ESSAY

DAUBERT AND THE *REFERENCE MANUAL:* AN ESSAY ON THE FUTURE OF SCIENCE IN LAW

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INTRODUCTION

THE Supreme Court's recent decision in *Daubert v. Merrell Dow Pharmaceuticals*[1] has attracted much commentary, all of it focused on the evidentiary test for the admission of expert scientific testimony[2] or closely related topics.[3] Discussion has centered both on the Supreme Court's rejection of the 1923

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[1] 113 S. Ct. 2786 (1993).

[2] See, e.g., David E. Bernstein, The Admissibility of Scientific Evidence After *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 15 Cardozo L. Rev. 2139, 2139 (1994) (calling *Daubert* "the most important case involving the admissibility of scientific evidence in seventy years."); Joseph Sanders, Scientific Validity, Admissibility, and Mass Torts After *Daubert*, 78 Minn. L. Rev. 1387, 1390 (1994) ("The Court's discussion raises two primary questions addressed in this Article: what approach should courts employ in assessing the admissibility of expert scientific opinion and, given this approach, how restrictive should courts be in allowing expert opinion into evidence?"); Developments in the Law—Confronting the New Challenges of Scientific Evidence, 108 Harv. L. Rev. 1481 (1995) (providing a comprehensive review of the admissibility of scientific evidence with particular attention to the consequences of *Daubert*).

[3] See, e.g., Margaret A. Berger, Procedural Paradigms for Applying the *Daubert* Test, 78 Minn. L. Rev. 1345 (1994) (exploring the use of the *Daubert* test for admissibility of scientific evidence in a number of differing procedural contexts); David L. Faigman, The Evidentiary Status of Social Science Under *Daubert*: Is it "Scientific," "Technical," or "Other" Knowledge?, 1 Psychology, Public Policy, and Law 960 (1995) (discussing application of the *Daubert* evidentiary standard to psychological research); Andrew E. Taslitz, *Daubert*'s Guide to the Federal Rules of Evidence: A Not-So-Plain-Meaning Jurisprudence, 32 Harv. J. on Legis. 3, 4 (1995) (focusing on *Daubert* "to understand and critique the Supreme Court's approach to interpreting the Federal Rules of Evidence").

"*Frye*" or "general acceptance" standard[4] for admission and on how, instead, the 1975 Federal Rules of Evidence are to govern scientific evidence.[5]

Our thesis in this Essay is that the significance of *Daubert* goes well beyond narrow evidentiary questions. We assert that *Daubert* signals a new receptivity to science as a functional component of American jurisprudence. This broader and more emblematic reading of the case will in time overshadow the technical importance of *Daubert* as a new "test" to be used for admitting scientific evidence. We predict that as a consequence of *Daubert*, a number of common practices of science will become common practices of law, erasing years of heated dispute about the inclusion of these scientific methods in law.

Our argument that *Daubert* heralds a new receptivity to science in law is drawn initially from the text of Justice Blackmun's opinion for seven members of the Court. There, he treated as wholly tantamount "scientific validity" and "evidentiary relevance and reliability,"[6] effectively integrating scientific method into the legal process. This strong reading of the majority's *Daubert* opinion appears to be shared ruefully by Chief Justice Rehnquist, who argued in dissent that the majority's bold statements might require federal judges to become "amateur scientists".[7] Arguments for a broad jurisprudential reading rather than a cramped evidentiary interpretation of *Daubert* are made more credible by recent activities of the Federal Judicial Center. That agency has greatly intensified efforts to provide judges with science education, and late in 1994, published a massive *Refer-*

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[4] Frye v. United States, 293 F. 1013 (D.C. Cir. 1923). The court in *Frye* held that expert opinion must be based on a scientific technique that has gained general acceptance, id. at 1014, a test not incorporated in Rule 702 of the Federal Rules of Evidence, which was adopted half a century after the *Frye* decision.

[5] See, e.g., Bert Black, Francisco J. Ayala & Carol Saffran-Brinks, Science and the Law in the Wake of *Daubert*: A New Search for Scientific Knowledge, 72 Texas L. Rev. 715 (1994) (discussing *Daubert* and application of the Federal Rules to scientific evidence); Clifton T. Hutchinson & Danny S. Ashby, *Daubert v. Merrill Dow Pharmaceuticals, Inc.*: Redefining the Bases For Admissibility of Expert Scientific Testimony, 15 Cardozo L. Rev. 1875 (1994) (similar); and Edward J. Inwinkelried, The *Daubert* Decision: *Frye* is Dead, Long Live the Federal Rules of Evidence, Trial, Sept. 1993 at 60 (similar).

[6] See infra notes 27-31 and accompanying text.

[7] *Daubert*, 113 S. Ct. at 2800 (Rehnquist, C.J., dissenting).

ence Manual on Scientific Evidence that has been distributed to all federal judges.[8] These and other unprecedented educational efforts may determine the scope of *Daubert's* ultimate impact.

If *Daubert* comes to be interpreted by judges as heralding a new openness to the fruits of the scientific method, what form will this openness take? In a number of important areas *not* involving questions of admissibility, the *Daubert* decision and the related campaign of judicial education may ultimately tip the jurisprudential balance in favor of weaving scientific epistemologies into the fabric of law. Although American courts are no strangers to science, a number of practices that are now the subject of frequent and heated debate would come to be routinely accepted as judicial techniques for solving urgent problems. More specifically, under this broad reading three currently contentious practices would become standard operating procedures in the law. First, the empirical approach of science—what the Court referred to as the "falsifiability, or refutability, or testability"[9] of science—would be readily incorporated in a range of law-making ventures, including techniques for reforming many types of court rules. Second, judicial fact-gathering practices founded on random sampling and inferential statistics, rather than individualized adjudication, would come to be routinely accepted, particularly in the resolution of mass tort cases. Finally, simulation research would gain greater acceptance as a basis for judicial decision-making in areas such as jury instructions.

