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Scientific Experts: Making Their Testimony More Reliable

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SCIENTIFIC EXPERTS: MAKING THEIR TESTIMONY MORE RELIABLE

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During the past seven years the U.S. Supreme Court started to change the rules of evidence with the goal of making expert testimony more reliable. This article analyzes some of the underlying problems and asks whether the effort can succeed.

I. INTRODUCTION

The use of scientific expert witnesses goes back to the Roman Empire.[1] The importance and power of scientific evidence in resolving legal issues is undisputed.[2] However, the role and the scope of expert testimony has been the subject of controversy[3] for more than a hundred years.[4] The testimony of medical experts has always been especially controversial because medicine touches life and death, much of it remains an art, and medical decisions involve subjective values.

During recent years the controversy has focused on the interface be-

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1. The first documented forensic expert report seems to be that of Antisius who was asked to examine the corpse of Julius Caesar and opined that only one of 23 sword wounds was deadly, namely the one perforating his thorax. *See* SUETONIUS, THE LIVES OF THE CAESARS BOOK I 111-13 (J.C. Rolfe trans., 1960).

2. Perhaps, the most dramatic recent example is DNA typing, which offers a far greater level of reliability in identifying individuals than, say, the traditional line-up. *See* NATIONAL INSTITUTE OF JUSTICE, CONVICTED BY JURIES, EXONERATED BY SCIENCE: CASE STUDIES IN THE USE OF DNA EVIDENCE TO ESTABLISH INNOCENCE AFTER TRIAL (visited Mar. 15, 1999) <http://www.ojp.usdoj.gov/search97cgi/s97_cgi>.

3. *See generally* Learned Hand, *Historical and Practical Considerations Regarding Expert Testimony*, 15 HARV. L. REV. 40 (1901); William L. Foster, *Expert Testimony, Prevalent Complaints and Proposed Remedies*, 11 HARV. L. REV. 169 (1897).

4. *See* SHEILA JASANOFF, SCIENCE AT BAR 24-25 (1995).

tween clinical medicine, clinical toxicology and molecular toxicology,[5] epidemiology, survey research, forensic DNA evidence, statistics, and multiple regressions.[6]

It has been claimed that the evidence rules encourage partisan bias and make expert testimony complex and time consuming.[7] In fact, Wigmore vigorously opposed the opinion rule, and claimed that it "has done more than any one rule of procedure to reduce our litigation towards a state of legalized gambling."[8]

Whether expert testimony is necessary is determined by the common sense inquiry. That is to say, whether an untrained lay person would be qualified to determine the particular issue intelligently and to the best possible degree without enlightenment from those having specialized understanding of the subject involved.[9]

The admissibility of scientific expert testimony varies from state to state, and is determined by an ever more complex array of statutory rules and common law decisions. California continues to apply the decision in the venerable *Frye* case,[10] while some other states have adopted the *Daubert* rules.[11] The federal courts currently follow a combination of the Federal Rules of Evidence, and the *Daubert, General Electric v. Joiner*,[12] and *Kumho*[13] cases, but the *Moore*[14] case, and the proposed revision of Rule 702 of the Federal Rules of Evidence[15] reflect the fact that many federal trial judges are uncertain about the interpretation and implementation of the recent Supreme Court decisions.

Trial judges have a large degree of discretion and their decisions can

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5. Toxicology is the study of the adverse effects of chemical agents on biological systems. *See* LOUIS J. CASARETT & JOHN DOULL, CASARETT AND DOULL'S TOXICOLOGY: THE BASIC SCIENCE OF POISONS 3 (Mary A. Amdur et al. eds., 4th ed. 1991).

6. *See generally* FEDERAL JUDICIAL CTR., REFERENCE MANUAL ON SCIENTIFIC EVIDENCE (1994). This manual offers suggestions for effective management of expert testimony and contains separate chapters on epidemiology, toxicology, survey research, DNA evidence, statistics, multiple regressions and estimation of economic loss in damage awards.

7. *See* 2 JOHN HENRY WIGMORE, EVIDENCE IN TRIALS AT COMMON LAW § 563, at 775 (J.H. Chadbourn ed., 1985).

8. *Quoted in* AMERICAN LAW INSTITUTE, MODEL CODE OF EVIDENCE 34 (1942).

9. *See* Mason Ladd, *Expert Testimony*, 5 VAND. L. REV. 414, 418 (1952).

10. Frye v. United States, 293 F. 1013 (D.C. Cir. 1923). *See, e.g.*, People v. Venegas, 18 Cal. 4th 47, 954 P.2d 525, 74 Cal. Rptr. 2d 262 (1998).

11. Daubert v. Merrill Dow Pharmaceutical, Inc., 509 U.S. 579 (1993). For the history and an analysis of *Daubert*, see Richard Bjur & James T. Richardson, *Expert Testimony Involving Chemists and Chemistry, in* EXPERT WITNESSING, UNDERSTANDING AND EXPLAINING SCIENCE 67-88 (Carl B. Meyer ed., 1999) [hereinafter EXPERT WITNESSING].

12. 522 U.S. 136 (1997).

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

14. Moore v. Ashland Chemical, Inc., 126 F.3d 679, *rev'd en banc*, 151 F.3d 269 (5th Cir. 1997).

15. NATIONAL CONFERENCE OF COMMISSIONERS ON UNIFORM STATE LAWS (NCCUSL), FEDERAL RULE OF EVIDENCE 702 (1998).

only be overturned when the trial judge acts capriciously.[16] The Federal Judicial Center has published a reference manual explaining the issues in seven of the most contentious areas.[17]

II. STATEMENT OF PROBLEM

The current confusion starts with the definition of many legal and scientific terms. The definition of the term "science" is broad.[18] In the context of expert witnessing, the term science includes physical scientists, social scientists, engineers, physicians, other health care professionals, and even lawyers.[19] However, each of these fields subscribes to different goals and uses different tools. Each requires not only much formal education, but many years of practical experience.[20]

The term "expert" means a person who has special skills or knowledge in a field.[21] This definition is articulated in Rule 702 of the Federal Rules of Evidence and in the corresponding definitions of the evidence laws of the fifty states:

> Fed. R. Evid. 702: Qualification as an Expert Witness
> (a) A person is qualified to testify as an expert if he has special knowledge, skill, experience, training, or education sufficient to qualify him as an expert on the subject to which his testimony relates. Against the objection of a party, such special knowledge, skill, experience, training, or education must be shown before the witness may testify as an expert.

However, in practice, an expert must not only be a scientific expert, but also an expert communicator and an expert persuader.[22]

Experts belong to a wide variety of professions and have widely divergent education and skills. The practice of medicine, law, and engineering requires a professional license and is subject to discipline by the respective state agencies or boards. These professionals, while acting as experts, and their expert testimony, are expected to conform to the standards of their professions.[23] Chemistry and physics have highly standardized curricula and

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16. *See* General Electric Co. v. Joiner, 522 U.S. 1136 (1998).

