normative statements are reduced to objectively measurable progress or decline in terms of criteria derived from some popular idea about 'the good' or 'the good life'. In the emotivist way, normative statements are interpreted as merely expressing a certain emotion or (temporary) mood of the speakers. In both cases scientists are free to impose their subjective notions about what 'good' really means on non-scientific, political normative notions; where the 'scientific' ideas, of course, are sold as scientifically responsible because 'objective' and therefore 'measurable' and 'operational'. For example, in scientific cost-benefit analysis, monetarized political preferences based on a historical analysis of budgetary decisionmaking (revealed preference) is taken to be more credible and reliable than recent political promises in official government declarations or party platforms.

Noise levels expressed in so-called Kosten-units are taken to be more reliable measurements for public decision-making for airport-related nuisance for stakeholders than the ears and experiences of nuisance from those directly affected by airplane noise.

These examples also evidence that lay knowledge is systematically down-played as not credible. *Conflicting knowledge* claims between disciplines are subjected to the usual conflict avoidance strategies; or settled simply because one discipline acquires intellectual hegemony over some policy domain at the cost of another one. *Uncertainty*, like normativity, is immediately cast in the language of 'knowing = measuring', that is quantitative and probabilistic tools for uncertainty analysis are the only credible ones (Van Asselt, 2000). Ultimately, uncertainty is a temporary problem to be solved by more and better research. As long as scientific uncertainty is considerable, adherents of the technocratic model do not consider it politically prudent to take it into account in public policymaking by other means than hedging and more research and experiments focused on uncertainty reduction.

Policy-oriented learning, in the technocratic perspective, is only possible through the implementation of public policy as social experiments, designed as closely as possible to the logic of laboratory experiments (Campbell & Stanley, 1966). In such an experimenting policy regime there will be mutual *trust* between scientists and that part of the political-administrative elite which goes along with the idea of policy-oriented learning through social experiments. Those who object to implementation-as-experiments, for example inspired by human rights, or moral principles like democratic citizenship, will be met with distrust. The *institutional nexus* between science and politics is limited to those complementary institutional forms in which politics *ex post factum* generates legitimacy and acceptability for technological and social developments initiated and steered by scientists and experts.

The technocratic model is probably most applicable to the stage 1945-1970, when academics and professionals in many new issue areas had plenty of opportunities to establish policy regimes according to their own ideas about an interventionist welfare state. In the sixties

even US president Eisenhower warned against a tacit take-over of the state by a techno-scientific elite concentrated in the military-industrial complex.. It is also the stage when a fledgling policy studies discipline succeeds in selling the idea of depoliticizing traditional political decision-making processes and replace them with modern scientific administrative tools like cost-benefit analysis and systems analysis. Planning, Programming, Budgeting Systems (PPBS) is still the most impressive manifestation of the technocratic idea in politics and administration. Even president Reagan bowed to the idea when he demanded that the Office of Management of the Budget (OMB) screen all policy proposals through cost-benefit analyses before taken seriously on political grounds by his staff and himself.

5.2. Models presupposing the primacy of politics

The *bureaucratic model* embraces the divergence between politics and science in a very specific form. As is well-known, the bureaucracy model is grounded in the politics-administration dichotomy, proposed by, among many others, founding fathers of the discipline of public administration like Woodrow Wilson and Max Weber. 'Administration' is taken to be any governmental action which is informed by a body of scientific or professional knowledge, irrespective of political judgment. As Woodrow Wilson expressed the idea: even tyrants can have 'good' administration. As such, the bureaucratic model is the oldest and most frequently used model for the mobilization of expert knowledge and the recruitment of knowledge workers from society at the service of political power. Since the days of the Roman Empire, late feudalism and absolute monarchy the state hired lawyers, financial experts, military strategists and civil engineers. In Napoleontic France, the Prussia of Fredrick the Great, and in the UK special educational systems were developed to spot the best and the brightest in regular professional and academic training institutes and mold these specialists into loyal servants of the public cause. The trick was to let them function harmoniously in the fine-grained structures of a bureaucratic

organization, which without demurral and whims of its own would bow to a political elite. Weber, Mannheim and even Habermas have for a long time considered bureaucracy as the vehicle *par excellence* of modernization by rationalization. Small wonder that this model, during the stages of the building of strong European states until around 1950, was applied in a most reflex-like manner on all knowledge workers in government. For example, Dutch departments financed their own research organizations and granted their knowledge workers the same protected status as other civil servants. In this way, next to the university system, through another system of quasi-university research organizations a public knowledge infrastructure was established which was, and to an extent still is very state-oriented.

In conformance to the politics-administration dichotomy, *valuative issues* are a political prerogative. Values are dictated by politics, and hierarchically, step-by-step they 'translated' into rules and instructions for lower-level implementing organizations. If goals achievement requires scientific research, this is considered a link in the chain of implementation. Therefore, research is primarily considered a provider of data for instrumental learning in the service of politically defined goals. *Conflicting knowledge claims* between disciplines are bureaucratically transformed in rules which define task specialization or turf, and demarcate domains of power and influence. This constructs a certain convergence between bureaucratic domains and disciplinary boundaries. For example, in the BSE catastrophe in the UK the disease was, for too long, considered an issue for veterinarian specialists, with no business for public health experts; in designing a goods-train railway connection between Rotterdam harbor and Germany ('Betuwelijn'), railway and civil engineers for a long time were the only players in the policy arena; ecological experts were not heard until much later (cf. Hisschemoller et al, 2001:454-459). The relationship between experts and lay persons in the bureaucratic model is an analogy of the relationship between a civil servant and a citizen with civil servants enjoying privileged access to information with a higher status. A citizen can only exert minuscule control over civil servants-researchers through his share in control over the political elite.

Like in all bureaucracies, *uncertainty* is dealt with through the pretense of reduction, if not elimination. This should be possible through the elimination of unruly and non-controlled social and economic (market) interactions. Bureaucracy's aspiration is to achieve a systems perspective on reality and a comprehensive approach to problem-solving through standard-setting and the enforcement of its norms. Contrary to the technocratic model which sess uncertainty as a temporary problem to be mastered through hedging against risk and more research, in the bureaucratic model uncertainty is a permanent and urgent danger to be tamed by means of rule-making and rule-enforcement. A good example is the Dutch Committee for the Advancement of Policy Analysis in the seventies. The civil servants manning this commission desired to lay down rules of cost-benefit analyses in a law, so that all departments would apply this method in identical ways.

