Where the Rubber Meets the Road: Thinking about Expert Evidence as Expert Testimony

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It has been more than a decade since the United States Supreme Court first delved into the problem of defining the limits of scientific (or more precisely, expert) evidence within the law in the now famous Daubert v. Merrell Dow Pharmaceuticals, Inc. decision and its "progeny."1 During this period, what has sometimes been called a "cottage industry" of Daubert scholarship has arisen, generating an enormous amount of legal scholarship and discussion.2 This attention is far from unwarranted. The use of expert evidence in the law clearly is an enormously important topic, and Daubert itself is now considered by evidence scholars, "perhaps the most important evidence case ever decided."3

This symposium celebrates the publication of the book No Magic Wand, the culmination and summation of Professors Caudill and LaRue's

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2. See Lawrence S. Pinsky, The Use of Scientific Peer Review and Colloquia to Assist Judges in the Admissibility Gatekeeping Mandated by Daubert, 34 HOUS. L. REV. 527, 528 (1997).

substantial contribution to this discussion. Professors Caudill and LaRue’s contributions are of particular interest to me because they attempt to bridge the discussion between two very different literatures: a literature that explores the relationship between science, technology and law from the point of view of the discipline of Science and Technology Studies ("S&TS") and the more familiar (to legal readers) doctrinal legal scholarship on expert evidence. Because S&TS, as a discipline, endeavors to produce empirically accurate accounts of scientific and technological knowledge-making as practices, it might reasonably be expected to have something to contribute to legal discourses that center around the need to appropriately handle expert evidence produced by scientists and technicians. As a scholar who was trained in S&TS and now works in a Law and Society program, Professors Caudill and LaRue’s efforts to synthesize these two streams of thought are of particular interest to me. In this paper, therefore, I would like to treat the publication of No Magic Wand as an occasion to take stock of the debate over expert evidence with particular emphasis on the potential contribution to this debate that has been, or could be, offered by S&TS. I will argue that the purported debate between legal and social scientific scholars, though still unresolved and perhaps irresolvable, masks large areas of consensus between most scholars. In particular, I will argue that those disagreements that do remain between legal and social scientific scholars are of little consequence in resolving how to best move forward in helping courts resolve what I call “the expert evidence problem.”

I. THE EXPERT EVIDENCE PROBLEM & JUDICIAL GATEKEEPING

By way of introduction, it useful to begin by reiterating why expert evidence is considered a problem, and why judicial gatekeeping is considered a solution to that problem. As Professors Denbeaux and Risinger note, the mere fact that expert evidence can be wrong or “bad” is not sufficient to render expert evidence problematic, because that is true of all evidence. Expert evidence can be combated like all other evidence through mechanisms such as cross-examination, presentation of contrary evidence and exclusion for lack of relevance. Indeed, the Daubert opinion contains a passage that would seem to imply that these should be the normal modes of combating expert evidence. Arguably, it might be inferred that the Court believed litigants should resort to admissibility challenges only in extraordinary cases. Some evidence scholars, for example, have

6. See Daubert, 509 U.S. at 596 ("Vigorous cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof are the traditional and appropriate means of attacking shaky but admissible evidence.").
now taken the position that Daubert's admissibility requirement is not necessary at all and that expert evidence should simply be treated like all other evidence. Of course, perhaps predictably, that has not been the case; in creating an admissibility requirement (or reinforcing the existing one), the Court created a procedural structure that is now simply treated as yet another weapon in the litigation arsenal.

The courts essentially have two choices in dealing with expert evidence. One option is to take the advice of those scholars cited above, allow all expert evidence into court and rely on that great truth-producing engine, cross-examination, to sort good evidence from bad. The other is to seek to "manage" expert evidence in some way—that is, to adopt some sort of admissibility procedure, mechanism, threshold, etc., by which the fact-finder is not permitted to hear some expert evidence. As Professors Denbeaux and Risinger cogently note, the Court's decision to opt for the latter, whether under a Frye or a Daubert regime, necessarily implies that it has determined that the former solution is inadequate. The reason for this must be that some expert evidence has the potential to be particularly misleading and therefore poisonous to the fact-finder, so poisonous indeed that the fact-finder must be protected from the expert (hence the gatekeeping metaphor). And, the reason for that must have something to do with the authority that is accorded "experts" in contemporary society. The Court seems to be reasoning that weak, downright misleading or even false evidence cloaked in the guise of expertise is far more pernicious than weak evidence lacking that imprimatur. Thus, we have admissibility standards so that those proffered witnesses who choose to don the mantle of "expert" may be held to a higher standard than the mere "relevance" required of ordinary witnesses. Under Daubert, "relevance" is neatly paired with an equally succinct R concept: "reliability."

The focus of the expert evidence literature has been primarily on the second R, "reliability." The Court's framework generates all sorts of vexing questions, such as how reliability is to be determined and whether judges are competent and consistent at determining reliability. I will not retrace those debates here.

For my purposes, I will note one perhaps unanticipated consequence of admissibility framework. The Court mandated a dichotomous framework for evaluating expert evidence. In the gatekeeping framework, evidence is either admissible or inadmissible. This is plainly inconsistent with the nature of expert evidence itself, which must be arrayed along a continuum of reliability between highly reliable evidence and evidence that is...
not reliable at all. With admirable economy, Professor Haack summed up my point as follows: “admissibility” is categorical; “reliability” is continuous.11 The dichotomous framework obviously invites the usual problems of drawing bright-line distinctions for phenomena which exist on a continuum. In addition, it presumably undervalues some evidence (highly reliable evidence that is treated as legally equivalent to far less reliable but nonetheless “admissible” evidence, plus pretty good evidence that just fails to meet the admissibility threshold but legally is considered equivalent to “junk” evidence) and overvalues other evidence (marginally reliable evidence that just barely meets the admissibility threshold but is legally equivalent to highly reliable evidence, plus “junk” evidence that has no redeeming value whatsoever, but nonetheless is considered legally equivalent to evidence that has some value, but not quite enough to meet the admissibility threshold).

It is important to note the homology between Daubert’s admissibility/inadmissibility dichotomy and a closely related dichotomous metaphor that was quite prevalent at the time: Peter Huber’s “junk science”/authentic science metaphor. The relationship between Daubert and Huber’s influential popular book on the supposed epidemic of “junk science” in the courts, and his popularization, if not coining, of this term, is complicated, and I will not fully explore it here.12 The point is that Huber’s propagation of the notion that there was a thing called “junk science” that could easily and reliably be distinguished from “real” science may have subtly reinforced the idea that assigning expert evidence to neat categories of “admissible” and “inadmissible” evidence would be both workable and relatively unproblematic.

Consider, for example, Huber’s characterization of “junk science” as the “mirror image” of authentic science.13 Huber’s metaphor could be read in at least two ways. On the one hand, one might read “mirror image” to mean “diametrically opposed,” in which it should be easy to distinguish “junk” from “real” science. On the other hand, the term “mirror image” is also used to denote objects that are indistinguishable, or barely distinguishable, from one another, as in the phrase “mirror image twins.” In this sense, Huber’s metaphor points precisely to the issue that will become the problem: that trial judges will find themselves in a house of mirrors in which every expert appears to be legitimate or, worse, one in which

11. I am grateful to Professor Haack, who made this point at the symposium and who explicates this point clearly elsewhere in her work. See Susan Haack, Not Cynicism, but Synechism: Lessons from Classical Pragmatism, 41 Transactions of the Charles S. Peirce Soc’y 299, 240 (2005); see also, D. A. Nance, Reliability and the Admissibility of Experts, 34 SETON HALL L. REV. 191, 200 (2003) (“[S]cientific validity is not an all-or-nothing characteristic; rather, it is a matter of degree.”).


the false experts appear trustworthy (because they are "slick" charlatans and con men) and the true experts appear untrustworthy (because as legitimate experts, they are unpolished, bumbling, socially awkward "geeks"). Indeed, it is wise to recall that the reason we developed the admissibility standard in the first place was that we were worried about pseudo-experts who would appear legitimate in the eyes of the jury, not about pseudo-experts who were readily identifiable as such. In fact, the whole idea of the pseudo-expert and all the rich terms used to describe such persons—charlatans, quacks, mountebanks, imposters, frauds, fakes, swindlers and con artists—is that they are untrustworthy experts who appear trustworthy, not untrustworthy experts who are identifiable as such.

In this sense Daubert would seem to presuppose its own ineffectiveness, in that it asks legal actors to discriminate between trustworthy and untrustworthy experts for the precise reason that it is difficult for jurors to distinguish between them. As a logical matter, Daubert can only be saved by assuming that judges, the legal actors Daubert asks to draw the distinctions, have a power of discernment that jurors, the legal actors who are presumed unable to draw the distinctions, lack. This assumption has been called into question by recent research, and it probably remains questionable despite Professors Caudill and LaRue's cogent critique of that research.

