TRANSPARENCY IN PUBLIC SCIENCE: PURPOSES, REASONS, LIMITS

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I
INTRODUCTION

Science and secrecy do not sit comfortably together. In technologically advanced democracies, it is almost an article of faith that openness is essential both for the advancement of science and for its beneficial interaction with society. Internally, scientific communities consider the free exchange of ideas through peer criticism and publication indispensable for progress.[1] Externally, too, the demands for openness have grown as science's relations with society have become more complex and pervasive.[2] Scientific knowledge underwrites an ever greater cross-section of the decisions that governments make about their citizens' health, safety, security, and welfare.[3] Democratic control over public decisions therefore demands some ability on the part of a polity to evaluate the knowledge claims that justify actions taken on its behalf. Otherwise, the door would be opened to arbitrary and irrational decisions in the name of government.

With the passage of the federal Administrative Procedure Act in 1946,[4] the U.S. government recognized the right of citizens to participate in agency rulemaking and an associated right to receive information, including scientific and technical information, in order to effectuate the goal of informed participation. Later U.S. statutes have consistently expanded the public's right to know and to assess the information underlying governmental decisions, even

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1. For example, the International Council for Science maintains that scientists' ability to participate freely and without discrimination in legitimate scientific activities is an essential element of the Principle of the Universality of Science. International Council for Science, Universality of Science Principle, http://www.icsu.org/5_abouticsu/INTRO_UnivSci_1.html (last visited Sept. 28, 2005).

2. *See, e.g.*, DAVID GUSTON, BETWEEN POLITICS AND SCIENCE: ASSURING THE INTEGRITY AND PRODUCTIVITY OF RESEARCH (2000) (analyzing the changing relationship between science and politics); DANIEL KEVLES, THE BALTIMORE CASE: A TRIAL OF POLITICS, SCIENCE, AND CHARACTER (2000) (recounting the investigation into the efficacy of Nobel-Prize-winner David Baltimore's gene transfer research).

3. *See, e.g.*, SHEILA JASANOFF, THE FIFTH BRANCH: SCIENCE ADVISERS AS POLICYMAKERS (1990) [hereinafter JASANOFF, THE FIFTH BRANCH] (discussing the current scientific advisory process and the influence of science on our daily lives).

4. Administrative Procedure Act, Pub. L. No. 109-41, 60 Stat. 237 (1946) (codified as amended in scattered sections of 5 U.S.C.).

when that information is highly technical.[5] Some of these laws aim to increase the transparency of governmental decisionmaking in general;[6] others are tailored to specific policy frameworks, such as health, safety, and environmental regulation. Consequently, U.S. citizens, more perhaps than in any other democratic nation, can count on having access to official information, including the evidence and reasoning relied upon by the government's extensive network of expert advisers.[7]

To be sure, normative considerations work against total transparency in government and may legitimately bar access to some stages or aspects of scientific knowledge production. These norms flow, in the first instance, from the nature of scientific research itself. Science, as a process, depends on a certain amount of unrestricted trial and error, as well as on competitiveness among peers.[8] Excessive or premature demands for public disclosure may therefore hamper creativity or produce disincentives for high-risk research. Additional constraints on disclosure derive from considerations largely external to science: for example, the need to protect the privacy of research subjects, the confidentiality of proprietary business information, the discretionary spaces of governmental decision-making, or national security interests. Openness and transparency in science, then, cannot be treated as absolute goods. Rather, the degree of openness is context-specific and needs to be traded off against other important social values. The problem for contemporary law and policy is to develop principled approaches to maintaining the desired balance.

That problem has grown in salience throughout the last half-century, assuming today an urgency that is, arguably, greater than at any time since the beginnings of the scientific revolution.[9] The reasons have to do with wide-ranging changes in the practice of science, as well as in its dynamic relationship

5. Important legislative expansions of the public's right to know and assess information used by the government include the Freedom of Information Act, 5 U.S.C. § 552 (2000), the Federal Advisory Committee Act, 5 U.S.C. app. §§ 1–15 (2000), and the Data Quality Act, a rider to the Treasury and General Appropriations Act for Fiscal Year 2001, Pub. L. No. 106-554, § 515, 114 Stat. 2663 (2000).

6. *See* Freedom of Information Act, 5 U.S.C. § 552 (requiring federal agencies to disclose certain information when requested by citizens); Federal Advisory Committee Act, 5 U.S.C. app. §§ 1–15 (authorizing "the establishment of a system of governing the creation and operation of advisory committees in the executive branch of the Federal Government" and requiring that advisory committee meetings be open to the public); Data Quality Act § 515 (requiring the Office of Management and Budget to provide federal agencies with rules that will increase the quality and integrity of information they produce).

7. Federal Advisory Committee Act, 5 U.S.C. app. §§ 1–15.

8. For sociological accounts of scientific practice, see BRUNO LATOUR, SCIENCE IN ACTION (1987) and H.M. COLLINS, CHANGING ORDER (1985).

9. *See, e.g.*, SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY, SCIENCE AND SOCIETY THIRD REPORT, 1999-2000, H.L. 38-1.1, *available at* http://www.parliament.the-stationery-office.co.uk/pa/ld199900/ldselect/ldsctech/38/3801.htm [hereinafter SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY] ("[T]here has never been a time when the issues involving science were more exciting, the public more interested, or the opportunities more apparent."). The *Commission White Paper on Governance Working Group 1b*, *Democratising Expertise and Establishing European Scientific References* (May 2001), *available at* http://europa.eu.int/comm/governance/areas/group2/report_en.pdf [hereinafter *Democratising Expertise and Establishing European Scientific References*], provides an example of the urgency that developing principled approaches to science has assumed within the European community.

with society. Robert Merton, America's first great sociologist of science, noted the early stirrings of discontent in his well-known 1942 essay on the norms of science.[10] At that time, science was under attack from totalitarian regimes in war-torn Europe. Threatened by powerful political forces, science, in Merton's view, needed to defend its autonomy as it had not been required to do in 300 years of unmitigated success.[11] At stake was science's right to govern itself and to maintain the culture of openness that antidemocratic governments of all stripes wished to suppress.[12] Defenders of science saw it as the foremost bastion of free thought and inquiry, as a firm refuge against ideology, and even as a perfect working model of democracy.[13] Science, they believed, was internally so transparent—so disciplined through processes of peer criticism—that it needed no further supervision by outsiders.[14] External interference would unduly politicize science, detracting from scientists' ability to produce disinterested, universal truths when left alone.[15]

Today, the threats to openness in science stem not so much from pressure by dictatorial regimes as from the increasing embeddedness of science in society.[16] Scientific knowledge is too important to be any longer characterized as "disinterested,"[17] as Merton termed it. The growth of national economies, the comparative military advantages of states, the market shares of companies, the health and safety of populations and the environment, and, increasingly, the vitality of universities and the personal fortunes of scientists all depend on producing useful scientific knowledge. Science can no longer afford to be disinterested; it serves too many purposes and too many masters to claim or to seek detachment.

Indeed, some scholars have argued that the sea change in scientific practices in the past few decades has led to a new era of "Mode 2" science, replacing the

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10. ROBERT K. MERTON, *The Normative Structure of Science, in* THE SOCIOLOGY OF SCIENCE: THEORETICAL AND EMPIRICAL INVESTIGATIONS 267 (Robert K. Merton ed., 1973). Merton argues that the unique ethos of science is defined by four norms: (1) communalism, (2) universalism, (3) disinterestedness, and (4) organized skepticism. *Id.* at 270–78.

11. *Id.* at 267–68.

12. *Id.*

13. For a classic elaboration of this argument, see Michael Polanyi, *The Republic of Science*, 1 MINERVA 54, 54–74 (1962), *available at* http://www.mwsc.edu/orgs/polanyi/mp-repsc.htm.

14. *See id. See also* Roy Macleod, *Science and Democracy: Historical Reflections on Present Discontents,* 35 MINERVA 369 (1997).

15. One classic statement of this position may be found in DON K. PRICE, THE SCIENTIFIC ESTATE (1965). Price observed that there are four estates involved in the work of government: the scientific, the professional, the administrative, and the political. He maintains that "[t]he most important principle seems to be a twofold one: (1) the closer the estate is to the end of the spectrum that is concerned solely with truth, the more it is entitled to freedom and self-government; and (2) the closer it gets to the exercise of power, the less it is permitted to organize itself as a corporate entity, and the more it is required to submit to the test of political responsibility, in the sense of submitting to the ultimate decision of the electorate." *Id.* at 137.