The *institutional nexus* between science and politics is shaped in accordance with the assumption that the state steers societal developments. Research is part of the competencies of the state; therefore, a scientist is a civil servant executing state tasks. Although the state in its capacity as principal of research tasks in principle respects the researcher's professional autonomy, the state demands his complete loyalty in exchange. This inevitably means that research gets embedded in bureaucratic structures, which impede the creative and independent aspects of research projects and programs. Research and development work gets ensnared in hierarchical planning an control mechanisms and acquires rigidities which cannot be squared with serendipity, flexibility and coherence in scientific projects.

In a sense, in the bureaucratic model scientific research is entirely subjects to *policy-oriented learning*. To the extent it is successful, it is merely instrumental, within its bureaucratically determined niche. In terms of *trust/distrust* this breeds an ambiguous and troublesome relationship. On the one hand, depersonalized bureaucratic rules imply trust in the scientist's professionalism. On the other hand, they express the organized distrust incorporated in hierarchical systems of accountability. So much is clear, in the long run it is very difficult to

sqeeze scientific research into a bureaucratic straightjacket. That is why in the stages of an expanding welfare state and the growth of a seamless web or *osmosis* between state and society the bureaucratic model is outrun by the alternative and more flexible engineering model.

Like the bureaucratic model, the *engineering model* is grounded in the idea of the mobilization of knowledge and the recruitment of knowledge producers and carriers from society at the service of the state. Here too, research is a social technology for the planned construction of society. But unlike the bureaucratic model, the engineering model does not seek to incoporate knowledge and knowledge workers in state institutions. And unlike the technocratic model where knowledge experts replace politicians and administrators or deliberately scientize administration and politics, in the engineering models politicians stay on top and the experts remain on tap. Political leaders and their administrative staffs articulate knowledge questions and assign detailed research projects to scientists-*as-engineers*. Different from scientific researchers who use their creativity and initiative for the production of generalizable knowledge for solving general problems, knowledge engineers apply existing bodies of knowledge for local solutions to local problems. On this presumption science and politics are convergent activities in which the primacy of politics is uncontested.

For one thing, *choice of values and goals* is predetermined by politics. What is different is that doing policy-relevant research is no longer in the hands of knowledge workers who are also state employees; instead it is outsourced. One of the advantages is that government can distance itself from conflicting knowledge claims between disciplines. In the ideal case, government as principal selects among the public and private knowledge providers exactly those who control bodies of knowledge and methods for knowledge production and legitimation, which are required for a complete answer to its questions. This implies a way of dealing with *uncertainty* different from the bureaucratic model. Instead of comprehensive reduction of uncertainty through rule-making and enforcement from a system's perspective, uncertainties in social and economic interactions and ecological situations are accepted in order to cope with them as prudently as possible. It implies

that a government acknowledges, like other policy actors, to perceive problems from a particular actor-bound perspective; and usually it means that government has a step-by-step, incrementalist approach to problem solving. In other words, in dealing with uncertainties the engineering model implies that government adopts a fallibilist attitude of trial-and-error learning.

Concerning *institutional nexuses* the engineering model boils down to priority setting and research programming by the state; and outsourcing research activities to either universities, or increasingly so in the last years to commercially operating consultants and other knowledge producers. The relationship between science and politics can be characterized as that of principal and agent for particular research projects (Guston, 1996). For the consequences for *policy-oriented learning* the jury is still out. At first sight there appear to exist fewer opportunities for learning than in the technocracy and bureaucracy models. Outsourcing of research functions usually means less carry-over of results into the organization; even more so when personnel policy, like in many governments these days, stimulates job rotation and thereby contributes to a lack if institutional memory in the principal. Instrumental learning by the research organizations may be stimulated because they have a chance to observe, compare and 'benchmark' many different problematic situations. On the other hand, their focus on single projects and resource dependency on the principals may simultaneously hamper the development of serious learning capacities in the research agents (Kobben & Tromp, 1999; Guston, 199X). The crucial fact is that neither principal nor research agent complete a full policy cycle except by accident. Thus, the feedback necessary for learning behavior will either not occur, or too late, or insufficiently. Evidently, by shaping the institutional nexus between science and politics according to principal-agent problems in contracting relationships building trust is not the prime objective of both parties; rather, the relationship is one of provisional distrust. After all, the bureaucracy model is thrown out in favor of the engineering model in order for the state to exchange one research institute for another one; and it is justified by the expectation that competition between research organizations will improve research results.

Outsourcing research governmental functions to fully commercialized knowledge producers like organization, policy and management consultant bureaus has increased enormously in the past decade. An engineering model with market-like contractual relations between government as principal and research organizations as agents fits a regime of strategic science in which the knowledge workers display a PLACE ethos, or will have to develop it on order to survive. But in many fields of research we will have to wait and see if real competition will develop; and if it does, whether or not it will bring better quality in research products.

5.3. Models presupposing not primacy, but dialogue

These models come in two versions. When the societal functions of politics and science are considered roughly analogous but more divergent than convergent, I speak of *advocacy models*. After all, it is the essential characteristic of these models that each voice in the political arena is considered to be an advocacy plea in favor or against positions defended by other political actors. Science is not an exception, but part of the regular political struggle over which view wins out in defining the public interest. The advocacy models branch in two again: the adversarial model and the dispositional or discourse coalition model. On the other hand, when functions are seen as roughly analogous with an inclination to favor convergence, we have policy-oriented *learning models*. In these models politics is not constructed as an arena for struggle, but as an 'agora' or forum for debate for a community of 'searchers' for acceptable solutions for shared problems. Learning models also branch in two sub-models: the pure learning model and the coping model.

5.3.1. Advocacy models

The *adversarial model* is the political pluralist counterpart of a state- and bureaucracy-steered engineering model. The preponderance of political pluralism is the model's vital assumption. Politics is the non-violent power struggle between organized interest groups which through processes of partisan mutual adjustment (Lindblom) lead to temporary compromises on the

public interest. Both from a normative and empirical perspective interest pluralism is key; each group in society has an equally effective chance to voice its views and defend its interests. The adversarial model is the cradle of the research-as-ammunition theory of knowledge use. The struggle between group interests functions as variety generator and selection environment for scientific arguments and underpinning of political positions and decisions. Every interest involved will look for the type of scientific expertise which harnesses and legitimizes its pre-formed political stance. Experts and analysts are like lawyers; advocacy is their business. Political scientists studying politically controversial issues with a high-level scientific content built the adversarial model. The controversy over the civic use of nuclear energy is the origin of these so-called scientific controversy studies (Nelkin, 1979).

