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Introduction

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IN THIS AGE OF SCIENCE, SCIENCE SHOULD EXPECT TO find a warm welcome, perhaps a permanent home, in our courtrooms. The reason is a simple one. The legal disputes before us increasingly involve the principles and tools of science. Proper resolution of those disputes matters not just to the litigants, but also to the general public—those who live in our technologically complex society and whom the law must serve. Our decisions should reflect a proper scientific and technical understanding so that the law can respond to the needs of the public.

Consider, for example, how often our cases today involve statistics—a tool familiar to social scientists and economists but, until our own generation, not to many judges. In 2007, the U.S. Supreme Court heard *Zuni Public Schools District No. 89 v. Department of Education*,[1] in which we were asked to interpret a statistical formula to be used by the U.S. Secretary of Education when determining whether a state's public school funding program "equalizes expenditures" among local school districts. The formula directed the Secretary to "disregard" school districts with "per-pupil expenditures . . . above the 95th percentile or below the 5th percentile of such expenditures . . . in the State." The question was whether the Secretary, in identifying the school districts to be disregarded, could look to the number of pupils in a district as well as the district's expenditures per pupil. Answering that question in the affirmative required us to draw upon technical definitions of the term "percentile" and to consider five different methods by which one might calculate the percentile cutoffs.

In another recent Term, the Supreme Court heard two cases involving consideration of statistical evidence. In *Hunt v. Cromartie*,[2] we ruled that summary judgment was not appropriate in an action brought against various state officials, challenging a congressional redistricting plan as racially motivated in violation of the Equal Protection Clause. In determining that disputed material facts existed regarding the motive of the state legislature in redrawing the redistricting plan, we placed great weight on a statistical analysis that offered a plausible alternative interpretation that did not involve an improper racial motive. Assessing the plausibility of this alternative explanation required knowledge of the strength of the statistical correlation between race and partisanship, understanding of the consequences of restricting the analysis to a subset of precincts, and understanding of the relationships among alternative measures of partisan support.

In *Department of Commerce v. United States House of Representatives*,[3] residents of a number of states challenged the constitutionality of a plan to use two forms of statistical sampling in the upcoming decennial census to adjust for expected "undercounting" of certain identifiable groups. Before examining the constitutional issue, we had to determine if the residents challenging the plan had standing to sue because of injuries they would be likely to suffer as a result of the sampling

1. 127 S. Ct. 1534 (2007).
2. 119 S. Ct. 1545 (1999).
3. 119 S. Ct. 765 (1999).

plan. In making this assessment, it was necessary to apply the two sampling strategies to population data in order to predict the changes in congressional apportionment that would most likely occur under each proposed strategy. After resolving the standing issue, we had to determine if the statistical estimation techniques were consistent with a federal statute.

In each of these cases, we judges were not asked to become expert statisticians, but we were expected to understand how the statistical analyses worked. Trial judges today are asked routinely to understand statistics at least as well, and probably better.

But science is far more than tools, such as statistics. And that "more" increasingly enters directly into the courtroom. The Supreme Court, for example, has recently decided cases involving basic questions of human liberty, the resolution of which demanded an understanding of scientific matters. Recently we were asked to decide whether a state's method of administering a lethal injection to condemned inmates constituted cruel and unusual punishment in violation of the Eighth Amendment.[4] And in 1997, we were asked to decide whether the Constitution protects a right to physician-assisted suicide.[5] Underlying the legal questions in these cases were medical questions: What effect does a certain combination of drugs, administered in certain doses, have on the human body, and to what extent can medical technology reduce or eliminate the risk of dying in severe pain? The medical questions did not determine the answer to the legal questions, but to do our legal job properly, we needed to develop an informed—although necessarily approximate—understanding of the science.

Nor were the lethal-injection and "right-to-die" cases unique in this respect. A different case concerned a criminal defendant who was found to be mentally competent to stand trial but not mentally competent to represent himself. We held that a state may insist that such a defendant proceed to trial with counsel.[6] Our opinion was grounded in scientific literature suggesting that mental illness can impair functioning in different ways, and consequently that a defendant may be competent to stand trial yet unable to carry out the tasks needed to present his own defense.

