Multi-Culturalism Redux:
Science, Law, and Politics

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The very word *justice* irritates scientists. No surgeon expects to be asked if an operation for cancer is just or not. No doctor will be reproached on the grounds that the dose of penicillin he has prescribed is less or more than *justice* would stipulate.¹

A third of a century has now passed since the British writer C.P. Snow sounded an alarm about the “two cultures” problem.² By “culture,” he meant both a course of intellectual development and “a group of persons living in the same environment, linked by common habits, common assumptions, a common way of life”³—definitions that will adequately serve my purposes here. Snow wrote of the “gulf of mutual incomprehension” yawning between the cultures of science and of literature, which he called “traditional” culture. Literary intellectuals’ misunderstanding of science, he noted, often verged on “hostility and dislike.”⁴

With the clairvoyance of hindsight, we can now see that Snow aimed at the wrong target.⁵ Misunderstandings between science and literature today are

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¹ Simeon E. Baldwin Professor, Yale Law School. Shorter versions of this paper were delivered as the Nordlander Lecture in Science and Public Policy at Cornell University on November 19, 1992, and as the “1 Lunedì Dell’Associazione” lecture at the Scuola Superiore di Studi Universitari e di Perfezionamento S. Anna on May 3, 1993. Bruce Ackerman, E. Donald Elliott, Michael Green, Jay Katz, David Kaye, and Joseph Sanders commented on earlier drafts. I also benefited from a discussion of the subject with Drs. Leonard Milstone and Jonathan Katz, and with the graduate students in Cornell’s Department of Science and Technology Studies. Comments received at a faculty workshop at the University of Michigan Law School on March 26, 1993, were also helpful, especially those by Richard Friedman. Tiffany West provided research assistance.


³ C.P. SNOW, THE TWO CULTURES (1965). For a legal scholar’s ruminations about a two cultures problem within legal education, see Harry Wellington, Challenges to Legal Education: The ‘Two Cultures’ Phenomenon, 37 J. LEGAL EDUC. 327 (1987).

⁴ Id. at 62-64.

⁵ Id. at 4.

⁶ Snow’s generally elegant, insightful essay also fails on other grounds. For example, he never satisfactorily explained why the misunderstanding between science and literature was problematic enough to justify his small book, not to mention the much larger commentary that immediately followed in its wake. The flood of responses provoked by his book made him feel (as he later recalled) “uncomfortably like the sorcerer’s apprentice.” Id. at 54. From the controversy stirred by his lecture, he inferred that his ideas on the subject “were not at all original but were waiting in the air.” Id. at 54-55.

⁷ He also failed to specify the links between intellectuals’ attitudes toward science and politicians’ willingness to support it. Thus, Snow failed to lay a foundation for his conviction that the anti-scientific attitudes emerging among intellectuals threatened science’s political support and thus its capacity to improve the conditions of life. Id. at 90-97. Moreover, the course of history has proved his prediction proved quite wrong, as the enormous growth since the 1950s in the NIH, NSF, and NASA budgets attest. Of course it is possible that even more resources would have been forthcoming, absent the antipathy that he described.

⁸ Nor did Snow identify the causes of the science-literature schism. He did observe that scientists were more optimistic; they distinguished, as the traditionalists did not, between the tragedy of the human...
rather a sideshow, peripheral to the main event. Science’s clashes with two other cultures, law and politics, seem far more consequential given the speed of technological change, the growth of the administrative state’s authority to control it, and the coercive power of legal and political authority.7

One is tempted to draw an analogy between this cultural conflict and the bitter religious and ethnic struggles that roil most countries and many American cities today. Like these other struggles, the science-law-politics conflict is fundamentally cultural; the ultimate prize is the power to shape how society thinks, feels, lives, values, and chooses. Like religio-ethnic confrontations, this conflict unfolds simultaneously at various levels: in obscurity (individual scientific research, legal argument, policy analysis) and in the glare of public view (NIH budget debates, Supreme Court decisions, regulatory legislation). And like them, the conflict—even when it goes unrecognized—lies near the center of our most important public debates.

The analogy to religious and ethnic struggles, of course, can only take us so far. Unlike the combatants in Bosnia, the Punjab, and South Central Los Angeles, the partisans of science, law, and politics generally recognize that their professional cultures are neither monolithic nor wholly self-defining, and that their social interdependence runs deep. They bear a common allegiance to the democratic institutions charged with regulating multi-cultural conflicts. They do not dispute their competitors’ legitimacy within the proper spheres of each. While their cultural chauvinism is often vehement, it is not violent—except rhetorically. Finally, precisely because these battles usually occur within a legislative chamber or courtroom over a discrete, often narrowly technical policy issue, the combatants can more easily forget that something much greater—a normative world-view—is actually at stake.

This article has three parts. Part I sets the stage for my analysis of this multi-cultural conflict. There I describe two notorious disputes, Bendectin and Agent Orange, which exemplify some of the patterns that I shall discuss.

6. It hardly need be said that my choice of three cultures is somewhat arbitrary. If greater analytical precision were the goal, one could easily multiply the number. Indeed, as I shall discuss, each of the three contains important subcultures. For example, Snow and many others have distinguished between pure and applied science. Id. at 31. I note some other distinctions. See infra text accompanying note 45. Professor Jasanoff has extended this distinction to that between research and regulatory science. SHEILA JASANOFF, THE FIFTH BRANCH: SCIENCE ADVISERS AS POLICYMAKERS 6 (1990).

Snow noted that his two cultures could as easily have been 102 or 2002. SNOW, supra note 2, at 9, 66. Similarly, my three cultures could be subdivided or increased with little difficulty. A more rigorous or taxonomic purpose would require more refined distinctions. For present purposes, however, taxonomic precision is less important than broad thematic coherence, which a proliferation of categories might diminish.

7. As to relative consequentiality, my colleague Owen Fiss has made a similar point about the effects of applying literary theory to the interpretation of legal texts. Owen M. Fiss, Objectivity and Interpretation, 34 STAN. L. REV. 739 (1982).
Part II extends the theme of cultural conflict beyond the litigation context by sequentially analyzing and comparing science, law, and politics along three dimensions: their central values; their distinctive incentive structures and decision techniques; and their characteristic biases, especially their orientations toward the tension between professional and populist values.

In Part III, I consider how we should approach the multi-culturalism problem in public policymaking, especially where science issues are involved. After noting that these conflicts are not only inevitable but socially desirable in a democratic-liberal-technocratic polity,\(^8\) I advocate a criterion of cultural competence for allocating decisional authority over multi-cultural issues. I suggest that by empowering one culture’s distinctive decision-making rules and institutions to control the issues lying at that culture’s core, the relevant scientific, legal, and political values can be integrated with greater synergy and less waste. I conclude by exploring some specific reform implications of the analysis, including the creation of new inter-cultural “bridging” institutions.

Before turning to the cases, some preliminary observations about the discussion that follows are in order. First, I treat multi-culturalism generally and more specifically in terms of the character of the three cultures, and the relations among them. I am primarily interested, however, in the relationship between science and law, a priority reflected in the discussion in Parts I and III. My reasons are fairly straightforward. Politics-law and politics-science conflicts are ubiquitous and are resolved through the fluid, workaday processes of political give-and-take. Subject to constitutional limits, politicians hold the trump cards and can impose whatever solutions they like. In a crucial sense, politics is a meta-culture, regulating other cultures and their interactions. Politicians’ collisions with law and with science are therefore ubiquitous and receive constant attention and sophisticated commentary. In both Agent Orange (and to a lesser extent, Bendectin), for example, politics was the forum to which those dissatisfied with the law’s handling of scientific issues could and did ultimately appeal. Conflicts between science and law, moreover, are more obscure and less visible to the public eye. These cultures are more technical and less open-textured than politics; hence their own internal structures and requirements, which are poorly understood by outsiders, constrain the solutions to their conflicts, which become matters primarily for insiders. Thus, public discourse about them is relatively parochial and impoverished.

Second, although the law intersects with scientific and technical analysis at almost every turn,\(^9\) I am primarily interested in two other legal domains.

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8. Democratic, liberal, and technocratic values, of course, can and often do clash with each other. For one exploration of these value clashes (analyzed under other labels), see JERRY L. MASHAW, BUREAUCRATIC JUSTICE: MANAGING SOCIAL SECURITY DISABILITY CLAIMS (1983).

9. For example, the law of intellectual property, especially patents, takes its very content from science, both pure and applied. The law of evidence often demands scientific support for the use of certain techniques, such as DNA typing and epidemiology, and for the drawing of particular inferences from
in which science plays an especially prominent role. The first is the public law of "social regulation"—environmental protection, occupational safety and health law, consumer product safety, and the like—in which government agencies develop and enforce general legal standards in order to promote public health. This domain is exemplified by the Bendectin litigation. The second is the private law of toxic torts in which individuals sue alleged polluters and product distributors for compensation for harm, usually personal injuries. Here, I offer the Agent Orange case as the example. In both domains, advocates and decision-makers must mobilize and interpret uncertain scientific data in support of legal arguments and authoritative decisions about risk assessment and risk distribution in society. I focus on social regulation and toxic torts because the differences among science, law, and politics are most profound, controversial, and problematic in these areas.

Third, I shall emphasize cultural conflict. By doing so, I do not mean to deny that these three cultures exhibit some important commonalities. For example, each culture is centrally concerned with solving problems, though, of course, not of the same kind or in the same way. Each culture is also highly professionalized; in order to join and succeed, its members must acquire an arcane knowledge, practice special techniques and skills, and subscribe to a distinctive set of norms, a world view common to the group. Each culture seeks to enhance the group's social power, its command of resources and values. Finally, each culture is supported by and indispensable to the modern state's effectiveness.

Still, the cultures' divergences are more striking than their commonalities. Science, law, and politics are not merely unique ways of living and thinking but also represent radically different modes of legitimating public decisions. Each invokes distinct values in support of its claims to exercise authority. Science appeals to the capacity of technical rationality and specialized expertise to generate and test empirically falsifiable propositions. Law appeals to the


11. The relationship between law and politics is especially close. Indeed, many would say—some have said—that law and politics are essentially indistinguishable. See, e.g., David Kairys, Legal Reasoning, in THE POLITICS OF LAW 11, 17 (David Kairys ed., 1982) (asserting that "law is simply politics by other means"). I do not agree with Kairys' use of the word "simply".

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capacity of universal, abstract, binding principles to produce justice.\textsuperscript{13} Democratic politics appeals to the capacity of participation, accommodation, and accountability to justify the state's coercive authority.\textsuperscript{14} Each, then, invokes a distinctive conception of truth or, less grandly, of how to achieve the good. The three cultures, then, compete at several different levels.\textsuperscript{15} They are encoded in diverse public symbols, appeal to discrete conceptions of decisional legitimacy, express their own rhetoric, and develop their own power bases. And because each culture is embedded in different governmental institutions, each must face special structural and constitutional obstacles to resolving multicultural tensions.\textsuperscript{16} This cultural competition is socially desirable in many ways, but unless it is creatively managed—the subject of Part III—it may also occasion great social cost.

The Bendectin and Agent Orange litigations with which I begin are hardly typical cases, but neither are they anomalous or anachronistic. They exhibit some of the deep normative and political conflicts that divide the scientific, legal, and political cultures. Such conflicts are certain to intensify in the future. Science's remarkable advances in instrumentation, methodology, theory, and data constantly generate new ethical and regulatory dilemmas which only a combination of law and politics can resolve. It unleashes a cascade of new products and new technologies which create new risks that often justify social control.\textsuperscript{17} Science's growing capacity to postpone death, for example, raises the most delicate questions about the quality and cost of life, while its emerging genetic wizardry engenders new value conflicts and Faustian bargains.\textsuperscript{18}

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\item \textsuperscript{14} Robert A. Dahl, A Preface to Democratic Theory (1956).
\item \textsuperscript{15} Snow was not evenhanded in appraising the scientific and traditional cultures. To be sure, he maintained that each was impoverished in its own way; scientists possessed under-developed imaginative faculties, while literary intellectuals were blind to the beauty and utility of the natural order. Nevertheless, no reader of The Two Cultures can doubt which of them he thought the more benighted and taxable with the heavy burdens of change. Whereas literary intellectuals were "natural Luddites," scientists were by nature progressive, leading society toward a luminous future. Snow, supra note 2, at 22.
\item \textsuperscript{16} See discussion infra text accompanying notes 131-133.
\item \textsuperscript{17} As Peter Huber has argued, the fact that the risks are new does not mean that they are greater than those which they may have displaced. Peter Huber, The Old-New Division in Risk Regulation, 69 Va. L. Rev. 1025 (1983).
\item \textsuperscript{18} See, e.g., Leon R. Kass, Toward a More Natural Science: Biology and Human Affairs (1985); see also Judith Areen et al., Law, Science and Medicine ch. 7 (Death and Dying), ch. 8 (Reproduction and the New Genetics) (1984); Gina Kolata, Ethicists Struggle to Judge the 'Value of Life', N.Y. Times, Nov. 24, 1992, at C3; Norman Frost, Regulating Genetic Technology: Values in Conflict, in 3 Genetics and the Law (Aubrey Milunsky & George J. Annas eds., 1985).
\end{itemize}
Law and politics, for their parts, are chronically ambitious, constantly striving to extend their jurisdictions to regulate scientific activities that were previously autonomous. This ambition is fortified by changing social attitudes about risk and expertise that weaken public deference to science. Recent disputes over products and technologies—asbestos, breast implants, video terminal displays, computer keyboards, cigarettes, electromagnetic fields, and many others—prefigure further political and legal growth. They presage a future of constant cultural collisions, pressures for regulatory controls, and novel personal injury litigation.