In the US and UK the adversarial model was actively practiced in the nineteen seventies and eighties by conservative political parties through the simultaneous retrenchment of government research budgets and the creation of private conservative think tanks (Peschek, 198X; Fischer, 1990; Garnett et al., 1998). Both empirically and normatively one may argue that scientific arguments as political ammunition improve the quality of political debate, at least if everybody has equal access to scientific expertise. To the extent that political controversies mobilize scientific expertise, they even contribute to knowledge use. On the other hand, this assessment runs counter to other insights which hold that polarized political positions increase the level of conflict to where arguments no longer count and everybody becomes over-critical towards scientific inputs (Janis & Mann, 1977; Collingridge & Reeve, 1986; Sabatier & Jenkins-Smith, 1993). On the other hand, hegemonic political views also make any use of scientific inputs superfluous (under-critical model) (Collingridge & Reeve, 1986).

In fact, science's influence is much more important in the second version of advocacy models. In the *dispositional* or *discourse coalition model*, politics is supposed to broadly distribute its attention over many different policy issues and domains. Most of them have two or more advocacy coalitions, consisting of different types if policy actors, which struggle over the content,

budgets, instruments and implementation programs for public policies on the basis of different belief systems. This model qualifies, or rather specifies the theory of scientific input as political ammunition for the political power struggle. The model starts from the basic assumption that successful public policy depends on more than just political compromises between political parties and interest groups. Each policy issue area is beset with wicked problems, and complex interdependencies between actors, resulting in intricate patterns of cooperation and opposition. Such complex interaction patterns bring together very different types of policy actors: representatives of political parties, representatives and administrators of sub-national policy organizations, (in Europe) corporatist and more ad-hoc interest groups, different professional and scientific or technical communities, users and other types of target groups, non-governmental organizations representing all kinds of non-material interests, local citizen groups, and frequently specialized media personalities and commentators. The *ensemble* of this apparently heterogeneous bunch of actors is called a functional policy subsystem or network. They have their own sub-politics (Beck), that is, they acquire a characteristic political and policymaking dynamic of their own, due to the uniqueness of the issue or problem, the pluralism of represented professional and scientific c disciplines, their specific managerial and administrative [8]logics, and last but not least their continuous tensions with overall (supra-)national politics and its actors, like MP's, Supreme Court judges, etcetera.

In order to bring and hold together such a multifarious and many-voiced policy subsystem requires permanent management for avoidance of *heterogeneity overload*. A shared language or style of discourse is an indispensable element. Frequently, so-called discourse coalitions form around story lines as a kind of rhetorical bridge between the divergent but overlapping scientific, professional, administrative and political communities involved in a policy subsystem. Story lines are held together by one or more fuzzy concepts, whose merit is precisely that they imply rhetorical commitment, and yet respect the divergent life words and action

contexts of the members of the policy subsystem. If and when a story line works successfully, the fuzzy concepts acquire not only rhetorical, but practical meanings and commitments to all kinds of practices (like consultation procedures, calculation models, norms and standards for benchmarking, etcetera). In other words, discourse structuration (rhetorical commitment) is transformed into discourses institutionalization (practical commitment and action coordination) – needless to say that both interact in a positive feedback cycle (Hajer, 1995).[9]

Let me now briefly discuss the similarities and dissimilarities between the two advocacy models in terms of our facet design of boundary traffic. It is inherent in the advocacy models that the *fact-value dichotomy* taken with considerable grains of salt. It is unnecessary in establishing the primacy of one over the other, and therefore one over the other institutional domain. Yet, there are important differences in dealing with normative issue between the two sub-models. In the adversarial model values are constructed as violation of vested interests. The idea is that all parties know their policy claims and interests; and that they can immediately judge every policy proposal in terms of furthering or violating one's interests. This is not true for the discourse coalition model. Although vested interests are indeed easily recognizable within the constraints of institutionalized discourses, one may not exclude the possibility that policy actors will change their views about self-interest as a consequence of communications with policy actors from other discourse coalitions. Values are taken to be socially constructed threats to existing identities and practices, or rather the uninterrupted fresh discoveries of novel identities and practices. Anyway, the discourse coalition model depicts policy actors and anlysts as much more flexible and creative in their dealings with values that the adversarial model.

[9] For the Netherlands, Pesch' analysis of the establishment of the Central Planning Agency (CPB) for economic policy in the nineteen forties and fifties is a good example (Pesch, 1999). Tinbergen's scientific ideas about macro-economic management functioned as a depoliticising discursive synthesis between two divergent political story lines: a socialist story line keen on taming the 'chaos' of the free market, and a Christian-democratic story line, the so-called 'break-through' idea, which promised socio-economic policymaking free from the pillarized politics of before the War. Tinbergen's scientific idea was sufficient for getting the CPB founded through a political compromise between Labour and the Christian-democratic parties. It proved insufficient to render the CPB's scientific ouputs authoritative in political debate. This required dropping the socialist story line and embracing the corporatist story line by Christian-democrats. Thereafter, CPB outputs started dominating the discourse of all those represented in the Socio-Economic Council, and later the Dutch Parliament.

Like in all pragmatist models, the equal status of expert and lay knowledge is key in both advocacy models. By the way, in both models it is not the case that experts bow to lay persons; rather scientific input helps in bringing about political consensus. But here too, the two models diverge their ways of handling *divergent knowledge types*. In the adversarial model scientific expertise plays the traditional 'frigidair' function: refer a difficult to handle problem to the scientific domain in order to create time delays, which will help in constructing sensible political compromise for an incremental policy in which the least committing steps are taken first and can be revoked always. Whether or not, and if yes, to what extent and how science actually plays a role in creating time delays is not very clear. In most cases the outcome of scientific reflection is a kind of *deus ex machina*; how and why the outcome was reached remains a closed black box in many adversarial analyses. The discourse coalition model, on the contrary, is rather specific about science's role. It is to provide new, if need be fuzzy concepts, which may function as conceptual bridges between originally separate fields of knowledge. Additionally, science may produce all kinds of other boundary objects, packages or objects (Griesemer, 19XX) like texts, documents, procedures, standardized practices, for a for overlapping memberships by experts and policy entrepreneurs, and what have you. In the conflict between scientific disciplines both models predict that the discipline that assembles the most useful functions for policy/politics will win (Hisschemöller et al., 2001:455-459).