17. *See* FEDERAL JUDICIAL CTR., *supra* note 6.

18. Science is knowledge attained through study or practice. WEBSTER'S NEW COLLEGIATE DICTIONARY 1051 (9th ed. 1991).

19. *See* FEDERAL JUDICIAL CTR., *supra* note 6, at 5.

20. *See* Carl Meyer, *Science, Medicine and the U.S. Common Law Courts, in* EXPERT WITNESSING, *supra* note 11, at 6.

21. WEBSTER'S NEW COLLEGIATE DICTIONARY (9th ed. 1991).

22. *See* Kathey M. Verdeal, *The Five Dimensions of Scientific Testimony, in* EXPERT WITNESSING, *supra* note 11, at 121; Patricia M. Ayd & Merle M. Troeger, *Presenting Sophisticated Evidence Persuasively: The Role of the Scientific Expert and the Attorney at Trial, in* EXPERT WITNESSING, *supra* note 11, at 133.

23. In California, physicians, dentists, osteopaths, chiropractors, registered and vocational nurses, psychiatric technicians, optometrists, pharmacists, and veterinary doctors are regulated by their own boards, which have the power to adopt, amend, or repeal regulations for regulating the practice of these professions. *See* CAL. BUS. & PROF. CODE § 800 (1999).

internationally recognized Ph.D. programs and degrees, but no licensing requirement.

Some fields, such as toxicology, include different professions[24] that are credentialed by separate private organizations.[25]

Second, in our technology oriented society, science has increasingly assumed a role that is similar to the medieval church,[26] in that its authority is increasingly invoked by people who lack scientific training in areas that are not scientific in nature.

Third, unlike lay witnesses, experts are allowed to express opinions,[27] respond to hypothetical questions, and rely on evidence that would otherwise not be admissible.[28] Their testimony, in the form of opinion, can include opinions concerning the ultimate issues before the court.[29] This gives experts and their litigators a freedom and power that rivals that of the trier of fact. As one trial judge expressed it:

> This matter of opinion is a peculiar one, anyhow. First the expert witness gets on the stand and gives his opinion that if such and such is the case, then such and such must be the result, that is his opinion; then the lawyer gives the jury the benefit of his opinion as to the opinion of the expert; and then the jury is called upon to give their opinions of the opinions of the lawyer and the expert, and it is only an opinion after all.[30]

Fourth, since, by definition, experts possess knowledge that is not shared by the jurors and judges, the veracity of their statements can only be determined by indirect measures, such as their credentials, their demeanor, and their ability to withstand criticism. A skilled, biased expert can under-

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24. Toxicology involves the study of toxic substances and toxins on humans and the laboratory animals used for testing on behalf of humans. The practitioners in this field engage in a variety of activities that differ in education and methodology, and have very little, if any, overlap. *See* Bernard D. Goldstein & Mary Sue Henifin, *Reference Guide on Toxicology, in* FEDERAL JUDICIAL CTR., *supra* note 6, at 185. Clinical toxicologists are usually physicians that treat the effect of poisoning, biological toxicologists tend to be biochemists with second degrees in veterinary medicine engaging in animal and biological experiments, and forensic toxicologist are mainly analytical chemists. *Id.*

25. By way of example, the American Board of Preventive Medicine, the American Board of Pediatrics, and the American Boards of Emergency Medicine offer examinations that certify members as diplomates in the subspecialty area of Medical Toxicology. *See American Board of Preventive Medicine* (visited Mar. 26, 1999) <http://www.abprevmed.org/infobook.htm>. Candidates must have graduated from an accredited medical school in the U.S., hold an active license as a physician, some postgraduate training and experience, and at least two years of essentially full time training or practice in the speciality field. *Id.*

26. *See* Ann Lennarson Greer, *The End of Splendid Isolation: Tensions Between Science and Clinical Practice, in* EXPERT WITNESSING, *supra* note 11, at 51; Ann Lennarson Greer & Carl Meyer, *Explaining Science to Judges and Jurors,* 75 THE CHEMIST 15-18 (Mar./Apr. 1998).

27. Opinion is a belief stronger than impression and less strong than positive knowledge. *See* WEBSTER'S COLLEGIATE DICTIONARY 828 (9th ed. 1991).

28. *See* FED. R. EVID. 703.

29. *See* FED. R. EVID. 704.

30. J. Joel M. Longenecker, *cited in* A. L. MUNDO, THE EXPERT WITNESS, xi (1938).

mine the fairness of the legal process, unless the expert possesses a high degree of personal integrity.

Fifth, criminal law, and an increasing part of our body of civil law, is established by legislatures through political procedures. The price of freedom in our democracy is the coexistence of a variety of differing, and sometimes incompatible, goals.

A dominant force for change of expert standards has nothing to do with science, but is motivated by a shift in economic concerns.[31] Thus, scientific and professional trade organizations tend to encourage testimony that is favorable to the industries on whose funding they depend,[32] but usually discourage scientific testimony on behalf of consumers or environmental groups. Also, during the past two decades, the public policy concerning product liability and environmental issues has shifted due to economic and political pressures. Defendants in product liability cases have claimed that unbridled testimony by scientific experts and junk science have misguided juries to come out with run-away verdicts that damage our economy.

Sixth, it is difficult to find evidence standards that are applicable to all sciences because each science is at a different stage of sophistication; each field uses different tools, operates on different assumptions, employs different methodologies, and has different goals, resulting in large cultural and language gaps.[33]

Seventh, our U.S. common law system is not conducive to comprehensive scientific contemplation. The trier of fact is limited to the closed universe of testimony selected and presented by the parties, and the admissibility of evidence is controlled by elaborate statutory and common law rules that allow the judge to shape issues by limiting testimony. Furthermore, expert testimony is traditionally oral; it is elicited in the form of direct examination, followed by cross examination[34] that focuses on credibility and bias

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31. *See* PETER W. HUBER, GALILEO'S REVENGE: JUNK SCIENCE IN THE COURTROOM 18 (1991).

32. *See generally* MARCIA ANGELL, SCIENCE ON TRIAL: THE CLASH OF MEDICAL EVIDENCE AND THE LAW IN THE BREAST IMPLANT CASE (1996); Philip H. Abelson, *Toxic Terror: Phantom Risks*, 261 SCI. 407 (1993); Philip H. Abelson, *Pathological Growth of Regulations*, 260 SCI. 1859 (1993); Philip H. Abelson, *Risk Assessment of Low Level Exposures*, 265 SCI. 1507 (1994).