16. *See* MICHAEL GIBBONS ET AL., THE NEW PRODUCTION OF KNOWLEDGE 4 (1994) (arguing that, in the new "Mode 2" of production, "knowledge is intended to be useful to someone whether in industry or government[] or society more generally and this imperative is present from the beginning").

17. MERTON, *supra* note 10, at 275.

disinterested, non-utilitarian "Mode 1" science of the academic ivory tower.[18] Mode 2 science, these analysts argue, is characterized by mission-oriented research, cross-disciplinary approaches, institutional diversification, and growing public demands for accountability.[19] As a result, it is no longer possible to ask science to merely give us "good"—that is, true or reliable—knowledge. Not content with merely good science, decisionmakers and publics are also asking, and advisedly so, "What is science good for, and is it good enough to serve those purposes?"[20] Questions like these, moreover, require input from a wider range of potential observers than the circle of peer reviewers traditionally called upon to certify the goodness of scientific claims.

Yet modern societies' increasing dependence on science has proceeded hand in hand with developments that disable most citizens, even the most technically expert, from effectively addressing the larger set of questions: Is it good science; what is it good for; and is it good enough? Science has not only become infused with multiple social and political interests; it is also in danger of escaping effective critical control. Too often scientific knowledge seems to be "sequestered," concealed from those who could benefit from it or who could comment meaningfully on its quality and relevance.[21] Along with the other contributions to this special issue, this article focuses on the breakdowns in openness that are of special concern for law and policy and seeks to propose appropriate remedies. But to solve the problem of sequestration, we need first to be clearer about what it is and how it arises.

A logical starting point for that inquiry is to question the term itself. What does sequestration of knowledge mean, both in general and, more particularly, in and for science? What makes it undesirable, and is it always so? Is sequestration especially problematic when the subject at issue is public science, that is, science used to support decisions of significant public concern? In what follows, the term *public science* includes policy-relevant knowledge in the broadest sense: science that underwrites specific regulatory decisions, science offered as legal evidence, science that clarifies the causes and impacts of phenomena that are salient to society, and science that self-consciously advances broad social goals, such as environmental sustainability. What measures can the law adopt to ensure the proper disclosure of such science, and

18. *See* GIBBONS ET AL., *supra* note 16, at 1–16 (thoroughly discussing the intersection, similarities, and differences between Mode 1 and Mode 2 science).

19. *Id.* at 1–3; *see also* HELGA NOWOTNY ET AL., RE-THINKING SCIENCE: KNOWLEDGE AND THE PUBLIC IN AN AGE OF UNCERTAINTY (2001).

20. *See Democratising Expertise and Establishing European Scientific References*, *supra* note 9; SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY, *supra* note 9.

21. *See* SHELDON KRIMSKY, SCIENCE IN THE PRIVATE INTEREST: HOW THE LURE OF PROFITS HAS CORRUPTED THE VIRTUE OF BIOMEDICAL RESEARCH 10–24, 82–85 (2003) (describing how ties to pharmaceutical companies have led academic scientists to downplay the evidence of adverse side effects and to respond unfavorably to fellow scientists' requests for information); Eyal Press & Jennifer Washburn, *The Kept University*, ATLANTIC MONTHLY, Mar. 2000, at 39, 41–46 (discussing the secrecy involved in corporate sponsored scientific research). *See also* discussion *infra* Part II.A (giving specific examples of harmful concealment).

are there circumstances when the law should erect barriers against disclosure and debate?

These questions will be approached here from two angles, in the hope that greater illumination will result from an intersection of perspectives. First, I will consider the issue of sequestration directly, asking how it relates to secrecy in general and how it comes about in the use and production of public science. Second, I will look at the idea of transparency, often regarded as the opposite of secrecy, paying special attention to how science and the law both promote transparency, and why they sometimes guard against it. In the article's conclusion, I will take up the normative challenges of designing regimes of scientific openness that promote informed debate on the aims, quality, and adequacy of public science, while avoiding moves that might hinder the production or use of reliable knowledge.

II
SECRECY AND SEQUESTRATION

The ordinary English term that comes closest to sequestration is *secrecy*. To define the former more precisely, let us begin with the latter. In writing on secrecy, the philosopher Sissela Bok takes "intentional concealment" as the core of the concept.[22] There are, she notes, many additional ideas, positive and negative, that have become entwined with the idea of secrecy; among them are "the concepts of sacredness, intimacy, privacy, silence, prohibition, furtiveness, and deception."[23] Nevertheless, she argues, there is a virtue to beginning with the most stripped-down and neutral definition because it allows the most room to explore how secrecy plays out ethically in various domains.[24]

Bok's proposal of beginning without fixed assumptions about the moral valence of secrecy makes good sense for us—both methodologically and normatively—in investigating secrecy at the intersections of science, policy, and the law. To arrive at good judgments about the merits of particular forms of concealment, it is necessary to begin from a position of agnosticism. Methodologically, assuming that sequestration, like secrecy in its most basic meaning, is simply about concealment allows for a symmetric consideration of how science and law treat the act of concealing. What, specifically, are the intentions that lead to intentional concealment, and how should those intentions be ethically or morally evaluated? Neither institution views disclosure as an unquestioned good, though both are firmly committed to openness and transparency. In each, there is a definite, though shifting, boundary between what should be shielded from external inspection and what should be fully available for review. By asking what counts as good and bad concealment in each institutional context, and on what grounds, we will lay the

22. SISSELA BOK, SECRETS: ON THE ETHICS OF CONCEALMENT AND REVELATION 9 (1982).
23. *Id.* at 6.
24. *Id.* at 9–10.

basis for asking how science and law can work together to maximize the positive and minimize the negative valences of sequestering knowledge.

There are two respects, however, in which Bok's definition of secrecy does not go far enough for our purposes. In equating secrecy with intentional concealment, she focuses more on the mindset of the individual agent who is hiding something than on the characteristics of the environment in which concealment is taking place or the person or persons from whom the thing is being hidden.[25] But sequestration, unlike secrecy, is not always intentional; it is often a product of contextual features that affect the transmission of knowledge. Further, the issue whether science is open enough, especially in the domain of policy-relevant knowledge, cannot be fully decoupled from this question: Open to whom? To be useful, scientific information has to be available to those in a position to appraise and use it. Put differently, information alone means little to society in the absence of an active interpretive culture that is willing to criticize and able to make sense of it. It may be said that sequestration of science is the concealment of scientific knowledge, intentionally or unintentionally, from audiences who would be in a position to make that knowledge better or more beneficial if it were open to them.

Identifying the right audiences is not an insignificant problem, and it is a relatively new one for contemporary policy-relevant science. In the era of Mode 1 science, universities and research centers not only produced knowledge but also produced the peer communities needed to certify its quality.[26] Because scientists needed to rely on each other's claims in order to make progress, it suited everyone's interests to put in place honest and capable processes of peer criticism.[27] Not coincidentally, the practice of peer review grew up side by side with the research practices of modern science itself. Scientists needed a trustworthy method of validating each other's claims if their enterprise was to move forward.[28] It should not surprise us that seventeenth century solutions to the problem of scientific openness do not fully live up to the needs of the twenty-first century. Mode 2 science has entailed a shift from narrower issues of quality control (is it good?) to broader questions of accountability (is it relevant; is it good enough?).[29] That shift, in turn, changes the terms of scientific openness, forcing us to consider again the rationale for, the processes of, and the limits to transparency. In particular, when science is generated to serve public purposes it becomes important to ensure that information will reach the right recipients and be appropriately scrutinized by them. Mere disclosure is

25. *See id.* at 3–15 (discussing secrecy and its definition from the perspective of the person with the secret).

26. GIBBONS ET AL., *supra* note 16, at 8.

27. *Id.*

28. For an absorbing historical account of this development, see STEVEN SHAPIN & SIMON SCHAFFER, LEVIATHAN AND THE AIR-PUMP: HOBBES, BOYLE, AND THE EXPERIMENTAL LIFE (1985).

29. Sheila Jasanoff, *Technologies of Humility: Citizen Participation in Governing Science*, 41 MINERVA 223, 234–35 (2003).

not enough. The question how to achieve transparency in public science inevitably morphs into questions about transparency to whom.

