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**Conjectures and exhumations: Citations of history, philosophy and sociology of science in US federal courts**

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## Conjectures and exhumations: Citations of history, philosophy and sociology of science in US federal courts

### Abstract

This article examines the circumstances in which a version of Sir Karl Popper's philosophy of science became US law. Among historians, philosophers and sociologists of science, as well as legal commentators, the US Supreme Court's *Daubert v. Merrell Dow Pharmaceuticals, Inc.* (1993) decision has received considerable attention. The case is significant because America's most senior court produced a definition of science (for legal purposes). This definition was authorized by the symbolic exhumation, celebration and appropriation of key elements of the philosophy of science developed decades earlier by Popper. Significantly, it was not just Popper's philosophy that was exhumed and resurrected but also his standing and the social authority of philosophy more generally. This article explores how the US Supreme Court invoked a mediated and essentialized representation of Popper's philosophy of science - in a context where the quality of expert evidence seems to have been conceived as a pressing socio-legal problem - to support the inauguration of a more onerous response to admissibility decision making in federal courts. In undertaking this task we also reflect on the use of the writings of other philosophers, historians and sociologists of science which have appeared somewhat erratically in recent judgments. These later references have been conspicuously less influential than the Supreme Court's attempt to grapple with the nature of science in *Daubert*.

In order to substantiate our claims we provide an analysis of references to the history, philosophy and sociology of science which have appeared in US federal court decisions. Our sample was gathered using the relatively straightforward methodology of searching the *WESTLAW* database for references to well-known authors from the history, philosophy and sociology of science. The search covered the period from the 1940's up to the time of writing. Our analysis is not quantitative (there were only a small number of relevant citations), but rather, qualitative. The significance and meaning of citations will be assessed against the backdrop of the wider socio-legal debates and judicial uses of *Daubert*.

### Keywords

federal, us, courts, sociology, philosophy, citations, science, conjectures, history, exhumations

### Disciplines

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# *Conjectures and Exhumations: Citations of History, Philosophy and Sociology of Science in US Federal Courts*

Gary Edmond & David Mercer

## *1. Introduction*

This article examines the circumstances in which a version of Sir Karl Popper's philosophy of science became US law. Among historians, philosophers and sociologists of science, as well as legal commentators, the US Supreme Court's *Daubert v. Merrell Dow Pharmaceuticals, Inc.* (1993) decision has received considerable attention. The case is significant because America's most senior court produced a definition of science (for legal purposes). This definition was authorized by the symbolic exhumation, celebration and appropriation of key elements of the philosophy of science developed decades earlier by Popper.<sup>1</sup> Significantly, it was not just Popper's philosophy that was exhumed and resurrected but also his standing and the social authority of philosophy more generally. This article explores how the US Supreme Court invoked a mediated and essentialized representation of Popper's philosophy of science — in a context where the quality of expert evidence seems to have been conceived as a pressing socio-legal problem — to support the inauguration of a more onerous response to admissibility decision making in federal courts. In undertaking this task we also reflect on the use of the writings of other philosophers, historians and sociologists of science which have appeared somewhat erratically in recent judgments. These later references have been conspicuously less influential than the Supreme Court's attempt to grapple with the nature of science in *Daubert*.

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database for references to well-known authors from the history, philosophy and sociology of science (see Appendix). The search covered the period from the 1940's up to the time of writing. Our analysis is not quantitative (there were only a small number of relevant citations), but rather, qualitative. The significance and meaning of citations will be assessed against the backdrop of the wider socio-legal debates and judicial uses of *Daubert*.

## 2. *Daubert: The legal apotheosis of Popper*

For those interested in expert evidence or the interactions between law and science more generally, the *Daubert* decision represents the most important judgment in recent years. Confronted with a range of inconsistent approaches to the admission of expert opinion evidence under the *Federal Rules of Evidence* (1975) ("FRE"), particularly concerning the application of the "general acceptance" test (drawn from *Frye*), the Supreme Court granted certiorari to hear an appeal from a Bendectin case.<sup>2</sup> Litigation over the teratogenic effects of Bendectin had been running in the federal courts for over a decade: although from the mid 1980s appellate courts had begun to exclude plaintiff's expert evidence, predominantly through an express preference for published epidemiological evidence on the issue of causation.<sup>3</sup> The *Daubert* judgment, however, confined itself to the issue of admissibility standards for expert opinion evidence under the FRE and whether the *Frye* general acceptance test had survived.

The entire Court agreed that the general acceptance test had not survived the enactment of the FRE in 1975. The majority replaced *Frye* with an emphasis on evidentiary reliability and an expectation that trial judges would undertake their own assessment drawing upon the features of "good science" and "the scientific method." In order to make admissibility decisions, the majority indicated that the judges were required to determine whether the evidence was properly scientific; that is, constituted genuine scientific knowledge. The majority, through Justice Blackmun's judgment, provided four criteria, effectively a judicial tool kit, to assist with that determination.

Ordinarily, a key question to be answered in determining whether a theory or technique is scientific knowl-

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edge that will assist the trier of fact will be whether it can be (and has been) tested. “Scientific methodology today is based on generating hypotheses and testing them to see if they can be falsified; indeed, this methodology is what distinguishes science from other fields of human inquiry.” **Green** 645. See also C. **Hempel**, *Philosophy of Natural Science* 49 (1966) (“[T]he statements constituting a scientific explanation must be capable of empirical test”); K. **Popper**, *Conjectures and Refutations: The Growth of Scientific Knowledge* 37 (5th ed. 1989) (“[T]he criterion of the scientific status of a theory is its falsifiability, or refutability, or testability”) (emphasis deleted).

Another pertinent consideration is whether the theory or technique has been subjected to peer review and publication. Publication (which is but one element of peer review) is not a *sine qua non* of admissibility; it does not necessarily correlate with reliability, see S. **Jasanoff**, *The Fifth Branch: Science Advisors as Policymakers* 61–76 (1990), and in some instances well-grounded but innovative theories will not have been published, see **Horrobin**, *The Philosophical Basis of Peer Review and the Suppression of Innovation*, 263 *JAMA* 1438 (1990). Some propositions, moreover, are too particular, too new, or of too limited interest to be published. But submission to the scrutiny of the scientific community is a component of “good science,” in part because it increases the likelihood that substantive flaws in methodology will be detected. See J. **Ziman**, *Reliable Knowledge: An Exploration of the Grounds for Belief in Science* 130–133 (1978); **Relman & Angell**, *How Good Is Peer Review?*, 321 *New Eng. J. Med.* 827 (1989). The fact of publication (or lack thereof) in a peer reviewed journal thus will be a relevant, though not dispositive, consideration in assessing the scientific validity of a particular technique or methodology on which an opinion is premised.<sup>4</sup>

The first two criteria — “testing” and “peer review and publication” —

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are interspersed with historical, philosophical, medical, and sociological support.<sup>5</sup> Popper and Hempel enter Supreme Court jurisprudence via reference to a legal academic, tort scholar Michael Green.<sup>6</sup> Jasanoff, Horrobin, Ziman, Relman and Angell, all appeared in *amicus curiae* briefs submitted to the Court in support of a variety of propositions. Of the four criteria, these first two were the most novel. The issue of testing was central to the *Daubert* judgment because it was characterized as the scientific method (or an essential component of it). Initially, the majority was so confident about the value of falsification/testing that they dispelled the need to worry about an expert's conclusions, providing the methods were reliable: "The focus, of course, must be solely on principles and methodology, not on the conclusions they generate."<sup>7</sup> Assumptions and practical complications underlying this rather ambitious dichotomization were subsequently read down by the Court in *General Electric Co. v. Joiner*.<sup>8</sup>

In addition to falsification, peer review and publication, the *Daubert* majority indicated that the known or potential rate of error of a scientific technique and whether it has been "generally accepted" in the relevant scientific community (re-introducing *Frye*) could also have a bearing on admissibility decisions.

Additionally, in the case of a particular scientific technique, the court ordinarily should consider the known or potential rate of error, see, e.g., *United States v. Smith*, 869 F.2d 348, 353–354 (CA7 1989) (surveying studies of the error rate of spectrographic voice identification technique), and the existence and maintenance of standards controlling the technique's operation, see *United States v. Williams*, 583 F.2d 1194, 1198 (CA2 1978) (noting professional organization's standard governing spectrographic analysis), cert. denied, 439 U.S. 1117, 99 S.Ct. 1025, 59 L.Ed.2d 77 (1979).

Finally, "general acceptance" can yet have a bearing on the inquiry. A "reliability assessment does not require, although it does permit, explicit identification of a relevant scientific community and an express determination of a particular degree of acceptance within that commu-

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nity.” *United States v. Downing*, 753 F.2d, at 1238. See also 3 Weinstein & Berger ¶ 702[03], pp. 702–41 to 702–42. Widespread acceptance can be an important factor in ruling particular evidence admissible, and “a known technique which has been able to attract only minimal support within the community,” *Downing*, 753 F.2d, at 1238, may properly be viewed with skepticism.<sup>9</sup>

The third and fourth criteria do not draw upon secondary (by which we mean non-legal literary) support. Instead, they referred to earlier appeals and influential legal texts.<sup>10</sup>

At this stage it is not our intention to make an assessment of whether the majority’s appropriation of the secondary authorities conform with their common sociological and philosophical iterations and uses nor to consider inconsistencies among the four criteria. Though, strictly speaking, falsification is normally interpreted as transcending sociologically orientated factors such as peer review and other philosophical criteria involved in confirmation of theories such as probabilistic analysis or the determination of error rates. What we do wish to emphasize is the degree of confidence invested by the majority in their Popperian inspired model of *the* scientific method and the absence, not only of conflicting and critical readings of Popper but of other philosophers and sociologists of science. The majority’s confidence was not, however, without qualification.

Whereas the majority expressed confidence in the utility of (what is presented as) Popper’s criterion, Chief Justice Rehnquist, joined by Justice Stevens, voiced a forceful dissent. Rehnquist CJ’s opinion exploits anxieties associated with moving conspicuously from legal discourse into other professional domains which might render legal decisions, reasoning and institutions vulnerable to exogenous criticism. Consequently, he urged caution:

Twenty-two amicus briefs have been filed in this case, and indeed the Court’s opinion contains no fewer than 37 citations to amicus briefs and other secondary sources. The various briefs filed in this case are markedly different from typical briefs, in that large parts of them do not deal with decided cases or statutory language — the sort of

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material we customarily interpret. Instead they deal with definitions of scientific knowledge, scientific method, scientific validity, and peer review — in short, matters far afield from the expertise of judges. This is not to say that such materials are not useful or even necessary in deciding how Rule 702 should be applied; but it is easy to say that the usual subject matter should cause us to proceed with great caution in deciding more than we have to, because our reach can so easily exceed our grasp.<sup>11</sup>

Accepting that trial judges would need to assume some kind of “gatekeeping *responsibility*,” Rehnquist CJ indicated that they should not be required to become “amateur scientists” or philosophers of science. The Chief Justice entertained serious doubts about the value of falsification as a legal standard.

I defer to no one in my confidence in federal judges; but I am at a loss to know what is meant when it is said that the scientific status of a theory depends on its “falsifiability,” and I suspect some of them will be too.<sup>12</sup>

Implying that the majority position raised more questions than answers, Rehnquist CJ wondered whether the criteria (especially falsification) would apply to expert opinion evidence tendered under the remaining (non-scientific) elements of the Rule 702 formulation: “technical and other specialized knowledge.”

Before proceeding, we should acknowledge that Blackmun J had also qualified the majority position and its reliance on secondary authority, through emphasizing differences between monolithic images of *law* and *science*.<sup>13</sup>

There are important differences between the quest for truth in the *courtroom* and the quest for truth in the *laboratory*. Scientific conclusions are subject to perpetual revisions. Law, on the other hand, must resolve disputes finally and quickly . . . That, nevertheless, is the balance that is struck by Rules of Evidence designed not for the exhaustive search for *cosmic understanding* but for the particularized resolution of legal disputes.<sup>14</sup>

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In practice, Rehnquist CJ's reticence and Blackmun J's qualifications both serve to sustain legal legitimacy while mediating potential criticism from outside the legal establishment.<sup>15</sup> Rehnquist CJ's reluctance to engage with the secondary literature operates as a legal prophylactic and Blackmun J's qualified incorporation as a form of legal inoculation.

Justice Blackmun's cosmological caveat — that at times courts may admit evidence that is in some ways less than scientific but still useful and *sufficiently* reliable — helps to create space for interpretive flexibility in the deployment of falsification. The idea that there is a clear distinction between exhaustive searches for cosmic understanding as opposed to the particularized resolutions of legal disputes, exploits a dichotomy which contradicts the broader rationale underpinning the majority *Daubert* judgment. Implicitly, warrant for the particularized resolution of legal disputes is reliant on reference to and conformity with “cosmic” scientific understanding; otherwise there would be little need for the level of concern displayed in *Daubert* with scientific methodology. In such circumstances, the admissibility of scientific claims could be evaluated against more pragmatic considerations. The cosmological caveat hints at the polysemous nature of scientific method doctrines.<sup>16</sup> Falsification could be used to demarcate — in a non-pejorative capacity — when expert evidence was not science, such as in the case of technical or specialized knowledge, but representations could also be more pejorative when the evidence was deemed “bad” or “junk” science. Flexibility in the classification and description of expert opinion evidence offered trial judges considerable discretion.<sup>17</sup> As we shall see, the flexible extension of testing to all expert opinion evidence in subsequent jurisprudence limited the significance of such formal boundaries.

The model(s) of science and assortment of authorities associated with the *Daubert* criteria are revealing. It would be inappropriate to describe the positions of the philosophers, sociologists and historians cited in *Daubert* as consistent or even reconcilable.<sup>18</sup> The approaches to science developed by Popper (1902–94) and Hempel (1905–97) represent different traditions within the philosophy of science and could not be considered to be representative of the numerous approaches to the sciences found in historical or contemporary studies of science or even in the pronouncements of scientists.<sup>19</sup> If we accept that attempts at fair representation might be difficult, controversial and are not the primary aim of

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judges, a more rewarding approach is to inquire about the reasons for the appearance of specific philosophers and sociologists of science and selections from their works, and the particular configurations of science that were developed in *Daubert* and the judgments which followed it. In attempting to pursue this mode of inquiry it is our contention that through the quite deliberate emphasis on falsification/testing the Court sought to inaugurate not only a more consistent — the putative reason for granting certiorari — but a more onerous approach to admissibility decision making within the federal courts.<sup>20</sup> We recognize, in adopting such an orientation, that many other descriptions of the sciences were available.<sup>21</sup>

Despite a few qualifications pertaining to peer review and publication, drawn from Jasanoff, Ziman, Horrobin, Angel and Relman (cited above), the *Daubert* criteria were intentionally focused on testing — particularly whether an opinion had actually been tested — and the (positive) existence of published materials.<sup>22</sup> This reading tends to be supported in Rehnquist CJ's dissent, where he wonders about the judicial response to falsification, and in judgments after *Daubert* where judges endeavoring to apply its doctrine have drawn most conspicuously on the positive aspects such as whether scientific (and other) knowledge claims *have been* literally tested and whether experts had *previously published* their opinions.<sup>23</sup> Indeed, in the following section we will consider how the Court of Appeals dealing with *Daubert* on remand modified the publication and peer review criteria to incorporate a test sensitive to the motivations guiding scientific inquiry. In the overwhelming majority of appeals, *Daubert's* qualifications to peer review and publication, drawn from (without endorsing) the constructivist approach of Jasanoff and others, are not only elided, but the subsequent preoccupation with and stigmatization of “science for litigation” sit very awkwardly against Jasanoff's published work.<sup>24</sup> It is perhaps not surprising to find Popper cited more often, and peer review and publication used routinely in decision making without reference to the qualifications and theoretical assumptions underpinning the writings of Jasanoff and others.

The philosophy of science developed by Popper (and others who appeared in the *Daubert* judgment such as Hempel and Jasanoff *et al*) was not in any simple way determinative of the models of science ultimately promoted in the judgments that cited it. Indeed Popper's philosophy of

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science was invariably described (or summarized) in a most cursory and rudimentary manner. Rather than represent the sudden appearance of Popper (and the others) as an attempt to engage with or accommodate the history, philosophy and sociology of science, judicial reference to such work seems to operate as synecdoche for an implicitly *proper* and *comprehensive* representation of science and its processes.<sup>25</sup> Invoking Popper and others in order to articulate a new vision of (what is consistently presented as *good*) science for legal settings was a deliberate response to anxieties about the prevalence of questionable expertise and gratuitous lawsuits in US courts. The new rigor endorsed by *Daubert* simultaneously promulgated judicial “gatekeeping”; supplanting “screening” as the appropriate metaphor through which to conceptualize admissibility decision making.