33. By way of example, clinical physicians are patient oriented; physicians at research institutions pursue the long-term goal of curing specific diseases. The goal of the first is to make new medication available to every patient; the goal of the second is to conduct large-scale trials, including placebos, to determine the over-all efficacy of new medication.

34. A full cross-examination of a witness upon the subject of his examination in chief is the absolute right, not the mere privilege of a party, and a denial of this right is a prejudicial and fatal error. *See* Gilmer v. Higley, 110 U.S. 47, 49-50 (1884). *See generally* Lindsey v. United States, 133 F.2d 368, 369 (D.C. Cir. 1942), *overruled on other grounds by* 405 F.2d 1352, 1359 (D.C. Cir. 1968); H. A. Hammelmann, *Expert Evidence*, 10 MOD. L. REV. 32, 34 (1947), *cited in* Paul Alan Lucey, *Medical Malpractice Law in the USSR: A New Emphasis on Civil Liability?*, 1985 WIS. L. REV. 989, 1001 (1985); Adolph Homburger, *Functions of Orality in Austrian and American Civil Procedure*, 20 BUFFALO L. REV. 9, 34 (1970); Brown v. Colm, 11 Cal. 3d 639, 645 (1974) (stating that the test is whether the witness has skill or experience sufficient so that testimony will aid the jury).

of the expert. The testimony takes place in the dramatic forum of the court room that includes armed bailiffs and a black-robed judge.[35]

Furthermore, in most jurisdictions, U.S. jurors are not yet allowed to ask questions; in many, they are not even allowed to take notes. Thus, especially in long trials involving multiple issues and a large number of witnesses, the trier of fact has insufficient ability to sift and organize contradictory information because they must screen and prune down information as the trial proceeds, long before the judge reads the jury instructions that tell the jurors the criteria for selecting relevant issues. This discourages jurors from analyzing facts and forming their own opinions, and encourages them to select and accept the opinions presented by the most persuasive witness.[36]

In order to reduce undue influences of expert witnesses in our system, the U.S. Supreme Court adopted a new set of rules during the past six years. In a nutshell, the *Daubert* decision allows the parties to ask for a pre-trial hearing during which the trial judge may apply one or all of the four *Daubert* criteria to determine whether testimony is sufficiently reliable to be presented to the jury.[37]

Determining the reliability of expert testimony involves two separate questions: Is the expert qualified to proffer an opinion; this is a question of law. The second is whether the expert opinion is reliable; this is traditionally a question of fact, and in the province of the jury, but *Daubert*, *Joiner* and *Kumho* have shifted it into the province of the judge. *Daubert* established four criteria for evaluating the reliability of scientific testimony: the falsifiability of a theory, the known or potential error rate, whether the findings have been subject to peer review, and the general acceptance. *Kumho* expanded the use of these criteria to all testimony based on scientific, technical, or other specialized knowledge, and established that one or more of these criteria *may*, or *may not* need to be considered by the trial judge depending on the nature of the issues, the expert's professional experience, or the subject of the testimony.[38]

The *Joiner* decision further expanded the discretion of trial judges by limiting appeals and encouraging judges to determine whether there is "too

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35. *See, e.g.*, David E. Asma, Courtroom Majesty and Defendant Frames: A Theater of Powerlessness 12, 22 (1996) (unpublished M.A. thesis, Northern Illinois University) (visited Mar. 6, 1999) <http://sun.soci.niu.edu/theses/asma.txt>.

36. This differs from the civil law systems in Continental European countries, which have a much smaller body of evidentiary rules. In these countries, the judge participates in and supervises discovery. Expert testimony is provided long before trial in the form of written reports, leaving ample time for obtaining written reviews by local, and sometimes worldwide professional peers and for further responses that are available to the trier of facts for review prior to trial. *See, e.g.*, Z. P. O. §§ 402-413, *translated in* CODE OF CIVIL PROCEDURES OF GERMANY (S.L. Gosen trans., 1990).

37. *See Daubert*, 509 U.S. at 593-94 (1993), *modified in part*, Kumho Tire Co. v. Carmichael, 119 S. Ct. 1167 (1999).

38. *See Kumho*, 119 S. Ct. at 1175-76.

large a gap" between the data underlying the opinion and the expert's opinion itself.[39] The fact that the *Daubert, Joiner*, and *Kumho* decisions charge the trial judges with the responsibility of evaluating the reliability of expert testimony presupposes that the traditional adversary process is insufficient to enable opposing counsel and their experts to ferret out inaccuracies and bias in expert testimony.

III. ANALYSIS OF THE PROBLEM

A. Lawyers and Scientists Tend to Underestimate the Barriers Blocking Communications Between Them

Most litigators and trial judges readily admit that they lack a solid foundation in science,[40] but they tend to underestimate the communication problem that results from this cultural gap.[41] While no lawyer would believe that he can intelligently discuss law with a person not schooled in law, whether he has barely finished high school or is a brilliant Nobel prize winner, a large number of attorneys and judges believe that they should be able to litigate and adjudicate scientific issues using common sense, without possessing basic scientific tools.[42] Unfortunately, common sense is not reliable. By way of a simple example, when two common liquids, water and alcohol, are combined, the resulting volume is not the arithmetic sum of the two, but smaller.[43]

The fact that professional scientists are not immune to being bewildered by common sense is demonstrated by the long detours that characterize the development of modern sciences. The history of chemistry provides many classical examples. The long reign of the phlogiston theory was based on the correct observation that carbon and other fuels disappear during combustion, and on the logical and rational conclusion that if the fuel disappeared, so did the chemical matter. It took several centuries and the genius of Lavoisier to demonstrate that carbon did not lose weight, but that, on the con-

39. *Joiner*, 118 S. Ct. at 517.

40. *See, e.g.*, Ethyl Corp. v. EPA, 541 F.2d 1, 67 (D.C. Cir. 1976) ("Because substantive review of mathematical and scientific evidence by technically illiterate judges is dangerously unreliable, I continue to believe we will do more to improve administrative decision-making by concentrating our efforts on strengthening administrative procedures."); International Harvester Co. v. Ruckelshaus, 478 F.2d 615, 651 (D.C. Cir. 1973) ("I recognize that I do not know enough about dynamometer extrapolations, deterioration factor adjustment, and the like to decide whether or not the government's approach to these matters was statistically valid.").

41. *See* Robert A. Bohrer, *The Fundamental Differences Between Sciences and the Law, in* EXPERT WITNESSING, *supra* note 11, at 41.

42. One reason for the difficulty in overcoming the professional gaps is that academic studies can provide only a fraction of the skills that are required to independently analyze problems and successfully practice medicine and chemistry because professional experience is as important in medicine, chemistry, and other sciences as it is in the practice of law.