At this point, one cannot help but mention yet another dichotomous framework that is also closely related to the Daubert regime. That, of course, is the philosopher Sir Karl Popper's theory of falsificationism, through which knowledge claims can be "demarcated" into two categories: science and pseudo-science. As many of the participants in this symposium have already explained, this theory is no longer current among philosophers of science. The association of Daubert with Popper comes

14. See Sanja K. Ivkovic & Valerie P. Hans, Jurors' Evaluations of Expert Testimony: Judging the Messenger and the Message, 28 LAW AND SOC. INQUIRY 441, 442 (2003) ("One key assumption underlying the Daubert line of cases is that jurors might be duped by a persuasive but untrustworthy expert who testifies about matters that are not based on sound scientific principles or data.").
15. I cannot resist referring here to the epigraph of one of my articles in which a character in a play by the late August Wilson remarks, "I never would have guessed he was selling fake insurance." Simon A. Cole, More Than Zero: Accounting for Error in Latent Fingerprint Identification, 95 J. CRIM. L. & CRIMINOLOGY 985, 985 (2005).
from several sources. First, the *Daubert* opinion explicitly cites Popper, a move which has been variously interpreted as a more or less wholehearted endorsement of his philosophy of science. Second, there is a misguided but understandable tendency to equate the demarcation of admissible from inadmissible evidence with the demarcation of science from pseudoscience. Since the popular educated imagination still holds that falsificationism "solved" the demarcation problem, it is natural to assume that Popper holds the key to *Daubert's* problem.

II. FROM SCIENTIFIC EVIDENCE TO EXPERT TESTIMONY

Although both philosophers of science (and other social scientific inquirers about science such as those in the discipline of S&TS) and courts take as their purported object of inquiry something called "science," for the most part they are dealing with quite different objects. Philosophers of science are generally dealing with "science," defined as an open-ended mode of inquiry for developing accurate knowledge about the natural world. The scientists about whom philosophers of science and S&TS scholars are seeking to generate plausible accounts are generally engaged in open-ended inquiries seeking to generate original new knowledge about phenomena that are little understood.

Courts, in contrast, are by and large dealing with scientific evidence. Generally, the knowledge claims that are advanced in courts are not the cutting edge knowledge claims that occupy both academic scientists and the philosophers and sociologists who try to account for those scientists. There are few court cases about, for example, string theory. Legal knowledge claims tend to be much more mundane applications of existing knowledge claims: How convincing is the evidence that this pathogen causes this disease? This is particularly the case for forensic science. Very little, if any, of what is called "forensic science" consists of the sort of open-ended basic research that is classically the object of philosophy of science. Some small portion of forensic science might consist of efforts to evaluate whether certain new technologies might prove forensically useful. The overwhelming majority of what is called "forensic science," however, consists of routine applications of existing assays to new materials. This is philosophically equivalent to the routine use of various assays in a large scientific laboratory. Although some in S&TS have valorized this "technical" work and emphasized its importance in constructing what counts as scientific knowledge, this is not generally the sort of work that occupies


19. Indeed, it may be argued that this was precisely what Justice Blackmun was thinking when he cited Popper in *Daubert*.

philosophers of science, such as Popper, who try to articulate how "science" may be distinguished from other endeavors.

In short, the *Daubert* Court, faced with the question of whether a particular set of evidential claims were properly considered in assessing whether disease causation could be established, drew on philosophers who were engaged in quite a different project. The philosophers of science that the Court drew on, such as Popper, were engaged in the larger project of how to characterize the broad enterprise known as "science." In particular, they were interested in those areas of that enterprise in which open-ended inquiry is made and new knowledge is generated. In other words, they were more interested in what went on at Princeton's Institute for Advanced Study than in what went on at a commercial diagnostic laboratory, even though both may appropriately be viewed as sites where "science" occurs.

At a superficial level, of course, the Court's use of philosophy of science made sense. The Court was engaged in defining proper scientific evidence, and philosophy of science may have seemed the area of academic inquiry that came closest to addressing that problem. Nevertheless, in fact, the subtle differences between the two endeavors may have been more consequential than the Court anticipated.

One consequence has been on the academic debate about the *Daubert* opinion. If, as I claim, Popper was simply inappropriate for the task with which the Court was faced, this renders largely moot the debate about whether Popper is "correct" or "generally accepted" by philosophers and others who study science. The unfortunate confusion between *Daubert* and Popper's projects has been responsible for a great deal of needless disagreement among scholars and legal actors alike concerning the problem of the expert witness.

Distinguishing admissible from inadmissible expert evidence is quite a different thing from distinguishing science from pseudo-science. First, not all expert evidence is necessarily science. It is well established that legitimate experts can be technicians or others with "specialized knowledge." This issue was in some sense resolved by *Kumho Tire*, which clarified the Court's view that *Daubert*'s relevance and reliability requirement extended to all expert evidence.21 Yet, as Professor Edmond points out, that Court did so by fitting an admissibility threshold that had been devised for an idealized model of *science* to all expert evidence, whether it claimed to be "science" or not, something he calls "science through the back door."22 Second, philosophers of science, like Popper, tend to think about knowledge claims in larger units of analysis than do lawyers and

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judges. Philosophers of science tend to frame problems in terms of disciplines, research programs or, at least, lines of research. How do we know that biology produces reliable knowledge? Or molecular biology? Or evolutionary theory? Admissibility determinations tend to focus on smaller units of analysis: How do we know whether this study establishes causation of this pathology? The distinction is important because philosophers are generally thinking about how one can defend the knowledge claims of a broad approach to knowing the world, whereas judges are thinking about how one can defend one very specific knowledge claim.

Finally, admissibility is fundamentally a policy determination, whereas Popper was concerned with defining “science” as a particular, and special, form of inquiry. It might be argued that the parallel is not really between admissibility and science, but between reliability and science. But even then, the parallel does not hold; there are all sorts of highly reliable forms of knowledge that are nonetheless not science.

Simply put, Daubert is clearly about the distinction between reliable and unreliable, and thus admissible and inadmissible, evidence. Nowhere does it purport to be about distinguishing science from pseudo-science. To be sure, the opinion helped confuse the issue because it discussed reliability in the context of scientific evidence, and, indeed, there is much slippage in the opinion between describing things as “reliable” and “scientific.” For example:

[1]n order to qualify as “scientific knowledge,” an inference or assertion must be derived by the scientific method. Proposed testimony must be supported by appropriate validation—i.e., “good grounds,” based on what is known. In short, the requirement that an expert’s testimony pertain to “scientific knowledge” establishes a standard of evidentiary reliability.

In this passage, “scientific” status is equated with both validation and reliability, neither of which necessarily require that a claim be categorized as scientific knowledge or be derived by the scientific method. Nor, for that matter, must every claim that we would call “scientific” be validated or even be susceptible to validation. Given this kind of language, it is no wonder that much of the discussion of Daubert, from the pages of law journals to the courtrooms, has focused on whether particular knowledge claims are “scientific.” The Kumho Tire case might be thought to have remedied some of the confusion; in holding that the Daubert gatekeeping re-

23. To be sure, this is not completely true. Popper often discussed specific knowledge claims, such as “all swans are white,” but he also discussed whether entire disciplines, such as psychoanalysis and Marxist history, were scientific.


quirement applied to all expert evidence, including that based on technical or specialized knowledge, the court implicitly clarified that not all expert evidence need be science. But, as Professor Edmond has noted, the effect of Kumho seems to have been further confusion, in that Popper’s standards for demarcating science from pseudo-science end up being applied to technical evidence.26

Again, one can readily understand how, on a superficial level, the Court may have been gullible into thinking that the demarcation of admissible from inadmissible or reliable from unreliable evidence was the same as the demarcation of science from pseudo-science. And, one can then understand how, saddled with this misapprehension, the Court would view it as appropriate to draw on by far the most famous demarcator of all, Popper. Yet, again, this issue is even more fundamental than the mere fact that Popper was “wrong” or that his view is no longer, if it ever was, widely accepted among professional philosophers. The more fundamental issue is that demarcating science from pseudo-science is very seldom, if ever, a useful exercise in any endeavor, and it is certainly not helpful in solving the problem that faced the Daubert Court. As Professor Haack points out, two meanings of the word “scientific,” one referring to a distinct mode of inquiry and the other being a honorific meaning something like “good,” “objective” or “well intentioned,” have become thoroughly confused in modern parlance.27 The Court’s task really had to do with the latter; it was necessary to distinguish generally well supported evidence from poorly supported evidence—that is, evidence that, in donning the mantle of expertise, was more likely to mislead than to educate the fact finder—rather than to distinguish “scientific” from “pseudo-scientific” evidence.

In sum, the Daubert regime has been characterized by a great deal of slippage, in both legal scholarship and practice, between the quite different issues of whether evidence is “reliable” or “admissible” and whether it is “scientific.” One example of this may be found in the area I know best: the admissibility battles over fingerprint evidence, in which legal actors—including, I would readily admit, myself—exhibited considerable slippage between these two issues.28 This slippage confused the record made in these admissibility hearings. Only in the 2004 decision United States v. Mitchell, five years after the first hearing, did a court bring clarity to the distinction.29

26. See generally Edmond, supra note 22.
27. See Haack, supra note 11, at 248.
III. SCIENCE & TECHNOLOGY STUDIES (S&TS) AND DAUBERT

The problem of whether and how much to trust purported “experts” is fundamental to my native discipline of S&TS. One of several possible characterizations of the field of S&TS is that it is the study of experts and expert knowledge.\textsuperscript{30} It so happens that some efforts have recently been made to, in effect, re-articulate the mission of the field of S&TS around this very question of what to do about experts, or more precisely, how to assign attributions of expertise to various actors in resolving social questions that invoke some sort of technical knowledge.\textsuperscript{31} To be sure, this effort has been resisted.\textsuperscript{32} Yet, the resistance has in part argued that this supposedly necessary re-articulation has already occurred. There is little serious dispute that expertise is a necessary and important object of study for S&TS. Where differences arise is over the nature of the study. Most S&TS scholars take as their object of study the very act of attribution of expertise by social actors (for instance, lawyers and judges). Their interest is documenting, studying, analyzing and revealing the process by which the status of “expert” is attributed or denied to various claimants.\textsuperscript{33} Professors Collins and Evans argue that this work is largely complete\textsuperscript{34} and that its point—that “expertise” is something that is attributed to social actors by other actors, rather than a natural category that exists outside of social interactions—has been made. They argue that it is time to move on to a new project, a normative project which would involve sorting out how to properly manage attributions of expertise, given the undeniable fact that such attributions cannot be made “naturally.”\textsuperscript{35}