An instructive example from the environmental arena is the Toxics Release Inventory, a compilation of plant-specific chemical emissions demanded by federal law and maintained by the U.S. Environmental Protection Agency (EPA).[30] Enacted in the aftermath of the Bhopal gas disaster,[31] the law aimed to benefit communities near emitting facilities by informing them of potentially toxic exposures.[32] Ordinary citizens, however, could not interpret and use the information without the aid of specialist organizations that, in effect, translated the raw data into usable terms.[33] Another example derives from the domain of international security. Following the 2003 war on Iraq, top leaders in the United States and Britain admitted that their knowledge of Saddam Hussein's ability to manufacture and deploy weapons of mass destruction was flawed. Apparently, it was not active deception that produced these dangerous states of ignorance. Rather, key actors were unable to assess the credibility and robustness of intelligence information derived from multiple sources, each operating with its own assumptions and standards of proof and evidence.[34] In building a principled foundation for the openness of public science, then, attention must be paid not only to who is responsible for disclosure, and what they must disclose, but also, importantly, to what kinds of critical reviewers those disclosures should be made.

A. Two Perspectives on Disclosure

Let us begin by looking at two examples that epitomize, respectively, the pros and cons of demanding the disclosure of policy-relevant scientific

30. The Toxics Release Inventory was established under the Emergency Planning and Community Right-to-Know Act of 1986, Pub. L. No. 99-499, 100 Stat. 1613 (codified as amended at 42 U.S.C. §§ 11001–11050 (2000)), and expanded by the Pollution Prevention Act of 1990, Pub. L. No. 101–508, 104 Stat. 1388–321 (codified at 42 U.S.C. §§ 13101–13109 (2000)).

31. On December 3, 1984, toxic gas leaked from Union Carbide's pesticide factory in Bhopal, India resulting in weeks of death, panic, and disorganization known as the Bhopal Disaster. See LEARNING FROM DISASTER: RISK MANAGEMENT AFTER BHOPAL (Sheila Jasanoff ed., 1994) [hereinafter LEARNING FROM DISASTER], to learn more about the Bhopal Disaster and its consequences.

32. U.S. Environmental Protection Agency, What is the Toxics Release Inventory (TRI) Program, http://www.epa.gov/tri/whatis.htm (last visited Oct. 6, 2005). Under the Emergency Planning and Community Right-to-Know Act of 1986, businesses are required to report the names of chemicals in their possession to their state and local government, and this information is then made available to the public. 42 U.S.C. § 11022.

33. For more details, see Susan G. Hadden, *Citizen Participation in Environmental Policy Making*, *in* LEARNING FROM DISASTER, *supra* note 31, at 91, 98–99.

34. In the United States, the Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction, currently known as the Weapons of Mass Destruction Commission, addressed these issues in its Report to the President on March 31, 2005. COMMISSION ON THE INTELLIGENCE CAPABILITIES OF THE U.S. REGARDING WEAPONS OF MASS DESTRUCTION, REPORT TO THE PRESIDENT OF THE UNITED STATES (Mar. 31, 2005), *available at* http://www.wmd.gov/report/wmd_report.pdf. In Britain, a comparable inquiry was made in the Investigation into the Circumstances Surrounding the Death of Dr. David Kelly, also known as the Hutton Inquiry. LORD HUTTON, REPORT OF THE INQUIRY INTO THE CIRCUMSTANCES SURROUNDING THE DEATH OF DR. DAVID KELLY, C.M.G. (2004), *available at* http://www.the-hutton-inquiry.org.uk/content/report/index.htm.

knowledge. A strong case for wider disclosure comes from the biomedical domain. Between 1998 and 2002, Britain's largest drug company, Glaxo SmithKline (GSK), conducted five clinical trials evaluating the effects of an anti-depressant, known in the United States as Paxil, on children and young adults.[35] According to a fraud suit filed in June 2004 by the New York State Attorney General Eliot Spitzer, GSK failed to disclose that in at least four of these studies the drug had performed no better than the placebo used as a control.[36] Worse, the drug appeared to increase suicidal thoughts in adolescents at a measurably higher rate than the placebo.[37] In August 2004, GSK settled the lawsuit by agreeing to disclose the negative trial information in a registry on its website and to pay New York State $2.5 million as compensation for its previous nondisclosure.[38]

The GSK case dramatized the problem of drug companies' not making negative results from clinical trials public, thereby skewing, in a favorable direction, the information available on their products. But GSK was not the only firm implicated in this kind of concealment. In September 2004, a U.S. drug company, Merck, announced a worldwide withdrawal of its blockbuster anti-arthritis drug, Vioxx, on the discovery that the drug causes "statistically significant" increases in heart attacks and strokes in patients taking the drug for sustained periods.[39] In November 2004, the *Wall Street Journal* reported that the company's e-mails showed the problem was known internally from the mid-1990s onward; Merck's own research director, Edward Scolnick, wrote in an e-mail in 2000 that the cardiovascular effects "are clearly there," although Merck later characterized his comments as unchecked initial impressions of the data.[40] A study by the Food and Drug Administration indicated that the drug could have caused more than 27,000 heart attacks and deaths before it was withdrawn.[41] By mid-2005, Merck was facing thousands of legal claims amounting to potentially as much as $50 billion in damages.[42]

In response to events like these, major policy actors enthusiastically took up the issue of disclosure. The National Institutes of Health (NIH) proposed a policy change that would require all scientists funded by the agency to make

35. David Teather & Sarah Boseley, *Glaxo Faces Drug Fraud Lawsuit*, THE GUARDIAN (London), June 3, 2004, Home Pages, at 1.

36. *Id.*

37. *Id.*

38. Press Release, Glaxo SmithKline, Glaxo SmithKline Settles Lawsuit with New York Attorney General's Office (Aug. 26, 2004), http://www.gsk.com/ControllerServlet?appId=4&pageId=402&newsid=301.

39. Gina Kolata, *Merck and Vioxx: The Overview; A Widely Used Arthritis Drug is Withdrawn*, N.Y. TIMES, Oct. 1, 2004, at A1.

40. *Merck Officials Explain Internal Documents Related to Safety Risks of Vioxx*, CALIFORNIA HEALTHLINE, Nov. 15, 2004, *available at* http://californiahealthline.org/index.cfm?Action=dspItem&itemID=107443.

41. *FDA Study Estimates More than 27,000 Heart Attacks Linked to Vioxx*, CALIFORNIA HEALTHLINE, Nov. 3, 2004, *available at* http://www.californiahealthline.org/index.cfm?Action=dspItem&itemID=107194.

42. Aaron Smith, *Merck's Vioxx Bill Could Hit $50 Billion,* CNN MONEY, Aug. 22, 2005, http://money.cnn.com/2005/08/22/news/fortune500/merck/.

their research results freely available to the public through its electronic database, PubMed Central.[43] Editors of a dozen leading medical journals announced that they would refuse to publish drug-company clinical trial results unless the results were registered in a public database from the start.[44] This step would help ensure that unfavorable studies did not simply disappear from view. Knowledge of studies that failed to show benefits would help guard against overoptimism in the evaluation of studies that did show positive results. A House subcommittee decided to hold hearings on the issue, prompting Merck to state that it would post its trial results on an NIH website.[45]

The second example, which puts demands for openness in a more ambiguous light, comes from the environmental domain. It arose pursuant to the Data Quality Act of 2000.[46] The Act itself is a classic example of non-transparent legislation—a two-sentence provision written by Jim Tozzi, an industry lobbyist, and inserted without any public debate into a massive and opaque appropriations bill.[47] On its face, the Act simply requires the Office of Management and Budget to ensure that all information disseminated by federal agencies meet standards of "quality, objectivity, utility, and integrity."[48] This could be seen as a bow toward greater transparency in that it subjects agency science to stricter external scrutiny. Skeptical outsiders may use the Act to question agency data for possible bias. In practice, however, as illustrated below, the Act authorizes challenges to publicly generated information on the basis of claims that are not themselves subject to equivalent standards of openness. While opening up some scientific practices, the Act in this respect encourages others that are not covered by law and are far from transparent. It is, from this standpoint, an invitation to asymmetry in the evaluation of public scientific claims.

Our illustrative case stems from a challenge initiated by the European chemical company Syngenta against a finding by the Environmental Protection Agency (EPA) that the company's profitable herbicide, atrazine, is an endocrine disruptor that causes hormonal changes in frogs and other animals. Privately sponsored research, conducted without the transparency mandates of public decisionmaking, was used in this case to challenge and destabilize EPA's expert judgment. To contest EPA's finding, Syngenta first turned to a private company, Eco-Risk, to sponsor additional studies on atrazine.[49] A University of

43. Policy on Enhancing Public Access to Archived Publications Resulting from NIH-Funded Research, NOT-OD-05-022, NIH Guide for Grants and Contracts (Feb. 4, 2005), *available at* http://grants.nih.gov/grants/guide/notice-files/NOT-OD-05-022.html.

