LAW AND SCIENCE: THE TESTING OF JUSTICE

*PAULINE NEWMAN**

Scientific Truth in the Courtroom

The communities of scientists and judges have a common interest: the search for truth. Yet there is continuing debate about the conduct of that search in the courtroom, and doubts about whether the truths of science and technology can be found there. Indeed, the debate enlarges with our increasing dependency on science and technology, in industry, in commerce, and in daily life. Disputed issues involving questions of science and technology require full access to the rule of law, with its protection of private rights and public interest, its safeguards to litigants, its openness, and its checks and balances. There must be confidence that the adjudicative process can provide the correct and just resolution. Indeed, absence of such confidence can affect the direction of our economy and our culture.

We are experiencing what has been called the twin revolutions—in science and technology and in social expectations. Much of today's lawmaking and regulation derives from advances in science and technology, as do our enhanced expectations of ameliorating the social abuses of the past. The courts, mirroring society, are confronting the impact of these advances, including their implications for the laws of property, privacy, and liberty. The courts are receiving science-based disputes for which there is little legal precedent, adding fresh challenges to the administration of justice. As our culture becomes increasingly dependent on the products of scientific advance, the content and mechanisms of science move farther from ordinary experience and comprehension. In Thomas Jefferson's day the study of natural philosophy was part of the liberal curriculum. Today we litigate questions whose scientific framework strains even persons in the same discipline. With this increasing complexity, the gap between the "two cultures" is continuing to widen. My thesis is that judges have a special obligation to bridge that gap, working with scientists for mutual understanding, so that differences that today can distort the search for truth may instead serve to guide it.

* Judge, United States Court of Appeals for the Federal Circuit.

The time has ripened for mutual understanding, after so many years of unproductive tension—in the courtroom as in society at large. I discern, in this generation, a shift toward broader appreciation of the capability and objectivity of science, a renewed interest in understanding its modalities. Any displacement of the subjectivity and variability of past cultural standards is of relevance to the judicial process. We shall never return to a society that is not pulled and pushed by scientific knowledge and its applications.

New legal issues that turn on questions of science and technology are intermingled with far-reaching policy concerns. Such issues often reach the courts before either the science or the policy has been fully developed. For example, the fields of electronic information and DNA-based biology raise familiar issues of privacy and intellectual property, but these issues take on fresh contours in these previously unexplored contexts. The new capabilities of science and technology raise new concerns for constitutional, personal, and commercial rights. If judges are to respond to these concerns, to find the truth in adjudication, we must sufficiently understand the science and technology.[1] No matter how finely tuned our "judicial intuition," in the words of Justice Cardozo, disputes that turn on scientific fact require more than the traditional judicial tools of reasoned analysis, an instinct for credibility, and worldly experience. We must also understand the subject matter.

In acting to achieve this understanding, judges should, and can, learn to meet the scientists on their own ground. Judges should, and can, learn enough about science and its methodologies to bring independent judgment to the resolution of disputes. With judicial appreciation of how science is done and is brought to practical application, with judicial understanding of scientific certainty, the just resolution of disputes that turn on questions of science and technology is an attainable goal. The challenge to the judiciary will be to preserve the traditional values of the common law, yet accommodate the increasingly powerful presence of science and technology in our culture. Indeed, the law and its guardians may encounter greater difficulty in the search for truth than will the scientists, for law is an imprecise truth, verifiable not in the laboratory but by history. Yet as the subject matter of modern litigation increases in complexity, so does the need to confidently bring the law to the resolution of disputes. The rule of law, and due process of law, permit no less.

1. Technology, in its Greek roots, means the systematic treatment of knowledge. For most purposes of adjudication, policy, science, and technology need not be distinguished.

The Methodology of Science

The protocols of scientific evidence arose primarily in matters of criminal identification. Historically, the forensic issues of fingerprints and lie detectors and blood typing and ballistics, as well as voiceprints and hair analysis and hypnosis, were evaluated for their general acceptance within the scientific community. According to the *Frye*[2] rule, if the scientific community accepted the principle and the method, the judges would admit the evidence. This was a passive role for judges, for it was not necessary for the judge to understand the underlying science. However, civil litigation today includes many issues for which the judge must indeed understand the science in order to decide the case, from toxic torts to patent infringement. Now the burden is on the judge to decide, at the threshold, whether proffered scientific or technologic evidence meets the criteria of validity from the viewpoint of persons in the technical field. The Supreme Court, with the advice of the National Academy of Sciences and the American Association for the Advancement of Science, has instructed the federal judiciary to determine whether such evidence is scientifically accurate, whether it was obtained in accordance with the methodology of science.[3]

