LAW AND ENGINEERING: IN SEARCH OF THE LAW-SCIENCE PROBLEM

JERRY L. MASHAW*

I
INTRODUCTION

Law is not unitary. Neither is science. Law pursues a host of divergent purposes: facilitating welfare-enhancing transactions, corrective justice (compensation for harms), preventing injury and disease, punishing crime, protecting our natural and cultural heritage, coordinating collective action, and promoting useful work in the arts and sciences. Law's multiple purposes are developed and pursued in different institutional domains: by courts, legislatures, administrative agencies, and private actors. Even when their purposes are similar, lawmakers in these different categories employ radically diverging processes. Given law's multiple purposes, domains, and processes, could the "law-science problem" possibly be a general one?

Scientific activity is similarly fragmented. Scientists are separated by their interests and techniques—theoretical, experimental, or applied. Scientists organize themselves into different disciplines—physics, biology, psychology, botany, chemistry, and so on. Science, like law, is pursued in differing fora: universities, free-standing institutes, commercial enterprises, and professional consulting firms. Much science is pursued independently of the interests of lawyers and legal institutions, but some is forensic in its basic orientation. The problems for the field have been set by the law's demands for peculiar sorts of knowledge. Could the problems of integrating science and scientists into law and legal processes possibly be the same across all these distinct scientific activities and interests?

When framed this way, the answers to these two questions seem obviously to be "no." Progress toward understanding and managing the law-science problem seems to require disaggregating the questions. If we look carefully at what kind of "science" and what kind of "law," then perhaps we can get some analytic leverage. If we cut the general problem into little pieces, we can at least ask more precisely what is problematic at which particular law-science interface. Lawyers and scientists have at least this much in common: Both har-

This Article is also available at http://www.law.duke.edu/journals/66LCPMashaw.
* Sterling Professor of Law, Yale Law School.
My heartfelt thanks to Elbert Lin, engineer, law student, and research assistant, for his outstanding assistance with this Article.

bor the intellectual conceit that a well-defined problem is not only a necessary, but almost a sufficient, condition for a successful solution.

The purpose of this Article, therefore, is to look at a particular applied science, engineering, in a particular context, health and safety regulation. Indeed, I will look at the law-science interface in the context of an agency that I have studied before, the National Highway Traffic Safety Administration ("NHTSA").[1] My beginning intuition is that engineers, as applied scientists, operate differently and have a different mindset than do theoretical or experimental scientists, and my initial hypothesis is that a regulatory process highly dependent on engineers and engineering data will generate different law-science interactions and problems than those encountered by Congress when assessing models of climate change, or by a court looking at DNA evidence, or even by the Food and Drug Administration ("FDA") when grappling with biological and chemical data. The ambition is to demonstrate that a disaggregated approach can yield progress. One agency dealing with one scientific community might not be able to solve all of its law-science problems, but it should be able to manage them successfully. If it cannot, why not?

II

ENGINEERS AND ENGINEERING

A. Why Engineers?

The choice to rethink the law-science problem in the context of NHTSA in some sense dictates a focus on engineers and engineering. Making cars safer is an engineering problem, as is the design and construction of roadways. In June 2001, NHTSA employed 120 engineers.[2] It employed only six other scientists of any type. Engineering is not everything, of course. Drivers still matter. But it was precisely the purpose of the Motor Vehicle Safety Act of 1966 to move beyond the law's historic focus on regulating drivers—a technique that many viewed as a failed strategy—to regulate the motor vehicle itself.

Some other health and safety agencies are similarly focused on engineers and engineering. The Occupational Safety and Health Administration ("OSHA") employs more than twice as many engineers as any other type of scientist. The Coast Guard, with a jurisdiction over water craft that parallels NHTSA's jurisdiction over motor vehicles, employs 317 engineers but only twenty-two other scientific types. The National Transportation Safety Board has seven-and-a-half times as many engineers as other scientists. The Nuclear Regulatory Commission employs 1195 engineers and only 155 other scientists.

1. *See generally* JERRY L. MASHAW & DAVID L. HARFST, THE STRUGGLE FOR AUTO SAFETY (1990).

2. The data on engineering and scientific employment in federal agencies here and elsewhere has been compiled from June 2001 employment information posted on a website run by the United States Office of Personnel Management. *See* Office of Personnel Management, Fedscope, *at* http://www.fedscope.opm.gov/employment.htm (last visited Apr. 11, 2003).

Even at the Environmental Protection Agency, engineers make up more than one-third of its large, in-house scientific community.

Although engineers are obviously important in the health and safety regulatory field, there are substantial variations as well. The FDA has ten times as many biologists and physical scientists as engineers. The Fish and Wildlife Service has more than 2700 scientists, most of them biologists, compared with only eighty-two engineers. The Department of Agriculture's Natural Resources Conservation Service has about 6000 biologists teamed with only 760 engineering personnel. At the Centers for Disease Control, biologists and physical scientists outnumber engineers 866 to 206.

These basic data about the employment of scientific personnel in federal regulatory agencies suggest at least two things. First, a focus on engineers and their relationship with law and lawyers at NHTSA may not be as narrow a definition of the law-science problem as it first appears. Experience there might be applicable to a host of other health and safety agencies, both those previously mentioned and agencies like the Federal Aviation Administration, where engineers number 2791 and represent approximately 98% of that agency's scientific community. Second, the variation across agencies potentially makes engineering a special problem. If for some reason, or reasons, engineers are not like biologists or physical scientists, the law-science problem in health and safety regulatory agencies remains multidimensional. Even in agencies with similar tasks, the law-science problem may not be reducible to a law-engineering problem.

B. Are Engineers Different?

The law-science literature is voluminous. It is also heterogeneous, but it is seldom congratulatory or optimistic concerning the law-science interface.[3] I will briefly characterize the broad contours of the law-science debate. I then turn to the issue of whether engineers as scientists and engineering data as scientific data might have characteristics that distinguish them from the usual suspects who have repeatedly been identified as the causes of our failure to bridge the law-science divide successfully.

One general strand of the literature sees some basic differences between science and the law that make their cooperation in the design of good laws and good public policy inherently problematic.[4] Science, it has been suggested,

3. Law-science literature is thick on the shelves. For general treatments, see DAVID L. FAIGMAN, LEGAL ALCHEMY: THE USE AND MISUSE OF SCIENCE IN THE LAW (1999), and STEVEN GOLDBERG, CULTURE CLASH: LAW AND SCIENCE IN AMERICA (1994). On science and administrative law, see, for example, SHEILA JASANOFF, THE FIFTH BRANCH: SCIENCE ADVISERS AS POLICYMAKERS (1990), and BRUCE L.R. SMITH, THE ADVISERS: SCIENTISTS IN THE POLICY PROCESS (1992). On science in the courts, see, for example, PETER W. HUBER, GALILEO'S REVENGE: JUNK SCIENCE IN THE COURTROOM (1991), and SHEILA JASANOFF, SCIENCE AT THE BAR: LAW, SCIENCE, AND TECHNOLOGY IN AMERICA (1995).