Contrary to the primacy models which without exception consider *uncertainty* something bad, the advocacy models depict uncertainty as having positive qualities. In these models uncertainty is by definition abundant and takes the form of heterogeneity overload. But this cognitive vice is turned into pluralist virtue. After all, in the adversarial model it facilitates bargaining and compromise-building between the parties and interests involved. In the discourse coalition model too, uncertainty is beneficial because it can be 'transformed' into the *ensemble* of heterogeneous and contingent contexts of practice of the multifarious and polyphonous members of policy subsystems – and this is exactly the environment in which fuzzy concepts can

thrive and tame heterogeneity. They facilitate continuous monitoring and evaluation of progress through comparisons, however contestable; and moreover, as long as the 'subsystem' is supposed to exist under some fuzzy umbrella, it is always possible to start all over, from scratch. By re-casting uncertainty as pluralism of perspectives, some argue that systematic cross-fertilization of perspectives is the road to flexible, yet robust novel policies (e.g., Schwartz & Thompson, 1990; WRR, 1994; Van Asselt, 2000).

Regarding *institutionalized nexus* between science and politics, both advocacy models offer plenty of opportunities to play with distance and overlap. This is in clear contradistinction to the primacy models which, by their very nature, minimize the institutional spaces within the constraints of their favored power position. However, in the adversarial model the institutional space appears to be limited to the temporary transfer of an issue form the political arena to the scientific domain. In the discourse coalition model, there are numerous options for the institutionalization of discursive spaces and organizational arrangements. Sometimes there is a preference for fixed and agreed rules for access, participation and exit (like in formal corporatist consultative procedures); at other times one relies on open and *ad hoc* arrangements with fluid participation in policy networks with rather undefined rules of entry, participation and exit (like in the negotiated rule-making made famous under the label of the Dutch 'polder model').

One ought to be skeptical about the possibilities for *policy-oriented learning* in advocacy models. Learning is an elusive, over-theorized and under-researched concept, and in both sub-models different actors may learn very different things. This is due to the fact that both the political compromises in the adversarial model, and the fuzzy concepts and boundary packages in the discourse coalition model, connect and separate at the same time. It appears very difficult to draw the exact line between a flexible policy and a political promise to 'have your cake and eat it too'; as well as to clearly separate between a robust policy and holding on to power for power's sake… Finally, in both models an unsteady balance between *trust and distrust* between science and politics prevails. To preserve the political glue of compromising in the adversarial model, and to

stave off heterogeneity overload of over-complex functional policy subsystems in the discourse coalition model, a uninterrupted trust cycle must be in place: a continued alternation between trust-building measures, trust-challenging decisions and actions, and a subsequent re-building of sufficient trust, and so on *ad infinitum*. In a sentence, advocacy models require permanent trust work as part of boundary work.

5.3.2. Learning models

Dialogical models presuppose equal status between the scientific and political domain. Learning models differ from advocacy models in the way and purpose of 'equalizing' both institutional spaces. In advocacy models science is considered one among multiple political voices that enable political debate, judgment and decision. In the learning models all actors are constructed as scholars, in a sense, engaged in a process of social learning through social debate.

Like the discourse coalition model, the *model of pure learning* assumes that scientists and policymakers cooperate through shared concepts and strategies of technological, economic, social and cultural innovation. But unlike the discourse coalition model, the learning model treats the policy process as a sort of research process in two respects: First, a policy or policy program is viewed as a set of hypotheses about the causal links between certain (collective, organizational) acts and a specified (desirable) future state of affairs. Second, policymaking is social experimentation. By close monitoring of the degree of goals achievement and a careful analysis of the causes of deviation, errors can be eliminated gradually. Subsequently, in analogy to Lakatos' qualified falsificationism for the assessment of research programs, policymakers evaluate the growth and decline of problem-solving capacity of policy lines and programs (Majone, 1989; Zonneveld, 1990).

In the pure learning model policy is a kind of action theory in three levels: a hard core of unshakeable ontological and normative first principles (ideologies), a protective belt of preferred policy instruments, and a positive/negative heuristic for preserving the hard core and improving

the problem-solving capacity by searching for novel solutions to old and new problems. The layered structure of the belief system largely explains why policy change is incrementalist and slow. As long as the policy line or program displays progress in terms of problem-solving capacity – thus, goals achievement is reasonable, policy instruments are usable in many policy domains, (re-)definition of state responsibilities is easily legitimized, etcetera – policy programs are assessed positively. The learning model therefore predicts that instrumental learning and learning during policy implementation between members of the same advocacy coalition who share a policy belief system or policy paradigm will come about fairly easy.

On the contrary, learning between different advocacy coalitions who hold diverging policy beliefs is much more difficult, if not impossible. Only when a policy line or program unmistakably looses problem-solving capacity will alternative policy paradigms become serious competitors and perhaps achieve political hegemony or domination in a policy domain. The stable equilibrium of incremental policy change is temporarily ruptured by periods of revolutionary and non-incremental policy change. In the pure learning model policy dynamics is eventually cognitively determined. The overall pattern of change is one of punctuated equilibrium (Baumgartner & Jones, 1993). Longer incremental changes within the same policy paradigm are suddenly superseded by short outbursts of fiercely non-incremental transformations from one policy core to another one. These interpunctions correspond to changes in the composition of advocacy and discourse coalitions between policymakers and scientific experts. The sudden transformation of neo-Keynesian macro-economic management to monetarist and supply-side forms of steering economic developments has been explained in this way as a cognitively determined process of policy-oriented learning (Hall, 198X).

In the *coping model,* learning, let alone analogies with scientific experimenting or the assessment of scientific research programs, is not key. This image is considered far too idealistic. In the real world of politics and administration it is usually not the case that one single policy paradigm is hegemonic. In the many consensus types of democracy (like The Netherlands) it is

much more frequently observed that two to four policy paradigm are active in a particular policy domain. Often there is a power equilibrium between those in favor of policy change advocated by one policy paradigm and those who can block such changes by invoking insights from a competing paradigm. Civil servants and other policy brokers or entrepreneurs in all kinds of debating fora find lifetime jobs in exploiting the tensions between policy paradigms through the ingenious construction of shifting minimum winning coalitions for minimally feasible policy proposals. The idea of sheer intellectual judgment of progression in problem-solving capacity of policy belief systems or paradigms is dropped in the coping model (Hoppe & Peterse, 1993; Eberg, 1997). In reality, we see not cognitive learning behavior, but interactive processes of problem coping that, like in a television series, occur in serial and recurring fashion. To tackle policy problems, policymakers and politicians, interest groups and citizens, primarily rely on their common sense and detailed knowledge of contingent local circumstances. Only from time to time they allow policy analysts to have an input of their own. Policy change is a continuous search process through trial-and-error, at every moment threatened by the political inclination to try and the political constraint not to fail, and consequently the political inability to learn.

