Mediating Science–Intensive Policy Disputes

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Abstract

Public policy disputes involving complex scientific issues usually entail conflicts not only over those scientific issues, but also over the distribution of gains and losses. The presence of scientific or technical dimensions to a dispute should not be allowed to mask underlying distributional considerations. On the other hand, science-intensive disputes require special attention. Merely resolving distributional conflicts without incorporating the best scientific judgment will produce unwise and potentially dangerous results. The usual adversarial approach that characterizes the handling of such disputes by agencies and courts is less than ideal for creating an understanding of scientific evidence or the resolution of scientific differences. A process of mediation, already applied in a number of significant cases, offers strong promise as a superior approach.

Public policy disputes revolving around ambiguous or contradictory scientific or technical information are puzzling in several respects. These disputes characteristically involve both scientific analysis and political considerations, both essential for designing realistic policy. Achieving a balance between scientific and political concerns is extremely difficult. Sometimes, scientific advice is reduced to an instrument for legitimating political demands. Scientific analysis, in turn can distort policy disputes by masking, beneath a veneer of technical rationality, underlying concerns over the distribution of costs and benefits. The problem is, how shall we attain the proper balance?

In 1974, the Occupational Safety and Health Administration (OSHA) held hearings to solicit public comments on a proposed permanent safety standard for workers involved in the production

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of vinyl chloride monomer (VCM) and polyvinyl chloride (PVC).[1] Both products are suspected carcinogens. Predictably, the industry opposed a "no detectable level" standard (zero parts per million parts air); not surprisingly such a standard was supported by labor unions, public health groups, and OSHA staff. Those who spoke for industry contended that health and safety levels in the workplace ought to be set relative to the actual benefits of production. According to industry experts, the cost of meeting the proposed standards would cause many plants to close and would result in the loss of 1.7 to 2.2 million jobs; the proposed standards, they asserted, were clearly too stringent. Industry's scientific witnesses argued for maximum exposure limits in the range of 20 to 40 parts per million. Supporters of the zero standard countered that if plastic could not be produced safely (in other words, by meeting the proposed standards), it should be phased out. They argued that safe substitutes should be the goal—and that the health and welfare of workers should not be sacrificed.

Advocates on all sides bolstered their positions by citing available scientific evidence. Industry scientists noted that studies by the Dow Chemical Company showed no increase in mortality rates among workers exposed to less than 200 parts per million during an 8-hour day. Moreover, they contended that the epidemiological evidence indicated that the incidence of angiosarcoma of the liver, the primary disease associated with vinyl chloride at that point, occurred primarily among reactor cleaners, who comprised only a small percentage of workers in the industry.

Supporters of the proposed zero standard argued that the lack of data on the effects of varying exposure levels precluded reliable epidemiological studies. Since no animal or human studies were available at exposures below 50 parts per million, a level at which carcinogenicity had been detected, they argued that only a "no detectable level" standard would guarantee an adequate margin of safety. Hence, scientific testimony was utilized to support two contradictory policy positions.

In a similar conflict, the Environmental Protection Agency (EPA), acting under a court order ensuing from a suit by the National Resources Defense Council, promulgated regulations restricting the use of lead additives in gasoline.[2] Under the 1970 Amendments to the Clean Air Act, EPA was required to control the major sources of ambient lead, a pollutant identified by EPA as a health risk. Section 211 of the Act specifically authorized EPA to regulate fuel additives. Accordingly, EPA proposed to phase down the use of lead additives to achieve ambient lead levels adequate to protect what EPA considered the most susceptible populations, which included young children and traffic policemen.

A number of gasoline and chemical manufacturers challenged EPA's proposed regulations. EPA's actions, they claimed, were not supported by available scientific evidence. They contested the prevalence of elevated blood lead levels among the general public, the extent to which automobile lead emission products are absorbed into the body, and the degree to which airborne lead mixes with dust and poses a health threat to children. If EPA's regulations were upheld, according to these petitioners, they would suffer substantial commercial losses.

The petitioners vigorously contested the scientific basis of the regulations. In a majority decision, the U.S. Circuit Court of Appeals, District of Columbia, found that this disagreement was not surprising given the uncertain nature of the scientific information. Nonetheless, the Court sustained the Agency's prerogative to make policy judgments in the face of conflicting and inconclusive evidence for the purpose of instituting preventive regulations.[3]

As these two cases illustrate, contending interests frequently seek to manipulate scientific advice to provide a rationale for the decision they prefer. This most often occurs when scientists disagree.[4] Disagreement can arise at two key points in a policy debate. As in the vinyl chloride case, scientists may disagree on the significance or implications of available scientific evidence; or, as the airborne lead case illustrates, scientists may disagree on the scientific evidence itself. Rather than dealing with these disagreements, decision makers operating through existing dispute resolution mechanisms commonly gloss over them and focus instead on the importance of constitutional guarantees.