4. This is the basic position taken by Goldberg. *See* GOLDBERG, *supra* note 3. This notion permeates much of the law-science literature.

favors progress. It focuses on substantive issues and their resolutions. In the end, scientists are committed to the idea that the scientific enterprise will yield the truth of the matter. Law, by contrast, is fixated on process. It often views "the fact of the matter" as inherently uncertain. Legal institutions are thus designed to manage uncertainty and resolve value conflicts for which there is no "right answer."

Science is also said to seek knowledge for its own sake. The scientist asks not "What will this be good for?" but "What is the next step in pushing back the frontiers of knowledge?" Law is more programmatically oriented toward the solution of individual disputes or social problems.[5] To do its job, law must understand what is certain and manage what is uncertain.[6] Once the policy or dispute-resolution issues are concluded, the law has no further interest in science—good, bad, or otherwise.

These different orientations produce a timing problem. Scientists may be impatient, but they are content to operate step-by-step. Their agenda is set by the current state of theory and data. "We don't know yet" is not an admission of failure; it merely defines a research agenda. Legal institutions need to decide cases now and make policy soon. The failure of scientists to agree about an issue relevant to some policy domain, or even to have taken the issue seriously, is seen as a big problem, often as a failure.[7]

Given these differing orientations it is not surprising that many commentators suggest simply that lawyers do not, perhaps cannot, understand scientists and vice versa. This misunderstanding is not only an artifact of role differentiation. Many suggest that those who end up in law school are those whose early education suggested that they were not whizzes at mathematics or science. The number of lawyers with hard science backgrounds is very small indeed. It has even been suggested that lawyers and scientists have distinct personality traits. The famous Myers-Briggs personality test will type them differently, and that typing represents a radically different set of orientations toward how knowledge is gained and why it has value.[8]

From one perspective, then, lawyers and scientists look at one another across a vast intellectual divide. Not only are their purposes different in pursu-

---

5. *See, e.g.*, Steven Goldberg, *The Reluctant Embrace: Law and Science in America*, 75 GEO. L.J. 1341, 1341-52 (1987) (discussing the differing values of scientists and lawyers); Nancy Levit, *Listening to Tribal Legends: An Essay on Law and the Scientific Method*, 58 FORDHAM L. REV. 263, 264-65 (1989) (critiquing the traditional absence of scientific methodology in the making of law).

6. *See, e.g.*, Harold P. Green, *The Law-Science Interface in Public-Policy Decisionmaking*, 51 OHIO ST. L.J. 375, 391-92 (1990). This divide between law and science is apparent, for instance, in the legislation of environmental policy. For discussions on how scientists and lawmakers differ in their approach to the environment, see Nicholas A. Robinson, *Legal Systems, Decisionmaking, and the Science of Earth's Systems: Procedural Missing Links*, 27 ECOLOGY L.Q. 1077 (2001); and Wendy E. Wagner, *Congress, Science, and Environmental Policy*, 1999 U. ILL. L. REV. 181 (1999).

7. *See, e.g.*, FAIGMAN, *supra* note 3, at 51-53 (explaining how "the most basic difference between law and science involves their very dissimilar schedules for decision-making").

8. Some basic data on psychological typing across a range of fields is contained in Mary H. McCaulley, *Psychological Types in Engineering: Implications for Teaching*, 66 ENGINEERING EDUC. 729 (1976).

ing basic facts, but their educations and personalities will not lead them to read the same magazines or join the same clubs or discussion groups. Lawyers and scientists are exemplars of C. P. Snow's famous argument that, at least since the scientific revolution of the eighteenth century, the world has divided itself into two distinctive and mutually mystifying cultures.

A second set of complaints might be categorized as arguing that legal institutions are generally poorly designed to receive, understand, and use scientific knowledge. The "junk science" debate, revolving importantly around how courts receive and test scientific evidence, has raged for decades.[9] This institutional mismatch complaint is echoed by those who argue that generalist courts are incapable of reviewing the output of technically specialized and scientifically oriented administrative agencies.[10]

Commentators do not necessarily believe that administrative agencies are on the side of good science, either. Critics view agencies' mission orientations as the enemies of good science. For some agencies, scientific data and conclusions are claimed to be mostly a charade, a mask for policy decisions made on other grounds.[11] Others decry the capacity of scientific uncertainty to disable necessary policy choice. Attempts to bring agency and scientific processes into closer alignment, such as agency efforts to mimic scientific peer-review processes, may merely ossify the administrative process.[12]

Others see science as hardly penetrating significant public policymaking because agencies (and certainly legislatures) have much too little "in-house" scientific talent.[13] In short, all legal institutions are accused of making bad law from uncertain science in virtually every way that can be accomplished, by taking the uncertain to be certain, as well as by using irreducible uncertainty to defeat the utilization of available scientific knowledge. Moreover, bad policymaking may be self-replicating; it biases scientific research in less-than-useful directions.[14] As a consequence, agencies may ultimately have the knowledge base upon which to construct coherent, but not particularly good, policies.

At a most basic level, those who have analyzed the law-science interface divide into two camps: (1) those who see it as an almost unbridgeable intellectual chasm and (2) those who believe that even if the chasm can be bridged,

---

9. *E.g.*, HUBER, *supra* note 3; Gary Edmond & David Mercer, *Trashing "Junk Science,"* 1998 STAN. TECH. L. REV. 1, 1 (1998); D. Hiep Truong, Daubert *and Judicial Review: How Does an Administrative Agency Distinguish Valid Science from Junk Science?*, 33 AKRON L. REV. 365, 370-72 (2000).

10. Sheila Jasanoff & Dorothy Nelkin, *Science, Technology, and the Limits of Judicial Competence*, *in* SCIENCE AND LAW: AN ESSENTIAL ALLIANCE 16 (William A. Thomas ed. 1983).

11. *E.g.*, Wendy E. Wagner, *The Science Charade in Toxic Risk Regulation*, 95 COLUM. L. REV. 1613, 1617 (1995) (discussing a "'science charade,' in which agencies exaggerate the contributions made by science in setting toxic standards to avoid accountability for the underlying policy decisions").

