Sources of Authority in Implementing Science Policy
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Of the two words that describe whatever it is we are talking about when we talk about 'science policy,' the word 'science' gets the most attention. And certainly the example of climate science policy illustrates the importance of getting the science part of it right. Not just the 'science as method' that a schoolbook might describe, but the whole ambiguous and complex relationship of that methodological enterprise to things that count in real societies. Precisely how science can inform policies to mitigate or adapt to vaguely looming catastrophe depends on what science really is, and how it is conducted, and how the machinery works that puts money in one end and spurts out social benefits at the other. It is to the elucidation of these aspects of science policy that the efforts of this workshop are largely directed. They are worthy and important efforts.

The other word, however – 'policy' – is just as important. The word 'policy' signifies a phenomenon just as ambiguous and complex as the word 'science,' and equally in need of deeper understanding by anyone who wants to harness rationality for public service. To paraphrase Pontius Pilate, "What is policy?" I think of it as a guide to action, but common usage implies much more. The rhetorical intention of Pilate's "What is truth?" is ambiguous – we may conclude either that Pilate thought the concept was so obvious as not to warrant further discussion, or so obscure as not to deserve further attention. Our attitude toward 'policy' is much the same, but the word implies a great deal that we should not simply take for granted. Francis Bacon, who appropriated Pilate's words (or rather St. John's) to launch his essay on the subject thought Truth was complicated.[1] I think Policy is complicated.

Unless we are talking about what might be called 'personal policies' – such as always sitting on the front row – the very idea of policy implies a *chain of assent*. It implies owners and actors, creators and promulgators. It implies that some agents bend their will to others – the policy-authorities – in a predictable way. Meaningful 'policy' depends on a disciplinary machinery, the modern study of which begins with Max Weber, the father of sociology, but its first inventors co-existed with the dawn of civilization. Chapter 3 of Weber's "Economy and Society" (1914) is entitled *The Types of Legitimate Domination*.[2] "Domination," explains Weber, is defined as "the probability that certain specific commands (or all commands) will be obeyed by a given group of persons. It thus does not include every mode of exercising 'power' or 'influence' over other persons. Domination ('authority') in this sense may be based on the most diverse motives of compliance: all the way from simple habituation to the most purely rational calculation of advantage. Hence every genuine form of domination implies a minimum

of voluntary compliance, that is, an *interest* (based on ulterior motives or genuine acceptance) in obedience." Applied to our case: policies are carried out by actors with an interest in obedience to the policy.

I am going to quote Weber at greater length, because what he has to say about authority and obedience bears on some difficult issues in science policy. But first I will relate some experiences from my earliest months as President George W. Bush's science advisor. In November 2001, following what were then regarded as incidents of terrorism involving mailed anthrax, Homeland Security Advisor Tom Ridge called me seeking urgent advice on what to do with a very large quantity of anthrax-laden U.S. mail. Working through my OSTP staff we formed an interagency task group to evaluate and recommend methods to neutralize the spores.[3] Along the way it turned out to be necessary to do some research to inform the procedure. This was truly applicable science on demand. Omitting many details, we were able to give the U.S. Postal Service precise instructions on how to employ electron-beam irradiation with equipment normally used for food sterilization. Our advice amounted to where to set the dials for beam intensity. The Postal Service officials were delighted. But at first the intensity was set much higher than we recommended, whereupon some of the first batches of mail burst into flame. After further trials, the intensity was dialed back down toward our recommended level, which produced discoloration and a foul odor, but generally acceptable results.[4]

Our guidance, which I would describe as a narrow form of policy advice, was accepted as to method, but not as to degree. Someone thought, as it were, that if five on the dial were good, ten would be better. That agent substituted his or her judgment for a well-defined policy recommendation based on careful science and unambiguous data. Much, of course, was at stake. The Postal Service was responsible for delivering mail that would not kill you. Better to be safe than sorry. You may smile at this minor episode, but it is a relatively benign example of a potentially disastrous behavior.