Failure to deal directly with conflicting scientific advice frustrates scientists and diminishes the public's faith in scientific expertise. Moreover, the decisions may be politically palatable, but scientifically unwise. FDA's approval of saccharin, for instance, was a scientifically unwise decision, in light of its ban on cyclamates, which are now generally thought to be less harmful than saccharin. The approval of saccharin appeared to undermine agency credibility.

Recent efforts to deal more effectively with science–intensive policy disputes date back to 1967 when one observer proposed a "science court."[5] Numerous variations on the science court idea have been suggested; most presume that the key to making wise decisions in science-intensive policy disputes is to have scientists first address "science questions" and to have decision makers then act on "policy questions." Since controversy appears to escalate when experts admit their differences publicly, proponents of the science-court approach suggest that a consensus on the scientific components of a dispute ought to precede any analysis of political choices. Indeed, the advocates of such thinking assert that scientists ought to reach a consensus on scientific issues without interference from non-expert participants.[6] In sum, science court proponents advocate separating "fact" and "value" questions, a task they view as difficult but not impossible.

While it is important to distinguish between disagreements over scientific evidence and disagreements over the implications of such information, making this distinction only partially addresses the troublesome aspects of incorporating scientific advice into policymaking. As we shall presently point out, scientific investigations often produce varying results depending on the institutional environments in which they are undertaken and the political orientation of the investigators.

We are not the first to express skepticism about the possibility of separating "fact" and "value" components of policy choices. Harvey Brooks has argued that science-intensive policy disputes demand a greater recognition of the "non-technical values and preferences that affect both the selection of evidence and its interpretation by all participants, both laypersons and experts."[7] Other writers state more pointedly that scientific findings are not pure "fact"; scientific and technical analyses are not devoid of value biases.[8]

While underscoring the complexity of folding scientific advice into policymaking, our objective here is to propose a framework for making decisions that are sound in both political and scientific terms.

THE RELATIONSHIP AMONG POLICY ACTORS

Disputes that entail the use of scientific evidence typically involve three sets of actors: individuals and groups likely to receive the benefits or bear the costs of a particular policy decision (affected interests); elected or appointed officials with decision-making authority (decision makers); and technical experts called upon to provide relevant technical expertise (scientists). In practice, these three sets of actors are rarely mutually exclusive: Public officials commonly hold allegiances to agencies with a stake in decisions, that is, they are "affected interests"; scientific advisors may be linked to an "affected interest," most conspicuously through the sources of their research funding; and individuals who are likely to be directly affected by a policy decision as well as public officials engaged in the debate may also be professionals with relevant expertise. Although the precise relationship among these three sets of policy actors is dependent on the affiliations of the individuals involved, certain generalizations can be made about the interactions among them.

In the formulation of mechanisms for the resolution of disputes, it is usually assumed that scientific experts stand apart from the "political" arena in which decision makers and affected interests operate. According to this view, scientists work within the protective insulation of their expertise, seeking to establish scientific "facts." On the basis of such "facts" they inform decision makers and affected interests about the outcomes associated with various policy options. By definition, such advice is presumed to be rationally sound and "apolitical."

Under such a model, decision makers are influenced directly by both technical and political exigencies. In some circumstances, therefore, political objectives can prevail as easily as technical ones. Several authors have observed that decision makers (and affected interests) tend to place especially heavy weight on scientific advice when it happens to support a decision they prefer on other grounds, and that they tend to place little weight on such advice when it conflicts with their political preferences. According to one former senate leader, he and other congressional leaders were well aware that scientists were skeptical of the idea that some threshold level existed, below which a given air pollutant could be said to offer no carcinogenic threat; yet despite that awareness the leaders continued to advocate federal legislation that presumed the feasibility of a "no threat" standard.[9] Behind that position was the political judgment that such a standard was the one most likely to win legislative support. Decision makers also find it easier to justify relying on political factors when scientific evidence fails to point to a firm conclusion, or when the implications of the evidence are in dispute. Such judgments have been upheld by the courts in several important instances.[10]

WHY SCIENTISTS DISAGREE

Because cases in which scientists disagree offer the greatest latitude for discussion based on political factors, it is important to understand the underlying causes of such disagreements.

Miscommunication

Some observers have suggested that scientists do not always disagree when the public thinks they do.[12] There are at least two explanations for the illusion of controversy. First, the intentional use of certain rhetorical devices may cause confusion. Second, the scientists involved may be addressing essentially different issues. In neither case is there what we would call a "substantive" conflict.

One author described how scientists have used rhetorical devices to sway public opinion in the nuclear power and fluoridation debates. Scientists on both sides frequently resorted to phrases such as, "There is no evidence to show that analysis is unhelpful, either because data are lacking or the available data are inconclusive." Scientists who support one of the options despite the absence of scientific evidence have been known to make such statements in order to disparage contending positions. A lay audience that hears opposing scientists use such language might easily infer that a "scientific" disagreement existed. Thus, while scientists may actually agree that no conclusive evidence to support either scientific claim is available, their public statements sound like they disagree about the facts.