Toward the end of this paper we will return to a more theoretical discussion of the sudden and relatively infrequent appearance of the history, philosophy and sociology of science in US federal courts. In the interim our trajectory will incorporate a range of cases intended to inform our assessment of the uses of Popper by providing the reader with a broad sample for comparative purposes. Our first step is to consider how Popper fares after his apotheosis in the *Daubert* decision.

### ***3. Post-Daubert and Kumho: The Sublimation of Popper***

It might not be surprising to find that in the wake of *Daubert* federal courts adopted a variety of responses to expert opinion evidence and the authority of historians, sociologists and philosophers supporting it. The following examples are intended to provide some sense of approaches and adaptations; they include: *bare citation* — *Daubert* as precedent; *modification and extension, leading to differentiation*; and finally, in *Kumho*, another appeal to the Supreme Court, the *sublimation of Popper* as testing became a self-supporting legal test potentially applicable to all expert opinion evidence. With the exception of *Kumho* all of the cases cited below draw upon not only *Daubert* but also some of the secondary sources cited in *Daubert*.

Of all the secondary authors referred to in the enunciation of the *Daubert* criteria, Popper is the most frequently cited. Most of the judgments citing Popper seem to serve the purpose of articulating the standard to be used by judges in making admissibility decisions after *Daubert*. So,

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for example, *City of Tuscaloosa v Harcross Chemicals, Inc.*, is typical of what might be described as a bare or straight citation. In commenting on the statistical and econometric analyses of the plaintiff's expert, Judge Guin quoted the first criteria from the *Daubert* judgment as the mechanism necessitating the exclusion of the expert evidence:

Ordinarily, a key question to be answered in determining whether a theory or technique is scientific knowledge that will assist the trier of fact will be whether it can be (and has been) tested. "Scientific methodology today is based on generating hypotheses and testing them to see if they can be falsified; indeed, this methodology is what distinguishes science from other fields of human inquiry." Green 645. See also C. Hempel, *Philosophy of Natural Science* 49 (1966) ("[T]he statements constituting a scientific explanation must be capable of empirical test"); K. Popper, *Conjectures and Refutations: The Growth of Scientific Knowledge* 37 (5th ed. 1989) ("[T]he criterion of the scientific status of a theory is its falsifiability, or refutability, or testability").<sup>26</sup>

The applicability of falsification to non-scientific evidence and the active attempts to demarcate the boundaries around what constituted science were emerging areas of inconsistency among the federal circuits.<sup>27</sup> Notwithstanding these issues, the doctrine of testability enabled (rather than required) the trial judge to exclude the plaintiff's evidence on the basis that it was insufficiently reliable.<sup>28</sup>

In the case of *US v. Havvard*, Judge Hamilton drew upon *Daubert's* reference to Hempel and Popper in support of the State's contention that latent fingerprinting represented a legitimate scientific activity. In relation to fingerprints:

That claim of uniqueness and permanence is a scientific claim in the sense that it can be falsified. Such falsifiability is the hallmark of a scientific claim. See *Daubert*, . . .<sup>29</sup>

Other judges cited Popper and Hempel (and others) to support propositions that are more relevant to probabilistic laws and physical mechanisms than falsification. Though, we should note that Popper and Hempel are

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merely reappearing after their Supreme Court debut. As part of a long string footnote they really add very little to the analysis, aside from implicit support for the particular proposition or as precedent, (apparent) judicial erudition and the need to test some types of knowledge before admitting them into the courtroom.<sup>30</sup>

Although it was not the first court to deal with the implications of the 1993 *Daubert* judgment., in 1995 the Ninth Circuit Court of Appeals considered *Daubert* on remand from the Supreme Court. That judgment provides an impression of how subsequent Courts were confronted — here explicitly daunted — with the expectations outlined in the original Supreme Court majority decision.

Our responsibility, then, unless we badly misread the Supreme Court's [*Daubert*] opinion, is to resolve disputes among respected, well-credentialed scientists about matters squarely within their expertise, in areas where there is no scientific consensus as to what is and what is not "good science," and occasionally to reject such expert testimony because it was not "derived by the scientific method." Mindful of our position in the hierarchy of the federal judiciary, we take a deep breath and proceed with this heady task.<sup>31</sup>

In undertaking their "heady task," the Court of Appeals introduced supplementary criteria — modification and extension of *Daubert* — drawn from the inflammatory, yet highly influential work of Peter Huber.<sup>32</sup> Notwithstanding Huber's apparent sympathy for a folk version of Popper's philosophy, much of his interest in the participation of expert witnesses seems to be acutely sensitive to their motivations and orientations. Such views — arguably concerns to which Popper, via falsification, was generally indifferent and concerns that are difficult to reconcile with the provision of a strict role for method or testability — are conspicuous in the judgment.<sup>33</sup>

. . . we may not ignore the fact that a scientist's normal workplace is the lab or the field, not the courtroom or the lawyer's office.

That an expert testifies based on research he has

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conducted independent of the litigation provides important, objective proof that the research comports with the dictates of good science. See Peter W. Huber, *Galileo's Revenge: Junk Science in the Courtroom* 206–209 (1991).<sup>34</sup>

Difficulties associated with the application of falsification as a meaningful demarcation criterion, especially in (mass tort) cases like *Daubert* which involved epidemiological evidence and complex assessments of causal relations, meant that judges occasionally developed additional criteria such as the pejorative appellation “science for litigation” and tended to rely upon the non-problematicized — that is, non-constructivist — implications of publication. In the same judgment, Huber is also cited as authority for the importance of subjecting expert conclusions to normal scientific scrutiny through peer review and publication. The Ninth Circuit Court of Appeals accepted that the *Daubert* criteria constituted good science. Nevertheless, they incorporated supplementary considerations, such as the purpose of inquiry and the motivations of scientists, to assist with their determinations. *Daubert* provides the general framework, though none of the secondary authors are cited. Only Huber's polemical text *Galileo's Revenge*, which rails against the purported dangers posed by the prevalence of “junk science” in US courts, is cited in support of these particular images of science.

It is unremarkable to encounter judges drawing upon the authority of higher courts in their endeavors to explain and justify their own decisions. However, the next two examples provide some limited indication of judicial recognition of the existence of disagreements among historians and philosophers of science — as well as lawyers and judges — over the value of Popper's philosophy. In the first example, *US v. Director of Ill. Dept of Corrections*, Zagel J (who we will meet again) drew upon the work of prominent evidence scholar Ron Allen to help introduce and contextualize the discussion of the history, philosophy and sociology of science.<sup>35</sup> In this respect Zagel's J approach resembled *Daubert* where Popper and Hempel were introduced into the judgment through the work of legal commentator Michael Green.

Under *Daubert*, I am to consider, roughly stated, whether a scientific theory can be (and has been) tested,<sup>9</sup> . . .

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9. Professor Allen disapproves of this test as an anachronism based on the philosophy of science of Karl Popper. He thinks Thomas Kuhn's philosophy is better. If I had to choose between Popper and Kuhn, I would pick Popper despite his flaws and so would nearly all scientists. I also find value in the work of the man who taught me logic. See Dudley Shapere, *Reason and Its Search for Knowledge* (1979). But the point may not have much practical consequence. The science in most courtrooms does not vary with what Kuhn would think of as a prevailing paradigm. The physics we use in courtrooms often operates on principles understood by the Egyptians, and we seldom have to concern ourselves with anything beyond Newton's physics, though it is possible that we may have to deal someday with black body radiation or the constant speed of light. In any event I do not understand Kuhn to take the position that the testing of hypotheses is anything other than a good idea, it is, in part, the impossibility of vigorous implementation of that principle that troubled Kuhn. Compare Karl Popper, *Objective Knowledge: An Evolutionary Approach* (1972) with Kuhn, *The Structure of Scientific Revolutions* (1970).<sup>36</sup>

Ultimately, Zigel J preferred Popper "despite his flaws" to Kuhn. Notwithstanding the recognition of alternative approaches and apparent weaknesses or limitations to the philosophy of Popper, Zigel J embraced Popper and effectively ignored any of their implications. Instead, Zigel J pondered whether the application of *Daubert* to non-organic psychiatric evidence might require "a wholesale reevaluation of the admissibility of this form of opinion evidence given the absence of testability."<sup>37</sup> Sensibly, Zigel J left that question for another day.

The practice of acknowledging a variety of history, philosophy and sociology of science perspectives which are subsequently ignored or

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trivialized in favour of simplistic interpretations of testing or peer review is widespread among legal commentators and judges. The tendency to “in-oculate” — admitting a little evil to prevent a greater one — is a pronounced feature of Foster and Huber’s influential text: *Judging Science*.<sup>38</sup> *Judging Science* purports to provide a definitive reading of the implications of *Daubert* and is designed to serve as a de-facto judicial guide for the legal interpretation of the reliability of scientific evidence. Notwithstanding some eclectic recognition of limits to the work of Popper and others, ultimately falsification is presented as the best legal solution to admissibility and sufficiency *problems* on the highly contentious basis that it provides the closest approximation to actual scientific practice.<sup>39</sup>

Similarly, recognition of criticisms of Popper in *US v. Hines* appears to have little impact on the application of the *Daubert* criteria.<sup>40</sup> Judge Gertner drew upon Rehnquist CJ’s dissent, legal commentaries (by Capron, Farrell and Schuck) and, like Zagel J, the work of Kuhn as part of a corpus of critical authority.<sup>41</sup> Having enumerated the four criteria and emphasized their flexible application, Gertner J produced the following footnote:

FN7. The Court’s approach — the extent to which it adopted the premises of science, notwithstanding its attention to the differences between the laboratory and the courtroom — has been subject to criticism. Chief Justice Rehnquist, for example, suggested that the majority should have given the lower courts the task, not of determining scientific validity, but of developing, on a case-by-case basis, a jurisprudence of science — a set of legal principles for using science’s truth in the interest of justice. See *Daubert*, 509 U.S. at 600–01, 113 S.Ct. 2786 (Rehnquist, J., concurring/dissenting); see also, Farrell, *supra*. Others have suggested that the Court had simply taken the definition of science from Karl Popper, a definition that others have criticized as deriving from a culturally defined, time-bound paradigm. See *Daubert*, 509 U.S. at 593, 113 S.Ct. 2786 (quoting Karl Popper, *Conjectures and Refutations: The Growth of Scientific Knowledge*, 37 (5th ed.1989)); Capron, *supra* at 23; Farrell,

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*supra* at 2195, 2205; Thomas S. Kuhn, *The Structure of Scientific Revolutions* 17–20 (2d ed.1970).<sup>42</sup>

The criteria from *Daubert* provided the judge with not only material legal resources (authority) but a more restrictive regime to support rigorous standards and the more qualified use of a once relied upon (rather than “reliable”) form of expertise.<sup>43</sup> The *Daubert* regime was changing the manner in which judges were to interpret and understand expert opinion evidence. The case of *Hines* was decided after *Starzecpyzel* and *Kumbo*, which are discussed immediately below. We have included it at this juncture because in determining the admissibility of handwriting expertise, the judge alluded to theoretical differences between Popper and others; notwithstanding that there is no discernible effect on the decision.

This brings us to the issue — confronting judges in cases like *Hines* — of whether *Daubert* applied to all expert opinion evidence, or just scientific evidence. We have already seen how part of Rehnquist CJ’s disquiet in *Daubert* emerged from concern with interpretation of “scientific, technical and other specialized knowledge” from Rule 702. Interest in the interpretation of the phrase was *encouraged* by Rehnquist CJ’s own concerns, espoused in *Daubert*, which created both a source of semantic instability and authority (*obiter dicta*) as well as the fact that in general *Daubert* presaged a more restrictive approach to expert evidence among the federal courts. Without intending to promote a deterministic approach or attribute essentialised meanings and uses, the combination of falsification being originally designed as a boundary-defining criteria, the exclusionary response adopted among the federal courts after *Daubert* and the actual text of Rule 702, encouraged many plaintiffs (really their wily lawyers) to attempt to restrict the more austere *Daubert* approach to the “scientific” domain and have their expert evidence admitted as “technical or specialized knowledge.” In the armoury of judicial gatekeepers Popper — in the guise of testing — was proving to be a formidable weapon.

The case of *US v Starzecpyzel* serves as an example of how criminal defendants sought to have forensic document examination evidence excluded on the basis that it did not meet the *Daubert* criteria — especially the rigours of falsification — and how the trial judge resisted that application on the basis of a restricted reading of *Daubert* where falsification applied only to scientific evidence.<sup>44</sup>

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The *Daubert* Court derives the gatekeeping task of the trial judge from a reevaluation of *Frye* (itself *limited to scientific testimony*) and from consideration of the word “scientific” in Rule 702. The essence of *Daubert*’s “reliability” standard lies within the Court’s citation to *philosopher of science* Karl Popper’s statement that “the criterion of the *scientific status* of a theory is its falsifiability, or refutability, or testability.” — U.S. — at — , 113 S.Ct. at 2797 (quoting Karl Popper, *Conjectures and Refutations: The Growth of Scientific Knowledge* 37 (5th ed. 1989)).<sup>45</sup>

For Judge McKenna, the *Daubert* criteria applied only to scientific evidence. The judgment provides an indication of active judicial management of legal reliability through the demarcation of science from non-science. By characterizing document examination as non-scientific, but not pseudo-science or junk science, McKenna J was able to admit the State’s evidence. Similar distinctions were raised in *Moore v. Ashland Chemical, Inc.* where the exclusion of a medical expert’s opinion was reversed and remanded on the basis that *Daubert* applied only to hard science and not to medical testimony: “The methodology of hard or Newtonian science is what distinguishes it from other fields of human inquiry.”<sup>46</sup> The examples of *Starzecpyzel* and *Moore* provide some indication of the flexibility associated with *Daubert*; however, in general *Daubert* propagated an exclusionary ethos among the federal courts.

In terms of the analysis to follow, it is important to refer to the existence of *Kumho Tire Co. Ltd. v. Patrick Carmichael*, another appeal to the US Supreme Court, notwithstanding that it features no direct reference to the philosophical, historical or sociological literature relied upon in *Daubert*.<sup>47</sup> In effect the issue to be resolved in *Kumho*, again flowing from inconsistency among the federal circuits (as indicated by *City of Tuscaloosa*, *Starzecpyzel* and *Moore*), was: Did the *Daubert* criteria apply to expert opinion evidence of a non-scientific nature, here engineering? While the Court did not refer to any literature that could be remotely characterized as the history, philosophy or sociology of science or technology, the case is interesting for a number of reasons that we intend to draw together. For the moment, we intend to identify four features of the

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*Kumho* judgment. First, the Court emphatically declared that trial judges *may* use some or all of the *Daubert* criteria.

. . . we conclude that the trial judge must have considerable leeway in deciding in a particular case how to go about determining whether particular expert testimony is reliable. That is to say, a trial court should consider the specific factors identified in *Daubert* where they are reasonable measures of expert testimony.<sup>48</sup>

This approach reinforced the earlier position, established in *Joiner*, about the abuse-of-discretion standard for judicial review of the trial judge's admissibility decisions.<sup>49</sup> Second, in line with much of the post-*Daubert* jurisprudence the judgment is littered with references to the trial judge's *gatekeeping obligation* and even a *gatekeeping requirement*.<sup>50</sup> The gatekeeping obligation reflects the expectations placed upon trial judges in *Daubert* and confirmed in *Joiner*. Third, notwithstanding the emphasis on the *flexible* application of the *Daubert* criteria, the majority actually applied them all — emphasizing testing — in their assessment of the expert's evidence.<sup>51</sup> The opinion evidence of an engineer (Carlson) with a masters degree from Georgia Tech was excluded from the court.<sup>52</sup> And finally, *Daubert's* earlier confidence in American juries and cross-examination was effaced. Instead, the trial judge was invested with what appears to be a more paternalistic obligation to *assist* the jury by only admitting reliable and relevant expert opinion evidence.

The trial judge's effort to assure that the specialized testimony is reliable and relevant can help the jury evaluate that foreign experience, whether the testimony reflects scientific, technical or other specialized knowledge.<sup>53</sup>

The questionable link between Popper's formulation, as well as the other criteria, and reliable evidence or its relationship to non-scientific forms of knowledge and practice is subtly elided. If the dominant Supreme Court articulations of Popper raise the standard for admissibility determinations then the politics around particular representations of reliability and the relevance of Popper and testing tend to be obscured.

