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Analyzing Scientific Evidence: From Validity to Reliability with a Two-Step Approach.

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Analyzing Scientific Evidence: From Validity to Reliability With a Two-step Approach

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"There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact."

Mark Twain[1]

I. Introduction: The Problem with Scientific Evidence

Perchloroethylene is a chemical commonly used in commercial dry cleaning.[2] Because of the probable exposure of this chemical to the general popu-

1. Mark Twain, Life on the Mississippi 109 (Harper & Row 1965).

2. *See* Twombley v. Fuller Brush Co., 158 A.2d 110, 114 (Md. 1960) (noting vapors created by perchloroethylene caused malaise and extraordinary intestinal disturbances but did not cause jaundice or hepatitis); Allen v. Uni-First Corp., 558 A.2d 961, 962 (Vt. 1988) (describing perchloroethylene as commonly known toxic, water soluble, organic compound

lation, the scientific community extensively studied its effects.[3] Through these studies, scientists determined that, although perchloroethylene is very toxic, it does not injure human kidneys.[4] Consequently, renal experts concluded that exposure to this chemical will not cause renal failure.[5] Yet, despite this overwhelming scientific evidence, a New York jury awarded a multimillion dollar judgment to the widow of a dry cleaner's employee who claimed that her husband's chronic renal failure was caused by on the job exposure to perchloroethylene fumes.[6] The New York judge admitted unsound scientific evidence[7] that the chemical caused kidney failure and the jury was swayed by it.[8] Despite the existence of "good science," "junk science" prevailed.[9] The New York judicial system came head to head with the special challenges of scientific evidence and, like many other jurisdictions,

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used in dry cleaning business). *See generally* Charles Lettow, *Strategic Choices in the Selection of Expert Eyewitnesses*, NAT. RESOURCES & ENV'T, Fall 1986, at 7 (explaining that renal experts have determined perchloroethylene does not damage human kidneys).

3. The administrator of the Environmental Protection Agency (EPA) listed perchloroethylene as a non-special carcinogen. *See* Assessment of Perchloroethylene as a Potentially Toxic Air Pollutant, 50 FED. REG. 52880 (1985) (stating that, excluding carcinogenicity, long term exposure to perchloroethylene does not create health risk). In fact, the manufacturers of perchloroethylene include warning labels on their chemicals that include the following language: "vapor harmful," "avoid prolonged or repeated breathing of vapors," "use only with adequate ventilation," "avoid contact with eyes," "avoid prolonged or repeated contact with skin," "do not take internally," and "do not eat, drink, or smoke in work area." George H. King, Note, 21 ARIZ. ST. L.J. 809, 813 n.39 (1989).

4. *See generally* Charles Lettow, *Strategic Choices in the Selection of Expert Eyewitnesses*, NAT. RESOURCES & ENV'T, Fall 1986, at 7 (1986) (noting that scientists have determined that perchloroethylene does not injure human kidneys).

5. *Id.*

6. *See* Geletucha v. 222 Delaware Corp., 182 N.Y.S.2d 893, 894 (N.Y. 1959) (confirming jury finding that perchloroethylene caused worker's death).

7. Most courts have not defined what is scientific evidence. One commentator stated that scientific evidence is "newly ascertained or applied scientific principles." *See* Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1198 (1980). *See generally* Ronald N. Boyce, *Judicial Recognition of Scientific Evidence in Criminal Cases*, 8 UTAH L. REV. 313, 314 n.19 (1962) (defining scientific evidence as those inquiries based upon scientific method).

8. *Id. See generally* Charles Lettow, *Strategic Choices in the Selection of Expert Eyewitnesses*, NAT. RESOURCES & ENV'T, Fall 1986, at 7 (describing jury influenced by expert testimony despite valid scientific evidence showing perchloroethylene does not cause liver damage).

9. Invalid science is termed "junk science." PETER W. HUBER, GALILEO'S REVENGE 2 (1991). Junk science is trial testimony provided by experts that is not supported by the scientific method, valid data, and standard scientific thinking. *See id.* at 24-35 (arguing that influx of junk science into courtroom is result of liberal evidentiary standard). *See generally* Deborah R. Hensler, *Science in the Court: Is There a Role for Alternative Dispute Resolution*, 54 LAW & CONTEMP. PROBS., Summer 1991, at 171, 173 (noting that junk science is often admitted in court).

failed.[10]

Throughout legal history, courts have wrestled with scientific evidence.[11] Sometimes the courts admitted invalid evidence disguised as science.[12] For example, in the fifteenth century, European courts used the laws of nature to convict and punish accused witches for causing blights, droughts, and diseases.[13] The American colonies followed suit in the seventeenth century.[14] In other instances, courts have ignored valid, novel scientific evidence.[15] In

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10. *See* Richardson v. Richardson-Merrell, Inc., 857 F.2d 823 (D.C. Cir. 1988). In *Richardson*, a jury awarded a significant monetary judgment to the plaintiff despite the introduction of valid scientific evidence conclusively showing that Bendectin does not cause birth defects in humans. *Id.* at 825. The district court entered judgment notwithstanding the verdict which the court of appeals affirmed. *Id.*

11. *See* Mercado v. Ahmed, 756 F. Supp. 1097, 1099 (N.D. Ill. 1991) (opining that although scientific theory was tentative, courts have relied upon it because of its practical use). *See generally* Learned Hand, *Historical and Practical Considerations Regarding Expert Testimony*, 15 HARV. L. REV. 40, 51-58 (1901) (analyzing problem of jurors deciding issue with only information provided by competing experts); Fredric I. Lederer, *Scientific Evidence: An Introduction*, 25 WM. & MARY L. REV. 517, 517 (1984) (noting rapid increase in amount of scientific evidence being introduced in court); Howard T. Markey, *Jurisprudence or "Juriscience"?*, 25 WM. & MARY L. REV. 525, 532 (1984) (contending that juriscience has long been replacing jurisprudence); John W. Osborne, Comment, *Judicial/Technical Assessment of Novel Scientific Evidence*, 1990 U. ILL. L. REV. 497, 497 (stating that courts have long been dealing with problem of scientific evidence).

12. *See* Baker v. DeRosa, 196 A.2d 387, 390 (Pa. 1964) (affirming trial court award based on erroneous scientific evidence that rear end collision caused lung cancer); Ortega v. State, 669 P.2d 935, 942 (Wyo. 1983) (allowing police to obtain blood stains without warrant because determining blood type from blood stains becomes more difficult over time). *See generally* Deborah R. Hensler, *Science in the Court: Is There a Role for Alternative Dispute Resolution*, 54 LAW & CONTEMP. PROBS., Summer 1991, at 171, 176 (discussing that many critics claim judges dismiss cases or consider claims based on skimpy scientific data, or pseudo-science); Peter W. Huber, *Medical Experts and the Ghost of Galileo*, 54 LAW & CONTEMP. PROBS., Summer 1991, at 119, 123 (arguing that junk science has invaded courtroom, allowing courts to determine causation when causation does not exist).

13. PETER W. HUBER, GALILEO'S REVENGE 9-10 (1991). In the fifteenth century, Heinrich Institor and Jakob Sprenger collaborated on a book detailing the evidence to prove the existence and harmful activities of witches. *Id.* at 9. Witch hunts started in Switzerland in 1427 and the hysteria soon spread throughout Europe. *Id.* at 10.

14. *See* Long v. Texas, 742 S.W.2d 302, 307 n.6 (Tex. Crim. App. 1987) (explaining that accused at Salem witch trials were not permitted counsel); Diehl v. Texas, 698 S.W.2d 712, 721 n.4 (Tex. App.—Houston [1st Dist] 1985, no writ) (noting bloodiness of Salem witch trials); Chambers v. Wyoming, 726 P.2d 1269, 1278 (Wyo. 1986) (recounting that four female Salem residents were hung for being witches in June 1692). *See generally* PETER W. HUBER, GALILEO'S REVENGE 10 (1991) (describing that between Renaissance and Reformation, half million accused witches burned at stake); Learned Hand, *Historical and Practical Considerations Regarding Expert Testimony*, 15 HARV. L. REV. 40, 46 (1901). Judge Hand retells the story of a 1665 witch trial when a court considered admitting the scientific evidence tendered by Dr. Brown. Dr. Brown offered scientific evidence to prove that the accused's behavior showed that she was a witch. *Id.*

15. Many opponents of the *Frye* rule contend that the generally accepted standards estab-

1946, comedian Charlie Chaplin defended himself in a paternity suit by presenting the court with a new scientific procedure, blood typing.[16] Through this technique Chaplin conclusively established he was not the father of the little girl who had brought suit.[17] However, the California court disregarded the new scientific procedure and affirmed the lower court's ruling that Chaplin was the father.[18] Other courts have improperly applied judicial precedent when faced with scientific evidence, finding causation where it did not exist.[19] As recently as 1968, courts have relied upon judicial precedent to admit erroneous scientific evidence that a traumatic blow could induce cancer.[20] The problems created by scientific evidence continue to haunt judicial systems despite repeated attempts to exorcise these demons.[21]

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lished by the *Frye* test are overinclusive. Critics argue that many of the scientific discoveries of the past that are now accepted would have failed under a *Frye* analysis. Rubanick v. Witco Chem. Corp., 593 A.2d 733, 747 (N.J. 1991). *See generally* Peter W. Huber, *Medical Experts and the Ghost of Galileo*, 54 LAW & CONTEMP. PROBS., Summer 1991, at 119, 123 (listing historical examples of scientific theories that probably would not satisfy *Frye* rule); Andre A. Moenssens, *Admissibility of Scientific Evidence—An Alternative to the* Frye *Rule*, 25 WM. & MARY L. REV. 545, 561-62 (1984) (discussing that rapid growth in forensic laboratories has created valid scientific discoveries that would not satisfy *Frye* test). Many courts have accepted novel scientific evidence including neutron activation and polygraph analyses. *Id.* Other courts, however, refuse to admit the novel scientific evidence, along with information concerning the psychology of eyewitness identification. *Id.*

16. Berry v. Chaplin, 169 P.2d 442, 450-51 (Cal. App. 1946).

17. *Id.* at 451.

18. *Id.* at 452.

19. In United States v. Wright, 37 C.M.R. 447, 453 (C.M.A. 1967), a military court adopted voiceprint evidence. *Id.* Later, courts applied only a cursory review of the scientific evidence and, instead, relied upon the precedent of *Wright* to admit voiceprint technology. *See, e.g.*, United States v. Baller, 519 F.2d 463, 465 (4th Cir.) (accepting voice print analysis based on precedent), *cert. denied*, 423 U.S. 1019 (1975); United States v. Franks, 511 F.2d 25, 33 (6th Cir. 1975) (admitting spectrographic analysis based on precedent and not analysis); State v. Olderman, 336 N.E.2d 442, 445-46 (Ohio App. 1975) (analyzing admission of scientific evidence based on precedent). *See generally* John W. Osborne, Comment, *Judicial/Technical Assessment of Novel Scientific Evidence*, 1990 U. ILL. L. REV. 497, 520 (concluding that courts are swayed by precedent rather than by valid review of scientific evidence).

20. *See* National Dairy Prod. Corp. v. Durham, 154 S.E.2d 752, 755 (Ga. App. 1967) (awarding judgment for plaintiff on theory that blow by seatbelt during automobile accident caused testicular cancer). For almost 100 years, the courts admitted erroneous scientific evidence that supported the proposition that trauma could induce cancer. At first, these claims were made pursuant to worker's compensation. Eventually the scientific evidence was admitted in ordinary tort cases. Consequently, in *Daly v. Bergstedt*, 126 N.W.2d 242, 244 (Minn. 1964), a woman was awarded damages after she purportedly developed breast cancer from a fall. *Id.* By the 1960's the courts realized their errors and began to discount this erroneous scientific evidence. *See generally* Peter W. Huber, *Medical Experts and the Ghost of Galileo*, 54 LAW & CONTEMP. PROBS., Summer 1991, at 119, 125-29 (describing admission of evidence supporting claim of trauma induced cancer).

21. *See Mercado*, 756 F. Supp. at 1100 (noting that understanding differences between

In the 1920's, courts developed a very limited standard of admissibility for scientific evidence.[22] Under the *Frye*[23] test, a scientific expert's conclusion was inadmissible unless the conclusion was generally accepted by the scientific community.[24] Although this conservative analysis prevented "junk science" from invading the courtroom,[25] the standard also protected invalid

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science and law have not always been easy); Smith v. W. Horace Williams Co., 84 So. 2d 223, 227 (La. App. 1956) (commenting that scientific evidence presented at trial was completely confusing); *see also* Victor B. Flatt, *OSHA Regulation of Low-Exposure Carcinogens: A New Approach to Judicial Analysis of Scientific Evidence*, 14 U. PUGET SOUND L. REV. 283, 290 (1991) (contending that federal courts have been confused by conflicting scientific evidence concerning low level exposure carcinogens); Thaddeus Murphy, Comment, *The Admissibility of Scientific Evidence in Illinois*, 21 LOY. U. CHI. L.J. 935, 935 (1990) (noting that many trial judges disdain topic of scientific evidence). *See generally*, Major Michael N. Schmitt & Captain Steven A. Hatfield, *Scientific Evidence in Courts-Martial: From the General Acceptance Standard to the Relevancy Approach*, 130 MIL. L. REV. 135, 137 (1990) (concluding that *Frye* analysis was established to counteract potential for confusion caused by scientific evidence). There is a nation-wide trend to increase the use of scientific evidence in the courtroom. The National Center for State Courts conducted a survey and found that almost one-third of those judges and attorneys that answered the survey dealt with scientific evidence in the courtroom. *See generally* Edward J. Imwinkelried, *The Standard for Admitting Scientific Evidence: A Critique from the Perspective of Juror Psychology*, 28 VILL. L. REV. 554, 554-55 (1982-83) (citing study investigating use of scientific evidence, 7 *Study to Investigate Use of Scientific Evidence*, NAT'L CENTER FOR ST. CTS. REP. 1 (Aug. 1980)); Vicki Christian, Comment, *Admissibility of Scientific Expert Testimony: Is Bad Science Making Law?*, 18 N. KY. L. REV. 21, 21 (1990) (noting several proposals to resolve problem created by scientific evidence).