The "scientific method" is generally described as proceeding in four stages. It starts with the raising of a question, perhaps arising from an observation of nature or the existence of a problem, perhaps simply an educated curiosity. This is followed by the formulation of a theory, a hypothesis to explain the observation or to shed light on the problem. Scientists usually have a theory before embarking on an experimental program, whether derived from a fixed goal, a creative hunch, or a leap of insight. Even those who conduct an experiment just to see what will happen expect that the result will enlarge their understanding in an area of interest.

The hypothesis is then subjected to empirical testing. Scholars of the method say that if a theory cannot be tested experimentally it is not science. It is implicit that the experimental work must be reproducible and the results verifiable. When the hypothesis is confirmed or adjusted or rejected, the results are tested further by communication to other scientists, generally by publication in an appropriate scientific journal. In accordance with the mandate of *Daubert*, judges are instructed to ascertain whether the proffered

2. Frye v. United States, 293 F. 1013 (D.C. Cir. 1923).

3. *See* Daubert v. Merrell Dow Pharm., Inc., 509 U.S. 579, 592-93 (1993); *see also* Gen. Elec. Co. v. Joiner, 522 U.S. 136 (1997); Kumho Tire Co. v. Carmichael, 526 U.S. 137 (1999).

scientific evidence has been experimentally verified, to review the procedures and evaluate their support for the proposed conclusion, to observe where that conclusion stands against previously established scientific principles, and to consider the acceptance of the work by the scientific community. We are directed to consider the error rate, as would scientists working in the field. We are taught about peer review and the various strata of scientific journals. *Daubert* and subsequent cases explain that the judge, in determining the admissibility of scientific evidence, must bring to bear the same perceptions, the same perspective, the same rigor as would scientists knowledgeable in the discipline. To do so the judge must understand the limits and the strengths of the underlying theory, the assumptions, the analytic procedures, the instruments.

This judicial approach to the evaluation of science as evidence is not free of criticism, as the *Daubert* Court itself recognized. Much has been written explaining to judges that science can be captured by institutions and custom, cautioning that there are scientists' biases and other subjective influences that can taint the value of experimental observations and conclusions. Much has been written on the flaws of peer review as a measure of scientific validity. Critics point out that if Copernicus or Einstein were to present his theories in today's courts, the judges would throw him out—although this was as likely under *Frye* as under *Daubert*. There is always a risk that innovative answers to difficult questions will not be readily accepted by the scientific establishment.

However, judges well understand the principle that the power of science is in its open and continuing exposure to confirmation—called "falsifiability" in *Daubert*. Openness to debate, continuing testing in different situations, and evolutionary change of fundamental concepts, are the strengths of the common law. And, judges are quite used to peer review, whether by higher courts or in myriad critical journals—although I have observed that scholarly review of judicial opinions rarely is directed to the court's scientific analysis, as contrasted with its legal reasoning; such a critical approach is incomplete, for if the court is wrong on the science, the legal reasoning is irrelevant.

Finding of Scientific Facts

How can our traditional system of justice perform the task of finding scientific truth when the scientists dispute the truth in the courtroom? The Supreme Court in *Daubert* and *Kumho Tire* made clear that the judge must assure that only valid scientific evidence is presented before the question of liability is decided. A somewhat

related assignment of judicial responsibility for patent cases was established in *Markman v. Westview Instruments, Inc.*,[4] the Court requiring that the judge construe the scientific/technological scope of the patented invention before the question of liability is decided. Thus the judge, at the threshold of the litigation process, must resolve the issues of science and technology when they are placed in dispute by conflicting technical evidence.

After judicial verification of the validity and admissibility of the scientific evidence, the litigation process proceeds in the traditional mode of adversary litigation, in accordance with the applicable burdens of proof and the criteria of credibility and weight of evidence. Judges must resolve disputes when they reach us, whatever the state of the science. That the next case may be decided differently does not mean that the law is unconcerned with scientific truth; it means only that the law is applied in accordance with the evidence of the moment. Thus the rigors of scientific truth are subordinated to the practicalities of dispute resolution.