Scientists may also cause some confusion by presenting the same facts in different ways. Harvey Brooks describes such a case, referring to the debate over the effects of nuclear fallout that preceded the adoption of the 1963 test ban treaty:

> Those [scientists] who favored testing expressed health dangers in terms of the increased chances of cancer for an individual exposed to fallout. Expressed as a fraction, such increases were miniscule. The critics of testing, however, often expressed the identical facts in terms of actual deaths that would occur worldwide within a period of 50 years . . . as a result of current fallout. Some figures were very high.[14]

The scientists were not actually disputing the facts. They were simply using different forms of measurement to translate statistical estimates into concepts they hoped would reasonate with their listeners. The different presentations, however, were intentionally designed to pull public opinion in contrary directions.

The case involving pollution standards for vinyl chloride provides another example of an instance in which scientific disagreement did not exist even though scientists were at odds. Pro-standards scientists stressed one set of concerns, industry scientists another. Proponents for the standard emphasized the toxicity of exposure, while industry scientists focused their testimony on the long-term effects of exposure upon death rates. If asked outright, it is likely that neither group would have challenged the validity of the other's arguments. In their testimonies, however, each side emphasized those aspects of the issues that best supported their own policy positions.

Differences in the Design of Inquiries

Other observers have concluded that scientists disagree because of the different ways in which they organize their research. Although the "scientific method" is widely accepted as a technique for testing the validity of a given proposition, it has become increasingly apparent that the method entails inescapable elements of subjectivity. Any research design, for instance, requires the framing of hypotheses, the specification of assumptions, and the selection of data; and each of these offers scientists an opportunity for the exercise of choice.

Consider the choice of data. Scientists attempting to answer the same questions can reach contradictory conclusions if they rely on different data sets. For example, in a report by the Committee on the Biological Effects of Ionizing Radiation of the National Research Council, a dissenting opinion noted a disconcerting discrepancy between findings, depending on whether one particular source study was included in the data base.[16] In the fluoride controversy, scientists routinely dismissed as invalid data that did not support their hypothesis.[17]

Consider, too, the simplifying assumptions that are a part of any study design. Any scientific inquiry rests on a set of operating assumptions aimed at simplifying reality. Such assumptions cannot be validated prior to (or even subsequent to) a particular inquiry. They rest squarely on the judgment of the individual investigator, and are often based on the prevailing logic in a particular academic discipline.

For example, in predictive analysis, assumptions must be made regarding future conditions within a system under study. One author cited a case in which two scientists, asked to predict the number of cancer cases per year likely to result from radiation exposure to nuclear power, gave responses that differed by an order of 10^6.[18] Upon closer examination, it became clear that the two had grounded their predictions on one powerfully different assumption—their estimate of the radiation level to which the population is normally exposed. One scientist based his calculation on what he thought the maximum allowable exposure level ought to be, while the other used estimated actual average exposure. While neither was "right" or "wrong," their estimates about the impact of nuclear power facilities critically hinged on an assumption that had no scientific base. Without the disclosure of such an underlying assumption, the lay public would be confused by the apparent disagreement between these two scientists.

Consider, finally, how hypotheses are formulated. Some observers have concluded that scientists called upon for advice often focus on different questions. As Thomas Kuhn has explained, "scientific knowledge" is built upon shared beliefs in certain untested axioms.[19] Scientists trained within a given "paradigm" tend to frame research questions in a manner that reflects their "school of thought." As a result, scientists with different ideologies examining the same issue (even using the same data) may arrive at contrary conclusions. Although they are not in agreement, neither are they actually disagreeing. More precisely, they are talking past each other. For example, an engineer evaluating highway options will choose the alternative most likely to increase the flow of traffic, while an ecologist or an economist will pick a different "best" option. In many instances, they will know that they disagree, but will prefer to avoid analyzing why they disagree and explaining how to pool their knowledge.

Errors in the Inquiry

Sometimes scientists present conflicting evidence or support opposing views because one or both have erred. Erroneous scientific findings can easily spark policy debates. At one juncture in the debate over the toxicity of "Agent Orange," for example, a study which suggested that the chemical might lead to malformations and tumors was found to be seriously flawed. As it happened, subsequent work confirmed the results of the flawed study. Yet it was that study which helped mobilize the groups on both sides of the debate.[20]

Differences in Interpretation of Findings

Even if two scientists agree upon the validity of a given body of evidence, they might disagree on how to interpret the evidence.[21] For instance, the existence of a geological fault line in an area that has not experienced perceptible tremors in 40,000 years may be interpreted to signal two contradictory futures. One geologist may read the finding to indicate that a future earthquake in the area is highly unlikely, while a colleague may conclude that the existence of the fault line indicates significant potential for an earthquake.