These three implications follow from the view that *Daubert* entails a new receptivity to science, since an empirical approach, sampling, and the use of simulation research are among the most common of scientific practices. Normative or value-driven aspects of law, of course, will remain unaffected by these developments, because science is largely positive in nature. In contrast,

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[8] Reference Manual on Scientific Evidence (Federal Judicial Ctr. ed., 1994) [hereinafter Reference Manual]. In a related proprietory development, the West Publishing Company will soon publish a manual, West's Companion to Scientific Evidence (D. Faigman, D. Kaye, M. Saks, J. Sanders, eds., forthcoming, 1995), providing analysis of numerous areas of science. See David L. Faigman, Mapping the Labyrinth of Scientific Evidence, 46 Hastings L.J. 555, 564 n.29 (1995).

[9] *Daubert*, 113 S. Ct. at 2796-97, (quoting K. Popper, Conjectures and Refutations: The Growth of Scientific Knowledge 37 (5th ed., 1989)).

court procedures for acquiring information necessary for making well-informed normative judgments would be greatly enhanced under a strong reading of *Daubert*. In Part I of this Essay, we briefly review the Supreme Court's approach to the use of science as it existed prior to *Daubert*. In Part II, we analyze the Supreme Court's *Daubert* opinion. The Federal Judicial Center's *Reference Manual* is described in Part III. In the heart of the Essay, Part IV, we detail the synergistic effects that *Daubert* and the *Reference Manual* likely will have on the use of science in federal courts and in those state courts which closely follow the federal example.[10] Finally, we offer our conclusions about the desirability of these trends.

I. THE SUPREME COURT AND SCIENCE BEFORE DAUBERT

It is surprising that the "general acceptance" test established in *Frye*,[11] surely a landmark case concerning the admissibility of scientific evidence, was not announced by the Supreme Court, but instead by a circuit court in what the Supreme Court referred to in *Daubert* as "a short and citation-free 1923 decision."[12] Even more surprising is the fact that in the seventy years after *Frye* was decided, the Supreme Court did not once cite *Frye* in a majority opinion—until *Daubert*. The Court's remarkable avoidance of *Frye* did not result, however, in any significant exploration of science by the Court itself. Instead, over this period—the majority of the twentieth century—the Court has studiously avoided making a major statement of its own about science in law. The Court has often relied upon the conclusions of scientific research without any consideration of the validity of the methods that produced those conclusions.

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[10] At least three states have explicitly decided to follow *Daubert*, and four other states have decided *Daubert* is consistent with local law. Bert Black, The State Court Reaction to Daubert, 2 Shepard's Expert and Scientific Evidence Quart. 291, 291 (1994).

[11] See *Frye*, 293 F. at 1014 ("Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs.").

[12] *Daubert*, 113 S. Ct. at 2793.

And on those relatively rare occasions when the Court did not offer conclusory scientific judgments, but rather undertook its own examination of science, the Court did so in an ad hoc and unsystematic manner.[13]

One example of the Court's use of the conclusions of scientific research, without a discussion of either the general acceptance of the methodology that produced those conclusions—i.e., without applying the *Frye* test—or any alternative index of the trustworthiness of those conclusions, is *Williams v. Florida*.[14] There, the Court cited six social science references to support its conclusion that six-person juries functioned the same as twelve-person juries, and thus trial by a six-person jury did not violate a criminal defendant's Sixth Amendment rights. The Court concluded that "[w]hat few experiments have occurred—usually in the civil area—indicate that there is no discernible difference between the results reached by the two different-sized juries."[15] Yet a cursory look at the methodology of these "experiments" would have illuminated why "[n]ot one of the references even began to address competently the empirical questions the Court posed for itself."[16]

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[13] On other occasions the Court has deferred to presumed administrative competence. For example, in Federal Power Comm'n v. Florida Power & Light Co., 404 U.S. 453, (1972), the Court reversed a lower court's decision to reject Federal Power Commission experts' conclusions that admittedly rested "upon representations of a reality imperfectly understood." Id. at 464. The Court quoted United States ex rel. Chapman v. Federal Power Comm'n, 191 F.2d 796, 808 (4th Cir. 1951), for the proposition that "[t]he court may not . . . ignore the conclusions of the experts and the Commission and put itself in the absurd position of substituting its judgment for theirs on controverted matters of hydraulic engineering." *Florida Power & Light*, 404 U.S. at 466. Similarly, in Washington v. Harper, 494 U.S. 210 (1990), the Court held that a prisoner's interests were "adequately protected, and perhaps better served," id. at 231, by a procedure which allowed medical professionals to order involuntary medication. Due process, the Court held, does not require a judicial decisionmaker. Id. See also John M. Conley, "The First Principle of Real Reform": The Role of Science In Constitutional Jurisprudence, 65 N.C. L. Rev. 935 (1987) (discussing the historical development of links between law and technology).

[14] 399 U.S. 78 (1970).

[15] Id. at 101.

[16] Michael J. Saks, Ignorance of Science Is No Excuse, Trial, Nov.-Dec. 1974 18, 18; See also Hans Zeisel, . . . And Then There Were None: The Diminution of the Federal Jury, 38 U. Chi. L. Rev. 710, 712-15 (1971) (criticizing the research cited in *Williams* as lacking acceptable foundation).