Within a decade of *Daubert*, the "gatekeeping" role of the trial judge was authoritatively reinforced. In making Rule 702 admissibility determi-

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nations the trial judge *may* apply the *Daubert* criteria to any type of expert opinion evidence. Unlike the *Daubert* judgment, in *Kumho* the majority decision actually undertakes or exemplifies the application of the criteria in the actual case before it. Applying all of the *Daubert* criteria to the plaintiffs' expert opinion evidence the majority excluded the expert's (Carlson) opinion and thereby the plaintiffs' case. In *Kumho* the Supreme Court expressed anxieties about jury competence, the existence of "expertise that is *fausse* and science that is junky," and reiterated the need for judicial vigilance in the guise of gatekeeping.

In *Daubert* a version of Popper's philosophy was translated (transmuted) into law. After *Kumho* only Popper's (legal) ghost remains to haunt plaintiffs — and to a lesser extent crime enforcement agencies. In a relatively brief period the earlier legal apotheosis of Popper and a large number of written judgments enabled the Supreme Court to draw upon considerable *legal* authority for its extension of the criteria to non-scientific forms of expert evidence in *Kumho*. Reference to Popper and the other commentators and especially the qualifications to peer review and publication could be displaced.<sup>54</sup> Numerous references to *Daubert* and the new doctrine of testing, rather than reference to arcane philosophical foundations, facilitates judicial legitimation without unnecessary philosophical engagement. The sublimation of Popper (and others) also operates to insulate legal institutions from external criticism. Now, more than ever, testing and the other criteria are ostensibly legal categories, and, as we have seen, in applying them judges can evade criticism of the adequacy of their epistemology — the so-called cosmic understanding qualification — on the basis that they are merely applying law in the routine administration of justice. The discretion invested in trial judges is belied by the Supreme Court's own rigorous application of all the criteria to the expert opinion evidence of Carlson as a very public lesson about the risks associated with "junk" science.

It is our intention to draw some of these cases and their references to the history and philosophy and sociology of science together, after a brief examination of the role played by Popper's philosophy in some earlier creation science litigation and the invocation of other historians and sociologists in recent decades.

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#### 4. *Creation science in McLean v Arkansas: Popper and the Establishment Clause*

Despite Popper's (historical) standing among philosophers of science and his invocation by the Supreme Court in *Daubert*, surprisingly there are very few references to either Popper or falsification in federal court judgments prior to the 1990s. The question — Why does Popper suddenly feature in judicial discourse in 1993? — is one to which we intend to return. However, some indication of the reasons for Popper's exhumation (and celebration) might be gleaned by reference to the circumstances associated with an earlier appearance.

It is no coincidence that an earlier incarnation of Popperian philosophy of science was invoked to deal with another type of *pernicious* “junk” science, namely creation science. In *McLean v Arkansas*, Judge Overton was confronted with the issue of whether an Arkansan statute prescribing equal time to the teaching of creation science and evolution violated the First Amendment prohibition against establishment of religion.<sup>55</sup> In answering this question, Overton J, assisted by the testimony of expert witnesses, developed a definition of science which excluded creation science, thereby characterizing creation science as part of a religion and making its state-sponsored teaching unconstitutional.<sup>56</sup>

Endeavouring to explain this decision Overton J articulated what he described as a “precise” definition of science:

. . . the essential characteristics of science are:

- (1) It is guided by natural law;
- (2) It has to be explanatory by reference to natural law;
- (3) It is testable against the empirical world;
- (4) Its conclusions are tentative, i.e., are not necessarily the final word; and
- (5) It is falsifiable. (Ruse and other science witnesses).<sup>57</sup>

Later Overton J drew upon publication and peer review as a further indication that creation science fails to meet the more general descriptions of “‘what scientists think’ and ‘what scientists do.’”<sup>58</sup>

This particular definition of science, admittedly developed in a separate context to the test espoused in *Daubert*, is discernably different.<sup>59</sup> Accepting that the *Daubert* judgment is concerned with explaining the

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admissibility standard for expert opinion evidence under Rule 702 of the FRE, nevertheless that decision dedicates very limited attention to the idea of natural law or naturalistic explanation (1) and (2), and makes no attempt to distinguish between testability (3) and falsifiability (5).<sup>60</sup> In attempting to distinguish law from science, Blackmun J shared Overton J's contention that scientific conclusions are tentative (4). Juxtaposed, *McLean* and *Daubert* might be used to suggest that definitions of science are developed strategically; sensitive to context. Notwithstanding several similarities, the representations of science developed in *McLean* and *Daubert* are different and are designed to perform different types of work. In *McLean*, scientific, philosophical and judicial recourse to falsification, in conjunction with an emphasis on natural law, is invoked to exclude creation science from the realm of *proper* science.

The contention that recourse to Popper's falsification is merely one of a number of strategic resources is reinforced by several other considerations. We will briefly consider two. First, *amicus curiae* briefs submitted in *Daubert* tend to provide a range of different models of science, of which many could not be classed as Popperian, and like *Daubert* tend not to discuss natural law in any detail. Second, the strategic and instrumental use of the history, philosophy and sociology of science (and other fields) is also supported in other pre-*Daubert* cases discussing the nature of science where neither Popper nor falsification receive any consideration.

Before falsification/testing became the preferred criterion in the Supreme Court through *Daubert* and *Kumho*, federal judges drew upon other sources of authority for insight and legitimacy and to display their erudition.<sup>61</sup> The 1991 decision in *Mercado v. Ahmed* provides an informative example.<sup>62</sup> Accepting that the case is unusual in its liberal use of secondary sources — philosophers, anthropologists, historians and political scientists such as Quine, Gadamer, Geertz, Kuhn and Wildavsky — it does provide evidence of (judicially recognised) alternative approaches to understanding the nature of science. To a *Daubert* sensitised audience, the case is conspicuous because Popper and falsification are both *missing*. Endeavouring to justify the exclusion of the evidence of an economist "on the cash value of the lost pleasure of life," Judge Zagel's meander through the secondary sources suggests that verification through the accuracy of prediction was the preferred answer to the problem of evidentiary reliabil-

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ity and admissibility both inside the courtroom and beyond. Referring to the writings of Quine and Gadamer, Zagel J found that:

This reliance upon prediction as validation comes from the positivist tradition in philosophy. This is today the accepted method for deciding what is science, what is scientifically known. But it may not be a comprehensive standard for all belief and knowledge.<sup>63</sup>

Rather than claiming that Zagel J was wrong or that the nature of science changed in the intervening two years (before *Daubert*, 1993), the example reinforces our contention that images of science developed in separate legal contexts can be substantially different and that such differences may be understood as significant, for us purposive.<sup>64</sup>

Another pre-*Daubert* appeal discussing scientific evidence and method, again without mentioning Popper, is the Bendectin case of *Brock v Merrell Dow Pharmaceuticals, Inc.*<sup>65</sup> In that case Kuhn's criticisms of the existence of a trans-historical scientific method are footnoted. The *Brock* appeal was subsequently cited in *Daubert*, but not for its insights on science.<sup>66</sup>

To some degree in *McLean* and more conspicuously in *Mercado* and *Brock*, federal judges produced definitions of science, also drawing upon scientific, philosophical, historical and sociological support, that simply do not conform with the flexible criteria promoted in *Daubert*. The majority judgment in *Daubert* makes no attempt to deal with those cases or respond to a number of heterogeneous fields and debates about the nature of science continuing long after the publication of Popper's most influential works. The questions of whether the sciences are meaningfully unified, or falsification reconcilable with the other three criteria, and the value of non-Popperian philosophies of science are controversial issues which are simply not addressed.

Consequently, it would seem that the judicial preference for falsification and testing, attributed to Popper in *Daubert*, was not the only possible approach nor an entirely neutral ascription. Before, finally, embarking on a more politically sensitive analysis of these cases we shall briefly consider the appearance of several other scholarly works, particularly by sociologists of science, in the federal courts in the course of the last three decades.

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### 5. (*in*)Significant others: Robert K. Merton, Bruno Latour and Sheila Jasanoff

So far we have concentrated on some of the most conspicuous appropriations associated with the *Daubert* regime. Through our final selection we will examine several examples of more isolated (or discrete) references to literature from the history, philosophy or sociology of science. These examples serve to support the particularized application of the law and normative images of science rather than to assist in the production of a legal standard as in *Daubert*. In this sense they are more characteristically factual and normative. The manifestations are also more sporadic and sensitive to the description and rationalization of specific cases. This leads to representations (and uses) which might, occasionally, appear inconsistent with a range of more familiar images of the sciences and scientific practice.

Most of the following cases refer to writings by Robert K. Merton.<sup>67</sup> Merton first published in the 1930s and is widely acknowledged as one of the founders of the sociology of science, particularly its North American incarnation. He made important contributions to developing links between the history of science and the sociology of knowledge, articulated an influential model of the ideal normative structure of the scientific community and helped develop a variety of methodological tools to examine the structure of scientific communities, such as through the analysis of scientific biographies.<sup>68</sup> Merton's work continues to exert some influence over the sociology of science, although over the last twenty years, in the wake of post-Kuhnian developments, his functionalist influenced approach has waned.<sup>69</sup> The last two examples refer to work by Bruno Latour and Sheila Jasanoff. Latour and Jasanoff are two of the best known figures in contemporary science studies. Latour has written a number of influential and provocative texts including works which helped inaugurate ethnographic studies of scientific laboratories and actor network theory. Apart from providing a rich repository of metaphors to explain the politics of science and technology this work has also displayed considerable theoretical novelty. "Actor network theory," for instance, challenges the use of traditional epistemological dichotomies in the social sciences — such as structure and agency and natural versus social — especially when considering technology and social change. Latour is Professor at the Center for the Study of Innovation at the School of Mines,

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Paris. Jasanoff has published numerous books and articles on U.S. regulatory culture, risk assessment and (reflecting her earlier professional training in law), science and law. She was the long-standing head of the Science & Technology Studies Department at Cornell University and recently took a personal chair in politics at the J.F. Kennedy School of Government, Harvard University. Despite the broader relevance of Latour and in particular Jasanoff, to matters involving law and science, both are cited only in a rather perfunctory manner as part of spirited dissenting judgments.

The first example, *Kewanee Oil Company v. Bicron Corporation*, was an appeal to the US Supreme Court.<sup>70</sup> On the question of whether state trade secret law was preempted by the federal patent laws a majority of the court indicated that as long as it did not trespass on the purpose of the Constitutionally-based legislative scheme enacted by Congress, the state law could co-exist. Outlining the reasons for these protections, Chief Justice Burger explained that trade secret law protected individuals and companies that had expended efforts in domains that were not patentable. Patenting was designed to encourage investment and industry whilst providing years of protection to the patent owner. In the words of Jefferson, some things “are worth to the public the embarrassment of an exclusive patent.”<sup>71</sup> In theory, patents encouraged the public dissemination of ideas, while protecting the interests and efforts of the owner. Whereas patent protection tended to act as a barrier to prevent people using the technique, procedure or process, the trade secret law protected items that would not be proper subjects for consideration for patent protection and operated more like a sieve. Trade secret law tended to provide far weaker protection than the patent law. So the fact that some might prefer the more limited protection afforded by trade secrets law to patent, was not considered sufficiently significant to interfere with the state’s legislative initiative. Burger CJ acknowledged that the more limited protections provided by the trade secrecy laws allowed — actually could stimulate — competitors to attempt to copy or approximate through “fair and honest means” such as reverse engineering. It was in this context that Chief Justice Burger, writing for the majority, drew on the work of Merton and others to support his contention that conferring secrecy on a limited selection of techniques would not significantly retard industry and national development.

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Nor does society face much risk that scientific or technological progress will be impeded by the rare inventor with a patentable invention who chooses trade secret protection over patent protection. The ripeness-of-time concept of invention, developed from the study of the many independent multiple discoveries in history predicts that if a particular individual had not made a particular discovery others would have, and in probably a relatively short period of time. If something is to be discovered at all very likely it will be discovered by more than one person. *Singletons and Multiples in Science* (1961), in R. Merton, *The Sociology of Science* 343 (1973); J. Cole & S. Cole, *Social Stratification in Science* 12–13, 229–230 (1973); Ogburn & Thomas, *Are Inventions Inevitable?*, 37 *Pol.Sci.Q.* 83 (1922).<sup>19</sup>

19. See J. Watson, *The Double Helix* (1968). If Watson and Crick had not discovered the structure of DNA it is likely that Linus Pauling would have made the discovery soon. Other examples of multiple discovery are listed in the Ogburn and Thomas article.<sup>72</sup>

For Burger CJ, the trade secret law offered many beneficial effects. It might be considered ironic that Merton, perhaps best known for his discussion of scientific norms, including the norms of openness and communalism, would be cited as support for the proposition that keeping some knowledges secret in order to reward research efforts and to stimulate industry might not retard scientific progress.<sup>73</sup>

A more conventional approach to the work of Merton is apparent in *Forsham v. Califano*.<sup>74</sup> *Forsham* was a case concerned with access to raw data from federally-sponsored scientific research under the Freedom of Information Act (FOIA). Bazelon's J dissent refers to Merton's normative scientific ethos in order to criticize the majority judgment. Bazelon J drew on both the purpose of the FOIA and the standards of the scientific community, as espoused by Merton, to support his position:

The essence of the scientific community, I had thought,

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is the commitment to the advancement of scientific truth by subjecting findings and conclusions to the “exacting scrutiny of fellow experts.”<sup>75</sup> Moreover, where scientific data bear the earmarks of agency “records” subject to FOIA, it would be the height of irony to deny disclosure on the ground that it could expose errors or frauds and thereby discourage those who do the work of the Government. FOIA was enacted in part to end the practice of withholding information “only to cover up embarrassing mistakes or irregularities . . .”

25. R. Merton, *The Sociology of Science* 275 (1973); *see also* B. Barber, *Science and the Social Order* 89 (1952).<sup>75</sup>

The third case, *Joel Blaz v. Michael Reese Hospital Foundation*, involved a motion to dismiss a civil action on the basis of the reach of the duty of care owed by a hospital-based research scientist studying the effects on former patients of radiation treatment in a Chicago hospital.<sup>76</sup> In undertaking the study and applying for research funding from the National Institutes for Health, a research scientist responsible for the Thyroid Follow-Up Program indicated that a study based on the Program showed “strong evidence” between the earlier treatment and various sorts of tumor. However, attempts to survey and inform patients were more circumspect. A questionnaire sent to former patients suggested that it was merely part of a follow-up study “to determine the possible associated risks.”<sup>77</sup> The question for determination was whether the research scientist, who was not the treating physician, and the hospital owed a duty of care to warn the hospital’s former patients about the risk of future tumors on the basis of the research results.

Acknowledging a responsibility, consistent with Illinois law, to interpret the extent of any duty carefully, District Judge Bucklo suggested that he could identify few reasons to exclude the researcher from a duty. Bucklo J found that even though the research scientist was not the treating physician, relative to the plaintiff he was in a special position to acquire relevant information and that hospitals and doctors maintained obligations to former patients. In assessing whether there were any policy reasons for limiting the extent of duty Judge Bucklo considered whether

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constructing such a duty would inhibit research into the effects of medical treatment by non-treating physicians. Bucklo J continued:

But this does not strike me as a real worry. First, the duty would be discharged by a mere warning which, as explained, would here have been neither costly nor burdensome to give. The more costly and burdensome the warning would be to give, of course, the less likely there would be a finding of duty. Second, the medical researchers' legitimate desire for professional prestige and honor due to new discoveries, *see generally* Robert K. Merton, *The Sociology of Science* (1973), would counteract any such inhibition; as of course would the concern for the well-being of its former patients which any self-respecting hospitals would have.<sup>78</sup>

In these three examples quite different views of the role of secrecy and open communication of scientific findings are being bolstered by citing Merton's characterizations of the ethos and structure of the scientific community. Like the uses of Popper identified previously, it is not our contention that this merely displays judicial ignorance or inadequate understanding of the meaning of secondary (non-legal) sources. Rather it implies a different kind of understanding: an understanding of the value of such citations and representations as strategic resources tailored to the demands of decision making in the specific case and, for courts of appeal, beyond.