In order to explain the problematic handling of disputes like Bendectin and Agent Orange, it arguably is not necessary to resort to the somewhat elusive notion of cultural conflict at all. In this view, a simpler, more parsimonious explanation would be that the law is just not very competent in resolving complex scientific disputes very well. This explanation, however, would merely raise a more basic question: why are legal rules and institutions still applied to such disputes when they have proved to be problematic in resolving them? The answer to this question, I believe, begins with the notion that the law approaches this adjudicative task in a culturally bound, hence normatively loaded, way, which confirms the law in viewing it simply as an old task arising in a new context. The law uses traditional methods not because it is mindless or hidebound but because these methods encode its most cherished, distinctive values.

The notions of culture and cultural conflict are certainly not the only, and may not even be the best, concepts for understanding the problematic outcomes that one increasingly observes at the intersection of law, science, and politics. Culture is a notoriously slippery concept, as the bitter controversy among social scientists over the existence of a “culture of poverty” reveals. As I have just suggested, however, the idea of law’s incompetence in dealing with science is even more question-begging. In attempting to understand both the law’s stubborn insistence on doing new things in the old ways and its continuing difficulty in comprehending and integrating the quite different modes of science and of politics, the idea of culture—of a unique way of viewing, valuing, and manipulating the world—seems as serviceable as any.
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I. TWO CASE STUDIES

Fortunately for our purposes, the twists and turns of the Bendectin and Agent Orange litigations have been comprehensively documented. They continue today, fifteen years after the first cases in each litigation were filed. In each case, science, law, and (to a lesser extent) politics were obliged to enter into a kind of shotgun marriage. In each, this awkward union was consummated not in nuptial bliss but in a bitter estrangement, as the unwilling partners pursued quite different, often incompatible directions. I do not claim that these litigations are altogether paradigmatic of the science-law-politics conflict. Like all mammoth cases, they are unusual in certain respects. I claim only that we can learn something from them about how one important social decision modality, namely court litigation, often addresses multi-cultural issues.

A. Bendectin

Bendectin was an anti-nausea drug marketed from 1956 until 1983 to some 30 million pregnant women for morning sickness until the manufacturer removed it from the market, citing the high cost of litigation over the drug. As recently as 1980, the Food and Drug Administration (FDA) approved Bendectin as safe and effective. Since 1977, when the first Bendectin case was filed, more than 2100 suits have been brought alleging birth defects or infant deaths caused by the drug. In each of the 27 cases that went to trial (25 of them before a jury and one consolidating more than 800 claims) the central factual issue was Bendectin’s “general causation”—its capacity to cause the kinds of injuries alleged by the plaintiffs. As is true in many but not all toxic tort disputes, this issue was made vastly more difficult in the Bendectin cases by the absence of either a pathognomonic (“signature”) disease or a generally accepted biological theory of causation. In almost all of these cases, essentially the same scientific evidence on causation—consisting of epidemiological, in vivo, in vitro, chemical structure, and secular trend studies—was presented in much the same way, usually by the same expert witnesses. At trial, many Bendectin plaintiffs won jury verdicts; indeed, their success rates were com-


parable to those obtained in products liability cases generally. Some of these jury verdicts were enormous; the most recent, rendered in September 1991, awarded $33.75 million in compensatory and punitive damages.

The plaintiffs' success at trial, however, was utterly at variance with the great weight of the scientific evidence on the drug's teratogenicity (i.e., its capacity to cause birth defects). This body of evidence grew larger, more rigorous, more consistent, and more unequivocal as the 1980s wore on.\(^2\) It strongly suggested to virtually all disinterested scientists that Bendectin was unlikely to have caused the alleged birth defects and that any remaining doubt on this score was probably irreducible. Moreover, since 1987, the federal appellate courts (where most of the litigation has occurred) have firmly endorsed this view of the evidence, taking the unusual step of reversing plaintiffs' verdicts instead of simply remanding them for new trials. The difference between the judges' and the juries' views of the plaintiffs' claims in these cases is striking.\(^2\)

This scientific and judicial consensus exonerating Bendectin makes it all the more remarkable that the rate of plaintiff victories at trial did not decline appreciably during the late 1980s and early 1990s. In fact, the two most recent Bendectin trials, far from following this consensus, actually produced a hung jury and the stunning $33.75 million award just mentioned. Thus science and the law (at least as applied in jury verdicts) have gone off in opposite directions.

In an effort to explain this divergence, Professor Joseph Sanders recently scrutinized the trial transcripts of a cross-section of Bendectin cases, hoping to determine how the trial lawyers actually used and presented scientific evidence on causation.\(^2\) His analysis focuses on the peculiar nature of the legal process which filters and translates the scientific record into expert testimony at trial.\(^4\)

Five aspects of the process, Sanders finds, were especially problematic in encouraging legal fact-finding to diverge from the scientific evidence offered

\(^{21}\) This was partly because investigating Bendectin's effects was easy relative to many other drugs. Green, supra note 20, at 677-78. Green, a chronicler of the Bendectin litigation, agrees with Sanders that "the scientific record on Bendectin's teratogenicity by the mid-to-late 1980s had become unusually rich." Id. at 677.

\(^{22}\) Michael Green points out that all of the plaintiffs' jury verdicts occurred either in Washington, D.C. (4), Philadelphia (1), or Texas (2), while juries found for Merrell Dow (or hung) throughout the rest of the country. He believes that the plaintiff verdicts were influenced by juries' wealth redistribution motivations. Letter from Michael D. Green, Professor of Law, University of Iowa, College of Law, to Peter H. Schuck, Simeon E. Baldwin Professor, Yale Law School (Dec. 17, 1992) (on file with author).


\(^{24}\) Another possible explanation for the divergence between science and legal outcome is incompetent lawyering. This seems doubtful, however, since each side chose to use the same small group of lawyers repeatedly throughout the litigation. A third possible explanation, incompetent juries, would be hard to distinguish from Sanders' legal process explanation.
in the Bendectin cases. First, expert witnesses were selected and deployed in ways that made it hard for the fact-finder, whether jury or judge, to evaluate and differentiate between their testimonies.\(^{25}\) Second, the nature of the experts’ testimony made all of the science seem to be of equal worth and relevance.\(^{26}\) Law’s fact-finders are not blind, Sanders observes; instead they lack “depth perception.” Third, cross-examination seldom clarified the strengths and weaknesses of witnesses’ scientific testimony; instead, it ritualistically centered on their putative biases and trivial misstatements. Fourth, Sanders notes, the nature of the evidence and the structure of the legal issues made it easier for the plaintiffs in Bendectin and other toxic tort cases to arrange the evidence into a coherent, persuasive story than for the defendants to do so.

Finally, Sanders suggests that the juries in Bendectin and other toxic tort cases may have discounted the kind of purely statistical evidence on causation, including epidemiological studies, upon which the defendants in these cases must often rely. Citing recent psychological experiments indicating that juries evaluate evidence according to how well it “fits” into each of the competing stories before them, he concludes that this may systematically advantage the plaintiffs in such cases. While plaintiffs can prevail even if the jury believes from the statistical evidence that the defendant’s product can cause only a very small fraction of the birth defects, defendants can prevail only if the jury believes that the drug is incapable of causing any of them.

Because science and the jury-made law of Bendectin have taken diametrically opposed paths,\(^{27}\) the politics of Bendectin has been free to move in several directions. This litigation is now one of the “bloody shirts” waved by partisans in order to mobilize public support in the struggle over products liability reform. It has become a cause celebre for diverse interests. To those who favor new restrictions on liability, for example, the Bendectin experience demonstrates how a safe, socially valuable drug can be forced off the market by malleable tort doctrines, costly nuisance claims, “junk science,” and irrational jury verdicts.\(^{28}\) To those who favor expanding (or at least retaining) existing liability levels, however, Bendectin shows that a lay jury, not an elite court, is the appropriate institution for resolving factual conflicts over expert

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25. For example, those who actually conducted the research tended to be neglected in favor of “secondary” experts; those who testified repeatedly tended to give more highly polished testimony; and the same number of experts tended to testify on both sides of an issue, creating an illusion of equal evidentiary weight. Sanders, supra note 20, at 24-36.

26. For example, the process and sequence through which expert testimony was introduced appeared to give equal weight to different kinds of studies that actually have different probative value, such as in vitro and epidemiological studies. Id. at 37-42.

27. According to Sanders, the science in Bendectin was also influenced by its intersection with the law in that the litigation affected the volume of research on the topic and caused scientists to become politicized on this issue. Letter from Joseph Sanders, Professor of Law, University of Houston Law Center, to Peter H. Schuck, Simeon E. Baldwin Professor, Yale Law School (Jan. 11, 1993) (on file with author). See also supra note 20.

28. The epithet “junk science,” which has entered the political lexicon, was apparently coined by Peter Huber. See HUBER, supra note 20, at 2.
scientific testimony on causation. The two sides talk past each other precisely because, as discussed in Part II, each speaks the language and invokes the values of a different culture. In order to achieve mutual intelligibility, they must turn to a third, hopefully more integrative culture—politics. As we shall also see, however, politics is not always a faithful translator.

B. Agent Orange

The Agent Orange litigation exemplifies an intriguingly different relationship among science, law, and politics. Like the Bendectin litigation, it was launched in the late 1970s and continues today, although the main action in Agent Orange ended in the late 1980s. The case was spawned by America’s involvement in the Vietnam War, a watershed in American politics, and became a controversy of immense proportions, involving a plaintiff class of 2.4 million people (ultimately producing about 250,000 individual claims), much of the chemical industry, and the U.S. Government. In addition to the $180 million required to settle the class action, the main parties (not counting the government) incurred litigation costs that certainly exceeded $110 million. Because of the case’s connection to the war and its high public profile, it also occasioned intense political and organizational activity by veterans groups at the federal and state levels, a factor that distinguishes it from the more fragmented Bendectin litigation.

As with Bendectin, the central issue of fact was general causation—whether the dioxin contaminant of Agent Orange could have caused the veterans’ cancers and other chronic diseases in light of the amount and conditions of their exposure to it. Because the injuries could not be traced to a single cause (as in the case of asbestosis), but instead could have been produced by a number of different factors, proof of causation was peculiarly dependent on naked statistical evidence rather than on direct evidence of exposure to the single causal agent. It was also more difficult to establish the soldiers’ levels of exposure to Agent Orange under highly variable wartime conditions than to measure a woman’s exposure to a drug, like Bendectin, taken under prescription. The plaintiffs’ diseases had long latency periods in Agent Orange; in Bendectin, however, they were manifest at birth.

Causation, then, was even harder to resolve here than it was in Bendectin. But the body of scientific evidence bearing on Agent Orange’s toxic effects was also larger, including numerous animal and epidemiological studies. In

29. At least one prominent plaintiff’s lawyer and defender of the tort system has been critical of the Bendectin litigation. Paul Rheingold, It’s Time to Change the System on Junk-Science, Quack-Expert Issues, MANHATTAN LAW., Nov. 1-7, 1988, at 13.

30. The account that follows is taken largely from Peter H. Schuck, Agent Orange on Trial: Mass Toxic Disasters in the Courts (enlarged ed. 1987). See also Green, supra note 20, at 659-61.
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theory, the latter were especially valuable for inferring causation; they were based on human populations and reflected a kind of "natural experiment" (since only individuals in Vietnam had been substantially exposed to Agent Orange). Some of these epidemiological studies, moreover, were unusually large and well-designed.\textsuperscript{31} All Agent Orange cases were in effect consolidated in a single federal court, obviating the prospect of the inconsistent verdicts that so plagued the Bendectin litigation. After settling the class action, the judge, Jack Weinstein, turned to the several hundred remaining "opt-out" cases. Having studied and mastered the scientific evidence to a degree that few other judges would even attempt, Judge Weinstein ruled that the animal studies were not helpful in proving the etiology of the plaintiffs’ conditions, that "the only useful studies having any bearing on causation" were the epidemiological studies, that the best of these were negative, and that plaintiffs’ scientific experts had not even discussed them. Since plaintiffs’ experts’ conclusions about causation were based wholly on their examination of individual medical records, which Judge Weinstein deemed irrelevant to proof of causation in such a case, he flatly excluded their testimony and dismissed the opt-out plaintiffs’ cases. This dismissal was upheld by the appellate court, albeit on grounds other than the causation evidence.\textsuperscript{32}

Judge Weinstein’s rulings on the causation evidence in Agent Orange have raised fundamental issues about the appropriate boundaries between the domains of science and law. May a judge, trained as a lawyer, simply reject on its scientific merits the testimony of reputable scientists concerning a complex causal issue within their professional ken? May he exclude from the jury’s consideration a large body of scientific evidence simply because he thinks that the jury might misunderstand it? May he insist that only epidemiological evidence, with all its flaws, constitutes acceptable proof of causation? May he treat as "negative" epidemiological evidence that most scientists would say is merely "inconclusive"? Does the fact that he could exclude testimony based on novel methods or principles mean that he may also exclude novel scientific opinions based on \textit{conventional} methods or principles?

These issues are highly controversial in the legal culture. The manner in which the courts resolved them in Agent Orange and Bendectin has affected the courts’ handling of causation evidence in other toxic tort cases, establishing a kind of "epidemiological threshold" that plaintiffs must cross in order to avoid having their claims dismissed.\textsuperscript{33} As in Bendectin, the tensions between science and law on these questions have created special opportunities for

\textsuperscript{31} Interview with Dr. Jan Stolwijk, Professor of Epidemiology, Yale School of Public Health, in New Haven, Conn. (Oct. 23, 1985).
\textsuperscript{32} \textsc{Schuck}, \textit{supra} note 30, at 226-44, 301.
\textsuperscript{33} \textit{See} Green, \textit{supra} note 20, at 672.
politicians. Despite (or perhaps because of) Judge Weinstein's firm conclusion that the scientific evidence did not establish Agent Orange's causal responsibility for human cancers, and despite subsequent epidemiological studies and other analyses that tended to confirm the accuracy of his conclusion, political pressures induced the Veterans Administration, and then Congress, to grant permanent disability benefits to veterans suffering from two forms of cancer.\textsuperscript{35}

My point is not that Judge Weinstein was correct and the VA and Congress wrong. Indeed, they may all have been correct, since each was responding to a somewhat different question and thus operating under a different standard of proof.\textsuperscript{36} The more pertinent point is that when neither scientific nor legal technocrats can furnish authoritative answers to problems arising at the increasingly crowded intersection of science and law, we must expect politicians to bridge the gap, using the uncertainty as a reason (perhaps a pretext) to supply their own answers.