Uncertainty represents perhaps the major interpretive hurdle for scientists, especially those working at the frontiers of a scientific field of knowledge. In many situations, analysts are constrained by methodological barriers and are forced to make estimates of some sort—the accuracy of which cannot be ascertained. When testing for adverse health effects in chemicals, for instance, experimenters commonly use high doses in an effort to estimate the effects of much lower levels of exposure. Similarly, experimenters commonly use the results of tests on laboratory animals as a substitute for epidemiological studies. The decision whether to accept such results as a basis for determining the actual effects of some given hazard is not often subject to scientific determination.

Uncertainty provided the basis for the petitioners' appeal of EPA's decision to reduce lead additives in gasoline. Because of the many channels by which lead can enter the body, because of the wide variations in the amount of ambient lead found in different sectors of the population, and because of the lack of data pertaining to the effect of lead on those exposed to it, scientists reached a legitimate disagreement over whether lead additive reductions would improve the health of the population.

For many scientists, the temptation to offer prescriptive advice is nearly irresistible. In addition, many policymakers seem to feel cheated if their scientific advisors stop short of offering policy recommendations. Yet, the question, "Does substance X induce cancer in laboratory animals?" is quite different in character from the question "Should substance X be banned from human use?" The first is within the legitimate realm of the scientists; the second is not. Their opinions about what ought to be done are no more scientific than those of nonscientists. Consequently, when scientists disagree about what ought to be done on a particular policy issue, the disagreement is more likely to be based on politics than on science.

RESOLVING SCIENCE-INTENSIVE POLICY DISPUTES

Policy disputes that entail considerable scientific controls are commonly handled through administrative action or judicial review. Federal legislation such as the National Environmental Policy Act and the Administrative Procedure Act, along with special provisions of specific laws, mandate opportunities for review and comment by affected interests; similar provisions are found in the legislation of the various states. Federal agencies proposing new regulations, for instance, are required to publish a notice of their intended rulemaking in the Federal Register, to promulgate a draft of regulations they are contemplating, and to receive and respond to written comments from interested parties. When regulations are challenged by a force with sufficient political clout and economic strength, public hearings are usually arranged to provide an opportunity for a public airing of the debate. Typically in science-intensive disputes, groups opposing the new regulations will present evidence that appears to contradict or cast doubt on the scientific basis for the proposed rules. Often without attempting to reconcile such discrepancies, the appropriate elected or appointed decision makers act on the proposal, usually approving the version proposed by agency staff.

Parties dissatisfied with the decisions of the agency can appeal to the courts. Rarely, however, do the courts have sufficient resources or expertise to conduct their own independent inquiry into the scientific aspects of a dispute. In fact, some legal scholars warn that the courts lack a public mandate to do so.[22] As a result, courts tend to restrict themselves to taking a "hard look" at the evidence submitted in order to determine whether or not a decision maker (or agency) has acted in a fashion consistent with existing statutory requirements. In short, the judiciary does not attempt to adjudicate scientific disputes.

Given the inadequacies of existing mechanisms for the resolution of disputes, various innovations have been proposed from time to time. Among these are various forms of the science court, scientific panels, and consensus-finding conferences.[23]

The science court concept extends the adversarial nature of the American legal system, involving scientists who espouse contradictory views in an adjudicatory process. Although its numerous variations differ in details, the science court idea revolves on an especially qualified judge or panel of judges who listen to prepared arguments of opposing "advocate scientists" and then come to conclusions on the basis of their own expertise. The authoritativeness of the court's findings derives primarily from the scientific reputations of the participating judges.

Scientific panels are structured less formally than science courts. They are akin to other appointed committees with members who are highly regarded in their fields. The panel reviews all available scientific evidence pertinent to a policy dispute and then issues a report and recommendations. The reports of such panels usually reflect at least a limited consensus among the members.

Consensus-finding conferences bring together scientists from diverse perspectives to discuss a disputed issue. The group can be divided into special workshops or subcommittees to examine relevant questions in detail. Through the course of the discussions, the experts seek to establish points of agreement and those on which further study is necessary. Like the science court and scientific panels, consensus-finding conferences allow scientists to communicate directly, thereby avoiding the intervention of attorneys.

Although each of these proposals has some appeal under the proper circumstances, they also suffer from fundamental shortcomings. One of the most common concerns about the science court is that the adversarial character and formalistic nature of its proceedings and the formalistic rules of conduct it engenders are antithetical to the conduct of "good science."[24] Expert panels often lack credibility in the eyes of the public, especially because of a suspicion that the deck has been stacked. And consensus-finding conferences suffer from the fact that, lacking authority, they may achieve little more than setting the stage for a court battle.[25]

It is worth noting that all three mechanisms presume that scientists can best contribute to the resolution of policy disputes by operating independently of the affected interests and the decisionmakers. Our earlier analysis suggests a separation may be unjustified, unwise and undesirable. As was observed earlier, differences in scientific judgments often arise from factors that are not "scientific" in character, such as differences in hypotheses and in simplifying assumptions. Isolating the scientists does little to educate decisionmakers and affected interests regarding the underlying factors that may have been responsible for the differences among the scientists.