43. Generally, a volume change takes place when two components are mixed to form a solution. *See* J. PHILIP BROMLEY, PHYSICAL CHEMISTRY 252 (1984). Thus, the combination of 1000 cm^3 water with 400 cm^3 of alcohol yields a volume of 1364.85 cm^3. *Id.*

trary, carbon gained weight during the combustion by combining with oxygen to form carbon dioxide.[44]

The fact that the public and most of our politicians still do not comprehend the chemistry of combustion is shown by the fact that power companies and other energy users are taxed for the use of cooling water, but not for the consumption of oxygen that they extract from the ambient air.

B. The Competence of Experts is Limited to Their Field

The time of universal scholarship is over. Most technical questions involve more than one field. By way of example, the proof of causation may involve five or more specialties. The plaintiff needs to prove: (a) the presence of a toxic source; (b) the emission rate of the toxic source; (c) the exposure level; (d) the toxic exposure experienced by the plaintiff; (e) the dose-response curve for the alleged toxic; and (f) the correlation between exposure and the symptoms presented by the plaintiff. The first step involves material sciences and chemistry; the second and third steps involve occupational hygiene and analytical chemistry; the third requires construction of a human exposure profile; the fourth involves molecular toxicology; and the last requires coordination between a clinical toxicologist and the plaintiff's treating physician. Each of these specialties involves different skills, and each specialist speaks a different language.

When, for economic or other reasons, a party uses experts to cover subjects outside of his field, the expert expresses what amounts to lay opinion. An example is provided by *Moore*,[45] whose expert, Dr. Jenkins, a highly credentialed M.D. and pulmonary specialist certified by the American Board of Internists, was unable to prove causation because he did not consider the importance of the toxic exposure level and could not interpret dose-response considerations, and, therefore, was unable to substantiate a link between the toxic source and Moore's poisoning.

It is noteworthy that the *Moore* court correctly excluded Dr. Jenkins testimony as "unscientific speculations offered by a genuine specialist,"[46] but failed to recognize that the root of the problem was that the expert was asked to express opinions outside of his own field.[47] Had the expert's qualifications been challenged, he would have been excluded under Fed. R. Evid. 702, eliminating the need for a *Daubert* hearing.

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44. *See, e.g.*, BEAT MEYER, SULFUR ENERGY AND ENVIRONMENT 187 (1978).

45. 151 F.3d at 277.

46. *Id.* at 278 (citing Rosen v. Ceiba-Geigy Corp., 78 F.3d 316 (7th Cir. 1996)).

47. The curriculum for pulmonary specialists and Diplomats of the American Board of Internists does not include industrial hygiene and molecular toxicology. In fact, a review of the curriculum of American medical schools, state licensing standards for M.D.s, and the specifications for certification as a diplomat in internal medicine shows that the sum total of required toxicological education and training consists of a two or three day course in poisoning that is usually offered during the second or third year of medical school. Telephone Interview with Dr. Sylvia Holoida, M.D. (Mar. 2, 1996).

C. Law, Science, and Medicine Are in a Cultural Struggle

Law, science, and medicine are interdependent,[48] but use different methodologies,[49] belong to different cultures,[50] and have different goals. The strength of science is to develop explanations that are universally valid, i.e., consistent with all prior established facts and theories. In contrast, the legal proceeding is able to produce localized, content-specific epistemological and normative understandings that are not subordinate to inappropriate universal claims and standards.[51]

Each field claims priority over some areas of our life. In matters of life and death, medicine demands a high level of priority; when natural forces are involved, natural laws take precedence over man-made law, but the latter determines the limits for the conduct of everybody, including physicians and scientists. This makes conflict inevitable.

We lawyers tend to forget that while our law enjoys supremacy in daily life and over daily activities, the validity of law is limited in time and space, while the validity of scientific law is universal and eternal. The tension between the different priorities tends to surface in product liability and environmental class actions, and sometimes results in distortion of issues and priorities.

The breast implant cases offer a good example that the adversary process is not good at solving multidisciplinary problems. First, physicians are more concerned with healing diseases than with the causation of diseases; the threshold for medical intervention is not the same as that required for establishing liability of a defendant manufacturer. Second, the law favors litigation against only one of the potentially responsible parties, the product manufacturers; it does not reach over-enthusiastic cosmetic surgeons who failed to adequately warn their patients of the discomfort and risk connected with the implants.[52] Third, the litigants emphasize the damage to the immune system and other health issues that are not yet fully understood and poorly proven.[53] Such questions are not suitable for adversary adjudication

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48. *See* Associate Justice of the Supreme Court of the United States Stephen G. Breyer, The Interdependence of Science and Law, Address at the 1998 American Association for the Advancement of Science Annual Meeting and Science Innovation Exposition (Feb. 16, 1998) (available in *The American Assoc. for the Advancement of Science* (visited Mar. 26, 1999) <http://www.aaas.org/scope/Breyer.htm>).

49. *See* Bohrer, *supra* note 41, at 43.

50. *See generally* Peter H. Schuck, *Multi-Culturalism Redux: Science, Law, and Politics*, 11 YALE L. & POL'Y REV. 1, 14 (1994).

51. *See* JASANOFF, *supra* note 4, at 222.

52. *See, e.g.*, GREAT BRITAIN DEPT. OF HEALTH: INDEPENDENT REVIEW GROUP TO CHIEF MEDICAL OFFICER, REPORT ON SILICON GEL BREAST IMPLANTS (1998) (visited Mar. 26, 1999) <http://www.silicone-review.gov.uk> [hereinafter REPORT ON SILICON GEL BREAST IMPLANTS]. Several of the nine recommendations in this report deal with better patient education. *See id.* For a copy of a typical warning label, see BREAST IMPLANTS, AN INFORMATIONAL UPDATE (visited Mar. 26, 1999) <http://www.fda.gov/oca/breast-implants/bitac.html>.

53. *See* REPORT ON SILICON GEL BREAST IMPLANTS, *supra* note 52.

by trial or by scientific panels selected by the court or by trade associations.[54] Fourth, the emphasis on the reliability of medical diagnosis belittles other issues, such as whether the patient gave fully informed consent,[55] and fifth, the class action format does not always allow adequate distinction of the disruption experienced by individuals.

Global solutions to the legal and medical questions are in intrinsic conflict with the goal of localized, content-specific solutions that are the purpose and goal of our common law system.[56]

D. The Reliability of Scientific Facts is not Limited to Facts That can be Explained

In science, observations have a higher rank than explanations and rationalizations. The history of science demonstrates that scientific phenomena are commonly confirmed and validated long before their cause and underlying processes are certain.[57] That is why we need a patent system that offers protection for scientific discoveries that are not consistent with prior knowledge, i.e., "novel."[58]

The same is true in medicine. A large part of the knowledge of medical practitioners consists of cultural and occupational experience that is individual and does not exist in libraries.[59] This does not distract from the reliability of this type of information.