A serious consequence of ignoring expert technical advice occurred in January 1986 when the NASA Challenger space shuttle launch rocket failed, killing seven astronauts. The best brief account I know of this tragedy is contained in Edward Tufte's 1997 "Visual Explanations" which includes a detailed analysis of the manner in which the advice was given. "One day before the flight, the predicted temperature for the launch was 26° to 29° [F]. Concerned that the rings would not seal at such a cold temperature, the engineers who designed the rocket opposed launching Challenger the next day." Their evidence was faxed to NASA where "A high level NASA official responded that he was "appalled" by the recommendation not to launch and indicated that the rocket-maker, Morton Thiokol, should reconsider… Other NASA officials pointed out serious weaknesses in the charts. Reassessing the situation after these skeptical responses, the Thiokol managers changed their minds and decided that they now favored launching the next day. They said the evidence presented by the engineers was inconclusive …"[5]

Even more was at stake when secret CIA reports to the White House starting in April 2001 advanced the opinion of an analyst – by reasonable standards a well qualified analyst – that certain aluminum tubes sought by Iraq were likely for use in a nuclear

weapons program. That claim was challenged immediately by Department of Energy scientists, probably the world's leading experts in such matters, and later by State Department analysts, who refuted the claim with many facts. The Administration, however, decided to accept the CIA version in making its case for war. Compared with the Postal Service incident this case is more complicated and hugely more consequential. Thanks to a thorough report by the Senate Select Committee on Intelligence (July 2004), the aluminum tubes case is very well documented.[6] This episode is another example of policy actors substituting their subjective judgment in place of a rather clear cut scientific finding. At least to the broad outside community the finding appeared to be clear. Did the small group of senior officials who secretly crafted the case for war simply ignore the science? I was not invited to that table and cannot judge from direct experience, but it looks more complicated than that.

From the evidence it appears the decision to invade Iraq was based more on a strong feeling among the actors that an invasion was going to be necessary than upon a rigorous and systematic investigation that would objectively inform that decision. Exactly what the basis for this feeling was, I will not speculate other than to observe that it was very strong. My interest is in how the policy actors in this case regarded science. They were obviously not engaged in a process of scientific discovery. They were attempting to build a case for an action they believed intuitively to be necessary – a legal case. And they regarded the conflicting testimony of credentialed experts from a legal, not from a scientific perspective. The case against the CIA conclusion, while overwhelming from a scientific point of view was nevertheless not absolutely airtight based on material provided to the decision makers. It was reported to the policy-making group by non-scientists who were transmitting summary information in an atmosphere of extreme excitement, stress, and secrecy. I assume that the highly influential CIA briefings on the aluminum tubes did make reference to the Energy Department objections. But this information was transmitted in a way that left a small but non-vanishing room for doubt. From a strict legal perspective, seriously limited by the closed and secret nature of the process, that loophole was enough to validate the proposition in their minds as a basis for the desired action.

What is important about these examples is that, as a point of historical fact, the methods of science were weaker than other forces in determining the course of action. The actors had heavy responsibilities, they were working under immense pressures to perform, and the decisions were made within a small circle of people who were not closely familiar with the technical issues. Scientists, and many others, find the disregard of clear technical – of scientific – advice incomprehensible. Most of us follow a kind of meta-policy that says the methods of science are the only sure basis for achieving clarity of thought. They are not, unfortunately, the swiftest. The methods of science, as even their articulate champion C.S. Peirce himself observed, do have their disadvantages. Peirce, an eminent logician and the founder of the philosophical school of pragmatism, wrote famous essays on how to make our ideas clear, and listed four ways, of which science is ultimately the only reliable one. However, to quote the Wikipedia authors, "Peirce held that, in practical affairs, slow and stumbling ratiocination is often dangerously inferior to instinct, sentiment, and tradition, and that the scientific method is

best suited to theoretical research, which in turn should not be bound to the other methods [of settling doubt] and to practical ends."[7] That the physical evidence for Saddam's hypothetical nuclear program was virtually non-existent, that its significance was appallingly exaggerated in statements by high public officials, and that the consequences of the action it was recruited to justify were cataclysmic, is beside the point. The fact is that while many factors influenced the decision to invade Iraq, science was not one of them, and it is a fair question to ask why not.