12. Thomas O. McGarity, *Some Thoughts on "Deossifying" the Rulemaking Process*, 41 DUKE L.J. 1385, 1407-10 (1992) (examining both the evidence and causes of an ossified rulemaking process and noting scientific review as one of the causes).

13. *See, e.g.*, Wagner, *supra* note 6, at 193-95 (listing the fact that few policymakers have scientific expertise as one of the significant reasons why lawmakers fail to understand the limits of science).

14. *See* Goldberg, *supra* note 5, at 1379-88 (predicting that scientists will play the system and sacrifice pure science to get more freedom and control over their research).

legal institutions have repeatedly demonstrated their incapacities to create structures that give us much confidence in getting from one side of the gorge to the other.

The question is whether these sorts of concerns provide an apt description of the law-engineering interface, whatever their validity with respect to other law-science interactions. There are a priori reasons to be somewhat more sanguine about law-engineering communication, particularly as that communication exists within administrative regulatory agencies. Both the nature of engineering and the regulatory process might justify *ex ante* optimism about legal-scientific collaboration where the lawyers are regulators and the scientists are engineers. Engineers, after all, are applied scientists. This is not to say that they have no theory, or that they fail to engage in experimentation, but engineers largely do not pursue knowledge for its own sake. They seek to solve problems. To say that someone has come up with a good engineering solution but that its application to any real world problem is as yet unknown is a nonsequitur.[15]

If the regulatory policy process sets problems for engineers and demands technological solutions, it is not engaging in some sort of cultural faux pas. Solving practical problems is what engineers do. Moreover, engineers are not oriented toward the discovery of error-free truth. The idea is to design something that is good enough to get the job done within the material or economic constraints that surround the problem. To this degree, engineers think much like lawyers, who are often described as "social engineers" or "transactional engineers." The intellectual divide between a regulatory lawyer and an engineer is not nearly so obvious as between a regulatory lawyer and a physicist. In addition, engineers are not "ivory tower" types. Most engineers are not academics or the worker bees of research institutes doing basic science. Few engineers operate outside of commercial firms or government bureaus.[16] They are accustomed to playing on a team whose goal is not to push back the boundaries of engineering science but to accomplish the commercial or regulatory mission of the firm or agency to which they are attached. Unlike basic scientists, engineers migrate easily to managerial posts and judge their success by how well the firm or agency is doing, not by how much progress the engineering profession is making.[17] Indeed, some sociologists of the professions note that engineering is a

15. *See* Kenneth O. Alexander, *Scientists, Engineers and the Organization of Work*, 40 AM. J. ECON. & SOC. 51, 53 (1981) (contrasting scientists, who are interested in "engaging in basic research [not] applied research[,]" with engineers); Alvin Rudoff & Dorothy Lucken, *The Engineer and His Work: A Sociological Perspective*, 172 SCIENCE 1103, 1108 (1971) ("[Engineering] is presented as at the vanguard of progress, the savior and builder of the nation, a haven for the brilliant and the creative.").

16. The organizational location of engineering yields, however, the usual conflicts between professional orientation and organizational imperatives. Alexander, *supra* note 15; F.E. Udwadia, *Management Situations and the Engineering Mindset*, 29 TECHNOLOGICAL FORECASTING & SOC. CHANGE 387, 395-96 (1986).

17. *See* Alexander, *supra* note 15, at 53 ("The engineer is relatively more concerned with contributing to the goals of the work institution [and] with gaining recognition from hierarchical superiors."); Lotte Bailyn & John T. Lynch, *Engineering as a Life-Long Career: Its Meaning, Its Satisfactions, Its Difficulties*, 4 J. OCCUPATIONAL BEHAV. 263, 264 (1983) ("Engineering is also not an occupational com-

subordinated profession that lacks both internal autonomy and a unified cognitive basis.[18]

If these claims are generally true about engineers, then they should not only narrow the divide that separates engineers and lawyers, but they should go some way toward solving the organizational problems of integrating engineering knowledge into regulatory policy. Engineers are not organizational outsiders pursuing their own interests rather than the agency's agenda. Additionally, their preponderance in a substantial number of health and safety regulatory agencies would suggest that those agencies' in-house scientific staffs are pursuing policy-relevant data, not some scientific frolic and detour of their own. Their "good enough to get the job done" mentality should reduce the tendency for scientific uncertainty to derail regulatory action. Perhaps most importantly, there is a convergence between the things that give engineers reputation and status and those that provide legal and political legitimacy for regulatory bureaucracies. Both succeed in some significant sense by keeping the Weberian promise to exercise power on the basis of knowledge.

There is, therefore, some reason to believe that the partnership of law and science, when redefined as a partnership between law and engineering, might avoid many of the pitfalls that the law-science literature instructs us are endemic to that often-troubled relationship. Is this optimism justified? I will prospect for evidence by mining the experience of NHTSA.

III

THE CASE OF THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

A. NHTSA from Inception to 1990

In 1990, when David Harfst and I published *The Struggle for Auto Safety*,[19] we did not conceive of the book as a study of the law-science interface. We used the National Highway Traffic Safety Administration ("NHTSA" or "the agency"), instead, as a microcosm of the health and safety regulatory process. The story as we conceived and told it was a tale of the confrontation between an ambitious, public-health-oriented, regulatory process and the legal and political culture within which it had to operate. Yet, in many ways, *Struggle* is a story of law and engineering. Looking back on the agency's performance from its inception in 1966 to the end of the 1980s, it is a story redolent with all the pathologies that the law-science literature leads us to expect.

---

munity, a collegial form of work association in which members 'claim a distinctive and valued social identity, share a common perspective toward the mission and practices of the occupation, and take part in a sort of interactive fellowship that transcends the workplace.'") (citation omitted); *cf.* Howard P. Segal, *The Third Culture: C.P. Snow Revisited*, IEEE TECH. & SOC'Y MAG., Summer 1996, at 29 (discussing engineers' allegiance to and reliance on corporations).

18. MAGALI S. LARSON, THE RISE OF PROFESSIONALISM: A SOCIOLOGICAL ANALYSIS 25-31 (1977).

19. MASHAW & HARFST, *supra* note 1.

The awkward fit between scientific knowledge and political ambition at the legislative level is much in evidence. With visions of NASA's recent successes dancing in their heads, senators and representatives voted virtually without dissent for a statute empowering the agency to force the technology of automobile safety.[20] The mandate of NHTSA was not to design automobiles; rather, it was to issue performance standards for their behavior. Congress's delegation of authority was breathtakingly broad. NHTSA was told simply to "meet the need for automobile safety" constrained only by the demand that its rules be "reasonable," be "stated in objective terms," and be "appropriate" to the type of vehicle to which the standards applied.[21] The political Zeitgeist within Congress was the legislative equivalent of a nation on Prozac: If engineers could put a man on the moon, making American vehicles safe should be child's play.