22. *See* People v. Kelly, 549 P.2d 1240, 1245 (Cal. 1976) (explaining that primary advantage of *Frye* is its conservative nature); Commonwealth v. Mendes, 547 N.E.2d 35, 41 (Mass. 1989) (stating that *Frye* test has been criticized for being too conservative); State v. Brown, 687 P.2d 751, 757 (Or. 1984) (contending that main advantage of *Frye* test is its conservative nature). *See generally* Mark S. Ellinger, *DNA Diagnostic Technology: Probing the Problem of Causation in Toxic Torts*, 3 HARV. J.L. & TECH., Spring 1990, at 48 (1990) (relaying that *Frye* test has been criticized as too conservative).

23. Frye v. United States, 293 F. 1013 (D.C. Cir. 1923) (establishing general acceptance test).

24. *Id.* 1014. In *Frye*, the court determined that the scientific technique or principle must be generally accepted within the particular scientific community from which it originates. *Id.*; *see also* United States v. Kozminski, 821 F.2d 1186, 1199 (6th Cir. 1987) (noting that general acceptance meant approval of expert's scientific principles and procedures); Little v. Armontrout, 819 F.2d 1425, 1431 (8th Cir. 1987) (applying general acceptance test). *See generally* Kenneth P. Kreiling, *Scientific Evidence: Toward Providing the Lay Trier with the Comprehensible and Reliable Evidence Necessary to Meet the Goals of the Rules of Evidence*, 32 ARIZ. L. REV. 915, 919 (1990) (noting that *Frye* court refused scientific evidence provided by predecessor of polygraph machine because procedure not accepted by scientific community); John D. Borders, Jr., Note, *Fit to be* Fryed: Frye v. United States *and the Admissibility of Novel Scientific Evidence*, 77 KY. L.J. 849, 851 (1989) (stating that *Frye* established general acceptance test).

25. United States v. Fishman, 743 F. Supp. 713, 718-20 (N.D. Cal. 1990) (applying *Frye* test to preclude admission of evidence regarding coercive persuasion in religious cults); State v. Davis, 814 S.W.2d 593, 600-02 (Mo. 1991) (admitting evidence of DNA fingerprinting under

scientific evidence already present in the system[26] and restricted the use of new, but valid, scientific techniques.[27] In response, many jurisdictions devel-

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Frye test); Hall v. Commonwealth of Virginia, 403 S.E.2d 362, 364 (Va. App. 1991) (applying *Frye* test to preclude admission of hypnotically refreshed testimony). *See also* PETER W. HUBER, GALILEO'S REVENGE 14 (1991) (arguing that *Frye* rule limited introduction of invalid scientific evidence). Professor Imwinkelried analyzed the Supreme Court's reasons for disallowing Arkansas' per se rule against hypnotically enhanced testimony by the accused. Imwinkelried concluded that the Supreme Court determined that when a party's constitutional rights outweigh the system's concern over the validity and reliability of scientific evidence, the courts should not apply the *Frye* test. *See generally* Edward J. Imwinkelried, *The Case for Recognizing a New Constitutional Entitlement: The Right to Present Evidence into Civil Cases*, 1990 UTAH L. REV. 1, 40-41 (1990).

26. *Olderman*, 336 N.E.2d at 448. In *Olderman*, the court stated that it was applying the *Frye* analysis. *Id.* However, the court still admitted the scientifically invalid technique, spectrographic analysis. *Id.* Several other courts also admitted invalid scientific evidence during the height of the *Frye* era. *See National Dairy Prod.*, 154 S.E.2d at 753 (introducing evidence that blow during auto crash caused cancer); *Daly*, 126 N.W.2d at 244 (noting testimony that fall caused cancer); *Baker*, 196 A.2d at 390 (affirming admission of erroneous scientific evidence that trauma produced cancer). *See generally* Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1218-19 (1980) (concluding that under *Frye*, judges often apply precedent rather than comprehensive evaluation); M. Thaddeus Murphy, Comment, *The Admissibility of Scientific Evidence in Illinois*, 21 LOY. U. CHI. L.J. 935, 941 (1990) (noting that *Frye* test may create judicial economy and uniformity because once evidence admitted under *Frye*, evidentiary ruling becomes precedent for future trials).

27. *See* United States v. Tranowski, 659 F.2d 750, 753-55 (7th Cir. 1981) (disallowing use of astronomical charts); United States v. Brown, 557 F.2d 541, 558 (6th Cir. 1977) (using *Frye* analysis, refusing to admit analyses detecting traces of cocaine and marijuana); People v. Owens, 508 N.E.2d 1088, 1094 (Ill. App. 1987) (holding evidence inadmissible because it did not satisfy general acceptance test). In *Tranowski*, the defendant allegedly lied under oath during his brother's counterfeiting trial. *Tranowski*, 659 F.2d at 751. The defendant stated that he had taken a picture of his brother, his mother, and his dog on May 12, in the middle of the afternoon. *Id.* at 751. At trial, the government offered testimony of an astronomer who opined that Tranowski could not have taken the picture at the time the defendant stated. *Id.* at 752. The astronomer premised his opinion upon a sun chart that had been developed fifteen years earlier for use in measuring the height of lunar mountains. *Id.* at 753. The Seventh Circuit refused to accept the expert's testimony though it was scientifically sound, determining that the evidence was unreliable because the expert (1) had no control over the experiment conducted to verify the technique, (2) had not explained or accounted for the distortion in the picture, (3) had not shown that the shadows accurately reflected the length of the shadows depicted, (4) had failed to take into account the slope of the ground, (5) had not verified the solar orientation of the Earth, (6) and had used a chart drawn for May 22 rather than May 12. *Tranowski*, 659 F.2d at 753-54. *See generally* James M. Doyle, *Applying Lawyers' Expertise to Scientific Experts: Some Thoughts About Trial Court Analysis of the Prejudicial Assessment Effects of Admitting and Excluding Expert Scientific Testimony*, 25 WM. & MARY L. REV. 619, 630 (1984) (stating that *Frye* test is restrictive); Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1223 (1980) (concluding that *Frye* test imposes restrictions upon use of scientific evidence).

oped more liberal evidentiary standards.[28] The liberal standards averted the "cultural lag" for which *Frye* was criticized,[29] but exposed the courtroom to a host of flawed scientific conclusions.[30] Clearly, neither *Frye*, nor any other established analysis, successfully resolved the special problems posed by scientific evidence.[31]

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28. United States v. Smith, 869 F.2d 348, 353 (7th Cir. 1989); United States v. Downing, 753 F.2d 1224, 1226 (3d Cir. 1985); Ellis v. International Platex, 745 F.2d 292, 304 (4th Cir. 1984); United States v. Williams, 583 F.2d 1194, 1198 (2d Cir. 1978), *cert. denied*, 439 U.S. 1117 (1979); United States v. Baller, 519 F.2d 463, 466 (4th Cir.), *cert. denied*, 423 U.S. 1019 (1975); *In re* "Agent Orange" Prod. Liability Litigation, 611 F. Supp. 1223, 1255 (E.D.N.Y. 1985). *See generally* Kenneth R. Kreiling, *Scientific Evidence: Toward Providing the Lay Trier with the Comprehensible and Reliable Evidence Necessary to Meet the Goals of the Rules of Evidence*, 32 ARIZ. L. REV. 915, 928 (1990) (reasoning that view of jury competence determines if court favors *Frye* or relevancy approach); L. Joane Garcia-Colson, Comment, *Through the Looking Glass:* Head v. Lithonia, *Scrutiny of the Underlying Bases of an Expert Opinion*, 67 DENV. U. L. REV. 587, 600 (1990) (noting relevancy test requires only that expert testimony be more helpful than prejudicial).

29. Andrews v. Florida, 533 So. 2d 841, 846-47 (Fla. Dist. Ct. App. 1988) (admitting DNA print identification and holding that using *Frye* test makes some reliable evidence inadmissible); Almeida v. Correa, 465 P.2d 564, 567 (Haw. 1970) (avoiding scientific cultural lag by rejecting visual comparison test in paternity suit); Saint Louis v. Boecker, 370 S.W.2d 731, 734 (Mo. App. 1963) (noting that customary conservative approach for scientific evidence results in cultural lag). *See generally* Joseph G. Petrosinelli, Comment, *The Admissibility of DNA Typing: A New Methodology*, 79 GEO. L.J. 313, 320 (1990) (concluding that relevancy test resolves cultural lag situation caused by *Frye* analysis).

30. *See Downing*, 753 F.2d at 1236 (criticizing relevancy approach because of potential to admit erroneous scientific evidence); State v. Schwartz, 447 N.W.2d 422, 424 (Minn. 1989) (discounting relevancy analysis because approach allows subjectivity). *See generally* Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1237-39 (1980) (discounting relevancy analysis because approach can mislead jury); John W. Osborne, Comment, *Judicial/Technical Assessment of Novel Scientific Evidence*, 1990 U. ILL. L. REV. 497, 531 (opining that relevancy approach not appropriate when underlying scientific principle unsound); Laurel Beeler & William R. Wiebe, Comment, *DNA Identification Test and the Courts*, 63 WASH. L. REV. 903, 937 (1988) (reasoning that relevancy test could be more restrictive than *Frye* analysis).

31. *See* Windmere, Inc. v. International Entrance Co., 506 A.2d 834, 838 (N.J. Super. 1986) (determining that major weakness in relevancy analysis is failure to understand problems of scientific evidence); *cf.* Ealy v. Richardson-Merrell, Inc., 897 F.2d 1159, 1159 (D.C. Cir.) (reversing $95 million verdict because expert testimony inadmissible), *cert. denied*, __ U.S. __, 111 S. Ct. 370, 112 L. Ed. 2d 332 (1990). *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 597 (1988) (noting that recently scientific evidence problems more onerous); John W. Osborne, Comment, *Judicial/Technical Assessment of Novel Scientific Evidence*, 1990 U. ILL. L. REV. 497, 546 (arguing that neither *Frye* nor relevancy approach adequately address scientific evidence problems); Major Michael N. Schmitt & Captain Steven A. Hatfield, *Scientific Evidence in Courts-Martial: From the General Acceptance Standard to the Relevancy Approach*, 130 MIL. L. REV. 135, 138 (1990) (explaining that though *Frye* widely accepted, *Frye* still does not solve scientific evidentiary problems).

II. CAUSES FOR THE QUANDARY

Scientific evidence presents admissibility problems. Two factors make scientific evidence a thorny legal problem. First, scientific information is unlike any other type of evidence.[32] It is created by individuals who do not think[33] or talk[34] like lawyers or laypersons.[35] Second, because science and law come

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32. *See* Mercado v. Ahmed, 756 F. Supp. 1097, 1100 (N.D. Ill. 1991) (explaining that though judicial system and scientific community both attempt to find truth, their methods and purposes differ). *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 597 (1988) (noting that scientific evidence creates special problems in court); Sheila Jasanoff, *Science and the Courts: Advice for a Troubled Marriage*, NAT. RESOURCES & ENV'T, Fall 1986, at 3 (reasoning that scientific evidence creates problems in litigation); Harold L. Korn, *Law, Fact, and Science in the Courts*, 66 COLUM. L. REV. 1080, 1080-81 (1966) (noting problems in judicial system caused by dependence upon experts); Kenneth R. Kreiling, *Scientific Evidence: Toward Providing the Lay Trier with the Comprehensible and Reliable Evidence Necessary to Meet the Goals of the Rules of Evidence*, 32 ARIZ. L. REV. 915, 916 (1990) (reasoning that scientific evidence is more dangerous than ordinary evidence); John W. Osborne, Comment, *Judicial/Technical Assessment of Novel Scientific Evidence*, 1990 U. ILL. L. REV. 497, 520 (1990) (distinguishing scientific and legal analysis and court reliance upon precedent rather than thorough analysis).

33. *See* Howard T. Markey, *Law and Science: A Dialogue on Understanding*, 68 A.B.A. J. 154, 154-58 (1982). Using the dialogue style, Howard Markey described the differences in the thought processes used in science and law.