E. Legal and Scientific Thinking are not Strictly Rational Processes

Any intellectual enterprise is bound by the limits of human abilities and facilities. Many problems involve multiple parameters that can be best resolved by creative problem solving, a process that involves moving or searching from a current state to a desired state.[60] This process requires intuitive approximation rather than merely linear, logical thinking. Problem solving is an art.[61] For example, creative legal problem solving requires con-

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54. *See* Betty A. Diamond et. al., *Rule 706 National Science Panel Report, In re Silicone Gel Breast Implant Product Liability Litigation* (MDL 926) (Nov. 19, 1998).

55. *See id.*

56. For an overview of breast implant litigations, see *The Federal Judicial Ctr.* (visited Apr. 16, 1999) <http://www.fjc.gov/BREIMLIT/ mdl926.htm>.

57. Some of the most widely used processes for smelting metals and producing sulfuric acid have been commercially used and documented for more than five hundred years, but the scientific basis for their understanding started less than hundred years ago, and much of it remains incomplete. *See, e.g.*, MEYER, *supra* note 44, at 187.

58. An invention is novel if it differs from prior art when no single prior art describes all of the invention's elements. *See* 35 U.S.C. § 102 (1994).

59. *See* JOSEPH M. JACOBS, DOCTORS AND RULES, A SOCIOLOGY OF PROFESSIONAL VALUES 15 (1995).

60. *See* Linda Morton, *Teaching Creative Problem Solving: A Paradigmatic Approach,* 34 CAL. W. L. REV., 375, 375-78 (1998).

61. *See* Janeen Kerper, *Creative Problem Solving v. the Case Method: A Marvelous Ad-*

sideration of six facets: the underlying needs and interests of the parties, an analysis of the values inherent in the process, available resources, creative thinking, problem prevention, and reflection whether the proposed solution is the best course of action and whom it affects.[62]

The train of human thought is not persistently rational.[63] Even the most disciplined level of human thinking is fraught with slips and gaps, providing the basis for cross-examination in litigation practice. John Locke's perception of human thought,[64] starting with perception, and proceeding with retention, discrimination, comparison, and culminating in composition of ideas,[65] leaves plenty of room for distraction from strictly logical thinking.

In the modern scheme, problem solving involves four steps: preparation (exploring of resources, preliminary screening), incubation (mulling over possibilities without preconception and rational restrictions, i.e., what might be called brain-storming), illumination (coalescence of reasoning, resources fall into place, and the results become defined), and verification (the results become polished).[66]

F. A Strictly Rational Approach is not Always the Best Approach to Solving Problems

While legal decisions need to be reasonable and reasoned, the laws of nature are not bound by similar restraints.

The best balance between art and science depends not only on the field, but on the state of a field and its goals. While the health sciences and clinical medicine share many goals, and while it is true that clinicians follow scientific methods in determining the diagnosis and treatment of diseases,[67] clinicians and health care scientists have great difficulty communicating with each other because they subscribe to a different balance between science and art. The clinician usually lacks time to experiment and sort out parameters; he cannot risk inflicting harm; he often needs to rely on subjective

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venture in Which Winnie-the-Pooh Meets Mrs. Palsgraf, 34 CAL. W. L. REV. 351, 367 (1998).

62. *See id.* at 378.

63. *See* HAROLD I. KAPLAN & BENJAMIN J. SADOCK, COMPREHENSIVE TEXTBOOK OF PSYCHIATRY 539-41 (6th ed. 1995).

64. Thought is a goal-directed flow of ideas, symbols and associations initiated by a problem or task, and leading towards a reality-oriented conclusion. *See* KAPLAN & SADOCK, *supra* note 63, at 539. When a logical sequence occurs, thinking is normal; parapraxis (unconsciously motivated lapse from logic termed a Freudian slip) is considered a normal part of thinking. *See id.* In a broad sense, activities called "thinking" are internally adaptive responses to intrinsic and extrinsic stimuli; not only do they express inner impulses, but they also serve to generate environmentally effective, goal-seeking behavior. 28 ENCYCLOPEDIA BRITANNICA 650-56 (15th ed. 1994).

65. *See generally* JOHN LOCKE, AN ESSAY ON HUMAN UNDERSTANDING (Prometheus Books 1994) (identifying five steps of mental operation).

66. *See* KAPLAN & SADOCK, *supra* note 63, at 539.

67. A diagnosis is always established by a four step sequence of taking a history of the patient, a physical exam, diagnostic tests, and then observing the patient's response.

presentation by the patient; he must consider personal and individual factors; his priority is to heal or improve the condition of the patient and start treatment in the face of uncertainty, even when the chance of success is far below the 50% threshold that civil litigators are accustomed to consider. The dean of a major U.S. medical school has stated that only 15% of the decisions a doctor makes every day are based on evidence.[68]

Thus, while the intensive, thirty year old program of the NIH to train Ph.D. physicians who are equally fluent in the world of health science and clinical care has attracted many of the most brilliant students, the program has not yet been able to diminish the gap.[69] The same need for balancing science and art for solving problems exists in other fields.

Creative thinking always contains elements of wishful and autistic thinking.[70] Even in the most rigorous and quantitative fields, such as theoretical physics, scientific reasoning is not purely mathematical, but depends upon simplification by creative use of approximations.

G. The Border Between Scientific and Experiential Evidence is Fluid

The definitions of scientific and experiential testimony are clear and the borders are sharp:

> The distinction between scientific and non-scientific expert testimony is a critical one. By way of illustration, if one wanted to explain to a jury how a bumblebee is able to fly, an aeronautical engineer might be a helpful witness. Since flight principles have some universality, the expert could apply general principles to the case of the bumblebee. Conceivably, even if he had never seen a bumblebee, he still would be qualified to testify, as long as he was familiar with its component parts.
>
> On the other hand, if one wanted to prove that bumblebees always take off into the wind, a beekeeper with no scientific training at all would be an acceptable witness if a proper foundation were laid for his conclusions. The foundation would not relate to his formal training, but to his first-hand observations. In other words, the beekeeper does not know any more about flight principles than the jurors, but he has seen a lot more

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68. Robert Califf, Director of the Duke University Clinical Research Institute, (quoted in Nancy Gibbs, *A Week in the Life of a Hospital*, TIME MAGAZINE 68 (Oct.12, 1998)).

69. *See* Elizabeth Bromley, Editor's Note, *The Evolving Relationship Between the Physician and the Scientist in the 20th Century*, 281 MS/JAMA 94 (1999).