Apart from *serial adjustment* through time, collective problem processing is a matter of mutual *political and social adjustment* of political positions and practices among policymakers condemned to each other through high degrees of mutual resource dependencies. Next to cognitive mechanisms, economic, social and purely political triggers condition problem coping processes (Lindblom & Cohen, 1970; Klok & Fenger, 2001). Some speculate about the relationship between the cognitive and non-cognitive parts of the coping model. The cognitive part is about how to bring to the attention of politics the potential solutions to policy problems that somehow crop up from experts' analyses and experiments. This is called learning through analysis and instruction (Van Gunsteren, 19XX). The social and political parts of the problem-coping are concerned with selecting the best ones out of the variety of suggested problem-solution couplings. This is called learning through variety and selection. In this way the coping

model displays a balance between science and politics which easily fits a decisionist-democratic political practice. Although the problem coping model is pragmatist in nature, there is no tension with the models that assign primacy to the political sphere. This is clearly different from the pure learning model that easily lends itself to the slippery slope of technocratic rule by a politico-scientific élite.

How do the two learning models compare through the lense of the facet design? In the pure learning model, *normative issues* are part of a policy paradigm's hard core, which is shared between like-minded politicians, policymakers and experts but hardly discussable between diverging groups. By a gradual increase of knowledge through error elimination, and through allowing normative issues to enter political debates in some sort of ethics of good reasons fashion, from time to time political learning processes between adherents of different policy paradigms do develop. In this way, gradually the politically 'decent' and tenable positions will converge in a few 'rational' ideologies (Paris & Reynolds, 1983). Ideological wars between evidently nonsensical positions – like between fascist, racist and anarchic idealogical views – will no longer occur in mature democracies. Fukuyama's idea that after the fall of communism only a pretty unified form of liberal ideology will be perennially dominant belongs in this category of thinking. On the contrary, the problem coping model rejects this speculation as unwarranted because normative issues and truly wicked problems will always be with us. In the long run a cyclical movement of the rise and fall of multiple policy paradigms is inevitable.

In the pure learning model, c*onflicting knowledge* claims between scientific and lay knowledge are part of the positive and negative heuristics of the policy paradigm, manifested national political and academic cultures. For example, the central role for citizens in the Danish consensus conference model of technology assessment for the Danish parliament originates in a very egalitarian political and corresponding academic culture. In the Netherlands too, the Rathenau Institute involves citizens in parliamentarian technology assessments. But in the so-called 'position debates', the Dutch amendment on the Danish consensus conference model, the

citizens' voice in fact is added to the separate voices of politicians, business interests, and experts. A more dominating role for citizens would simply not fit into the iron cage of government, business and labor, other (commercial) interests, and scientists prescribed by the corporatist Dutch polder model and academic culture (Hoppe & Grin, 1999). Another part of handling conflicting knowledge claims is dealt with, in the pure learning model, through management of the level of conflict on an issue. If conflict intensity rises beyond a certain level, it is conceded that the pure learning model no longer works. This flies in the face of the coping model that simply assumes processes of serial and partisan mutual adjustment to be so robust that they will always be able to deal with such conflicts. In the coping model, interdisciplinary knowledge conflicts simply do not exist. In the pure learning model, it is assumed that such conflicts will not arise, given the dominant position of some policy paradigm. In normal cases scientific expertise has a natural monopoly. In pre-paradigmatic stages with potentially intense interdisciplinary strife, productive conflict management is a matter of prudent selection and multi-disciplinary peer review.[10]

In the pure learning model, *dealing with uncertainty* boils down to the deliberate organization of Lakatosian learning strategies and evaluations of policy paradigms within the boundaries of a rational political consensus. In this way *policy-oriented learning* in teams of like-minded politicians, administrators, policymakers and experts becomes possible. In the problem processing or coping model, policy-oriented learning is left to a spontaneous interweaving of analysis and political interaction, or rather analysis in the service of continued interactions between those who are politically accountable (Wildavsky). The problem coping model acknowledges cognitive processes, but stresses unplanned instances of political learning through debate (partisan mutual adjustment, networking) and instrumental learning during policy implementation (serial adjustment, formative evaluations).

[10] For example, in response to attacks of bias on the RIVM's Environmental Audits, its director promised more internally extended peer reviews (Hoppe & Huijs, 2002).

As far as *institutionalized nexus* between science and politics are concerned, both learning models stress different aspects, but without excluding each others alternative positions. The pure learning model points out the beneficial effects of professional platforms for technical communities in policy subsystems; these have the required intellectual discipline for more or less systematic learning behavior. In the problem coping model the issue is how to speed up and foster the spontaneous interweaving of analysis and political interaction; and how to create, where necessary, deliberate new discursive spaces and accountability systems. Both models implicitly assume sufficient amounts and quality of *trust* between scientists and politicians/policymakers. After all, the fundamental analogies which drive the models – a forum for debate, and the (spontaneously) learning community of searchers – simply presume sufficient mutual trust. Evidently, this requires lots of permanent trust work.

Some final remarks are in order here. First, the eight elaborated models of boundary traffic and boundary work between politics and science do indeed bring into sharper relief the shortcomings and biases in the three cliché images in popular discourse. In Figure 2 the results of the exercise are summarized in a few key concepts.

FIGURE 2 ABOUT HERE

Second, the eight models should not be interpreted as static images. Yet, it is premature to speculate about temporal and historical dynamics. It is likely that a particular model will evolve into another one, and the resulting model may even evolve further into yet another one.[11] But we need much more research on the conditions, perhaps different for different issues, or policy

[11] On the basis of Pesch, 1999 one might speculate that the science/politics nexus on socio-economic policymaking in the Netherlands evolved from enlightenment, through discourse coalition and bureaucracy (foundation and early stages of the Cental Planning Bureau), into technocracy (in the sense that members of the Socio-Economic Council and political parties have to participate in economic discourse introduced by CPB-modelling).