An illustration of the Court's own attempt at a makeshift critique of scientific evidence presented to it can be found in *Lockhart v. McCree*[17], where the Court labored to identify "some of the more serious problems with McCree's studies"[18] purporting to demonstrate that "death-qualified" juries were biased in favor of the prosecution. Among these flaws were the fact that the "studies were based on the responses of individuals randomly selected from some segment of the population, but who were not actual jurors sworn under oath to apply the law to the facts of an actual case involving the fate of an actual capital defendant."[19] That the Court, on numerous other occasions, had relied on just such studies was left unsaid.[20]

II. THE *DAUBERT* DECISION

The wariness with which the Court approached science for seven decades renders the *Daubert* decision all the more remarkable. That case involved actions brought by minor children and their parents to secure damages for limb reduction birth defects. The cases filed in the California state courts claimed that the birth defects had been caused by the mothers' use of Bendectin, an anti-nausea drug.[21] The defendant drug manufacturer, Merrell Dow Pharmaceuticals, removed the cases to federal court and, after a period of discovery, moved for summary judgment, arguing that Bendectin does not cause birth defects in humans, and asserting that the plaintiffs would be unable to come forward with any admissible scientific evidence to the contrary.[22] Merrell Dow supported this motion with an affidavit describing a literature review of more than thirty published studies. The affidavit concluded that no study had found Bendectin to be capable of causing such birth defects. Plaintiffs did not dispute the validity of the Merrell Dow affidavit. Instead they offered

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[17] 476 U.S. 162 (1986).

[18] Id. at 173.

[19] Id. at 171.

[20] See, e.g., Williams v. Florida, 399 U.S. 78, 101 n.49 (1970) (citing research by Harry Kalven and Hans Zeisel which employed mock jurors) and Ballew v. Georgia, 435 U.S. 223, 231 n.10 (1978) (citing research by Michael Saks which employed mock jurors).

[21] *Daubert*, 113 S. Ct. at 2791.

[22] Id.

the testimony of eight of their own experts regarding a variety of other studies and analyses which suggested the potential of Bendectin to cause human birth defects.[23] The district court granted Merrell Dow's motion, discounting the plaintiff's research because the methods employed were not "sufficiently established to have general acceptance in the field to which it belongs."[24] The Court of Appeals for the Ninth Circuit affirmed, citing the same *Frye* "general acceptance" test on which the trial court had relied.[25]

In *Daubert*, the Supreme Court reversed the Ninth Circuit, unanimously holding that the *Frye* test was superseded by the adoption of the Federal Rules of Evidence. Observing that *Frye* predated the Rules by almost a half-century, Justice Blackmun examined Rule 702, which governs expert testimony. He found nothing in the Rule to establish the "general acceptance" test and noted that the drafting history makes no mention of either *Frye* or the "general acceptance" requirement.[26]

Later in his opinion, now writing for a Court of seven, Justice Blackmun described the responsibility of the trial judge in reviewing scientific evidence under the Rules. "[T]he trial judge must ensure that any and all scientific testimony or evidence admitted is not only relevant, but reliable."[27] He derived this obligation from the language of Rule 702 and the mention of "scientific . . . knowledge."[28] He then outlined "general observations" for judges determining the admissibility issue. After proposing a number of considerations, Justice Blackmun summarized the inquiry under Rule 702 as follows: "Its overarching

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[23] Id.

[24] Daubert v. Merrell Dow Pharmaceuticals, 727 F. Supp. 570, 572 (S.D. Ca. 1989) aff'd, 951 F.2d 1128 (9th Cir. 1991), vacated and remanded, 113 S. Ct. 2786 (1993) (citing United States v. Kilgus, 571 F.2d 508, 510 (9th Cir. 1978)).

[25] *Daubert*, 951 F.2d 1128, 1129 (9th Cir. 1991), vacated and remanded, 113 S. Ct. 2786 (1993).

[26] *Daubert*, 113 S. Ct. at 2794 ("Given the Rules' permissive backdrop and their inclusion of a specific rule on expert testimony that does not mention 'general acceptance,' the assertion that the Rules somehow assimilated *Frye* is unconvincing. *Frye* made 'general acceptance' the exclusive test for admitting expert scientific testimony. That austere standard, absent from and incompatible with the Federal Rules of Evidence, should not be applied in federal trials.").

[27] Id. at 2795.

[28] Id.

subject is the scientific validity—and thus the evidentiary relevance and reliability—of the principles that underlie a proposed submission."[29] Thus Justice Blackmun treated the epistemology of science as tantamount to the epistemology of law. Any doubt about his intention can be set aside by his earlier statement of the same basic proposition in a footnote: "In a case involving scientific evidence, *evidentiary reliability* will be based upon *scientific validity*."[30] The significance of this language was clear to Chief Justice Rehnquist, who wrote in his dissent, "Indeed, in footnote 9, the Court decides that '[i]n a case involving scientific evidence, *evidentiary reliability* will be based upon *scientific validity*.'"[31] Later, Justice Blackmun essentially restated this conclusion a third time: "[T]he Rules of Evidence—especially Rule 702—do assign to the trial judge the task of ensuring that an expert's testimony both rests on a reliable foundation and is relevant to the task at hand. Pertinent evidence based on scientifically valid principles will satisfy those demands."[32] Justice Blackmun's repeated treatment of scientific and legal reasoning as fungible essentially replicates the argument offered to the Court jointly by the American Association for the Advancement Science and the National Academy of Sciences in an amicus brief, which stated that "the basic logic of science does not differ from the logic of the law."[33]

III. THE *REFERENCE MANUAL*

A particularly significant effect of the *Daubert* decision was the immediate encouragement given to judicial education about science. The Federal Judicial Center took the lead. At the time

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[29] Id. at 2797.

[30] Id. at 2795 n.9.

[31] Id. at 2800 (Rehnquist, C.J., dissenting).

[32] Id. at 2799.