> SCIENCE: (fingers entwined) Even our methods are directly opposite. Few of your followers understand my empirical method. My scientific method involves a general "law" from repeatedly and experimentally tested hypotheses.
>
> LAW: (pointing) And few of your followers understand my dialectic method. My judicial process normally applies an already evolved legal principle to a legally proved set of individual facts. Incidentally, your use of my name as a label for scientific phenomena - like gravitation, motion, thermodynamics - may impede understanding. Our masters can disregard my principles, but your so called laws are inviolable. The outlaw gets punished, not the falling rock.

Id. at 155-56.

34. *See id.* In dialogue style, Howard Markey describes the differences in the way law and science communicate:

> LAW: I agree that communication among our present followers is a must. But to pierce the complexity curtain between them, they must speak the same language. If I had my way, there would be an english major stationed in the door of every scientific laboratory with instructions to translate into english every scientific report or statement intended for my followers. "Deoxyribonucleic acid," even "DNA," is jargon. Why not say "the stuff that controls heredity?"
>
> SCIENCE: Aah, but that is a two way street. Nowadays, your followers are less likely to say "res ipsa loquitur" than "the thing speaks for itself," but you still have a long way to go. As reported in the federal judiciary's newsletter, *The Third Bench*, a recent study of a simple court hearing disclosed repeated use of 18 words not employed even once in a normal million words used by our masters. Another 25 words used at that hearing are used only once in every million by our masters.

Id. at 157-58.

35. *See* Barefoot v. Estelle, 463 U.S. 880, 929-30 (1983) (Blackmun, J., dissenting) (con-

from very different perspectives,[36] scientific information does not fit into established evidentiary molds.[37] Consequently, judges and jurors alike easily misconstrue the information scientific evidence provides.[38] Different participants in the judicial process capitalize upon the vulnerability of the judicial system to admit erroneous scientific information.[39] Motivated by greed and

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tending that inexperienced juries are incapable of "separating the wheat from the chaff"); Ealy v. Richardson-Merrell, Inc., 897 F.2d 1159, 1160 (D.C. Cir.) (noting trial court's improper admission of erroneous scientific evidence that Bendectin causes birth defects), *cert. denied*, __ U.S. __, 111 S. Ct. 870, 112 L. Ed. 2d 332 (1990). *But see* United States v. Baller, 519 F.2d 463, 466 (4th Cir.) (noting that unless scientific technique is prejudicial, juries not misled because attorneys effectively utilize cross-examination), *cert. denied*, 423 U.S. 1019 (1975). *See also* Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1240 (1980) (stating that effect of polygraph evidence on jury deliberations inconclusive); Harold L. Korn, *Law, Fact, and Science in the Courts*, 66 COLUM. L. REV. 1080, 1104-05 (1966) (arguing that judges better suited to consider scientific evidence than juries because judges have superior intelligence); John W. Osborne, Comment, *Judicial/Technical Assessment of Novel Scientific Evidence*, 1990 U. ILL. L. REV. 497, 528 (concluding that jurors often misapply scientific evidence because they do not understand it).

36. *See generally* Steve Gold, *Causation in Toxic Torts: Burdens of Proof, Standards of Persuasion, and Statistical Evidence*, 96 YALE L.J. 376, 382-92 (1986) (illustrating general perspective of science but specific perspective of law); Donald W. Large & Preston Michie, *Proving that the Strength of the British Navy Depends on the Number of Old Maids in England: A Comparison of Scientific Proof With Legal Proof*, 11 ENVTL. L. 557, 561-62 (1981) (contrasting disciplines of science and law).

37. *See generally* Fredric I. Lederer, *Scientific Evidence—An Introduction*, 25 WM. & MARY L. REV. 517, 520 (1984) (asserting need for special rules to deal with scientific evidence); John D. Borders, Jr., Note, *Fit to Be* Fryed: Frye v. United States *and the Admissibility of Novel Scientific Evidence*, 77 KY. L.J. 849, 857-58 (1988-89) (noting that courts must decide whether to apply relevancy test or establish special rules to adequately deal with scientific evidence).

38. For example, some courts have admitted voice print evidence by relying upon the technical reliability of the equipment rather than the validity of the underlying scientific premises. United States v. Raymond, 337 F. Supp. 641, 643-45 (D.D.C. 1972), *aff'd*, 498 F.2d 741 (D.C. Cir. 1974). *See generally* Nathan Isaacs, *The Law and the Facts*, 22 COLUM. L. REV. 1, 7 (1922) (contending that some scientific aspects of case so complicated even highly qualified and intelligent judges cannot adequately assess information).

39. *See* Oxendine v. Merrell Dow Phamaceuticals, Inc., 506 A.2d 1100, 1102-03 (D.C. 1986); *cf.* Barrett v. United States, No. 76 CIV., 1991 WL 60365 (S.D.N.Y. 1991) (noting that Federal Torts Claims Act created to counteract avaricious goals of lawyers). In *Oxendine*, Mary Oxendine was awarded a jury verdict after her attorney and scientific expert convinced the jury that Bendectin caused the twelve year old girl's shortened right arm and missing fingers. *Oxendine*, 506 A.2d at 1103. The jury gave the little girl $750,000 in compensatory damages. *Id.* at 1103. Although the defense introduced substantial valid scientific evidence, the jury was swayed by the erroneous scientific information provided by the plaintiff's expert. *Id.* The trial court granted a judgment notwithstanding the verdict, and the court of appeals affirmed. *Id.* at 1114. The case was reopened in 1988 because the plaintiff's expert testimony was considered so erroneous as to constitute perjury. Oxendine v. Merrell Dow Pharmaceuticals, Inc., 563 A.2d 330, 332 (D.C. 1989). The Oxendine litigation exemplifies how attorneys

avarice, these individuals manipulate the judicial process for their own economic gain.[40] These two factors, the uniqueness of scientific evidence and the vulnerability of the judicial system, combine to create devastating admissibility problems.[41]

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and scientists attempt to use the evidentiary problems created by scientific evidence to mislead juries. *See generally* Deborah R. Hensler, *Science in the Court: Is There a Role for Alternative Dispute Resolution*, 54 LAW & CONTEMP. PROBS. Summer 1991, at 171, 172 (arguing that participants in litigation use scientific evidence as weapon).

40. *See* Raymark Indus., Inc., v. Stemple, No. 88-1014K, 1990 WL 72588 (D. Kan. May 30, 1990) (illustrating attempt to manipulate judicial process). This action resulted from a settlement between two parties in an asbestos exposure case. *Id.* at 1. The defendant firm filed fraud charges against the plaintiff's attorneys and doctors. *Id.* The firm alleged that the attorneys had unethically solicited clients and, with the help of scientific experts, had formulated a claim generating scheme. *Id.* at 2. The court noted that the scheme made a farce out of both the law and medicine. *Raymark*, No. 88-1014K, 1990 WL 72588 at 2-3. The court noted that the attorneys and doctors established an organization called the "National Tire Workers Litigation Project." *Id.* at 5. The group bought a van and refurbished the vehicle with x-ray equipment to canvass the affected region for potential asbestos claimants. *Id.* The group called these vans "exam-mobiles." *Id.* Each doctor was paid fifty dollars per diagnosis and completed 100-150 examinations each day. *Raymark*, No. 88-104K, 1990 WL 72588 at 5. The diagnoses indicated that many of the individuals suffered from pleural disease, fibrosis, and lung cancer. *Id.* at 6. The doctor-designed health questionnaire asked:

> Have you worked at the Danbury (yes, no, years)?
> Have you worked at the mill?
> Have you worked curing rubber?
> Have you worked in the cement house?
> Have you worked in the tire room?
> Have you worked close to the lined "hot pipes?"
> Have you been a fork lifter tractor operator?
> Have you done janitorial work?
> Have you worked in the warehouse?
> Have you worked with or close to: soapstone? talcum powder? asbestos?
> Do you smoke cigarettes? How many packs per day?
> Did you stop smoking? If so, when?
> Are you short of breath?
> Can you climb stairs? How many flights?
> Do you cough in the morning? Do you cough up anything?

Id. at 7.

The court noted that these questionnaires were clearly inadequate. *Id.* at 8. The judge noted that this case was motivated by greed which clouded each lawyer's professional judgment. *Raymark*, No. 88-1014K, 1990 WL 72588 at 13. Consequently, the court denied the defendant's motion for summary judgment. *Id.* at 1.

41. *Mercado*, 756 F. Supp. at 1101 (reasoning that scientific evidence cannot be truly understood by court until reliability and validity both considered); Symposium on Science and the Rules of Evidence, 99 F.R.D. 187, 232 (1983) (noting problem with scientific evidence that lawyers do not comprehend scientific principles). *See generally* Peter W. Huber, Comment, *A Comment on Toward Incentive Based Procedure: Three Approaches for Regulating Scientific Evidence by E. Donald Elliot*, 69 B.U. L. REV. 513, 513 (1989) (arguing that science and law systems originate from different perspectives).

A. *Incongruity Between Legal and Scientific Reasoning*

1. Different Views on Scientific Truth

The scientist and the lawyer address truth from very different positions.[42] Because determining truth is the goal of a trial, truth has a utilitarian purpose for an attorney.[43] An attorney's goal is to convince the trier of fact that her version of the truth is correct.[44] Because the courts readily declare what is the truth despite harboring doubts,[45] the attorney need not establish truth

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42. *See* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 614 (1988) (citing Danner & Sagall, *Medicolegal Causation: A Source of Professional Misunderstanding*, 3 AM. J. LAW & MED. 303, 303 (1977), that states law and science view causation differently). *But see* Steven Goldberg, *The Reluctant Embrace: Law and Science in America*, 75 GEO. L.J. 1341, 1350 (1987) (arguing differences between law and science do not preclude disciplines from understanding each other).

43. *See* United States v. Inadi, 475 U.S. 387, 396 (1986) (describing trial as process for determining truth); United States v. Havens, 446 U.S. 620, 626 (1980) (stating that "arriving at the truth is a fundamental goal of our legal system"); Trammel v. United States, 445 U.S. 40, 50 (1980) (noting predominant principle of litigation: finding truth); Tehan v. United States, 382 U.S. 406, 416 (1966) (holding that determining truth is primary purpose of trial). *See generally* John T. Noonan, *The Purposes of Advocacy and the Limits of Confidentiality*, 64 MICH. L. REV. 1485, 1487 (1966) (stating primary purpose of trial is to establish most accurate results possible); Louis R. Raveson, *Advocacy and Contempt: Constitutional Limitations on the Judicial Contempt Power, Part One: The Conflict Between Advocacy and Contempt*, 65 WASH. L. REV. 477, 530 (1990) (relaying that most prevalent model explaining role of trial is that trial conducted to find truth); Major Michael N. Schmitt & Captain Steven A. Hatfield, *Scientific Evidence in Courts-Martial: From the General Acceptance Standard to the Relevancy Approach*, 130 MIL. L. REV. 135, 139 (1990) (noting that limiting aspect of *Frye* can hinder determining truth).

44. MODEL CODE OF PROFESSIONAL RESPONSIBILITY Canon 7 (1981) (declaring duty of attorney to zealously represent client within limits of law); MODEL RULES OF PROFESSIONAL CONDUCT Rule 3.1 (1983) (explaining duty to advocate aggressively but within bounds of law). *See generally* William W. Schwarzer, *The Federal Rules, The Adversary Process, and Discovery Reform*, 50 U. PITT. L. REV. 703, 712 (1989) (contending that purpose of trial is to win); Roger J. Traynor, *Ground Lost and Found in Criminal Discovery*, 39 N.Y.U. L. REV. 228, 249 (1964) (arguing that adversary system provides society with best possible method for determining truth).

45. Often the federal courts will instruct a jury that a preponderance of the evidence means to prove that something is more likely than not. EDWARD J. DEVITT, ET AL., 3 FEDERAL JURY PRACTICE AND INSTRUCTION (CIVIL) § 72.01, at 32 (4th ed. 1987). Preponderance of the evidence means such evidence as, when considered and compared with opposing evidence, has more convincing force, and produces a belief that something is more likely true than not true. *Id.* The rule does not require the evidence to establish an absolute certainty, since certainty is seldom possible. *See generally* WAYNE R. LAFAVE & A.C. SCOTT, HANDBOOK ON CRIMINAL LAW § 4, at 16 (1972) (noting that criminal case burden of proof is reasonable doubt, while civil case burden is preponderance of evidence). *But see* Rita J. Simon & Linda Mahan, *Quantifying Burdens of Proof: A View from the Bench, the Jury, and the Classroom*, 5 L. & SOC'Y REV. 319, 329-30 (1971) (explaining that jurors often cannot tell difference between beyond reasonable doubt and preponderance of evidence standards); C.M.A. McCauliff, *Burdens of Proof: Degrees of Belief, Quanta of Evidence, or Constitutional*

unequivocally. Her truth must only be more believable than her opponent's.[46]

For their part, judges and jurors anticipate hearing opposite versions of truth.[47] First, the triers of fact assess the reliability of all the evidence presented in the case.[48] Using the reliable evidence, the triers then deter-

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Guarantees?, 35 VAND. L. REV. 1293, 1330-31 (1982). Researchers have surveyed judges and jurors to determine what level of probability would equate to a preponderance of evidence standard in the triers' minds. *Id.* at 1330. Of those judges answering the survey, about three-fifths chose a probability of fifty to fifty-five percent, two-fifths chose sixty percent or greater, almost one-fifth chose seventy percent or better, one-tenth chose eighty percent or greater, and one-twentieth chose ninety to one hundred percent. *Id.* at 1331. Jurors were less willing to harbor doubts. *Id.* Four-fifths chose a probability of seventy percent or greater, fifty percent chose a probability of eighty percent or greater, and more than ten percent chose ninety-five to one hundred percent. C.M.A. McCauliff, *Burdens of Proof: Degrees of Belief, Quanta of Evidence, or Constitutional Guarantees?*, 35 VAND. L. REV. 1293, 1330-31 (1982).