Dealing with	enlightenment	technocracy	bureaucracy	engineering	advocacy	learning
Values	Political responsibility	Scientific operationalizations of the 'good'	Political responsibility	Political responsibility	Pluralist interest articulation	Convergent 'rational' ideologies; cyclical priorities
Knowledge conflicts	Conflict avoidance	Conflict avoidance; spontaneous hegemony	Rule-bound demarcation of expertise and tasks	Ad libitum; actor-bound, local	Equal status; usable knowledge	Positive/negative heuristic; mutual adjustment
Uncertainty	Political responsibility	Temporary problem; disregard or hedge	Rule-governed control from systems perspective	Fallibilist; actors' perspective	Negotiation; robustness	Designed and/or spontaneous learning
Institutional nexus	Accidental, ad hoc	Science leads; politics legitimises	Politics leads; loyal instrumental research	Project-focused; principal – agent	Flexible play with distance and overlap	Professional platforms and/or social debate
Policy-oriented learning	Accidental	Experimental logic	Instrumental learning	Not structurally guaranteed	Spontaneous learning	Designed and/or spontaneous learning
Trust/distrust	Institutional distrust	Institutional distrust	ambivalent	Conditional trust	Unsteady balance; trust-work	Institutional trust

Table 2. Overview of (dis)similarities between models of boundary work/traffic on selected facets.

domains, or countries, that determine why a particular model comes into being, flourishes, decays, and is substituted by another one. Third, we are dealing not only with temporal transitions but also with simultaneity and configurations or models. Like tectonic plates, the models have been pushed over and under each other in the course of history. The functioning of a particular knowledge institute may well be the consequence of the frictions, chafings and clashes between the different models that make up a layered boundary work structure. Fourth, part of those clashes and tensions may be due to the normal gap between the beliefs and rules actually acted upon (the action theory, or the contingent repertoire, or the back-office talk and practices) and those merely appealed to in accounting for one's conduct to outsiders (espoused theory, or rationalistic repertoire, or front-office talk) (Hoppe & Huijs, 2002). For example, the

political correctness of the decisionist models may very well cloak a technocratic practice. The pure learning model may be a rationalizing discourse for a practice of coping; and the learning model itself may very well be used to legitimize technocratic practices. But, again, much more research into the discursive dynamics and pairings of the models is in order.

6. Towards transparent boundary work?

We need to do away with the argumentative pin-ball machine that so far appears to represent boundary work between politics and science. We need more transparent boundary work. The challenge is to simultaneously interweave the scientific and political domains where possible, and to separate them where necessary. And not in a once and for all fashion, but in ways that are flexible and (re-)negotiable. This is the only chance for more transparency in boundary work and traffic. How can the overview of models contribute to this end?

The first contribution is that, even though we do not yet know exactly, we (as knowledge institute, advisory body, or meeting platform for science and politics) may use the models as a kind of mirror. What do we publicly say we are doing, and what do we really do? Is this what we intended? Are we doing a good job? If not, why? Next to their use as help in self-diagnosis, the second contribution might be in the design of possible futures or *futuribles* (De Jouvenel). On the basis of known historical analogies and partially supported by creative theoretical abduction it is possible to design and think through all kinds of futuribles. For example, one may project the future of scientific expertise as the new *legislator* or *technocrat* (deciding on norms and setting standards) who demands or gets maximum leeway from politics; or as a *facilitator* for consultative arrangements for typically mixed scientific and policy activities; or as a *coordinator* of exercises in internal extended peer reviews for many divergent local scientific review activities; or as a *translator* and *councilor* for all kinds of interdisciplinary, paradigmatic or local scientific and political differences; and many more.

A third possibility would be to elaborate a transaction cost sheet for each model. This could be done through systematically mapping all costs and benefits for all involved parties for each facet/aspect. This would help the gradual emergence of a theory of transaction costs between politics and science as a branch of transaction cost economics. More empirically grounded views on the strengths and weaknesses of each model on each (or other) aspects would certainly help in anticipating and responding on criticisms. Finally, and depending on how likely of desirable a particular futurible is deemed to be, one may design realistic transition paths from *Sein* to *Soll*. This requires a much better understanding of the transformative dynamics of one to the other model. Combining this with better insights into relative costs and benefits this should lead to more realistic efforts in modulated or directed change towards more transparency in boundary work.

REFERENCES

Asselt, M.B.A. van (2000) *Perspectives on Uncertainty and Risk*, Kluwer, Boston, hoofdstuk 3A.

Asten, F. van (2000) *Onzekerheid in de praktijk*, scriptie bij de Faculteit Gezondheidswetenschappen, UM, 39-50.

Bal, R. (1999) *Grenzenwerk. Over het organiseren van normstelling voor de arbeidsplek*, Enschede: Twente University Press.

Bal, R. (1999) *Grenzenwerk. Over het organiseren van normstelling voor de arbeidsplek*, Twente University Press, Enschede.

Barker, A. and B. G. Peters, Eds. (1993). *The Politics of Expert Advice: Creating, Using and Manipulating Scientific Knowledge for Public Policy*. Edinburgh, Edinburgh University Press.

Baumgartner, F. en B. Jones (1993) *Agendas and Instability in American Politics*, The University of Chicago Press, Chicago.

Bont, A. de (2000) *De organisatie van een virus. Over de wereldgezondheidsorganisatie, wetenschap, en transnationale politiek*, proefschrift, Maastricht: Universiteit van Maastricht.

Boom, H. en M. Metze (1997) *Slag om de Betuweroute – Het spel langs de lijn*, Amsterdam: Balans.

Bulmer,.....

Campbell, D.T. and J.C. Stanley (1963) *Experimental and quasi-experimental designs for research*, Chicago: Rand MacNally

Caplan, N., Morrison, A. & Stambough, R. (1975) *The use of social science knowledge in policy decisions at the national level*. Ann Arbor: University of Michigan press.

Collingridge, D. and C. Reeve (1986) *Science Speaks to Power: The Role of Experts in Policymaking*, New York: St. Martin's Press

Cozzens, S.E., and E.J. Woodhouse (1995) Science, Government, and the Politics of Knowledge, in S. Jasanoff et al. (eds.), *Handbook of Science and Technology Studies*, Thousand Oaks: SAGE

Denham, A. and M. Garnett, *British think-tanks and the climate of opinion*, London: UCL Press

Dror, Y (1971), *Design for Policy Sciences*, New York: Elsevier

Dunn, W.N. (1994) *Public Policy Analysis. An Introduction*, Englewood Cliffs, N.J.: Prentice Hall (2nd ed.)