44. Shankar Vedantam, *Journals Insist Drug Manufacturers Register All Trials*, WASH. POST, Sept. 9, 2004, at A2.

45. Gardiner Harris, *Merck Says It Will Post the Results of All Drug Trials*, N.Y. TIMES, Sept. 6, 2004, at C4.

46. Data Quality Act, Pub. L. No. 106-554, § 515, 114 Stat. 2663 (2000).

47. *See* Rick Weiss, *Data Quality Law Is Nemesis of Regulation*, WASH. POST, Aug. 16, 2004, at A1 (discussing, in part, the origin of the Data Quality Act).

48. Data Quality Act § 515 (a).

49. Weiss, *supra* note 47.

California scientist hired by Eco-Risk confirmed that atrazine reduces testosterone levels in male tadpoles and produces hermaphrodites, but the terms of his agreement blocked him from publishing his result.[50] Other studies tending to show opposite results, however, continued to be funded by Eco-Risk, and these became the basis for a petition against EPA by Jim Tozzi's Center for Regulatory Effectiveness.[51] Tozzi also argued that EPA could not rely on the studies demonstrating atrazine's ill effects because the agency had not yet developed a "gold standard" test for endocrine disruption.[52] Heavily criticized by EPA's scientific advisers, the studies put forward by Eco-Risk nevertheless managed, in the words of one observer, to "manufacture uncertainty."[53] In the end, EPA opted for continued monitoring of atrazine rather than restricting its use more stringently.[54]

The two cases put the issue of secrecy on a complex footing, substituting shades of gray for stark black-and-white judgments. They point to three problems that require closer investigation:

(1) the problem of imperfect accountability, reflected in the fact that mere production of new scientific studies, without disclosure to competent critics, neither guarantees increased validity or authenticity of results nor ensures their appropriate interpretation (illustrated by both cases);

(2) the problem of asymmetric standards, evinced by the fact that codes of scientific openness are not uniformly observed or enforced in practice, thereby creating asymmetries in the standards applied to privately and publicly sponsored research (illustrated by both cases);

(3) the problem of excessive transparency, displayed in the fact that expanded disclosure requirements and more formal accountability procedures do not necessarily lead to "better" science, either in the sense of more reliable knowledge or in the sense of science better suited to serving its intended purposes (illustrated by the atrazine case).

Before returning to the policy implications of these three points, the reasons for the uneasy balance struck between disclosure and concealment in scientific and legal practice should be probed more deeply. Why, and through what mechanisms, does each institution sometimes violate so foundational a principle as openness?

B. Legitimate Concealment?

Openness, it may be noted, is a concern only when someone who is outside a domain wishes to be or to look inside it. From this perspective, it is not

50. *Id.*
51. *Id.*
52. *Id.*
53. *Id.*
54. *Id.*

surprising that the vast bulk of scientific activity is never subjected to demands for more transparency. In the everyday world of the laboratory or the field, most researchers go about their business without feeling constrained by closed doors or locked drawers; they are in free communication with co-participants in the production of new knowledge. Nor, in the absence of specific reporting requirements,[55] are they required to account to outsiders for their routine activities. The situation changes dramatically when the products of the lab bench, namely scientific claims and representations, are used to justify actions taken outside the spaces of research—for example in supporting a patent application, or in supporting or questioning a regulatory decision, or in charging a manufacturer or discharger with negligence. It is in these situations—when science moves from contexts of production to contexts of public use and application—that pressures for disclosure most often arise.[56] Communication among and certification by peers and co-workers are no longer sufficient to guarantee the quality and relevance of the science in question. Critics situated outside the original research environment also ask to be allowed to look in at the way the claimed research was done.

When are these demands entitled to respect, and how should the law respond? Should any interested outsider have the right, on demand, to gain access to any aspect of public, or policy-relevant, science that the challenger thinks ought to be questioned? To clarify these issues further, it is necessary to characterize the most common sources of sequestration in public science. Each kind of concealment is problematic when not kept within reasonable bounds, but each is justifiable under some conditions. In each case, too, the problem revolves as much around the appropriate audience for the disclosure (to whom should science be open?) as it does around what should be disclosed and by whom. Once again, the problem for law and policy is how to strike the right balance between the competing demands of concealment and disclosure.

There is, to begin with, the kind of secrecy that everyone deplores but that is fostered by institutional cultures of self-interest, both public and private—when scientific facts that the public has a right to know are intentionally hidden and knowingly withheld to preserve the economic or political standing of powerful organizations. Examples include drug companies that fail to disclose reports of adverse reactions to their products,[57] car manufacturers that hide technical defects in their vehicles,[58] employers and polluters who conceal data about

55. Researchers working with animal and human subjects, for example, must maintain records that satisfy legal obligations for animal welfare and informed consent. Testing laboratories must satisfy legally mandated standards for good laboratory practices and maintain the records needed to make their operations transparent to inspectors.

56. *See generally* JASANOFF, THE FIFTH BRANCH, *supra* note 3 (providing an analysis of the interaction between advisory committees and the scientific process).

57. *See* discussion *supra* Part II.A.

58. In August 2000, for example, Bridgestone-Firestone announced the recall of tires because of tread separations that were alleged to have caused dozens of fatal accidents. Although Ford Motor Company had recalled similar tires on vehicles sold outside the United States, those recalls were not reported to the U.S. National Highway Traffic Safety Administration. Tamara Audi & Jennifer Dixon,

illness caused by their activities,[59] and governmental agencies that paper over malfunctions in technologies that are deemed key to the success of their missions.[60] Impediments to criticism and communication have also arisen within universities, the traditional strongholds of scientific openness, as a result of private sponsorship that contractually demands secrecy.[61] Yet, problematically for law and policy, unlawful or indefensible concealment is bound up even in these relatively clear-cut cases with defensible grounds for not making things known. Corporate-funded science, for example, may enjoy commercial confidentiality, and publicly funded science in sectors such as computers or biotechnology may be shielded by legitimate, if overused, demands for secrecy in the name of national security.[62] Even the legal process, which prizes openness as a core value, sanctions some types of concealment because it is deemed to serve the higher purpose of delivering justice.[63]

Second, institutional features of large organizations may impede the flow of scientific and technical information in ways that serve key organizational interests, but that produce the effect of concealment without malign intent. Such blindness occurs, in particular, when organizations "normalize deviance," that is, rationalize seemingly harmless deviations from rules so that they become taken for granted and part of the routine. Recording every minor misstep could bring any organization to a grinding halt, and some level of trust in colleagues is essential to an organization's effective functioning. At what point the mere suspicion of things being wrong rises to the level of reportable misconduct is always a discretionary question, as Merck argued in connection with its internal e-mails on Vioxx.[64] On the other hand, failure to report repeated, systemic problems creates the preconditions for more serious breakdowns. It may take a disaster to sound a wake-up call. Signals of failure at low temperatures in the o-rings of the Challenger space shuttle's booster rocket went officially unnoticed until the shuttle blew up in 1986;[65] years later, the loss of the Columbia space shuttle in January 2003 revealed similar

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Documents Show Ford Was Warned About Tire Tread; Automaker Says It Acted Quickly Once It Received Hard Data, DETROIT FREE PRESS, Oct. 6, 2000, at 1A.

59. *See, e.g.*, PAUL BRODEUR, OUTRAGEOUS MISCONDUCT: THE ASBESTOS INDUSTRY ON TRIAL (1985) (relating how companies such as Johns-Manville and W.R. Grace & Company systematically concealed medical information about the nature and extent of asbestos-induced diseases among their workers).

60. See DIANE VAUGHAN, THE CHALLENGER LAUNCH DECISION: RISKY TECHNOLOGY, CULTURE, AND DEVIANCE AT NASA 238–77 (1996) for a discussion of the defects in reporting and communication that led to the loss of the space shuttle Challenger.

61. KRIMSKY, *supra* note 21, at 27–52 (describing how corporate and industrial funding at major universities, including Harvard and the University of California at Berkeley, has led to unethical research, inappropriate conflicts of interest, and biased hiring and firing decisions).

62. *See, e.g.*, Ryan Ricks, *Science and Security in the Post-9/11 Environment*, AAAS Science and Policy Programs (July 2004), http://www.aaas.org/spp/post911/publishing/ (discussing how concerns of national security have been used to restrict the availability of scientific data since the terrorist attacks on September 11, 2001).