Why are authoritative answers at the science-law frontier so elusive that politicians must intervene? The inherent complexity of the problems is aggravated by the short time frames that public law and public opinion frequently demand and the limited problem-solving resources that they provide. Often—as when the issue is whether exposure to low levels of a chemical caused a tort plaintiff's cancer—the question is "trans-scientific" (to use physicist Alvin Weinberg's term): although it can be formulated in scientific terms, it cannot

\textsuperscript{34} See, e.g., Marilyn Fingerhut et al., Cancer Mortality in Workers Exposed to 2,3,7,8-Tetrachlorodibenzo-p-Dioxin, 324 NEW ENGL. J. MED. 212 (1991); Warren E. Leary, High Dioxin Levels Linked to Cancer, N.Y. TIMES, Jan. 24, 1991, at A16 (stating that Fingerhut study found increased incidence of soft-tissue sarcomas in workers with dioxin levels in their blood of 3600 parts per trillion (ppt), but found no excess cancer in workers with levels of 640 ppt; Vietnam veterans exposed to Agent Orange had levels of 45 to 400 ppt); Warren E. Leary, Higher Risk of Rare Cancer Found for Vietnam Veterans, N.Y. TIMES, Mar. 30, 1990, at A10 (noting that veterans showed no increased rate of five suspect cancers, but did show increased rate of sixth cancer, non-Hodgkin's lymphoma, but that rate of this cancer was highest among sailors on ships, who had least exposure to Agent Orange); Keith Schneider, Panel of Scientists Finds Dioxin Does Not Pose Widespread Cancer Threat, N.Y. TIMES, Sept. 26, 1992, at 9 (stating that EPA-convened panel finds human cancer risks confined to chemical workers and victims of dioxin-related industrial accidents). In mid-1991, an Illinois appeals court threw out a $16.28 million jury verdict against Monsanto, the manufacturer of a chemical containing a tiny quantity of dioxin, for a train spill of the chemical in Missouri which occasioned one of the longest jury trials in American history. The court's ruling reflected the fact that the jury did not find that dioxin had caused plaintiffs any actual injury. Kemner v. Monsanto Co., 576 N.E.2d 1146 (Ill. App. Ct. 1991).

\textsuperscript{35} Adam Clymer, Bill Passed to Aid Veterans Affected by Agent Orange, N.Y. TIMES, Jan. 31, 1991, at B6 (stating law covers non-Hodgkin's lymphoma and soft-tissue sarcoma). This law also granted disability benefits for chloracne, a condition that had previously been found to be caused by dioxin exposure. Since then, the VA has also granted benefits to certain victims suffering from peripheral neuropathy. See Vietnam Veterans to Get Benefits for Ailment Tied to Agent Orange, N.Y. TIMES, July 3, 1991, at B6.

\textsuperscript{36} For Judge Weinstein, the question was whether the veterans should be able to shift their losses to the chemical companies (and, ultimately, to the government), and the standard was therefore relatively demanding ("preponderance of the evidence"). For the VA, it was whether its statute required, permitted, or precluded its paying compensation for certain illnesses. For Congress, it was simply a policy question, essentially unconstrained by any legal standard, as to whether certain illnesses should be compensated.
be conclusively answered by science alone. In these cases we must also look to other, non-scientific criteria of decision.37

This trans-science problem, however, is minimized in the Bendectin and Agent Orange cases.38 Although expert witnesses can almost always be found to create an issue of fact, the scientific conclusion was not in genuine doubt in either of these cases.39 By the time the courts had to rule in them, mainstream science had reached a reasonably firm consensus that the evidence did not establish causation.40 The real issue in these cases, then, was not the scientific consensus on causation but rather science’s authority, legitimacy, and intelligibility in the larger, transcendent worlds of law and politics.

Even so, the fact that the legal outcomes in Bendectin and Agent Orange turned out to be consistent with the best available science is only mildly reassuring, for in both cases this convergence required extraordinary judicial interventions—reversal of jury verdicts in Bendectin and close technical scrutiny of expert testimony in Agent Orange. With less audacious courts, both cases could easily have gone the other way.41 These narrow victories remind us that important social decisions can be distorted when agents of one culture control decisions more properly governed by another culture operating under quite different rules. Such mismatches of authority and competence will often produce costly decision processes that generate substantive outcomes of doubtful legitimacy, if not outright error.42 Cultural imperialism can be as problematic in domestic policymaking as in world politics.

38. We should remember that for all their complexity, they were “easy” cases in this limited sense. Multi-cultural conflict often takes much more intractable forms.
39. Another example of such a case is Wells v. Ortho Pharmaceutical Corp., 615 F. Supp. 262 (N.D. Ga. 1985), involving the alleged teratogenicity of a contraceptive jelly. It is discussed in these very terms in Gross, supra note 23, at 1121-24.
40. The qualifications are necessary here because some contrary scientific testimony, which plaintiff proffered but the lower courts excluded, purports to discredit the defendant’s negative studies. The excludability of this testimony is now at issue before the Supreme Court. See Daubert v. Merrell Dow Pharmaceuticals, Inc., 951 F.2d 1128 (9th Cir. 1991) (excluding testimony of Dr. Shanna Helen Swan), cert. granted, 113 S. Ct. 320 (Oct. 13, 1992) (No. 92-102). For a discussion of the excludability controversy, see Eliot Marshall, Supreme Court to Weigh Science, 259 SCIENCE 588 (1993).
41. As it was, the outcome in Bendectin came only after a socially valuable drug was removed from the market. See infra text accompanying note 70.
42. American policymaking may be uniquely pathological in these respects. Whether the substantive issue is regulation of toxic substances, nuclear power plants, occupational safety and health, or environmental protection more generally, important policy decisions are fiercely contested, always open to reconsideration, and subject to competing criteria of justification. See, e.g., RONALD BRICKMAN ET AL., CONTROLLING CHEMICALS: THE POLITICS OF REGULATION IN EUROPE AND THE UNITED STATES 301-02, 312-13 (1985); JOSEPH BADARACCO, JR., LOADING THE DICE (1985); STEVEN KELMAN, REGULATING AMERICA, REGULATING SWEDEN: A COMPARATIVE STUDY OF OCCUPATIONAL SAFETY AND HEALTH POLICY (1981); EUGENE BARDACH & ROBERT KAGAN, GOING BY THE BOOK: THE PROBLEM OF REGULATORY UNREASONABLENESS (1982); DAVID VOGEL, NATIONAL STYLES OF REGULATION: ENVIRONMENTAL POLICY IN GREAT BRITAIN AND THE UNITED STATES (1986).
Although defining and defending each culture's appropriate jurisdiction are hard tasks, as I discuss in Part III, the difficulties in defending whatever jurisdictions are defined are even greater. The combatants in public policy struggles will always attempt to obscure whatever jurisdictional lines have been drawn. Special interests—whether engaged in institutional design, justificatory rhetoric, litigation, or legislative-bureaucratic politics—strategically deploy some expedient mixture of scientific "facts," legal "principles," and political consensus norms. Jurisdictional line drawing is pointless unless these lines can be defended, in which case trans-cultural understanding, respect, and cross-fertilization become even more imperative to reduce the now greater risk that each culture will wall itself off into a dangerous isolation.

II. THE COMPETING CULTURES

Before I proceed, a caveat. In order to contrast science, law, and politics, one must characterize the three cultures in ways that are stylized but hopefully not caricatured. The generalizations I make about each culture are subject to important exceptions, qualifications, and distinctions. Although I note these refinements, my approach—which exaggerates the purity, consistency, and exclusivity of each culture's normative structure—risks some over-simplification. If one hopes to identify the major lines of cultural cleavage, anticipate the conflicts that they are increasingly engendering, and consider how they might be ameliorated, this risk cannot be avoided altogether.

I organize the analysis of each culture around three different dimensions: (1) the central values to which members of the culture subscribe; (2) the incentive structures that animate the culture's members and the decision techniques that they typically employ; and (3) the characteristic biases and orientations of the culture.

A. Science

1. Central Values

Given Snow's purpose, one might have expected him to be a kind of anthropologist of the scientific culture, probing its deep structure. In fact, he tells us rather little about it. Scientists, he observes, are optimistic and practical, concerned above all else with understanding nature and solving problems.\(^{43}\) He maintains that they read few literary books and have under-

\(^{43}\) Snow, supra note 2, at 6-7.
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developed imaginations.\textsuperscript{44} He notes, however, that the scientific culture is not monolithic, suggesting that pure scientists have little more in common with engineers and other applied scientists than with literary intellectuals.\textsuperscript{45} Snow surely exaggerates here, for whatever the differences among scientific subcultures, there is a core of beliefs, training, and techniques common to those who are recognized as scientists by the scientific community, at least as conventionally defined.\textsuperscript{46}

What constitutes this common core? Peter Huber, an engineer-lawyer who is a militant scientific positivist and a caustic critic of the law’s treatment of scientific evidence, asserts that “[i]he scientific ideal stands in sharp contrast to the windy agnosticism of the modern philosopher, litigator, or social engineer.”\textsuperscript{47} Huber holds that the modern scientist is not dogmatic but is instead “a credulous skeptic—skeptic in that he demands serious evidence and proof; credulous in that he concedes, not just offhandedly but very systematically, that every measurement, correlation, analysis, or theory may contain some margin of error, which may in turn conceal important but unrecognized new truth.”\textsuperscript{48} Science, Huber insists, is the domain of systematic verification to which social purposes are quite irrelevant.\textsuperscript{49}

Other commentators, less tendentious than Huber, are also less certain of science’s detached, ahistorical objectivity. Sheila Jasanoff, reviewing the work of historians and sociologists of science, notes three of their major findings.\textsuperscript{50} First, scientific facts are not immanent in an objective reality waiting to be discovered by any scientists who look in the right place. Instead, they are constructed and validated through a social process dominated by those in the scientific community who possess authority to do so. Second, this validation process is itself shaped by the scientific paradigms, the shared assumptions and prejudices of the professional community that dominate the thought of a

\textsuperscript{44} Id. at 12-13.
\textsuperscript{45} Id. at 31-32. Today, the colloquial appellations “hard” and “soft” as applied to the natural and social sciences denote important differences in their training, methodologies, public support, and prestige.
\textsuperscript{46} This qualification about the conventional definition of scientific communities follows recent research findings in the field of sociology of science. \textit{See infra} text accompanying notes 50-51. This work emphasizes that scientific “facts,” like the scientific enterprise itself, are socially constructed; they are recognized as facts only if (in a recent formulation) “they are produced in accordance with prior agreements about the rightness of particular theories, experimental methods, instrumentation techniques, validation procedures, review processes, and the like. These agreements, in turn, are socially derived through continual negotiation and renegotiation among relevant bodies of scientists.” Non-science institutions—including legal fact-finders like judges and juries—also participate in the construction of science. Sheila Jasanoff, \textit{What Judges Should Know About the Sociology of Science}, 32 JURIMETRICS J. 345, 347, 356-58, & sources cited (1992). This issue is discussed in greater detail at \textit{infra} text accompanying notes 113-116.
\textsuperscript{47} HUBER, supra note 20, at 221.
\textsuperscript{48} Id. at 222.
\textsuperscript{49} Id. at 221-22; see also Steven Goldberg, \textit{The Reluctant Embrace: Law and Science in America}, 75 GEO L.J. 1341, 1343 (1987). Huber’s formulation recalls Robert K. Merton’s earlier notion of “organized skepticism” as a central element of the scientific ethos. ROBERT K. MERTON, \textit{Social Theory and Social Structure} 542 (1968).
\textsuperscript{50} See JASANOFF, supra note 6, at 12-14; see also Jasanoff, supra note 46.
particular period. These paradigms hold sway for reasons that may have less
to do with their intrinsic merit than with their support of existing social
structures, including the scientific establishment. Third, the authority to
validate science rests in part on boundary-drawing and other strategic behavior
by scientific disputants, behavior that can effectively exclude their less influen-
tial competitors.

To these findings, one might add another so obvious that it may easily
escape notice. For most scientists, the search for particular facts is not guided
solely by their autonomous, spontaneous curiosity. Instead, the search is
constrained and channeled by the resources available for research, which in
turn reflect the priorities of politicians, corporations, foundations, and other
sources of funding for science.

This insistence on the contingent, socially constructed, and validated,
resource-constrained character of scientific paradigms and propositions,
especially in areas of great uncertainty or in which dominant views are firmly
institutionalized, is an important antidote to the more transcendent, universal
pretensions of certain conceptions of science. But it would be equally wrong
to conclude from the fact of science's social embeddedness that its culture is
as flexible, indeterminate, and relativistic as those of law and politics. In its
professional norms and aspirations, and to some extent in its actual perfor-
mance, science is committed to a conception of truth (though one that is always
provisional and contestable) reached through a conventional methodology of
proof (though one that can be difficult to apply and interpret) based upon the
testing of falsifiable propositions.51

2. Incentives and Techniques

What motivates scientists to behave as they do in their professional
settings? Like other highly educated people, of course, they are driven by a
desire for professional recognition, economic security, social influence, job
satisfaction, and intellectual stimulation, among other things. But some of the
goals that motivate them are peculiar, if not unique, to the scientific culture.
Perhaps most important, scientists subscribe to and are actuated by rigorous
standards of empirical investigation and proof; to deviate from these standards
is to be deemed professionally incompetent, or worse. Scientists also define
themselves in part by their membership in larger scientific communities that
both contribute to, and are entitled to exploit, their own work. These principles
of peer review invigorate and enforce their adherence to a norm of extreme
cautions.