46. Absolute certainty is not required. Larson v. Jo Ann Cab Corp., 209 F.2d 929, 934 n.25 (2d Cir. 1954); King's Case, 225 N.E.2d 900, 902 (Mass. 1967); Bertram v. Wunning, 385 S.W.2d 803, 806-07 (Mo. App. 1965), *upon subsequent appeal*, 417 S.W.2d 120, 124-25 (Mo. App. 1967); Bornstein v. Metropolitan Bottling Co., 139 A.2d 404, 411 (N.J. 1958); Frazier v. Frazier, 89 S.E.2d 225, 235 (S.C. 1955); McDonald v. Union Pac. R.R. Co., 167 P.2d 685, 689 (Utah 1946) (Wolfe, J., concurring). *See generally* 9 JOHN H. WIGMORE, EVIDENCE IN TRIALS AT COMMON LAW § 2498 (1981) (illustrating philosophy behind truth-seeking model of justice); Louis S. Raveson, *Advocacy and Contempt: Constitutional Limitations on the Judicial Contempt Power - Part One: The Conflict Between Advocacy and Contempt*, 65 WASH. L. REV. 477, 530 (1990) (describing truth-seeking model of justice where judge views case from distance, observing parties offering different versions of truth); Michael E. Tigar, *Jury Argument: You, the Facts, and the Law*, LITIG., Summer 1988, at 21-22 (describing litigation process where jury presented evidence so that it can make ultimate decision as to which facts are most truthful).

47. *See* Miley v. Oppenheimer & Co., 637 F.2d 318, 325 (5th Cir. 1981). In *Miley*, the court considered the claims of a customer who said he was a novice investor. *Id.* The broker asserted that the customer was adept at trading. *Id.* The court stated that "the truth probably lay somewhere between the two conflicting stories." *Id. See generally* Ronald J. Allen, *A Reconceptualization of Civil Trials*, 66 B.U. L. REV. 401, 408 (1986) (stating that jury considers two different versions of reality).

48. *See* Watkins v. Sowders, 449 U.S. 341, 347 (1981) (holding that jury's responsibility is to assess reliability of identification evidence); Manson v. Brathwaite, 432 U.S. 98, 113-14 (1977) (suggesting reliability of evidence determines its admissibility); United States v. Skillman, 922 F.2d 1370, 1375 (9th Cir. 1990) (opining that witness' credibility is factor for jury to consider when jury assesses reliability of evidence); *see also* Mark S. Ellinger, *DNA Diagnostic Technology: Probing the Problem of Causation in Toxic Torts*, HARV. J.L. & TECH., Spring 1990, at 46 (explaining that judges must determine reliability of scientific evidence to establish admissibility); Eleanor Swift, *A Foundation Fact Approach to Hearsay*, 75 CAL. L. REV. 1339, 1341 (1987) (explaining that trier of fact determines reliability of evidence); Michael E. Tigar, *Jury Argument: You, the Facts, and the Law*, LITIG., Summer 1988, at 21-22 (noting that juries assess evidence presented at trial to establish truthful facts); Anne S. Toker, *Admitting Scientific Evidence in Toxic Tort Litigation*, 15 HARV. ENVTL. L. REV. 165, 166 (1991) (relaying that judge can prevent jury from hearing scientific evidence if judge determines evidence unreliable).

mine which version is most probable.[49] That version is heralded as the truth.[50] Because judges and juries require reliable evidence to determine legal truth, reliability is the linchpin in the adversarial process.[51]

The concept of truth is quite different for the scientist.[52] Although determining truth may be catalyzed by the needs of society,[53] for the pure scien-

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49. *See* United States v. Padilla, 869 F.2d 372, 378 (8th Cir. 1989) (illustrating that jury decides which version of truth is most probable); Olds v. Neil, 482 F.2d 301, 304 (6th Cir. 1973) (noting jury chose between confession and defendant's testimony at trial); California v. Freemen, 97 Cal. Rptr. 717, 721-22 (Cal. App. 3d 1971) (stating that jury can choose which party's version is true or discount both). *See generally* LOUIS NIZER, MY LIFE IN COURT 911 (1961); Daniel Shaviro, *Statistical-Probability Evidence and the Appearance of Justice*, 103 HARV. L. REV. 530, 540 (1989) (explaining that after jury decides which version of truth is more probable, they begin to view that version as what really happened). In *My Life in Court*, Nizer stated:

> The jury decides the case because of the rule of probability. It accepts one version as against another because it accords with its own standards of experience. The judge, when he is faced with conflicting testimony, decides on the basis of probability. We talk of the credibility of witnesses, but what we really mean is that the witness told a story which meets the test of plausibility and is therefore credible.

LOUIS NIZER, MY LIFE IN COURT 911 (1961).

50. *See* Hall v. Kelso, 892 F.2d 1541, 1546 (11th Cir. 1990) (noting that jury tries to establish truth through verdict). *See generally* V.C. Ball, *The Moment of Truth: Probability Theory and Standards of Proof*, 14 VAND. L. REV. 807, 808 (1961) (contending that once jurors have determined true facts of case, those facts considered conclusive); Mark Brodin, *Accuracy, Efficiency, and Accountability in the Litigation Process—The Case for the Fact Verdict*, 59 U. CIN. L. REV. 15, 15 (1990) (arguing that jury's job is to find truth); Jack B. Weinstein, *Some Difficulties in Devising Rules for Determining Truth in Judicial Trials*, 66 COLUM. L. REV. 223, 229 (1966) (noting that verdict reflects only triers' determination of truth).

51. *See* United States v. A & S Council Oil Co., 947 F.2d 1128, 1133 (4th Cir. 1991) (stating that reliability of scientific evidence must be extremely high to counteract "aura of infallibility"); Christophersen v. Allied-Signal Corp., 939 F.2d 1106, 1111 (5th Cir. 1991) (opining that evidentiary reliability ultimate concern of judicial system); Jones v. State, 716 S.W.2d 142, 151 (Tex. Crim. App. 1986) (holding that reliability of scientific evidence must be stronger when no other evidence supports guilty verdict). *See generally* Major Michael N. Schmitt & Captain Steven A. Hatfield, *Scientific Evidence in Courts-Martial: From the General Acceptance Standard to the Relevancy Approach*, 130 MIL. L. REV. 135, 137 (1990) (stating that reliable evidence essential, especially in cases dealing with scientific evidence).

52. *See* Chalk v. United States Dist. Ct. for Cent. Dist. of Cal., 840 F.2d 701, 712 (9th Cir. 1988) (Sneed, J., concurring) (explaining that medical scientific truths often change because of new data); Ferebee v. Chevron Chem. Co., 736 F.2d 1529, 1535 (D.C. Cir.) (noting that court can determine scientific truth even when conflicting conclusions drawn by scientific community), *cert. denied*, 469 U.S. 1062 (1984); Mercado v. Ahmed, 756 F. Supp. 1097, 1100 (N.D. Ill. 1991) (stating scientists seek truth for truth's own reward rather than for utilitarian purpose). *See generally* Howard T. Markey, *Jurisprudence or "Juriscience"?*, 25 WM. & MARY L. REV. 525, 526-27 (1984) (opining that science and law look for and find truth in different ways); Milton R. Wessel, *Adversary Science and the Adversary Scientist: Threats to Responsible Dispute Resolution*, 28 JURIMETRICS J. 379, 380 (1988) (describing how science and law have different perspectives).

53. *See* Mississippi Empl. Sec. Comm'n v. Martin, 568 So. 2d 725, 728 (Miss. 1990) (re-

tist, discovering truth rarely has an utilitarian purpose.[54] Truth is its own reward. To the scientist, truth is more a process than a result.[55] The scientist determines truth slowly and systematically.[56] In fact, a scientist may spend his entire life searching for truth and never discover it.[57]

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lating that scientists researched alcoholism to determine which gene caused tendency toward alcoholism); Cullin v. Wyoming, 565 P.2d 445, 455 (Wyo. 1977) (explaining that science increased ability of courts to determine truth through fire arms identification, finger print identification, blood analysis, and alcoholic intoxication analysis). *See generally* John W. Osborne, Note, *Judicial/Technical Assessment of Novel Scientific Evidence*, 1990 U. ILL. L. REV. 497, 519 (noting that scientific endeavors often directed towards particular goal, like curing disease).

54. *See Mercado*, 756 F. Supp. at 1100 (stating that scientific truth has no utilitarian purpose). *See generally* Steven Goldberg, *The Reluctant Embrace: Law and Science in America*, 75 GEO. L.J. 1341, 1344-45 (1987) (contending that science is not utilitarian).

55. *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 622 (1988) (noting that practice of science is evolutionary process); Richard Delgado & David R. Millen, *God, Galileo, & Government: Toward Constitutional Protection for Scientific Inquiry*, 53 WASH. L. REV. 349, 356 (1978) (explaining that study of science is creative process); Gary L. Francione, *Experimentation in the Marketplace Theory of the First Amendment*, 136 U. PA. L. REV. 417, 422 (1987) (noting belief that science introduces more true facts into marketplace of ideas); John Veilleux, Note, *The Scientific Model in Law*, 75 GEO. L.J. 1967, 1980 (1987) (opining that scientists now believe scientific truth is not yet conclusively determined).

56. *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 622 (1988) (explaining systematic approach of scientists); John W. Osborne, Note, *Judicial/Technical Assessment of Novel Scientific Evidence*, 1990 U. ILL. L. REV. 497, 522 (describing scientists as continually attempting to validate their work).

57. *See generally* Steven Goldberg, *The Reluctant Embrace: Law and Science in America*, 75 GEO. L.J. 1341, 1342-43 (1987) (describing procedural and systematic approach of scientific method); Kenneth R. Kreiling, *Scientific Evidence: Toward Providing the Lay Trier with the Comprehensible and Reliable Evidence Necessary to Meet the Goals of the Rules of Evidence*, 32 ARIZ. L. REV. 915, 960 n.243 (1990). Professor Kreiling reasoned that the scientific and legal systems differ. *Id.* The scientific system requires very high standards for establishing truth. *Id.* In fact, some scientific philosophers contend that there is no way to determine truth. *Id.* Professor Kreiling delineates a simplified model of the scientific method:

> (1) The scientist forms a hypothesis based on her practical experiences, observations, intuition, and drawing upon previously established theory. Typically, the hypothesis defines a causal relationship between two or more variables.
> (2) Next, the scientist plans an experiment, such as a systematic observation, to test the hypothesis. A good experiment will contain a mechanism to control rival influences.
> (3) The scientist then performs the experiment, documenting the procedure to ensure replication.
> (4) The experiment should incorporate a number of subjects to eliminate the possibility that the result was but a coincidence.
> (5) Finally, the hypothesis is confirmed, or is refuted. For instance, the experiment may indicate that the subject causes some other result than what was expected.

Kenneth R. Kreiling, *Scientific Evidence: Toward Providing the Lay Triers with the Comprehensible and Reliable Evidence Necessary to Meet the Goals of the Rules of Evidence*, 32 ARIZ. L. REV. 915, 966-67 (1990).

To the scientist, a theory is a hypothesis explaining the reason a phenomenon occurs.[58] Consequently, a theory is not useful unless the reasoning used to form and support the theory is valid.[59] For example, Sir Isaac Newton hypothesized that apples fall downward because of some invisible force called gravity. Fifteenth century scientists thought apples fell because of an invisible force called witchcraft. Both conclusions are theories. However, one theory is useless because the theory is not based on cogent and well-grounded reasoning. In short, scientists require valid reasoning to determine scientific truth.[60] Therefore, validity is the linchpin in the scientific process.[61]

When science makes its way into the courtroom, a quandary develops because each discipline views truth differently. Law demands reliability but science demands validity. Therefore, scientific evidence requires a two-step analysis.[62] First, the court must ascertain if the theory is valid.[63] Once

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58. *See* Reed v. State, 391 A.2d 364, 421 (Md. 1978) (Smith, J., dissenting) (describing scientific desire for mathematical reliability); Buhrle v. State, 627 P.2d 1374, 1377 (Wyo. 1981) (questioning validity of expert's scientific theory as not accurately explaining battered woman syndrome); *see also* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 617 (1988) (defining theory as spectrum, from body of established knowledge to educated guess); Nancy Levit, *Listening to Tribal Legends: An Essay on Law and the Scientific Method*, 58 FORDHAM L. REV. 263, 269 (1989) (stating essential element of theory is that theory accurately explains phenomena).