[33] Brief for The American Association for the Advancement of Science and The National Academy of Sciences as Amici Curiae in Support of Respondent at 19, Daubert v. Merrell Dow Pharmaceuticals, 113 S. Ct. 2786 (1993) (No. 92-102). The brief continued, "The characteristics of valid science are neither remote nor arcane, and a judge should not hesitate to consider them in evaluating disputed scientific evidence. Although judges often will be unable to bring the same expertise to such a task as a specially trained scientist, they are in a position to determine if scientific evidence possesses the characteristics of valid science and to consider the same factors that busy scientists use to evaluate research performed by other scientists." Id. at 20.

of the *Daubert* decision, the Center already had undertaken a science education project as a follow-up to a report of the Carnegie Commission on Science, Technology, and Government.[34] The *Daubert* decision encouraged the continuation and rapid completion of this project.[35] The Center published the *Reference Manual on Scientific Evidence* in late 1994.[36] In his introduction, Judge William Schwarzer, the director of the Center, described the relationship between *Daubert* and the publication of the *Reference Manual*, pointing out that *Daubert* "has heightened the need for judicial awareness of scientific reasoning and meth-

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[34] Carnegie Commission, Science and Technology in Judicial Decision Making: Creating Opportunities and Meeting Challenges (1993).

[35] William W. Schwarzer, director of the Center, wrote in the Center's 1993 Annual Report that "[the Center] has undertaken a multipronged science and technology project, partially funded by the Carnegie Corporation, to help courts deal with science-intensive cases. The Supreme Court's decision in Daubert v. Merrell Dow Pharmaceuticals, Inc., 113 S. Ct. 2768 (June 28, 1993), underscores the importance of this effort by directing that 'the trial judge . . . ensure that any and all scientific . . . evidence admitted is not only relevant, but reliable.'" 1993 Annual Report of the Federal Judicial Center at 1. Schwarzer described the Center's project as "proceeding on several fronts to help courts make better use of scientific evidence." Id. at 2-3. He explained that one effort involved the production by the Center of a "reference manual on scientific evidence. . . . The protocols will explain the methods and the reasoning of the science, identify the issues most commonly in dispute, and illuminate their analysis." Id. at 3. He added that "[t]he Center will also conduct a series of seminars and workshops to demonstrate the use of the manual and assist federal judges in dealing with complex issues of science and technology." Id. At another point in the report Schwarzer wrote that "[t]he Center's materials will address the principles and methodology of science, not the conclusions generated by scientific studies." Id.

[36] In addition, the Einstein Program for Law and Judicial Policy Studies at George Washington University's Center for Health Policy Research is in the process of developing a series of bench books, "Science in the Court: Finding Your Way." The project is supported by the State Justice Institute, the National Institute of Justice, The Federal Bureau of Investigation, and the Human Genome Project of the U.S. Department of Energy. Each volume will detail the scientific background of evidence and link it to adjudication procedure. Some of the projected bench books are: "Adjudication of Forensic DNA Evidence in Criminal Cases," "Adjudication of Genetic Testing and Gene Therapy Cases," "Neuroscience Evidence in Competency and Guardianship Adjudication of the Senile Dementias," "Medical Practice Guidelines as Scientific Evidence in Health Care Cases," and "Neuroscience Evidence in Criminal Adjudication of Addictive Disorders." See Paul S. Miller et al., Daubert and the Need for Judicial Scientific Literacy, 77 Judicature 254, 259-60 (1994); Developments in the Law—Confronting the New Challenges of Scientific Evidence, 108 Harv. L. Rev. 1481, 1518 & n.77 (1995).

ods. . . ."[37] He explained that "[t]he trial judge is assigned a '-gatekeeping responsibility' to make 'a preliminary assessment of whether the reasoning or methodology underlying the testimony is scientifically valid and of whether that reasoning or methodology properly can be applied to the facts in issue.'"[38]

The bulk of the *Reference Manual*, Part II,[39] and the novel part in jurisprudential terms, consists of "reference guides" to areas often the subject of scientific expert testimony. Significantly, Judge Schwarzer emphasizes in his Introduction that the focus of these reference guides is *not* on evidentiary questions of admissibility, but on the epistemology of science:

> The reference guides do not instruct judges concerning the admissibility of specific types of expert evidence or conclusions of specific scientific studies, and they are not intended to establish minimum standards for acceptable scientific testimony. Instead, they present a primer on the methods and reasoning of selected areas of scientific evidence and suggest a series of questions that will enable judges to identify issues that are likely to be disputed among experts and to explore the underlying basis of proffered evidence.[40]

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[37] William W. Schwarzer, Introduction to Reference Manual, supra note 8, at 2.

[38] Id.

[39] Reference Manual, supra note 8, at 119-523. The first part is concerned with the management and admissibility of expert evidence and includes two papers, the first focusing largely on implications of the Federal Rules of Civil Procedure for management of scientific evidence, and the second focusing chiefly on the Federal Rules of Evidence and their implications for questions of admission of scientific evidence. See William W. Schwarzer, Management of Expert Evidence, *in* Reference Manual on Scientific Evidence at 9-35; Margaret A. Berger, Evidentiary Framework, *in* Reference Manual, supra note 8, at 56-67. This part of the Manual is traditional in nature and does not represent an important addition to our jurisprudential notions. The third part of the Manual is also traditional in nature, concerned with two specific techniques for using expert scientific evidence: the potential for court-appointed experts and the use of special masters. See Joe S. Cecil & Thomas E. Willging, Court Appointed Experts, *in* Reference Manual, supra note 8, at 525-73; Margaret G. Farrell, Special Masters, *in* Reference Manual, supra note 8, at 575-622; see generally, Review—Essays: Reference Manual on Scientific Evidence, 36 Jurimetrics J. 121 (1996) (summarizing and reviewing the contents of the Reference Manual); and John M. Conley & David W. Peterson, The Science of Gatekeeping, The Federal Judicial Center's New *Reference Manual on Scientific Evidence*, 74 N.C. L. Rev. 1183 (1996) (similar).