51. For one consensus statement of this faith, see Amicus Brief of 72 Nobel Laureates, 17 State
Academies of Science, and 7 Other Scientific Organizations in Support of Appellees at 23-24, Edwards
These values and incentives lead to a distinctive set of scientific practices and techniques. I have just noted the importance of peer review. Other practices reflect science's changing context. The team approach to research, for example, has become the norm as science fragments into a large number of increasingly narrow technical specialties and as intricate research problems cut across these specialty boundaries. Today, much research requires a large investment of time, money, staff, and other resources for which scientists must vigorously compete, yet the payoffs in basic knowledge or in practical application are highly uncertain and often far in the future. Contemporary science, then, is a high-risk activity requiring large aggregations of capital and talent as well as techniques for diversifying the risks of failure. For all these reasons, much scientific enterprise has grown more collaborative, corporate, and dependent upon government support. In most fields, the solitary investigator is becoming an inspiring relic of an increasingly anachronistic, Renaissance vision of science. Today, teamwork is more the norm.

In addition, the time frame of science is relatively open-ended. It is true, of course, that competitive pressures often demand speed where a discovery may have important commercial applications, as in pharmaceutical research. Nevertheless, science—especially basic research—tends to move in its own, largely autonomous rhythms. These rhythms are dictated by the pace of technological development and dissemination, the availability of resources for further investigation, and the process of consensus formation among scientists. Imposing arbitrary deadlines cannot accelerate these factors.

3. Biases and Orientations

Like all cultures, science nurtures certain biases, blind spots, and predispositions. Most scientists receive an intensely technical training, face strong incentives to follow highly specialized career paths, and must keep up with voluminous research literatures that are often more specialized still. Generalist scientists today are few and far between. These conditions foster a decidedly narrow, technocratic perspective. Their hunger for the respect of other scientists, buttressed by peer review, causes the vast majority to shun advocacy of controversial positions on technical issues in the mass media or other non-

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52. Even so, basic science operates with relative freedom from the "day-to-day judicial and political constraints common elsewhere in American society." Goldberg, supra note 49, at 1364.

53. Nevertheless, a reaction against "big science" seems to have set in recently. This is visible not only in the public sector, where massive high-technology projects such as the supercollider and Star Wars have encountered much scientific and congressional opposition, see Malcolm W. Browne, Budget Plans Worry Some Scientists, N.Y. TIMES, Apr. 11, 1993, at 20, col. 3, but also in the private sector, where many market-driven firms—be they giants like Bell Labs and IBM or small biotech and software start-ups—have decentralized their research and development activities on the theory that scientific innovation is more likely to flourish in less bureaucratic settings. It is generally accepted that new jobs are disproportionately generated by smaller firms.
professional public forums, including courtrooms and legislative hearings. Doubtful about lay understanding and fearful of being misinterpreted, they tend to be far more comfortable reporting on their work in the precise, qualified, technical language of the peer-reviewed journal than holding press conferences to announce their latest findings to reporters whose scientific training may not extend much beyond a course in biology taken many years ago. Skittish about active involvement in politics and wary of lawyers and other professional advocates who do not subscribe to their distinctive canons, they prefer the familiar environments of the laboratory, the seminar room, and the specialized scientific meeting to the courtroom or talk show.\(^5\)

Experimental scientists are preoccupied with the process of unearthing hard facts; their goal is discovery, their master techniques are the analysis of data and the testing of theories. Unlike lawyers and politicians, there is little in their training, professional norms or work environment that gives them a sophisticated understanding of social value conflicts or equips them even to address such conflicts. The political process that pits science against other normative systems is the bailiwick of specialized science bureaucrats. For most practicing scientists, however, politics is \textit{terra incognita}. Scientists' uneasiness around politicians is really a special case of their more general suspicion of populism. One defining feature of any culture is its orientation toward the roles of expert and lay judgments in conferring legitimate authority on decisions, and science is no exception. Its distinctive position can be illustrated if we imagine a spectrum along which attitudes about the sources of legitimate decision-making authority are arrayed, with professional autonomy at the left-hand pole and lay decision making on the right-hand pole.\(^5\) Science, with its technocratic commitments to rigorous method, objectivity, and expert judgment, would occupy the professional autonomy pole; pure science would be on the extreme left and applied science to its right. As we shall see in our discussion of the other two cultures, expert bureaucracy would lie a bit further to the right, law—divided into non-jury and jury components—would lie somewhere near the middle, while political bureaucracy would be located nearer the lay decision-making pole. (The market and familism are included in order to fill out the extreme right-hand position.)

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\(^5\) Partly for this reason, "[l]egal control of technology provides something more of a jolt to the scientist than it does to the lawyer." Goldberg, \textit{supra} note 49, at 1368.

\(^5\) On this point, I am indebted to Bruce Ackerman, who has elaborated a somewhat analogous distinction between the ideal types of "scientific policy-maker" and "ordinary observer." \textit{Bruce Ackerman, Private Property and the Constitution} 10-20 (1977).
As this spectrum suggests, science harbors a deep aversion to populist legitimations of decision-making authority; many dangerously false claims have been propagated in the name of public opinion. Science exalts instead the trained expert who possesses esoteric knowledge and who adheres to values and methods that ordinary people can scarcely understand. The scientific spirit of "credulous skepticism" rejects folk wisdom and conventional assumptions that cannot pass through the profession's fine-meshed empirical screen.\(^56\)

These broad generalizations about the culture of science, of course, describe what is in fact a far more complex social reality. Many exceptions should properly be noted. For example, scientist-writers like Stephen Jay Gould\(^57\) and C.P. Snow himself exhibit a broad humanistic vision reflecting their deep familiarity with the literary culture. Scientists like Barry Commoner and Samuel Epstein are ardent controversialists who gravitate eagerly to the public forum;\(^58\) many others are also perfectly delighted when the science reporter from the New York Times or even USA Today calls to discuss their work. Certain distinguished scientists turn out to be fine science bureaucrats as well; examples include Maxine Singer and Rene Dubos. The canons of scientific proof are not as clear-cut as they seem; they contain (and conceal) difficult issues of methodology and interpretation, as the many disputes over

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\(^{56}\) Given this bias, it is not surprising that scientists (other than science bureaucrats) find Congressman John Dingell's ongoing crusade to "cleanse" science of its elitist practices and pretensions incomprehensible, which may explain why they have been so ineffectual in opposing it. See Robert Cook, A Capital Collision, NEWSDAY, May 9, 1989, at 3; Bernard D. Davis, Fraud vs. Error: The Dingelling of Science, WALL ST. J., Mar. 8, 1989, at 14.


\(^{58}\) Barry Commoner's involvement in the public forum has included running for President in 1980. Philip Shabecoff, Commoner Says Victory is Not Object of His Drive, N.Y. TIMES, Oct. 30, 1980, at B19. Dr. Samuel Epstein's participation in the public arena has included numerous appearances before Congress testifying on a variety of scientific issues. See CONGRESSIONAL INFORMATION SERVICE INDEX (listing at least 17 appearances by Dr. Epstein as a witness at congressional hearings since 1974).
environmental carcinogens attest.59 And there are always scientists—some "clinical ecologists," for example—who flagrantly violate those canons.60

Some distinctions should also be drawn. For example, the conventional contrast between "hard" and "soft" sciences tracks important divisions that belie the merely superficial unity of the scientific culture.61 Although physicians are scientifically trained, they do not approach data in the same manner as do practicing scientists.62 Theoretical and experimental scientists do quite different things and think in different ways. Even within a particular scientific specialty or sub-specialty, practices and values are likely to vary among countries, regions, and even research groups in the same locality. Although it is common to speak of the scientific "community" (and I do so here), such usage is a rather quaint way to describe what has in fact become a fragmented profession.

In addition to these exceptions and distinctions, some qualifications are in order. Science has changed a great deal since the time that Snow wrote. Peer review has come under severe criticism as an inadequate and sometimes corrupt method of regulating a given profession.63 Moreover, despite (or perhaps because of) the remarkable success of many branches of science in improving the conditions of life, the gap between the demand for and the supply of research funds has widened. This development has significantly altered the norms and practices of science. It is no longer enough for scientists to describe and analyze interesting phenomena: in order to justify continued financial support, even pure researchers must demonstrate how others will be able to use their work. Science is no longer the self-contained, autonomous enclave it once was. Instead, researchers must increasingly interact with and satisfy the outside interests on whom they have come to depend. But even recognizing these exceptions, qualifications, and changes, the theory and

59. E.g., Gio B. Bori, Overturning the Verdict on Carcinogens, WALL ST. J., Aug. 27, 1992. Indeed, last year the National Toxicology Program's [NTP] Board of Scientific Findings issued an advisory review of NTP in which it suggested that the scientific methodology upon which the NTP relies in classifying compounds as carcinogens may not present any significant threat of cancer to human beings. See also What Price Cleanup, N.Y.TIMES, Mar. 21-26, 1993 (series of five articles highlighting some of the mistakes of American environmental policy).

60. See, e.g., discussion of Bertram Carnow in HUBER, supra note 20, at 92-93. For a recent lampoon-editorial on this subject, see Daniel E. Koshland, Jr., The Great Overcoat Scare, 259 SCIENCE 1807 (Mar. 26, 1993).

61. See supra note 45.

62. According to one research scientist who also treats patients, clinicians tend to be much less rigorous; they tend to seek only enough data to enable them to be comfortable with their best clinical judgments. Telephone Interview with Dr. Leonard Milstone, Associate Professor of Dermatology, Yale University School of Medicine (Dec. 22, 1992).

63. See, e.g., Symposium, Guarding the Guardians: Research on Editorial Peer Review, 263 JAMA 1306 (1990) (cited in Amicus Brief of the American Association for the Advancement of Science and the National Academy of Sciences at 16, Daubert v. Merrell Dow Pharmaceuticals, Inc., No. 92-102 (U.S. filed Jan. 19, 1993) [hereinafter Amicus Brief]). For present purposes, however, the more important point is that "[e]ven the most vocal critics of the peer review system do not . . . recommend that it be dismantled," Amicus Brief, supra, at 16-17.
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practice of science exhibit enough normative coherence and behavioral regularity that one can fairly speak of science as a culture, as a way of seeing, thinking, valuing, and acting that distinguishes it from other cultures, particularly law and politics.

B. Law

If the scientific culture, with its emphasis on rigorous methodology and proof, is arcane and remote from public view and common experience, the legal culture—or at least much of it—is to the average citizen more conspicuous (e.g., the imagery of trial), part of the vernacular (the language of rights), and numbingly familiar (the preparation of tax returns). 64

1. Central Values

Law's version of truth only dimly resembles the version advanced by science. Indeed, the notion of verifiable truth to which scientists appeal in their experiments and research bears almost no relationship to the conception of truth ordinarily pursued in legal proceedings. Legal principles are normative propositions about which particular states of the social world should be sought, not positive statements about how the natural or social world does in fact work. Legal principles seek and find their justification in arguments derived from a bewildering array of social policy goals: fairness, efficiency, administrative cost, wealth distribution, and morality, among others. Legal decision-makers balance these goals in non-rigorous, often intuitive ways that are seldom acknowledged and sometimes ineffable. 65 Moreover, courts explicitly invoke other considerations in support of their decisions that are essentially social policies in disguise. 66 Even the classic principle of stare decisis, for example, appeals to the policies of predictability, expectations, and decision cost minimization. The practice of analogical reasoning appeals to the policy of treating like cases alike. The principle of deference to particular institutions appeals to the policy of specialized, expert decision making.

This difference between science and law entails a fundamental distinction between the pursuit of "truth" (science’s province) and the pursuit of "justice"

64. I do not mean to deny, of course, that much of the legal culture is inaccessible to non-lawyers, a phenomenon that has provided grist for satirists and critics throughout the ages. I am simply comparing law to science in this regard.
65. See generally MICHAEL POLANYI, PERSONAL KNOWLEDGE (1958).
66. The relationship between principles and policies is developed in RONALD H. DWORKIN, TAKING RIGHTS SERIOUSLY (1977).
I hasten to add that this familiar distinction is one of degree only. Both paradigms are ideal types, abstractions employed to isolate some of their essential features rather than to represent a far more complex reality. In this connection, I have noted that scientific fact-finding is not wholly objective; its data, methods, interpretation, and authoritativeness are contextual, contingent, and often controversial.

By the same token, the justice sought by law is not purely subjective, not simply in the eye of the beholder. It is true, of course, that notions of justice do vary with time and place, and that the most bitter, protracted debates in any society revolve around its meaning. But justice does contain a more objective component. Ultimately, its normative claims depend upon the truth value—defined in a relatively rigorous, scientific sense—of the empirical propositions that at least implicitly underlie those claims. Law's legitimacy, at least in the long run, rests in part upon its ability to generate outcomes that are more or less correct. To be "correct," an outcome must comport with the common morality and common sense of the lay community, and also command the respect of the relevant communities of experts. If instead these lay and expert communities come to view the legal system's errors of fact or law as systematic or otherwise substantial, they are bound to call law's integrity and utility into question.

How much may law deviate from scientific truth before its legitimacy is jeopardized? Like conceptions of justice, a society's tolerance for legal error is a variable, not a constant. Changes in public attitudes, political discourse, and scientific opinion can alter the level of legal error that society, and hence the law, will accept. The Bendectin litigation illustrates the point. In a few of the early cases, juries found that Bendectin caused birth defects; some juries even awarded punitive damages against the producer. As studies casting doubt on the drug's causal responsibility proliferated in the early to mid-1980s, the scientific community responded by strongly criticizing the evidence on which these findings had been based. In time, this criticism undermined, and in some cases reversed, the earlier decisions. More important, it contributed to a more general discrediting of the tort system. This system, after all, managed to

67. These labels, of course, are conventional. See John Thibaut & Laurens Walker, A Theory of Procedure, 66 CAL. L. REV. 541 (1978). Those authors view "truth" as concerned with cognitive conflicts and "justice" as concerned with conflicts of interest. Id. at 543-44.