70. "Autistic thinking" arises from intrinsic influence, responsive to emotional and motivational impulses, including free associations, fantasy, dreaming and pathological thinking. *See* 28 ENCYCLOPEDIA BRITANNICA, *supra* note 64, at 655. It arises from wishes and needs, and represents activity through which individual symbolical gains and gratification can be achieved that the environment does not provide. *See id.* Kaplan defines it as a preoccupation with an inner, private world, somewhat similar to dereism. *See* KAPLAN & SADOCK, *supra* note 63, at 539. Dereism is a mental activity not concordant with logic or reality. *See id.* at 527.

For a more detailed explanation of the different forms of thinking that cooperate in the solution of medical problems, see EUGEN BLEULER, DAS AUTISTISCH -UNDISZIPLINIERTE DENKEN IN DER MEDIZIN UND SEINE ÜBERWINDUNG (5th ed. 1962).

bumblebees than they have.[71]

However, all scientific reasoning starts with an observation. That's why scientists are primarily experiential witnesses, and why rational explanations are secondary to experience. What separates the successful scientist from the lay person are two things: first, good scientists have an extensive base of knowledge,[72] a large set of tools to evaluate their observations, and the scientist is more disciplined and systematic in the choice of his line of reasoning; and second, good scientists have extensive practice in solving problems, acquired by tackling complex, real-life problems, followed later, whether successful or not, by careful post-mortem analysis of their procedures.

A good problem solver relies first on as many objective criteria as possible, preferentially, criteria established by consensus (scientific laws or engineering standards) and use of patterns of associations (such as semiology in clinical analysis, or chemometrics in analytical chemistry) to organize data and narrow the possible solutions.

Furthermore, the various sciences are at varying degrees of perfection and few have achieved a completely rational level. Traditionally, scientific reasoning is thought of as consisting of a reiterative process including five steps: observation, tentative description, hypothesis and prediction, testing of the hypothesis, and modification of the result by repetition of all elements.

In fact, insistence on a fully rational explanation of scientific facts and phenomena encourages circular reasoning and pseudo-explanations; Pseudo-science starts with the results, usually derived from solutions to critical social or political problems.[73] Pseudo- and junk science can also find their way into expert opinions if the expert succumbs to wishful thinking or undisciplined thinking as a short-cut to find pat answers to complex problems.[74]

H. Are Judges Better Qualified to Conduct an Independent and Objective Validation of the Expert's Testimony Than Opposing Experts?

Traditionally, the responsibility for exposing flaws in expert testimony

71. Berry v. City of Detroit, 25 F.3d 1342, 1349 (6th Cir. 1994).

72. The knowledge base includes knowledge derived from formal structured learning in a structured curriculum, including textbook based and literature based learning, learning from peers and mentors in smaller groups, and individual experience that is unique to the individual practitioner and is usually not recorded in written form. *See* BLEULER, *supra* note 70, at 127-39.

73. Pseudo-science is usually used to provide an imaginary solution to a pressing social or healthcare problem. Practitioners need to be skilled in the art of persuasion in order to retard and prevent the normal error correction and peer review procedures. *See* JEFFREY M. BLUM, PSEUDOSCIENCE AND MENTAL ABILITY 154-60 (1978).

74. *See, e.g.*, BLEULER, *supra* note 70, at 127-39. *See generally* BLUM, *supra* note 73 (analyzing the pseudo-scientific aspects of the long-popular IQ test).

rests with the expert of the opposing party. *Daubert* shifts a large part of the responsibility to the court.[75]

However, the time when a college degree assured scientific competence is long over. Most judges lack the basic training and experience that is necessary for evaluating scientific opinions, and their individual level of scientific competence varies. This causes serious problems because the key to a successful legal system is that it provides a uniform application of rules of law so that the outcome is predictable. In order to assure this, judges and lawyers undergo extensive and standardized legal training. However, legal licensing requirements and judicial qualifications do not test the applicant's ability to understand scientific problems and require no minimum standard[76] of scientific literacy.[77] Therefore, judges must rely on their individual knowledge derived from short courses, from opinions expressed by neutral experts, or from more or less remote memories of public school science courses,[78] and their comprehension and handling of scientific issues is intrinsically not predictable.

IV. PROPOSED SOLUTIONS

Many different solutions have been proposed in the past. The most common, without reservations, are:

A. Change Procedural Rules to Assist Jurors With Rational Decisionmaking

The reliability of expert testimony is not the only barrier towards finding justice. If our goal is to increase the reliability of the outcome of trials, one needs to consider the entire process.

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75. *But see Moore*, 151 F.3d at 276 ("The party seeking to have the district court admit expert testimony must demonstrate that the expert's findings and conclusions are based on the scientific method and therefore reliable. This requires some objective, independent validation of the expert methodology. The expert's assurances that he has utilized generally accepted scientific methodology is insufficient.").

76. The level of literacy required to evaluate scientific opinions differs, depending on the field, and other factors.

77. "Literacy" means an individual's ability to read, write, and speak in English, and compute and solve problems at levels of proficiency necessary to function on the job and in society, to achieve one's goals and develop one's knowledge and potential. *See* National Literacy Act of 1991, Pub. L. No. 102-73, § 3. "Scientific literacy" standards have evolved from work by several groups and committees sponsored by the American Association For The Advancement Of Science. *See, e.g., Benchmarks for Science Literacy and Project 2061*; *in* SCIENCE FOR ALL AMERICANS (1993).

78. Scientific literacy, defined in U.S. High School graduation requirements, includes familiarity with some basic mathematical skills that are traditionally acquired between grades 7 and 10 in junior high and high school courses, such as the ability to solve story problems, fundamentals of algebra, differential calculus and statistics. These courses are still required of all students who seek admission to European universities, but U.S. high school standards are currently substantially lower than one hundred years ago, and admission tests require only minimal mathematical skill. *See supra* note 76 and accompanying text.

Whether an expert is qualified to express an opinion is a question of law; whether his testimony is reliable is a question of fact. The first is in the province of the judge, the second in that of the jury. There is no hard empirical evidence supporting the argument that a lay jury cannot critically evaluate scientific evidence.[79] By charging the judge with determining the reliability of expert testimony, *Daubert* and *Joiner* shift the responsibility between the two on the theory that the evidence rules give experts excessive authority and make jurors excessively vulnerable to pseudo-scientific testimony. However, it seems proper to ask whether this problem could not be resolved without disturbing the balance between law and fact.