63. *See* discussion on this point *infra* Part IV.

64. *See* discussion *supra* Part II.A.

65. VAUGHAN, *supra* note 60, at xi–xiii, 238–77.

organizational blinkers.[66] Similarly, the 9/11 Commission's report called attention to the failure of public authorities to predict adequately on the basis of available knowledge.[67] Within science, misconduct cases have reached egregious proportions before colleagues of the deviant scientists were prepared to acknowledge that something was wrong.[68]

Third, claims of inappropriate concealment may arise when technical information moves across institutions that have different, perhaps incompatible, standards of disclosure and transparency—as, for example, from the lab bench to a regulatory agency or court of law. Relations of trust that are present within and between institutions familiar with each other's mission and operations often break down when information crosses cultural lines. Police departments, for instance, may trust their testing laboratory's investigative protocols when seeking information about a suspect's DNA. Those same protocols may be questioned more critically by defense attorneys when the test results could affect their client's life or liberty or could determine a child's parentage and immigration status. Thus, in the O.J. Simpson trial,[69] defense lawyers in effect asked permission to replicate the tests done by Cellmark, the lab used by the prosecution.[70] The defense demanded a share of the crime scene blood samples in order to conduct its own tests.[71] The request was not granted, but the episode illustrates how divergent standards of credibility may be invoked when science travels into legal contexts.[72] Similarly, industries affected by EPA's standard for fine particulate matter wanted access to the supporting epidemiological data produced by the Harvard School of Public Health;[73] for opponents of the rule, the acceptance of those data by the researchers' scientific peers and their publication in professional journals were not sufficient warrants of credibility. That controversy led to the enactment of the so-called Shelby amendment, which provides broad public access to federally funded research used to support regulatory decisions.[74]

Fourth and finally, disclosure alone may amount to little more than concealment unless it is made to audiences who can perform the desired critical

66. COLUMBIA ACCIDENT INVESTIGATION BOARD, FINAL REPORT ON COLUMBIA SPACE SHUTTLE ACCIDENT 122–92 (vol. 1 2003), *available at* http://anon.nasa-global.speedera.net/anon.nasa-global/CAIB/CAIB_lowres_full.pdf.

67. 9/11 COMMISSION, FINAL REPORT OF THE NATIONAL COMMISSION ON TERRORIST ATTACKS UPON THE U.S. 254–77 (2004) (referring to frequent, but neglected, threats of terror attacks throughout 2001).

68. *See* WILLIAM BROAD & NICHOLAS WADE, BETRAYERS OF THE TRUTH 161–80 (1982) (discussing the "club" atmosphere of scientific communities).

69. In the mid-1990s, former athlete O.J. Simpson was accused of and tried for the murder of his wife and her friend. For more details of this legal controversy, see Sheila Jasanoff, *The Eye of Everyman: Witnessing DNA in the Simpson Trial*, 28 SOC. STUD. SCI. 713 (1998).

70. *Id.* at 724–25.

71. *Id.* at 725.

72. *Id.* at 726.

73. The study is published in Douglas W. Dockery et al., *An Association Between Air Pollution and Mortality in Six U.S. Cities*, 329 NEW ENG. J. MED. 1753 (1993).

74. The Shelby Amendment was passed as a rider to the Omnibus Appropriations Act for Fiscal Year 1999, Pub. L. No. 105-277, 112 Stat. 2681-495 (1998).

functions. Thus, review by experts may not, in and of itself, effectuate the purposes of disclosure. They must also be the right experts. Being a scientist does not necessarily confer a privileged position with respect to ensuring adequate quality control—even if experts in the aggregate are better informed than laypeople about major scientific theories or better able to judge the plausibility of complex mathematical estimates. In cases involving public science, experts may be too self-interested or too narrow in their disciplinary outlook to ensure unbiased review. For instance, a scientist with expertise in tropical forest ecosystems may be poorly placed to evaluate intricate arguments about ocean-atmosphere feedback loops influencing climate change, and a behavioral geneticist may be far less capable of assessing the health effects of silicone gel breast implants than the scientifically untrained woman who actually wears them in her body.

To detect problems in scientific arguments, it takes sufficient familiarity to appreciate the subject matter under discussion and, at the same time, sufficient detachment and distance to want to query the objectives and methods underlying particular claims.[75] That detachment is especially hard to achieve in the context of highly consequential public science, in which the intellectual and social biases of experts are most likely to come into play.[76] Difficulties in securing responsible criticism are compounded when, as is often the case for public science, claims and data cut across disciplines, involve significant uncertainties or entail significant methodological innovations.[77] Achieving an acceptable balance between blind trust and unfounded skepticism in review processes for this kind of science has proved to be problematic for governments.[78]

All these considerations point to a need to reevaluate the practices by which scientific knowledge comes to be either sequestered or else made openly available in decisionmaking environments. Everyone has an interest in preventing cases of outrageous misconduct, in which the knowing concealment of critically important data leads to injury or death. But given the central role of science in public life, correcting these most flagrant abuses cannot be the only goal. It is important to ensure that good scientific information not only is available in the abstract, but also is *made* available to the right people, at the right times, and in ways that promote accountability in the production, transmission, and use of knowledge. Ideals of openness need to be extended, in

75. Sociologist of science Donald MacKenzie argues that there is a "credibility trough" that operates in relation to scientific claims: in general, those closest to the production of knowledge (the primary research community) and those most distant from it (laypeople, for instance) tend to be most skeptical of claims; other users and consumers of knowledge are more trusting, or credulous. In the context of public science, regulatory agencies and their expert reviewers arguably fall within that intermediate zone of lowered skepticism. DONALD MACKENZIE, INVENTING ACCURACY: A HISTORICAL SOCIOLOGY OF NUCLEAR MISSILE GUIDANCE 370–72 (1990).

76. For a hard-hitting investigation of the failure to achieve balance in science during the George W. Bush administration, see CHRIS MOONEY, THE REPUBLICAN WAR ON SCIENCE (2005).

77. *See generally* JASANOFF, THE FIFTH BRANCH, *supra* note 3.

78. On the recurrent problems of scientific advice to government, see *id.*

short, not only to the factual outputs of scientific research, but also—judiciously—to science as a dynamic, social process of knowledge-making, with normative components that call for public debate. And complicating all moves toward greater transparency is the need to balance openness against institutionally well-justified needs for concealment, or black-boxing, in both science and law.

III

BLACK-BOXING KNOWLEDGE: SEQUESTRATION WITHIN SCIENCE

Observers of science from Merton and Polanyi onward have claimed openness as one of the core values of scientific research. Science would not be science without the structured peer criticism that Merton referred to as "organized skepticism."[79] The belief that science transcends political and cultural borders and is, or ought to be, equally open to all animates the work of scientific societies such as the International Council for Science.[80] Recent work decrying the negative influence of corporate funding on scientific exchange also assumes that openness is the expected and desired state of affairs in science.[81] Federal laws and policies mandating disclosure, insisting on peer review, protecting whistle-blowers, and penalizing fraud in science give legal effect to these deep-seated convictions.

These bows toward transparency in public science need to be juxtaposed, however, with the contrasting metaphor of the "black box" that has grown from work in the past three decades in the social studies of science and technology.[82] The concept of black-boxing describes the consolidation of scientific theories and claims, as well as of technological systems,[83] into entities that resist being pulled apart, or seen through, once they become stable or established. The "facts" of science and the products of technological systems become resistant in this way when they are backed by sufficiently strong coalitions of actors, institutions, norms, practices, and artifacts.[84] Once this condition is attained, the means by which facts were produced or artifacts took on particular shapes, however contested these means may once have been, are eventually boxed up

79. MERTON, *supra* note 10, at 277.

80. This commitment is reflected in the International Council for Science's adherence to the Principle of the Universality of Science, which stresses the need for free flow of scientists and scientific information across political borders. *See supra* note 1 and accompanying text.

81. *See* DANIEL S. GREENBERG, SCIENCE, MONEY, AND POLITICS: POLITICAL TRIUMPH AND ETHICAL EROSION (2001) (discussing the politics of and financing of science in the last half century); KRIMSKY, *supra* note 21, at 177–95 (criticizing the decline of public-interest science done in universities).