Dunn, W.N. and B. Holzner (1988) Knowledge in Society: Anatomy of an Emergent Field, in *Knowledge in Society. The International Journal of Knowledge Transfer and Utilization*, 1/1, 1-29

Eberg, J. (1997) *Waste Policy and Learning. Policy Dynamics of Waste Management and Waste Incineration in the Netherlands and Bavaria*, Delft, Eburon.

Ezrahi, Y. (1984) 'Science and Utopia in Late 20th Century Pluralist Democracy' in E. Mendelsohn & H. Nowotny (eds*), Niniteen Eighty Four: Science Between Utopia and Dystopia. Sociology of the Sciences, Vol. VIII*, pp.283-286.

Ezrahi, Y. (1990) *The Descent of Icarus. Science and the Transformation of Contemporary Democracy*, Cambridge, Mass.: Harvard UP.

Fischer, F. (1990), *Technocracy and the Politics of Expertise*, Newbury Park: SAGE

Fischer, F. (1995) *Evaluating Public Policy*, Chicago: Nelson –Hall.

Funtowicz, S.O. en J.R. Ravetz (1992) 'Three Types of Risk Assessment and the Emergence of Post-Normal Science' in: S. Krimsky en D. Golding (eds.), *Social Theories of Risk*, Westport: Preager, 211-232.

Gieryn, T.F. et al.,(1985),.....

Gieryn, T.F. (1995) 'Boundaries of science' in: S. Jasanoff et al. (red.), *Handbook of Science and Technology Studies*, Thousand Oaks: Sage, 393-443.

Gieryn, T. (1999). *Cultural Boundaries of Science: Credibility on the line*. Chicago, Chicago University Press.

Graaf, H. van de en R. Hoppe (1996) *Beleid en Politiek*, Countinho, Bussum.

Graaf, J. de (1986) *Elementair begrip van de ethiek*, Utrecht/Antwerpen.

Grin, J. en R. Hoppe (1999) 'Het kan verkeren: Een vergelijkende analyse van drie technology assessments' in: *Beleidswetenschap*, 13, 3, pp.260-286.

Grin, J., H. van de Graaf en R. Hoppe (1997) *Interactieve Technology Assessment. Een eerste gids voor wie het wagen wil*, Rathenau Instituut, Werkdocument 57, Den Haag.

Guston, D. (1996) Principal-agent theory and the structure of science policy, in *Science and Public Policy*, 23/4, 229-240

Guston, D.H. (200X*) Between Politics and Science: Assuring the integrity and productivity of research*, New York: Cambridge University Press

Guba, E. And Y. Lincoln (1989*) Fourth Generation Evaluation*, Newbury Park: SAGE

Halffman, W. (2002), *Boundaries of Regulatory Science. Eco-Toxicology and aquatic hazards of chemicals in the US, England and the Netherlands, 1970-1995*, Amsterdam: University of Amsterdam (unpublished Ph.D. thesis)

Hajer, M. (1995) *The Politics of Environmental Discourse, Ecological Modernizations, and the Policy Process*, Clarendon Press, Oxford.
Hall, P. (????) 'Policy Paradigms, Social Learning and the State' in: *Comparative Politics*, 25:275-296
Hisschemöller, M., R. Hoppe, W.N. Dunn, J.R. Ravetz, *Knowledge, Power, and Participation in Environmental Policy Analysis*, Policy Studies Review Annual, vol. 12, New Brunswick, N.J.: Transaction Publishers
Holzner, B. and J. Marx (1979) *Knowledge application: The knowledge system in society*, Boston: Allyn and Bacon
Hoppe, R. en A. Peterse (1993) *Handling Frozen Fire. Risk Management and Political Culture*, Bouder, Westview Press.
Hoppe, R. en A. Peterse (red.) (1998) *Bouwstenen voor argumentatieve beleidsanalyse*, Den Haag: Elsevier.
Hoppe, R. (1999). "'Policy analysis, science, and politics: from "speaking truth to power" to "making sense together"'." *Science and Public Policy*, **26**(3): 201-210.
Hoppe, R. and J. Grin (1999). 'Pollution through traffic and transport: the praxis of cultural pluralism in parliamentarian technology assessment'. *Cultural Theory as Political Science*. M. Thompson, G. Grendstad and P. Selle. London, Routledge**:** 154-169.
Hoppe R. and S. Huijs (2002) Grenzenwerk tussen wetenschap en beleid: paradoxen en dilemma's, Enschede: Twente University (unpublished manuscript, essay for RMNO)
In 't Veld, R. (2000) *Willens en Wetens*, Utrecht: Lemma
Janis, I.L. and L. Mann (1977*) Decision Making. A Psychological Analysis of Conflict, Choice, and Commitment*, New York: Free Press
Jasanoff, S. Et al. (eds.) (1995) *Handbook of Science and Technology Studies*, Thousand Oaks: SAGE
Jasanoff, S. (1996), Beyond Epistemology: Relativism and Engagement in the Politics of Science, in *Social Studies of Science*, **26**/2, 393-418
Klok, P.-J. And M. Fenger (2001), ..., in *Policy Sciences*, ….-….
Knorr-Cetina, K. (1995) Laboratory Studies: The Cultural Approach, in S. Jasanoff et al. (eds*.), Handbook of Science and Technology Studies*, 140-166
Köbben, … and …Tromp (1999*) De onwelkome boodschap, of Hoe de vrijheid van wetenschap bedreigd wordt*, Amsterdam: Mets.
Lasswell, H.D. and D. Lerner (1951) *The Policy Sciences: Recent Developments in Scope and Method*, Stanford: Stanford University Press
Lasswell, H.D. (1971*) A Pre-View of Policy Sciences*, New York: Elsevier
Latour (1987) *Science in Action*, Cambridge, Mass.: Harvard UP.
Lindblom, Ch.E. and D. Braybrooke (1963*) A Strategy of Decision*, New York: Free Press
Lindblom, Ch.E., *The Intelligence of Democracy*, New York: Free Press, 1965
Lindblom, Ch.E. en D. Cohen (1979) *Usable Knowledge: Social Science and Social Problem Solving*, New Haven, Yale University Press.
Loeber, A. (1998) 'Dynamiek in beleid door debatten tussen overheid, bedrijfsleven en wetenschappers: het fosfatenbeleid in Nederland' in: R. Hoppe en A. Peterse (red.), *Bouwstenen voor argumentatieve beleidsanalyse*, Den Haag: Elsevier.
MacRae, D. Jr. and D. Whitaker (1997*), Expert Advice for Policy Choice,…..*
Majone, G. (1989) *Evidence, Argument, and Persuasion in the Political Process*, New Haven, Yale University Press.
Menzel, M. (1999) 'Think tanks, policy-making, and a Dutch advisory council', in: *Science and Public Policy*, 26, 3, 171-178.
J.G. Morone & E.J. Woodhouse (1986) *Averting Catastrophe. Strategies for Regulating Risky Technologies*, Berkeley and Los Angeles: University of California Press
National Health Council: Committee on the Health Impact of Large Airports (1999) Public health impact of large airports, The Hague: Health Council of the Netherlands, 1999/14E
Nelkin, D. (ed.) (1979) *Controversy*, London: Sage.
Paris, D.C. and J.F. Reynolds (1983) *The Logic of Policy Inquiry*, New York:….
Patton, M., Q. (1997) *Utilization-Focused Evaluation: The new century text*, 3rd. Ed. Thousend Oaks, CA: Sage
Pesch, U. (1999) *Het CPB en de sjablonen van het economisch beleid. Afstudeeronderzoek naar het gebruik van CPB-modellen in het Tweede Kamer-debat*, Enschede, UT.
Peschek, J.G. (1987) *Policy-Planning Organizations. Elite Agendas and America's Rightward Turn*, Philadelphia: Temple University Press
Peters, G. (????) 'Models of Governance for the 90s', pp.15-44.
Peterse, A. (1998) 'Heijplaat: hoe een beleidsongeval werd voorkomen' in: R. Hoppe & A. Peterse, o.c., pp. 115-146.
Rathenau Instituut (1998) *In de arena van wetenschap en politiek*, Jaarverslag.