Although the bulk of Daubert discussion has taken place largely within the confines of legal doctrinal scholarship, it is perhaps fair to say that S&TS has made a modest contribution to the discussion. Indeed, one

\textsuperscript{30} I am not sure where, or if, this is explicitly stated, but the person who crystallized it for me was Professor Michael Aaron Dennis.
\textsuperscript{33} Exemplary in this regard is Sheila Jasanoff, Expert Games in Silicone Gel Breast Implant Litigation, in SCIENCE IN COURT 83 (Freeman and Reece eds., 1998). Another excellent contributor is none other than CAUDILL & LARUE, supra note 4.
\textsuperscript{34} See Collins & Evans, supra note 32. Professors Collins and Evans are careful to note that this sort of work is still worth doing and that they still do it.
\textsuperscript{35} See id. In so doing, Collins and Evans argue against what may or may not be a caricature of the rest of S&TS, which is that most S&TS scholars favor a “leveling” of expertise attributions: essentially, if expertise is not a natural category, everyone should be accorded equal expertise over every technical question. Collins and Evans argue that this is plainly absurd and that some better normative guidelines for defining relevant expertise are necessary. The dispute, in part, is about whether S&TS scholars actually take the position that Collins and Evans ascribe to them.
S&Ts scholar was cited in the *Daubert* opinion, although one can fairly debate whether it was in fact a “sincere” citation or an “opportunistic” one (that is, a cynical or ignorant use of an authority to support a proposition that did not actually accord with the author’s intent). There are several reasons for S&Ts interest in expert evidence problems. First, the practical problem facing the *Daubert* Court—how to evaluate the trustworthiness of expert evidence—is a problem over which both scholars allied with the field of S&Ts and more conventional philosophers of science might be considered to have some disciplinary “jurisdiction,” although, as I will argue below, there are also strands within both fields that tend toward dis-


37. Defining the field of S&Ts is problematic. A literal definition would hold that S&Ts would include anyone who studies science and technology from any scholarly disciplinary perspective. Moreover, S&Ts is widely understood to be an interdisciplinary endeavor and to be an outgrowth of the social science, the humanities or both. At the same time, however, it is undeniable that the term “S&Ts” has come to be associated with something more specific that would be closer to a particular intellectual movement or school of thought than to a generic term for any study of the institutions of science and technology from any discipline or perspective. This movement is generally associated with the sociology of scientific knowledge, or even more specifically with “the strong programme in the sociology of scientific knowledge,” and it is to this movement that scholars often refer when they talk about S&Ts or “science studies.” See Haack, *supra* note 17. As I have noted elsewhere, this ambiguity can be problematic, especially when S&Ts *itself* becomes a subject of *Daubert* inquiry. In such circumstances, S&Ts cannot possibly be defined as an intellectual movement (to do so would be akin to defining “chemistry” intellectually, i.e. as people who believe in certain chemical theories, rather than as people who study the chemical makeup of matter). But, there is sufficient disagreement among scholars who study science that, if S&Ts is defined broadly and generically, it becomes very difficult to make general statements about the field’s view on anything, including such fundamental issues as the nature of science itself. Especially pronounced and best known in this regard is the disagreement between many philosophers of science and many sociologists of science over generally “realist” or “relativist” views of scientific knowledge. See id.
interest in this problem. Second, social and institutional actors' attempts to define the limits of scientific knowledge are inherently interesting to S&TS scholars—they are data to us. Thus, the law's attempt to limn scientific knowledge has become a topic of study, albeit a relatively small one, within S&TS.\textsuperscript{38} The final reason, perhaps the least significant motivation, is that some scholars may believe that the S&TS knowledge itself—that is, social scientific knowledge about science, technology and expertise—might actually be useful to legal actors faced with expert evidence problems. It is this last point that, at least in part, motivates Professors Caudill and LaRue's book \textit{No Magic Wand}, as well as my own work in this area.

Much of the early S&TS \textit{Daubert} scholarship considered whether \textit{Daubert} "got science right." Did \textit{Daubert}, in other words, evince an accurate understanding of the enterprise of scientific (and expert) knowledge-making, or at least an understanding informed by the latest and best social science research on the issue? The answer, explicated in perhaps the greatest detail in the collected works of the teams of Professor Caudill and his collaborators, Professors Redding and LaRue, and Professors Edmond and Mercer, was "no.\textsuperscript{39} Of course, one need not have been an S&TS scholar to find \textit{Daubert}'s understanding of science lacking. For instance, while the thrust of Professors Haack and Schwartz's critiques are quite different, both found the explicit and implicit philosophy of science contained in \textit{Daubert} to be inconsistent, incoherent and outmoded.\textsuperscript{40} Professors Caudill and Redding, in famously\textsuperscript{41} calling \textit{Daubert} "junk philosophy of science,"\textsuperscript{42} were making a different point. They faulted \textit{Daubert} not only for using outmoded philosophy of science, but also for ignoring the contributions of history, sociology and anthropology of science—in a word, S&TS—to the discussion of expert evidence.

Most evidence scholars have tended to accept \textit{Daubert}'s supposed philosophy of science at face value.\textsuperscript{43} Whether they did so because that was the philosophy of science to which they adhered or simply because that was the \textit{Daubert} Court's philosophy of science was not always entirely clear.
It should be clear now, based on the discussion in Part II, that this debate to some extent misses the point. It does not matter whether Popper, or Daubert, “got science right” because Daubert is not about science. It is about the reliability and admissibility of evidence. The Supreme Court was not really doing philosophy of science, at least not in the sense that Popper was. It was, to be sure, confusing, and perhaps even pretentious, of them to cite philosophy of science, but, nonetheless, it would probably be more true to say they were not doing philosophy of science than to say they were doing it badly.

It should be noted that, at the same time, the best known S&TS legal scholar, Professor Jasanoff, offered a more generous reading of Daubert. Jasanoff was perhaps more willing to read the contributions of S&TS between the lines of the Daubert text. Daubert’s notorious vagueness made it possible for one to, in a sense, make facts on the ground by claiming room for S&TS in the Daubert opinion.44 Professor Haack’s conclusion is not at all different in that, after amply deconstructing Daubert’s philosophy of science, she concludes that its philosophical inconsistency does not matter all that much and should not distract us from more important issues at hand.45

In sum, while legal scholars, philosophers of science and S&TS can find much to quibble with, both in Daubert and amongst themselves, none of them seems to make a particularly strong argument that these quibbles matter all that much for the central practical matter at hand: the problem of expert evidence. Most scholars, from Professor Jasanoff to Professor Haack, advocate a generally pragmatist approach to this problem.46 Professors Caudill and LaRue’s book, No Magic Wand, is indeed remarkably pragmatist in orientation.47

IV. THE “DAUBERT FACTORS”

Another area in which both S&TS and philosophy of science have made contributions is in criticizing the so-called “Daubert factors,” the now notorious four-part “checklist” (that the Court warns judges not to treat as a checklist)48 which purports to assist courts in determining whether proffered evidence is “reliable.” S&TS scholars and philosophers of science have criticized the factors for being internally inconsistent, overly Popperian and unworkable. My view, as articulated above, is that the argument that the factors constitute poor philosophy of science largely misses the point because the trial judge’s task is not the philosophers’. Yet, this still

44. See Jasanoff, supra note 38.
45. See Haack, supra note 17.
47. See generally Caudill & LaRue, supra note 4.
does not excuse the factors. I think it has become clear with the passage of time that the principal harm of the factors is that they have come to overwhelm the concept they were supposed to elucidate: reliability.49 Rather than being read as they were written, as an illustration of one possible way to make a reliability inquiry, the Daubert factors have come to be read as a four-pronged test of admissibility (not reliability) and have encouraged actors to almost forget about the notion of reliability altogether. That this would occur was perhaps inevitable: the Court was at best naïve if it believed that the Daubert factors would not become a four-pronged test. But, in any case, I have come to believe that the Court might have been wiser to state that admissibility required a two-prong test—relevance and reliability—and left it at that.

V. Fit

I have tried to argue that many of the disagreements that characterize Daubert scholarship are more apparent than real. In this section, I will focus on one concept that, in my view, unites rather than divides scholars who think about scientific evidence. That concept has been characterized in many different ways, but it was succinctly characterized by the Daubert Court as “fit.”50 By “fit,” I mean whether the expert testimonial claim is appropriately supported by evidence. The issue is not whether a given expert can muster evidence supporting her ability to make some, legally admissible, testimonial claim, but rather, whether she can muster evidence supporting her ability to make precisely the testimonial claim that she will give.

An examination of the Daubert literature, both the legal literature and the literature related to S&TS or philosophy of science, shows that a wide variety of scholars who generally would be thought to disagree about many issues share a common view that “fit” is matter of crucial importance. Scholars as diverse as Professor Imwinkelried,51 Professor Black,52 Professor

49. A quick glance at the legal literature shows that scholars’ use of Justice Rehnquist’s characterization of the four prongs as dicta has decreased as Daubert became more familiar and accepted with the passage of time. See id. at 600 (Rehnquist, C.J., dissenting).