82. *See, e.g.*, LATOUR, *supra* note 8, at 2–3, 81–82; THE SOCIAL CONSTRUCTION OF TECHNOLOGICAL SYSTEMS: NEW DIRECTIONS IN THE SOCIOLOGY AND HISTORY OF TECHNOLOGY 21–22 (Wiebe Bijker et al. eds., 1987) [hereinafter SOCIAL CONSTRUCTION].

83. *See* SOCIAL CONSTRUCTION, *supra* note 82 (discussing the concept of the black box in technological systems).

84. *See* LATOUR, *supra* note 8, at 179–257; Michel Callon, *Some Elements of Sociology of Translation: Domestication of the Scallops and Fishermen of St. Brieuc Bay*, *in* POWER, ACTION, AND BELIEF: A NEW SOCIOLOGY OF KNOWLEDGE? 196 (John Law ed., 1986).

and made invisible in everyday social interaction.[85] The process of producing science becomes less transparent with the passage of time.

Black-boxing of this kind, sociologists have argued, is essential to the progress of science and, to some extent, also of technology.[86] It is the feature that permits later generations of scientists to accept and build on the work of earlier ones without needing to go back and redo every step that others may have traversed.[87] Indeed, it would be perverse to insist on reexamining the foundations of securely established knowledge once they have been firmly laid down through long testing and repeated practical reconfirmation.[88] At some point, most scientists would argue, valid claims reach a state of repose that *should* preclude further questioning of the ways in which they were produced. This sense of legitimate closure applies not only to basic or bench science, but also to much-studied phenomena in the realm of regulatory or policy-relevant science: for example, that tobacco smoke causes cancer or that we are experiencing a period of anthropogenic, or human-caused, climate change. When claims have arrived at a certain degree of robustness, then asking for renewed scrutiny of the ways in which those conclusions were reached strikes many observers not as justifiable curiosity but as "manufacturing uncertainty" for political ends.[89] When public health and safety are at stake, such needless production of uncertainty could be not erely frivolous but downright dangerous.

As has been extensively documented, the black boxes of science refuse to stay closed under the pressure of adversarial processes—and claims begin to unravel no matter how secure relevant scientific or policy communities believe the black-boxing to have been.[90] From a policy standpoint, such deconstruction is often warranted because it reveals previously unacknowledged methodological bias or weakness and can lead to eventual improvements. Evidence from DNA tests, for example, was at first deemed foolproof and hence was uncritically accepted in dozens of U.S. criminal trials until, beginning with the New York case of *People v. Castro*[91] and the Minnesota case of *Schwartz v. State*,[92] knowledgeable experts

85. LATOUR, *supra* note 8, at 218.

86. On the black-boxing of technology, see SOCIAL CONSTRUCTION, *supra* note 82.

87. *See* LATOUR, *supra* note 8, at 80–83 (describing how robust scientific claims get tied to too many black boxes for a would-be dissenter to be able to untie them all).

88. Both scientists and lawyers speak about replication as the ultimate test of validity of a claimed scientific fact. In practice, however, studies and experiments are seldom replicated. Even if they were replicated, the conditions of replication would never be identical, and skeptics could keep questioning the results through a process termed "experimenters' regress." *See* COLLINS, *supra* note 8, at 2, 84 (defining the principle of experimenter's regress).

89. David Michaels, an epidemiologist at George Washington University, uses the term "manufactured uncertainty" to refer to the practice of corporations challenging scientific findings in order to delay government action based on those findings. Jeff Nesmith, *New Product for U.S. Industry: "Manufactured Doubt,"* AUSTIN AM-STATESMAN, June 26, 2005, http://www.statesman.com/search/content/insight/stories/06/26doubt.html.

90. For historical accounts, see SHEILA JASANOFF, SCIENCE AT THE BAR: LAW, SCIENCE, AND TECHNOLOGY IN AMERICA (1995) [hereinafter JASANOFF, SCIENCE AT THE BAR] and TAL GOLAN, LAW'S OF MEN AND LAWS OF NATURE: THE HISTORY OF SCIENTIFIC EXPERT TESTIMONY IN ENGLAND AND AMERICA (2004).

91. 545 N.Y.S.2d 985 (Sup. Ct. 1989).

began questioning the methods used by DNA-typing companies, leading courts to reject the evidence. Subsequent wide-ranging efforts to standardize testing practices greatly improved the consistency and reliability of DNA identification.[93] Similarly, the protocols for government-funded clinical trials of AIDS drugs changed significantly when patient groups began questioning the need for restrictive methodological assumptions,[94] and pressure from women and minorities led the NIH to formally require that researchers include understudied groups as subjects in epidemiological research.[95] Partly with such examples in mind, a committee of the U.S. National Research Council recommended in 1996 that official risk assessments should be open to a recursive analytic–deliberative process in order to expose all phases of expert decisionmaking to wider public supervision.[96]

Yet there are strong arguments favoring the erection of some bulwarks against the full-blown deconstruction of public science. Even within research science, peer review and publication mark a sort of closure, a limit to transparency. Scientists generally feel they can put their skepticism on hold when relying on published results to develop further work, although the process of publication is never wholly open—identities of reviewers are frequently protected in order to encourage honest appraisals, and publication itself entails considerable editorial discretion.[97] From a policy standpoint, the reasons for closure are still more compelling. Decisions cannot be postponed indefinitely while relevant facts are questioned and re-questioned. Prudence demands that scientific debates should not be allowed to proceed unchecked when there are potentially grave consequences for public health and safety. Indeed, the growing recognition of the precautionary principle in international environmental and health law reflects the world community's acceptance of precisely this normative judgment.[98] Effective policy systems therefore have to include stopping rules[99] that close debate when it no longer serves the public interest. Applied to science, these rules would block skeptical inquiry beyond some point that society holds to be reasonable. The law decrees when enough is enough, and at that point transparency ends.

A related set of concerns originates in the sociology of science, where scholars have wondered how to ensure that criticism of public science is founded on

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92. 447 N.W.2d 422 (Minn. 1989).

93. On the standardization of DNA tests, see NATIONAL RESEARCH COUNCIL, THE EVALUATION OF FORENSIC DNA EVIDENCE (1996) and Eric S. Lander & Bruce Budowle, *DNA Fingerprinting Dispute Laid to Rest*, 371 NATURE 735, 735–38 (1994).

94. STEVEN EPSTEIN, IMPURE SCIENCE: AIDS, ACTIVISM, AND THE POLITICS OF KNOWLEDGE 208–64 (1996).

95. UNDERSTANDING RISK: INFORMING DECISIONS IN A DEMOCRATIC SOCIETY 118–32 (Paul C. Stern & Harvey V. Fineberg eds., 1996) [hereinafter UNDERSTANDING RISK].

96. *Id.* at 3–4.

97. *See* JASANOFF, THE FIFTH BRANCH, *supra* note 3, at 61–83 (analyzing peer review and its relationship to the scientific process).

98. *See generally* PRECAUTION: ENVIRONMENTAL SCIENCE AND PREVENTIVE PUBLIC POLICY (Joel A. Tickner ed., 2003).

99. *See* discussion *infra* Part IV.

defensible epistemological grounds.[100] Put simply, not everyone is equally well positioned to formulate meaningful questions about science in a given policy context. Can we then ask whose inputs are essential to improving the quality and reliability of policy-relevant science, and then tailor our transparency mechanisms to ensure that these, and only these, critics come within the charmed circle of openness? In other words, can the question "Open to whom?" be resolved by issuing entry tickets to designated kinds of persons and excluding all others?

In one exploration of how to identify the appropriate critics, Harry Collins and Rob Evans argued that legitimate participants in a scientific debate ought to satisfy one or more of three criteria of relevant expertise: (1) they should be able to *contribute* directly to the subject matter under debate (as in disciplinary peer review), (2) they should be in a position to *interact* conceptually with those at the core of the debate (as in the case of expert witnesses questioning DNA tests in *Castro* and *Schwartz*), or (3) they should have *experiential* knowledge relevant to the issues being debated (as in the case of AIDS patients involved in a clinical trial or the wearer of breast implants in a legal proceeding about the implants' effects on health).[101] They should, in other words, possess contributory expertise, interactional expertise, or experiential expertise. Presumably, persons who do not meet any of these tests should be excluded from attempts to join a controversy that leads to the opening up of otherwise black-boxed scientific claims.