[40] Reference Manual, supra note 8, at 3.

The reference guides include seven topics: epidemiology, toxicology, survey research, forensic analysis of DNA, statistical inference, multiple regression analysis, and estimation of economic loss. The collection of topics is obviously eclectic, including specific fields of research (epidemiology and toxicology), subjects of study (DNA and economic loss), and particular methodologies (surveys, regression analysis, and statistics). The Comment on the Use of the Reference Guides emphasizes, as did Judge Schwarzer in his Introduction, that "[t]he guides are not intended to instruct judges concerning what scientific evidence should be admissible."[41] Each reference guide was written by an author or authors nationally recognized as highly informed about a particular scientific discipline or technique. These draft views were then extensively critiqued by attorneys, scientists, and others knowledgeable about the use of science. All of the reference guides describe particular scientific methodologies with little or no mention of evidentiary questions. Just as we suggest that the most important holding in *Daubert* is epistemological, the writers of the guides emphasize epistemological questions and put aside narrow questions of admissibility.[42] Thus, in our view, *Daubert* and the *Reference Manual*, together, comprise a major commitment to the use of science in law—a result much more significant than merely the establishment and elaboration of a test governing the admissibility of scientific evidence.

IV. THE SYNERGISTIC EFFECTS OF *DAUBERT* AND THE *REFERENCE MANUAL*

The Supreme Court's *Daubert* decision, the publication of the Federal Judicial Center's *Reference Manual*, and related science education projects for judges can be expected to have important effects on the practices of American courts. Encouraged by the Supreme Court, and instructed by a quasi-official treatise, judges are not likely to continue business as usual when confronting an opportunity to use science. These unique conditions will almost

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[41] Reference Manual, supra note 8, at 119.

[42] See, e.g., David H. Kaye & David H. Freeman, Reference Guide on Satistics *in* Reference Manual, supra note 8, at 335 ("This reference guide focuses on the nature of statistical thinking rather than on the rules of evidence or substantive legal doctrine.").

certainly result in novel judicial responses. For example, we believe that three currently contentious practices will become commonplace in the law. First, the empirical approach of science—what the Court referred to as the "falsifiability, or refutability, or testability"[43] of science—will be readily incorporated in a range of law-making ventures, including techniques for reforming many types of court rules. Second, judicial fact-gathering practices founded on random sampling and inferential statistics, rather than on individualized adjudication, will come to be routinely accepted, particularly in the resolution of mass tort cases. Finally, simulation research will gain less skeptical acceptance as a basis for judicial decision-making in areas such as jury instructions.

A. An Empirical Approach

One probable result of the reception of science will be the widespread adoption by the judiciary of an "empirical" approach to issues concerned with the legal process. An empirical approach is often contrasted with a "rational" one. A rational approach "rests on the belief that people can understand through reason and intuition alone."[44] An empirical approach, in contrast, "begins with the assumption that direct observation and experience provide the only firm basis for understanding nature."[45]

The fruit of an empirical approach to knowledge, empirical research, "refers to any activity that systematically attempts to gather evidence through observations and procedures that can be repeated and verified by others."[46] *Daubert* itself, of course, dealt directly with an empirical approach to establishing causality in a tort action: Did the maternal prenatal use of Bendectin cause children to have birth defects? The proof offered by both plaintiffs and defendant was a variety of data collected by several scientific methods.[47]

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[43] See supra note 9.

[44] John M. Neale & Robert M. Liebert, Science and Behavior: An Introduction to Methods of Research 2 (2nd ed., 1980).

[45] Id.

[46] Id. at 7.

[47] *Daubert*, 727 F. Supp. at 573-576.

The educational campaign developed in response to *Daubert* is designed to communicate an empirical approach to knowledge, and an appreciation for empirical research, to the judiciary. For example, the potential efficacy of the empirical approach is illustrated by all seven of the guides incorporated in the *Reference Manual.* Each of the guides is concerned with methods for gathering and interpreting "data." As David Kaye and David Freedman wrote in one of the guides, "[a]n analysis is only as good as the data on which it rests."[48]

One area of law where an empirical approach is having a significant impact is the process of adopting and amending court rules. Until now, this process has been largely "rational"—i.e., "intuitive"—in technique, and the judiciary and other rulemakers have shown only sporadic interest in the real-world effects of rules and rule changes.[49] The rulemaking process, particularly with regard to civil rules, has recently reached a state of crisis so severe that Stephen Burbank has called for a moratorium on further rule production,[50] and Linda Mullenix has argued that recent changes to discovery rules may well be founded on what she referred to as "myth."[51] Her remedy was clearly stated: "Sound, persuasive empirical study ought to undergird every rule reform effort; in particular, there must be convincing evidence

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[48] David H. Kaye & David H. Freeman, Reference Guide on Statistics *in* Reference Manual, supra note 8, at 341, 341.

[49] See Maurice Rosenberg, The Impact of Procedure-Impact Studies In The Administration of Justice, Law & Contemp. Probs., Summer 1988 at 13 ("Regrettably, the examples of such impacts [of empirical research on the functioning of procedural rules] have not been numerous. In part this lack of influence is due to the unreceptiveness of the intended users. Many lawyers and judges appear to believe that thinking like a lawyer means relying on law books, logic, speculation, argument, and—when it comes to addressing questions of societal reality—invoking intuition."); see also Laurens Walker, Perfecting Federal Civil Rules: A Proposal for Restricted Field Experiments, Law & Contemp. Probs., Summer 1988 at 67 (arguing for the adoption of restricted field experiments to predict the impact of proposed changes to the Federal Rules of Civil Procedure).

[50] Stephen B. Burbank, Ignorance and Procedural Law Reform: A Call For A Moratorium, 59 Brook. L. Rev. 841, 842 (1993) ("We need a moratorium on procedural law reform, whether by court rule or by statute, until such time as we know what we are doing.").