The next example, *American Geophysical Union v. Texaco Inc.*, was an appeal in a copyright infringement action against Texaco.<sup>79</sup> The publishers of scientific journals alleged that unauthorised reproduction of copyright protected articles by Texaco scientists and engineers was inconsistent with "fair use." We are concerned with the dissenting judgment of Judge Jacobs. Unlike the majority, Jacobs J determined that photocopying of articles in order to assemble a personal "archive" was within the realm of "fair use." In a passionate dissenting judgment, it is perhaps not surprising to find Jacobs J drawing on work by sociologists and historians of science to support an alternative understanding of the nature of science. Expressing a preference for a broad model of research — "In my view, the research function is far broader than the majority opinion and the district

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court opinion contemplate” — Jacobs J suggested that the practice of science extended beyond the laboratory experiment.<sup>80</sup>

The scientific method, properly conceived, is much more than a system of repeated laboratory experimentation. Rather, it is a dynamic process of “planned cooperation of scientists, each of whom uses and continues the investigations of his predecessors . . .” Edgar Zilsel, “The Sociological Roots of Science,” in Hugh F. Kearney, ed. *Origins of the Scientific Revolution*, 97 (1968).<sup>81</sup>

In particular, as part of the argument Jacobs J referred to the work of Latour and Woolgar to support the preferred image of research and to emphasise the importance of photocopying to the routine practice of science.

The anthropologist Bruno Latour spent two years studying scientists at the Salk Institute for Biological Sciences. During the course of his study, he conducted anthropological observations of a neurobiologist working on an article for a journal. This scientist’s desk was littered with copies of journal articles authored by other scientists:

Xeroxed copies of articles, with words underlined and exclamation marks in the margins, are everywhere. Drafts of articles in preparation intermingle with diagrams scribbled on scrap paper, letters from colleagues and reams of paper spewed out by the computer in the next room; pages cut from articles are glued to other pages; excerpts from draft paragraphs change hands between colleagues while more advanced drafts pass from office to office being altered constantly, retyped, recorrected, and eventually crushed into the format of this or that journal.

Bruno Latour and Steve Woolgar, *Laboratory Life: The Social Construction of Scientific Facts*, 49 (1979). One essential step toward this drafting process is the accumu-

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lation over time of the journal articles that reflect the current state of knowledge that the journal author seeks to advance. Latour confirms that the photocopying of journal articles, and the use of them, is customary and integral to the creative process of science.<sup>82</sup>

Ultimately, *Laboratory Life* — one of the most influential and controversial texts produced by science studies scholars during the previous two decades — is reduced to the proposition that “the photocopying of journal articles, and the use of them, is customary and integral to the creative process of science.”

In conjunction with a particular construction of the copyright statute, Jacobs J drew on the history of science, to support the contention that strict application would stifle progress and that professional considerations aside from profit — “in order to gain distinction, appointment, resources, tenure”<sup>83</sup> — motivate authors to read and produce the scientific literature.<sup>84</sup> Referring again to Zilsel, Sir Francis Bacon, *Philosophical Transactions*, William Eamon, A. Rupert Hall and Robert K. Merton’s earlier historical study, Jacobs J insisted that the primary objective of copyright is to “promote the Progress of Science and useful Arts” and that these objectives are coterminous with the scientific project.

The incentives for scientific publication have been in place since the project of science began to be perceived as a cooperative venture more than three centuries ago.<sup>85</sup>

It is significant that in the realm of copyright law, even after the Supreme Court’s seminal *Daubert* judgment., Jacobs J drew on the work of historians, and sociologists who had undertaken ethnographic work, rather than the images of science developed by philosophers like Popper. As in the case of *McLean*, different contexts and uses seem to encourage the production of different images of science.

We have already encountered the work of Jasanoff cited in *Daubert* as a qualification to the efficacy of peer review. In *Markman v. Westview Instruments, Inc.*, her short essay, revealingly titled “What judges should know about the sociology of science,” was cited by a dissenter for the proposition that the practice of science can be unruly and that social dimensions influence the legitimation of scientific facts.<sup>86</sup>

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## 6. Conclusion: *The ghost of Popper and judicial reification*

Previously we have made allusions to some of the more overtly political dimensions of Popper's philosophy, especially falsification, with limited elaboration. In part this is because these ideological dimensions of Popper's work are invariably opaque in the various judgments.<sup>87</sup> Indeed, it is quite possible that judges and even some of those championing Popper and falsification may have been oblivious to this political history.<sup>88</sup> Consequently, our conclusion will begin with a brief outline of some of these considerations.

Popper's academic career spanned several decades. He published from the late 1930's, enjoying his widest intellectual prestige in the Cold War Anglophone world of the 1950's and 1960's where he exerted a long standing influence at the London School of Economics. Born in Austria (1902), he was knighted in 1965. Popper's jurisprudential reification in *Daubert* (1993) occurred during the nadir of his career, shortly prior to his death in 1994. By then numerous challenges to his views and alternative philosophies of science were *de rigueur*.

Conventionally, Popper is regarded as a politically conservative philosopher.<sup>89</sup> The normative dimension of Popper's philosophical work conformed to his Cold War-inspired aspirations to celebrate the superiority of liberal democracy, the so called "Open Society," over its fascist and communist alternatives.<sup>90</sup> For Popper, the conduct of scientists, displayed by icons such as Einstein, and the critical, open-minded attitude they supposedly embodied, through employment of the method of falsificationism, exemplified the ideals underpinning liberal democracies and the values that fascist and communist regimes actively suppressed.<sup>91</sup> Popper openly promoted falsification, his demarcation criteria, as a direct way of exposing the scientific pretensions of Marxist social theory. Popper argued that such theories relied on a mixture of assertions that were unfalsifiable or — even with the most charitable logical reconstructions — had been falsified by historical events. Popper also challenged the scientific pretensions of various psychological theories, especially those generally associated with Freudian traditions. Throughout his long career he was quite vocal in asserting how these branches of knowledge failed to withstand falsification.

Popper is regularly chosen as an authority for popular criticism of

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pseudo-science, by groups such as The Skeptics, where the more measured and frequently circumspect appraisal of his work characteristic of specialized academic communities is often absent. Popper's philosophy of science is also invoked in the writings and comments of scientists, science journalists and science educators, notwithstanding that considerable investigation by sociologists and historians has suggested only the most tenuous relations between falsification and actual scientific practice. Nevertheless popular primers, such as Brian Magee's widely quoted text, which contain simplified celebratory versions of Popper's philosophy and critical ideology, abound.<sup>92</sup> It is perhaps not surprising to find that some of the more recent proponents of Popper's work, particularly those associated with legal contexts and policy debates, have been conspicuously critical of the appearance and admission of certain types of psychological knowledge — such as syndrome evidence — and an alleged decline in the general standard of expert evidence admitted to US courts.<sup>93</sup>

Apart from the relative familiarity and political resonances which may have helped Popper's work to achieve recognition and some popularity among certain social groups, various aspects of his philosophy may have also predisposed it to being put to use in settings where a variety of predominantly critical applications were possible. On the basis of its original ideological orientation Popper's philosophy may be particularly susceptible to strategic iteration and appropriation. This contention is supported if we consider an empirical investigation by Gilbert and Mulkay. In a study of the use of images of Popper's method in debates between research scientists they concluded that:

The generality of the Popperian rules, their lack of interpretive particularization and their independence of institutionalised social relationships, allow individual scientists considerable freedom to conceive of their own actions as Popperian in character and to attribute their intellectual success to the effectiveness of the Popperian approach.<sup>94</sup>

In making determinations about the admissibility of scientific evidence judges may, similarly, refer to sources of authority for the constitution of scientific knowledge that are flexible and abstract.

On the basis of the materials we have presented, and there does not

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appear to be a great deal more professional history, philosophy and sociology of science cited in federal court judgments (see Appendix), Popper's work appears conspicuously at a temporal juncture where the Supreme Court was sufficiently concerned with a perception of the socio-legal circumstances to be willing to intervene: undertake judicial review and, in effect, inaugurate an admissibility revolution.<sup>95</sup> In *Daubert*, the Court granted certiorari because of inconsistency among the federal circuits and because of widespread anxieties about spurious litigation predicated upon contentious "junk" science.<sup>96</sup> Originally, the majority may have naively embraced Popper as an apparently practical means of identifying reliable expertise. If it was known, the political ideology may have been conceived as irrelevant or inconsequential. After *Daubert*, however, judicial perseverance with Popper — in the guise of a rhetorical commitment to falsification/testing — should be understood in more deliberate and critical terms. The application of *Daubert* was wreaking effects in the federal courts, and through *Joiner* and *Kumho*, the exclusionary aspects of gatekeeping, declining confidence in the civil jury and recognition of the threat posed by the existence of what the Supreme Court itself described as "science that is junky" became more conspicuous in both the Supreme Court jurisprudence and consequently among the federal circuits.

Recourse to citation of Popper's philosophy of science as a legal literary technology capable of assisting with strategic articulations of science (and non-science) sits comfortably alongside other restrictive uses; as in the creationism case of *McLean v Arkansas*.<sup>97</sup> The apparent elegance and simplicity of falsification and concurrent anxieties about unreliable expertise were reflected in the relative success of the work by the (sometimes) polemicist Huber (and his occasional co-author Foster). In recent decades, Huber and Foster have been cited in numerous federal court judgments for perspectives on the nature of science or the dangers of partisanship and junk science. Works by Foster and Huber have been assisting judges in their gatekeeping capacities. Like Popper's work manifested in *Daubert*, they have provided a range of literary resources ostensibly designed to exclude unreliable evidence, which also impact disproportionately against plaintiffs. Interestingly, notwithstanding the rhetorical import of judicial consistency, *Daubert*-inspired arguments against the reliability and admissibility of state forensic science have encountered limited success: exemplified in *Starzecpyzel* and *Havvard*. Often, as in the

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case of latent finger-printing, long standing use triumphs over the strict application of falsification.

In commenting upon citations, we acknowledge the potential significance of some of the varied conditions under which judges operate as well as differences between courts in the legal hierarchy. While judges generally write or supervise their own judgments, there is considerable variation in the extent of influence over the cases which come before them, the issues which they need to decide and how they are practically resolved, the quantity and quality of submissions, briefs and legal work, the legal and non-legal authorities presented, the resources available to the parties and the stakes involved both directly and indirectly as well as their own education and experience. The appearance and use of non-legal authority is often difficult to anticipate and interpret. In our discussion of *(in)Significant Others* we explained how work in the history, philosophy and sociology of science is typically cited in support of a particular value or norm associated with science (in-general). For example, in *Mercado* Judge Zagel seems to have cited an eclectic assortment of philosophers and anthropologists to support various arguments and perhaps more importantly, demonstrate erudition. In contrast, in *Daubert*, the standing of *amici curiae* such as the National Academy of Science (NAS), the American Association for the Advancement of Science (AAAS), the American Medical Association (AMA) and the New England Journal of Medicine, in conjunction with the serious implications involved in the elaboration of a new federal admissibility standard, may have influenced the majority decision, particularly their endorsement of a fairly traditional — but nevertheless *useful* — image of science extracted from the work of Popper.<sup>98</sup> Accepting difficulties in ascertaining how non-legal sources influenced Zagel J, it seems reasonable, given direct reference to the *amicus curiae* briefs in *Daubert*, that Supreme Court judges were attentive to the submissions produced on behalf of large, well resourced and authoritative scientific organizations given the social context of the appeal.<sup>99</sup>

The pattern of citation of history, philosophy and sociology of science literatures culminating in *Kumho* suggests that the Supreme Court does not *depend* upon extrinsic support in its judgments. Popper and falsification were not required when judges excluded expert evidence or challenged its purported value in *Brock* and *Mercado*. It appears that citations can be invoked in order to persuade or justify, especially in the (appar-

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ently) more radical departures such as (re-)defining science in order to facilitate the qualified repudiation of *Frye* in *Daubert*. So even if not strictly necessary, the standing of advocates (such as the NAS and AAAS) and the pre-existing valencies or cultural capital associated with some perspectives or approaches undoubtedly eases specific appropriations and the potential for criticism.<sup>100</sup> On some issues the decision to ignore a professional group, or develop its own framework may expose senior courts to criticism. In such cases we can expect judges to make recourse to legal qualifications, like those provided by Blackmun J: the resolution of disputes by law will be distinguished from the quest for cosmic understanding. Law will be presented as an activity quite different from science. Notwithstanding such representations, we should remain sensitive to the possibility that on other occasions, such as in Zagel J's *Mercado* judgment, legal and scientific epistemologies will (be made to) appear to converge. Recourse to ostensibly *reliable* scientific evidence remains essential to the explanation and rationalization of a high percentage of legal disputes.

In the foregoing discussion, we have endeavored to provide a broad and thematic approach to judicial references to material from the history, philosophy and sociology of science which we acknowledge is only a single dimension of what are almost always multi-dimensional cases and judgments. One feature of this qualitative approach to citations is that even if we accept its fairly narrow thematic orientation it nevertheless provides a rich semantic platform. In concluding we hope that this article contributes not only to an improved understanding of the uses of the history, philosophy and sociology of science in law — subjects that have received very little attention in their respective communities<sup>101</sup> — but also that it offers an example of some of the possibilities available through qualitative citation studies. In a sense, we would contend that some of the more quantitative approaches to citation studies provide a fairly cold and sterile approach to social legitimacy, persuasion and the construction, articulation and development of the law in (response to) real world contexts.<sup>102</sup> Without having to essentialise Popper, certain features of his philosophy were embraced and perpetuated. Accepting a place for quantitative studies, we would contend that our analysis of the appearance and uses of Popper (and science studies more generally) are more informative than quantitative attempts to record the number of times Popper or social scientists appear in judgments, the types of litigation or characteristics of

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the court or judge. All of these may be useful, as a form of background information, but the reasons Popper, as opposed to another philosopher or aspect of his philosophy appears, and why he appears and disappears at particular times and places tend to remain beyond the scope of such analyses. In contrast, our approach offers more explanatory purchase. Our interpretation explores uses and purposes. From this perspective, the fact that Popper (and the others) do not appear in *Kumho* is just as significant — or deserving of attention and explanation — as his debut in the socio-political matrix surrounding the production of *Daubert*. It is our contention that omitting explicit reference to Popper from the *Kumho* judgment reflects judicial exnomination as an aspect of his philosophy was transformed into law.<sup>103</sup>

In this way our approach to Popper, which attempts to map the influence of citation in contextual qualitative terms, bears similarity with the approach adopted by Latour and Woolgar in their seminal text *Laboratory Life*. Mapping the processes of citation in stabilizing scientific facts, Latour and Woolgar explained the importance of locating citations against the context of their use and the form of statement linked to them.<sup>104</sup> For Latour and Woolgar citation is an important part of the fact-making process they describe as “literary inscription” — a cycle of activity where the work of scientists is transformed as it travels through various contexts and processes of literary production ranging from measuring devices, laboratory reports to the scientific paper. As a “fact” reaches the status of temporary closure the signs of negotiation, uncertainty and other “modalities” are effaced. This can be understood as largely consistent with the reification of Popper, consequent upon his disappearance as literal textual entity, as testing. Latour and Woolgar note that the strength and facticity of statements about scientific entities frequently are proportional to the absence of qualifying citations and conditional statements. Working backwards from accepted statements in authoritative scientific texts towards earlier laboratory and informal contexts more citations and contextual modalities appear attached to statements:<sup>105</sup>

The function of literary inscription is the successful persuasion of readers, but the readers are only fully convinced when all the sources of persuasion seem to have disappeared. In other words, the various operations of

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writing and reading which sustain an argument are seen by participants to be largely irrelevant to “facts,” which emerge solely by virtue of these same operations.<sup>106</sup>

The apparent absence of Popper, or his virtual or ghostly presence, does not mean the end of the influence or the ethos ushered in, in part, by drawing upon his social capital, or authority.<sup>107</sup> Rather, new images of legal “science” — less legally (and socially) controversial — have become routinized: available to serve as legitimatory resources.<sup>108</sup>

Our analysis was made possible by contextualizing Popper’s philosophy and locating its invocation and use at a particular temporal juncture. Notably, where federal circuits were interpreting the FRE inconsistently, partially in response to mass tort litigation, an increased volume of litigation and concerns about the availability of insurance.<sup>109</sup> The appearance of new investigative techniques, such as DNA profiling in the early 1990s, presumably also influenced the Court to hear the *Daubert* appeal.<sup>110</sup> By 1998, when the Supreme Court heard the appeal in *Kumho* there was sufficient social warrant and judicial authority, reflected in federal court jurisprudence, a social problem literature, submissions and legal academic commentary, to efface reference to the secondary (non-legal) sources originally relied upon to support the *Daubert* majority’s framing of science. The transformation of Popperian “falsifiability” into a legally acceptable image of not only scientific — but also technical and specialized — knowledge was complete. Together, the provision of tools (the various criteria articulated in *Daubert* and their subsequent elaborations) and a restrictive ethos were later reinforced in *General Electric Co. v. Joiner* (1997) and emphatically exemplified in *Kumho Tyre Co. v. Carmichael* (1999).<sup>111</sup> We should note that while federal circuits had been inconsistent throughout the twentieth century in their admissibility practices, it was only when inconsistency was seen as a sufficiently serious socio-legal problem that the Supreme Court intervened, and through *Joiner* and *Kumho* continued to intervene.