The Supreme Court's docket is only illustrative. Scientific issues permeate the law. Criminal courts consider the scientific validity of, say, DNA sampling or voiceprints, or expert predictions of defendants' "future dangerousness," which can lead courts or juries to authorize or withhold the punishment of death. Courts review the reasonableness of administrative agency conclusions about the safety of a drug, the risks attending nuclear waste disposal, the leakage potential of a toxic waste dump, or the risks to wildlife associated with the building of a dam. Patent law cases can turn almost entirely on an understanding of the underlying technical

4. Baze v. Rees, 128 S. Ct. 1520 (2008).
5. Washington v. Glucksberg, 521 U.S. 702 (1997); Vacco v. Quill, 521 U.S. 793 (1997).
6. Indiana v. Edwards, 128 S. Ct. 2379 (2008).

or scientific subject matter. And, of course, tort law often requires difficult determinations about the risk of death or injury associated with exposure to a chemical ingredient of a pesticide or other product.

The importance of scientific accuracy in the decision of such cases reaches well beyond the case itself. A decision wrongly denying compensation in a toxic substance case, for example, can not only deprive the plaintiff of warranted compensation but also discourage other similarly situated individuals from even trying to obtain compensation and encourage the continued use of a dangerous substance. On the other hand, a decision wrongly granting compensation, although of immediate benefit to the plaintiff, can improperly force abandonment of the substance. Thus, if the decision is wrong, it will improperly deprive the public of what can be far more important benefits—those surrounding a drug that cures many while subjecting a few to less serious risk, for example. The upshot is that we must search for law that reflects an understanding of the relevant underlying science, not for law that frees companies to cause serious harm or forces them unnecessarily to abandon the thousands of artificial substances on which modern life depends.

The search is not a search for scientific precision. We cannot hope to investigate all the subtleties that characterize good scientific work. A judge is not a scientist, and a courtroom is not a scientific laboratory. But consider the remark made by the physicist Wolfgang Pauli. After a colleague asked whether a certain scientific paper was wrong, Pauli replied, "That paper isn't even good enough to be wrong!"[7] Our objective is to avoid legal decisions that reflect that paper's so-called science. The law must seek decisions that fall within the boundaries of scientifically sound knowledge.

Even this more modest objective is sometimes difficult to achieve in practice. The most obvious reason is that most judges lack the scientific training that might facilitate the evaluation of scientific claims or the evaluation of expert witnesses who make such claims. Judges typically are generalists, dealing with cases that can vary widely in subject matter. Our primary objective is usually process-related: seeing that a decision is reached fairly and in a timely way. And the decision in a court of law typically (though not always) focuses on a particular event and specific individualized evidence.

Furthermore, science itself may be highly uncertain and controversial with respect to many of the matters that come before the courts. Scientists often express considerable uncertainty about the dangers of a particular substance. And their views may differ about many related questions that courts may have to answer. What, for example, is the relevance to human cancer of studies showing that a substance causes some cancers, perhaps only a few, in test groups of mice or rats? What is the significance of extrapolations from toxicity studies involving high doses to situations where the doses are much smaller? Can lawyers or judges or anyone else expect scientists always to be certain or always to have uniform views

7. Peter W. Huber, Galileo's Revenge: Junk Science in the Courtroom 54 (1991).

with respect to an extrapolation from a large dose to a small one, when the causes of and mechanisms related to cancer are generally not well known? Many difficult legal cases fall within this area of scientific uncertainty.

Finally, a court proceeding, such as a trial, is not simply a search for dispassionate truth. The law must be fair. In our country, it must always seek to protect basic human liberties. One important procedural safeguard, guaranteed by our Constitution's Seventh Amendment, is the right to a trial by jury. A number of innovative techniques have been developed to strengthen the ability of juries to consider difficult evidence.[8] Any effort to bring better science into the courtroom must respect the jury's constitutionally specified role—even if doing so means that, from a scientific perspective, an incorrect result is sometimes produced.