59. *See* Environmental Defense Fund v. Environmental Protection Agency, 548 F.2d 998, 1006 (D.C. Cir. 1976) (admitting evidence of carcinogenicity because scientific method was valid); State v. Dorsey, 539 P.2d 204, 205 (N.M. 1975) (requiring validation of theory to hold polygraph test reliable enough for admission); *Buhrle*, 627 P.2d at 1377 (holding evidence concerning battered women syndrome inadmissible because invalid use of scientific method). *See generally* Edward J. Imwinkelried, *Judge Versus Jury: Who Should Decide Questions of Preliminary Facts Conditioning the Admissibility of Scientific Evidence?*, 25 WM. & MARY L. REV. 577, 598-606 (1984) (describing validity analysis).

60. *See Mercado*, 756 F. Supp. at 1100 (arguing that explanatory power not enough to show validity); *see also* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 600 (1988) (arguing scientific truth determined by validity of expert's conclusion based on expert's reasoning); David L. Faigman, Note, *The Battered Woman Syndrome in Self-Defense: A Legal and Empirical Dissent*, 72 VA. L. REV. 619, 622 (1986) (encouraging courts to ascertain validity of expert opinions).

61. *See* Washington v. Armstrong World Indus., 839 F.2d 1121, 1123 (5th Cir. 1988) (refusing to admit scientific evidence because evidence not supported by medical literature); *Mercado*, 756 F. Supp. at 1098 (stating that expert opinions must be proven to be valid). *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 599 (1988) (explaining that validity means product resulted from sound reasoning); Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1200-01 (1980) (stating that validity of scientific evidence must be established).

62. *See Christophersen*, 939 F.2d at 1110 (5th Cir. 1991) (establishing four guideposts to review scientific evidence with focus on reliability and validity); Easson v. Velsicol Chem. Co., No. CIV.A.89-188, 1991 WL 220955, at *1 (E.D. La. Oct. 23, 1991) (applying *Christophersen*

proven, the trier of fact must determine if the theory is reliable.[64] A jury should consider only the scientific evidence that passes this two-step approach.[65]

2. Different Interpretations of the Scientific Method

Besides holding different perspectives on truth, the two groups also have divergent views on what the scientific method implies.[66] Lawyers normally

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analysis). *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 599 (1988) (arguing that court must verify validity and reliability of evidence); Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1204 (1980) (stating that evidence should be analyzed for validity and reliability).

63. *Cf.* Osburn v. Anchor Lab. Inc., 825 F.2d 908, 915 (5th Cir. 1987) (allowing testimony regarding leukemia because expert relied on acceptable methods), *cert. denied*, 485 U.S. 1009 (1988); *Buhrle*, 629 P.2d at 1377 (questioning validity of expert scientific method concerning battered woman syndrome). *See generally* David L. Faigman, *The Battered Woman's Syndrome in Self Defense: A Legal and Empirical Dissent*, 72 VA. L. REV. 619, 622 (1986) (stating that courts should question validity of battered woman's syndrome); Edward J. Imwinkelried, *Judge Versus Jury: Who Should Decide Questions of Preliminary Facts Conditioning the Admissibility of Scientific Evidence?*, 25 WM. & MARY L. REV. 577, 598-606 (1984) (arguing that judge should not admit scientific evidence until judge determines evidence is valid).

64. *See* United States v. Williams, 583 F.2d 1194, 1198-99 (2d Cir. 1978) (weighing reliability of spectrographic voice analyses), *cert. denied*, 439 U.S. 1117 (1979); *Dorsey*, 539 P.2d at 205 (requiring showing of reliability to admit evidence of polygraph test); State v. Kersting, 623 P.2d 1095, 1101-02 (Or. App. 1981) (admitting microscopic comparison of hair samples after determining evidence was reliable), *aff'd*, 638 P.2d 1145 (Or. 1982). *See generally* Andre Moenssens, *Admissibility of Scientific Evidence—An Alternative to the* Frye *Rule*, 25 WM. & MARY L. REV. 545, 567-74 (1984) (contending that reliability should be basis upon which scientific evidence analyzed); John D. Borders, Jr., Note, *Fit to Be* Fryed: Frye v. United States *and the Admissibility of Novel Scientific Evidence*, 77 KY. L.J. 849, 856 (1989) (stating that scientific evidence must be proven reliable before evidence admissible); Vicki Christian, Comment, *Admissibility of Scientific Expert Testimony: Is Bad Science Making Law?*, 18 N. KY. L. REV. 21, 34 (1990) (noting that under refined *Frye* rule, courts should admit reliable scientific evidence).

65. *See Mercado*, 756 F. Supp. at 1101 (noting that more reliable and valid evidence has greater chance of being admitted). *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 599 (1988) (dictating two-step approach).

66. *Cf.* Roe v. Wade, 410 U.S. 113, 120 (1973) (illustrating confidence courts have in scientific method by deferring to doctors in pregnancy termination decisions); Funk Bros. Seed Co. v. Kalo Inoculant Co., 333 U.S. 127, 130 (1948) (illustrating that courts view some phenomena as laws of nature); Symposium on Science and the Rules of Evidence, 99 F.R.D. 187, 232 (1983) (stating that lawyers do not understand scientific method). *See generally* Deborah R. Hensler, *Science in the Court: Is There a Role for Alternative Dispute Resolution*, 54 LAW & CONTEMP. PROBS., Summer 1991, at 172 (noting that science and law have different methods of determining truth but scientific method preferred for determining correct answer to scientific questions); Howard T. Markey, *Law and Science: A Dialogue on Understanding*, 68 A.B.A. J. 154, 154-58 (1982) (noting judges unaware that science is search for truth rather

consider science from a traditional perspective.[67] They believe that the scientific method is a completely objective process, void of values and biases.[68] Additionally, lawyers believe that there are fundamental and absolute laws in science.[69] However, the traditional view of science suggests an accuracy and veracity that does not exist.[70]

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than determination of truth); Mary W. Costley, Comment, *Scientific Evidence—Admissibility* Fryed *to a Crisp*, 21 S. TEX. L. REV. 62, 62 (1990) (analyzing scientific method as facilitating objectivity).

67. *Cf. Environmental Defense Fund*, 548 F.2d at 1004 (discounting effect of contradicting scientific evidence); *Reed*, 391 A.2d at 421 (Smith, J., dissenting) (stating that scientists like precision, exactness, and mathematical reliability); People v. Barbara, 255 N.W.2d 171, 194 (Mich. 1977) (disallowing use of polygraph fearing scientific technique takes issue away from law). *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 617 (1988) (describing positivist view of science); Peter W. Huber, Comment, *A Comment on Toward Incentive Based Procedure: Three Approaches for Regulating Scientific Evidence by E. Donald Elliot*, 69 B.U. L. REV. 513, 515 (1989) (stating courts have decided environmental cases based on scientific evidence that appeared accurate at time, but now looks questionable); Edward J. Imwinkelried, *The "Bases" of Expert Testimony: The Syllogistic Structure of Scientific Testimony*, 67 N.C. L. REV. 1, 2 (1988) (noting that once hypothesis proved valid, scientific truth is determined); Mary W. Costley, Comment, *Scientific Evidence—Admissibility* Fryed *to a Crisp*, 21 S. TEX. L. REV. 62, 62 (1990) (describing scientific method as completely objective); John Veilleux, Note, *The Scientific Model in Law*, 75 GEO. L.J. 1967, 1973-74 (1987) (noting that society craves proof).

68. *See* Thomas Brooks Chartered v. Burnett, 920 F.2d 634, 646 (10th Cir. 1988) (stating that National Traffic Safety Board's function to provide recommendations based on neutral and scientific study); *cf.* Crowther v. Seeborg, 312 F. Supp. 1205, 1233-35 (D. Colo. 1970) (dismissing new scientific information while giving deference to prior scientific conclusions of Atomic Energy Commission). *See generally* George T. Frampton, *Scientific Eclat and Technological Change: Some Implications for Legal Education*, 63 MICH. L. REV. 1423, 1425 (1965) (contending that scientist is neutral but lawyer is biased); John Veilleux, Note, *The Scientific Model in Law*, 75 GEO. L.J. 1967, 1967 n.2 (1987) (stating scientists determine truth based on empirical testing and rational inquiry).

69. *See* Baker v. Selden, 101 U.S. 99, 100-01 (1879) (explaining that one cannot patent that which is scientific truth); *cf.* United States v. Ridling, 350 F. Supp. 90, 94 (E.D. Mich. 1972) (recognizing that once scientific conclusion established, conclusion can be judicially recognized); United States v. Lopez, 328 F. Supp. 1077, 1085 (E.D.N.Y. 1971) (holding that, after relying on qualified scientific testimony, scientific evidence can become so stable to justify judicial notice). *See generally* Gary L. Francione, *Experimentation in the Marketplace Theory of the First Amendment*, 136 U. PA. L. REV. 417, 490 (1987) (noting prevalent idea in law that science is truth); John Veilleux, Note, *The Scientific Model in Law*, 75 GEO. L.J. 1967, 1967 (1987) (contending that science is like a faith to Americans).

70. *See* People v. Wesley, 533 N.Y.S.2d 643, 644 (N.Y. Crim. Ct. 1988) (opining that DNA fingerprinting was "the single greatest advance in the search for truth"); *cf.* Industrial Union Dep't v. American Petroleum Inst., 448 U.S. 607, 615-25 (1980) (considering quantitative risk assessments without analyzing reliability of data); United States v. Nova Scotia Food Prod. Corp., 417 F. Supp. 1364, 1370-71 (E.D.N.Y. 1976) (accepting scientific investigation concluding that C. botulinum Type E common in Great Lakes). *See generally* Howard Latin, *Good Science, Bad Regulation, and Toxic Risk Assessment*, 5 YALE J. ON REG. 89, 93 (1988) (explaining that purpose of science is to objectively determine truth); Milton R. Wessel, *Adver-*

The legal system's misconception of scientific theory illustrates the predicament. Under the traditional view, a scientific theory is valid if the theory predicts recognizable events.[71] If the scientific theory accurately predicts the events, most courts view the theory as conclusive.[72] However, if even one prediction fails, courts and juries discount the theory,[73] unless an attorney can incorporate the theory into a broader argument.[74]

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sary Science and the Adversary Scientist: Threats to Responsible Dispute Resolution, 28 JURIMETRICS J. 379, 380-81 (1988) (describing how science provides information and law makes sociologically based decisions); John Veilleux, Note, *The Scientific Model in Law*, 75 GEO. L.J. 1967, 1987 (stating that spirit of science is skepticism).

71. *See Armstrong World Indus.*, 839 F.2d at 1123 (disallowing expert's testimony because testimony not supported by medical literature); Frye v. United States, 293 F. 1013, 1014 (D.C. Cir. 1923) (inferring that untested scientific technique less valid); *see also* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 617 (1988) (noting that traditional approach holds that theory only valid if theory predicts observable consequences); Edward J. Imwinkelried, *The "Bases" of Expert Testimony: The Syllogistic Structure of Scientific Testimony*, 67 N.C. L. REV. 1, 2 (1988) (concluding that scientific theory invalid until hypothesis verified); C. Kaufman, *The Scientific Method in Legal Thought: Legal Realism and the Fourteen Principles of Justice*, 12 ST. MARY'S L.J. 77, 79 (1980) (noting that for theory to be valid, theory must be based on reality).

72. Under this presumption, many courts determined that a novel application of a scientific principle was admissible because that scientific evidence had been previously accepted. *See* Medley v. United States, 155 F.2d 857, 860 (D.C. Cir.), *cert. denied*, 328 U.S. 873 (1946). In *Medley*, to prove a murder case, the prosecution wanted to introduce evidence of a spectrographic metallurgic analysis of certain pieces of metal from the defendant's bullet. *Id.* Although the technique had been applied for industrial purposes, the process had not been used in this manner. *Id.* However, the court agreed to accept the analysis because the analysis had been accepted previously, although for a different purpose. *Id.*; People v. Haggart, 370 N.W.2d 345, 353 (Mich. App. 1985). In *Haggart*, the court allowed the use of serological electrophoresis. *Id.* The court had never accepted electrophoresis for this specific purpose, but had accepted the method for other applications. *Id. But see* United States v. Tranowski, 659 F.2d 750, 754 (7th Cir. 1981) (refusing to consider scientific theory because of different application).

73. In these instances courts have used the guise of Federal Rule of Evidence 703 (Rule 703) to establish that a scientific technique is invalid. Courts resort to Rule 703 when some aspect of the test or experimentation supporting the evidence either was not complete or showed contrary results. Therefore, the courts sometimes use Rule 703 by assuming the scientist did not base his opinion on evidence normally used by peers. *Osburn*, 825 F.2d at 915-16; Higgins v. Kinnebred W. Motors, Inc., 547 F.2d 1223, 1226 n.2 (5th Cir. 1977); Nanda v. Ford Motor Co., 509 F.2d 213, 222 (7th Cir. 1974).