Quantitative studies not only tell us very little about why Popper first appears, but in addition, they do not adequately explain why the Supreme Court granted certiorari in *Daubert* and *Kumho*, or the social significance of the case which led highly respected and influential organisations such as the National Academy of Sciences and the American Association for

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the Advancement of Sciences, and many others, to submit *amicus curiae* briefs. Citation studies also tend to remain mute about the implications of selecting particular sources/theories; about dissent such as that voiced by Rehnquist CJ; and about the existence of cultural and ideological baggage associated with authorities — like Popper and other academics such as Merton, Latour and Jasanoff. Interestingly, courts tended to endorse and perpetuate restrictive dimensions of Popper's approach to demarcating science from other forms of *inferior* types of knowledge, but made few attempts to engage or even consider the epistemological relativism and political implications of work by Latour or Jasanoff.<sup>112</sup>

We can only speculate about what quantitative citation studies would make of all this.

For the purpose of our discussion we included Section 5, (*in*)*Significant Others*, predominantly to provide the reader with some indication of the circumstances in which the work of other prominent theorists of science has been cited. These examples reinforce one of our major claims: that context shapes use.<sup>113</sup> The work of Merton, Latour and Jasanoff is cited to support particular arguments. Their work stands (as authority) for particular propositions, norms or acts. Others could have been cited, and alternative approaches were possible. Significantly, several appear in dissentient judgments. In contrast to Popper in *Daubert*, these authors are not used to support a macroscopic model of science,<sup>114</sup> but more limited insights into particular features of scientific practice and commitments: such as the proper level of openness and secrecy or the fantastically mundane observation about how scientists routinely make and use photocopies. From our perspective, as sociologists of science, these uses might be characterised as *thin* descriptions.<sup>115</sup> They exemplify extremely “thin” descriptions of the various bodies of work, or even the particular volumes cited. We accept that this is not the only possible reading, even amongst sociologists of science. But, just for the record, we would challenge a reader from any discipline or tradition to examine *Laboratory Life* for themselves.

Typically, reference to work from the history, philosophy and social studies of science comprises only a small part of any judgment. The presence of this work, however, implies that it fulfills some role(s), and it is to these roles that we have endeavoured to attend.<sup>116</sup> Litigation and judgments are special contexts and genres where authors, literatures and

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ideas are removed from some of their more usual groundings. Without intending to attribute an essential meaning to the science studies corpus, the genre of judgment writing enables judges to incorporate a range of opinions, sources and authorities and to deal with them quite capriciously. The aegis of doing law effectively insulates judicial practice from other types of activity, especially reflexive epistemology. We saw how Blackmun J explained that he was not doing cosmology, and Rehnquist CJ didn't expect judges to become amateur scientists, or even philosophers for that matter. Recourse to law and things legal — such as procedure and rules, legal standards and tests, burdens of proof, expedition and even justice — enabled judges to remain relatively immune from exogenous comment and criticism. We accept that judges aren't doing social theory, they're doing judging.<sup>117</sup> But we should never forget that judging is *both* ideological and practical.

Notwithstanding some inconsistency in application, it is our contention that as a generalization *Daubert* and its progeny have contributed to a more restrictive era in admissibility jurisprudence. *Daubert* may not only have made it more difficult for plaintiffs and criminal defendants to have their expert evidence admitted, but it may have simultaneously chilled litigation, making it harder to pursue certain types of legal action.

What to some may have appeared as the innocuous appearance of Popper may have signaled the inauguration of a subtle but dramatic shift in the US litigation landscape. For how long the judicial necromancy will continue, and with what resources Popper's ghost will be exorcised, remain to be seen.

### *Appendix*

We searched for over 100 historians, philosophers and sociologists based on our own familiarity with the field, bibliographies in leading journals and texts, and by following citations in federal courts. For example, we were particularly sensitive to authors (like Popper) cited in the leading judgments (such as *Daubert*). Accepting that we may have "missed" eminent scholars, we would contend that we have not overlooked (m)any from the most influential federal admissibility decisions of the last few decades. In undertaking this survey it was our intention to be indicative rather than exhaustive. Judgments cited in the article are denoted with an

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asterix (\*). Typically, the inquiry — conducted on Westlaw — was limited by searching for a name (such as “Kuhn”) and a root (such as “scien!”) appearing in the same paragraph. The results were as follows:

Jonathan Cole and Stephen Cole

*Kewanee Oil Co. v. Bicron Corp.*, 416 U.S. 470, 94 S.Ct. 1879, 40 L.Ed.2d 315, 181 U.S.P.Q. 673 (U.S.Ohio 1974).\*

Bernard Barber

*Forsham v. Califano*, 587 F.2d 1128, 190 U.S.App.D.C. 231, 4 Media L. Rep. 1122 (D.C.Cir. 1978).\*

Rudolf Carnap

*Old Colony Bondholders v. New York, N. H. & H. R. Co.*, 161 F.2d 413 (2nd Cir. 1947).

*Berg v. Morris*, 483 F.Supp. 179 (E.D.Cal.1980).

Morris Cohen

*Old Colony Bondholders v. New York, N. H. & H. R. Co.*, 161 F.2d 413 (2nd Cir. 1947).

*American Kennel Club v. Hoey*, 148 F.2d 920, 45-1 USTC P 9268, 33 A.F.T.R. 1209 (2nd Cir. 1945).

William Eamon

*American Geophysical Union v. Texaco Inc.*, 37 F.3d 881, 63 USLW 2295, 1994 Copr.L.Dec. P 27,312, 32 U.S.P.Q.2d 1545 (2nd Cir. 1994).\*

*American Geophysical Union v. Texaco Inc.*, 60 F.3d 913, 144 A.L.R. Fed. 745, 1995 Copr.L.Dec. P 27,417, 35 U.S.P.Q.2d 1513 (2nd Cir. 1994).\*

Stephen Jay Gould

*Saint Francis College v. Al-Khazraji*, 481 U.S. 604, 107 S.Ct. 2022, 95 L.Ed.2d 582, 55 USLW 4626, 43 Fair Empl.Prac.Cas. (BNA) 1305, 43 Empl. Prac. Dec. P 37,018, 38 Ed. Law Rep. 1165 (U.S.Pa. 1987).

*Perkins v. Lake County Dept. of Utilities*, 860 F.Supp. 1262 (N.D. Ohio 1994).

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A. Rupert Hall

*American Geophysical Union v. Texaco Inc.*, 37 F.3d 881, 63 USLW 2295, 1994 Copr.L.Dec. P 27,312, 32 U.S.P.Q.2d 1545 (2nd Cir. 1994).\*  
*American Geophysical Union v. Texaco Inc.*, 60 F.3d 913, 144 A.L.R. Fed. 745, 1995 Copr.L.Dec. P 27,417, 35 U.S.P.Q.2d 1513 (2nd Cir. 1994).\*

Carl Hempel

*Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 113 S.Ct. 2786, 125 L.Ed.2d 469, 61 USLW 4805, 27 U.S.P.Q.2d 1200, 23 Env'tl. L. Rep. 20,979, 37 Fed. R. Evid. Serv. 1, Prod.Liab.Rep. (CCH) P 13,494 (1993).\*

*National Ass'n of Farmworkers Organizations v. Marshall*, 628 F.2d 604, 24 Wage & Hour Cas. (BNA) 564, 202 U.S.App.D.C. 317, 88 Lab.Cas. P 33,892, 1980 O.S.H.D. (CCH) P 24,309 (D.C.Cir. 1980).  
*U.S. v. Havvard*, 117 F.Supp.2d 848, 55 Fed. R. Evid. Serv. 1087 (S.D.Ind. 2000).\*

*Savage v. Union Pacific R. Co.*, 67 F.Supp.2d 1021 (E.D.Ark. 1999).\*

*National Bank of Commerce v. Associated Milk Producers, Inc.*, 22 F.Supp.2d 942 (E.D.Ark. 1998).\*

*National Bank of Commerce (of El Dorado, Ark.) v. Dow Chemical Co.*, 965 F.Supp. 1490 (E.D.Ark., 1996).\*

*Freeman v. Case Corp.*, 924 F.Supp. 1456, 44 Fed. R. Evid. Serv. 1041, Prod.Liab.Rep. (CCH) P 14,768 (W.D.Va. 1996).\*

*City of Tuscaloosa v. Harcros Chemicals, Inc.*, 877 F.Supp. 1504, 1995-1 Trade Cases P 70,967 (N.D.Ala. 1995).\*

*In re Joint Eastern and Southern Dist. Asbestos Litigation*, 827 F.Supp. 1014, Prod.Liab.Rep. (CCH) P 13,566 (S.D.N.Y. 1993).\*

*Granville House, Inc. v. Department of Health and Human Services*, 550 F.Supp. 628 (D.Minn. 1982).

Sheila Jasanoff

*Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 113 S.Ct. 2786, 125 L.Ed.2d 469, 61 USLW 4805, 27 U.S.P.Q.2d 1200, 23 Env'tl. L. Rep. 20,979, 37 Fed. R. Evid. Serv. 1, Prod.Liab.Rep. (CCH) P 13,494 (1993).\*

*Markman v. Westview Instruments, Inc.*, 52 F.3d 967, 63 USLW 2663, 34

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U.S.P.Q.2d 1321 Fed.Cir.(Pa.) (1995).\*

*Savage v. Union Pacific R. Co.*, 67 F.Supp.2d 1021 (E.D.Ark.,1999).\*

*National Bank of Commerce v. Associated Milk Producers, Inc.*, 22 F.Supp.2d 942 (E.D.Ark.,1998).\*

*National Bank of Commerce (of El Dorado, Ark.) v. Dow Chemical Co.*, 965 F.Supp. 1490 (E.D.Ark., 1996).\*

Daniel Kevles

*Government of Virgin Islands v. Penn.*, 838 F.Supp. 1054 (D.Virgin Islands, 1993).

Thomas Kuhn

*Brock v. Merrell Dow Pharmaceuticals, Inc.*, 874 F.2d 307, 57 USLW 2742, Prod.Liab.Rep. (CCH) P 12,157 (5th Cir. 1989).\*

*U.S. v. Hines*, 55 F.Supp.2d 62, 52 Fed. R. Evid. Serv. 257 (D.Mass., 1999).\*

*U.S. ex rel. Kokoraleis v. Director of Illinois Dept. of Corrections*, 963 F.Supp. 1473 (N.D.Ill., 1997).\*

*In re Breast Implant Cases*, 942 F.Supp. 958, 46 Fed. R. Evid. Serv. 68 (E.D.N.Y., 1996).

*Mercado v. Ahmed*, 756 F.Supp. 1097, 59 USLW 2519, 32 Fed. R. Evid. Serv. 397 (N.D.Ill., 1991).\*

Bruno Latour

*American Geophysical Union v. Texaco Inc.*, 37 F.3d 881, 63 USLW 2295, 1994 Copr.L.Dec. P 27,312, 32 U.S.P.Q.2d 1545 (2nd Cir. 1994).\*

*American Geophysical Union v. Texaco Inc.*, 60 F.3d 913, 144 A.L.R. Fed. 745, 1995 Copr.L.Dec. P 27,417, 35 U.S.P.Q.2d 1513 (2nd Cir. 1994).\*

Larry Laudan

*Estate of Mauro By and Through Mauro v. Borgess Medical Center*, 137 F.3d 398, 7 A.D. Cases 1571, 12 NDLR P 23 (6th Cir. 1998).

David Lindberg

*American Geophysical Union v. Texaco Inc.*, 37 F.3d 881, 63 USLW 2295, 1994 Copr.L.Dec. P 27,312, 32 U.S.P.Q.2d 1545 (2nd Cir. 1994).\*

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*American Geophysical Union v. Texaco Inc.*, 60 F.3d 913, 144 A.L.R. Fed. 745, 1995 Copr.L.Dec. P 27,417, 35 U.S.P.Q.2d 1513 (2nd Cir. 1994).\*

Robert Merton

*Kewanee Oil Co. v. Bicron Corp.*, 416 U.S. 470, 94 S.Ct. 1879, 40 L.Ed.2d 315, 181 U.S.P.Q. 673 (1974).\*

*American Geophysical Union v. Texaco Inc.*, 37 F.3d 881, 63 USLW 2295, 1994 Copr.L.Dec. P 27,312, 32 U.S.P.Q.2d 1545 (2nd Cir. 1994).\*

*American Geophysical Union v. Texaco Inc.*, 60 F.3d 913, 144 A.L.R. Fed. 745, 1995 Copr.L.Dec. P 27,417, 35 U.S.P.Q.2d 1513 (2nd Cir. 1994).\*

*Forsham v. Califano*, 587 F.2d 1128, 190 U.S.App.D.C. 231, 4 Media L. Rep. 1122 (D.C.Cir. 1978).\*

*Blaz v. Michael Reese Hosp. Foundation*, 74 F.Supp.2d 803 (N.D.Ill. 1999).\*

*Lotus Development Corp. v. Paperback Software Intern.*, 740 F.Supp. 37, 59 USLW 2071, 1990 Copr.L.Dec. P 26,595, 15 U.S.P.Q.2d 1577 (D.Mass. 1990).\*

Ernst Nagel

*Old Colony Bondholders v. New York, N. H. & H. R. Co.*, 161 F.2d 413 (2nd Cir. 1947).

*In re Joint Eastern and Southern Dist. Asbestos Litigation*, 827 F.Supp. 1014, Prod.Liab.Rep. (CCH) P 13,566 (S.D.N.Y. 1993).\*

*American Kennel Club v. Hoey*, 148 F.2d 920, 45-1 USTC P 9268, 33 A.F.T.R. 1209 (2nd Cir. 1945).

Dorothy Nelkin

*McLean v. Arkansas Bd. of Ed.*, 529 F.Supp. 1255, 2 Ed. Law Rep. 685 (E.D.Ark., 1982).\*

Otto Neurath

*American Kennel Club v. Hoey*, 148 F.2d 920, 45-1 USTC P 9268, 33 A.F.T.R. 1209 (2nd Cir. 1945).

Michael Polanyi

*Kleindienst v. Mandel*, 92 S.Ct. 2576 (1972).

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Karl Popper

*Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 113 S.Ct. 2786, 125 L.Ed.2d 469, 61 USLW 4805, 27 U.S.P.Q.2d 1200, 23 Env'tl. L. Rep. 20,979, 37 Fed. R. Evid. Serv. 1, Prod.Liab.Rep. (CCH) P 13,494 (1993).\*

*Moore v. Ashland Chemical, Inc.*, 126 F.3d 679, 47 Fed. R. Evid. Serv. 881 (5th Cir. 1997).\*

*U.S. v. Bonds*, 12 F.3d 540, 62 USLW 2450, 38 Fed. R. Evid. Serv. 688 (6th Cir. 1993).

*U.S. v. Havvard*, 117 F.Supp.2d 848, 55 Fed. R. Evid. Serv. 1087 (S.D.Ind. 2000).\*

*Savage v. Union Pacific R. Co.*, 67 F.Supp.2d 1021 (E.D.Ark. 1999).\*

*U.S. v. Hines*, 55 F.Supp.2d 62, 52 Fed. R. Evid. Serv. 257 (D.Mass. 1999).\*

*U.S. v. Carucci*, 33 F.Supp.2d 302 (S.D.N.Y. 1999).

*National Bank of Commerce v. Associated Milk Producers, Inc.*, 22 F.Supp.2d 942 (E.D.Ark. 1998).\*

*U.S. ex rel. Kokoraleis v. Director of Illinois Dept. of Corrections*, 963 F.Supp. 1473 (N.D.Ill. 1997).\*

*National Bank of Commerce (of El Dorado, Ark.) v. Dow Chemical Co.*, 965 F.Supp. 1490 (E.D.Ark., 1996).\*

*Freeman v. Case Corp.*, 924 F.Supp. 1456, 44 Fed. R. Evid. Serv. 1041, Prod.Liab.Rep. (CCH) P 14,768 (W.D.Va. 1996).\*

*Stibbs v. Mapco, Inc.*, 945 F.Supp. 1220, Prod.Liab.Rep. (CCH) P 14,889 (S.D.Iowa 1996).