Fundamental to this practicality is judicial understanding of the differences between the standards of scientific certainty and legal probability. Scientific facts are not like the traditional facts of lawsuits, found by judges or juries and based on the human components of recollection and credibility and intent. In traditional juridical factfinding there are gradations of truth and falsity, questions of weight and value of evidence. What the law calls facts are matters in which there is a difference of opinion. In contrast, scientific facts are by definition objectively verifiable and consistently reproducible. Despite differences in expert opinion, science tells us that there is only one right answer, even if it has not yet been discovered. What the law calls a fact is most akin to a hypothesis, and what scientists call a fact is really a law. A semantic curiosity, perhaps, but also a signal of the mutual incomprehension between these major forces in today's society. A curious state of affairs: the two cultures, their paths crossing in the corridors of justice, using in their ordinary language opposite definitions of the simple word "fact," and not knowing they are doing so.

Resolution of disputes that require findings of questions of science and technology present a continuing challenge to the judiciary, for the subject matter is often beyond our experience. Nonetheless, most judges are not ready to depart from the traditional procedures of the adversary system. As judges acquire experience with varied scientific and technologic issues in litigation, we

4. 517 U.S. 370 (1996).

learn that many such questions do not have a clear answer; we learn that scientific and technologic evidence is amenable to the traditional criteria of credibility and weight; we learn that litigated issues of science and technology are often driven by societal concerns that are well within judicial cognizance; and we learn that when scientific questions are subjected to the combat of trial, the universality of scientific truth and the vaunted objectivity of its practice are often impeached.

Scientific issues in litigation are usually presented by expert witnesses. However, the mechanisms of the adversary system are at odds with the methods of science, with the result that science and its witnesses often look bad in court. At least, they can be made to look bad. When we put scientific theory and evidence on the witness stand and subject them to cross-examination, by their very nature they are vulnerable to attack. The great strengths of scientific investigation become weaknesses in the courtroom, for inherent in the scientific method is the principle that any theory can be challenged. There is no Supreme Court of scientific law.

The adversary system is well tuned to the challenge of assumptions and inferences, and all science is grounded on assumptions and inferences. Experimentation provides a natural pathway of attack: were the instruments properly calibrated; when were they last checked; were the background conditions stable; how many variables were changed; what experiments were not carried out, and why; were the data correctly recorded, and how and by whom; did the data all fit the curve, or how many outlying points were discarded; was there a statistical analysis of the data; who did it, and how? Data to the scientist is evidence to the lawyer. Thus data are challenged in court that would not be reasonably challenged within the scientific community.

Scientists know that investigation is rarely a smooth progression from hypothesis to publication. Scientists know that the process of probing the unknown is not neat. While scientists thrive on the thrill of discovery, along the way experiments are inconclusive, the data do not fit prediction, results resist reproduction, theories are refined or discarded. Although scientific data and observations are objective in that they should not change with the observer, the path to verified conclusion is lengthy and uncertain. A powerful lesson I learned in my days at the laboratory bench is how long it takes to develop a theory and test it experimentally, and how much longer it takes to be confident of the results. The same institutions that sustain scientific progress and give legitimacy to scientific results understand the erratic path of the enterprise. But when a sci-

entist's progress is scrutinized in court, the strengths of a tolerant and exuberant method that fosters creativity become fodder for aggressive cross-examination. The strengths of scientific endeavor—its uncertainty, evolution, questioning and open-endedness—are weaknesses on the witness stand. When the scientific mind is already open, it can always be pried farther open by a skillful questioner—to the discomfiture of the witness, who is compelled to admit all the things he does not know or did not do or spilled on the floor.

The procedures of trial, the rules of evidence, and the techniques of cross-examination all expose the doubts and uncertainties inherent in the practice of science. However, as judges come to understand that the continuing questioning of results is a strength, not a weakness, of the scientific method, the processes of adjudication should be enhanced, to the larger benefit of both law and science. By its laborious methodology, science has produced a marvelous rigor in the body of knowledge. The explanations of nature, their discovery and proof, are a powerful intellectual achievement, of immeasurable value to modern life. However, the culture of science, aided by the popular press, has persuaded the public that science can and will discover the true picture of the real world. A consequence is that when scientific issues arise in litigation, the judge expects that science and scientists will simply present objective truth. On this expectation, judges find it hard to understand that established scientists can hold opposing views on quite basic questions. With the aura that scientific truth is objective and absolute, having only one correct answer, when judges are presented with differences of scientific opinion, in the form of conflicting expert testimony, we think that someone must be lying.