68. See supra text accompanying notes 50-51.

69. Even in criminal procedure, where a libertarian bias favoring false negatives over false positives is particularly strong ("it is better that nine guilty defendants go free than that one innocent defendant be wrongfully convicted"), there are social limits to the bias. This is indicated by the intense, continuing debates over the appropriate standards for bail and preventive detention, the minimum size of the jury, and the scope of the habeas corpus remedy. In civil law, bitter controversies over the location and shifting of burdens of proof likewise demonstrate how society's views concerning permissible error levels change over time. A recent example is § 105 of the Civil Rights Act of 1991, Pub. L. 102-166, which amended § 703 of the Civil Rights Act of 1964, 42 U.S.C. § 1981 (amending 42 U.S.C. § 2000e-2), to overrule the Supreme Court's decision in Wards Cove Packing Co. v. Atonio, 403 U.S. 642 (1988).
discover the error only after Bendectin had been driven off the market, depriving consumers of an often effective and unique remedy for a serious condition, and only after its manufacturer had incurred more than $100 million in legal fees. The law’s repudiation of bad science in the Bendectin litigation thus came tragically late.

Today, the law seems to be demanding greater reliability of scientific claims before it will honor them, although evidence of this shift remains fragmentary. Some courts, perhaps emboldened by Judge Weinstein’s exhaustive scrutiny of the expert medical testimony in the Agent Orange case, have recently insisted upon greater rigor in the law’s use and interpretation of scientific evidence, especially on the issue of causation in toxic tort cases. A swelling chorus of scientifically informed commentary has also criticized the law’s traditional approach to technical evidence. Even more significant in the long run, perhaps, the Environmental Protection Agency is currently conducting a thorough reevaluation of its diverse risk assessment methodologies, a review prompted in part by widespread criticism of that approach by many prominent scientists and economists.

These convergences between the standards of truth in science and in law are noteworthy and on the whole encouraging, but the more general point remains: the two cultures characteristically pursue fundamentally different ends—verifiable fact for the one, and justice for the other. This difference also implies that science and law have different orientations toward the distributive consequences that their activities generate. Many individual scientists, of course, care deeply about whom their findings benefit and burden, yet the culture of science in principle must take a dispassionate stance on that question. The canons of science, after all, dictate that if research uncovers a new truth, scientists must not suppress it but should instead let the chips fall where they may. In principle, at least, how society ultimately decides to use (or misuse) scientific facts is a separate question about which they may feel strongly but usually possess no special expertise.

70. For a pithy discussion of this episode, see Huber, supra note 20, at 111-29. The high litigation costs, unfortunately, are not peculiar to Bendectin. They have been much higher in Agent Orange cases, see Schuck, supra note 30, at 5, and in asbestos cases, see Schuck, The Worst Should Go First: Deferral Registries in Asbestos Litigation, 15 Harv. J.L. & Pub. Pol’y 541, 553-68 (1992).

71. See generally Schuck, supra note 30.

72. Green, supra note 20, at 666.


In contrast, the legal culture is anything but neutral about the distribution of outcomes, even in principle. It is normative to its core. The law, of course, defines rights and duties with desired substantive outcomes very much in view when it protects property, proscribes criminal conduct, exacts taxes, supports wars, demands equal treatment for similarly situated groups, and regulates social and economic relationships. Practicing lawyers are expected to advocate their clients' biases and implement their agendas; failure to do so may constitute professional malpractice. Academic lawyers routinely elaborate legal theories designed to promote values they personally prefer. Among those in the field of law, only judges are expected to put aside their normative goals when those goals conflict with the properly understood rule of law.

2. Incentives and Techniques

The incentives that motivate legal actors are varied but largely conventional. In this respect, the law is no different than other cultures. Some of the incentives that shape lawyers' conduct, however, are distinctive to their professional milieus. For practicing lawyers, the decisive incentive is the need, consistent with both self-interest and professional ethics, to effectively represent the client's interests, whatever those interests may be. The lawyer's income (if not always her psychic well-being) is enhanced by her willingness to subordinate her personal policy views to those of her client. Somewhat paradoxically, this substantive self-abnegation actually reinforces, and then rationalizes, the legal culture's singularly powerful normative thrust by ensuring that any client that can afford to hire a lawyer can enjoy some access to the policy-making and adjudicative processes, where it can press its claims. Where the scientist's "clients" are verifiable facts waiting to be revealed and used, the lawyer's are social interests seeking gratification and advancement.

Lawyers' strong client orientation also colors how incentive structures in the two cultures treat uncertainty and complexity. Paradigmatically, science progresses by generating new data and hypotheses that often undermine the then-dominant theories. When this occurs, the resulting uncertainties and complexities may persist for a long time; although these uncertainties often contain the seeds for new progress, they must first germinate. Despite this tendency toward uncertainty and complexity, however, science's ultimate goals are precisely the opposite: it seeks the most parsimonious theory that can both explain all existing data and yield testable new hypotheses.

In contrast, legal actors are more agnostic about whether and to what extent certainty and simplicity are virtues in law. For practicing lawyers, it all

75. This access is subject to the increasingly rigid constraints of standing doctrine. E.g., Lujan v. Defenders of Wildlife, 112 S. Ct. 2130 (1992).
76. KUHN, supra note 12.
depends on their clients' interests, which may militate in favor of certainty on one issue, uncertainty on another, and a shifting balance over time on a third. For judges, it depends on how they balance various goals of the legal system—for example, the competing policies of having clear rules and of responding flexibly to equitable considerations in individual cases. Legislators and bureaucrats, who also face countervailing incentives, will tend to favor legal complexity and uncertainty because it helps them both to resolve intricate political and policy disputes and to develop special expertise that confers autonomy, prestige, and power over decisions.\textsuperscript{77}

The law is usually in much more of a hurry to decide than science is. Ironically, however, law's findings, although less reliable and tested than those of science, are treated as more final and authoritative. Law operates under pressure to resolve particular disputes speedily and conclusively. Once it finds facts (and confirms them on appeal), those findings are considered res judicata—final for the law's purposes, however erroneous they may be in fact. Science, in contrast, seeks to develop a professional consensus on the truth of its propositions. This consensus often takes a long time to assemble, yet even then it is conditional, always open to revision on the basis of new data or theories.\textsuperscript{78}

Richard Cooper, a former general counsel of the FDA, has analogized cross-examination in the courtroom to peer review in the scientific journal, noting that cross-examination is simply a more concentrated form of review suitable to the law's more hurried, arbitrary pace.\textsuperscript{79} Many scientists, however, would surely reject any analogy between scrupulous peer review and what they view as the truth-obscuring manipulations and tricks of the interrogating attorneys. Most scientists would probably also be dubious about permitting juries to hear and rely upon scientific evidence that has not previously been published in a peer-reviewed professional journal—an issue raised by a Bendectin case pending before the U.S. Supreme Court.\textsuperscript{80}

The legal culture, of course, is hardly indifferent to the dangers of making premature decisions on the basis of incomplete information. Judges fashion many legal principles—for example, procedural rules allocating evidentiary burdens,\textsuperscript{81} and substantive rules defining the legal consequences of knowledge

\textsuperscript{77} For a detailed discussion of this point, see Peter Schuck, \textit{Legal Complexity: Some Causes, Consequences, and Cures}, 42 Duke L.J. 1, 27-31 (1992).

\textsuperscript{78} As Michael Green puts it, "[t]he notion of refusing to reconsider a determination that one knows is wrong would drive scientists even wilder than trotting out the concept of justice." Letter from Michael D. Green to Peter H. Schuck, \textit{supra} note 22.


\textsuperscript{80} Daubert v. Merrell Dow Pharmaceuticals, Inc., 951 F.2d 1128 (9th Cir. 1991), \textit{cert. granted}, 113 S. Ct. 320 (Oct. 13, 1992) (No. 92-102).

\textsuperscript{81} \textit{See}, e.g., 9 John H. Wigmore, \textit{Evidence in Trials at Common Law} § 2509 (Chadbourn rev. 1981) (discussing \textit{res ipsa loquitur} doctrine).
and ignorance— in order to create incentives to produce, use, and disseminate information that policymakers may need. Agencies and legislatures also seek to stimulate new information that can help to solve legal problems.

Nevertheless, judges are obliged to adjudicate the disputes that come before them promptly and on the basis of the best evidence that can then be adduced, even if that evidence seems wholly inadequate to support a scientific claim. Judges do not ordinarily have the luxury of deferring a decision until additional studies are conducted, the data are more conclusive, and a firm scientific consensus is reached. Instead, they must decide on the basis of uncertain, incomplete evidence, a circumstance that Cooper likens to "a jury verdict reached midway during a trial." The law's demand for an immediate resolution of disputes, he observes, may force it "to choose among competing scientific theories, a choice that legal decision-makers are not competent to make, and that scientists are not ready to make." Although agencies usually enjoy greater control over their dockets and decision priorities than do courts, they too are under considerable compulsion—occasionally judicial, sometimes legislative, often political—to act promptly despite data gaps that would dismay a research scientist and implementation gaps that would astonish an engineer.

I have already noted the central importance of peer review in science. Peer review is much more peripheral to lawyers, however, and the structure of incentives that shapes their behavior reflect its marginality. Lawyers are hardly indifferent to their reputations among fellow lawyers; client referrals as well as professional recognition and pride are at stake. Moreover, the institution of appellate review is a kind of peer-administered control structure. But the legal culture has not developed peer review systems genuinely analogous to science's refereed journals, grant review committees, and academic appointments processes. Law's highly competitive, public-oriented, adversary system contributes to this difference. Scientists participate in a truly global community of peers, yet they may achieve world renown (even Nobel Prizes) by impressing a very small set of experts in a narrow sub-specialty with their quiet,
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painstaking, imaginative work. Lawyers' reputations, in contrast, depend on a more localized notoriety among less sophisticated audiences dominated by lay clients with largely economic interests. More than in science, the legal culture (or at least a good part of it) richly rewards combativeness, self-promotion, and an aggressive, vivid personality—although these qualities are by no means unknown among top scientists.

The incentive structures in science and law, however, do not simply reflect their different client orientations, attitudes toward complexity and uncertainty, and peer review systems. They also reflect differences in how the two cultures are organized and financed. While the number of scientific investigators is quite large, science is administered predominantly through a relatively "clustered" structure consisting of a comparatively small number of leading universities, research institutes, and corporations. Within this structure, considerable coordination occurs through sub-specialty journals, professional conferences, and the funding decisions of a limited number of sources.

Legal activity is not nearly so coordinated. Hundreds of thousands of lawyers act daily on behalf of millions of clients. They make claims and deploy arguments that are utterly fragmented except insofar as the law provides clear rules or unambiguous principles of decision, and not simply a conventional rhetoric of rights. Formal legal institutions such as legislatures, courts, and agencies do provide some coordination and guidance to lawyers, their clients, and others. In some respects, however, these institutions simply increase the chaos; they too are radically decentralized (within both the federal system and each state system). Their pronouncements are often susceptible to competing interpretations, and they provide multiple access and decision points for any legal actors who are dissatisfied with one or another interpretation.

3. Biases and Orientations

Law, like science, has its characteristic blind spots and preoccupations. The differences between the two cultures in this respect are fortified by their members' distinctive training. Scientific education is largely didactic and constructive; it emphasizes the transmission of information, the techniques of theory-building, and the modes of empirical investigation. Legal education, in contrast, is essentially deconstructive and dialogic; it emphasizes the malleability of facts, the plasticity of legal doctrine, the indeterminacy of legal texts, and the power of rhetorical skill. Decades after specialty and subspecialty training became common for doctors, moreover, lawyers continue to be trained and practice as generalists. Their mere admission to the bar usually entitles them to practice law in any field they like with no legal
requirement for specialty certification. Most American judges are also generalists not only because of the nature of their legal education but also because of the general jurisdiction of their courts. Indeed, unlike their colleagues in civil law countries, they receive no special training to be professional judges. The legal culture exhorts both judges and ordinary lawyers to have a broad, synthetic, social vision rather than a narrow, insular, technocratic one.

On the other hand, lawyers’ central role in the adversary system can foster a kind of truculent tendentiousness that can encourage them to take frivolous positions, overlook or obscure complexities, and give short shrift to other points of view. They can do so with the easy conscience of advocates who confidently assume that any extreme claims they make will be countered by others no less extreme and will then be resolved by judges who understand this exercise in hyperbole and routinely make allowances for it. Their professional penchant for advocacy and rhetoric, intensified by the financial interest that many have in disputes and litigation, often promotes conflict rather than resolving it. Commentators have noted that the adversary process is far better at deconstructing scientific claims than at reconstructing “the communally held beliefs that reasonably pass for truth in science.” Few scientists feel comfortable in this contentious milieu. Most find it particularly repugnant both as an intellectual process for seeking truth and as a matter of personal and professional style.

Finally, the fact that law is both authoritative and suppletive—that it both legitimates official actions and facilitates private ones—creates other biases. Because much law must be predicted, understood, and applied by many ordinary people with limited resources, simplicity is often a compelling legal virtue. Law cannot afford to be as nuanced as the realities it seeks to shape; it necessarily draws lines and creates categories that force many legal decisions into a binary mold; one is either in or out of the category, and it matters a great deal which.