MEDIATION OF SCIENCE-INTENSIVE DISPUTES

Mediation, in our view, offers a greater opportunity for constructive interaction among scientists, affected interests, and decision makers. The flexibility of the mediation process allows the values and interests of each group to be expressed at appropriate moments during the fact-finding process. Mediation allows the distribution of costs and benefits to be woven into the process of analysis. Moreover, the credibility of the process derives less from the pre-established reputations of the participants than from the success of the process itself.

Several studies describe the application of mediation to public policy disputes; some providing case studies[26] and others more theoretical discussions.[27] We will sketch only the more prominent features of mediation, especially those that indicate its applicability to policy disputes that entail substantial scientific considerations.

Mediation is a voluntary process distinguished from simple negotiation by the inclusion of a nonpartisan facilitator who serves at the pleasure of the disputants. A mediator is responsible not only for tending to the more mechanical aspects of negotiation such as scheduling meetings and keeping records, but also for more substantive functions such as ensuring a common understanding of technical points among all participants, suggesting courses of action for helping to resolve disputed points, and proposing alternative formulations of agreements. In disputes of the kind considered here, participants might include government agencies, special interest groups, and private individuals, along with their respective scientific advisors.

A number of techniques routinely employed during mediation may be particularly well suited for resolving science–intensive disputes. These include information sharing, joint factfinding, and collaborative model building.

Information Sharing

Information is the key to scientific analysis. Theoretically, the more information an analyst is able to incorporate, the more compelling his or her work should be. In the community of scientists, information is presumed to be socialized.[28] That is, scientists readily share new-found knowledge with their colleagues to further the search for scientific truths. This is in contrast to adversarial approaches to dispute resolution, which encourage the withholding of information helpful to an adversary's case. In contrast, some observers have suggested that mediation creates a setting especially conducive to the scientist's information-sharing norms.[29] While disputants in adjudicatory proceedings see every non-supportive piece of information as a threat to their claims, participants in a mediation process are encouraged to see information as a means of opening up new possibilities for dealing with differences.

Moreover, in mediation, any effort to suppress information carries with it the possibility of being discovered, resulting in a subsequent loss of credibility. As mediation unfolds, the participants usually become more reluctant to risk the success of the effort for the uncertain gain associated with suppressing information.

Mediation also has the virtue of placing the decision makers in any dispute in a participating role. In adversary proceedings, the decision-makers remain aloof, hearing the claims of the contending parties and having relatively little influence over the type and format of the information presented. As a participant in mediation, decision makers can demand and receive information in whatever form they feel best highlights the contradictory claims put forth by affected interests. Their understanding of critical issues will likely result in better-grounded policy decisions.

Joint-Factfinding

Mediation can easily accommodate joint factfinding if the participants so desire. The participants can jointly frame the research questions, specify the method of inquiry, select the researchers, and monitor the work, injecting their concerns at every appropriate point. If the parties to a dispute make these decisions collectively and debate the possible alternatives before an analysis is completed, they are less likely to reject the scientific findings that emerge. Their understanding of technical aspects of the issue is also likely to improve through such an exercise.

One vehicle for joint factfinding is the collaborative building of forecasting models. Science-intensive disputes frequently revolve around projections of the likely consequences of proposed actions. When more than one forecasting model is possible, competing parties usually subscribe to the one that best supports their claims.

Every modelling effort incorporates some value-bound assumption such as the specifications of sub-system boundaries, the level of sub-system complexity, the extent to which historical data can be used to describe future circumstances, and the relative importance of forces and factors external to the model. Mediation can provide a means of disengaging each party from its preferred models and encouraging a collaboration that forces a discussion of those assumptions. If the parties to a technical dispute can develop a model that incorporates key assumptions acceptable to all of them, they are more likely to produce a prediction that none can easily dismiss. The deceptive shield that technical analysis sometimes offers to affected interests wishing to disguise the self-serving nature of their position is torn away. An example from the Law of the Sea negotiations illustrates.

One sticky impasse in the negotiations concerned the allocation of profits from mining manganese modules in the ocean floor. Predictably, representatives from developing countries and countries without mining interests supported financing schemes that would tax miners heavily for mining rights in international waters. Delegates from countries with mining interests favored lower payments. A computer model was developed under conditions that led the participants to see it as nonpartisan. The model provided a means of testing various allocation plans based on a wide range of assumptions about future costs and prices. Delegates took turns trying out their financing proposals to determine what their consequences would be under the conditions they considered most likely. Because the structure of the model was perceived as neutral with regard to the interests of the various parties, the representatives felt no loss of face in revising their financial demands in accordance with the results of the model.