To my knowledge, no nation has an official policy that requires its laws or actions to be based upon the methods of science. Nor is the aim of science to provide answers to questions of public affairs. That science nevertheless does carry much weight in public affairs must be attributed to something other than the force of law. It is worth asking why advocates of all stripes seek to recruit science to their cause, and why we are so offended by actions that 'go against science.' Studying the source from which science derives its legitimacy may shed some light on conditions under which it is likely to be superseded.

Weber lists "three pure types of legitimate domination" based on different grounds as follows: (1) "Rational grounds – resting on a belief in the legality of enacted rules and the right of those elevated to authority under such rules to issue commands." This Weber calls *legal authority*, and he furnishes it with all the bureaucratic trappings of administration and enforcement of what we would call 'the rule of law.' In this case the authorities themselves are rule-bound. (2) "Traditional grounds – resting on an established belief in the sanctity of immemorial traditions and the legitimacy of those exercising authority under them." This is the traditional authority of tribes, patriarchies, and feudal lords. And (3) "Charismatic grounds – resting on devotion to the exceptional sanctity, heroism or exemplary character of an individual person, and of the normative patterns or order revealed or ordained by him." Weber applies the term *charisma* "to a certain quality of an individual personality by virtue of which he is considered extraordinary and treated as endowed with supernatural, superhuman, or at least specifically exceptional powers or qualities. These are such as are not accessible to the ordinary person …"[8]

Weber intended these types to be exhaustive. It is an interesting exercise to attempt to fit the authority of science in society into one or more of these categories. If we admit that science is not sanctioned by law, then of the two remaining choices charismatic authority seems the best match. To a scientist this is an absurd conclusion. It is precisely because the operation of science does *not* require charismatic authorities that we trust it to guide our actions. We tend to accept the authority of science as uniquely representing reality, and to act against it as a mild form of insanity. Experience shows, however, that such insanity is widespread. (Consider only public attitudes toward demonstrably risky behavior like smoking, or texting while driving.) Unless it is enforced through legal bureaucratic machinery the guidance of science must be accepted voluntarily as a personal policy. Science is a social phenomenon with no intrinsic authoritative force.

The fact that science has such a good track record, however, endows its practitioners with a virtue that within the broad social context closely resembles Weber's "exceptional powers or qualities" that accompany charismatic authority. And indeed the public regard for science is linked in striking ways to its regard for scientists. In our era, our Western culture gives high marks for objectivity, and science, as Peirce compellingly argued, is unique among the ways of making our ideas clear in arriving at objective, publicly shareable results. In America, at least, there is broad but voluntary public acceptance of science as a source of authority. Its authority is not mandated, but those who practice it and deliver its results are endowed with charismatic authority.

The National Academies of Science inherit this charismatic quality from the status of its members. I was never more impressed with the power of the Academies and its reports than in a series of events associated with the development of the proposed Yucca Mountain nuclear waste repository. I can only give an outline of these events here, but they began with a 1992 law requiring the Environmental Protection Agency to base its safety regulations for the facility on a forthcoming NRC report.[9] When the report appeared in 1995 it recommended radiological safety guidelines extending over very long times – up to a million years! – related to the half-lives of certain radioactive components of spent nuclear fuel.[10] Rule-making required estimating the impact of potential radiological contamination of groundwater on populations living in the vicinity of Yucca Mountain over more than a hundred thousand years. The science of such regulations requires constructing scenarios for both the physical processes of the storage system and the human population over that time period. There is no credible scientific, *i.e.* empirically validatable, approach for such long times, and the EPA acknowledged this through a change in its methodology after 10,000 years. When the regulations were challenged in court, the U.S. Court of Appeals, to my amazement, ruled that the EPA had not adhered to the letter of the NRC report as required by law and told EPA to go back to the drawing board.[11] A member of the committee that produced the report, a respected scientist, said that he never expected the report to be used this way. It had become a sacred text. In 2008 both the Secretary of Energy and the EPA Administrator asked my advice on how to proceed, but the issue had passed far beyond the bounds of science. I speculated that in far fewer than a thousand years advances in medical science would have altered completely the consequences of hazards such as exposure to low level ionizing radiation. But such speculations play no role in the formal legal processes of bureaucratic regulation. Yucca Mountain has become a social problem beyond the domain of science.