As is all too common in safety and health regulatory statutes, Congress seems to have assumed that the data necessary to answer technological questions was readily available. Congress gave the agency no power to force automobile manufacturers to generate the data it needed, nor did it fund NHTSA's research facility for nearly a decade. The funding thereafter was scant.

As the agency discovered, the roads to some of its simplest regulatory standards were cratered with potholes in scientific knowledge. A braking standard, for example, foundered for years on lack of information concerning the frictional qualities of both automobile tires and road surfaces.[22] It is easy enough to specify that an automobile have brakes that will bring it from a certain speed to a full stop within a specified number of yards. For such a standard to be "objective," however, the agency must answer the questions "rolling on what?" and "traveling on what surface?" Developing friction coefficients for tires and road surfaces turned out to be an arduous task, and this was a relatively easy problem.

Congress was not only guilty of imagining a scientific world in which answers are easy and discovered without cost. Scientifically sound approaches turned out to be politically unacceptable, and politically necessary approaches were, scientifically, quite silly. Getting people to wear their seatbelts with an ignition interlock device was, as an engineering matter, straightforward and, as a production matter, incredibly cheap. Before it could reliably be determined whether the American public would become habituated to and accept the ignition interlock, however, Congress passed legislation repealing the agency's rule and attaching a legislative veto provision to any further attempts to impose mandatory or passive restraints that might protect both drivers and passengers

20. The National Traffic and Motor Vehicle Safety Act of 1966, Pub. L. No. 89-563, 80 Stat. 718 (1966) (current version codified at 49 U.S.C. §§ 30,101-70 (2000)), passed the House 371 to 0 and the Senate 76 to 0. 112 CONG. REC. H19669 (1966) (House of Representatives vote); 112 CONG. REC. S14256 (1966) (Senate vote).

21. Motor Vehicle Safety Act § 103, 80 Stat. at 719 (current version at 49 U.S.C. § 30,111).

22. Paccar, Inc. v. NHTSA., 573 F.2d 632, 636-39 (9th Cir. 1978) (discussing the tortured history of Standard 121); *see also* MASHAW & HARFST, *supra* note 1, at 101-02.

in the event of a crash.[23] Congress, thus, put a political damper on regulations that would carry out the central epidemiological insight that undergirded the whole regulatory regime: the joint recognition that (1) injuries are caused by occupants' collisions with the inside of a vehicle, not vehicles' collisions with each other or something else, and (2) the path to injury and death reduction lay in re-engineering the automobile to respect inherent human limitations, not in changing driver behavior.

Having politically vetoed its own mandate for vehicle safety through safety engineering, Congress, in the same legislation, mandated regulations having no scientific basis and possibly creating new safety hazards in the bargain. Of the 108,641 Americans dying in vehicular accidents in 1972 and 1973, only about 150 were school bus related.[24] Of these 150 fatalities only ninety were school children, and two-thirds of those were killed as pedestrians near, but not in, a school bus.[25] Moreover, at least five of the thirty children killed inside a school bus were killed in one catastrophic accident—being run down by a railroad train.[26] Yet, responding to what it felt was political necessity, Congress required that NHTSA promulgate school bus safety standards that would add tens of millions of dollars to the cost of school buses.[27] These school bus integrity standards were unlikely to have any substantial effect on the safety of America's children unless, of course, the enormously increased cost of school buses caused fiscally strapped school districts to run old, unsafe buses much longer, thereby increasing the probability of accidents and fatalities.

NHTSA's encounters with the legal culture in the form of reviewing courts were, from a scientific-engineering perspective, no less bizarre. Its initial passive restraints rule was overturned as being nonobjective because the anthropomorphic dummy to be used in crash tests for passive restraints had not been completely specified.[28] That the rule would not take effect for three years, and that no one doubted that the engineering work to fully specify the dummy would be completed well in advance of that date, seems to have been lost on a court apparently fixated on the notion that to be "objective" a rule must resolve all uncertainty in one stroke.[29] From the perspective of a practicing engineer who operates empirically—by design, fabrication, testing, and redesign—the

23. Act of Oct. 27, 1974, Pub. L. No. 93-492, 88 Stat. 1470 (1974).

24. MASHAW & HARFST, *supra* note 1, at 142.

25. *Id.*

26. School Transportation News, School Bus Safety, Railroad Grade Crossings, *at* http://www.stnonline.com/stn/schoolbussafety/railroadcrossings/rail_chart1.htm (last visited Apr. 11, 2003) (reporting of one known accident between a railroad train and school bus during 1972 and 1973, in which five children died).

27. These costs were considered in the debate over the 1974 amendments to the Motor Vehicle Safety Act of 1966. *See Amendments to the National Traffic and Motor Vehicle Safety Act of 1966: Hearings on H.R. 7505, H.R. 5529, and S. 355 Before the Subcomm. on Commerce and Finance of the House Comm. on Interstate and Foreign Relations*, 93d Cong. 864 (1973); *see also* MASHAW & HARFST, *supra* note 1, at 142-43 (stepping through the costs of improving buses in accordance to the 1974 amendments).

28. Chrysler Corp. v. Dep't of Transp., 472 F.2d 659 (6th Cir. 1972).

29. *Id.* at 675-78.

court's approach was laughable. That the court's decision set in motion a series of legal and political events that delayed passive restraints regulation for nearly two decades and arguably cost tens of thousands of lives is less of a laughing matter.

Indeed, in the period that we studied prior to the publication of *Struggle*, a substantial number of NHTSA's rules were challenged in court, and the agency lost half of those challenges.[30] The usual reason for such losses was that the agency could not demonstrate that its requirements were reasonable and practicable, because there was no significant "on-the-road" experience with the engineering requirements embodied in the rules. If that is the requirement for legality, however, then the agency is legally impotent to force the development of automotive safety technologies. A statute, apparently designed to put safety on par with style in the engineering of automobiles, had morphed into a statute that only permitted NHTSA to demand the dissemination of off-the-shelf equipment. The automobile industry could be required to improve its engineering performance only to the extent that some firm had already paved the way by demonstrating reasonableness and practicability through inclusion of new safety features in its own cars. The judiciary implicitly reinterpreted the statute as a civil rights regime. All Americans would be entitled to equal protection, that is, to the same safety engineering pioneered by Cadillac, Mercedes, and Volvo.