Despite the difficulties, I believe there is an increasingly important need for law to reflect sound science. I remain optimistic about the likelihood that it will do so. It is common to find cooperation between governmental institutions and the scientific community where the need for that cooperation is apparent. Today, as a matter of course, the President works with a science adviser, Congress solicits advice on the potential dangers of food additives from the National Academy of Sciences, and scientific regulatory agencies often work with outside scientists, as well as their own, to develop a product that reflects good science.

The judiciary, too, has begun to look for ways to improve the quality of the science on which scientifically related judicial determinations will rest. The Federal Judicial Center is collaborating with the National Academy of Sciences through the Academy's Committee on Science, Technology, and Law.[9] The Committee brings together on a regular basis knowledgeable scientists, engineers, judges, attorneys, and corporate and government officials to explore areas of interaction and improve communication among the science, engineering, and legal communities. The Committee is intended to provide a neutral, nonadversarial forum for promoting understanding, encouraging imaginative approaches to problem solving, and discussing issues at the intersection of science and law.

In the Supreme Court, as a matter of course, we hear not only from the parties to a case but also from outside groups, which file amicus curiae briefs that help us to become more informed about the relevant science. In the "right-to-die" case, for example, we received about 60 such documents from organizations of doctors, psychologists, nurses, hospice workers, and handicapped persons, among others. Many discussed pain-control technology, thereby helping us to identify areas of technical consensus and disagreement. Such briefs help to educate the justices on potentially relevant technical matters, making us not experts, but moderately educated laypersons, and that education improves the quality of our decisions.

8. *See generally* Jury Trial Innovations (G. Thomas Munsterman et al. eds., 1997).

9. A description of the program can be found at Committee on Science, Technology, and Law, http://www.nationalacademies.org/stl (last visited Aug. 10, 2011).

Moreover, our Court has made clear that the law imposes on trial judges the duty, with respect to scientific evidence, to become evidentiary gatekeepers.[10] The judge, without interfering with the jury's role as trier of fact, must determine whether purported scientific evidence is "reliable" and will "assist the trier of fact," thereby keeping from juries testimony that, in Pauli's sense, isn't even good enough to be wrong. This requirement extends beyond scientific testimony to all forms of expert testimony.[11] The purpose of *Daubert*'s gatekeeping requirement "is to make certain that an expert, whether basing testimony upon professional studies or personal experience, employs in the courtroom the same level of intellectual rigor that characterizes the practice of an expert in the relevant field."[12]

Federal trial judges, looking for ways to perform the gatekeeping function better, increasingly have used case-management techniques such as pretrial conferences to narrow the scientific issues in dispute, pretrial hearings where potential experts are subject to examination by the court, and the appointment of specially trained law clerks or scientific special masters. For example, Judge Richard Stearns of Massachusetts, acting with the consent of the parties in a highly technical genetic engineering patent case,[13] appointed a Harvard Medical School professor to serve "as a sounding board for the court to think through the scientific significance of the evidence" and to "assist the court in determining the validity of any scientific evidence, hypothesis or theory on which the experts base their testimony."[14] Judge Robert E. Jones of Oregon appointed experts from four different fields to help him assess the scientific reliability of expert testimony in silicone gel breast implant litigation.[15] Judge Gladys Kessler of the District of Columbia hired a professor of environmental science at the University of California at Berkeley "to answer the Court's technical questions regarding the meaning of terms, phrases, theories and rationales included in or referred to in the briefs and exhibits" of the parties.[16] Judge A. Wallace Tashima of the Ninth Circuit has described the role of technical advisor as "that of a … tutor who aids the court in understanding the 'jargon and theory' relevant to the technical aspects of the evidence."[17]

Judge Jack B. Weinstein of New York suggests that courts should sometimes "go beyond the experts proffered by the parties" and "appoint indepen-

10. Gen. Elec. Co. v. Joiner, 522 U.S. 136 (1997); Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579 (1993).

11. Kumho Tire Co. v. Carmichael, 119 S. Ct. 1167 (1999).

12. *Id*. at 1176.