This rather arbitrary binary classification, so characteristic of legal thought and so evident in the Bendectin and Agent Orange cases, is utterly alien to science. Where the practicing lawyer or judge speaks casually of chemical A being (or not being) a carcinogen, or of action B having “caused” condition C,

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87. I am aware of one limited exception. In order to prosecute a patent claim before the Patent Office, one must be certified as a specialist. 37 C.F.R. § 10.10 (1988). This requirement, however, does not apply to the litigation of patent claims in the courts.
88. See Jasanoff, supra note 46, at 353; see also Sanders, supra note 20, at 44.
89. See, e.g., Sanders, supra note 20, at 30.
90. See generally Schuck, supra note 77.
91. Thus a defendant is either guilty or not guilty, negligent or not, in breach of the contract or statute or in compliance with it. One’s agent is either a servant or an independent contractor. The court either has jurisdiction over a case or lacks it. The will is either valid or invalid. The AFDC claimant is either eligible for the benefit or she is ineligible.
the careful scientist is much more circumspect. To her, causal relationships are only stochastic predictions, not categorical facts. In science, the goal is not to facilitate socially useful action at low cost, as it sometimes is in law, but instead to understand the world in all its complexity. For science, theoretical simplification—the slice of Ockham's Razor— is not a condition of normativity but merely one technique for deepening and extending this understanding.

In part (but only in part), this tendency toward categorical reductionism in the law reflects its commitment to the jury as a lay decision-maker in many disputes. In no other legal system in the world does the jury play so large a legal and political role. Invoking populist premises, the legal culture depicts it as the embodiment of common sense and yeoman virtue; it institutionalizes a mode of knowing, of which experts and other elites who suffer from “trained incapacity” (in Philip Selznick’s apt phrase) are thought to be incapable. Lay jurors are often the triers of even complex facts, and much legal doctrine enshrines the cognitive and behavioral standards of ordinary people (the “man on the Clapham omnibus,” in one formulation), rather than expert standards, as the test of legally approved conduct. Finally, the jury affirms populist values by exercising certain political functions, serving as the voice of common morality, a bulwark of common liberty, and a decentralized organ of popular government, one that is constantly refreshed. The jury thus reflects the legal culture’s singular compromise between professional autonomy, which in science counts for everything, and popular sovereignty, which in science counts for little (but trouble).

92. See WEBSTER’S THIRD NEW INTERNATIONAL DICTIONARY 1501 (1976) (“the philosophic rule that entities should not be multiplied unnecessarily”).
94. Indeed, juries are still constitutionally permitted to decide questions of law in Maryland and Indiana. See VALERIE P. HANS & NEIL VIDMAR, JUDGING THE JURY 157 (1986).
96. For reflections on how well the civil jury fulfills these expectations, see generally the contributions in THE VERDICT, supra note 93. On the jury’s political functions, see Akhil R. Amar, The Bill of Rights as a Constitution, 100 YALE L.J. 1131 (1991).
97. This formulation is too cute. It is not meant to suggest, of course, that scientists are not committed to democratic values, or that science could continue to thrive in the absence of political freedom or broad public support. I mean only that science qua science—as a culture that investigates the world in a particular way—does not depend on popular sovereignty, and that a militant populism often threatens it. For science, any political system permitting genuinely free inquiry will do.
Politics, the pursuit and exercise of the coercive, prescriptive, and symbolic powers of the state, lies near the core of all social life, appearing in many forms and venues. Here, I am principally interested in how politicians approach those public policies whose legitimacy draws heavily on scientific authority and on scientific propositions about the natural world. As noted earlier, my paradigmatic examples are regulation of the safety of foods, drugs, consumer products, the environment, and the workplace.9

Politics relates symbiotically to both science and law but in different ways. Science has its own politics, often fierce and bitter, in which scientists pursue power, recognition, and resources from the government, the profession, and other sources.99 Just as scientists often play politics, politicians also have many opportunities to exploit the prestige and symbols of science in order to fortify their empirical claims, legitimate and build public support for their decisions, and clothe themselves in the mantle of scientific truth.

1. Central Values

Like all cultures, politics pursues a mix of values some of which are unique to its particular way of life.100 In a liberal democratic polity like ours, which purports not to privilege particular visions of the good, these are chiefly process values, although they are deployed in pursuit of substantive ends. Three of these process values seem paramount. The participation norm holds that individuals should be empowered, in the interest of human dignity, to play some meaningful role in shaping decisions that affect their vital interests. The accountability norm demands that officials be held politically responsible to the public for their actions. The conflict management norm emphasizes that other values can be achieved only if social conflicts are kept within tolerable limits.

98. Supra text accompanying notes 9-10.
100. This contradicts the assertion by one commentator (who, as a federal judge, should know better) that "[s]cience and law are all we have." Howard T. Markey, Science and Law: The Friendly Enemies, 30 IDEA 13 (1989).
2. Incentives and Techniques

These values engender an equally distinctive set of political incentives and decision techniques. Virtually all academic models of politics, as well as many less systematic commentaries, posit that politicians are primarily, if not exclusively, driven by the need to build and maintain a winning electoral coalition. No sophisticated political analyst, of course, doubts either that most politicians' definition of the winning coalition is complex enough to accommodate other personal and ideological goals which they possess, or that politicians sometimes take positions on issues that cannot easily be explained simply in terms of conventional calculations of electoral advantage. But even when the electoral imperative is narrowly conceived, it explains their actions better than any other single factor.

From this preoccupation with election, certain behavioral strategies follow, most of which sharply differentiate the political culture from the scientific and legal ones. One important difference relates to the cultures' audiences and thus to the form of discourse that is possible. Unlike scientists and judges, who mainly address their professional colleagues and can employ technical and theoretical kinds of arguments, politicians speak to a lay and largely uninformed electorate. Often, they can only reach the voters through media that, while sometimes more sophisticated than the voters, are also severely constrained by the voters' limitations of time, understanding, and interest.

Instead of the nuanced, abstract arguments deployed in the scientific and legal cultures, then, political rhetoric is relatively crude and particularistic. Where both scientific and legal discourses are designed to pursue truth through the elaboration of principles, the point of political discourse ultimately is to persuade. Rhetorical strategies that would be professionally unacceptable in science and often in law—explicit appeals to sentiment, ideology, or interest—are standard tactics in politics, where the "mobilization of bias" is both normal and normative.

In addition to a distinctive audience and rhetoric, politics has its own time horizon. Especially when compared to science, but even when contrasted with law, political decisions tend to be spasmodic and impulsive. They are shaped by deadlines that seem highly arbitrary from almost any other perspective—

101. Most, but not all. Credit-claiming, for example, pervades each of the three cultures, although not in the same way and to the same extent. Politicians, the quintessential entrepreneurs, trumpet their virtues to the public without reserve or shame. Scientists, more tempered by the professional dictates of collaboration, peer review, and caution, are more circumspect. They must seek to burnish their reputations with peers and funding agencies, yet, they are wary of premature claims that can be decisively discredited. Lawyers and judges are constrained by ethical canons from conventional advertising, so they avidly seek (and find) imaginative alternative forms of self-presentation.

102. E.E. SCHATTSCHNEIDER, THE SEMI-SOVEREIGN PEOPLE 29-30 (1960) (asserting that political interest groups are themselves "a mobilization of bias in preparation for action") (emphasis omitted).
especially that of a scientific model of decision making in which evidence is gathered, alternative hypotheses are considered, and a deliberate, rational judgment is reached. The political culture often demands swift action, and when it does it will not tolerate delay, even if prudence might counsel otherwise. The pace of mass democratic politics is driven by the insistent rhythm of public opinion, which will not be temporized.

Another distinction of the political culture relates not to discursive method but to decisional technique. In theory and largely in fact, scientific hypotheses are confirmed or refuted by experimentation, and judicial rulings proceed by reasoned elaboration of established principles. In contrast, the paradigmatic decision technique in liberal democratic politics is bargaining to a consensus, a process that is complex, amorphous, and continuous. Numerous participants form constantly shifting alliances and deploy a fluid mixture of rewards, threats, special interest claims, public interest ideals, and evocative symbols. Because the process is so open-ended in time, participation, and issue-space, political outcomes are not merely unpredictable; they are also opaque and hard to identify. Even the enactment of legislation, itself a protracted affair, is only a shadowy guide to what it will become. Its meaning will depend upon its future implementation.

These defining features of political behavior shape the criteria for evaluating that behavior. Political bargains can be criticized on a variety of procedural and substantive grounds. But the complaint that an outcome is inconsistent with earlier ones, which often will be a decisive objection in science and law, carries far less weight in the political culture. In the political environment, change is an effective rallying cry, flexibility is a crucial resource, and policy innovation is a desideratum. Inconsistency in politics is as likely to be an asset as a liability. By the same token, the complaint that a political decision lacks strong empirical support is also often beside the point. Such evidence may be unavailable when the decision must be made, or if it is available, may well be subject to controversial, normatively charged interpretations. Even beyond this, constitutional principles do not ordinarily prevent a legislature from deciding...
against the weight of the evidence; in most policy areas, any "rational basis"—even one hypothesized by the reviewing court—will suffice.\textsuperscript{105}

3. Biases and Orientations

As these last observations suggest, politics also has its characteristic blind spots. A notable one is its abhorrence of firm principle. This, of course, is seldom publicly acknowledged as such; instead, it is portrayed and celebrated as a benign commitment to consensus and compromise. We can better understand this bias by comparing it with how firm principle is treated in science and law.

Science, by its very nature, demands that its practitioners rigorously observe certain canons of investigation and verification, and that they accept, or at least respect, its substantive principles until they can disprove them. Legal principles, while not verifiable in any scientific (or other) sense, are also treated as presumptively binding. In law's normative hierarchy, they govern conduct unless and until they are contradicted by other principles of an equal or higher dignity.

In the political culture, however, compromise of principle is not merely inevitable and habitual; it is also normative. A successful practitioner of politics must possess both a taste and a talent for compromise. House Speaker Sam Rayburn's well-known advice to the novice—"if you want to get along, go along"—remains a fundamental precept of the politician's creed. Many politicians, of course, do not view compromise as an abandonment of principle but instead justify it as simply a tactic employed in the service of a larger principled strategy, much as a sailboat caught in an unfavorable wind must tack back and forth in order to reach its destination. Doubtless this is often true. But however one views this conduct, the result is much the same: compromise of principle is essential to the profession of politics.

Another distinctive bias of politics is its populism—its appeal to the superior virtues of common people. We have already seen that this populism is anathema to science. The legal culture's use of the jury and the veneration of its findings, as well as the election of many judges, manifest a limited but important commitment to populism. Though law is more populist than science, politics is even more populist than law. In law, expertise is often privileged. For example, qualified expert witnesses may offer opinion testimony in many circumstances in which lay witnesses may not.\textsuperscript{106} Scientific treatises and other authoritative works may be admitted under an exception to the hearsay

\textsuperscript{105} McGowan v. Maryland, 366 U.S. 420, 426 (1961) ("statutory discrimination will not be set aside if any state of facts reasonably may be conceived to justify it").

\textsuperscript{106} Compare FED. R. EVID. 701 with FED. R. EVID. 702.
rule. Professional custom constitutes the standard of care in malpractice cases, and the business judgment rule governs most corporate transactions. Judges are obliged to set aside those jury verdicts that they deem irrational or contrary to the weight of the evidence.

Our political culture embraces many of the populist premises that science and to a lesser degree law repudiate. It maintains the principle that the legitimacy of public decisions must rest primarily upon bases other than the professional status, esoteric knowledge, or special expertise of the decision-maker. This principle applies regardless of whether the decision-maker is a regulatory bureaucracy, corporation, or individual official. It affirms that however much technocracy can contribute to public deliberations, the popular will is the ultimate touchstone of policy. It insists, sometimes to the point of outright pandering, that the people know best even when it is clear that they do not. This principle goes well beyond a grudging, realistic recognition that in a democracy the voters have the last word; it is also fundamentally normative. It elevates the wisdom of popular judgments, their superiority to those of the experts, and the independent integrity of the political process, to the level of central articles of the democratic faith.

Although it is not inaccurate to speak of a political culture, as I have done, it is also useful for certain purposes to differentiate broadly between two political subcultures: elected officials and their political appointees, on the one hand, and the career civil service, especially in its lower, more technical reaches, on the other. I characterized these two groups earlier as "political" and "expert" bureaucrats—a crude but serviceable distinction. In terms of their attitudes toward lay participation in decision making, political bureaucrats, whom democratic theory supposes to be exquisitely responsive to electoral concerns, lie near the lay decision-making end of the spectrum, far from science. The expert bureaucrats lie closer to the professional autonomy pole; their fidelity to programmatic clients, bureaucratic traditions, and professional canons competes with the norms of hierarchical authority and responsiveness to the electorate.

Both of the political biases which I have noted—aversion to principle, and obeisance to populism—are visibly at work in the Agent Orange and (to a lesser extent) Bendectin cases. While scientific principles eventually proved capable of resolving these cases to most toxicologists' satisfaction, these

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107. FED. R. EVID. 803(18).  
108. Populist politics, of course, reflects many factors, including our democratic institutions, our Horatio Alger myth of individualism, and our anti-hierarchical, anti-authoritarian, anti-intellectual traditions. See Richard Hofstadter, Anti-Intellectualism in American Life (1963).  
109. See supra text accompanying notes 55-56.  
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principles bore less dignity in the political world where lay judgments often dominate professional ones. In Congress, where populism routinely trumps science and rewrites the law, neither the scientific fact that Agent Orange did not harm the veterans nor the legal conclusion that this denied them any right to compensation was decisive. In the Bendectin cases, the sequence of events made politics' subordination of scientific values less salient. Some politicians rebuked the FDA's scientist-bureaucrats for overriding lay jurors' populist wisdom in the early cases, but the manufacturer's withdrawal of the drug from the market in 1983 quickly mooted the point.