Why was this particular model perceived as nonpartisan within the negotiation setting? There were several reasons.[30] First, although the model was created by a team of American academic researchers at M.I.T., with funding from a U.S. government agency, the project was undertaken without direct reference to the Law of the Sea negotiations. Second, the various key estimates, such as research and development costs, operating costs and capital investment requirements were established independently by those who had designed the model. Moreover, those who used the model were free to substitute their own assumptions if they preferred. Fourth, the model had been critically reviewed at two conferences attended by American academics, technical representatives of the mining consortia and government scientists, and had been revised thereafter in response to points raised in the conferences. At those meetings, little reference had been made to the Law of the Sea negotiations. Finally, the fact that the model's early findings failed to give clear support to the position of any particular delegation at the negotiations seemed to enhance its credibility.

Models can be used to facilitate a settlement as long as the model structure is perceived as neutral with respect to the interests of the parties involved. Although in the Law of the Sea example the model's nonpartisanship was achieved by happenstance, a perception of nonpartisanship has been established in other cases through the collaboration of the participants.[31]

Creating and using a model in this way represents a form of mediation. The process provides a favorable climate for joint fact-finding and collaborative model building because disputants deal with each other face-to-face. Decision makers and representatives of affected interests, constantly drawing on the scientists, are able to remain at the helm of the dispute, injecting their own value preferences when value judgments are required and gaining a clearer understanding of the variations that are produced by changes in the scientific analyses. The participation of affected interests and scientists facilitates debate over the values and distributional concerns at every stage of the dispute, from the specification of assumptions to the final prescriptive judgments. Most importantly, decision makers gain a more accurate understanding of the political nature of technical advice.

ROLE OF THE MEDIATOR

Although the role of the mediator has been variously conceived and contested,[32] a process in which the mediator assumes an activist role offers special promise for "keeping the negotiators honest." As long as mediators can remain aloof from judging whether any given distribution of costs and benefits is superior to any other, they can retain sufficient distance from the debate to perform a critical nonpartisan role. A mediator can ensure that information is conveyed in a language that is readily comprehensible to all the participants, and that technical assistance is made available to all. By meeting with parties in private sessions, the mediator can ascertain whether the participants share a common understanding of key technical points. If not, the mediator can take steps to remedy the discrepancies; for instance, in a negotiation involving the conversion to coal of an oil-fired electric generating plant in Massachusetts,[33] the mediator organized training sessions to educate the participants in the more technical aspects of the dispute. In short, as a guardian of the process, a mediator can intervene to correct miscommunications, to clarify ambiguous messages, and to challenge deceptive communications. Also, a mediator can point out when differences in interpretations have arisen and when participants are making prescriptive rather than descriptive statements.

THE NEW YORK CITY DIOXIN DISPUTE

Illustrative of the mediator's role was the handling of a 1984 dispute over the building of a series of refuse plants in New York City. At the request of the New York City Sanitation Department, the New York Academy of Sciences organized a meeting of the parties concerned about the city's proposal to build a series of such plants. It was clear that some such alternative to landfill would soon be needed to handle the 20,000 tons per day of trash that the city produces. Residents of Brooklyn, living near the site of the first proposed facility, had grown increasingly alarmed about the health risks posed by the plan. Barry Commoner, a noted environmentalist and Professor at Queens College, issued several reports criticizing the city for underestimating the dioxin risks likely to be created by such facilities.[34] While the leaders of the Academy were not willing to assemble a blue ribbon committee of scientists to determine the "true" level of risk associated with the proposed plants, they were willing to organize and host a mediation effort.

On December 18, 1984, 55 men and women gathered at the Academy's mid-Manhattan offices. Most of the members of the city's Board of Estimate—the elected council of the city, charged with making the decision whether to adopt the program—were represented. Approximately 30 neighborhood and environmental groups, including a heavy concentration from Brooklyn, were in attendance. With the help of a mediator, national experts were present who could address various key issues; the engineering of resource recovery plants; the epidemiology of the health risks associated with dioxin emissions; and the physics of mass burning of municipal trash. The mediator worked with the Academy staff to assemble and summarize all the relevant technical documents, including the environmental impact and risk assessments prepared by the city and its consultants.[35] He organized and moderated the panels of engineers and scientists. The Academy staff worked with the Board of Estimate to ensure that all their questions and concerns were addressed by the panel. Open discussion followed each panel session. Throughout, the mediator maintained a visual record of the key points made and highlighted the points of agreement and disagreement at the conclusion of each section of the program. The session lasted almost nine hours. By the time it ended, the sources of scientific and technical disagreement had been clarified and the policy makers felt better equipped to move ahead.

The most telling disagreement was over the estimation of risks associated with the resource recovery technology selected by the city. This disagreement stemmed in part from gaps in the basic research in the field. It also grew out of the fact that there are competing theories of the combustion process; some experts assume that dioxins are a normal byproduct of the burning of municipal waste, while others assume that dioxin only occurs when the burning process is not managed properly. A third source of disagreement was the reliability of various pollution control devices and strategies. Finally, the disagreements were also traced to substantial uncertainty surrounding the estimates of the threat to human health, which had been calculated by scaling up the results of laboratory tests on rats.