50. See id. at 600; United States v. Downing, 753 F.2d 1224, 1242 (3d Cir. 1985).


52. See generally Bert Black, Focus on Science, Not Checklists, 39 TRIAL 26 (Dec. 2003) (“Focus on the specifics of an expert’s opinion, not just the field of expertise.”).
sor Nance, Professor Berger, Professor Beecher-Monas, Professor Faigman and Professors Gross and Mnookin all appear to agree on the crucial importance of fit. Furthermore, it is difficult to find scholars who argue the opposite position—that fit should not matter.

Perhaps the most thought-through view is that of Professor Friedman, who coins the useful term “over-claiming” to refer to instances in which expert witnesses exaggerate the probative value of the knowledge claims. Professor Friedman notes that the Daubert binary admissibility framework is of little use in controlling this problem. Its sole remedy, the “axe-wielding demarcationist” one of exclusion of evidence, will generally appear to judges to be too draconian a sanction for a little over-claiming, especially when they have already, in an admissibility ruling, committed themselves to the position that the evidence is reliable and therefore admissible. Moreover, Professor Friedman usefully considers the logical

53. See Nance, supra note 11, at 253. Nance notes that: The use of a dichotomous concept of reliability, whether or not founded on deference to a non-legal discipline, simply poses too many problems. These problems, in turn, encourage an epistemically invasive use of admissibility to monitor the weight of the evidence. It is time to turn away from that kind of thinking and try another tack, one that draws on more manageable comparative reliability assessments that build on a gradational concept of reliability.

54. See Margaret A. Berger, Expert Testimony in Criminal Proceedings: Questions Daubert Does Not Answer, 33 SETON HALL L. REV. 1125, 1140 (2003) (“Admissibility and sufficiency determinations rest on more than satisfaction of a reliability component; they require careful attention to what the evidence proves and how the trier of fact will use it.”).


57. See generally Samuel Gross & Jennifer L. Mnookin, Expert Information and Expert Evidence: A Preliminary Taxonomy, 34 SETON HALL L. REV. 141 (2004) (“As important as an examination of method, however, and much less noted, is another dimension: the degree of certainty that the expert posits in what she offers.”).

58. Professor Kaye and co-authors argue persuasively that “fit” is generally implied in any appropriate deployment of the notion of validity. They concede, however, that “Daubert’s reference to ‘fit’ serves as an important reminder that the ‘scientific validity’ of a technique or instrument depends on the use to which it is put.” DAVID H. KAYE ET AL., THE NEW WIGMORE: EXPERT EVIDENCE, §6.3.1 (2004).

59. See Friedman, supra note 7. Friedman explains: Perhaps, though the problem is that the expert witness over-claimed the significance of the serological result. If that is the problem, then the solution would not be to exclude evidence of the underlying serological phenomenon, but to try to prevent the over-claiming, or at least to ensure that the jury is not misled by it. It does not seem to me that the Daubert framework is of much help here.

60. Haack, supra note 11, at 248.
extent of the emphasis on fit by taking the counterintuitive position that evidence that is wrong more often than it is right can nonetheless have probative value (and, therefore, should be admissible), provided only that the fact finder is properly informed of the evidence's reliability.\footnote{See Friedman, \textit{supra} note 7. Professor Friedman acknowledges that this argument also requires the assumption that it can shown or assumed that the reliability of the evidence can be properly conveyed to the fact-finder and that the fact-finder can appropriately integrate it with other evidence. As a factual matter, of course, both of these are highly suspect assumptions, as Professor Friedman acknowledges.}

Despite all these pronouncements, the paeans to "fit" are almost homilies; scholars do not say much about fit, other than that they are in favor of it. This is perhaps not surprising as a consequence of the issues discussed earlier; most scholars view admissibility demarcation as analogous with the demarcation of science from pseudo-science and, therefore, focus on demarcation rather than assessment of fit. What I want to propose here is a shift of focus away from the overemphasized issue of demarcation and toward the neglected issue of fit. In some sense, I view "fit" as another overlooked gem in the \textit{Daubert} Trilogy, much as Professors Denbeaux and Risinger have sought to elevate \textit{Kumho Tire's} "task at hand" requirement to a central place in the evaluation of expert evidence.\footnote{See generally Denbeaux & Risinger, \textit{supra} note 5; Imwinkelried, \textit{supra} note 26.}

There is, of course, some resemblance between "fit" and the "task at hand." Both concern an appropriate relationship between the evidentiary claim and what Professors Denbeaux and Risinger usefully call the "warrants" for that claim. However, Professors Denbeaux and Risinger's focus is primarily on the validity of the procedures that produce evidence. My focus here is further downstream; it is on how that evidence is used in the courtroom. Even valid procedures can produce invalid testimony, if the testimony does not fit the warrants that support that testimony. Much scientific evidence scholarship, including my own, has focused on the need to validate forms of evidence that are used in court.\footnote{See David L. Faigman \textit{et al.}, \textit{Modern Scientific Evidence: The Law and Science of Expert Testimony} (2d ed. 2002); Edward J. Imwinkelried, \textit{Coming to Grips with Scientific Research in Daubert's "Brave New World": The Courts' Need to Appreciate the Evidentiary Differences between Validity and Proficiency Studies}, \textit{61 BROOK. L. REV.} 1247 (1995); Imwinkelried, \textit{The Meaning of "Appropriate Validation"}, \textit{supra} note 25; Simon A. Cole, \textit{Is Fingerprint Identification Valid? Rhetorics of Reliability in Fingerprint Proponents' Discourse}, \textit{28 J.L. \\& POL'Y} 109 (2006).} I am becoming convinced, however, that it is in testimony that "the rubber meets to road" for the problem of the expert in law. The problem with experts for law is not so much what the evidence says, but what the expert says to the fact finder.

Hitherto, scholars and courts have largely focused on the validity of evidence, seen in a dichotomous admissibility framework. Valid evidence is admissible, invalid evidence inadmissible. What happens after admissibility has largely been given short shrift, and experts are permitted to say...
more or less anything about evidence deemed admissible, even if what they say overstates (or understates) the probative value of the evidence. I suggest that courts and scholars need to spend a lot more time thinking about expert testimony and perhaps a little less time thinking about scientific evidence.

VI. BRINGING THE STRANDS TOGETHER

What I want to argue, in sum, is that courts (and scholars) should not be demarcating at all, but rather assessing fit. I would hypothesize that more damage is done by "over-claiming"—by expert testimony that exaggerates its own probative value—than by evidence that is deemed admissible when it should not be. Gone would be the binary distinction between admissible and inadmissible, reliable and unreliable evidence. In its stead would be an evaluation of where particular evidentiary claims stand along a continuum of trustworthiness. Most crucially, that evaluation would control not whether the evidence is heard, as in a Daubert-like binary admissibility framework, but rather the nature of the testimonial claim that is heard. In other words, judges would carefully calibrate the strength of the testimonial claim to the strength of the warrants that support that claim. My claim is that this is precisely what is missed in a binary admissibility framework in which judges assume that their work is done once they have ruled proffered evidence admissible or inadmissible. I suggest that in this framework, weak evidence that is ruled admissible probably routinely over-claims. Meanwhile, as Professor Friedman notes, fact finders may be deprived of weak evidence that nonetheless might have probative value as long as it is restricted from over-claiming.

VII. FORENSIC EVIDENCE: A CASE STUDY IN OVER-CLAIMING

In this section, I will report on a provisional attempt to apply this over-claiming framework to a problematic area of scientific evidence: forensic science or forensic evidence. The choice of forensic evidence does not merely reflect the fact that it is the area of scientific evidence with which I am most familiar. Over-claiming has already been identified as a particular problem with forensic evidence by a number of scholars (though they do not necessarily use that term). Over-claiming has long been identified as a problem for microscopic hair comparison. The National Research Council’s (NRC) report on Comparative Bullet Lead Analysis (CBLA) revealed rampant over-claiming over the course of the nearly

64. See Berger, supra note 54, at 1132 ("We know from cases and news accounts that hair examiners often embellish their testimony with probability estimates based on their personal experience for which there is no empirical basis."); Friedman, supra note 7, at 1063; see also generally Peter Neufeld, The (Near) Irrelevance of Daubert to Criminal Justice and Some Suggestions for Reform, 95 AM. J. PUB. HEALTH S107 (2005); Clive A. Stafford Smith & Patrick D. Goodman, Forensic Hair Comparison Analysis: Nineteenth Century Science or Twentieth Century Snake Oil?, 27 COLUM. HUM. RTS. L. REV. 227 (1996).
forty-year history of FBI testimony concerning results of that assay, including the completely unfounded claim that two analytically indistinguishable bullets “must have come from the same box or from another box that would have been made by the same company on the same day.” Indeed, much of the scholarly attention devoted to CBLA and the NRC report has focused on the very interesting statistical issues raised by CBLA evidence and the FBI’s and NRC’s alleged failure to deal with them adequately. Nevertheless, in some sense these sexy statistical issues have induced many scholars to miss the forest for the trees. Setting the issues of statistical inference aside, the CBLA episode can be read as a simple story of over-claiming: the testimonial use of claims well beyond what empirical evidence did, or even could, support. And, indeed, it is in the testimony where the damage was done. The NRC report documents sworn government witnesses testifying that a bullet recovered from a crime scene “must have come from the same box” as a bullet found in the defendant’s possession “or from another box that would have been made by the same company on the same day,” a claim that is unsustainable no matter what one thinks about the value of CBLA.