74. *See* Canon Reliance Coal Co. v. Industrial Comm'n of Colo., 211 P. 868, 869 (Colo. 1922) (rationalizing use of scientific evidence stating that whole subject "shrouded in mystery"); Stordahl v. Rush Implement Co., 417 P.2d 95, 99 (Mont. 1966) (rationalizing past decisions dealing with trauma induced cancer by contending that anything possible in scientific world). *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 618 (1988) (describing how positivists adapt to rationalize failure of theories); Peter W. Huber, *Medical Experts and the Ghost of Galileo*, 54 LAW & CONTEMP. PROBS., Summer 1991, at 119, 122 (stating that under positivist view, when scientific truth is discovered it "transcends time, place, and the individual scientist"); David Rosenberg, *The Causal Connec-*

Scientists no longer accept this traditional view of science[75] and agree that hypotheses do not exist in a vacuum.[76] Instead, scientists conclude that their own beliefs and values influence the scientific method.[77] Scientists recognize that there may be hundreds of theories to explain just one phenomenon.[78] In such situations, a theory is nothing more than conjecture.[79] This

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tion in Mass Exposure Cases: "Public Law" Vision of the Tort System, 97 HARV. L. REV. 849, 905-24 (1984) (proposing replacement of case by case adjudication in mass exposure cases with public system so that individuals compensated on probability of developing disease).

75. *See* Newman v. Quigg, 877 F.2d 1575, 1580 (D.C. Cir. 1989) (realizing that phenomenon may have several theories explaining it); Carter-Wallace, Inc. v. Gardner, 417 F.2d 1086, 1092 (4th Cir. 1969) (recognizing that scientists have many different theories to explain depression). In *Newman*, the district court refused to accept a masters report, labeling it as contradictory to the laws of thermal dynamics. *Newman*, 877 F.2d at 1580. The inventor appealed. *Id.* The court of appeals supported the inventor's argument by agreeing that thermal dynamics can be explained by a number of theories. *Id. See generally* Jo Ann Marie Longobardi, Comment, *DNA Fingerprinting and the Need for a National Database*, 17 FORDHAM URB. L.J. 323, 325 (1989) (noting different theories explaining technology of DNA fingerprinting); John W. Wesley, Note, *Scientific Evidence and the Question of Judicial Capacity*, 25 WM. & MARY L. REV. 675, 676 (1984) (opining that scientific knowledge is always in flux).

76. James Boyle, *Is Subjectivity Possible? The Post-Modern Subject in Legal Theory*, 62 U. COLO. L. REV. 489, 498 (1991) (citing T. KUHN, THE STRUCTURE OF SCIENTIFIC REVOLUTION (2d ed. 1970) contending scientist's values affect scientific theory). *See generally* Howard Latin, *Good Science, Bad Regulation, and Toxic Risk Assessment*, 5 YALE J. ON REG. 89, 91 (contending that scientists use inadequate data and scientific knowledge).

77. *See* Ake v. Oklahoma, 470 U.S. 68, 81 (1985) (stating that psychiatry not exact science); Perry v. United States, 755 F.2d 888, 892 (11th Cir. 1985) (holding that epidemiological study flawed because built to establish predetermined conclusion); *In re* "Agent Orange" Product Liability Litigation, 611 F. Supp. 1223, 1241 (E.D.N.Y. 1985) (noting that government conducted studies could have been biased), *aff'd*, 818 F.2d 187 (2d Cir. 1987); Johnston v. United States, 597 F. Supp. 374, 410-414 (D. Kan. 1984) (refusing to accept expert's evidence because expert's statistics lacked objectivity); Markakis v. Liberian S/S the MPARMPA Christos, 161 F. Supp. 487, 498 (S.D.N.Y. 1958) (observing that scientific experts' testimony lacked neutrality). *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 617 (1988) (arguing that scientist influenced by values); James Boyle, *Is Subjectivity Possible? The Post-Modern Subject in Legal Theory*, 62 U. COLO. L. REV. 498, 498 (1991) (illustrating subjectivity of modern legal theory by noting that scientific method is not objective).

78. *See* Bennett v. City of Grand Prairie, 883 F.2d 400, 405 (5th Cir. 1989) (noting that other circuits deem polygraphs reliable because of scientific developments); *Williams*, 583 F.2d at 1198 (contending scientific technique need not be infallible to be admissible); *cf. In re* Air Crash Disaster at New Orleans, La., 795 F.2d 1230, 1234 (5th Cir. 1986). Judge Higginbotham referred to the relevancy approach to expert testimony as the "let it all in" philosophy. *Id. See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 613-27 (1988) (comparing traditional and modern views of science); Peter W. Huber, *Medical Experts and the Ghost of Galileo*, 54 LAW & CONTEMP. PROBS., Summer 1991, at 119, 122-23 (explaining relativist theory of science); Peter Tillers & David Schum, *A Theory of Preliminary Fact Investigation*, 24 U.C. DAVIS L. REV. 931, 932 (1991) (noting that scientific philosopher, Kuhn, explained relativist philosophy of scientific theory recognizing subjective aspect of science).

modern view of science recognizes that theories are not to be proven but are to be used as tools for understanding natural phenomena.[80] In other words, although science is a systematic discipline based upon reason and objectivity, more often than not, it is both inexact and value based.[81]

Lawyers and judges are not alone in misunderstanding the scientific method.[82] Often jurors will use scientific information improperly[83] because

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79. *See* Whitcomb v. Chavis, 403 U.S. 124, 169 n.5 (1971) (intimating that evidence provided by expert witness not reliable); United States v. Distler, 671 F.2d 954, 961 (6th Cir. 1981) (stating that ion microprobic analysis of human hair not generally accepted in scientific community and is conjecture); United Steelworkers of Am. v. Marshall, 647 F.2d 1189, 1204 (D.C. Cir. 1981) (noting that over time, science developed better methods of measuring lead exposure). *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 617 (1988) (describing strength of theories as guess work to established doctrine); Nancy Levit, *Listening to Tribal Legends: An Essay on Law and the Scientific Method*, 58 FORDHAM L. REV. 263, 274-75 (1989) (contending that scientific experimentation and analysis leads to better understanding); Paul T. Wangerin, *Objective, Multiplistic, and Relative Truth in Developmental Psychology and Legal Education*, 62 TUL. L. REV. 1237, 1238 (1988) (explaining that scientists realize that scientific truths always open to change); Peter W. Huber, Comment, *A Comment on Toward Incentive Based Procedure: Three Approaches for Regulating Scientific Evidence by E. Donald Elliot*, 69 B.U. L. REV. 513, 520 (1989) (stating that no question is ever closed in science).

80. *See* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 617 (1988) (describing theory as framework within which scientists view phenomena).

81. *See* Brock v. Merrell Dow Pharmaceuticals, Inc., 874 F.2d 307, 309 n.6 (5th Cir.) (noting changes in scientific thought illustrate that scientist's reviews not objective), *cert. denied*, 494 U.S. 1046 (1990); Commonwealth v. Hart, 501 A.2d 675, 677 (Pa. Super. Ct. 1985) (relaying doctor's testimony that, based on nature of child's wounds, doctor could conclude child murdered). *See generally* Howard T. Markey, *Jurisprudence or "Juriscience"?*, 25 WM. & MARY L. REV. 525, 529-30 (1984) (explaining that value based questions can become indistinguishable from scientific fact); Stephen J. Morse, *Crazy Behavior, Morals in Science: An Analysis of Mental Health Law*, 51 S. CAL. L. REV. 527, 591 (1978) (describing ease by which scientist can interject own values into testimony); John Veilleux, Note, *The Scientific Model in Law*, 75 GEO. L.J. 1967, 1971 (1987) (stating that scientists question their own objectivity and reliance on strict empiricism models).

82. *See* United States v. Addison, 498 F.2d 741, 744 (D.C. Cir. 1974) (contending scientific evidence may "assume a posture of mystic infallibility in the eyes of a jury of laymen"); *cf.* United States v. Yee, 129 F.R.D. 629, 631-32 (N.D. Ohio 1990) (illustrating difficulty understanding DNA profiling because of unfamiliarity with scientific doctrine). *See generally* MICHAEL J. SAKS & RICHARD VAN DUIZEND, THE USE OF SCIENTIFIC EVIDENCE IN LITIGATION 5-6 (1983) (describing survey where over 75% of judges and lawyers believed juries found scientific evidence more credible than other types of evidence); John W. Wesley, Note, *Scientific Evidence and the Question of Judicial Capacity*, 25 WM. & MARY L. REV. 675, 678 (concluding that juries assign scientific evidence undue credibility); Neufeld & Colman, *When Science Takes the Witness Stand*, SCI. AM., May 1990, at 46 (relaying that after a recent trial, juror said, "you can't argue with science").

83. *See* United States v. Wilson, 361 F. Supp. 510, 513 (D. Md. 1973) (explaining juries may be misled by polygraph evidence because of complex nature); State v. Schwartz, 447 N.W.2d 422, 428 (Minn. 1989) (reasoning that juries may give idea like DNA testing undue weight and deference). *But see* Jack Ewing, *Connecticut Jury Disregards DNA Test*, NAT. L.J.,

the jurors harbor the traditional view of science.[84] The jurors also believe that scientific testimony is based on objective and reasoned analysis.[85] Consequently, jurors often consider scientific evidence more credible than other evidence.[86] Jurors easily overestimate the probative value of the scientific evidence, misinterpreting conjecture or an erroneous theory as an accepted

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Apr. 23, 1990, at 9. Recently, in a Connecticut case, a jury convicted an individual for rape even though DNA evidence established that the semen collected at the crime scene was not the defendant's. *Id.* The prosecutor stated that the case illustrates that juries are not overly swayed by DNA evidence. *Id. See generally* Edward J. Imwinkelried, *The Standard for Admitting Scientific Evidence: A Critique from the Perspective of Juror Psychology*, 28 VILL. L. REV. 554, 570 (1982-83) (arguing that scientific evidence overwhelms jurors); Andre A. Moenssens, *Admissibility of Scientific Evidence—An Alternative to the* Frye *Rule*, 25 WM. & MARY L. REV. 545, 546 (1984) (contending that courts should ensure juries consider only scientific evidence proven reliable).

84. *See* Barefoot v. Estelle, 463 U.S. 880, 929-30 (1983) (Blackmun, J., dissenting) (complaining juries may be unable to distinguish between valid and invalid scientific evidence); United States v. Azure, 801 F.2d 336, 340 (8th Cir. 1986) (explaining that scientific expert may appear to be more truthful); United States v. Downing, 753 F.2d 1224, 1236 (3d Cir. 1985) (noting juries can be swayed into believing that scientific testimony is especially reliable and trustworthy); United States v. Barnard, 490 F.2d 907, 912 (9th Cir. 1973) (stating juries may sacrifice common sense when considering scientific evidence); People v. King, 72 Cal. Rptr. 478, 493 (Cal App. 1968) (realizing that scientific information's aura of certainty may mislead jury). *See generally* Major Michael N. Schmitt & Captain Steven A. Hatfield, *Scientific Evidence in Courts-Martial: From the General Acceptance Standard to the Relevancy Approach*, 130 MIL. L. REV. 135, 142 n.34 (1990) (contending juries may not be able to critically analyze complexities of science); Linda Swafford, *Admissibility of DNA Genetic Profiling Evidence in Criminal Proceedings: The Case for Caution*, 18 PEPP. L. REV. 123, 131 (1990) (stating novel scientific evidence can dazzle jury).

85. *See Wilson*, 361 F. Supp. at 513 (noting juries may give too much weight to expert testimony); *Reed*, 391 A.2d at 370 (arguing that jurors can be mislead because of apparent objectivity of sophisticated evidence); Watson v. State, 219 N.W.2d 398, 403 (Wis. 1974) (stating juries can believe expert's testimony even though scientific evidence shows evidence false). *See generally* John W. Wesley, Note, *Scientific Evidence and the Question of Judicial Capacity*, 25 WM. & MARY L. REV. 675, 678 (1984) (explaining that jurors may accord scientific evidence undue weight).

86. United States v. Fosher, 590 F.2d 381, 383 (1st Cir. 1979) (noting aura of infallibility of scientific evidence); United States v. Brown, 557 F.2d 541, 555 (6th Cir. 1977) (explaining that some scientific evidence has aura of trustworthiness); Smith v. United States, 389 A.2d 1356, 1359 (D.C.) (explaining that expert opinion appears more authoritative to juror), *cert. denied*, 439 U.S. 1048 (1978); Commonwealth v. Nazarovitch, 436 A.2d 170, 173 (Pa. 1981) (stating that polygraph evidence inadmissible because jury will not view evidence critically). *But see* United States v. Metzger, 778 F.2d 1195, 1205 (6th Cir. 1985) (noting other specific knowledge under Rule 702 does not necessarily create aura of reliability). *See generally* Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1237 (1980) (concluding that most significant danger of scientific evidence is potential that impression of infallibility will mislead jury); John B. Myers et al., *Expert Testimony in Child Sexual Abuse Litigation*, 68 NEB. L. REV. 1, 10 (1989) (contending juries have difficulty assessing scientific evidence because juries awed or confused); John W. Wesley, Note, *Scientific Evidence and the Question of Judicial Capacity*, 25 WM. &

scientific conclusion.[87]

Although some studies indicate that a majority of juries both understand and apply scientific evidence correctly,[88] without sufficient guidance, juries can make horrific mistakes.[89] In *Ferebee v. Chevron Chemical Co.*,[90] the jury awarded sixty thousand dollars to an agricultural worker who claimed that his lung cancer was caused by the prolonged exposure of his skin to the herbicide, Paraquat.[91] Ferebee offered the testimony of two pulmonary specialist who, though noting that Paraquat rarely caused lung cancer, sup-

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MARY L. REV. 675, 678 (describing how jurors may find scientific evidence more credible than evidence is).