The most significant source of controversy, however, resulted from neither the scientific, engineering, or epidemiological differences mentioned above. The primary source of disagreement hinged, it turned out, on Professor Commoner's use of a "worst case" scenario. It soon became clear that what had been thought of as a fundamental disagreement regarding the facts, or the basic science, was in reality a disagreement over the appropriate method of analysis.

While the sessions were somewhat heated, the debate proceeded in an orderly fashion. The scientists were urged by the mediator to present their ideas and findings in language understandable to the representatives of the Board of Estimate.

After considering what it heard at the session sponsored by the Academy, the Board decided to proceed with a full assessment of the impact of a city-wide system of trash-to-energy plants. By that time, they had a better grasp of the sources of risk. The interest groups in attendance understood why and how the decision makers had reached their conclusions. The scientific and technical discourse had, with the help of the mediator and the Academy staff, provided a common basis for decision making, one shared by elected officials and interest group representatives.

THE PROMISE OF MEDIATION

Mechanisms that seek to resolve disagreements among scientists by separating them from decision makers and affected interests are undesirable because they place power in the hands of the scientists to which they are not entitled. Many steps within the analytic process require judgments that rest on subjective considerations and individual values. Allowing scientists to select the "one best answer" to what appears to be purely technical aspects of a policy dispute, gives responsibility to an elite corps who are in no way accountable to the public.

Mediation is one method of resolving disputes that casts the scientists in an appropriate role in relation to decision makers and affected interests. Techniques available in a mediation context directly confront value-bound components of scientific analysis, which we suggest lie at the root of conflicting scientific testimony. By revealing the basis of disagreement among scientists when disagreement appears to exist, mediation may help to clarify the power and the limitations of scientific analysis.

The success of a mediation process, however, depends on a number of issues.

The first requirement for success is appropriate representation. Mediation should only proceed if all the key interests are adequately represented. Without the participation of every party that has the political or economic power to block resolution, the process will not succeed.

Moreover, mediation is dependent on the willing participation of all the relevant parties. Since the participants do not surrender their legal rights to resort to the adversarial approach, efforts at coercing the parties into mediation have their distinct limits.

Mediation has been applied in a number of environmental disputes over the past decade or so.[36] Several mediation experiments have also been conducted, aimed at resolving intergovernmental policy conflicts.[37] Federal agencies have begun to take an interest in mediated rulemaking. In fact, the Environmental Protection Agency recently completed several exercises of this sort.[38] Many of these mediation projects have involved a substantial amount of hotly contested, highly technical information. Most have also involved heated emotions tied to distributional issues. Mediation has a long way to go before it will become commonplace, but as the costs of the existing adversarial approaches become more widely recognized, the demand for more effective methods may well intensify.

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NOTES

1. Michael Brown, "Setting Occupational Health Standards: The Vinyl Chloride Case," in Dorothy Nelkin, ed., *Controversy*, (Beverly Hills, CA: Sage Publications, Inc., 1984), pp. 125–142.
2. Phillip Boffey, *The Brain of America: An Inquiry Into the Politics of Science*, (New York: McGraw Hill, 1975) pp. 229–244.
3. *Ethyl Corporation v. EPA*, 541 F.2d (D.C. Circuit, 1976).
4. See Yahron Ezrahi, "Utopian and Pragmatic Rationalism: The Political Context of Scientific Advice," *Minerva*, 18 (1980): 111–131; and Dorothy Nelkin, "The Political Impact of Technical Expertise," *Social Studies of Science*, 5 (1975): 35–54.
5. Arthur Kantrowitz, "Proposal for an Institution for Scientific Judgment," *Science*, (156)33776 (May 12, 1967): 763–764.
6. See, for example, Allan Mazur, "Science Courts." *Minerva* (15)3 (Spring 1977): 1–4; J. D. Nyhart and Milton M. Carron, eds., *Law and Science in Collaboration*, (Lexington, MA: Lexington Books, 1983); and Milton Wessel, *Science and Con-Science*, (New York: Columbia University Press): p. 49.