Latent print identification is perhaps the only discipline for which over-claiming is institutionalized. Because professional guidelines mandate that the only inclusionary conclusion latent print examiners may offer in their sworn testimony is that of “individualization” (the claim that the defendant or suspect’s skin is the source of the latent or crime-scene print to the exclusion of all other possible sources in the universe), and such


67. If such a concept is even possible.


claims are obviously unsustainable, all inclusionary latent print testimony is over-claimed.70

Whether latent print evidence is the only forensic discipline that enjoys institutionalized over-claiming is currently the subject of a vociferous debate among students of tool mark analysis.71 It is clear that tool mark examiners sometimes testify that the correspondence between a crime scene tool mark and a test tool mark somehow warrants them to testify the object that made the test tool mark is the object that made the crime scene mark. Further, they claim that all other tools in the universe—even the next consecutive tool produced on the assembly line—can be eliminated as potential sources of the crime scene mark. Courts have noted that this is an “extraordinary” claim in its epistemological strength and probative value, and they have noted that it is particularly extraordinary given the paucity of evidence supporting it.72 The ultimate resolution of this debate, which concerns precise interpretations of the wording of the Association of Firearms and Toolmark Examiners’ “Theory of Identification,” is less important for our purposes than the mere fact that the issue remains ambiguous. The very fact that there is debate over the nature of properly framed tool mark testimony illustrates not only that another professional group may be engaging in systematic over-claiming in our courts, but also the casualness with which courts, scholars and practitioners approach matters of testimonial nuance in their eagerness to focus on Daubert’s dichotomous admissible/inadmissible distinction.

Forensic odontologists have also been accused of over-claiming. In one case, the witness testified, not only that a crime scene bite mark was consistent with the defendant’s dentition, but also that no other dentition among the 3.5 million inhabitants of the Detroit metropolitan area would also be found consistent with this particular bite mark.73 As the Sixth Cir-
cuit Court of Appeals, and the state court before it, noted, this testimony exaggerated the probative value of the evidence not merely because the witness had not actually observed the dentition of those 3.5 million individuals, but also because the witness lacked any data from which to even make responsible estimate of the rarity of the observed features of the bite mark in a population of that size.74

Indeed, some scholars have noted that the weakest areas of forensic science appear to be the most prone to over-claiming; something they view as “ironic” that might equally be viewed as entirely unsurprising and perhaps even as a predictable outcome of the Daubert framework.75 And yet, even a discipline with sufficient data to support very precisely formulated testimonial claims and forensic DNA profiling is not immune to over-claiming. For several years now, forensic scientists have debated the propriety of rounding very low random match probabilities into testimonial claims of “source attribution”—that the defendant “is” the source of the crime-scene DNA sample.76

A. A Preliminary Empirical Study of Over-claiming

The evidence concerning over-claiming in the previous section is generally anecdotal or indirect. Arguments concerning over-claiming are typically supported by reference to notorious cases, and such cases may not necessarily be common or representative. Another method of documenting over-claiming is to examine policy statements, promulgated standards or other documents generated by professional organizations or other standard-setting bodies. My argument concerning institutionalized over-claiming by latent print examiners and perhaps tool mark examiners can be supported by reference to such documents.77

74. Id.

75. See John I. Thornton & Joseph L. Peterson, The General Assumptions and Rationale of Forensic Identification, in SCIENCE IN THE LAW: FORENSIC SCIENCE ISSUES 1, 25 (Faigman, et al. eds., 2002) (“It is ironic that those areas of forensic science that have real underlying data offer more modest statements of individualization, while those limited to subjective or impressionistic data make the strongest statements, sometimes of absolute certainty.”).


77. See Nichols, supra note 71; Scientific Working Group on Friction Ridge Analysis Study and Technology, Standards for Conclusions (2003). Among latent print examiners, I can also show that institutionalized over-claiming does not just exist at the center of the latent print community; the principle has trickled down to the local level. For example, the New Hampshire State Police Laboratory latent print protocol states that testimony should be given as follows: “The latent impression developed on exhibit _____ has been identified as the fingerprint impression of ________.” New Hampshire State Police Forensic Laboratory, Latent Print Examination: Interpretation and Reporting of Conclusions, IDU-001-03 (2005). The report form of another laboratory contained the preprinted words: “After examination of
There are, of course, good reasons for using such documents as indicators of the nature of testimonial claims used by the witnesses who belong to the relevant disciplines and/or organizations. Although the standards promulgated by these bodies are not typically "binding" in any strict sense, they presumably do have some persuasive authority with those expert witnesses who either belong to the relevant organizations or consider themselves members of the relevant disciplines. 78

American trial practice, however, is a vast and disparate body of activity that is incompletely and sporadically reported. Therefore, there is little way of knowing to what extent the pronouncements of professional organizations and self-appointed standard-setting bodies constrain the testimony of actual expert witnesses in American courtrooms. And, this, after all, is the heart of the matter: what witnesses say to juries every day all over the country clad in the mantle of expertise. Once again, in my view, the essence of forensic science is not merely what is done but, at least as importantly, what is said.

Despite the importance of the issue, determining what expert witnesses say in American courtrooms is far from an easy matter. No organization systematically, or even unsystematically, collects such data. The law's historical convention of treating appellate opinions, rather than trial transcripts, as the site at which law "happens" has led to a situation in which—the far from minor manner of publication, unpublishation and depublication aside—79—transparent, fully searchable records are kept of appellate decisions, but almost no searchable databases of trial transcripts exist. It is true that some proprietary trial transcript databases do exist, and it so happens that some of these focus on scientific evidence. But these proprietary databases tend to focus on the scientific evidence that is used in civil, not criminal, litigation. 80

78. Some guidelines may have even more authority than this. For example, resolutions of the International Association for Identification echo the point made by SWGFAST above, banning conclusions less then "individualization." International Association for Identification, Resolution V, 30 IDENTIFICATION NEWS 3 (1980); International Association for Identification, Resolution VII, 29 IDENTIFICATION NEWS 1 (1979). The IAI's somewhat different language, banning "probabilistic" identifications, essentially amounts to the same thing, but it also carries with it an implicit threat of professional sanction, such as expulsion from the IAI. Although the IAI has expelled members for other reasons, I am not aware of any case of expelling a member for expressing a probabilistic conclusion, even when such a conclusion has been reported in a published legal opinion. See Michigan v. Ballard, 2003 Mich. App. LEXIS 547 (Mich. Ct. App. Feb. 28, 2003); see also Latent Print Certification Actions, 55 J. FORENSIC IDENTIFICATION 658 (2005) (explaining reasons why other IAI members were expelled).


In order to gain a more precise understanding of the semantic nature of forensic expert testimony, I have begun collecting trial transcripts of criminal cases in which forensic expert evidence is presented. I began with latent print evidence, the area with which I have the most familiarity, but I am actively collecting transcripts in other areas as well. The analysis presented here derives from a set of thirty-four latent print transcripts, which comprise a non-representative opportunistic sample. I acquired some transcripts through my work as a scholar interested in latent print evidence, as a consultant to criminal defendants in cases involving latent print evidence, and as an expert witness on the validity or lack thereof of latent print evidence in such cases. In addition I also received some unsolicited transcripts directly from convicted inmates who were aware of my work on latent print evidence. Fifteen of the thirty-four transcripts were gathered in this manner. I acquired additional transcripts by soliciting transcripts on defense attorney listservs and by directly emailing attorneys of my acquaintance who were interested in forensic evidence issues. Seventeen of the thirty-four transcripts were gathered by this method. Finally, two trial transcripts involving fingerprint evidence from high profile trials—United States v. McVeigh and United States v. Nichols—were publicly available on the internet (see Appendix for details on the transcripts).

Any form of spoken, sworn testimony concerning an inclusionary conclusion drawn from latent print evidence was considered suitable for inclusion. The intent was to understand what probative conclusions expert witnesses uttered in sworn testimony. Thus, the transcripts derive from trials, preliminary hearings and depositions. Affidavits, such as the notorious “100% identification” affidavit used to wrongly arrest attorney Brandon Mayfield in the Madrid bombing, were not included. The thirty-four transcripts derive from twelve states and from federal court. One transcript derives from a foreign source, the state of Western Australia. The transcripts derive from criminal cases involving a variety of charges, ranging from burglary to mass murder (e.g., United States v. McVeigh), from obscure to extremely high-profile cases (McVeigh again). The dates the transcripts were generated range from 1986 to 2006. The mean year is 2000.

Obviously, the transcripts analyzed here derive from an opportunistic sample, and no claims can be made concerning their representativeness. Methods of gathering a more representative sample can be imagined, but they would be quite unwieldy. The important question, however, is


82. It would be necessary to assemble a set of representative jurisdictions, define a representative time period, and examine all criminal transcripts for the pres-
whether the transcripts analyzed here are likely to overstate or understate the quality of latent print testimony as it exists in the universe not captured by these transcripts. Because my argument is generally critical of the current testimonial practice concerning latent print evidence—in that I claim there is routine, institutionalized over-claiming—we need only worry about the possibility that this data understates the quality of testimony. If this data overstates the quality of testimony, and if I have erred, I have erred in favor of my adversary.