13. Biogen, Inc. v. Amgen, Inc., 973 F. Supp. 39 (D. Mass. 1997).

14. MediaCom Corp. v. Rates Tech., Inc., 4 F. Supp. 2d 17 app. B at 37 (D. Mass. 1998) (quoting the Affidavit of Engagement filed in Biogen, Inc. v. Amgen, Inc., 973 F. Supp. 39 (D. Mass. 1997) (No. 95-10496)).

15. Hall v. Baxter Healthcare Corp., 947 F. Supp. 1387 (D. Or. 1996).

16. Conservation Law Found. v. Evans, 203 F. Supp. 2d 27, 32 (D.D.C. 2002).

17. Ass'n of Mexican-American Educators v. State of California, 231 F.3d 572, 612 (9th Cir. 2000) (en banc) (Tashima, J., dissenting).

dent experts" as the Federal Rules of Evidence allow.[18] Judge Gerald Rosen of Michigan appointed a University of Michigan Medical School professor to testify as an expert witness for the court, helping to determine the relevant facts in a case that challenged a Michigan law prohibiting partial-birth abortions.[19] Chief Judge Robert Pratt of Iowa hired two experts—a professor of insurance and an actuary—to help him review the fairness of a settlement agreement in a complex class-action insurance-fraud case.[20] And Judge Nancy Gertner of Massachusetts appointed a professor from Brandeis University to assist the court in assessing a criminal defendant's challenge to the racial composition of the jury venire in the Eastern Division of the District of Massachusetts.[21]

In what one observer has described as "the most comprehensive attempt to incorporate science, as scientists practice it, into law,"[22] Judge Sam Pointer, Jr., of Alabama appointed a "neutral science panel" of four scientists from different disciplines to prepare a report and testimony on the scientific basis of claims in silicone gel breast implant product liability cases consolidated as part of a multidistrict litigation process.[23] The panel's report was cited in numerous decisions excluding expert testimony that connected silicone gel breast implants with systemic injury.[24] The scientists' testimony was videotaped and made part of the record so that judges and jurors could consider it in cases returned to the district courts from the multidistrict litigation process. The use of such videotape testimony can result in more consistent decisions across courts, as well as great savings of time and expense for individual litigants and courts.

These case-management techniques are neutral, in principle favoring neither plaintiffs nor defendants. When used, they have typically proved successful. Nonetheless, judges have not often invoked their rules-provided authority to appoint their own experts.[25] They may hesitate simply because the process is unfamiliar or because the use of this kind of technique inevitably raises questions. Will use of an independent expert, in effect, substitute that expert's judgment for that of the court? Will it inappropriately deprive the parties of control over the presentation of the case? Will it improperly intrude on the proper function of the jury? Where is one to find a truly neutral expert? After all, different experts, in total honesty, often interpret the same data differently. Will the search for the expert

18. Jack B. Weinstein, Individual Justice in Mass Tort Litigation: The Effect of Class Actions, Consolidations, and Other Multiparty Devices 116 (1995).

19. Evans v. Kelley, 977 F. Supp. 1283 (E.D. Mich. 1997).

20. Grove v. Principal Mutual Life Ins. Co., 200 F.R.D. 434, 443 (S.D. Iowa 2001).

21. United States v. Green, 389 F. Supp. 2d 29, 48 (D. Mass. 2005).

22. Olivia Judson, *Slide-Rule Justice,* Nat'l J., Oct. 9, 1999, at 2882, 2885.

23. *In re* Silicone Gel Breast Implant Prod. Liab. Litig., Order 31 (N.D. Ala. filed May 30, 1996) (MDL No. 926).

24. *See* Laura L. Hooper et al., *Assessing Causation in Breast Implant Litigation: The Role of Science Panels,* 64 Law & Contemp. Probs. 139, 181 n.217 (collecting cases).