It is unlikely, however, that these threshold tests of expertise could have prevented the sorts of prolonged controversies that have arisen in connection with the effects of tobacco or, on a global scale, the causes of climate change. In these cases, which were widely judged to be unproductive for public policy, dissident scientists[102] frequently met the first two of Collins's and Evans's tests of epistemic competence: they belonged to the set of clearly knowledgeable, contributory experts or they were in a position to interact productively with that core set. It is not, then, the technical qualifications of experts that alone ensure unbiased or thorough scrutiny. Rather, the manufacture of uncertainty in these cases raised the kinds of procedurally grounded concerns encountered as well in the Vioxx and atrazine cases—specifically, the challengers were funded by special interests and represented only one perspective on the issues in question (imperfect accountability), or the basis for the challengers' claims was not as rigorously tested as the claims they were contesting (asymmetric standards), or, given the gravity of the possible harm, adequate stopping rules were not in place (excessive transparency).

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100. *See* H.M. Collins & Robert Evans, *The Third Wave of Science Studies: Studies of Expertise and Experience*, 32 SOC. STUD. SCI. 235, 235–39 (2004) (suggesting that expertise should be the measure of a critic's credibility).

101. *Id*. at 254–56.

102. One dissident scientist is MIT professor and atmospheric physicist Richard S. Lindzen who is known for vocal opposition to generally accepted beliefs about global warming. Richard S. Lindzen, *Global Warming: The Origin and Nature of the Alleged Scientific Consensus*, REGULATION, Spring 1992, *available at* http://www.cato.org/pubs/regulation/reg15n2g.html.

Epistemic closeness to a technical dispute undoubtedly helps critics open up crucial questions of theory and method, but it does not guarantee that second-order questions about the adequacy of knowledge or its fit to important social purposes will be raised, or raised in appropriate forms. Experts close to the technical heart of a debate are best at deciding whether science is good or not good, according to accepted professional standards of evaluation; they may be less well qualified to address what the science is good for or whether it is good enough. Moreover, when scientific knowledge crosses disciplinary lines or breaks new methodological ground, it may take a period of open-ended debate even to determine who has the expertise to advance the processes of knowledge-making and criticism.[103] In short, although Collins's and Evans's criteria might serve as necessary conditions for determining who must be included in the universe of possible critics, they are not sufficient to ensure lack of bias or full accountability in public science. Science's own ideas of quality must in these instances be supplemented by legal ideas of representation, fairness, relevance, and sufficiency.[104]

IV
SEQUESTRATION UNDER LAW

Problems of sequestration take different forms when science is generated and deployed within the legal process—which has become an increasingly important site of knowledge-making in modern societies. The law's background commitment, like that of science, is of course to total openness. Particularly in the United States, the law's no-holds-barred methods of discovery and of querying evidence[105] seem to effectuate that ideal. Procedures such as depositions and cross-examinations can reveal biases and shortcomings that do not surface through standard processes of scientific peer review and publication. Indeed, because litigation itself is such a powerful prod to producing new scientific evidence, adversarial legal processes sometimes provide the only significant testing ground for claims relevant to settling disputes.[106] Yet, what the law helps to generate it also sometimes chooses not to make public, and the reasons underlying these practices have largely been taken for granted by legal analysts and practitioners. Two of these reasons are worth examining more closely in order to determine when sequestration within the legal system may be considered legitimate.

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103. UNDERSTANDING RISK, *supra* note 95, at 84–85.

104. *See infra* Part V.

105. According to the Federal Rules of Civil Procedure,

> parties may obtain discovery regarding any matter, not privileged, that is relevant to the claim or defense of any party, including the existence, description, nature, custody, condition, and location of any books, documents, or other tangible things and the identity and location of persons having knowledge of any discoverable matter.

FED. R. CIV. P. 26(b)(1). Similarly, all relevant evidence—evidence tending to make more or less probable any fact of consequence to the case—is admissible unless otherwise prohibited. FED. R. EVID. 401–402.

106. JASANOFF, SCIENCE AT THE BAR, *supra* note 90, at 20.

First, the law's institutional interest in finality and repose is sometimes advanced to bar disclosures of scientific information. A telling example is the sealing of court records following an out-of-court settlement in private litigation. Justified as an inducement to parties to resolve their disputes without the expense of a trial, the practice nonetheless prevents potentially valuable scientific studies from entering the public domain. In cases involving repeated technological failure, as, for example, the case of Bic lighters igniting in users' shirt pockets,[107] sealing records may contribute to deaths and injuries that might have been prevented through timely disclosure. Similarly, the settlement of environmental damage claims may prevent the entry into the public domain of new knowledge about ecological or health risks. Advances in economics and other social sciences occurring in antitrust or discrimination cases may likewise escape disclosure through settlements.

The bias against reopening cases not only bars the introduction of new evidence but may stand in the way of socially beneficial research. Even in criminal cases, courts have not always opened their doors to the possibility of new scientific findings (such as DNA tests) that might, if ordered and credited, have overthrown prior convictions and judgments.[108] Uncertainty about judicial receptivity is an obvious disincentive to potentially costly scientific investigations. In civil cases, early settlement may deter follow-up studies of affected populations, thereby rendering invisible the longer term health and environmental effects that might have come to light through continued research.[109] In other words, the law's desire for finality not only impedes the disclosure of available science, but also militates against the open communication and exchange that lead to the production of new scientific knowledge. Science generated to serve the purposes of litigation remains case-bound and context-specific, often through specific acts of judicial sequestration. Hence, knowledge produced in the litigation context is less likely to circulate or to fertilize new research trajectories than knowledge produced in less constricted research environments.

Decisions to entrust judges with active gatekeeping functions in relation to scientific evidence create a somewhat different barrier to critical investigation of scientific claims under U.S. federal law. The Supreme Court's 1993 ruling in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*[110] and two subsequent evidence decisions[111] may be seen, in the context of our discussion, as moves to prevent the

107. Littlejohn v. Bic Corp., 851 F.2d 673 (3d Cir. 1988).

108. *See, e.g.*, Harvey v. Horan, 278 F.3d 370, 373 (4th Cir. 2002) (denying a prisoner's claim for postconviction DNA testing on the ground that legal finality cannot be sacrificed to changes in technology).

109. Health effects, in particular, may take longer to manifest themselves than the time to settlement, especially if they affect succeeding generations, as in the case of "DES daughters" born to pregnant women treated with diethylstilbestrol (DES), or induce long-latency diseases like cancer or neurological damage, as in the cases of Vietnam veterans exposed to Agent Orange or Bhopal victims exposed to gaseous methyl isocyanate.

110. Daubert v. Merrell Dow Pharm., 509 U.S. 579 (1993).

111. Kumho Tire Co. v. Carmichael, 526 U.S. 137 (1999); Gen. Elec. Co. v. Joiner, 522 U.S. 136 (1997).

deconstruction of a claimed scientific status quo on the basis of evidence that judges find inadequate.[112] The trilogy of evidence decisions aims, in principle, to set high threshold standards of adequacy for new scientific evidence. Evidence generated within the litigation context to serve a party's interests can never claim to be completely disinterested. In asking judges to scrutinize such claims with special care, the Supreme Court arguably recognized and sought to redress the problems of asymmetric standards and excessive transparency that have arisen in rulemaking processes such as EPA's evaluation of atrazine.

Daubert and its progeny serve as stopping rules against unwarranted deconstruction. Evidence deemed insufficient is kept away from jury members, who might not meet any of Collins and Evans's three criteria of epistemic competence.[113] But then neither do most judges. The three evidence rulings accordingly have introduced asymmetries and inconsistencies of their own into legal disputes about the quality and reliability of science. They have done so chiefly through an uncritical acceptance of the scientific method and by casting the judiciary in the role of amateur sociologists of knowledge.[114] In these decisions the Court also turns a blind eye to what we may call the political economy of knowledge production. Incentives for replicating and building on litigation-generated research are, at present, asymmetrically distributed. Corporate defendants have strong reasons, and resources, to sponsor studies that will negate claims made by plaintiffs' experts;[115] comparable incentives do not necessarily exist on the plaintiffs' side, except to the extent that lawyers expect to benefit from pursuing mass tort claims and may therefore support the production of necessary expert evidence. And neither corporate interests nor those of trial lawyers are likely, without additional safeguards, to lead to the production of the highest-quality scientific knowledge.

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112. In *Daubert*, the Supreme Court rejected general acceptance as the test for whether science is good or not good. 509 U.S. at 589. The Court chose, instead, to adopt a more stringent rule, which considers, among other things, whether the science "has been subjected to peer review." *Id.* at 593. After *General Electric Co.*, parties seeking to introduce science also must establish that the conclusions reached, as opposed to just the methods used, by science are relevant and established. 522 U.S. at 144, 147. The Supreme Court extended these stringent rules to technological testimony, as well, in *Kumho Tire Co*. 526 U.S. at 148–52.