7. Harvey Brooks, "The Resolution of Technically Intensive Public Policy Disputes," *Science, Technology, and Human Values*, (9)1 (Winter, 1984): p. 49.
8. For example, Nelkin, 1984, pp. 16–19; and Briane Wynne, *Rationality and Ritual: The Windscale Inquiry and Nuclear Decisions in Britain*, (England: The British Society for the History of Science, 1982).
9. H. Shep Melnick, *Regulation and the Courts: The Case of the Clean Air Act*, (Washington, D.C.: The Brookings Institute, 1983), p. 253.
10. See *Industrial Union. AFL-CIO v. Hodason*, 162 U.S. Appl. D.C. 331, 499 F.2d 467 (1974); and *South Terminal Corporation v. EPA*, 504 F.2d 646 (1st circuit, 1974).
11. Among others, see Lawrence Bacow, "The Technical and Judgmental Dimensions of Impact Assessment," *Environmental Impact Assessment Review*, (1)2 (June 1980): 109–124; Stephen Kelman, *Regulating America, Regulating Sweden*, (Cambridge, MA: M.I.T. Press, 1981): and Helen Longino, "Beyond 'Bad' Science: Skeptical Reflections on the Value-Freedom of Scientific Inquiry," *Science, Technology, and Human Values*, (8)1 (Winter 1983): 7–17.
12. Brooks; and Allan Mazur, "Disputes Between Experts," *Minerva*, (11) (1973): 243–262.
13. Mazur, 1973, p. 249.
14. Brooks, p. 39.
15. For an illustrated discussion of these non-objective judgments, see Lawrence Susskind and Louise Dunlap, "The Importance of Non-Objective Judgments in Environmental Impact Assessment," *Environmental Impact Assessment Review*, (2)4 (December 1981): 335–366.
16. National Research Council, Committee on the Biological Effects of Ionizing Radiations, *The Effect on Populations of Exposure to Low Levels of Ionizing Radiation: 1980* (Washington, D.C.: National Academy Press, 1980), p. 262.
17. Mazur, 1973, pp. 254–255.
18. Ibid., pp. 249–250.
19. Thomas Kuhn, *The Structure of Scientific Revolutions*, (Berkeley, CA: University of California Press, 1967).
20. Wessel, pp. 151–152.
21. Mazur, 1973, pp. 255–256.
22. See, for example, David Bazelon, "Science and Uncertainty: A Jurist's View," *Harvard Environmental Law Review* (5)2 (1981): 209–215; and Thomas O. McGarity, "Judicial Review of Scientific Rulemaking," *Science Technology, and Human Values*, (9)1 (Winter 1984): 97–106.
23. See Mazur, 1977; Nyhart and Carrow; and Wessel.
24. Nancy Ellen Abrahms and R. Stephen Berry, "Mediation: A Better Alternative to Science Courts," *Bulletin of the Atomic Scientists*, 33 (April 1977): 50–53.
25. See Wessel.
26. See R. B. Goldman, *Roundtable Justice: Case Studies in Conflict Resolution*, (Boulder, CO: Westview Press, 1980); Lawrence Susskind, Lawrence Bacow, and Michael Wheeler, eds., *Resolving Environmental Regulatory Disputes* (Cambridge, MA: Schenkman Publishing Company, 1983); Lawrence Bacow and Michael Wheeler, *Environmental Dispute Resolution* (New York: Plenum Press, 1984); and Allan Labot, *Settling*

Things: Six Case Studies in Environmental Mediation, (Washington, D.C.: The Conservation Foundation, 1–95).

27. Thomas Colosi, "Negotiation in the Public and Private Sectors," *American Behavioral Scientist,* (27)2 (November/December 1983): 229–253; and Lawrence Susskind and Connie Ozawa, "Mediated Negotiation in the Public Sector: Mediator Accountability and the Public Interest Problem," *American Behavioral Scientist,* (27)2 (November/December 1983): 255–276.

28. Michael Polanyi, "The Republic of Science: Its Political and Economic Theory," *Minerva* 1 (Autumn 1962): 54–73.

29. See Susskind, Bacow, and Wheeler; Bacow and Wheeler.

30. James K. Sebenius, "The Computer as Mediator: Law of the Sea and Beyond," *Journal of Policy Analysis and Management* (1)1 (Fall 1981): 77–95.

31. See descriptions of collaborative model building in mediated cases in Goldmann.

32. A well-articulated debate over the role of mediation can be found in the following set of three articles: J. P. McCrory, "Environmental Mediator—Another Piece of the Puzzle," *Vermont Law Review* (6)1 (Spring 1981): 49–84; J. B. Stulberg, "The Theory and Practice of Mediation: A Reply to Professor Susskind," *Vermont Law Review* (6)1 (Spring 1981): 85–117; and Lawrence Susskind, "Environmental Mediation and the Accountability Problem," *Vermont Law Review,* (6)1 (Spring 1981): 1–47.

33. See H. Burgess and D. Smith, "Brayton Point Coal Conversion," in Susskind, Bacow, and Wheeler, pp. 122–155.

34. Barry Commoner, Karen Shapiro and Thomas Webster in *"Environmental and Economic Analysis of Alternative Municipal Solid Waste Disposal Techniques,"* (Flushing, NY: Center for The Biology of Natural Systems, Queens College, CUNY, 1982).

35. Fred Hart, Environmental Impact Statement.

36. Goldmann; Talbot; Susskind, Bacow and Wheeler; Bacow and Wheeler.

37. Nancy A. Huelsberg and William F. Lincoln (Eds.), *Successful Negotiating In Local Government,* (Washington, DC: International City Managers Association, 1985).

38. Lawrence Susskind and Gerald McMahon, "The Theory and Practice of Negotiated Rulemaking," *Journal of Regulation,* Yale Law School, forthcoming.