87. This concern has led courts to develop a conservative approach towards scientific evidence. *See* United States v. Alexander, 526 F.2d 161, 168 (8th Cir. 1975) (limiting scientific evidence because of evidence's mesmerizing effect); *Reed*, 391 A.2d at 371 (applying *Frye* test because fear of scientific evidence); State v. Holt, 246 N.E.2d 365, 368 (Ohio 1969) (illustrating that jury gave too much weight to witness' opinion because of witness' prestige and educational background); Commonwealth v. O'Searo, 352 A.2d 30, 32 (Pa. 1976) (holding that admitting psychological testimony encourages jury not to critically analyze facts of case); Edward J. Imwinkelried, *Judge Versus Jury: Who Should Decide Questions of Preliminary Facts Conditioning the Admissibility of Scientific Evidence?*, 25 WM. & MARY L. REV. 577, 603 (1984). Professor Imwinkelried stated that jurors may realize that a scientific technique is invalid because a technique has a large margin of error. *Id.* However, juries often consider the evidence anyway because the expert's credentials are so impressive. *Id. See generally* Vicki Christian, Comment, *Admissibility of Scientific Expert Testimony: Is Bad Science Making Law?*, 18 N. KY. L. REV. 21, 32 (1990) (opining that scientific evidence normally has significant affect upon juries).

88. *See Barefoot*, 463 U.S. at 902-03 (opining that juries have sufficient competence to determine which expert witness most credible); *Williams*, 583 F.2d at 1200 (2d Cir. 1978) (concluding juries competent enough to handle expert testimony); *Ridling*, 350 F. Supp. at 95-96 (stating that cross examination sufficiently ensures juries will not give expert testimony undue deference); Worley v. State, 263 So. 2d 613, 616 (Fla. Dist. Ct. App. 1972) (Mager, J., concurring) (concluding that juries can sufficiently analyze scientific evidence); Coppolino v. State, 223 So. 2d 68, 70-71 (Fla. Dist. Ct. App. 1968) (holding that jury properly considered new scientific technique developed specifically for prosecution's case), *appeal dismissed*, 234 So. 2d 120 (Fla. 1969), *and cert. denied*, 399 U.S. 927 (1970). *See generally* PETER W. HUBER, GALILEO'S REVENGE 65-66 (1991). In his book, Huber relates the story of the Bradosky family who brought suit against Audi. *Id.* at 65. The Bradoskys argued that their son was killed as a result of sudden acceleration caused by a defect in their Audi 5000. *Id.* After reviewing the tire marks, analyzing the photographs, and viewing recreations of the incident, the jury discounted the scientific evidence offered by the plaintiffs' expert, William Rosenbluth, and exonerated Audi. *Id.* 66.

89. *See* Mekdeci v. Merrell Nat. Labs., 711 F.2d 1510, 1517 (11th Cir. 1983) (noting lower court's finding that jury awarded $20,000 in compromise verdict); Richardson v. Richardson-Merrell, Inc., 649 F. Supp. 799, 804 (D.D.C. 1986) (granting judgment notwithstanding the verdict after lower court mistakenly awarded $1.16 million); Johnson v. American Cyanamid Co., 718 P.2d 1318, 1320 (Kan. 1986) (reversing jury award of over $8 million in punitive damages).

90. 736 F.2d 1529 (D.C. Cir.), *cert. denied*, 469 U.S. 1062 (1984).

91. *Id.* at 1532.

ported Ferebee's causation theory.[92] The court refused to consider the validity of the scientific information, concluding that the jury, not the judge, decides the value of such evidence.[93] The jury awarded Ferebee a money judgment. Consequently, Chevron compensated Ferebee for an injury Chevron did not cause.[94]

Even in the face of valid scientific evidence, juries still periodically choose junk science.[95] In *Richardson v. Richardson-Merrell Inc.*,[96] Richardson contended that her baby's birth defects were caused by the drug Bendectin[97] which Richardson took to treat nausea during her pregnancy.[98] At trial, Richardson's expert, Dr. Alan K. Drone, testified that Bendectin had, in fact, caused the birth defects.[99] The district court questioned the validity of Dr. Drone's theory, but allowed the jury to consider the evidence.[100] The defense experts testified that Bendectin does not cause birth defects and noted that almost the entire scientific community agreed with this conclusion.[101] Despite overwhelming valid scientific evidence against the plaintiff's causation theory, the jury still found that Bendectin caused the birth defects.[102] Although the district court granted a judgment not withstanding the verdict, *Richardson* illustrates the powerful illusory effect of scientific evidence.

B. *Greed, Avarice, and Calabresian Analysis*

Scientific evidence is a powerful tool. However, if science is not properly understood and analyzed in the courtroom, it can be destructive to jus-

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92. *Id.* at 1535.

93. *Id.*

94. *Ferebee*, 736 F.2d at 1543.

95. See *Osburn*, 825 F.2d at 915 (opining that jury may consider scientific evidence not accepted by general scientific community); *Richardson*, 649 F. Supp. at 799, 801 (noting physician's acceptance of erroneous evidence that Bendectin causes cancer). *See generally* Deborah R. Hensler, *Science in the Court: Is There a Role for Alternative Dispute Resolution*, 54 LAW & CONTEMP. PROBS., Summer 1991, at 173 (explaining that some critics contend jurors often base decision on junk science); Peter W. Huber, *Medical Experts and the Ghost of Galileo*, 54 LAW & CONTEMP. PROBS., Summer 1991, at 132 (arguing that courts often use bad science, endorse bad science, or ignore science completely).

96. 649 F. Supp. 799 (D.D.C. 1986).

97. *Id.* at 800.

98. *Id.*

99. *Id.* at 801.

100. *Richardson*, 649 F. Supp. at 801, 803.

101. *Id.* at 802.

102. *See id.* at 799-800 (granting judgment notwithstanding the verdict, reversing award of $1.16 million because no reasonable jury could find plaintiff's birth defects caused by Bendectin).

tice.[103] In 1970, Yale law professor Guido Calabresi developed a new wrinkle in liability law. Calabresi concluded that the purpose of liability is to efficiently control costs.[104] To Calabresi, the best method to reach this goal is to attribute the cost of an accident to those who could have most cheaply avoided the accident.[105] These entities are identified as the "cheapest cost avoiders."[106] Misunderstanding the unique qualities of scientific evidence, proponents of Calabresian analysis concluded that science can determine both the cause of the accident and the cause which could have been avoided

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103. *See id.* at 800 (D.D.C. 1986) (illustrating that junk science can result in erroneous jury verdict).

104. See Dellwo v. Pearson, 107 N.W.2d 859, 862 (Minn. 1961) (opining that negligence determined by foresight and proximate cause by hindsight). *See generally* Guido Calabresi & Jon T. Hirschoff, *Toward a Test for Strict Liability in Torts*, 81 YALE L.J. 1055, 1084 (1972) (describing purpose of strict liability as avoiding costs of accidents); Guido Calabresi & Alvin K. Klevorick, *Four Tests for Liability in Torts*, 14 J. LEGAL STUD. 585, 599 (1985) (arguing that purpose of liability is to increase safety by inducing actors to correct past mistakes).

105. *Cf.* Matthias v. Lehn & Finks Prod. Corp., 424 P.2d 284, 290 (Wash. 1967) (illustrating that consumer can be party best able to avoid costs of accident); Kavafian v. Seattle Baseball Club Ass'n, 177 P. 776, 777 (Wash. 1919) (holding that plaintiff may be in best position to determine risk and avoid injury). *See generally* Guido Calabresi & Alvin K. Klevorick, *Four Tests for Liability in Torts*, 14 J. LEGAL STUD. 588, 588-89 (1985). Calabresi divides his theory into two parts. *Id.* at 588. Loss will fall upon the victim unless the injurer could have more cheaply avoided the accident. *Id.* From the other perspective, the loss lies upon the injurer unless the victim could have more cheaply avoid the accident. *Id.* at 589. In the analysis, cost encompasses more than the monetary outlay. Guido Calabresi & Alvin K. Klevorick, *Four Tests for Liability in Torts*, 14 J. LEGAL STUD. at 589. Cost includes the moral, social, economic, and political issues that surround determining who would best prevent the accident. *Id.* at 588-89.

106. *See* Beshada v. Johns-Manville Prod. Corp., 447 A.2d 539, 549 (N.J. 1982) (holding defendant corporation liable because best suited to avoid the injury); Suter v. San Angelo Foundry & Machine Co., 406 A.2d 140, 151-52 (N.J. 1979) (finding defendant in best position to most cheaply avoid accident). The cheapest cost avoider is often referred to as the best decider. *See generally* John Attanasio, *The Principle of Aggregate Autonomy and the Calabresian Approach to Products Liability*, 74 VA. L. REV. 677, 706-707 (1988). The best decider application of Calabresian analysis states that the responsible party is the party that can best decide whether the product reflects the cost of possible accidents. *Id.* The application dictates that a party aware of possible accidents should consider insuring against that loss. *Id.* In Calabresian analysis, there are four factors used to determine the cheapest cost avoider: (1) the relative knowledge of the risk; (2) the capacity to control or reduce the risk; (3) the desire to take the risk; and (4) the ability to adjust after making an incorrect choice. *See* Guido Calabresi, *Products Liability: Curse or Bulwark of Free Enterprise*, 27 CLEV. ST. L. REV. 313, 319 (1978). Professor Howard Latin applied Calabresian analysis to conclude that automobile manufacturers should bear the cost of automobile accidents. *See* Howard A. Latin, *Problem-Solving Behavior and Theories of Tort Liability*, 73 CAL. L. REV. 677, 726-29 (1985). Latin opined that unlike automobile manufacturers, automobile users are not in the position to fully understand the risk they undertake. *Id.* at 726. Consequently, the manufacturers should take steps to avoid accidents by providing safety devices. *Id.*

for the least cost.[107] Consequently, Calabresian analysis became an important instrument by which erroneous scientific evidence infected the courtroom.[108]

The confusion created by the misunderstanding of scientific evidence has become law's Achilles' heel.[109] Three groups have seized upon the opportunity to manipulate the system for their own economic gain. Lawyers have shopped for scientific witnesses who will testify according to the lawyer's needs.[110] Scientists have developed flawed evidence to collect huge consulting fees.[111] The public has adopted a roulette mentality, blaming others for

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107. *See* Johnson v. American Cyanamid Co. 718 P.2d 1318, 1320-22, 1327 (Kan. 1986) (illustrating application of least cost analysis). In *Johnson*, the father of a little girl who had recently been vaccinated for polio was stricken with the disease. *Id.* at 1320. The jury awarded *Johnson* $10,000,000 although the scientific evidence indicated that the tragedy was a very rare occurrence. *Id.* However, the jury found the drug company responsible because the company was aware of the risk. *Id.* at 1321-22. On appeal, the Kansas Supreme Court overturned the jury verdict. *Johnson*, 718 P.2d at 1327; *see also* Bean v. United States, 533 F. Supp. 567, 577-78 (D. Colo. 1980) (reviewing the scientific evidence concerning causation between swine flu vaccine and Guillain-Barre syndrome). *See generally* GUIDO CALABRESI, THE COST OF ACCIDENTS 312 (1970) (contending that causation problems should be search for cheapest cost avoider); Troyen A. Brennan, *Causal Change and Statistical Links: The Role of Scientific Uncertainty in Hazardous-Substance Litigation*, 73 CORNELL L. REV. 469, 488-89 (1988) (noticing that Calabresian analysis meshes with probablistic types of evidence provided in toxic tort litigation).

108. *See* Grubbs v. United States, 581 F. Supp. 536, 539 (N.D. Ind. 1984) (sighting epidemiological study to support judgment); Sulesky v. United States, 545 F. Supp. 426, 430-31 (S.D. W. Va. 1982) (relying upon doctor's scientific opinion concerning causation). *See generally* Troyen A. Brennan, *Causal Change and Statistical Links: The Role of Scientific Uncertainty in Hazardous-Substance Litigation*, 73 CORNELL L. REV. 469, 493 (1988) (explaining that courts want scientific evidence to determine causation).

109. *See* Ealy v. Richardson-Merrell, Inc., 897 F.2d 1159, 1159 (D.C. Cir.) (noting lower court award of $75 million verdict for plaintiff), *cert. denied*, __ U.S. __, 111 S. Ct. 370, 112 L. Ed. 2d 332 (1990); *Richardson*, 649 F. Supp. at 801 (reversing improper lower court award of $1.16 million); Oxendine v. Merrell Dow Pharmaceuticals, Inc., 506 A.2d 1100, 1100 (D.C. Cir. 1986) (upholding $750,000 verdict for plaintiff).