III. LOOKING AHEAD

Multi-cultural conflicts among the legal, political, and scientific cultures should not be a cause for regret. They are not only inevitable, but they serve essential social functions. They raise certain competing interests to the level of public consciousness and debate, which no wise polity can afford either to suppress or to ignore. They encourage social innovation and policy flexibility by infusing the polity with a varied array of legitimating norms and problem-solving techniques, making it difficult for any single world-view to always dominate. They also increase and refine our stock of social information, supplying policymakers with values, ideology, imagery, and problem-solving techniques whose diversity makes them all the more valuable. No single culture, moreover, can possibly mobilize all of these social resources all of the time. For example, the scientific ethos, which gained sway during the New Deal period, yielded some ground to the participatory politics of the Great Society, which in turn led to the more demanding legal controls of the late 1960s and early 70s. In the 1980s we reached a more fluid, transitional stage, which recognized the values of all three cultures to some degree but in which none was clearly ascendant.

As the Bendectin and Agent Orange cases illustrate, the mix of values necessary to resolving multi-cultural conflicts is not fixed but changes over time. Moreover, the cultures interact in complex, often unexpected, ways. In the Bendectin cases, for example, scientific values came to dominate purely legal ones after the mid-1980s, as the scientific evidence in support of the drug's safety grew steadily more conclusive and the courts became more uneasy about permitting juries to exercise their legally sanctioned power to deviate from that conclusion in individual cases. In the Agent Orange cases, Congress infused new political values into an earlier legal-scientific consensus

111. Clearly, changing partisan divisions within the federal government also had a great deal to do with these cycles, but this hardly refutes my observation, since the political parties differed with respect to the weight that should be accorded to different cultures' values and decisions.
when it decided to compensate veterans whose injuries the court had found, relying on the best available science, to be insufficiently linked to the herbicide. In that litigation’s intricate blend of science, law, and politics, each culture insisted on its own centrality while opportunistically borrowing values from the others.

This cultural eclecticism was most evident on the causation issue. Organized groups—the chemical industry, the veterans, and the U.S. government—recruited scientists to buttress their political and legal interests. The scientists were then obliged to set their cultural norms of discourse and proof to one side as they had to testify in the less scientific terms—for example, “more probable than not”—that the legal rules demanded. The lawyers, while mobilizing scientific data and methodology in the form of expert testimony, also looked to politicians and bureaucrats to help resolve the dispute. The politicians and bureaucrats, for their part, funded epidemiological studies and paid their verbal respects to the scientific evidence, then awarded veterans benefits with little regard to its findings.

These cases demonstrate that in the fluid worlds of politics and policy-making, the relevant cultural boundaries are poorly marked and evanescent, so much so that we constantly cross them without even knowing it. We may find it expedient to draw careful lines in order to preserve for each a core domain, a clearly defined jurisdiction within which each culture’s special values and procedures can govern. While I suggest some line-drawing criteria below, the fact is that the most interesting and important conflicts, such as those in the Agent Orange cases, will occur near the cultures’ peripheries where these domains touch and begin to overlap, and where the optimal mix remains highly uncertain.

We have seen that many questions that society poses to science are really “trans-scientific” in nature. In the same way, other questions that we delegate to politicians and to judges are trans-political and trans-legal, respectively. But although cultural boundaries will become more permeable as society grows more complex and undertakes more ambitious goals, we must not conclude reductively that these boundaries are simply formal constructions that we can safely ignore or transgress. Notwithstanding their permeability, science, law, and politics remain coherent cultures. When one of them addresses a question that it is normatively and technically competent to answer, and does so through a process that conforms to its distinctive competencies, society should strongly presume that its answers are valid and legitimate, and those challenging them should bear a very heavy burden of proof.

What, then, are the contours of each culture’s appropriate sphere? Which issues is each competent to decide? Here, the conventional concepts of core

112. See supra text accompanying note 37.
and periphery are helpful, though not decisive in the hard cases. Setting epistemological quibbles to one side, some issues may be said to be (or treated as if they were) scientific, legal, or political at their core, although not at their periphery. Because a cultural sphere's contours are not self-defining or immanent but are instead shaped by evolving social values, purposes, and perceptions of appropriateness, the domains of core and periphery shift over time and in different contexts.

Consider some examples. The operation of clinical testing laboratories was long-treated as a matter within the core of scientific activity. Social concerns about rising health care costs and incompetent diagnoses, however, moved clinical laboratories out toward the periphery of science where they overlap with law and politics, which now subject them to extensive regulation. Occasionally the movement is in the other direction. Recombinant DNA research, a controversial political topic during the 1970s, was originally subjected to strict legal controls. As its benefits became more apparent and its risks all but vanished, however, DNA research gravitated to the legal and political peripheries and beyond. Shedding the earlier controls, it entered the realm of essentially unrestricted science.

As these examples suggest, the three cultures commonly converge at their peripheries when confronted with a multi-cultural issue. This convergence demands a complex decision-making structure that can somehow integrate the values of several conflicting cultures in pursuit of a satisfactory, if often contingent, resolution. It must negotiate the relative weights of the conflicting values in a more or less ad hoc fashion since they ordinarily cannot be specified in advance. Such a system is inevitably messy and to some degree indeterminate, but this is a condition of liberal-democratic-technocratic society that we simply must learn to live with and manage better.

While recognizing that the power to characterize issues as scientific, legal, or political is often the power to determine who will decide them and what the ultimate outcome will be, this allocation should be relatively unproblematic where an issue lies at a culture's core, that is, where it involves a quint-essentially scientific, legal, or political question.113

Nevertheless, current legal arrangements often confound such an allocation even in the clearest core cases. The central question in the Bendectin cases—whether and under what circumstances the drug causes birth defects when taken during pregnancy—is scientific at its core, in at least the following four senses. First, it is a question about a factual relationship, with few "value" elements. Second, the scientific community has reached a consensus on how this question should be formulated, which methodologies are appropriate for

113. Multi-cultural issues, of course, do not come to us neatly and objectively labeled; indeed, the labels are themselves social constructions whose meanings are contingent upon how people succeed in deploying them. See supra note 46 and text accompanying notes 50-51.
answering it, and what counts as evidence. Third, no objective person—
scientist, lawyer, or politician—really believes that this answer should turn on
who asks the question or who administers the experiments. Finally, neither law
nor politics seriously disputes that this is indeed a scientific issue in all of these
senses.

Some, however, will view even these propositions as socially constructed
conventions rather than as objective truths. The propositions are not self-
evident; they raise hard questions that deserve—and in the sociology and
history of science are receiving—serious responses. For example, what
is a “fact”? Who belongs to the “scientific community”? Is its self-constituting
character an invitation to narrow-mindedness or even corruption? Who gets
to decide these questions? Questions like these, which emphasize the social
constructedness, contingency, and political pedigree of ostensibly scientific
facts, are important cautions against adopting what Sheila Jasanoff calls “a
naïvely positivist image of science.”

These questions can lead to valuable insights. But we should not carry their
logic so far as to preclude rational, coherent discourse about science—or
indeed about any other salient social practice that needs to be better under-
stood. If the necessary terms of discourse are themselves contingent social
constructs that are devoid of intelligible meaning, then rational discourse
becomes impossible. We place ourselves in an infinite regress culminating in
analytical inconclusiveness and prescriptive paralysis. This frustrating prospect,
of course, cannot refute the social constructedness of science; that a conclusion
is dismal does not mean that it is wrong. It should encourage us, however, to
search for other strategies, even though they are imperfect.

Two pragmatic considerations further justify viewing the causal issue in
the Bendectin cases as a core scientific one. First, even if the propositions
supporting this view are merely social conventions, they are so widely accepted
as to be canonical. Indeed, if Bendectin’s causation is not a scientific question,
it is difficult to imagine one that is. Second, society has made remarkable
material progress by treating such issues precisely as if they were scientific
at their core to view science as essentially an epiphenomenon of politics and
law would be to place these gains (and future ones) in serious jeopardy.

I have argued that a core scientific issue like causation should be authorita-
tively decided within the scientific culture by institutions that this culture
designates as appropriate to the task, subject only to controls (such as judicial
review) that are designed to advance, or at least are consistent with, the

114. Id.
115. See Jasanoff, supra note 46, at 356.
116. In this connection it seems revealing that Professor Jasanoff, a sophisticated expositor of the
sociology of science view, employs terms like “science” and “scientist” as if they possessed some core,
objective meaning not altogether contingent upon the speaker’s idiosyncratic conceptions. Id. passim.
particular cultural values in question (such as factual accuracy). In the Bendectin cases and many others like it, the Food and Drug Administration (FDA) is that institution.

This is not to say, of course, that the FDA fully instantiates the scientific ideal. Criticism of that agency for being unduly influenced by regulated firms and for lacking sufficient technical expertise and enforcement resources has long been a staple of American regulatory politics. But this cannot be a decisive consideration, for in our system the same is true of virtually all government institutions. For better or for worse, the FDA is the agency that the public has empowered to make authoritative judgments of this kind on its behalf. In recent years, moreover, its technical and enforcement resources have been significantly enhanced due in part to its uncommonly strong leadership. Its counterparts in Europe receive a level of deference from their publics and courts that no American agency is likely to enjoy; the more competitive, fragmented, populist character of our politics assures that even technical agency decisions will be vigorously contested. Nevertheless, we should strive to justify greater public and judicial deference both by strengthening the agency’s scientific base and by increasing the authoritativeness of its decisions for juries in tort cases.

In Bendectin, however, well-settled legal principles prevented the court from according any greater deference to the FDA’s finding on the causation question than to an individual’s (or a juror’s) flip of a coin. As I and others have argued elsewhere, it is hard to justify this repudiation of the cultural competence principle, which is rather like permitting English majors to authoritatively answer complex physics problems on which important social consequences turn. If they get it right, it is purely by accident.

The cultural competence norm should be equally decisive in the political and legal cultures. In order to maintain the integrity and patrol the boundaries of the political culture against unwarranted intrusions by law, the courts have adopted certain self-denying principles and stratagems—for example, the political question doctrine and the so-called “passive virtues.” These safeguards, however, are notoriously weak; courts, both “liberal” and “conservative,” commonly breach such boundaries. As for core legal issues, few if any would exist in a purely democratic, majoritarian polity, where all issues

117. See supra note 42.
118. See, e.g., SCHUCK, supra note 30, at 291.
are subject to political resolution. Liberal constitutionalism, however, carves out a significant legal core by placing certain activities, such as speech, beyond the reach of politics, and by barring governmental actions, such as bills of attainder, that lack sufficient generality to control legislative abuse.\footnote{An example is the kind of legislative veto invalidated by the Supreme Court in INS v. Chadha, 462 U.S. 919 (1983). There, Congress exercised the power to reverse a quintessentially legal decision, one that adjudicated the legal rights of a lone individual whose personal liberty was being infringed upon by the government. This is a paradigmatic instance in which our constitutional tradition of due process proscribes politics from invading the adjudicatory function.}

I have noted, however, that the most interesting multi-cultural issues—especially conflicts between science and law—lie not at the core of one culture but near the periphery of several. Here, the problem is not to allocate the issue to one culture and then protect its decisional autonomy and integrity, but rather to ensure that the culture with ultimate decisional authority infuses into its decision process the relevant values of the other cultures. Thoughtful, imaginative scholars have advanced and carefully dissected many interesting proposals for accomplishing this integration with respect to science-law conflicts. Since it would be idle for me to rehearse these proposals, I shall simply group the various approaches.

**Administrative law.** Many of the administrative law innovations since the 1960s have been designed to assimilate diverse cultural values into the decision process of agencies. These include increased rule-making, broadened participation and hearing rights, heightened judicial review, greater access to information and to the decision process, technical advisory groups, and the like.\footnote{See generally Stephen G. Breyer & Richard B. Stewart, Administrative Law and Regulatory Policy: Problems, Text, and Cases (3d ed. 1992). Unfortunately, some of these administrative law innovations have not been successful. See, e.g., Clayton P. Gillette & James E. Krier, Risk, Courts, and Agencies, 138 U. Pa. L. Rev. 1027, 1061-99 (1990) (arguing that proposals to increase the scope of agency authority at the expense of judicial scrutiny are premature); Jerry L. Mashaw, Improving the Environment of Agency Rulemaking: An Essay on Management, Games, and Legal and Political Accountability, Law & Contemp. Probs. (forthcoming 1993).}

**Expert testimony.** Another approach to reform emphasizes the manner in which scientific evidence is not only discovered and prepared, but also presented to and constraining of the trier of fact (usually a jury). Such proposals usually involve some alteration in the form, timing, neutrality, sponsorship, screening, criticism, or review of expert testimony.\footnote{E.g., Gross, supra note 23, at 1208-30; Richard Marcus, Discovery Along the Litigation/Science Interface, 57 Brook. L. Rev. 381 (1991); see E. Donald Elliott, Toward Incentive-Based Procedure: Three Approaches for Regulating Scientific Evidence, 69 B.U. L. Rev. 487 (1989); E. Donald Elliott, The Future of Toxic Torts: Of Chemophobia, Risk as a Compensable Injury, and Hybrid Compensation Systems, 25 Hous. L. Rev. 781 (1988); Huber, supra note 20, ch. 11.} The Supreme Court is now considering (in a Bendectin case) one such proposal: the revival of the
so-called Frye standard for the admission of scientific evidence.\textsuperscript{124} Another proposal, advanced by John Monahan and Laurens Walker under the rubric of "social frameworks," would authorize courts to instruct juries with respect to established social scientific facts that recur from case to case (as in Bendectin), much as they now instruct juries with respect to binding legal principles.\textsuperscript{123}

\textit{Trier of fact.} Other proposals are concerned with the nature and technical qualifications of the entity that determines the facts in court litigation or administrative regulation. They must address the different statuses that expert and lay judgments enjoy in science and in law, differences which make it difficult to agree upon a suitable composition, function, and control mechanism for this entity. Such proposals usually advocate the use of specialized juries, a new allocation of fact-finding duties between judge and jury, or some form of "science court" or other expert tribunal.\textsuperscript{126}