25. Joe S. Cecil & Thomas E. Willging, *Accepting Daubert's Invitation: Defining a Role for Court-Appointed Experts in Assessing Scientific Validity,* 43 Emory L.J. 995, 1004 (1994).

create inordinate delay or significantly increase costs? Who will pay the expert? Judge William Acker, Jr., of Alabama writes:

> Unless and until there is a national register of experts on various subjects and a method by which they can be fairly compensated, the federal amateurs wearing black robes will have to overlook their new gatekeeping function lest they assume the intolerable burden of becoming experts themselves in every discipline known to the physical and social sciences, and some as yet unknown but sure to blossom.[26]

A number of scientific and professional organizations have come forward with proposals to aid the courts in finding skilled experts. The National Conference of Lawyers and Scientists, a joint committee of the American Association for the Advancement of Science (AAAS) and the Science and Technology Section of the American Bar Association, has developed a program to assist federal and state judges, administrative law judges, and arbitrators in identifying independent experts in cases that present technical issues, when the adversarial system is unlikely to yield the information necessary for a reasoned and principled resolution of the disputed issues. The program locates experts through professional and scientific organizations and with the help of a Recruitment and Screening Panel of scientists, engineers, and health care professionals.[27]

The Private Adjudication Center at Duke University—which unfortunately no longer exists—established a registry of independent scientific and technical experts who were willing to provide advice to courts or serve as court-appointed experts.[28] Registry services also were available to arbitrators and mediators and to parties and lawyers who together agreed to engage an independent expert at the early stages of a dispute. The registry recruited experts primarily from major academic institutions and conducted targeted searches to find experts with the qualifications required for particular cases. Registrants were required to adhere to a code of conduct designed to ensure confidence in their impartiality and integrity.

Among those judges who have thus far experimented with court-appointed scientific experts, the reaction has been mixed, ranging from enthusiastic to disappointed. The Federal Judicial Center has examined a number of questions arising from the use of court-appointed experts and, based on interviews with participants in Judge Pointer's neutral science panel, has offered lessons to guide courts in future cases. We need to learn how better to identify impartial experts, to screen for possible conflicts of interest, and to instruct experts on the scope of

26. Letter from Judge William Acker, Jr., to the Judicial Conference of the United States et al. (Jan. 2, 1998).

27. Information on the AAAS program can be found at Court Appointed Scientific Experts, http://www.aaas.org/spp/case/case.htm (last visited Aug. 10, 2011).

28. Letter from Corinne A. Houpt, Registry Project Director, Private Adjudication Center, to Judge Rya W. Zobel, Director, Federal Judicial Center (Dec. 29, 1998) (on file with the Research Division of the Federal Judicial Center).

their duties. Also, we need to know how better to protect the interests of the parties and the experts when such extraordinary procedures are used. We also need to know how best to prepare a scientist for the sometimes hostile legal environment that arises during depositions and cross-examination.[29]

It would also undoubtedly be helpful to recommend methods for efficiently educating (i.e., in a few hours) willing scientists in the ways of the courts, just as it would be helpful to develop training that might better equip judges to understand the ways of science and the ethical, as well as practical and legal, aspects of scientific testimony.[30]

In this age of science we must build legal foundations that are sound in science as well as in law. Scientists have offered their help. We in the legal community should accept that offer. We are in the process of doing so. This manual seeks to open legal institutional channels through which science—its learning, tools, and principles—may flow more easily and thereby better inform the law. The manual represents one part of a joint scientific–legal effort that will further the interests of truth and justice alike.

29. Laura L. Hooper et al., Neutral Science Panels: Two Examples of Panels of Court-Appointed Experts in the Breast Implants Product Liability Litigation 93–98 (Federal Judicial Center 2001); Barbara S. Hulka et al., *Experience of a Scientific Panel Formed to Advise the Federal Judiciary on Silicone Breast Implants,* 342 New Eng. J. Med. 812 (2000).

30. Gilbert S. Omenn, *Enhancing the Role of the Scientific Expert Witness,* 102 Envtl. Health Persp. 674 (1994).