The "quality" of expert testimony is not an obviously measurable thing. Essentially, what we would be concerned about is that the testimony found in this data set is somehow "worse"—less responsible, less defensible—than the typical testimony given during the comparable time period in comparable jurisdictions. There are several reasons to conclude that this data set is, if anything, likely to overstate the "quality," however that is measured, of latent print expert testimony. First, the transcripts are relatively recent in origin. The mean year of generation is 2000. Latent print testimony has been offered in U.S. courts for almost a century. Although defendants challenged the evidence when it was first introduced, by the 1920s the admissibility and presumed reliability were widely sanctioned by the courts. Over the course of the twentieth century, latent print examiners have remarked on defense attorneys' reluctance to challenge evidence. In 1999, however, a criminal defendant challenged the admissibility of latent print expert evidence under Daubert v. Merrell Dow Pharmaceuticals, Inc. This challenge stimulated more admissibility challenges, and these provoked a fair amount of notice within the latent print community and some consternation about whether the technique might be ruled inadmissible under Daubert. There was even a brief scare when one court did limit the admissibility of latent print evidence before reversing itself. Thus, if ever within nearly a century of expert testimony, la-

38. See People v. Jennings, 96 N.E. 1077 (Ill. 1911).
40. See 6 Finger Print and Identification Magazine 2 (1924); Andre A. Moenssens, Testifying as a Fingerprint Witness, 54 Finger Print and Identification Magazine 3 (1972).
42. See, e.g., David L. Grieve, Rocking the Cradle, 49 J. Forensic Identification 719 (1999).
tent print examiners were going to be careful about how they phrased their conclusions, it would have been after 1999. Because half of the transcripts date from 2000 or after, we should expect them to represent relatively carefully phrased testimony.

Second, the transcripts derive from relatively serious crimes. Of the eighteen transcripts for which the charge can be determined, half derive from homicide cases. Homicide cases represent around one percent of felony cases prosecuted nationwide. Thus, the data set oversamples serious cases. All other things being equal, the quality of both legal representation and expert testimony is likely to be higher the more serious the case. Similarly, with two of the thirty-four cases representing very high-profile cases, the data set surely oversamples high-profile cases. Again, all other things being equal, the quality of both representation and testimony should be relatively high in high-profile cases. Although some forensic scientists have claimed that latent print analysis is more error-prone in high-profile cases, this claim has not been extended to sloppy phrasing of testimony. Finally, with six out of thirty-four cases, the federal jurisdiction is also surely overrepresented in the data set. Again, all other things being equal, the quality of both representation and expert testimony may be expected to be generally higher in the federal jurisdiction. This is especially true in the area of forensic evidence, where the expert witnesses very likely come from such vaunted organizations as the FBI, the Secret Service, the ATF, the Postal Police, Homeland Security and the IRS.

Third, the level of experience of the examiners testifying was not remarkably low. Of the cases in which the level of the examiner’s experience was stated in the transcript, the average number of years of experience was fifteen. The latent print community generally uses experience as a rough measure of ability, given the absence of any other measure (other than certification), although the facile equation of ability with


92. Moreover, the claim is unsupported. See generally Cole, supra note 81; Thompson & Cole, supra note 81.

93. Jon S. Byrd, Confirmation Bias, Ethics, and Mistakes in Forensics, 56 J. FORENSIC IDENTIFICATION 511, 520 (2006) ("[T]he training and experience of the examiner becomes the vital element in the identification process.”) (emphasis added); Pat A. Wertheim, The Connection: Faulty Forensics (NPR radio broadcast, June 10, 2004), available at http://www.theconnection.org/shows/2004/06/20040610_b_main.asp (questionably interpreting Llera Plaza II as holding, “[t]he reliability of the examiner through training, experience, and testing is the key to the reliability of the evidence they [sic] present in court.”); see also Llera Plaza, 188 F.Supp. 2d at 549. One of the ways in which this is manifested is through the frequent reference to “training and experience” as warrant for the expert’s claim.
experience has been questioned by some.94 In general, however, it does not seem plausible to claim that the examiners represented in this data set under-represent the level of experience of latent print examiners testifying in the U.S. in recent years.

Finally, the method of collection itself is a rough indicator of generally high quality of justice. First, the trial transcript is in the possession of an attorney, meaning that someone is appealing the conviction. Second, the possessor of that transcript either: (1) subscribes to a listserv, itself an indicator of a relatively engaged attorney, and took the opportunity to respond to an academic researcher's request for information without any prospect of compensation; or (2) engaged the services of the author as a consultant, indicating a relatively high level of engagement in the litigation. These may be considered rough measures of a case that is enjoying a reasonably high level of representation, not cases from the backwoods95 using latent print examiners out of touch with current practice. For all of these reasons, it would seem safe to conclude that the transcripts do not represent atypically "poor" expert testimony.

In analyzing the transcripts, I focused on what I call the "source attribution moment," the moment at which the expert connected the latent print to the defendant or the moment at which the expert identified the defendant as the source of the latent print. This is the moment when the latent print expert does his or her work: telling the jury that the defendant is the source of an incriminating print. Generally speaking, this moment should occur on direct examination, and for consistency purposes, I only analyzed direct testimony even though cross examination yielded some highly incriminatory statements in some cases.

Using a process of open coding,96 I read through the "source attribution moments" in several iterations to allow the data to suggest categories, rather than imposing my own categories upon the data. This process yielded three broad categories of testimony capable of encompassing all thirty-four testimonies. A few testimonies fit in more than one category. Note, however, that two categories would have been sufficient to encompass all but three of the testimonies. The third category ("Identity") should thereby be regarded as less significant than the other two.

B. About Identification Testimony

Latent print (or "fingerprint") evidence is perhaps best characterized as "source attribution" evidence.97 The probative value of such evidence typically lies in the identification of a particular individual as the source of

95. Or, say, Philadelphia.
96. See ANSELM L. STRAUSS, QUALITATIVE ANALYSIS FOR SOCIAL SCIENTISTS (1987).
97. See Keith Inman & Norah Rudin, Principles and Practice of Criminalistics: The Profession of Forensic Science 137 (2001); William C. Thompson &
trace evidence found at a crime scene. This is done through a finding of consistency between that crime scene trace and a reference sample known to come from that individual (typically because it was taken from the individual while held in custody). For the past century or so, such evidence has been offered in court for such forms of trace evidence as fingerprints, bite marks, serology, hair and handwriting. During this past century, there appears to have been relatively little systematic thought about how testimony concerning such evidence should be given. There does not appear to have been any organized control over forensic expert testimony. Nor did the courts appear to exercise much control, save the occasional sanction when a witness went too far, such as by straying into the province of the jury. Forensic expert witnesses testified in a variety of formulations, most typically stating that the crime scene trace “matched” the defendant.

This situation changed with the introduction of forensic DNA profiling. As DNA typing developed, expert testimony evolved into what has been called a “two-stage” form of testimony. The first stage was a statement of consistency. Presumably such statements should have also included the criteria by which traces were judged on consistency, an accounting of any inconsistencies, an explanation of why it was still permissible to find the traces consistent and some measure of the “amount” of consistency. The second was an estimate of rarity. Such statements sought to convey the significance, or the probative value, of the finding of consistency to the fact-finder by estimating the rarity of the features found consistent in stage (1) in a given population. To use an obvious example, an eyewitness sighting of a perpetrator fleeing in a Rolls Royce has a higher probative value than the sighting of a perpetrator fleeing in a Toyota because Rolls Royces are more rare. This general framework for presenting forensic evidence to the fact finder commanded widespread agreement and was endorsed by two NRC panels, although there were, and still are, fierce disputes over the details.


102. See Jay Aronson, Genetic Witness: Science, Law and Controversy in the Development of DNA Profiling; see also Michael Lynch et al., Truth Ma-
The dominance of the two-step model has led to a climate in which it has become difficult to understand why anyone would want to present source attribution evidence in any other way. Nonetheless, those disciplines that historically predate the development of forensic DNA profiling remain committed to their traditional methods of characterizing evidence. Primarily, this is because they lack the data with which to calculate the estimates necessary to complete the second step.\textsuperscript{103} Even so, the implicit contrast with DNA profiling has led to some discomfort with the match language in the traditional source attributions disciplines. Bite mark examiners have been the most proactive in this regard, seeking to develop a sort of linguistic scale of certainty along which judgments of consistency could be calibrated.\textsuperscript{104} The obvious question prompted when disciplines that testify about “matches” are contrasted with forensic DNA profiling is: what is meant by a “match”? Is a “match” an assertion that the reference sample is consistent with trace, and nothing else could be consistent? Or, is it an assertion that the reference sample is consistent, and some other number of objects in the world might also be consistent? Typically, this ambiguity inherent in the word “match” is not resolved in expert testimony (or even necessarily in the witnesses’ mind).\textsuperscript{105} Of course, as evidence scholars have noted, testimony about “matches” is unhelpful to fact-finders who are unable to assess the probative value of the evidence without knowing the rarity of the “match.”\textsuperscript{106}

A statement such as “the latent print is not inconsistent with the known print of the suspect” is, in my view, a scientifically defensible statement to make about a latent print analysis. It is not false on its face; it does not imply the existence of studies, data and conclusions that do not exist (as does the statement, “[t]he latent print is consistent with the known print of the suspect, and no other known print could be found consistent”). Nevertheless, even this more scientifically defensible statement serves the fact-finder poorly. The fact-finder still does not know how many individuals in the relevant population can produce known prints that would be deemed “not inconsistent” with the crime scene trace and, therefore, cannot calculate the probative value of the evidence. The prob-
These issues notwithstanding, given that latent print examiners have no data or methods with which to assess the rarity of the features that they find consistent in their analyses, in my view the only defensible testimony latent print examiners could give would be statements like the following:

"I was not able to exclude the defendant as the source of the latent print."