What emerges from these reflections is that the authority of science is inferior to statutory authority in a society that operates under the rule of law. Its power comes entirely from voluntary acceptance by a large number of individuals, not by any more structured consensus that society will be governed by the methods and findings of science. At most, science carries a kind of charismatic power that gives it strength in public affairs, but in the final analysis has no force except when embedded in statute. Advocates who view their causes as supported by science work hard to achieve such embedding, and many examples exist of laws and regulations that require consultation with technical expert advisory panels. The Endangered Species Act, for example,

"requires the [Fish and Wildlife Service and National Marine Fisheries Service] to make biological decisions based upon the best scientific and commercial data available." Also "Independent peer review will be solicited … to ensure that reviews by recognized experts are incorporated into the review process of rulemakings and recovery plans …"[12] The emphasis on 'experts' is unavoidable in such regulations which only sharpens the charismatic aspect of scientific authority. The law typically invokes science through its practitioners except when adopting specific standards which are often narrowly prescriptive. Standards too, however, are established by expert consensus.

At this point the question of the source of scientific authority in public affairs merges with questions about the nature of science itself, and its relation to scientists. That society does not automatically accept the authority of science may not come as a surprise. But in my conversations with scientists and science policy makers there is all too often an assumption that somehow science must rule, must trump all other sources of authority. That is a false assumption. Science must continually justify itself, explain itself, and proselytize through its charismatic practitioners to gain influence on social events.

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[1] Pilate's question "What is truth" appears only in the gospel of St. John 18:38, the most literate and philosophical of the gospels. Sir Francis Bacon's essay "Of Truth" is the lead essay in the third and last edition of "Essays" (1625). Its first sentence is "What is truth? said jesting Pilate, and would not stay for an answer."

[2] Max Weber *"Economy and Society"* (1914). Modern edition Ed. by Guenther Roth and Claus Wittich, University of California Press (1978).

[3] Agencies participating in the early OSTP Task Force were the U.S. Postal Service, National Institute for Standards and Technology, Federal Drug Administration, Armed Forces Radiobiology Research Institute, U.S. Department of Agriculture, and Sandia National Laboratories. Later these were joined by the Library of Congress and the National Archives.

[4] According to my notes from an August 2002 briefing, the fire occurred at the Bridgeport facility of IBA, a manufacturer and operator of irradiation equipment.

[5] Eward Tufte, *"Visual Explanations,"* Graphics Press (1997)

[6] Senate Select Committee on Intelligence, *Report on the U.S. Intelligence Community's Prewar Intelligence Assessments on Iraq* (2004). A more readable account appeared later in the New York Times (October 3, 2004).

[7] Wikipedia article on C.S. Peirce. The quoted text cites *"Philosophy and the Conduct of Life,"* Lecture 1 of the 1898 Cambridge (MA) Conferences Lectures, Reprinted in *The Essential Peirce*, Vol 2, The Peirce Edition Project, Indiana University Press 1998.

[8] See reference 2

[9] Energy Policy Act of 1992 (P.L. 102-486)

[10] "Technical Bases for Yucca Mountain Standards" National Academies Press (1995)

[11] Nuclear Energy Institute, Inc, vs. EPA, U.S. Court of Appeals, District of Columbia Circuit, No. 01-1258, July 9, 2004

[12] The Federal Register, Vol.59, p. 34270, 1994. Cited on the U.S. Fish & Wildlife Service website on the Endangered Species Program www.fws.gov/endangered/policy/pol003.html