Restivo, S. (1995) The Theory Landscape in Science Studies: Sociological Traditions, in S. Jasanoff et al. (eds.), *Handbook of Science and Technology Studies*, 95-110

Rip, A. (1997) A cognitive approach to relevance of science, in *Social Science Information*, 36/4, 615-640

Rip, A. (2001) 'Aggregation machines:a political science of science approach to the future of the Peer Review System' in: M. Hisschemoller, R. Hoppe, W.N. Dunn en J.R. Ravetz (eds.), *Knowledge, Power, and Participation in Environmental Policy Analysis*, Policy Studies Review Annual, Volume 12, Transaction Books, New Brunswick, N.J.(in druk).

Rip, A. en R. Kemp (1998) 'Technological Change' in: S. Rayner & E.L. Malone (eds.), *Human choice and climate change; Volume Two. Resources and Technology*, Batelle Press, Columbus/Richland, pp.327-399.

Sabatier, P.A. and H.C. Jenkins-Smith (1993) *Policy Change and Learning. An Advocacy Coalition Approach*, Boulder: Westview Press

Schmutzer, M.E.A. (1994) *Ingenium und Individuum. Eine sozialwissenschaftliche Theorie von Wissenschaft und Technik*, Wien/New York: Springer.

Schomberg, R. von (1997) *Argumentatie in de context van wetenschappelijke controverse: een analyse van de discussie over de introductie van de invoering van genetisch gemodificeerde organismen in het milieu*, Delft: Eburon.

Schwartz, M. And M. Thompson, *Divided We Stand, …..*

Sluys, J.P. van der (1997) *Anchoring Amid Uncertainty. On the Management of Uncertainties in Risk Assessment of Anthropogenic Climate Change*, Leiden: Mosterd en van Onderen!

Sluys, J.P., van der, R. Hoppe et al. (2002), A *Leidraad* for Uncertainty Scanning and Assessment at RIVM. Utrecht, Copernicus Institute for Sustainable Development and Innovation, Universiteit Utrecht.

Star, S. L. and J. Griesemer (1989). "Institutional Ecology, 'Translations', and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-1939." *Social Studies of Science* **19**: 387-420.

Swierstra,, T. (2000) *Kloneren in de polder. Het maatschappelijk debat over kloneren in Nederland februari 1997 – oktober 1999*, Rathenau Instituut, Studie 39.

Van Eeten, M. And E.J. Ten Heuvelhof (1998) 'Serviceable truth': de procescontingente inzet van wetenschappelijke expertise, in Hoppe & Peterse, *Bouwstenen voor Argumentatieve Beleidsanalyse*, 161-174

Van Eeten, M.J.G. (1999). *Dialogues of the Deaf. Defining New Agendas for Environmental Deadlocks*. Delft: Eburon Publishers.

Van Eeten, M.J.G. (2001), "Recasting Intractable Policy Issues: The Wider Implications of the Netherlands Civil Aviation Controversy." *Journal of Policy Analysis and Management,* 20 - 3, 391-414.

Van Gunsteren, H. (19XX), ...

Weimer & Vining (1996) 'Public choice' benaderingen in Economics' in: D.F. Kettl & H. Brinton Milward, *The State of Public Management*, Baltimore: Johns Hopkins University Press, pp.92-117.

Weiss, C.H. (1991) 'Policy Research: Data, Ideas, or Arguments?' in: P. Wagner e.a. (eds.), *Social Sciences and Modern States: National Experiments and Theoretical Crossroads*, Cambridge: Cambridge UP, 307-332.

Weiss, C., Bucuvalas, M. (1980) *Social science research and decision making*, NY (etc.): Columbia UP, 1980

Carol Weiss (1999) *Factors that improve the use of research in social policy: case studies*. Research design for a UNESCO/MOST programme project - http://www.unesco.org/most/weiss.htm

Winner, L. (1997) *Autonomous Technology*, Cambridge, Mass.: MIT Press.

Wittrock, B. (1991) 'Social knowledge and public policy: eight models of interaction' in: P. Wagner e.a. (red.), *Social Sciences and Modern States. National Experiences and Theoretical Crossroads*, Cambridge: Cambridge UP.

Woodhouse, E.J. en D. Nieusma (1997) 'When Expert Advice Works, and When it Does Not' in: *IEEE Technology and Society Magazine*, 23-29.

WRR (Scientific Council for Government Policy) (1994), Duurzame risico's: een blijven gegeven (Sustainable risks: a permanent given), The Hague: Sdu Uitgevers

Yearly, S. (1988), Science, *Technology and Social Change*, London: Unwin Hyman

Ziman, J.M. (1990) 'What is happening to science?' in: S.E. Cozzens et al. (red.), *The Research System in Transition*, Dordrecht: Kluwer Academic, 23-33.

Zonneveld, W. (1990) *Conceptvorming in ruimtelijke planning. Patronen en processen*, Amsterdam: Planologisch en Demografisch Instituut van de UvA.