[51] Linda S. Mullenix, Discovery in Disarray: The Pervasive Myth of Pervasive Discovery Abuse and the Consequences For Unfounded Rulemaking, 46 Stan. L. Rev. 1393 (1994).

that a problem exists before any rulemaking group begins the process of rule revision."[52]

A significant change may be underway. In June, 1993, the Committee on Rules of Practice, Procedure and Evidence of the Judicial Conference of the United States, in response to this perceived crisis in federal rulemaking, directed the Subcommittee on Long Range Planning to undertake a self-study of the rulemaking process.[53] The Subcommittee was asked to evaluate thoroughly federal judicial rulemaking procedures and to furnish recommendations. The Committee received the Report at a meeting held January 10-12, 1996.[54] This Report, produced at the same time as enhanced programs of science education, seems likely to result in a shifting from a rationalistic approach to an empirical approach to rulemaking.

The Report includes three recommendations, all, in essence, urging enhanced use of an empirical approach. First, the Report recommends to all Advisory Committees that "[e]ach Advisory Committee should ground its proposals on available data and develop mechanisms for gathering and evaluating data that are not otherwise available . . . ."[55] This proposal was based on the conclusion that "the Standing Committee ought to be able to expect that the Advisory Committees will rely to the maximum possible extent on empirical data as a basis for proposing rules changes."[56]

Second, the Report recommends to the Advisory Committee on Civil Rules that "[t]he Advisory Committee should report on and make suggestions about how data gathered from the experi-

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[52] Id. at 1396.

[53] A Self-Study of Federal Judicial Rulemaking, A Report from the Subcommittee on Long Range Planning to the Committee on Rules of Practice, Procedure and Evidence of the Judicial Conference of the United States 1 (December 1995).

[54] Telephone conversation with Mark Shapiro, Rules Committee Support Office, Administrative Office of the United States Courts (Jan. 24, 1996). The mechanics of federal judicial rulemaking—including the role of the several Advisory Committees—is described in Thomas E. Baker, An Introduction to Federal Court Rulemaking Procedure, 22 Tex. Tech. L. Rev. 323 (1991). See also, Laurens Walker, A Comprehensive Reform For Federal Civil Rulemaking, 61 Geo. Wash. L. Rev. 455 (1993).

[55] A Self-Study of Federal Judicial Rulemaking, A Report from the Subcommittee on Long Range Planning to the Committee on Rules of Practice, Procedure and Evidence of the Judicial Conference of the United States 16 (December 1995).

[56] Id.

ence under the Civil Justice Reform Act of 1990 might effectively be used in rulemaking."[57] The Report notes that several provisions of the 1990 Act created noteworthy opportunities for data collection regarding district court practices.[58]

Third, the Report also recommends to the Advisory Committee on the Civil Rules that the Committee "should assess the effects of creating local options in the national rules."[59] The Report explains that "[a]s part of the 1993 amendments to the Federal Rules of Civil Procedure, districts were afforded the discretion to opt-in or opt-out of various discovery rule changes. The resulting patchwork provides the equivalent of field experiments in the effectiveness of the optioned rules changes."[60] These three recommendations are a significant step toward the first official endorsement of an empirical approach in the history of federal judicial rulemaking.

B. Sampling and Inferential Statistics

The use of sampling and inferential statistics is among the most common aspects of science. According to Earl Babbie, "[t]he ultimate purpose of sampling is to select a set of elements from a population in such a way that descriptions of those elements (statistics) accurately portray the parameters of the total population from which the elements are selected."[61] It is often impossible or impractical to measure every person or thing in the large group (or "population") in which one is interested (e.g., every voter in the country). Sampling allows a researcher to select only a portion of the large group (the "sample") for measurement. Inferential statistics permit a researcher to estimate how well results obtained with this sample can be generalized back to the larger population of interest.[62]

The scientific evidence at issue in the *Daubert* case itself relied heavily upon sampling and the use of inferential statistics. Merrell Dow relied on epidemiological proof to suggest there is no

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[57] Id. at 17.
[58] Id. at 16-17.
[59] Id. at 17.
[60] Id.
[61] Earl Babbie, The Practice of Social Research 144 (4th ed., 1986).
[62] See id. at 413-25 (describing the methodology and use of inferential statistics).

connection between maternal use of Bendectin and limb reduction defects.[63] The method of these studies typically involves a comparison of disease rates between groups of persons—a comparison which requires sampling and the use of inferential statistics.[64] The *Reference Manual* contains a reference guide on Survey Research written by Shari Diamond. The guide describes the virtues of the survey method:

> Although surveys may count or measure every member of the relevant *population* (e.g., all plaintiffs eligible to join in a suit, all employees currently working for a corporation, all trees in a forest), *sample surveys* count or measure only a portion of the objects, individuals, or social organisms that the survey is intended to describe . . . . When properly designed, executed, and described, surveys (1) economically present the characteristics of a large group of objects or respondents and (2) permit an assessment of the extent to which the measured objects or respondents are likely to adequately represent a relevant group of objects, individuals, or social organisms.[65]

The *Reference Manual* also contains a Reference Guide on Statistics by David Kaye and David Freedman that details in step-by-step fashion how to draw inferences from sample data to populations of interest.[66] Given these precedential and educational developments, the openness of courts to the use of sampling and inferential statistics may be on the rise.

One area of law where a new receptivity to the use of sampling and inferential statistics would have important effects is mass torts. According to Michael Saks and Peter Blanck:

> Mass torts represent a sampling theorist's dream. The population of cases from which the sample is to be drawn is known with unusual completeness. This provides the *sampling frame*

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[63] *Daubert*, 727 F. Supp. at 575.