\textit{Positivism.} Another approach encourages scientists and judges to characterize and differentiate their decisions in a way that distinguishes sharply between questions of fact and questions of value. The notion is that by isolating facts and values and explicitly calling decision-makers' attention to this distinction, decisions can be reviewed and legitimated in ways that are democratically and technocratically appropriate to their epistemological nature.\textsuperscript{127}

\textit{Cross-cultural understanding.} The most uncontroversial proposal stresses the importance of greater tolerance and acceptance of the diverse values and perspectives that different cultures bring to the decision process. The notion is that educating scientists, lawyers, and politicians about each other's value systems and modes of thinking will enhance the quality and political acceptability of social decisions. In this spirit, exchange programs bring scientists to Capitol Hill and executive branch agencies, while law students and political science majors are encouraged to enroll in university science and technology studies programs and to participate in interdisciplinary education. Judge Howard Markey of the U.S. Court of Appeals for the Federal Circuit, which

\begin{itemize}
\item \textsuperscript{124} Daubert v. Merrell Dow Pharmaceuticals, Inc., 951 F.2d 1128 (9th Cir. 1991), \textit{cert. granted}, 113 S. Ct. 320 (Oct. 13, 1992) (No. 92-102).
\item \textsuperscript{125} See generally \textsc{John Monahan \& Laurens Walker}, \textit{Social Science in Law: Cases and Materials} ch. 5 (2d ed. 1990).
\item \textsuperscript{126} E.g., James A. Martin, \textit{The Proposed "Science Court,"} 75 \textit{Mich. L. Rev.} 1058 (1977); Stephen Sugarman, \textit{The Need to Reform Personal Injury Law: Leaving Scientific Disputes to Scientists}, 248 \textit{Science} 823 (1990); Cooper, supra note 79; Milton R. Wessel, \textit{Science, Technology and the Law in America: A Plea for Credibility in Dispute Resolution}, 22 \textit{Jurimetrics J.} 245 (1981); see also Schuck, supra note 93.
\end{itemize}
handles patent, copyright, trademark, and other technical issues, is a typical advocate of this strategy: "We need to think long and hard," he writes, "about the future of a society as technologically oriented and as law-soaked as ours when our scientists and lawyers cannot even talk to each other." 128

These approaches to managing multi-cultural issues all have the attractive features emphasized by their proponents. Each, however, is also problematic in important respects. While many of the ideas about opening up the administrative process to diverse interests have already been instituted, they have not been notably successful. 129 Most expert testimony reforms threaten the deeply embedded (though highly contestable) norms of the adversary system of proof. Attempts to transform the trier-of-fact are likely to be political non-starters. This is especially true of efforts to alter the jury, one of our legal system's sacred cows, in the name of expertise, one of our political system's bete-noirs. 130 Positivist reforms rest upon a fact-value distinction that is both controversial in principle and often objectionable in practice. A rigid, categorical positivism is especially vulnerable when applied to policy approaches like risk regulation, whose social authority rests heavily on political forms of legitimation. 131 Even cross-cultural understanding, an obviously desirable goal, risks sensitizing us to underlying normative differences without doing much to resolve them. Indeed, emphasizing a culture's own distinctiveness may actually reinforce its chauvinistic impulses and intensify cultural conflict. My earlier analogy to heightened ethnic consciousness is hardly reassuring in this regard.

Moreover, each of these remedial approaches (save the last) would collide at the most fundamental level with certain structural, constitutional, and normative features of our public law system. Competing governmental organs institutionalize the three cultures in different degrees. Technocratic expertise, the paradigmatic scientific value, is primarily the domain of executive branch agencies, although Congress has sought greater technical parity in recent years. 132 Principled decision making is both a judicial and bureaucratic

128. Markey, supra note 100, at 18; see also Leon Rosenberg & Guido Calabresi, Law and Medicine, 32 Yale L. Rep. 12 (1986) (dialogue between medical school and law school deans about effects of malpractice litigation). Stephen Goldberg's proposal for "science counselors," who would help scientists to be more sensitive to the social implications of their research and its applications, is a variant of this approach. Goldberg, supra note 49, at 1379-87.
129. See supra note 121.
130. See, e.g., Schuck, supra note 93.
131. These observations are not inconsistent, I think, with the kind of pragmatic, positivistic reforms that I recommend below. See supra text accompanying notes 114-16.
132. There has been a rapid growth of congressional staff agencies. Michael J. Malbin, Unlected Representatives 4, 9-24 (1980) (four congressional support agencies: Library of Congress, General Accounting Office, Office of Technology Assessment, and the Congressional Budget Office increased significantly in both size and importance between 1945 and 1980); Norman J. Ornstein et al., Vital Statistics on Congress 1989-1990 xv, 127, tables 5-1 & 5-8 (after explosive growth in the 1970s, size of congressional staffs has stabilized in recent years). In February 1991, the Carnegie Commission on Science, Technology and Congress released a report recommending ways to improve the means by which
virtue. But because this value is threatened in bureaucracies, it is ultimately enforced in the courts, where it can operate under less cultural stress. Participation and accountability, preeminent political values, are primarily the province of Congress and the executive agencies. Still, some courts have tried to secure them through a variety of substantive and procedural public law doctrines.133

**Bridging institutions.** If the chasms that separate the cultures are structural as well as normative and political, we must try to design new institutions capable of bridging them. These institutions should expose each culture's own blind spots, broaden its relevant knowledge base, and augment its modalities of proof. They should acknowledge, and then seek to undermine, the smug certitudes and parochialism that afflict all cultures: national, ethnic, or professional.

Science bureaucrats, for example, can experiment with new ways to incorporate political valuation techniques into ostensibly and inertially technocratic agency choices. Former EPA administrator William Ruckelshaus attempted this when he allowed industrial communities to vote on tradeoffs of economic and environmental values before setting pollution standards.134 Judges and lawyers should devise evidentiary procedures—putting expert testimony in written form, for example135—that will make scientists more comfortable in the hearing room or court rather than causing the best of them to shun public forums. Courts should also adopt procedures better suited to gathering and analyzing political and scientific information bearing on the consequences and implementation costs of their far-reaching decisions.136 Politicians should organize policy-making structures in order to achieve better mixes of empirical validity, legal legitimacy, and political accountability. Elected officials, for example, can provide technocratic regulators with more specific decision criteria that formulate questions that science can actually answer—questions, for example, about the number of life-years saved; the

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135. See sources cited supra note 123.

136. For a discussion of one such approach, see PETER H. SCHUCK, *SUING GOVERNMENT: CITIZEN REMEDIES FOR OFFICIAL WRONGS* 188-89 (1983) (deed implementation analysis).
number and severity of injuries avoided per dollar spent or job lost; and regulatory risks in comparison to risks currently accepted by the public, as revealed in their everyday choices. Such an approach not only should improve the means-ends rationality of policy decisions but should also strengthen political control and accountability of those decisions.

These proposals are of course modest. But managing multi-cultural issues near the peripheries has proved so difficult that considerable humility by reformers is warranted. Only culturally eclectic reforms have a reasonable chance of gaining the necessary political support; monocultural ones are likely to fail. Some proposals that I have mentioned—increasing the use of written testimony on direct examination to improve both the accuracy and intelligibility of scientific evidence, for example—promise to strengthen scientific and legal values without sacrificing political ones, a kind of Pareto-superior move. On the other hand, most of them—including the more fundamental changes like greater use of court-appointed experts or eliminating juries—may succeed in advancing the values of one (or two) of the cultures only by appearing to subordinate the values of the other(s), which is more problematic.

But even the most controversial reforms may be propelled forward by the cyclical changes in the culture that move beneath the surface of normal politics. The most important turn of this meta-cultural cycle, of course, occurred during the New Deal when the cultures of science and bureaucratic politics waxed at the expense of the more traditional judicial-legal culture. Then, a growing faith in technocratic expertise converged with (and itself encouraged) fundamental institutional reforms that supplanted much common law adjudication and common law thinking with a system of policy-oriented, technocratic, and electorally-sensitive administration.

The relative autonomy of this “public science,” however, did not survive the convulsions of the 1960s. A more highly politicized, legalistic society, one increasingly suspicious of the neutrality and benignity of a science allied with power, insisted on new political and legal controls on technocratic decision making in public agencies and in private laboratories affected with a public interest. Whether or not these controls have proved effective is a surpassingly

137. For recommendations along these lines, see ACKERMAN & HASSLER, supra note 83; Albert L. Nichols & Richard Zeckhauser, OSHA After a Decade: A Time for Reason, in CASE STUDIES IN REGULATION: REVOLUTION AND REFORM 203 (1981); Sidney A. Shapiro & Thomas O. McGarity, Reorienting OSHA: Regulatory Alternatives and Legislative Reform, 6 YALE J. ON REG. 1, 37 (1989) (calling for the increased use of performance standards). A very limited move in this direction has been taken by the U.S. Senate when it passed the Government Performance and Results Act, which is pending in the House.

138. See, e.g., Gross, supra note 23, at 1215-18. The pending proposed Federal Rule of Civil Procedure 26(a)(2)(B) will, if adopted (which appears probable) require a written report by an expert whom a party expects to testify. FED. R. CIV. P. 26(a)(2)(B) (submitted by the Judicial Conference to the Supreme Court, Nov. 27, 1992) (copy on file with author). Neither the proposed rule nor the commentary on it mentions the question of this report's admissibility. Id. commentary at 99-101.

139. See Gross, supra note 23, at 1208-32.
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important social question, but it is beside the present point about cultural cycles: the time for a triumphant, hegemonic culture of public science came and then went.

IV. CONCLUSION

Conceivably, we are on the verge of another tectonic cultural change. If the themes of the 1992 presidential campaign are any guide, the American public has become both skeptical about much judicial and political regulation and optimistic about the potential social gains from market-driven, scientific and technological innovation. Perhaps this bespeaks a new zeitgeist that will once again exalt and institutionalize scientific values in public policymaking. Perhaps unified Democratic Party control over the political branches (and in time possibly the courts) will allay suspicions, which flourished during the era of divided government in the 1970s and 1980s, that scientific values serve as little more than pretexts and camouflage for the pursuit of narrow partisan, bureaucratic, or ideological advantage.140

But even if the time is propitious for this new consensus, it is safe to predict that science will never enjoy the degree of autonomy that its remarkable achievements, tantalizing promise, and methodological self-discipline141 might seem to have earned for it. If past is prologue, law and politics will continue to rein in even a resurgent science despite the innovation costs, lost opportunities, and policy errors that crude controls often entail. Science will have to make its case at the bars of public opinion and administrative law as well as in the laboratory and the market for technology.

The public forum, however, is precisely where law and politics enjoy the greatest tactical advantage; it is here that their cultural values, so often incompatible with scientific canons, tend to prevail. They alone possess the extra-

140. Although much has been made of the corrosive effects of divided government, e.g., James Sundquist, Needed: A Political Theory for the New Era of Coalition Government in the U.S., 103 POL. SCI. Q. 613 (1988), the truth of the matter is far more complex, as seen in the first few weeks of the Clinton administration, during which conflicts erupted between the new Democratic President and the Democratic chairmen of the Senate Judiciary, Armed Services, and Finance committees. See Ruth Marcus & David S. Broder, President Takes Blame for Rushing Baird Selection; Clinton Says He Knew of Problem Before Nomination, WASH. POST, Jan. 23, 1993, at A1 (Biden and Clinton clash over Baird nomination); Michael Wines, The Gay Troop Issue: This Time, Nunn Tests A Democrat, N.Y. TIMES, Jan. 30, 1993, at 1 (Nunn and Clinton disagree on the issue of admitting homosexuals into the military); Mary McGrory, Confirmation Shalalacking, WASH. POST, Jan. 17, 1993, at C1 (Moynihan criticizes Clinton-nominee Shalala's lack of emphasis on Social Security and welfare reform at her confirmation hearings); see also DAVID R. MAYHEW, DIVIDED WE GOVERN: PARTY CONTROL, LAWMAKING, AND INVESTIGATIONS, 1946-1990 (1991) (noting that the incidence of major legislation and investigations is unaffected by divided government); Martin Shapiro, APA: Past, Present, Future, 72 VA. L. REV. 447 (1986) (finding that divided government affects theories of the proper relationship among branches).

141. These scruples are neither universal nor always availing, as the incidence of scientific fraud demonstrates. See, e.g., Marcus, supra note 123, at 388-90.
ordinary powers to conclusively choose, coerce, and legitimate social action. Unfortunately, power, knowledge, and wisdom seldom coincide in the real world. Law and politics, like science, offer partial, biased, and distorted solutions to multi-cultural issues. Nevertheless, the values to which politics and law appeal—legal principle, public tradition and symbolism, populist ideology, and democratic consent—will increasingly carry the day, subordinating scientific rigor and independent inquiry to demands for political relevance and public control.

In the epigraph to this article, Karl Menninger asserts that scientists find the word “justice” irrelevant to most of their work. To many lawyers and politicians, however, the notion of objective scientific truth is a parochial conceit, sometimes useful to one’s client or cause but otherwise not to be taken too seriously. From these mutual suspicions, valuable lessons may be drawn. Scientists must remember that it is lawyers and politicians who formulate the public rules for our complex society. Lawyers must remember that the project of science demands, and generally deserves, a kind of freedom to which legal controls will often be inimical. Politicians must remember that science, which has become the motor of this social progress, is to some irreducible degree an elite enterprise that cannot flourish under the incubus of a militant populism. Ordinary citizens must remember that the ideals of scientific advance, fair process, and democratic legitimacy are all precious and indispensable, and must hope that this multi-cultural competition can somehow unite them.

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142. Indeed, the additional myopia engendered by their ultimate decisional power may magnify the deficiencies of legal and political solutions.

143. For a recent decidedly negative view of this development, see Bryan Appleyard, Understanding the Present: Science and the Soul of Modern Man (1992).