Meanwhile, the courts took a radically different approach to the agency's demands that automakers recall a vehicle that contained some "defect related to motor vehicle safety."[31] Whether recalling torsion bars on nine-year-old Cadillacs that could only break at speeds below three miles per hour[32] or protecting Ford drivers from windshield wipers that might fly off once every million miles traveled,[33] the agency's recall efforts were always blessed by the courts in which they were challenged. In addition, Congress happily funded the agency's recall efforts,[34] a political posture strongly supported by the ever-potent trial lawyers lobby. Sadly, for reasons too complicated to go into here, there is essentially no evidence that the mandated recalls contribute anything to motor vehicle safety.[35]

---

30. NHTSA lost in six of the twelve rulemaking cases that were decided on the merits. Jerry L. Mashaw & David L. Harfst, *Regulation and Legal Culture: The Case of Motor Vehicle Safety*, 4 YALE J. ON REG. 257, 273 n.38 (1987) (listing the twelve rulemaking cases).

31. Motor Vehicle Safety Act § 110(a), 15 U.S.C. § 1399(a) (1970) (current version codified at 49 U.S.C. § 30,118 (2000)).

32. *See* United States v. Gen. Motors Co., 561 F.2d 923 (D.C. Cir. 1977) (upholding recall of pitman arms).

33. *See* United States v. Ford Motor Co., 453 F. Supp. 1240 (D.D.C. 1978) (upholding recall of Ford windshield wipers).

34. *See* MASHAW & HARFST, *supra* note 1, at 164 (discussing how "congressional support and a green light from the courts produced an orgy of recall activity in the latter half of the 1970s"); *see also, e.g.*, U.S. OFFICE OF MGT. & BUDGET, BUDGET OF THE UNITED STATES GOVERNMENT app. (1970) (indicating a spike in congressional support of NHTSA in the 1970s, the heyday of recalls).

35. *See* MASHAW & HARFST, *supra* note 1, at 11, 167-71 (making this argument in detail).

With its rulemaking activity bludgeoned both by lawmakers and judges and its recall efforts applauded by everyone, by 1990 NHTSA had turned into an agency dominated by lawyers and awash in the "investigate and punish" regulatory culture that the Motor Vehicle Safety Act of 1966[36] was designed to suppress. With the one notable exception of the eventual promulgation of the passive restraints rule,[37] NHTSA had by the late 1980s gone out of the technology forcing business, which had been the unique province of its engineering staff. Indeed, it had virtually gone out of the rulemaking business.

While *Struggle* tells this as a story of agency response to a dominant legal-political culture, the agency's scientific culture was not entirely blameless. Even before the courts and Congress waded into the regulatory fray, the agency's first administrator, William Haddon, the man whose scientific work had virtually defined the agency's principal mission, had created an internal culture of caution and scientific exactitude. Lacking conclusive data on the average size of American drivers, NHTSA's first regulation on the accessibility of automobile pedals and dashboard controls merely required that they be within the reach of "a person."[38] Furthermore, in the absence of comprehensive data on the stickiness of various sorts of tires and all road surfaces then in use, the first braking standard simply required that cars have a braking system that would stop the car. As Haddon's exasperated deputy administrator testified before Congress when resigning from the agency, Wilt Chamberlain is "a person" and a car will stop without any brakes once it runs out of gas.[39]

In short, *Struggle* depicts a classic tale of law-science disaster involving NHTSA. Institutional ignorance, cross-cultural misunderstanding, willful disregard of the facts, scientific preciosity, and virtually any other pathology identified in the law-science literature was present. Presumably agencies, even courts and legislatures, can learn, however. Judicial conservatism might be overcome as the regulatory process becomes familiar. Demonstrable results can create a respect for facts and the engineering personnel who develop and test them. What has the last decade wrought at NHTSA?

B. NHTSA from 1990 to the Present

This is hardly the place to write another monograph about automobile safety regulation. But, perhaps we can explore the law-science or law-engineering interface at NHTSA through the medium of three questions that seem crucially related to NHTSA's potential for success as a safety regulatory agency. First, has the judiciary become more accepting of the realities of engineering methodology, the need to proceed incrementally without necessarily having

36. National Traffic and Motor Vehicle Safety Act of 1966, Pub. L. No. 89-563, 80 Stat. 718 (1966) (current version codified at 49 U.S.C. §§ 30,101-70 (2000)).

37. 49 Fed. Reg. 28,962-29,010 (July 17, 1984) (issuing final rule that amended Standard 208); *see also* MASHAW & HARFST, *supra* note 1, at 211.

38. MASHAW & HARFST, *supra* note 1, at 76 (discussing the revisions to proposed Standard 101).

39. *Motor Vehicle Safety Standards: Hearings Before the Senate Comm. on Commerce*, 90th Cong. (1967) (statement of William Haddon); *see also* MASHAW & HARFST, *supra* note 1, at 76-77.

complete answers to all possible questions of efficacy and reliability at the outset of real world experience? Second, has rulemaking at NHTSA moved forward in directions that attack major vehicle safety problems that might be amenable to engineering solutions? Finally, has Congress been willing to supply critical funding for NHTSA's legal-scientific enterprise and permit the agency's policies to be guided by scientific criteria rather than political expediency?

In some ways, litigation about NHTSA's rules over the past decade suggests judicial accommodation to the inherent uncertainties of the engineering-regulatory process. The Sixth Circuit Court of Appeals, for example, is the court that first derailed NHTSA's passive restraints rule in 1972 and is an adherent to the so-called "hard look" approach to judicial review of agency rulemaking.[40] Yet, in 1995, that circuit upheld NHTSA's rejection of a petition to modify its rules on the safe transport of students in wheelchairs, rejecting a barrage of technical and legal arguments.[41] The court affirmed the agency's decision on the prudential ground that the agency had behaved reasonably and was under no obligation to consider every conceivable alternative offered by a litigant or rulemaking participant.[42]

Similarly, in the denouement of a rulemaking proceeding that had been ongoing since the early 1970s, the Tenth Circuit Court of Appeals upheld NHTSA's anti-lock brake system performance standards for vehicles with air brakes without even permitting oral argument.[43] In this case, the petitioner had claimed that because NHTSA's standard presumed the use of automatic braking system technology, it was in effect a "design specification[]" rather than a "performance criteri[on]" and was therefore not authorized by the Motor Vehicle Safety Act.[44] Recognizing that the distinction between performance and design is "much easier to state in the abstract than to apply," the Tenth Circuit concluded with an affirmation of pragmatic problem solving: "We would, accordingly, be hesitant to invalidate this carefully developed safety standard solely on the basis of its indefinite place on the conceptual spectrum between performance and design."[45]

Theoretical purity seems to be retreating before the armies of engineering practicability. The wheelchair litigation, however, involved a host of claims that skated dangerously close to sanctionable frivolity under Rule 11 of the Federal Rules of Civil Procedure. Additionally, the anti-lock brake system performance criteria were being applied to technology then in widespread use throughout the trucking industry. The Sixth Circuit exhibited considerably greater skepticism,

40. Chrysler Corp. v. Dep't of Transp., 472 F.2d 659, 669 (6th Cir. 1972); *see also* Neighbors Organized to Insure a Sound Env't, Inc. v. McArtor, 878 F.2d 174, 178 (6th Cir. 1989); Crounse Corp. v. Interstate Commerce Comm'n, 781 F.2d 1176, 1193 (6th Cir. 1986); MASHAW & HARFST, *supra* note 1, at 87-92.