*U.S. v. Starzeczyzel*, 880 F.Supp. 1027, 63 USLW 2661, 42 Fed. R. Evid. Serv. 247 (S.D.N.Y., 1995).\*

*City of Tuscaloosa v. Harcros Chemicals, Inc.*, 877 F.Supp. 1504, 1995-1 Trade Cases P 70,967 (N.D.Ala. 1995).\*

*Marylanders for Fair Representation, Inc. v. Schaefer*, 849 F.Supp. 1022 (D.Md. 1994).

*In re Joint Eastern and Southern Dist. Asbestos Litigation*, 827 F.Supp. 1014, Prod.Liab.Rep. (CCH) P 13,566 (S.D.N.Y. 1993).\*

Willard Quine

*Blue Cross and Blue Shield of New Jersey, Inc. v. Philip Morris, Inc.*, 138 F.Supp.2d 357 (E.D.N.Y. 2001).

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*Bethel v. Jefferson*, 589 F.2d 631, 18 Fair Empl.Prac.Cas. (BNA) 789, 18 Empl. Prac. Dec. P 8694, 191 U.S.App.D.C. 108 (D.C.Cir. 1978).  
*Mercado v. Ahmed*, 756 F.Supp. 1097, 59 USLW 2519, 32 Fed. R. Evid. Serv. 397 (N.D.Ill., 1991).\*

Hans Reichenbach

*Skidmore v. Baltimore & O.R. Co.*, 167 F.2d 54 (2nd Cir. 1948).  
*Old Colony Bondholders v. New York, N. H. & H. R. Co.*, 161 F.2d 413 (2nd Cir. 1947).

Michael Ruse

*McLean v. Arkansas Bd. of Ed.*, 529 F.Supp. 1255, 2 Ed. Law Rep. 685 (E.D.Ark., 1982).\*

Bertrand Russell

*Old Colony Bondholders v. New York, N. H. & H. R. Co.*, 161 F.2d 413 (2nd Cir. 1947).  
*Allen v. U.S.*, 588 F.Supp. 247 (D.Utah 1984).

Patrick Suppes

*In re Joint Eastern and Southern Dist. Asbestos Litigation*, 827 F.Supp. 1014, Prod.Liab.Rep. (CCH) P 13,566 (S.D.N.Y. 1993).\*

Robert Westman

*American Geophysical Union v. Texaco Inc.*, 37 F.3d 881, 63 USLW 2295, 1994 Copr.L.Dec. P 27,312, 32 U.S.P.Q.2d 1545 (2nd Cir. 1994).\*  
*American Geophysical Union v. Texaco Inc.*, 60 F.3d 913, 144 A.L.R. Fed. 745, 1995 Copr.L.Dec. P 27,417, 35 U.S.P.Q.2d 1513 (2nd Cir. 1994).\*

Aron Wildavsky

*International Union, United Auto., Aerospace & Agr. Implement Workers of America, UAW v. Occupational Safety & Health Admin.*, 938 F.2d 1310, 60 USLW 2085, 291 U.S.App.D.C. 51, 15 O.S.H. Cas. (BNA) 1145, 1991 O.S.H.D. (CCH) P 29,399 (D.C.Cir. 1991).  
*International Union, United Auto., Aerospace and Agr. Implement Workers of America, UAW v. Johnson Controls, Inc.*, 886 F.2d 871, 58 USLW

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2193, 50 Fair Empl.Prac.Cas. (BNA) 1627, 51 Empl. Prac. Dec. P 39,359, 14 O.S.H. Cas. (BNA) 1217, 1989 O.S.H.D. (CCH) P 28,673 (7th Cir. 1989).

*New York State Ophthalmological Soc. v. Bowen*, 854 F.2d 1379, 272 U.S.App.D.C. 170, 22 Soc.Sec.Rep.Ser. 632, Med & Med GD (CCH) P 37,238 (D.C.Cir. 1988).

*Building and Const. Trades Dept., AFL-CIO v. Brock*, 838 F.2d 1258, 267 U.S.App.D.C. 308, 18 Envtl. L. Rep. 20,507, 13 O.S.H. Cas. (BNA) 1561, 1988 O.S.H.D. (CCH) P 28,134 (D.C.Cir. 1988).

*Common Cause v. Nuclear Regulatory Commission*, 674 F.2d 921, 218 U.S.App.D.C. 262, 8 Media L. Rep. 1190 (D.C.Cir. 1982).

*Mercado v. Ahmed*, 756 F.Supp. 1097, 59 USLW 2519, 32 Fed. R. Evid. Serv. 397 (N.D.Ill., 1991).\*

*U.S. v. Atlantic Richfield Co.*, 429 F.Supp. 830, 9 ERC 1993, 1978 A.M.C. 1304, 7 Envtl. L. Rep. 20,635 (E.D.Pa. 1977).

*Nixon v. Sampson*, 389 F.Supp. 107 (D.D.C. 1975).

#### Steve Woolgar

*American Geophysical Union v. Texaco Inc.*, 37 F.3d 881, 63 USLW 2295, 1994 Copr.L.Dec. P 27,312, 32 U.S.P.Q.2d 1545 (2nd Cir. 1994).\*

*American Geophysical Union v. Texaco Inc.*, 60 F.3d 913, 144 A.L.R. Fed. 745, 1995 Copr.L.Dec. P 27,417, 35 U.S.P.Q.2d 1513 (2nd Cir. 1994).\*

#### Edgar Zilsel

*American Geophysical Union v. Texaco Inc.*, 37 F.3d 881, 63 USLW 2295, 1994 Copr.L.Dec. P 27,312, 32 U.S.P.Q.2d 1545 (2nd Cir. 1994).\*

*American Geophysical Union v. Texaco Inc.*, 60 F.3d 913, 144 A.L.R. Fed. 745, 1995 Copr.L.Dec. P 27,417, 35 U.S.P.Q.2d 1513 (2nd Cir. 1994).\*

#### John Ziman (also Siman)

*Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 113 S.Ct. 2786, 125 L.Ed.2d 469, 61 USLW 4805, 27 U.S.P.Q.2d 1200, 23 Envtl. L. Rep. 20,979, 37 Fed. R. Evid. Serv. 1, Prod.Liab.Rep. (CCH) P 13,494 (1993).\*

*National Bank of Commerce (of El Dorado, Ark.) v. Dow Chemical Co.*, 965

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F.Supp. 1490 (E.D.Ark., 1996).\*

*Savage v. Union Pacific R. Co.*, 67 F.Supp.2d 1021 (E.D.Ark. 1999). (cites Siman rather than Ziman: Eisele J)\*

*National Bank of Commerce v. Associated Milk Producers, Inc.*, 22 F.Supp.2d 942 (E.D.Ark. 1998). (cites Siman rather than Ziman: Eisele J)\*

Many of the author searches encountered little success. These included: Ken Alder, Barry Barnes, Wiebe Bijker, Joseph Ben-David, David Bloor, Harvey Brooks, Michel Callon, Alberto Cambrosio, Daryl Chubin, Harry Collins, Susan Cozzens, Peter Dear, David Edge, Yaron Ezrahi, Paul Feyerabend, Jerry Fodor, Joan Fujimura, Steve Fuller, Peter Galison, Ron Giere, Nigel Gilbert, Susan Haack, Edward Hackett, Ian Hacking, Donna Haraway, Rom Harre, Mary Hesse, Stephen Hilgartner, Gerald Holton, David Hull, Alan Irwin, Evelyn Fox Keller, Karin Knorr-Cetina, Noretta Koertge, Philip Kitcher, Marcel LaFollette, Imré Lakatos, John Law, Bruce Lewenstein, Helen Longino, Michael Lynch, Donald MacKenzie, Ernán McMullin, Everett Mendelsohn, Mike Michael, Michael Mulkay, Alan Musgrave, Helga Nowotny, Andy Pickering, Trevor Pinch, Robert Proctor, Hilary Putnam, Jerome Ravetz, Sal Restivo, Hilary and Steven Rose, Joseph Rouse, Simon Schaffer, Steven Shapin, Wesley Shrum, Susan Star, Norman Storer, Stephen Toulmin, Norton Wise, Brian Wynne, Steven Yearley, Harriet Zuckerman.

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- 1 For a sample of Popper's best known discussion of his philosophy of science, see *Conjectures and Refutations* (London: Routledge & Kegan Paul, 1963) and *The Logic of Scientific Discovery* (London: Hutchison, 1959). For some standard philosophical critiques of Popper's philosophy, see Alan Chalmers, *What is this Thing Called Science* (St. Lucia: University of Queensland Press, 1976), pp. 35–46; David Oldroyd, *The Arch of Knowledge* (Kensington: New South Wales University Press, 1986), pp. 297–317. It is important to indicate that it is not our intention in the following discussion to offer a philosophical critique of Popper's philosophy *per se*.
  - 2 *Frye v US*, 293 F. 1013 (D.C.Cir. 1923); *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 125 L. Ed.2d 469, 113 S. Ct. 2786 (1993).
  - 3 For a critical examination of this litigation and its legal analysis, see Gary Edmond and David Mercer, "Litigation Life: Law-Science Knowledge Construction in (Bendectin) Mass Toxic Tort Litigation," 30 *Social Studies of Science* 265 (2000).

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- 4 Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579, 593, 125 L. Ed.2d 469, 483, 113 S. Ct. 2786, 2797 (1993). (emphasis added)
  - 5 One of the early authoritative legal sources for discussions of authority is John Henry Merryman, "The Authority of Authority: What the California Supreme Court Cited in 1950," 6 *Stan. L. Rev.* 613 (1954).
  - 6 Michael Green, "Expert Witnesses and the sufficiency of Evidence in Toxic Substances Litigation: The Legacy of Agent Orange and Bendectin Litigation," 86 *Northwestern U. L. Rev.* 643 (1992). See also Michael Green, *Bendectin and Birth Defects: The Challenges of Mass Toxic Substances Litigation* (Philadelphia: University of Pennsylvania Press, 1996).
  - 7 Daubert v. Merrell Dow Pharmaceuticals, Inc., 113 S. Ct. 2786, 2797 (1993). Compare *Clair v. Burlington Northern R. Co.*, 29 F.3d 499, 501 (9th Cir. 1994); *Hopkins v. Dow Corning Corp.*, 33 F.3d 1116, 1124 (9th Cir. 1994); *In re Paoli R.R. Yard P.C.B. Litigation*, 35 F.3d 717, 743–745, 746 (3rd Cir. 1994); *Hall v. Baxter Healthcare Corp.*, 947 F. Supp. 1387, 1399, 1411 (D. Or. 1996).
  - 8 522 U.S. 136, 139 L. Ed. 2d 508, 519, 118 S. Ct. 512 (1997). See also Gary Edmond, "Deflating Daubert: *Kumho Tire Co. v. Carmichael* and the inevitability of general acceptance (Frye)," 23 *U. New South Wales L. J.* 38 (2000).
  - 9 509 U.S. 579, 594. 125 L. Ed.2d 469, 483, 113 S. Ct. 2786, 2797 (1993). (emphasis added)
  - 10 Such as the cases of *Smith, Williams, Downing* and Jack Weinstein and Margaret Berger's textbook, *Federal Evidence*.
  - 11 Daubert v. Merrell Dow Pharmaceuticals, Inc., 125 L. Ed.2d 469, 486 (1993). In December 2000, Rule 702 was amended. See Catherine Brixen and Christine Meis, "Codifying the 'Daubert Trilogy': The Amendment to Federal Rule of Evidence 702," 40 *Jurimetrics J.* 527 (2000).
  - 12 Daubert v. Merrell Dow Pharmaceuticals, Inc., 125 L. Ed. 2d 469, 487 (1993).
  - 13 Steven Goldberg, *Culture Clash: Law and Science in America* (New York: New York University Press, 1994); Gary Edmond and David Mercer, "Manifest Destiny: Law and Science in America," 10 *Metascience* 40 (1996). A similar tendency is apparent in some autopoietic approaches. Compare, e.g., Richard Nobles and David Schiff, *Understanding Miscarriages of Justice: Law, the Media, and the Inevitability of Crisis* (Oxford: Oxford University Press, 2000), and Gary Edmond, "Whigs in Court: Historiographical Problems with Expert Evidence," 14 *Yale J. L. & Humanities* 123–75 (2002).
  - 14 Daubert v. Merrell Dow Pharmaceuticals, Inc., 125 L. Ed. 2d 469, 485 (1993), p. 485. (emphasis added)
  - 15 Elsewhere we have examined how judicial expressions of causation are frequently couched with similar sorts of qualifications in order to distinguish legal causation from articulations by philosophers and scientists. See Gary Edmond and David Mercer, "Rebels without a cause: Judges, scientific evidence and the uses of causation," in Ian Freckelton and Danuta Mendelson, eds., *Causation in Law and Medicine* (Dartmouth: Ashgate, 2002), pp. 83–121.
  - 16 John Schuster and Richard Yeo, eds., *The Politics and Rhetoric of Scientific Method* (Dordrecht, the Netherlands: Reidel 1986); David Mercer, "Scientific Method Dis-

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courses in the Construction of ‘EMF Science’: Interests, Resources and Rhetoric in Submissions to a Public Inquiry,” 32 *Social Studies of Science* 205–33 (2002).

- 17 For an analysis of the implications of classification, consider: Geoffrey Bowker and Susan Starr, *Sorting Things Out: Classification and its Consequences* (Cambridge, MA: MIT Press, 1999).
- 18 For a succinct background discussion of Popper and Hempel set against broader traditions in the philosophy of science, see John Losee, *A Historical Introduction to the Philosophy of Science*, 4th ed. (Oxford: Oxford University Press, fourth edition, 2001), pp. 143–176.
- 19 Popper’s popularity may be, in part, attributable to his willingness to explicitly link his ideals of scientific method to normative and quite prescriptive accounts of the nature of science. Some of the normative orientation, associated with his early career, can be linked to his Cold War political views, and in his later career to fears that the images of science promoted by Kuhn and others represented a dangerous skepticism towards the scientific enterprise. See discussions in: Oldroyd, *supra* note 1; John Horgan, *The End of Science: Facing the Limits of Knowledge in the Twilight of the Scientific Age* (London: Abacus, 1998), pp. 32–41; Brian Magee, *Popper* (London: Woburn Press, 1974); Randal Albury, *The Politics of Objectivity* (Melbourne: Deakin University Press, 1983), pp. 18–33; “Symposium: Karl Popper, 1902–1994, Learning from Negative Instances,” 70 *Radical Philosophy* 2 (1995); Imre Lakatos and Alan Musgrave, *Criticism and the Growth of Knowledge* (Cambridge: Cambridge University Press, 1974).
- 20 This sits oddly with some of the discussion of liberality associated with *Frye* and the FRE. We acknowledge that the majority *Daubert* judgment explicitly claims that it is acting in fulfillment of the liberalization of admissibility laws required by the enactment of the FRE in 1975. Indeed, after the *Daubert* judgment was handed down both parties publicly claimed victory. While the Court might have been disingenuous in its account there are alternative explanations considered by or consistent with the thrust of this article. Briefly, in some courts *Frye* had been used to actively exclude evidence so that alternative tests may have been conceived as more liberal. Another possibility is that the judges — acting as naïve realists — were interested in the model of science, championed by authoritative *amici* such as the NAS and AAAS, as relevant and useful criteria for identifying genuine and implicitly reliable knowledge.

We should also indicate that we do not intend to make a teleological claim about the Supreme Court’s designs. These may have developed diachronically as the exclusionary ethos seems to have been intensified in the later cases of *Joiner* and *Kumho*.

- 21 It would seem that by characterizing the *Daubert* decision as some type of judicial *accommodation*, by which we mean a type of pragmatic eclecticism, the question of why particular authors and images of science were preferred remains obscured. We suggest that *appropriation* is a better description because accommodation implies an inclusive dimension to divergent philosophical positions which are neither accommodated in the Supreme Court judgments nor in subsequent judicial practice. The *Daubert* and *Kumho* appeals were heard because of social and legal concerns about expert opinion evidence in the federal courts. Even if the judges were originally ambivalent or to some degree accommodating of various theoretical positions, a more plausible reading of the Supreme Court appeals from *Daubert* to *Kumho* is that they constitute an escalating judicial

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response to perceived socio-legal problems with few indications of any incorporation of constructivist or critical approaches to the sciences. For some discussion of these issues, consider: Sheila Jasanoff, "Beyond Epistemology: Relativism and Engagement in the Politics of Science," 26 *Social Studies of Science* 393, 403 (1996); Sheila Jasanoff, *Science at the Bar: Law, Science and Technology in America* (Cambridge, Mass.: Harvard University Press, 1995) p. 63. See also David Caudill and Richard Redding, "Junk Philosophy of Science?: The Paradox of Expertise and Interdisciplinarity in Federal Courts," 57 *Wash. & Lee L. Rev.* 685 (2000); Gary Edmond and David Mercer, "Representing the sociology of scientific knowledge and law," 19 *Science Communication* 307 (1998). Our own work has been cited in several Australian federal court judgments and in oral argument before the Australian High Court. However, we would be reluctant to suggest that these citations provide much evidence for its impact on Australian jurisprudence.