[64] Linda Bailey et al., Reference Guide on Epidemiology *in* Reference Manual, supra note 8, at 121, 127.

[65] Shari S. Diamond, Reference Guide on Survey Research *in* Reference Manual, supra note 8, at 221, 225-26.

[66] David H. Kaye & David A. Freeman, Reference Guide on Statistics *in* Reference Manual, supra note 8, at 331. There is also a reference guide on Multiple Regression, by Daniel Rubinfeld, that similarly deals with issues of inferential statistics. Daniel L. Rubinfeld, Reference Guide on Multiple Regression *in* Reference Manual, supra note 8, at 415.

> from which any type of case sampling proceeds. In addition, many details are known or can be learned about each member of the population. Thus, the degree to which the sample is representative of the population can be known with near certainty—a great improvement over most sampling situations.[67]

Courts are beginning to respond to this "sampling theorist's dream." Consider three recent cases in which courts have employed sampling to solve the problems posed by a population of thousands of plaintiffs. In *Cimino v. Raymark Industries*,[68] Judge Robert Parker employed sampling as a key process in his effort to resolve the claims of more than two thousands persons who claimed damages as a result of exposure to asbestos. The court selected a random sample from each of several disease categories and then tried the sample cases in order to determine the damages due all of the class members. Each plaintiff whose damage claim was submitted to the jury was awarded the amount of the individual verdict, while each non-sample class member was awarded the average verdict for the relevant disease category.[69] The plaintiffs agreed to the sampling procedure, but the defendants objected vigorously, claiming a right to individual adjudication of the damage claims of all class members.[70]

In *Watson v. Shell Oil Company*,[71] the court of appeals approved a trial court plan intended to resolve the punitive damage aspect of some eighteen thousand cases arising from an explosion at a manufacturing facility. According to that plan, twenty sample cases would be tried and the jury would be asked to decide the amount of actual damages as well as the amount of punitive damages. The trial court then proposed to use the results of these twenty cases to determine a ratio of punitive damages to actual damages and proposed to use this ratio to award punitive damages after determination of actual damages in the individual cases. The Fifth Circuit approved the plan.[72]

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[67] Michael J. Saks & Peter D. Blanck, Justice Improved: The Unrecognized Benefits of Aggregation and Sampling in the Trial of Mass Torts, 44 Stan. L. Rev. 815, 841 (1992).

[68] 751 F. Supp. 649 (E.D. Tex. 1990).

[69] Id. at 653.

[70] Id. at 665.

[71] 979 F.2d 1014 (5th Cir. 1992).

[72] Id. at 1018-20. However, a distinction was drawn between the *Watson* case and

In *In re Estate of Ferdinand E. Marcos Human Rights Litigation*,[73] a class action suit against the estate of Ferdinand Marcos, former President of the Philippines, by persons claiming to have suffered injuries during the Marcos regime, Judge Manuel Real employed sampling to determine compensatory damages.[74] The trial was divided into three phases—liability, exemplary damages, and compensatory damages. In the compensatory damages phase, Judge Real allowed the jury to hear evidence of damages from a random sample of plaintiffs in three subclasses.[75] According to Judge Real, "[p]ragmatically, the jury could not hear testimony of nearly 10,000 plaintiffs in this action within any practicable and reasonable time, to do justice to the class members."[76]

Daubert and the resulting wave of judicial education about science may incline courts in the direction of considerably greater use of sampling and inferential statistics. Practices such as these used in *Cimino*, *Watson* and *Marcos Human Rights Litigation* may be more routinely employed in the future. Judges who follow *Daubert* and read the *Reference Manual* will come to understand that the sampling process is a practical solution both for collecting scientific data and for determining the amount of damages in cases involving hundreds or thousands of plaintiffs.[77]

C. Simulation Research

Simulation research is a third facet of science that is likely to receive greater judicial acceptance in the wake of *Daubert* and

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the asbestos litigation: "We find the instant case distinguishable . . . because the . . . jury is to make a determination about punitive damages in a mass-disaster context, rather than compensatory damages in products liability litigation." Id. at 1019.

[73] In re Estate of Ferdinand E. Marcos Human Rights Litigation, 910 F. Supp. 1460 (D. Haw., 1995).

[74] "Of the 137 randomly sampled claims, 67 were torture victims, 52 were execution victims and 18 were disappearance victims." Id. at 1464, 1466.

[75] Id. at 1462.

[76] Id.

[77] In a related development, the United Nations Compensation Commission, established to determine claims against Iraq resulting from its invasion of Kuwait, has made widespread use of scientific practices, including sampling, to resolve the over 2.5 million claims. See Frances E. McGovern, The Intellectual Heritage of Claims Processing at the United Nations Compensation Commission in the United Nations Claim Commission 187 (Thirteenth Sokol Colloquium, Richard Lillich, ed., 1995).

the *Reference Manual.* Simulation, or "laboratory" research, has been defined as "the exercise of a flexible imitation of processes and outcomes for the purpose of clarifying or explaining the underlying mechanisms involved."[78] The use of simulation pervades both the physical and social sciences. As Shari Diamond has stated, "[a]stronauts walked on the moon because planning research was able to study in the laboratory much of what would be encountered in space."[79]

Indeed, some of the research at issue in *Daubert* used simulation techniques: studies using Bendectin on animal "subjects" were extrapolated to human subjects, i.e., the plaintiffs.[80] The *Reference Manual* details the potential benefits of simulation studies in the law. In the Reference Guide on Epidemiology, Linda Bailey, Leon Gordess, and Michael Greene state:

> In addition to observational epidemiology, *toxicology* models based on animal studies (*in vivo*) may be used to determine toxicity in humans. Animal studies have a number of advantages. They can be conducted as experiments, and researchers control all aspects of the animals' lives. This avoids the problem of confounding, which epidemiology often confronts. Exposure can be carefully controlled and measured. Ethical limitations are diminished and animals can be sacrificed, which may improve the accuracy of disease assessment. Animal studies often provide useful information about pathological mechanisms and play a complementary role to epidemiology by assisting in framing hypotheses and in developing study designs for epidemiological studies."[81]

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[78] Robert P. Abelson, Simulation of Social Behavior *in* 2 The Handbook of Social Psychology 274, 275 (Gardner Lindzey & Elliot Aronson eds., 2d ed., 1968) (emphasis omitted).