113. *See* discussion *supra* Part III.

114. Sheila Jasanoff, *Law's Knowledge: Science for Justice in Legal Settings*, 95 AM. J. PUB. HEALTH S49, S49–S50, S53 (2005). For additional critical perspectives on *Daubert*, see JASANOFF, SCIENCE AT THE BAR, *supra* note 90, at 62–67 and John H. Mansfield, *Scientific Evidence Under Daubert*, 28 ST. MARY'S L.J. 1 (1996).

115. In the case of silicone gel breast implant litigation, for example, this defensive strategy led to the production of considerable amounts of epidemiological data tending to disprove claims of immune system disorders caused by the implants. Some commentators took this as evidence of the legal system's reliance on bad science, overlooking the law's pivotal role in prompting study of the issue in the first place. *See, e.g.*, MARCIA ANGELL, SCIENCE ON TRIAL: THE CLASH OF MEDICAL EVIDENCE AND THE LAW IN THE BREAST IMPLANT CASE (1996).

V
CONCLUSION: A REASONED TRANSPARENCY—OPENING BLACK BOXES IN SCIENCE AND LAW

Openness is a treasured attribute of science, but like most good things, even scientific openness has to be purposefully cultivated and judiciously deployed in order to serve its intended functions well. Taking Sissela Bok's treatment of secrecy as a point of departure, I have suggested that concealment, even when it is intentional, is not itself a problem for science. It is necessary to distinguish between good and bad concealment. For public science, that inquiry entails a critical look at sequestration practices that conceal science, unintentionally or otherwise, from particular audiences.

In practice, both scientific communities and other social institutions have recognized the need for trade-offs between partial sequestration and complete openness. Science is never wholly transparent to all eyes. Its instruments, processes, and outputs are only selectively available for external review and criticism—not necessarily to those audiences that could most effectively criticize or rely on them. Some potentially effective critics are barred from participation by lack of knowledge or access to information; others are too close to the research to have the necessary critical detachment; still others are excluded through organizational practices that produce concealment as an unintended consequence. As the links between science and society have grown more dense and as science has come to influence more decisions affecting the collective well-being of democratic societies, the need has therefore grown to reexamine the practices of sequestration and to adjust, if need be, the existing compromises between openness and concealment.

That the quality of scientific claims is no longer the only issue of social concern complicates that rebalancing. Supplementary questions about the purposes of science (what is it good for?) and about its adequacy (is it good enough?) have grown in significance over the past several decades. Those normative judgments cannot be left exclusively in the hands of researchers responsible for producing knowledge. Accordingly, standard practices of review by technically informed peers have to be extended to include other interested and informed critics. In the case of public, or policy-relevant, science, the question, "How transparent should science be?" thus entails an automatic corollary: To whom should it be transparent? Experience suggests that this question can be answered fruitfully only if we recognize and take note of some common pathologies of science-based decisionmaking. Three common pathologies were identified above as worthy of special attention, namely, the problems of imperfect accountability, asymmetric standards, and excessive transparency.

All three affect the production of reliable scientific knowledge, but all reflect at bottom procedural deficiencies: withholding access from, or in some cases granting it to, the wrong people, at the wrong times, for the wrong purposes. The law—with its traditional emphasis on procedural adequacy—

should serve in principle as an important source of corrective principles and policies. Those principles may have to be reflexively applied within the law itself. Even though the law has become an important site for the production of public science, it operates with its own institutional interests and practices that may at times stand in the way of optimal openness.

If opening up science to the world at large is neither feasible nor likely to produce more reliable results, how can citizens be assured that their interests will be fairly represented in the evaluation of public science? U.S. administrative law offers two solutions, which, if consistently implemented, might make for significant improvements and might also prevent blatant episodes of illegitimate concealment. The first is to leave it to citizens themselves to answer the question, "Open to whom?" In effect, legal provisions that permit interested and affected parties to question the basis of agency decisions do just that, although in practice it may take exceptional resources or motivation to make use of the rights so granted. The second approach is to ensure, as far as possible, that public science is evaluated by bodies representing an adequate range of competence and interests, as the Federal Advisory Committee Act seeks to do. To include an appropriate breadth of perspectives, it may be necessary to accommodate both lay and professional viewpoints, as is currently done in many ethics advisory committees.[116] The normative questions that arise in the assessment of policy-relevant science may demand a similar expansion in the membership of important technical advisory committees as well.

Notions of fairness and balance, systematically applied, could go some distance toward correcting the problem of asymmetric standards. Courts, agencies, and other governmental decisionmakers are frequently in a position to note, and remedy, the application of discrepant standards to science emerging from different sources. There are a number of recurrent sources of asymmetry in disputes involving public science. For example, is privately generated science subject to the same requirements of disclosure and peer review as science sponsored with public funds? Are different disclosure standards being applied in different institutional contexts or (as in the recent controversies over pharmaceutical drug trials) applied to negative as opposed to positive study results? Are inappropriately high thresholds being set for those who produce novel evidence or develop new methods, especially in work that reveals previously unrecognized risks and threats?

Finally, well-crafted stopping rules, such as the law's very general rule of stare decisis[117] or rules of judicial deference to expert agency judgments,[118] can

116. *In re* Quinlan, 355 A.2d 647, 668 (N.J. 1976) (noting that most hospital ethics committees are comprised of members who are not doctors).

117. The doctrine of stare decisis requires courts "to follow earlier judicial decisions when the same points arise again in litigation." BLACK'S LAW DICTIONARY 1414 (7th ed. 1999).

118. *See* Chevron, U.S.A., Inc. v. Natural Res. Def. Council, 467 U.S. 837 (1984) (holding that an agency's permissible construction of the statute it administers is entitled to deference if Congress has not directly spoken to the precise question at issue); Baltimore Gas and Elec. Co. v. Natural Res. Def.

provide some protection against excessive transparency. In determining when to end further debate, thereby black-boxing the scientific status quo, judges and policymakers should, however, ask focused questions about the adequacy of the debate that has already taken place. Generally, the argument for continued debate or additional review is weakest where delegation and fairness concerns are explicitly addressed and where there are no pressing questions about the epistemic competence of researchers or reviewers. Correspondingly, a demonstration that these basic attributes of rational decisionmaking were neglected offers strong grounds for opening up contested scientific matters to wider scrutiny.

The transparency of science generated for the purpose of litigation raises additional issues for law and policy. Here, the question is not only about how to ensure the quality and reliability of expert evidence—the concerns addressed in the Supreme Court's three evidence rulings—but also, when appropriate, about how to ensure its evenhanded production and wider dissemination for the benefit of science and society. The law's focus on individual cases and its commitment to closure create substantial disincentives to the free flow of knowledge, and it will take thoughtful institutional innovations to lower those barriers without compromising the interests of justice. Settlement practices, in particular, need to be reexamined to make sure that expediency in the particular case does not override society's need for accumulating knowledge. Made suitably anonymous, registers of studies conducted pursuant to products liability or environmental damage lawsuits could serve a data-gathering function similar to NIH's register of negative clinical trials of pharmaceutical drugs. Once we recognize, moreover, that litigation is an indispensable aid to knowledge production, procedures aimed at increased transparency, such as enforced negotiation between parties and some forms of external review, could be devised to improve the quality and reliability of the science that lawsuits help generate.

It is perhaps appropriate to end these reflections on the openness of public science with a final comment on *Daubert*, celebrated for more than a decade as returning the control of science in the legal process to scientists—mediated, to be sure, by judges who are trusted to apply science's own standards to the admissibility of evidence. Besides its much-discussed conceptual weaknesses, the *Daubert* trilogy shuts off the kind of normative inquiry that should be central to the evaluation of public science. It is not enough for judges looking at evidence generated within the legal process to ask only the question that scientists have classically asked of each other's work: "Is it good science?" Judges, as society's delegates, should also ask the normative questions that must be raised in evaluations of public science: Is the science good for the purposes we need it for, and is it good enough for those purposes? In allowing those

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Council, Inc., 462 U.S. 87 (1983) (holding that the court's only task on review is to determine whether the agency has considered the relevant factors and articulated a rational connection between the facts it found and the choice it made).

issues to resurface within the purview of admissibility hearings, sophisticated post-*Daubert* judges may conclude that they should think not only like scientists, but also like concerned and committed citizens—arguably, in short, like jurors.