- 22 Notwithstanding its apparent simplicity, research into scientific practice and scientific controversies has been used to demonstrate some of the potential difficulties associated with attempts to determine what should count as a *valid* test. We would contend that much non-mainstream and novel "science" placed before courts could still claim to be, in some way, testable or have arisen from some form of testing. Where there is fundamental theoretical disagreement one party in a scientific dispute may argue that some claims are not testable because experiments are measuring phantom effects that are theoretically implausible or that a given test is flawed. Informal and relatively flexible considerations of whether a test and a result are theoretically plausible appear to be more important than the mechanical application of abstract philosophical models of scientific method. According to Michael Mulkey and Nigel Gilbert, "Putting Philosophy to Work: Karl Popper's Influence on Scientific Practice," 11 *Philosophy of the Social Sciences* 389, 398 (1981):

[A]ssessments of conformity to Popper's basic rule of scientific method hinge on scientists' interpretation of the term "falsification"; and the meaning of "falsification" depends *entirely* on researchers' technical and scientific judgments. In situations of scientific uncertainty these judgments, and hence the meaning of the Popperian rules, will be variable. Consequently, when there is uncertainty, the Popperian rules cannot provide a straightforward guide for scientists' actions or decisions. There is a gap between the rule and particular action which can only be bridged by the very scientific choice which the rule is intended to constrain.

For more detailed discussions of some of these issues see Harry Collins and Trevor Pinch, *Frames of Meaning: The Social Construction of Extraordinary Science* (London: Routledge and Kegan Paul Ltd, 1982); Harry Collins and Trevor Pinch, *The Golem: What Everyone Should Know About Science* (Cambridge: Cambridge University Press, 1993); Harry Collins and Trevor Pinch, *The Golem at Large* (Cambridge: Cambridge University Press, 1996); David Gooding, Trevor Pinch and Simon Schaffer, eds., *The Uses of Experiment* (Cambridge: Cambridge University Press, 1989); Gary Edmond and David Mercer, "Keeping Junk History, Philosophy and Sociology of Science out of the Courtroom: Problems with the Reception of *Daubert v. Merrell Dow Pharmaceuticals, Inc.*" 20 *U. New South Wales L. J.* 48 (1997).

- 23 See, e.g., *Cummins v. Lyle Indus.*, 93 F.3d 362, 368 (7th Cir. 1996).

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- 24 Jasanoff is cited, in *Daubert*, for limitations to peer review and publication. These citations and references tend to displace her constructivist theoretical position, and apart from qualified reference by a dissentient in the case of *Westman* (discussed below) she is never cited for, or associated with, constructivist insights or a relativist epistemology. Superficially, Jasanoff's analysis of peer review bears resemblance to other works, such as Daryl Chubin and Edward Hackett, *Peerless Science: Peer Review and US Science Policy* (Albany: State University of New York Press, 1990) and Marcel LaFollete, *Stealing Into Print: Fraud, Misconduct and Plagiarism in Scientific Publishing* (London: University of California Press, 1992), and those of Relman, Angell and Horrobin, which do not share all of Jasanoff's theoretical predispositions. See also Jasanoff, *supra* note 21. For a recent review of academic peer review, see Juan Miguel Campanario, "Peer Review for Journals as it Stands Today-Part Two" 19 *Science Communication* 277 (1998) and the empirical work of Harry Collins, "Tantalus and the aliens: Publications, audiences and the search for gravitational waves," 29 *Social Studies of Science* 163 (1999).
- 25 At the very least, a respectable, or perhaps *safe*, model for legal purposes.
- 26 877 F.Supp. 1504, 1529 (N.D.Ala. 1995).
- 27 For a discussion of the contestation and negotiation around the construction of scientific boundaries, consider: Thomas Gieryn, *Cultural boundaries of science: Credibility on the line* (Chicago: University of Chicago Press, 1998), and Bowker and Starr, *supra* note 17.
- 28 Note the tautological loop. The selection of falsification as the scientific method and the appropriate means of identifying scientific knowledge, in effect determines what is scientific and therefore to be considered *reliable*.
- 29 *US v Havvard*, 117 F.Supp.2d 848, 852 (S.D.Ind. 2000). See also Simon Cole, *Suspect identities: A history of fingerprinting and criminal identification* (Cambridge, Mass.: Harvard University Press, 2001); Jennifer Mnookin, "The Image of Truth: Photographic Evidence and the Power of Analogy" 10 *Yale J. L. & Humanities* 1 (1998).
- 30 *In re Joint Eastern and Southern District Asbestos Litigation*, 827 F. Supp. 1014, 1026–1027 (S.D.N.Y. 1993); *National Bank of Commerce v. Dow Chemical Co.*, 965 F.Supp. 1490, 1494 (E.D.Ark. 1996); *National Bank of Commerce v. Associated Milk Producers, Inc.*, 22 F.Supp.2d 942, 947–948 (E.D.Ark. 1998); *Savage v. Union Pacific Railroad Company*, 67 F.Supp.2d 1021 (E.D.Ark. 1999). The last three judgments were all written by Judge Eisele.
- 31 43 F.3d 1311, 1316 (9th Cir. 1995).
- 32 Peter Huber, *Galileo's Revenge: Junk science in the courtroom* (New York: Basic Books, 1991). Compare: Kenneth Chesebro, "Galileo's retort: Peter Huber's junk scholarship," 42 *American U. L. Rev.* 1637 (1993); Edmond and Mercer *supra* note 13; Gary Edmond and David Mercer, "Trashing 'junk' science," *Stan. Tech. L. Rev.* <[http://stlr.stanford.edu/STLR/Articles/98\\_STLR\\_3/contents\\_f.htm](http://stlr.stanford.edu/STLR/Articles/98_STLR_3/contents_f.htm)> (1998).
- 33 Huber, *supra* note 32 at 192–228. Although a more detailed reading of Popper reveals that despite his best known claims for falsification as a clean philosophical/logical criteria for demarcating science from non-science he also stipulated the need for scientists to nurture the appropriate critical attitude. See Oldroyd, *supra* note 1, and Horgan, Albury, Magee, *supra* note 19.
- 34 43 F.3d 1311, 1317. It is worth observing that Blackmun J's cosmological caveat might

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- actually be invoked, in response to the Court of Appeals' approach to *Daubert* on remand, to argue that courts will not always require pure or idealized models of expert opinion. In endeavoring to resolve refractory problems expeditiously, courts may divert from the quest for cosmological understanding that purportedly underpins the modern sciences.
- 35 Ronald Allen, "Expertise and the *Daubert* Decision," 84 *J. Crim. L. & Criminology* 1157 (1994).
- 36 *US v. Director of Illinois Dept. of Corrections*, 963 F.Supp. 1473 (N.D.Ill. 1997).
- 37 963 F.Supp. 1473, 1489–1490 (N.D.Ill. 1997).
- 38 Kenneth Foster and Peter Huber, *Judging science: Scientific knowledge and the federal courts* (Cambridge: MIT Press, 1998). Compare Gary Edmond and David Mercer, "Juggling science: From polemic to pastiche," 13 *Social Epistemology* 215 (1999).
- 39 Ironically, because the Supreme Court endorsed an eclectic and highly idealized model of scientific method, that was not based on actual study of what scientists do in their day-to-day work, expert witnesses have become increasingly dependent upon lawyers to translate and frame their practices and evidence into legally tractable forms. By invoking Popper, courts have to some extent exacerbated the very conditions they were endeavoring to ameliorate. This is one of the costs of both Blackmun J's inoculation and Rehnquist CJ's prophylactic approach. In addition, the new standards provide means to challenge almost any submission, on the basis of inadequacies of testing and replication. See Harry Collins, *Changing Order: Replication and Induction in Scientific Practice* (London: University of Chicago Press, 1985), and Collins and Pinch, *supra* note 22; Mike Lynch, "The Discursive Production of Uncertainty: The OJ Simpson 'Dream Team' and the Sociology of Knowledge Machine," 28 *Social Studies of Science* 829 (1998).
- 40 55 F.Supp.2d 62, 65 (D.Mass. 1999).
- 41 Alexander Morgan Capron, "*Daubert* and the Quest for Value-Free "Scientific Knowledge" in the Courtroom," 30 *U. Rich. L. Rev.* 85 (1996); Margaret Farrell, "Coping with Scientific Evidence: The Use of Special Masters," 43 *Emory L. J.* 927 (1994) and "*Daubert v. Merrell Dow Pharmaceuticals, Inc.*: *Epistemology and Legal Process*," 15 *Cardozo L. Rev.* 2183 (1994); Peter Schuck, "Multicultural Redux: Science, Law and Politics," 11 *Yale L. Policy Rev.* 1 (1993).
- 42 *US v. Hines*, 55 F.Supp.2d 62, 65 (D.Mass. 1999).
- 43 There has been an ongoing assault on evidence generated through the examination of handwriting. This accords well with our general discussion of anxieties about forms of unreliable science. See, e.g., D. Michael Risinger, Mark Denbeaux and Michael J. Saks, "Exorcism of Ignorance as a Proxy for Rational Knowledge: The Lessons of Handwriting Identification Expertise," 137 *U. Pa. L. Rev.* 731 (1989).
- 44 880 F.Supp. 1027 (S.D.N.Y 1995).
- 45 880 F.Supp. 1027, 1040. (italics added) See also *Freeman v. Case Corp.*, 924 F.Supp. 1456, 1466 (W.D.Va. 1996).
- 46 126 F.3d 679, 685 (5th Cir. 1997). Citing Green, Popper and Faigman, Judge Dennis distinguished between "hard" or "Newtonian" science and "knowledge outside the realm of hard science." The term Newtonian stems from the work of the eminent evidence scholar Imwinkelried and appears to be based on a very casual analysis of the history and

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- philosophy of science, Green, *supra* note 6; Edward Imwinkelried, “The Next Step After *Daubert*, Developing a Similarly Epistemological Approach to Ensuring the Reliability of Nonscientific Expert Testimony,” 15 *Cardozo L. Rev.* 2271 (1994); David Faigman, “To have and Have Not: Assessing the Value of Social Science to the Law as Science and Policy,” 38 *Emory L. J.* 1005 (1989). Judge Dennis also cited the case of *Starzeczyzel*.
- 47 143 L. Ed.2d 238 (1999).
- 48 *Kumho Tire Co. v. Carmichael*, 143 L. Ed.2d 238, 252 (1999).
- 49 *General Electric Co. v. Joiner*, 522 U.S. 136, 139 L. Ed.2d 508, 519, 118 S. Ct. 512 (1997).
- 50 This is an escalation from “role” (Rehnquist CJ) and “responsibility” (Blackmun J) espoused in *Daubert*.
- 51 *Kumho Tire Co. v. Carmichael*, 143 L. Ed.2d 238, 253, 257 (1999). Justice Stevens was critical of this practice. Nevertheless, the majority’s exemplification and the ideological value of casting Carlson as a junk scientist was significant: “We further explain the way in which a trial judge ‘may’ consider *Daubert*’s factors by applying these considerations to the case at hand.” See Gary Edmond, “Legal Engineering: Contested representations of law, science (and non-science) and society,” 32 *Social Studies of Science* (2002) (forthcoming).
- 52 *Kumho Tire Co. v. Carmichael* 143 L Ed 2d 238, 253 (1999). It is not our intention to enter this non-reflexive debate about the adequacy of Carlson’s opinion, other than to suggest that the Supreme Court’s orientation is not the only way to interpret the case, and to indicate how different models of science and particular emphases enable judges, and others, to represent and treat expert evidence in quite inconsistent ways. See, e.g., Gary Edmond, “Science, Law and Narrative: Helping the ‘Facts’ to Speak for themselves” 23 *S. Ill. U. L. J.* 555 (1999).
- 53 *Kumho Tire Co. v. Carmichael*, 143 L. Ed.2d 238, 251 (1999).
- 54 Even if the inclusion of qualifications was a form of judicial accommodation, subsequently they could be elided and displaced. Of course, Supreme Court judges do not have complete control over the use of their decisions.
- 55 Several articles and books have examined the case of *McLean v Arkansas*, see Michael Ruse, ed., *But is it Science? The Philosophical Question in the Creation/Evolution Controversy* (New York: Prometheus Books, 1996); “Special Section on Creationism, Science, and the Law,” 40 *Science Technology and Human Values* 9 (1982); Thomas Gieryn, G. Bevins and S. Zehr, “Professionalization of American Scientists: Public Science in the Creation/Evolution Trials,” 50 *American Sociological Review* 392 (1985); Marcel LaFollette, *Creationism, Science and the Law: The Arkansas Case* (Cambridge, Mass.: MIT Press, 1983).
- 56 529 F.Supp 1255 (E.D.Ark. 1982).
- 57 529 F.Supp 1255, 1267.
- 58 529 F.Supp. 1255, 1268.
- 59 This position is supported by the images of science presented in *amicus curiae* briefs submitted in a later appeal — involving another creation science case — to the Supreme Court in *Aguillard v Edwards*, 482 U.S. 578, 107 S. Ct. 2573 (1987). In that case, the

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images of science propounded again reflected the exigencies of the case (context of use), and also the federal jurisprudence. In a brief submitted on behalf of 72 Nobel laureates (and others) general acceptance — the dominant legal standard prior to *Daubert* — is invoked in addition to the testing of naturalistic explanations. For example: “Neither appellants nor their *affiants* suggest that their definition of “creation science” is generally accepted” and “Science is devoted to formulating and testing naturalistic explanations for natural phenomena. . . . The scientific method involves the rigorous, methodological testing of principles that might present a naturalistic explanation for those facts. . . . An explanatory principle that is by its nature cannot be tested is outside the realm of science.” It is interesting to note the emphasis placed in a secondary account of the construction of the *amicus* brief produced by the Nobel laureates in the work of Michael Shermer, director of the The Skeptics (US). In his account the brief is portrayed as if it represented a unique point in the construction of a unified image of the scientific method. Shermer does not acknowledge that other briefs may have produced or endorsed different definitions and emphases, see Michael Shermer, *Why People Believe Weird Things: Pseudoscience, Superstition, and other confusions of our time* (New York: Freeman, 1997), pp. 154–172.

Another brief in *Edwards* also placed different emphases. In the brief submitted by the NAS, they suggest that scientific findings “have confirmed the essential validity of the theory of evolution developed by Charles Darwin and others.” They also stress that: “Creation-science is not science. It cannot meet any of the criteria of science. Indeed it fails to display the most basic characteristic of science: reliance upon naturalistic explanations. . . . Science welcomes new discoveries and ideas. Scientists operate within a system designed for continuous testing of ideas.”

- 60 Overton’s J judgment, following the testimony of philosopher of science Michael Ruse, tends to treat testability and falsification as overlapping categories, see Michael Ruse, “Witness Testimony Sheet, *McLean v. Arkansas*,” in Ruse, *supra* note 55 at 302. Our own research has identified some unusual twists in the use of Popperian philosophy in an Australian trial which concerned claims made about the existence of Noah’s Ark. See Gary Edmond and David Mercer, “Saving science: Creating (public) science in the Noah’s Ark case,” 8 *Public Understanding of Science* 317 (1999). Others have noted the willingness, depending on the specific context, for proponents of creation science to bolster their claims by enrolling images of scientific practice from the philosophy of science. See, e.g., Dorothy Nelkin, *Science Textbook Controversies and the Politics of Equal Time* (Cambridge, Mass.: MIT Press, 1977); Simon Locke, “The Use of Scientific Discourse by Creation Scientists: Some Preliminary Findings,” 3 *Public Understanding of Science* 403 (1994). At various times during his career Popper questioned the falsifiability of the central plank of Darwinian evolution by natural selection, namely “the survival of the fittest.” See K. Popper, *Unended Quest* (La Salle, Ill.: Open Court, 1976) pp. 167–79, 234–35. The possibility of using Popper’s philosophy as a tool to challenge the scientific veracity of Darwinism raises some interesting ironies. Consider the discussion in Michael Ruse, “Prologue: A Philosopher’s Day in Court” in Ruse, *supra* note 55 at 13–35; Larry Laudan, “Science at the Bar: Causes for Concern” 7 *Science Technology & Human Values* 61 (1982); Philip Quinn, “The Philosopher of Science as Expert Witness,” in James Cushing, C.F. Delaney and Gary Gutting, eds., *Science and Reality: Recent Work in the Philosophy of Science* (Notre Dame, Ind.: University of Notre Dame Press, 1984) pp. 32–53.