"It is my opinion that the latent print and the known print may have derived from a common source."

"Using a process whose accuracy is not known, I reached a conclusion that the latent print and the known print derived from a common source."

"The consistencies between the latent print and the known print show that potential donors of the latent print are the defendant and an unknown number of other individuals."

These are not the sorts of statements I found in my analyses of actual transcripts. The most carefully and precisely worded conclusion was without question the following one:

"The latent print that appears on this lift, which is Government's Exhibit 44, was made by the same individual whose inked fingerprint appears in the left ring finger block of the fingerprint card, Government Exhibit Number 60, which bears the name Latrell Lanthrom Gilchrist."  

C. Categories of Testimony

1. Process Statements

Eighteen testimonies fit into a category I will call "Process statements" because the witness characterized the evidence not in terms of probative value, but as the outcome of process. Typically, the witnesses have told the jury that they "identified" or "matched" the latent print "to" the defendant. An example of such a "Process statement" is the following: "This impression here, No. 3 upper, right-hand corner, No. 18, was identified to the ink impression of Victor Reyes' left palm in this area here."

In some ways, the "Process" category belies much of the discussion we have had up to this point. Process statements are not really source attribution moments in that the expert never actually states that defendant is the source of the crime scene trace. Nor do Process statements misstate the

107. I am grateful to Professor Jennifer Mnookin for making this point.
109. See Florida v. Reyes, Tr. Trans. at 49.
probative value of the evidence; indeed, what is remarkable is that such statements would seem, on their face, to have very little probative value or perhaps no probative value at all. What does it mean for an expert witness to say they “identified” a trace “to” the defendant? Or to have “matched” the crime scene trace to a known sample from the defendant? It has often been noted that the claim of a “match” is in itself meaningless, if not accompanied by any further information about how unusual is such match.110 In addition, it is necessary to know the accuracy of this “matching” or “identification” process. Absent such knowledge, the jury has no way of assessing the probative value of a “match” or “identification.”111 Any statistically or logically informed evaluation of a Process statement—which, of course, is not something we can expect from juries—would prompt the questions: What is this Process by which the defendant was “identified” (or “matched”)? How accurate is it? How discriminating? The Process statements do not say, and, therefore, the jury should not be able to infer any probative value from them at all. Consider: it would be one thing to “identify” a bloodstain “to” a defendant by visual analysis (the defendant has a fresh wound), another to “identify” the bloodstain “to” the defendant by serological analysis (same ABO blood type) and still another to “identify” it “to” the defendant by DNA profiling. The probative values of each “matching” process are wildly divergent, yet none of that divergence is accounted for or communicated to the jury if all three processes are characterized by nothing more than Process statements.

Of course, Process statements are not valueless, at least when they concern latent print evidence. Common sense and numerous cases attest that juries will find defendants guilty beyond a reasonable doubt based solely on latent print evidence.112 Something must be bestowing probative value on the evidence that is not discernible merely by reading the expert’s testimony on its face.

110. For a discussion of “matches,” see supra note 106 and accompanying text.

111. See United States v. Green, 405 F.Supp.2d 104, 119 (D. Mass. 2005) (noting that expert evidence may be excluded “because the factfinder has no information about the likelihood of error in the opinions, and thus cannot adjust the weight to be given to the evidence.”)

It is not difficult to imagine what this "something" might be. The most likely explanation is that it is the word "fingerprint" that does the expert's work of conveying to the jury the idea that this is an identification process with very high probative value. Fingerprinting enjoys a very high level of popular acceptance and enjoys a mythos that makes it nearly synonymous with infallibility. In other words, it is not necessary for the expert to state the probative value of this "identification" or "matching" process; the jury does that for the expert based on the "cultural assumption" that a latent print "match" or "identification" is an absolute fact and the result of an "infallible" process. This saves the witness from having to misstate the probative value of the evidence, or even from having to state it all. The latter benefit is especially useful for latent print evidence where, many scholars have argued, one of the fundamental problems is that expert witnesses have no way of generating a defensible estimate of the probative value of the evidence.

2. Source Attribution Statements

Sixteen testimonies contained what I call "source attribution statements." These are flat assertions that the defendant "made" the print, that the print "is" the print of the defendant or that the defendant "could be the only source" of the print. The model testimony cited above is an example of such a statement. More typical is the following:

The No. 1 latent fingerprint was the No. 10 finger of Terry Patterson, which is the left little finger. The No. 2 latent fingerprint is Terry Patterson's No. 9 finger, which is the left ring finger; and the No. 3 latent is the No. 8 finger, which is the left middle finger of Terry Patterson.

These statements are more problematic than Process statements for several reasons. First, they represent the problem of over-claiming that we have been discussing here. It has become axiomatic among forensic sci-
tists that all forensic evidence is inherently probabilistic.\textsuperscript{117} It has been cogently argued that latent print analysis must also be inherently probabilistic.\textsuperscript{118} To claim that the defendant "made" the latent print is to essentially claim that the analyst has reached a level of probability so high that the possibility of the alternative hypothesis is no longer even worth mentioning to the fact-finder. Whether this is wise policy in any instance has been questioned,\textsuperscript{119} but it is particularly problematic when this purportedly astronomically high probability has not even been calculated but merely subjectively inferred based on "experience."\textsuperscript{120}

Second, the statement that the defendant "made" the print would seem not to be a scientific statement. It does not state the results of some instrumental, or even subjective, laboratory process. It does not even confine itself to the trace evidence. It is not a statement about the evidence that the expert presumably analyzed. It is a statement about an event that occurred at the time of the crime, that the expert has presumably inferred from the evidence. But why should an expert be permitted to make such an inference? Shouldn't experts be expected to confine their statements to what they can infer directly from the evidence before them? In this case, that would be something closer to "the latent print and the defendant's known print are not inconsistent with originating from a common source" than "the defendant made the print." Of course, the law of expert testimony is generally thought to control expert testimony in this precise way. That the experts in these transcripts appear to have evaded that restriction without comment or sanction, I would suggest, supports my argument that the courts' attention is usually directed toward something other than control (as opposed to admissibility) of expert testimony.

In such testimonies, experts have gone beyond the bounds of what they know from their expert analysis into the realm of what they infer from that analysis. The problem with such testimony is not merely that it invades the province of the jury; it is that it is not science and not derived solely from expert knowledge.\textsuperscript{121}

3. Identity Statements

As noted, the third category of statements is less quantitatively significant than the first two. Only three testimonies could not be accounted for using the first two categories. These testimonies used what I call an "Iden-

\textsuperscript{117} See Aitken, supra note 100.
\textsuperscript{118} See Champod, supra note 103; Champod & Evett, supra note 103.
\textsuperscript{119} See Population Genetic Models, in Forensic DNA Evidence Interpretation 65 (John Buckleton et al. eds., 2005).
\textsuperscript{120} See Thompson & Cole, supra note 97.
\textsuperscript{121} See Nance, supra note 11, at 243 (stating "for the expert to give an opinion on an ultimate issue, the expert must implicitly weigh other evidence in a case, including evidence that goes beyond any expert's asserted expertise"); see also Kaye, supra note 58, at § 1.3.1. My formulation of this argument has also benefited from discussions with Professor William C. Thompson.
ity statement” at the source attribution moment. One additional testimony used an Identity statement in conjunction with both other types of statements. The expert witness states that the latent print and the reference print were “identical” or “one and the same.” For example: “Finger No. 6 on the submitted fingerprint card was one and the same with the latent print that I developed on the Item 9 piece of paper.”

This category of statements is curious. To begin with, the testimony is false. It is axiomatic in latent print examiners’ and forensic scientists’ own literature that not only are no two impressions from different fingers “identical,” but no two impressions even of the same finger are “identical.” The correctly formulated testimony of a latent print expert witness should concern the possibility that the latent print and the known print derive from a common source, not the possible sameness of the two prints. The statements are also, of course, false as matters of logic and semantics. The two prints are not “one and the same”; they are two different prints. Arguably, they cannot be “identical” either, without some sort of agreed upon definition of how much variance is permissible for two prints to still be deemed “identical.”

Even if Identity statements are taken at face value, as with the Process statements, they leave unsaid information that would be important for a statistically or logically informed evaluation of the statement. Even if two prints are “identical,” and something meaningful is meant by “identical,” it would still be necessary to know how many other individuals might also be capable of producing prints deemed “identical” to one of these under whatever parameters are being used to define “identicality.”

Of course, as with Process statements, the persuasive value of Identity statements is presumably not diminished by the fact that they make little sense on their face. As with Process statements, the poor wording and logic of Identity statements is presumably compensated for by the fact that everyone—including, of course, jurors—knows what a latent print expert witness means when he or she says that the latent print and the known print are “one and the same.” The expert does not mean that the prints are exactly the same; he or she means that they appear generally the same—the same “within tolerance” is the current parlance—and that the expert has inferred from this appearance of sameness that they must

122. See Jackson v. Commonwealth, 590 S.E.2d 520 (Va. 2004), Tr. Trans., at 832.
123. See generally Wikipedia, Fingerprint, http://en.wikipedia.org/wiki/Fingerprint (last visited Apr. 2, 2007) (explaining flexibility of friction ridge skin means that no two finger or palm prints are ever exactly alike (never identical in every detail), even two impressions recorded immediately after each other); see also Inman & Rudin, supra note 97, at 133.
124. See generally Champod, supra note 103.
come from a common source and ruled out the possibility that they come from different sources.