41. Simms v. NHTSA, 45 F.3d 999, 1011 (6th Cir. 1995).

42. *Id.*

43. Washington v. Dep't of Transp., 84 F.3d 1222, 1223 (10th Cir. 1996).

44. *Id.*

45. *Id.* at 1224.

if not quite its 1970s antagonism, toward NHTSA's rulemaking in a 1990 case involving standards for the deflection of steering columns in front-end collisions.[46] The court invalidated NHTSA's requirements applicable to a particular weight range of trucks because the agency had not provided any practicable testing procedure for manufacturers who built specialized vehicles on standard truck chassis supplied by major manufacturers. Crash testing of these limited-production vehicles was obviously out of the question on economic grounds, and no simulation testing methodology had been developed.[47] The agency's pleas that these specialty manufacturers could avoid compliance difficulties simply by requiring a certificate of compliance from the chassis manufacturer fell on unsympathetic judicial ears.[48] NHTSA had not demonstrated that the manufacturers would be willing to supply the certificates.[49]

Moreover, when NHTSA finally lost a recall case,[50] the court's rationale revealed that the case might as easily be understood as a rulemaking review proceeding. The grounds for the court's refusal to allow the recall was its belief that the agency's rule had given inadequate notice to the manufacturer of the safety requirements that the agency claimed the manufacturer was violating. The recall was disallowed because the rule was incomplete.[51]

Most other cases during the last decade involving NHTSA related to the non-safety aspects of its jurisdiction, particularly its power to adopt mileage standards for automobile fleets. The agency won all of these cases, but its posture was revealing. Almost all were suits attempting to force the agency to exercise regulatory authority that it declined to use.[52] In short, when subjected to substantive review, NHTSA still seems to do no better than chance in the courts of appeals. Unless it does not do anything. Then it always wins.

This tour of the last decade's judicial review proceedings suggests a second question: What has NHTSA been doing in its rulemaking process for the past ten-plus years? After all, the anti-lock truck braking standard had been under development for over a quarter century, and school bus standards for the transport of students in wheelchairs, while of some social significance, has no predictable impact on vehicle safety as a public health concern. Has the agency been preoccupied since 1990 with the bureaucratically ancient and the epidemi-

46. *See* Nat'l Truck Equip. Ass'n v. NHTSA, 919 F.2d 1148, 1156 (1990) ("A careful review of the record reveals that the Administration never considered this problem carefully, and largely ignored it when private parties raised it.").

47. *Id.* at 1154-55.

48. *See id.* at 1155.

49. *Id.*

50. United States v. Chrysler Corp., 158 F.3d 1350 (1998).

51. *Id.* at 1356-57.

52. In *Competitive Enterprise Institute v. NHTSA*, 956 F.2d 321, 327 (D.C. Cir. 1992), the court ordered NHTSA to reconsider its refusal to reduce the corporate average fuel economy ("CAFE") standards for model years 1989 and 1990, but the court ultimately affirmed the agency's position in *Competitive Enterprise Institute v. NHTSA*, 45 F.3d 481, 486 (D.C. Cir. 1995). The same court similarly rejected petitions for changes in the CAFE standard in *Competitive Enterprise Institute v. NHTSA*, 901 F.2d 107, 111 (D.C. Cir. 1990) and *General Motors Corp. v. NHTSA*, 898 F.2d 165, 166 (D.C. Cir. 1990).

ologically trivial? Not quite. However, a review of NHTSA's final rules since 1990 reveals an agency preoccupied with two tasks: (1) updating longstanding rules to take account of new technology, and (2) responding to specific, new statutory directives from Congress.

NHTSA has issued several dozen new "rules" since 1990, but virtually none of them qualify as new "motor vehicle standards."[53] Most merely extend requirements adopted in the late 1960s and early 1970s to new classes of vehicles or update pre-existing rules to deal with new technologies, such as electric braking systems. The few truly "new" standards seem unlikely to have major effects on the numbers of deaths and injuries in vehicle accidents. It is probably important, for example, to have a fuel tank integrity standard for vehicles powered by compressed natural gas, but this is a pretty small fleet.

Moreover, even with the great majority of its activity limited to updating its rule inventory, many of NHTSA's rules remain in the same form as in the late 1960s or early 1970s. When the Firestone tire controversy broke in the late 1990s, for example, NHTSA's 1969 standard did not even apply to the suspect equipment. Its rule covers only bias-ply tires, which are an outdated technology in our current radial-tire world.[54] Extension of passenger car rules to light trucks has made some progress but is far from complete, even though the fastest growing segment of the automobile industry has been light trucks.[55]

To say that the agency has been engaged in updating old rules may not be to say much. Moreover, a review of both agency rulemaking issues and the secondary literature suggests that a huge proportion of NHTSA's energy over the last decade or so has been spent on two controversies: (1) the problem of deaths and injuries from air bag inflation, and (2) the response to tire safety and rollover problems involving sport utility vehicles.[56] In both cases, the agency's agenda and approach have been dictated by congressional politics, not safety engineering.

Indeed, both the agency's modest rulemaking output and its choice of topics can be laid at the door of the Congress. First, NHTSA has been understaffed and underfunded. The agency's budget and staff were cut nearly in half by the

53. Federal motor vehicle safety standards in effect as of December 1998 and their effective dates are available on NHTSA's website, Federal Motor Vehicle Safety Standards and Regulation, *at* http://www.nhtsa.dot.gov/cars/rules/standards/safstan2.htm (last visited Sept. 27, 2002). Additional notices and final rules can be found at NHTSA, Notices and Final Rules, *at* http://www.nhtsa.dot.gov/cars/rules/rulings (last visited May 31, 2003).