One cannot solve mathematical or scientific problems before the problem is clearly stated and the parameters are defined. Traditionally, in jury trials, the jurors hear the evidence without a compass to find their way. Arizona has been a pioneer in implementing procedures that help jurors comprehend issues. Since December 1, 1995, the parties may read pleadings to jurors,[80] jurors are permitted to submit written questions directed to witnesses and the judge,[81] and jurors may take notes in civil[82] as well as criminal cases.[83] Jurors are allowed to discuss evidence[84] and review notes during recesses and during deliberations.[85] In complex cases, jurors may be provided notebooks that include jury instructions, key documents, witness names and pictures, and a glossary of legal terms. B. Michael Dann, a Maricopa County Superior Court judge in Phoenix who was the chair and "spiritual leader" of the jury reform committee, also favors the practice of jurors asking questions. In his initial instructions, he explains to the jury that their questions must meet the same standards the attorneys follow. The Supreme Court currently is considering two additional rules changes: one would extend juror discussions during trial to criminal cases. The second would allow a trial judge to require counsel to summarize depositions and agree upon a written summary rather than reading the contents in the traditional question and answer format. The Arizona experiment is being evaluated by the National Center of State Courts.[86]

B. Use a Legal Standard to Evaluate Scientific Evidence

In its recent decisions, the U.S. Supreme Court gives federal trial

79. *See* Emanuel Imwinkelreid, *The Standard for Admitting Scientific Evidence: A Critique from the Perspective of Juror Psychology*, 100 MIL. L. REV. 99, 114-16 (1983).

80. *See* ARIZ. R. CIV. P. 39(b) (1997).

81. *See id.* 39(b)(10); *see also* ARIZ. R. CRIM. P. 18.6, 18.6(c), 18.6(d) (1997).

82. *See* ARIZ. R. CIV. P. 39(b), 39(b)(10) (1997) and comments.

83. *See* ARIZ. R. CRIM. P. 18.6 (1997).

84. *See* ARIZ. R. CIV. P. 39(f) (1997) and comments.

85. *See id.* 22.2.

86. *See* Tom Munsterman & Paula Hannaford, *Innovations in Jury Trial Procedures, A Manual on Innovations in Jury Trial Procedures* (visited Mar. 15, 1999) <http://www.ncsc.dni.us/research/projects/admin.htm>.

judges increasing discretion to determine the admissibility of scientific evidence on the basis of rather broad and vague concepts.[87] The Reference Manual on Scientific Evidence prepared by the Federal Judicial Center has tried to help by providing scientific guidelines for trial judges.[88] Trial judges have also been the beneficiaries of informal short courses offered by public and special interest groups.[89] The main problem with these approaches is that judges are encouraged to apply an individual and undefined standard.

C. Use Neutral Experts

Another widely promoted proposal is for judges to use FRE 706 and select their own, "neutral" experts. This approach will eliminate the diversity of scientific opinions, but hearing only one side does not make testimony more reliable.[90] Furthermore, judges have difficulties finding competent experts.[91]

D. Delegate Scientific Issues to Panels of Scientists or Professional Societies

There have been periodic efforts to delegate the resolution of scientific questions to scientists, either by appointment of committees or to some form of science court. These efforts have failed because the scientific problem—solving methodology favors professional competence and authority rather than due process, and professional and trade organizations are mired by conflicts of interest that favor politics over scientific facts. The use of scientific panels introduces other difficulties; specialists lack experience in interdisciplinary communications. They constitute an extra-legal tribunal, using extra-legal procedures, substituting professional ethics[92] for legal standards,[93]and their proceedings are insufficiently open and public.[94]

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87. *See Daubert*, 509 U.S. at 594-596; *Joiner*, 118 S. Ct. at 512; *Kumho*, 119 S. Ct. at 1167.

88. *See* FEDERAL JUDICIAL CTR., *supra* note 6.

89. Among the sponsors of short courses for federal and state judges have been the National Research Council, the American Association for the Advancement of Sciences, and organizations sponsored by special interest groups, such as the Heritage Foundation and the Einstein Institute for Science, Health and the Courts.

90. *See generally* Carl Meyer, *Science and Law: The Quest for the Neutral Expert: A View from the Trenches*, 13 J. NAT. RESOURCES AND ENVTL. L. 36 (1997).

91. *See* Joe S. Cecil & Thomas E. Willging, *Court-Appointed Experts, in* FEDERAL JUDICIAL CTR., *supra* note 6 at 524. *See generally* Tahirih V. Lee, *Court-Appointed Experts and Judicial Reluctance: A Proposal to Amend Rule 706 of the FRE*, 6 YALE L. & POL'Y REV. 480 (1988).

92. Professional ethics in that it is "a scheme of law enforcement . . . by private policemen where privately declared laws are punished by penalties imposed by private 'judges' after privately conducted trials." 128 TRADE REG. RPTR. (FTC) ¶ 17950 at 20329 (1967).

93. This problem is discussed in *Fashion Originator's Guild v. Federal Trade Commn*, 312 U.S. 457, 463 (1941).

In *Joiner*, the U.S. Supreme Court recommends that judges use professional societies as intermediaries or sponsors for neutral experts or expert panels.[95] However, even the most widely respected professional organizations have conflicting priorities and agendas. By way of example, the American Dental Association offers continued dental education, it resolves patient-dentist conflicts by sponsoring peer review panels, and it enforces its code of professional ethics, including limits on advertising that the Federal Trade Commission has described as a continuing conspiracy to fix the price of dental services.[96] The history of the century old battle over the safety of dental amalgam[97] further illuminates the irrational decisions that result when an organization has conflicting goals.[98]

By way of a second example, the world's largest professional society, the American Chemical Society, not only publishes more than a dozen of the world's most prestigious technical journals and organizes biannual technical meetings that serve as an international forum for catalyzing progress in all fields of academic and applied chemistry, but, less visible to its academic members, it also takes an active role in protecting and defending the chemical industry against public criticism and litigation.[99]

Finally, in the large number of cases where the knowledge resides within the defendant industry, the panel either lacks competence or consists of employees of, consultants to, or trade associations representing, the defendants.

E. The Proposed Fed. R. Evid. 702

Perhaps the most promising proposal, has originated with the National Council on Uniform State Laws which submitted to the federal judicial counsel a proposed draft of a revised FRE 702 which provides:

> (REVISED) RULE 702. TESTIMONY BY EXPERTS
> If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact at issue, a witness

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94. The requirement of open proceedings is not only necessary for legal, but also for scientific reasons. *See* Arthur Kantrowitz, *Elitism vs. Checks and Balances in Communicating: Scientific Information to the Public*, 4 RISK: ISSUES IN HEALTH & SAFETY 101-11 (1993).

95. *See* Justice Breyer, *supra* note 48.

96. *See, e.g.*, California Dental Ass'n v. Federal Trade Comm'n, 128 F.3d 720 (9th Cir. 1997) (enforcing cease and desist order on price advertising).

97. *See generally* ROBERT W. MCCLUGGAGE, A HISTORY OF THE AMERICAN DENTAL ASSOCIATION: A CENTURY OF HEALTH SERVICE 67 (1959).