It is often suggested that the court-appointed expert is the best way to resolve such differences. I agree that neutral advice can be quite helpful. However, scientists and engineers tell us quite frankly that a truly "neutral" expert does not exist, that every scientist and engineer has a viewpoint. Indeed, scientists have far less trouble than do judges in understanding that persons of solid scientific credentials can take opposing positions on the kinds of issues that reach the courtroom. And lawyers complain that since the court-appointed expert is not presenting the view of a party litigant, it is hard to ferret out the expert's inherent biases.

There is a continuing discourse on the virtues and problems of expert witnesses, the pitfalls and pratfalls of scientists as witnesses, the pros and cons of the court-appointed expert. Judges have made only limited usage of court-appointed experts, although they are

authorized in the Federal Rules. Some judges explain that in their experience the presentation by adversary witnesses works well enough, citing the additional cost of another expert, accompanied by concern lest the decision-making role be transferred to the "neutral" expert. However, the recent use of a panel of highly qualified scientists in the breast-implant litigation[5] has brought fresh support for the principle of providing expertise beyond that proffered by the parties, at least in areas of scientific complexity and conflicting evidence.

Judges are skilled at detecting the false witness—but few, I daresay, are able to find the scientific truth when the question is close and the science is beyond our experience. What then is the answer? Although not a practical solution in all cases, and particularly in highly complex fields of science and technology, I return to the proposition that the judge must learn enough of the science or technology he/she is adjudicating to retain independence of decision. The litigation process itself, when effectively tended, can go far to provide the judge with the knowledge needed to resolve most disputes. Adversary procedures can be a very effective forum for judicial education, for by refutation and exhortation of opposing forces, attention and enlightenment can be exhaustively focused on the narrow issue that is dispositive. Within my appellate review of many high-tech patent cases, I have observed that often the judge can achieve knowledge adequate to decide the particular scientific or technologic issue correctly, while preserving the values of the generalist tradition of adjudication.

The generalist tradition provides a breadth of judicial experience that should not lightly be displaced. Indeed, the generalist tradition can be viewed as a judicial contribution to the ongoing discourse, among philosophers of science, about whether science should be viewed as an objective path to truth about nature based on insight and experiment, or as a social activity whose implications are cultural and historical; for in the general law these approaches are melded. A frequent result is that in the grip of the judge charged with application of the law, the rigors of the scientific method may be overwhelmed by the social and cultural values of the institutions of justice.

These values are timeless, and invoke the continuity of history and civilization. Law pervades today's culture, but we use the law as

5. *See* In re Silicone Gel Breast Implant Prods. Liab. Litig. (MDL 926), Report of National Science Panel (November 17, 1998), *available at* http://earth.fjc.gov/BREIMLIT/SCIENCE/report.htm.

it has been used for millennia. Indeed, today's judicial process bears a striking resemblance to that of ancient Greece, where the threshold responsibility to assure the validity of the evidence was on the judge—the role rehabilitated in *Daubert*. The judge would decide what evidence was presented, and by what witnesses. Aristotle cautioned that we should not expect "knowledge," which he defined as proof established beyond challenge, from the lawyer and partisan witnesses, but that we should expect it from the mathematicians—the scientists of the day—who were often called to advise on damages. People with expert knowledge could testify in the Attic tribunals, and Aristotle explained in the *Rhetoric* that the effectiveness of the proof depended on the credentials of the expert. Hearsay was prohibited, but oracles could testify—not unlike today's court-appointed experts.

Law is Not Science

Ultimately, law is revered not for its ability to ferret out objective truth but for its reflection of societal concerns, its powerful moral underpinnings, its sustenance of the ideal of justice. It is to these fundamentals of the law that we look when science presents us with knowledge of such power that there arises a clash of human interests, commercial pressures, intellectual freedom, and cultural values. Law is not science, but these fundamentals are eviscerated if the processes of law can not provide a correct and just resolution of disputes, whatever the subject matter.

There is room, and it is time, to rethink the effect of the changing subject matter to which we apply the law. Even as we attribute the commercial and intellectual and social vigor of the United States to our uniquely American legal philosophy, even as we recognize the hospitality that this philosophy has provided to the progress of science, we must recognize and accommodate the needs of science in the rule of law. The complexity of the interaction between law and science remains to be understood. As we enter this intellectual endeavor with greater urgency, the judge and the scientist must take strong steps to understand each other, the better to serve each other.