54. Judy Pasternak, *Safety Agency Takes Heat over Firestone Tire Recall*, L.A. TIMES, Aug. 19, 2000, at A1.

55. John D. Battle, *Light Trucks Hit Paydirt*, AFTERMARKET BUS., Mar. 2001, at 22, 25.

56. On the air bag crisis, see, for example, Jim Mateja, *NHTSA Offers Ways to Make Air Bags Safer*, CHI. TRIB., Dec. 1, 1996, at Transp. 3; Jayne O'Donnell & James R. Healey, *Deadly Delay: Agency Spins Wheels As Air-Bag Death Toll Rises*, USA TODAY, Nov. 15, 1996, at 1B; and David B. Ottaway & Warren Brown, *From Life Saver to Fatal Threat; How the U.S., Automakers and a Safety Device Failed*, WASH. POST, June 1, 1997, at A1. For a brief glimpse into the problems with sport utility vehicles, see, for example, Myron Levin, *NHTSA Inaction on Rollover Issue Seen as Typical*, L.A. TIMES, Sept. 18, 2000, at C1; John O'Dell & Terril Yue Jones, *Tire Recall Has Brought Many Changes in the Name of Safety*, L.A. TIMES, Aug. 9, 2001, at Bus. 1; and Pasternak, *supra* note 54.

Reagan Administration and have never recovered.[57] Adjusted for inflation, NHTSA's 1999 budget was one-third less than its budget in 1980.[58] Its staff peaked at just over 900 employees in the late 1970s but was down to just over 600 in 1982, where it has hovered ever since. Equally important, Congress has been willing to fund public information and recall activity at much higher levels than the development of safety standards. In the fiscal year 2002 budget, NHTSA was authorized to spend twice as much on the development of front and side impact test ratings for new vehicles as it was on the development of safety standards.[59] The budget for recall investigation and enforcement was six times the figure authorized for standards development.[60] Congress has essentially required the agency to direct its energies in the directions of recalls and consumer information, which have little, if any, scientific support as effective safety strategies.

In addition, congressional intervention into the agency's rulemaking process has diverted its rulemaking energies, such as they are, to problems that are essentially of Congress's own making. In 1991, for example, the Intermodal Surface Transportation Efficiency Act required that all passenger cars manufactured on or after September 1997 and light trucks manufactured after September 1998 have both passenger and driver side air bags in addition to manual lap and shoulder belts.[61] This legislation effectively took the agency's performance requirements embodied in Federal Motor Vehicle Safety Standard 208[62] and transformed them into design requirements. And the design has some difficulties.

By the mid-1990s, it was becoming clear that, while air bags have substantial safety advantages, they also injure and kill passengers who would otherwise escape vehicle accidents with lesser injuries or no injuries at all. The problems particularly affect children and small adults.[63] Congress responded, not by giving the agency back its discretion to trade off air bags against other technologies, but with the Transportation Equity Act for the 21st Century.[64] That statute specifically required the agency to improve vehicle restraint protection for occupants of all sizes; to minimize air bag risks to infants and children; to maintain protections for unbelted occupants; to require advanced air bag technology; and

57. Cindy Skrzycki, *NHTSA Will Share Hearing Spotlight*, WASH. POST, Sept. 5, 2000, at E1. NHTSA budget and personnel data referred to here and elsewhere have been compiled from the appendices to the annual budget of the United States government. *E.g.*, U.S. OFFICE OF MGT. & BUDGET, BUDGET OF THE UNITED STATES GOVERNMENT app. (1989). Some numbers have also been compiled from NHTSA budgets in brief, which are available at NHTSA, Budget in Brief, *at* http://www.nhtsa.dot.gov/nhtsa/whatis/bb (last visited May 31, 2003).

58. Skrzycki, *supra* note 57, at E1.

59. NHTSA FY 2003 Budget in Brief, at 6-7, *available at* http://www.nhtsa.dot.gov/nhtsa/whatis/bb/2003/index.htm (last visited May 20, 2003).

60. *Id.* at 6, 8.

61. Intermodal Surface Transportation Efficiency Act of 1991 § 2508, 49 U.S.C. § 30127 (2000).

62. 49 C.F.R. § 571.208 (2001).

63. *See, e.g.*, Ottaway & Brown, *supra* note 56.

64. Pub. L. No. 105-178, 112 Stat. 107 (1998) (codified as amended in scattered sections of 23 U.S.C. and 49 U.S.C.).

to do so with rules that would be completed no later than September 2003 and phased in no later than September 2006.[65] Is this feasible? Sensible? Who knows? And NHTSA is now legally prohibited from asking those questions.

Furthermore, the agency's rulemaking activities since 1998 have largely been devoted to implementing this legislation and the Transportation Recall Enhancement, Accountability and Documentation Act of 2000 ("TREAD").[66] As its acronym suggests, TREAD was Congress's response to the Ford-Firestone tempest of the late 1990s. As most readers will remember, evidence mounted during the late 1990s that Ford Explorer sport utility vehicles were involved in a substantial number of rollover accidents and that the failure of Firestone tires were implicated in many fatal Explorer rollovers.[67] This episode took on the character of a morality play when it was discovered that Firestone had recalled these same tires in a number of other countries; that both Firestone and Ford had failed to keep NHTSA informed of the mounting evidence that the tires were unsafe, at least as used on Ford Explorers; and that NHTSA itself had received a number of warnings that had somehow gotten lost in its antiquated data processing system.[68] Congress responded once again by beefing up NHTSA's recall authority and requiring that it adopt a number of rules, all related to defect investigations and notifications (that is, recalls). Once again, the statute had a mandatory time limit that would commandeer the agency's limited resources.

The dog that is not barking in this scenario is the known propensity for sport utility vehicles of all types to experience an excessive number of rollover accidents when compared with the passenger car vehicle fleet as a whole. Both NHTSA and industry testing have documented this propensity for over a decade.[69] The response, one might have thought, would be a stability standard for passenger vehicles that would require some redesign of the sport utility vehicle fleet. Yet, at the behest of the motor vehicle industry and its allies in Congress, NHTSA has rejected this solution, maintaining that such requirements would be impracticable.[70] By that it means that redesign would add substantial economic cost to the most profitable segment of the American motor vehicle industry.

Meanwhile, the agency has done some work on the development of dynamic rollover tests for purposes of beginning a consumer information program on rollovers. The TREAD legislation cements this approach by requiring NHTSA

65. *Id.*; *see also* Public Citizen website, at http://www.citizen.org/autosafety/Air_Bags/articles.cfm?ID=6022 (last visited Apr. 11, 2003).

66. Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act, Pub. L. No. 106-414, 114 Stat. 1800 (2000) (codified as amended in scattered sections of 49 U.S.C.).

67. *E.g.*, Ricardo Alonso-Zaldivar, *Errors, Short Staffing Led to Missed Tire Warnings*, L.A. TIMES, Nov. 10, 2000, at A1.

68. *E.g.*, *id.*; Tom Incantalupo, *Agency in Hot Seat*, NEWSDAY, Sept. 13, 2000, at A7; Pasternak, *supra* note 56.

69. Levin, *supra* note 56.

70. Diana Hembre & Eve Pell, *Feds Abandon Car Safety Measure*, S.F. EXAMINER, Oct. 2, 1994, at A1.

to develop dynamic tests for motor vehicle rollovers, carry out a set of tests, and initiate a rulemaking proceeding to determine how best to disseminate these test results to the public. Dissemination will not be easy. Like NHTSA's now-famous barrier crash tests for passenger restraint systems, the real world applicability of these test results will be problematic. Most cars do not crash into static barriers, and stability measured on a single, well-specified slalom course is unlikely to mimic the behavior of automobiles maneuvering in highly diverse driving circumstances. In the end, the consumer information may be misleading, as the industry has long maintained concerning NHTSA's (and the insurance industry's) crash-test results. Congress, however, likes information regulation. It funds NHTSA's crash test information program at 200% of the agency's budget for rulemaking.

IV

REFLECTIONS AND RE-INTERPRETATIONS

Do we gain anything from retelling the vehicle safety regulation story from a law-science perspective—from focusing on a domain in which applied scientists, engineers, are the source of technical information? Perhaps not. All of the usual pathologies have emerged. Either my hypothesis about engineers and engineering data is wrong—they are just as culturally divorced from the work of regulatory agencies as are more "theoretical" scientists and scientific information—or, even if I am right, the difference does not matter. The problems at the law-science interface are still critical.

In this concluding segment, I briefly explore this latter possibility. Perhaps the lesson to be drawn from NHTSA's sub-par technocratic performance is just this: The clash between technocratic regulatory aspirations and the legal culture is not necessarily evidence of a mismatch between scientific practice and regulatory processes that are desperate to employ scientific evidence but incapable of internalizing scientific information in an intelligent fashion. The problem may not be that law misunderstands and misapplies science, but that we have misunderstood law—at least administrative or regulatory law. Perhaps agencies, like courts and legislatures, are not interested in facts of any kind when normative commitments, call them "political imperatives," trump knowledge.

We have long excused, or partially excused, scientific absurdities in legislation on the ground that legislation is norm-creating, not fact-finding. Statutes emerge from debates over interests and values. Legislative arguments appeal to visions of both reality and possibility, but the truth of either is hardly relevant as a standard for the legality of legislation. In the familiar rational-basis approach to the constitutionality of statutes, courts need only the ability to imagine a world in which the legislature's actions would make sense.

Similarly, litigation is about conflict resolution. Most cases settle without determining "the fact of the matter." Those that go to trial are often submitted to juries whose role as triers of fact is often rationalized on the basis that they,

like legislators, are there to bring community values to bear on the settlement of controversies. Juries are "instructed" on the facts by advocates whose strategic interests only incidentally converge with truth-seeking. We have recently begun a serious attempt to shield juries from "bad science," but the failure of that effort, if it fails, will not necessarily impeach our attachment to either the adversary process or the jury system.

To be sure, our belief that legislatures are capable of making socially acceptable policy choices or that trials can fairly resolve disputes may crumble in the face of persistent and prolonged inattention to true states of the world. But, both legislation and the output of judicial proceedings are likely to be judged acceptable more by virtue of their capacities to resolve social and individual conflict within the terms of an appealing normative framework than by their capacities to get the facts right.

Administrative lawmaking has long been thought to be different. Indeed, earlier I described engineers and administrative agencies as appealing to the same source of legitimacy, the promise to exercise power on the basis of knowledge. Administration is the true legal-institutional home of instrumental rationality, or so our conventional administrative law norms instruct us.[71] The failure of administrators to operate on the basis of the best available information, including scientific and technical information, is not an excusable lapse in the context of the pursuit of other social goals. It is an institutional failure that undermines administrative legitimacy and often determines the legality of administrative action.

To be sure, administrative lawyers have long understood that the practice of administrative decisionmaking might be better described as "interest representation," "micro-political accommodation," or just "muddling through," than as the embodiment of "instrumental rationality." Furthermore, recent reform efforts have emphasized the desirability of negotiation, collaborative rulemaking, and regulatory flexibility rather than expert judgment. We seem capable of admitting that regulation is policymaking and that policy is never apolitical.

Yet, in some fundamental ways, we maintain our bedrock normative expectations of instrumentally rational administration. Juries and legislatures (and courts who avoid opinion writing) can decide without reasons. Administrative rules or orders without contemporaneous supporting reasons are generally illegal for that reason alone. Moreover, we mean by reason-giving a demand for instrumental explanation—how this policy or that decision implements a legislative norm given the current state of the world and the predicted impact of the administrative action on some future state of the world. We thus demand causal explanation, the stuff of scientific inquiry, and reject the agency's determination as unlawful unless it can tell a factually and scientifically plausible story. Unreasoned decisions, silence, and imagined states of the world are not allowed. We soften the hard edges of the demand for rationality with deference

71. Jerry L. Mashaw, *Small Things Like Reasons Are Put in a Jar: Reason and Legitimacy in the Administrative State*, 70 FORDHAM L. REV. 17, 26 (2001).

norms and occasional instances of nonreviewability. Candid political rationalization—assertions, for example, that this resolution of the matter was acceptable to most affected interests, was in line with administration policy, was dictated by resource constraints, or was demanded by powerful legislative factions—are ruled out-of-bounds.

In short, our normative demands are at war with our understanding of the practical necessities of administration. We have failed to construct a normative model of administration that fits its realities, or more properly, a normative model that builds on best practices in an administrative world beset by inadequate budgets, legislative imperatives, and public resistance, as well as real scientific uncertainties.

We are, thus, still inclined to ascribe the failure of regulatory policies to track the best scientific or technological understanding of a problem as a failure somehow to design a "good" administrative process—that is, one that is impervious to the political, social, and economic forces that deflect administrators from the path of scientific virtue. The truth of the matter, I have come to believe, is that we do not always want the law to follow science, even law as made by administrators. Our practice belies our proclaimed rationalistic commitments. The problem from this perspective is not how to reform law to better accommodate science, but how to reframe our aspirational norms about administrative law to better accommodate what we really seem to demand of administration.