98. *See* Michael A. Royal, *Amalgam Fillings: Do Dental Patients Have a Right to Informed Consent?—Risks Suggested by (Admittedly Controversial) Studies of Amalgam Fillings Warrant Permitting Patients to Choose Alternatives*, 2 RISK: ISSUES IN HEALTH & SAFETY 141 (1991).

99. *See, e.g.*, Amicus Curiae Brief of the American Chemical Society, Bush Ranch, Inc. v. E.I. DuPont De Nemours & Co., 918 F.Supp. 1524 (M.D.Ga. 1995), *rev'd*, 99 F.3d 363 (11th Cir. 1996). *See generally* CHEM. & ENG. NEWS, Dec. 18, 1995 (criticizing a federal trial judge, and arguing that expert witnesses for the chemical industry should not be compelled to disclose the results of all laboratory experiments that they conduct).

qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise.
(a) General rule. A witness may testify in the form of opinion or otherwise if the following are satisfied.
(1) Basis for testimony. The testimony is based on scientific, technical, or other specialized knowledge.
(2) Assistance to trier of fact. The testimony will assist the trier of fact to understand evidence or determine a fact at issue.
(3) Qualification of witness. The witness is qualified by knowledge, skill, experience, training, or education as an expert in the scientific, technical, or other specialized field.
(4) Reasonable reliability. The testimony is based upon principles or methodology which is reasonably reliable as established under subdivision (b), (c), or (e).
(5) Reliably applied to facts of case. The witness has applied the principles or methodology reliably to the facts of the case.
(b) Reliability deemed to exist. A principle or methodology is deemed reasonably reliable if its reliability has been established by controlling legislation or judicial decision.
(c) Presumption of reliability. A principle or methodology is presumed to be reasonably reliable if it has substantial acceptance within the relevant scientific, technical, or specialized community. A party may rebut the presumption by proving that it is more probable than not that the principle or methodology is not reasonably reliable as provided in subdivision (e).
(d) Presumption of unreliability. A principle or methodology is presumed not to be reasonably reliable if it does not have substantial acceptance within the relevant scientific, technical, or specialized community. A party may rebut the presumption if it is more probable than not that the principle or methodology is reasonably reliable as provided in subdivision (e).
(e) Other reliability factors. When determining the reliability of a principle or methodology, the court shall consider all relevant additional factors, which may include:
(1) Testing. The extent to which the principle or methodology has been tested;
(2) Research methods. The adequacy of research methods employed in testing the principle or methodology;
(3) Peer review. The extent to which the principle or methodology has been published and subjected to peer review;
(4) Rate of error. The rate of error in the application of the principle or methodology;
(5) Experience of expert. The experience of the witness as an expert in the application of the principle or methodology; and
(6) Acceptance within the field. The extent to which the field of knowledge has substantial acceptance within the relevant scientific, technical, or specialized community.[100]

It remains to be seen how much of this revision after a revised version is prepared by the Federal Judicial Council, will change.

V. CONCLUSIONS

Our arguments can be summarized as follows:

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100. Proposed FED. R. EVID. 702, Preliminary Draft of Proposed Amendments to the Federal Rules of Civil Procedure and Evidence.

It is intrinsically difficult for litigators and the courts to determine the reliability of scientific, technical, and other specialized testimony. During the past seven years, the U.S. Supreme Court has established a new set of rules to allow scientifically untrained lawyers and judges to determine whether certain types of scientific testimony is reliable and to exclude "scientifically unreliable" testimony before it is heard by jurors. This effort has had mixed success because it is difficult for scientifically untrained lawyers and judges to distinguish between scientific reasoning and pseudo-scientific rationalizations.

While *Kumho* has clarified that the *Daubert* rules apply not only to scientific but to all technical and other specialized knowledge, it has compounded problems for litigants by giving trial judges broad discretion to determine in each case which of the *Daubert* criteria they wish to apply. The lack of an objective standard, combined with the lack of a minimum standard for the scientific proficiency of litigators and judges, defies a basic goal of the law, namely to make the outcome of a *Daubert* hearing predictable.

In our diverse society, there always will be disagreement on how disputes should be resolved and what type of evidence should be admitted in our courts. Critics of our court system often overestimate the importance of science relative to social and public policy concerns. They tend to forget that local laws, even criminal laws, differ, and that the goal of the court is to find solutions that match local needs. Furthermore, the availability and reliability of evidence differs for each element that is necessary to prove or defend a case. The standard of admissibility of scientific evidence might need to be adjusted to conform to the needs of an individual case.

Scientific evidence is often unreliable not because the science lacks reliability, but because it is misstated, or its reliability is misstated, or because the expert's expertise is misstated. For instance, treating physicians are rarely challenged when they expound toxicological opinions, even though toxicology is not taught in medical school and most clinical physicians have no toxicological knowledge or experience.

Neutral experts do not solve the problem of scientific illiteracy of judges and attorneys, but they do reduce the dialogue that helps the trier of fact balance the interests of the parties.

The litigating attorneys have more time and are in a better position to evaluate expert qualifications and expert opinions. Much of the need for the complex *Daubert* rules and their time consuming implementation could be avoided if litigators possessed sufficient scientific understanding and skill to analyze the competence of experts and the reliability of their testimony.

The emotionally charged atmosphere of the U.S. common law court is not conducive to resolving scientific issues.[101] The Arizona experiment, which allows jurors to ask questions and take notes, greatly improves the comprehension of scientific issues.

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101. *See* Munsterman & Hannaford, *supra* note 86.

Large, nationwide class actions litigations, such as asbestos litigations or breast implant litigations, reveal the intrinsic conflict between the goal of science to produce universally valid solutions and the goal of the courts to produce quick and final local solutions to disputes.

Since jurors and judges are limited to the closed universe of evidence presented by the parties, and expert testimony is filtered by lawyers who do not understand the underlying science, the quality and reliability of scientific opinions could be greatly improved if expert reports were exchanged earlier, if the response of third-party professional peers could be solicited, and if both would be available to the judge and jurors without editing or filtering by counsel.[102]

If the purpose of the *Daubert* rule is to implement a more restrictive public policy of compensation in product liability cases, it would be easier and more candid to use the well established concept of "proximate causation," rather then esoteric evidence rules, to limit recovery.[103]

102. This proposal is similar to the procedures used in regulatory proceedings and in civil litigation in the Civil courts of continental Europe.

103. "What we do mean by the word 'proximate' is that, because of convenience, of public policy, of a rough sense of justice, the law arbitrarily declines to trace a series of events beyond a certain point. This is not logic. It is practical politics." Palsgraf v. Long Island R.R., 248 N.Y. 339, 343, 162 N.E. 99, 103-04 (1928).