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- 61 We would not contend that these isolated uses are as systematic as the *Daubert*-inspired references after 1993.
- 62 756 F.Supp. 1097 (N.D.Ill. 1991).
- 63 756 F.Supp. at 1099, 1101. Such an onerous standard seems to conform to Zigel J's anxiety that courts are too liberal in their admissibility decisions: "Neither courts nor scientists agree what precise degree is required for entry into the canon of science or admissibility. I would be satisfied if we excluded what we sometimes admit, that is, expertise with virtually no reliability and no validity."
- 64 Notably, here Zigel J makes no attempt to distinguish fact-finding in law from scientific inquiry. This is inconsistent with the dichotomy developed in relation to Blackmun's J *Daubert* opinion. Note that after *Daubert* Zigel J endorsed a Popperian approach in *US v. Director of Illinois Dept. of Corrections*.
- 65 874 F.2d 307, 309 (5th Cir. 1989), citing Bert Black, "A Unified Theory of Scientific Evidence," 56 *Fordham L. Rev.* 595 (1988) and Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962), pp. 5–7.
- 66 *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 125 L. Ed.2d 469, 485.
- 67 For discussion of Merton and the traditional "standard" sociological view of science, see Michael Mulkay, *Science and the Sociology of Knowledge* (London: George Allen and Unwin, 1979), pp. 19–26.
- 68 Well known studies by Merton include his Weberian inspired thesis, *Science Technology and Society in Seventeenth Century England* (New York: Harper and Row, 1970), [originally published in *Osiris* (1938)], where he linked the rise of modern science to the cultural ethos of Puritanism. Merton also made major contributions to methodology in the sociology of science, *The Sociology of Science: Theoretical and Empirical Investigations* (Chicago, University of Chicago Press, 1973); T. Gieryn, ed., *Science and Social Structure (A Festschrift for RK Merton)* (New York: New York Academy of Sciences, 1980). Interestingly, Merton and his students were influential in the development of scientometrics and bibliographical studies of scientific texts. Debates about the respective value of qualitative versus quantitative approaches continue in the sociology of science. For a recent example of work which is critical of the more qualitative work produced by sociologists of scientific knowledge consider: Stéphane Baldi, "Normative Versus Social Constructivist Processes in the Allocation of Citations: A Network-Analytic Model," 63 *American Sociological Review* 829 (1998).
- 69 Barry Barnes, *T.S. Kuhn and Social Science* (New York: Columbia University Press, 1982); Michael Mulkay, "Norms and Ideology in Science," 4/5 *Social Sciences Information* 637 (1975).
- 70 94 S. Ct. 1879 (1974). See also *Lotus Dev. Corp. v. Paperback Software Intern.*, 740 F. Supp. 37, 77–79 (D. Mass. 1990).
- 71 94 S Ct 1879, 1890 (1974).
- 72 94 S Ct 1879, 1890 (1974).
- 73 These claims are more consistent with the work of Mitroff and Mulkay. Ian Mitroff, "Norms and Counter-norms in a select group of the Apollo Moon Scientists: A Case Study in the Ambivalence of Scientists," 39 *American Sociological Review* 579–595 (1974); Michael Mulkay, "Interpretation and the use of rules: The case of the Norms of

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- Science,” in T. Gieryn, ed., *Science and Social Structure (A Festschrift for RK Merton)* (New York: New York Academy of Sciences, 1980), p. 111. For some recent studies providing overviews of the shaping by commercial, state and public interests of the reward system, normative ethos and professional ideologies of science, see Henry Etzkowitz and Andrew Webster, “Science as Intellectual Property,” in Sheila Jasanoff, et al, eds., *Handbook of Science and Technology Studies* (Thousand Oaks: Sage, 1995), pp. 480–505; Helga Nowotny, Peter Scott and Michael Gibbons, *Rethinking Science: Knowledge and the Public in an Age of Uncertainty* (Cambridge: Polity Press, 2001); Philip Mirowski and Esther-Mirjam Sent, eds., *Science Bought and Sold: Essays in the Economics of Science* (Chicago: University of Chicago Press, 2002).
- 74 587 F.2d 1128 (D.C.Cir. 1978).
- 75 587 F.2d at 1147–1148.
- 76 74 F.Supp.2d 803 (N.D.Ill. 1999).
- 77 74 F.Supp.2d at 804.
- 78 74 F.Supp.2d at 807.
- 79 60 F.3d 913 (2nd Cir. 1994).
- 80 Compare the rhetorical importance of the (Huber inspired) laboratory-centered and generally more restrictive models of science elaborated by the Court of Appeals in the remand from *Daubert*, *supra* note 31.
- 81 60 F.3d at 933.
- 82 60 F.3d at 934–935.
- 83 Legal support for this proposition is drawn from: *Weissmann v. Freeman*, 868 F.2d 1313, 1324 (1989). Judges often seem to prefer legal authority to other sources of authority, even when confronted with non-legal specialized knowledges. This tendency was conspicuous in early judicial descriptions of DNA typing technology, where prior judgments were as common as scientific texts; both as authority for admission and use as well as descriptions of appropriate practice and the limitations associated with the technology.
- 84 Once again these representations are quite different to the motivations characterized as legitimate by Huber, *supra* note 32.
- 85 60 F.3d at 940–941.
- 86 52 F.3d 967 (Fed. Cir. 1995).
- 87 Perhaps they were not clearly understood by judges. On the basis of support from pre-eminent institutions such as the AMA, NAS and AAAS, they may have — embracing some kind of naïve realism — actually thought that Popper’s theory captured what is often conceived as the privileged epistemology of science.
- 88 Though, we suspect many commentators such as Foster and Huber, *supra* note 38, were not.
- 89 Oldroyd, *supra* note 1 at 308–315.
- 90 K Popper, *The Open Society and its Enemies*, 2 volumes (London: Routledge & Kegan Paul, 1945).
- 91 Albury, *supra* note 19.
- 92 Magee, *supra* note 19.

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- 93 See, e.g., Stephen Odgers and James Richardson, “Keeping bad science out of the courtroom – Changes in American and Australian expert evidence law,” 18 *U. New South Wales L. J.* 108 (1995); Ian Freckelton, “Contemporary comment: When plight makes right – The forensic abuse syndrome,” 18 *Criminal Law Journal* 29 (1994); Huber, *supra* note 32; Foster and Huber, *supra* note 38; David Bernstein, “Junk science in the United States and the Commonwealth,” 21 *Yale J. International L.* 123 (1996).
- 94 Gilbert and Mulkay, *supra* note 22.; Michael Mulkay, *Sociology of Science: A Sociological Pilgrimage* (Milton Keynes: Open University Press, 1991), p. 130.
- 95 We accept that the extent of the *revolution* is open to contestation. In part it depends upon the emphasis of elements of novelty as opposed to continuity. It would be our contention that falsification is frequently unworkable or of limited value as an admissibility criterion. This is not to suggest that *Daubert* is insignificant, but rather to interpret the *Daubert, Joiner, Kumho* “trilogy” as a shift in ethos or the inauguration of a new regime which encouraged federal judges to be more critical about admissibility decisions.
- 96 In this regard Judge Weinstein’s oft-cited contention is emblematic: “An expert can be found to testify to the truth of almost any factual theory, no matter how frivolous.” Jack B. Weinstein, “Improving Expert Testimony,” 20 *U. Rich. L. Rev.* 473, 482 (1986).
- 97 For some discussion of the role of a literary or discursive technology consider: Timothy Lenoir, “Inscription practices and materialities of communication,” in Timothy Lenoir, ed., *Inscribing Science: Scientific texts and the materiality of communication* (Stanford: Stanford University Press, 1998), pp. 1–19; Simon Schaffer, “The Leviathan of Parsontown: Literary Technology and scientific representation” in *Inscribing Science: Scientific texts and the materiality of communication, supra* at pp. 182–222; Alan G. Gross, Joseph E. Harmon and Michael Reidy, *Communicating Science: The Scientific Article from the 17th Century to the Present* (Oxford: Oxford University Press, 2002).
- 98 The following are references to *amicus curiae* briefs submitted to the Supreme Court in relation to the *Daubert* appeal. AAAS and NAS, pp. 6, 7, 8, 10: “Science . . . represents a process for refining theoretical explanations about the world that are subject to further testing and refinement,” “science does proceed through a series of interrelated steps centered on the generation and testing of hypotheses,” “An hypothesis is accepted as generally valid to the extent that it has survived repeated attempts at falsification”; AMA, pp. 6–7, 9, 10, 11: “The scientific method involves replicable, empirical testing of hypotheses”; New England Journal of Medicine, p. 2; Carnegie Commission, pp. 5, 6, 9, 11, 12: “Scientists proceed by formulating hypotheses that they then test.” Other briefs which endorsed Popper or testing include: American Law Professors; Pharmaceutical Manufacturers, p. 13; Respondent, p. 21; American Tort Reform Association, p. 8; Product Liability Advisory Council, pp. 16–17; American College of Legal Medicine, p. 11; Bloembergen et al, pp. 3, 5, 7, 8, 12. It is also worth noting that many of the briefs stressed the importance of publication and peer review, several citing Angell and Relman. Notably, the NAS and AAAS brief cited Relman and Angell, Horrobin, Green and Ziman. A brief submitted by eminent physicians, scientists and historians of science seems to have made little identifiable impact.
- 99 Given their seniority and Popper’s waning popularity, it is quite possible that Popper’s philosophical writings were encountered by some of the judges during their university education.

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- 100 Recourse to Popper's work may have also opened the Court to exogenous criticism — Rehnquist CJ's concern — and this may be one of the reasons why Popper is eventually, in Barthes' terminology, exnominated.
- 101 Historians and anthropologists seem to have been more reflexive about their participation in legal settings and the judicial use of their professional work. *See, e.g.*, Ruse, Laudan and Quinn *supra* note 60.
- 102 *See, e.g.*, Mary Bobinski, "Citation Sources and the New York Court of Appeals," 34 *Buffalo L. Rev.* 965 (1985); Russell Smyth, "What do judges Cite? An Empirical Study of the 'Authority of Authority' in the Supreme Court of Victoria," 25 *Monash U. L. Rev.* 29 (1999). Compare: G. Nigel Gilbert, "Referencing as Persuasion," 7 *Social Studies of Science* 113 (1977); John Law and R.J. Williams, "Putting Facts Together: A Study of Scientific Persuasion," 12 *Social Studies of Science* 535; Steven Yearley, "Textual Persuasion: The Role of Social Accounting in the Construction of Scientific Arguments," 11 *Philosophy of the Social Sciences* 409 (1981); Steve Woolgar, "Discovery: Logic and Sequence in a Scientific Text," in Karin Knorr, Roger Krohn and Richard Whitley, eds., *The Social Processes of Scientific Investigation* (Dordrecht: D. Reidel Publishing Company, 1980) 239; G. Nigel Gilbert and Michael Mulkay, "Warranting Scientific Belief," 12 *Social Studies of Science* 383 (1982). For a more general critical appraisal of qualitative and quantitative approaches consider the classic position advanced by Aaron Cicourel, *Method and Measurement in Sociology* (New York: The Free Press, 1964).
- 103 It appears as no coincidence that after the *Daubert* judgment the relevance of Popper (and *Daubert*) was contested in the various *amicus curiae* briefs submitted to the Supreme Court in relation to the admissibility standard for non-scientific expert evidence. *See also* Edmond (2002), *supra* note 51.
- 104 Bruno Latour and Steve Woolgar, *Laboratory Life: The Social Construction of Scientific Facts* (London: Sage, 1979) p. 75.
- 105 Although there is no simple mathematical relationship between citation or its absence indicating facticity. In some contexts citation may still act to bolster an established claim. *See also* Bruno Latour, *Science in Action* (Cambridge Mass.: Harvard University Press, 1987) pp. 21–62.
- 106 Latour and Woolgar, *supra* note 104 at 76.
- 107 Pierre Bourdieu, "The force of law: Toward a sociology of the juridical field," 38 *Hastings L. J.* 814 (1987).
- 108 The transformation of citations of Popper's falsification into a more standardized legal image of testing also resonates with Ravetz's work on the standardization of facts. Ravetz observed that "facts" which are useful to a specific technological application may bear little resemblance to their original formulation in a research context:

[W]hen the fact undergoes standardization, not merely the nuances of its first intimation, but even some important but subtle aspects of its assertions or its objects, are smoothed over and forgotten. This seems and may indeed be, a regrettable vulgarization, especially when the end by-product is examined by an expert in the corresponding descendent field of research. But it is quite necessary, if the fact is to be useful to those who lack

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the time, skill, or inclination to master the elaborate theoretical context in which its sophisticated versions are comprehensible.

Jerome Ravetz, *Scientific Knowledge and its Social Problems* (Harmondsworth: Penguin Books, 1973) p. 201. See also Stephen Hilgartner, "The Dominant View of Popularization: Conceptual Problems, Political Uses," 20 *Social Studies of Science* 519 (1990).

- 109 Regardless of their reality, these *anxieties* had been prevalent since the mid 1980's. See Edmond and Mercer (2000), *supra* note 3.
- 110 It is arguable that the third *Daubert* criteria was a direct response to new diagnostic technologies like DNA typing.
- 111 General Electric Co. v. Joiner 522 U.S. 136, 139 L Ed 2d 508, 519, 118 S. Ct. 512 (1997); Kumho Tire Co. v. Carmichael 526 U.S. 137, 143 L Ed 2d 238, 119 S. Ct. 137 (1999). See also US v. Scheffer 523 U.S. 303, 140 L. Ed 2d 413, 118 S. Ct. 1261 (1998).
- 112 Several commentators have undertaken very critical reviews of the sociological work of Latour and Jasanoff. See, e.g., Alan Sokal and Jean Bricmont, *Intellectual Impostures* (London: Profile Books, 1998), pp. 115–123; David Bereby, "That Damned Elusive Bruno Latour," *Lingua Franca* 22 (Sept/Oct., 1994); Norman Levitt, *Prometheus Bedeviled: Science and The Contradictions of Contemporary Culture* (New Brunswick: University Press, 1999). For some overviews of the so called Science Wars see Andrew Ross, ed., *Science Wars* (Durham, NC: Duke University Press, 1996); David Mercer, "The Higher Moral Panic: Academic Scientism and its Quarells with Science and Technology Studies," 17 *Prometheus* 77 (1999); Jay A. Labinger and Harry Collins, eds., *The One Culture?: A Conversation About Science* (Chicago: The University Of Chicago Press, 2001).
- 113 Jonathan Potter, *Representing Reality: Discourse, rhetoric and social construction* (London, Sage, 1996).
- 114 Mike Michael, "Lay Discourses of Science: Science in General, Science in Particular, and Self," 17 *Science Technology and Human Values* 313 (1992).
- 115 Clifford Geertz, "Thick description: Toward an interpretative theory of culture" in C. Geertz, *The interpretation of cultures* (New York, Basic Books, 1973) 3.
- 116 Conventionally, the long involvement of social science in US courts is linked to the introduction of the Brandeis brief in *Muller v. State of Oregon*, 208 U.S. 412, 28 S. Ct. 324 (1908). More recent and influential work by Monahan and Walker provides an indication of prevailing debates around the role of the social sciences. Monahan and Walker proposed that findings of social scientific work could be used by courts as a form of precedent, comparable to the use of legal precedent. We would contend that this study might illustrate some of the potential limitations to such a proposal. Because such authority is often incorporated, qualified and transmuted in judgments it would seem that, apart from the logistics of monitoring ongoing research and assessing and weighing (often competing) methodologies, such a model ignores the strategic and legitimacy flexibility central to judicial decision making. See John Monahan and Laurens Walker, "Social Authority: Obtaining, Evaluating, and establishing social science in law," 134 *U. Pa. L. Rev.* 477 (1986); *Social Science in Law: Cases and Materials* (New York, The Foundation Press, Inc., 1985); Laurens Walker and John Monahan, "Scientific Authority: The Breast Implant Litigation and Beyond," 86 *Va. L. Rev.* 801 (2000).
- 117 Consider: Harvey Sacks, "On doing 'being ordinary,'" in Maxwell Atkinson and John

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Heritage, eds., *Structures of Social Action: Studies in Conversation Analysis* (Cambridge: Cambridge University Press, 1984), p. 413; Michael Moore, "Demonstrating the Rationality of an Occupation," 8 *Sociology* 111 (1974).