[79] Shari S. Diamond, Simulation: Does the Microscope Lens Distort? 3 Law and Human Behavior 1, 1 (1979).

[80] 727 F. Supp. 570, 574-75 (S.D.Cal. 1989).

[81] Linda A. Bailey et al., Reference Guide on Epidemiology *in* Reference Manual, supra note 8, at 129-30. The authors also point out that simulation studies have disadvantages, particularly that the results must be extrapolated to human beings, a different species with different physical characteristics. Id. In the Reference Guide on Toxicology written by Bernard D. Goldstein and Mary Sue Henifin, the authors describe as one of the central tenants of toxicology that "the responses of laboratory animals are useful predictors of toxic responses in humans." Bernard D. Goldstein & Mary S. Henefin, Reference Guide on Toxicology *in* Reference Manual, supra note 8, at 185. They too point out the questions involved in extrapolation from one species

Recently, the Arizona Supreme Court Committee on More Effective Use of Juries has relied on social science research, including several simulation studies, to propose expanded use of preliminary jury instruction. "Research shows that telling jurors more, rather than less, in advance of the evidence assists the jurors in understanding and organizing the evidence as they hear it, improves their recall of evidence, reduces the chances that the jurors will apply the wrong rules to the evidence and increases juror satisfaction."[82]

Similarly, recent decisions by two state Supreme Courts have highlighted other potential uses of social science laboratory simulations in the law. In *Mitchell v. Gonzales*[83], the California Supreme Court held that a trial court erred when it gave the jury a pattern instruction on "proximate cause."[84] The court based this holding largely on the results of jury simulation studies in which persons who read this instruction were "befuddled" as to its meaning. For example, "in one experiment, 'the term "proximate cause" was misunderstood by 23% of the subjects . . . They interpreted it as "approximate cause," "estimated cause," or some fabrication.'"[85] In People v. Allen,[86] the Supreme Court of Michigan amended the Michigan Rule of Evidence dealing with the practice of impeaching criminal defen-

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to another. Id. at 187.

[82] Jurors: The Power of 12, Report of The Arizona Supreme Court Committee on More Effective Use of Juries 81 (1994). Judge B. Michael Dann, Chairman of the Supreme Court's Committee, has elsewhere called for widespread use of social science research to reform juries. See B. Michael Dann, "Learning Lessons" and "Speaking Rights": Creating Educated and Democratic Juries, 68 Ind. L. J. 1229, 1278 (1993) ("The legal profession's traditional bias against social science research and its results should be reexamined and modified, if not discarded altogether"). For an early use of simulation research about jury instructions, see Harvey S. Perlman, Pattern Jury Instructions: The Application of Social Science Research, 65 Neb. L. Rev. 520 (1986) (describing the drafting of Alaska civil and federal criminal jury instructions).

[83] 819 P.2d 872 (1991).

[84] The instruction in question (BAJI No. 3.75) had read:

> A proximate cause of [injury] [damage] [loss] [or] [harm] is a cause which, in natural and continuous sequence, produces the [injury] [damage] [loss] [or] [harm] and without which the [injury] [damage] [loss] [or] [harm] would not have occurred.

Id. at 873.

[85] Id. at 877-78 (citing Robert P. Charrow and Veda R. Charrow, Making Legal Language Understandable: A Psycholinguistic Study of Jury Instructions, 79 Colum. L. Rev. 1306, 1353 (1979).

[86] 420 N.W.2d 499 (1988).

dants by prior conviction. It did so after citing several jury simulation experiments done with undergraduate students as subjects, demonstrating that "there is an 'overwhelming probability' that most prior conviction evidence introduced for the purpose of impeachment will be considered as if it had been introduced to show that the defendant acted in conformity with his criminal past."[87] The simulation studies, the majority held, are "relevant, support our view, and deserve consideration."[88]

CONCLUSION

The fixation by commentators on the implications of *Daubert* for the "admissibility" of scientific evidence is unfortunate. The *Daubert* case opens vistas for the use of science in law that stretch far beyond narrow evidentiary "tests." Arm-in-arm with the Federal Judicial Center's *Reference Manual*, *Daubert* is likely to herald a new receptivity to science in American law. While the precise contours of this openness are not easy to discern, three facets of science seem most easily absorbed into the legal process. The empirical approach of science will be readily incorporated in a range of law-making ventures, including techniques for adopting many types of court rules. Judicial fact-gathering practices founded on random sampling and inferential statistics, rather than individualized adjudication, will come to be routinely accepted, particularly in the resolution of mass tort cases. And simulation research will gain increased respect as a basis for judicial decision-making in areas such as jury instructions. We predict that these and other common practices of science will become common practices of law, resolving decades of costly uncertainty about how courts can learn about the real world. In our view this development is clearly beneficial, rendering *Daubert* and the *Reference Manual*, together, a very conspicuous landmark along the path of science in law.

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[87] Id. at 510 (citing Richardson v. Marsh, 481 U.S. 200 (1987)).

[88] Id. at 580, but see Matter of Personal Restraint of Lord, 868 P.2d 835, 855 (Wash. 1994) ("It would be somewhat anomalous to allow the verdict to be impeached with evidence that members of the public who were not jurors, but who participated in an empirical study of jury instructions, would have misunderstood the same instructions.").