D. Other Attributes of Testimony

1. Bolstering

What is surprising about many of these testimonies is how little probative value they seem to convey. Most of them fail to actually address the issue of the probative significance of the evidence. In eight of the thirty-four cases, however, the perceived probative value of the evidence was bolstered by hyperbolic statements that, though not necessarily bearing any logical relation to the probative value of the evidence, nonetheless presumably served to heighten the fact-finder’s sense of the “infallibility” of latent print analysis. Latent print expert witnesses told jurors that they were “positive,” that they were “absolutely certain,” that they had “no doubt” that the match was “to the elimination of all other fingers on the planet” and that “once a fingerprint or a palm print has been identified to an individual it cannot belong to anybody else except that individual.” Some of these statements, such as the experts’ self-characterizations as being “positive” or “certain,” may exploit jurors’ (and perhaps experts’) confusion between confidence and accuracy. Others, however, such as the claim to have eliminated all other fingers on the planet, have no basis.126

2. Quantifications of Certainty

As noted, latent print examiners do not tend to attempt to quantify the probative value of their conclusions of consistency. This is in part because no data exists from which to make a responsible estimate of that value. In addition, however, latent print examiners are banned by professional guidelines from attaching probabilistic estimates to their conclusions.127 An exception to the ban on quantification, however, is made for the proportion “100%.” This is because latent print examiners are permitted to conclude that an individual is the only possible source of a latent print in the universe.128 They are not, however, permitted to conclude that an individual might be the source of a latent print (the only statistically defensible conclusion). Obviously, under such conditions, the use of the

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proportion "100%" cannot be considered quantification in any meaningful sense because it is the product of a policy decision rather than any sort of reasoning or calculation. The fact-finder, however, is unlikely to be aware of these background conditions and might interpret the use of the proportion "100%" to be the outcome of some sort of chain of calculations based on meaningful data and information. Four of the thirty-four testimonies quantified the witness's certainty as "100%," in this manner.

E. Conclusions from the Transcript Data

What is most surprising about the sloppiness of these formulations is not so much that they are prejudicial to the defendant, but instead, how little they offer to the government. Latent print expert witnesses' testimonial statements are remarkably lax about giving prosecutors what they theoretically need in terms of probative value. It would appear that a good deal of latent print testimony actually given in U.S. courtrooms is not particularly probative, but is nevertheless extremely persuasive. What, then, accounts for the vaunted power of latent print evidence?

Again, the answer seems obvious. The power of the testimony derives from the talismanic power of the word "fingerprint," rather than from any articulation of the probative value of the evidence. Indeed, one almost suspects that latent expert witnesses could say the word "fingerprint" and then essentially say anything that indicated that their conclusion was incriminating, rather than exculpatory, and the jury would afford the testimony enormous probative value. This suggests that the remedy I propose in this article—greater judicial control over testimonial claims, rather than over admissibility—may be insufficient in the case of latent print testimony because the cultural mythos is so strong and so deep that even judicial control over testimony may be incapable of overcoming it. It is for this precise reason that Judge Thorne concluded that latent print evidence required a jury instruction to overcome the "cultural assumption" of its "infallibility."

A deeper way of thinking about this issue is suggested by Professor Wells's seminal psychological research on juror evaluation of statistical evi-

129. This might suggest a reason that latent print practitioners have historically been so unconcerned with devising methods of calculating the probative value of latent print evidence. In a sense, they have mapped an alternative route to evidentiary power; rather than DNA's route through precisely quantified calculations of probative value, latent print evidence achieved evidentiary power through cultural mythos. See generally Cole, supra note 81.

130. My argument about the power of the word "fingerprint" is supported by the tendency of expert witnesses testifying about other disciplines to seek to utter the word "fingerprint" whenever possible: "DNA fingerprinting," "brain fingerprinting," "unique marking just like a fingerprint," etc. See Lynch, supra note 102.

Wells sought to understand what has now become known as the "Wells effect," juror reluctance to convict or award civil damages based on a "naked statistic," a statistical inference unsupported by any other evidence. The Wells effect has been illustrated by reference to the following two statistically equivalent statements:

**Expert Witness A.** Based on a blood test that is 99.8% accurate, I conclude that the defendant is the father.

**Expert Witness B.** Based on a blood test, there is a 99.8% probability that the defendant is the father.

Wells found that jurors were much more likely to assign paternity when presented with Expert A than when presented with Expert B. Wells suggests that difference between the two statements has to do with the way in which the expert witness vouches for the conclusion. Although the probability is the same in both cases, Expert A has in some sense staked something on the conclusion in a way that Expert B has not. Wells suggests that this generates a bond between the evidence and the ultimate fact for Expert A that is absent for Expert B: If the defendant turns out not to be the father, then Expert A was wrong—having said something false—but Expert B was not wrong. After all, Expert B clearly told the jury that there was a chance, albeit a small one, that the defendant was not the father. Were the defendant wrongly found liable for paternity, Expert B certainly could not be held morally responsible. Expert A, however, would seem more morally culpable. In short, Expert B shifts the moral responsibility for making a difficult decision—whether to convict or award civil damages based on nothing more than statistical evidence, even if the probability of error is quite low—to the jury. Jurors, Wells suggests, do not appreciate expert witnesses shifting that responsibility to them—they feel it belongs with the expert. Therefore, jurors punish Expert B accordingly by affording Expert B's testimony less weight even though its probative value is statistically equivalent to that given by Expert A. Wells calls this a "bidirectional test of good evidence"; "good" evidence, in jurors' view, is that evidence whose truth or falsity is tightly bound to the truth or falsity of the ultimate fact. "Good" evidence must become false when the ultimate fact that it indicates is proven to be false. Thus, Expert A's testimony survives the bidirectional test of good evidence, but Expert B's does not.

How does the Wells effect map onto fingerprint evidence? Professor Wells himself pointed to fingerprint evidence as an example of the sort of evidence that might pass the bidirectional test. In making this argument,
Wells used a formulation that would correspond to the Source Attribution Statements I have previously described. Indeed, his argument would certainly seem to hold for those statements. In Source Attribution Statements, the expert witness flatly states that the defendant is the source of the print. Even the preamble about the accuracy of the test used in Wells's simulation is gone. The latent print expert witness is fully morally accountable if the testimony turns out to be mistaken. Indeed, some latent print examiners have located the reliability of the technique in precisely this notion of moral accountability.

But what of the Process Statements? Assessing whether or not these statements meet the bidirectional test is more difficult mainly because they are so devoid of probative value; they are not on their face incriminating statements, and thus, it is difficult for them to meet bidirectionality. It is notable, however, that eight of the seventeen Process statements use the first person (e.g., "I identified all three fingerprints with Mr. Terry Nichols."). Perhaps by the use of the first person, the witness takes moral responsibility in the manner described by Professor Wells.

VIII. CONCLUSION

I have argued that in controlling the problem of expert evidence, judges and legal scholars need to shift their focus from the admissibility of evidence to control of testimony. I have suggested that the dangers to naïve fact-finders rests not so much with hearing the evidence at all, but rather with over-claiming that is often, and in some cases routinely, attached to expert testimony. I have attempted to illustrate this point with some modest empirical data on what I believe to be the typical practice of expert testimony for one of the best trusted forms of forensic evidence in the U.S. over the last two decades.

I believe that this data supports my argument, but it is illuminating in other ways as well. First, it demonstrates the wide variability of testimony

135. See Wells, supra note 132, at 749 ("Fingerprint experts, when allowed to state conclusions (e.g. 'I conclude that the prints lifted from the glass are those of the defendant'), are likely to pass this bidirectional test of good evidence.").

136. This does not mean, of course, that some latent print examiners who do make mistakes are not capable of shifting blame, uttering things like "the system failed me" or "I made an honest mistake." See generally Simon A. Cole, More Than Zero: Accounting for Error in Latent Fingerprint Identification, 95 J. CRIM. L. & CRIMINOLOGY 985 (2005). In marked contrast, was the behavior of some, but not all of the examiners in the Mayfield misattribution who readily accepted blame for the error. See generally Simon A. Cole, The Prevalence and Potential Causes of Wrongful Conviction by Fingerprint Evidence, 37 GOLDEN GATE U. L. REV. 39 (2006).

137. See Rhonda Boston, 147 THE WEEKLY DETAIL (June 7, 2004), http://www.clpex.com/Articles/TheDetail/100-199/TheDetail147.htm ("The latent print examiner needs to realize that each and every time he or she makes a call on an identification/individualization they put themselves and their credentials on the line.").

that can be attached to what is essentially the same evidence in U.S. courtrooms. Such casualness concerning how testimony is phrased illustrates my argument that courts and scholars have focused too much on admissibility of evidence and too little on the nuances of testimony. Testimony should not be this haphazard. There is no way to exercise judicial control over testimony until the testimony itself is stabilized and standardized. Latent print examiners, for example, are restricted to only three possible conclusions, but have almost no restrictions on their testimony.\textsuperscript{139} For routine procedures like latent print analysis, testimony should be professionally controlled at least to the extent that conclusions are professionally controlled.\textsuperscript{140} Once professional bodies articulate what testimony they think is defensible, the question of whether such testimony is indeed defensible can then be litigated. This would be sort of pragmatic approach to a particular problem with the use of scientific and technical evidence in the courts for which \textit{No Magic Wand} so resoundingly calls.

\textsuperscript{139} The exception, perhaps, is the ban on probabilistic statements. For a discussion of the exception, see \textit{supra} note 125 and accompanying text.

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