110. *See* Virginia Tech Found., Inc. v. Family Group Ltd. V, 666 F. Supp. 856, 858 (W.D. Va. 1987) (stating that expert witnesses are hired guns testifying as employer dictates). *See generally* PETER W. HUBER, GALILEO'S REVENGE 17-18 (1991) (arguing that attorneys find scientific witnesses who will correlate with attorneys' causation theory). Huber quotes Marvin Belli as saying, "If I got myself an impartial witness, I'd think I was wasting my money." *Id.* at 17. Huber also quotes the ex-president of the American Bar Association as saying, "I would go into a lawsuit with an objective, uncommitted, independent expert about as willingly as I would occupy a foxhole with a couple of non-combatant soldiers." *Id.* at 18; *see also* R.J. Gerber, *Victory vs. Truth: The Adversary System and its Ethics*, 19 ARIZ. ST. L.J. 3, 11 (1987) (labelling as prostitutes those expert witnesses who say what attorney wants experts to say).

111. *See* Dupree v. Malpractice Research, Inc., 445 N.W.2d 498, 500 (Mich. App. 1989) (reasoning that a contingent fee would make an expert look like hired gun). *See generally* PETER W. HUBER, GALILEO'S REVENGE 19 (1991). Huber quotes Dennis Roberts, a personal

their misfortune in order to take a spin at the judicial system's own "wheel of fortune."[112] Together, these three groups have joined forces to manipulate justice.[113]

Attorneys have the professional responsibility to zealously represent their clients.[114] On the other hand, attorneys have the ethical duty not to file frivolous claims.[115] Somewhere between these two responsibilities lies a vast grey area where no bright line rule exists.[116] This is the breeding ground for

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injury lawyer in California as stating, "You get a professor who earns $60,000 a year and give him the opportunity to make a couple of hundred thousand in his spare time and he will jump at the chance. They are like a bunch of hookers in June." *Id.* at 19; *see also* Roy D. Simon, Jr., *Fee Sharing Between Lawyers and Public Interest Groups*, 98 YALE L.J. 1069, 1109 (1989) (opining that expert witnesses may resort to unethical activities); C. Randal Johnson, Comment, *Fee-Splitting with Non-Lawyers*, 12 J. LEGAL PROF. 139, 145 (1987) (reasoning that fee-splitting with expert may be unethical).

112. *See generally* Jack B. Weinstein, *Improving Expert Testimony*, 20 U. RICH. L. REV. 473, 482 (1986) (arguing that experts may be found to testify to even frivolous theories); Ronald J. Allen, Comment, *Rationality, Mythology, and the "Acceptability of Verdicts" Thesis*, 66 B.U. L. REV. 541, 548 (1986) (describing that under acceptability thesis, plaintiffs have right to use judicial process as roulette wheel).

113. In many cases, lawyers, scientific witnesses, and plaintiffs worked together to persuade the jury to award outlandish judgments based on little or no causation evidence. *See Ealy*, 897 F.2d at 1159-60 (considering lower court's $95 million judgment); *Richardson*, 649 F. Supp. at 801 (overturning improper jury award of over $ 1 million); *Oxendine*, 506 A.2d at 1100 (upholding $750,000 award).

114. *See generally* MODEL CODE OF PROFESSIONAL RESPONSIBILITY Canon 7, DR7-101 (1980) (requiring attorney use all lawful means to enhance goals of client). *Id.* at EC7-1 (outlining duty of attorney to zealously represent client). *Id.* at EC7-4 (stating that lawyer cannot bring a frivolous claim).

115. *See generally* MODEL CODE OF PROFESSIONAL RESPONSIBILITY DR7-102 (1980) (dictating that attorney may not bring false claims). Numerous tests have been devised to determine when zealous representation conflicts with the duty to not bring frivolous lawsuits. The two main approaches are the conduct and negligence approaches. *Id.*; *see also* Ellen P. Quackenbos, Note, *Rule 11 and Papers Not Warranted By Law*, 58 FORDHAM L. REV. 1085, 1087-93 (1990) (describing difficulty setting boundary between what is zealous and what is frivolous); E. Joshua Rosenkranz, *A Ghost of Christmas Yet to Come: Standing to Sue For Future Generations*, 1 J.L. & TECH. 67, 109 (1985) (arguing society endures some frivolous suits to ensure justice will occur).

116. *Cf.* Martin v. New Orleans, 678 F.2d 1321, 1327 (5th Cir. 1982) (illustrating that without awarding for emotional distress, some claims very small), *cert. denied*, 459 U.S. 1203 (1983); Davis v. Graviss, 672 S.W.2d 928, 933 (Ky. 1984) (affirming $390,000 award for emotional trauma). *See generally* Peter Barton & Frances Hill, *How Much Will You Receive in Damages from the Negligent or Intentional Killing of Your Pet Dog or Cat?*, 34 N.Y.L. SCH. L. REV., 411, 418 (1989) (relaying that plaintiff can receive $10,000 or more for emotional distress caused by pet's death); Rebecca J. Cook, *Antiprogestin Drugs: Medical and Legal Issues*, 42 MERCER L. REV. 971, 984 (1991) (noting juries are very sympathetic to plaintiff's pain and suffering and medical expenses); S.Y. Tan, *The Medical Malpractice Crisis: Will No-Fault Cure the Disease?*, 9 U. HAW. L. REV. 241, 243 (1987) (generalizing that parties play upon sympathy of jury to obtain high award).

junk science cases.

Most lawyers recognize that claims arising out of sympathetic fact situations often result in significant monetary awards.[117] No child should suffer with a deformity caused by an anti-nauseant medication her mother took while pregnant. No childless woman should be left sterile by an IUD. No construction worker should die of cancer caused by a blow he received on the job. These individuals make good plaintiffs[118] and these tragedies make good cases.[119] Lawyers have used Calabresian analysis to ensure that these types of plaintiffs garner a winning judgment by conditioning the system to accept flawed scientific evidence.[120]

Recently, a renowned attorney litigated several personal injury cases, introducing junk science to prove that ingestion of Bendectin by pregnant women caused birth defects.[121] Although the juries ruled for the plaintiffs, judges persistently overturned the juries' verdicts.[122] The courts soon dis-

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117. *See, e.g.*, Honeywell v. Rogers, 251 F. Supp. 841, 846 (W.D. Pa. 1966) (upholding $45,000 jury award for child severely crippled by hypodermic injection); Moniodis v. Cook, 494 A.2d 212, 215, 217 (Md. App.) (awarding employee $300,000 as compensation for wrongful discharge and infliction of emotional distress), *cert. denied*, 500 A.2d 649 (Md. 1985); Dow Chem. Co. v. Alfaro, 786 S.W.2d 674, 690 n.2 (Tex. 1990) (Gonzalez J., dissenting) (noting newspaper's report of Texas attorney who solicited clients promising high awards). *See generally* Jeffrey O'Connell, *Offers That Can't Be Refused: Foreclosure of Personal Injury Claims by Defendant's Prompt Tender of Claimants' Net Economic Losses*, 77 NW. U. L. REV., 589, 591 (1982) (noting that defendants and plaintiffs try to play upon juries' sympathies by admitting highly emotional evidence). *See Ealy*, 897 F.2d at 1159 (describing that plaintiff did not have thumbs and could not bend elbows); Glenn v. National Supply, 129 N.E.2d 189, 190 (Ohio 1954) (awarding large judgment to widow of man who developed traumatic cancer after receiving blow on last day of work).

118. *Ealy*, 897 F.2d at 1159 (noting lower court's $95 million judgment); *Glenn*, 129 N.E.2d at 189 (granting money judgment for widow).

119. Lawyers have introduced junk science in order to win awards in Bendectin cases, paternity suits, cancer causation actions, and immune deficiency suits. *See Ealy*, 897 F.2d at 1160 (noting lower court admission of invalid scientific evidence implicating Bendectin for causing birth defects); Berry v. Chaplin, 169 P.2d 442, 452 (Cal. App. 1946) (using visual appearance test to determine paternity); Rubanick v. Witco Chem. Corp., 576 A.2d 4, 15 (N.J. Super. 1990) (Stern J., concurring) (stating evidence that PCB's caused colon cancer should be admitted); Menarde v. Philadelphia Transp. Co., 103 A.2d 681, 684 (Pa. 1954) (affirming admission of doctors' testimony that trauma induced cancer). *See generally* Peter W. Huber, *Medical Experts and the Ghost of Galileo*, 54 LAW & CONTEMP. PROBS., Summer 1991, at 119, 132 (arguing that because *Frye* test is no longer commonly used, courts open to more and more junk science).

120. *Ealy*, 897 F.2d at 1160; *Richardson*, 649 F. Supp. at 801; *Oxendine*, 506 A.2d at 1100. *See generally* PETER W. HUBER, GALILEO'S REVENGE 118-22 (1991) (describing cases dealing with Bendectin).

121. *Ealy*, 897 F.2d at 1159; Koller v. Richardson-Merrell Inc., 737 F.2d 1038, 1045-46 (D.C. Cir. 1984); Mekdeci v. Merrell Nat'l Labs., 711 F.2d 1510, 1517 (11th Cir. 1983); *Richardson*, 649 F. Supp. at 801.

122. *Ealy*, 897 F.2d at 1159; *Koller*, 737 F.2d at 1038; *Mekdeci*, 711 F.2d at 1510.

covered that both of the attorney's key scientific witnesses were frauds[123] and castigated one of the witnesses for misrepresenting his credentials.[124] A scientific journal reported that the other witness had altered the results of his experiments to enhance the data's "court appeal."[125] Though the scientific evidence was discredited, the attorney continued to file claims based on the fraudulent evidence, the courts continued to admit the evidence, and juries continued to award verdicts for the plaintiffs.[126]

Though unscrupulous attorneys may attempt to capitalize upon the weaknesses in evidentiary standards, the attorneys would be summarily dismissed but for the ammunition provided by a few equally unscrupulous scientists. The scientific community sadly admits that there is an increase in flawed scientific theories.[127] This trend has developed to satisfy the Calabresian need to finger the cheapest cost avoider.[128] Scientists have formed research organizations to accumulate data supporting their erroneous scientific evi-

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123. *See generally* PETER W. HUBER, GALILEO'S REVENGE 125-32 (1991) (citing to Sept. 1989 Australian medical journal uncovering scientific fraud of Bendectin expert witness, Dr. William McBride).

124. *See* PETER W. HUBER, GALILEO'S REVENGE 123 (1991) (citing Memorandum Order, Oxendine v. Merrell Dow Pharmaceuticals, Case No. 1245-82 slip op. at 4 (D.C. Super. Ct., Feb. 12, 1988)).

125. *See generally* PETER W. HUBER, GALILEO'S REVENGE 127 (1991). Huber explained that in December 1987 Australian television aired an interview with a Scottish pediatrician and a scientific journalist. *Id.* They asserted that McBride altered the results of his tests to support his findings. *Id.* The pediatrician and journalist had concluded that McBride was scientifically unethical. *Id.*

126. *See* Cosgrove v. Merrell Dow Pharmaceuticals, Inc., 788 P.2d 1293, 1293 (Idaho 1990) (contending that Bendectin caused child's birth defects); Obiago v. Merrell Nat'l Lab., Inc., 560 So. 2d 625, 626 (La. 1990) (suing for birth defects allegedly caused by Bendectin); Thompson v. Merrell Dow Pharmaceuticals, Inc., 551 A.2d 177, 178 (N.J. Super. 1988) (alleging Bendectin caused child's birth defects); Coyle v. Richardson-Merrell, Inc., 584 A.2d 1383, 1384 (Pa. 1991) (claiming Bendectin caused infant's limb defect); Blum v. Merrell Dow Pharmaceuticals, Inc., 560 A.2d 212, 213 (Pa. Super. Ct. 1989) (arguing that child's club feet caused by Bendectin). *See generally* PETER W. HUBER, GALILEO'S REVENGE 128 (1991) (discussing ultimate outcome of Bendectin cases).

127. *See generally* Peter W. Huber, *Medical Experts and the Ghost of Galileo*, 54 LAW & CONTEMP. PROBS., Summer 1991, at 119, 120 (stating that SCIENTIFIC AMERICAN periodically lists junk science theories); Kenneth R. Kreiling, *Scientific Evidence: Toward Providing the Lay Trier with the Comprehensible and Reliable Evidence Necessary to Meet the Goals of the Rules of Evidence*, 32 ARIZ. L. REV. 915, 916 n.1 (1990) (explaining that federal agencies are investigating 87 instances of unethical behavior in scientific community); W. Anthony Purcell, *Criminal Procedure—Match Game 1990's: The Admissibility of DNA Profiling*—State v. Pennington, 13 CAMPBELL L. REV. 209, 216 (1991) (noting that scientists agree there are number of flawed theories dealing with hypnotically refreshed testimony). .

128. *Cf.* Beshada v. Johns-Manville Prod. Corp., 447 A.2d 539, 548 (N.J. 1982) (holding corporation liable as cheapest cost avoider). *See generally* Guido Calabresi & John T. Hirschoff, *Toward a Test for Strict Liability in Torts*, 81 YALE L.J. 1055, 1084 (1972) (noting purpose to avoid costs of accidents); Guido Calabresi & Alvin K. Kalevorick, *Four Tests of*

dence.[129] The number of professional expert witnesses has increased.[130] Some scientists even attend seminars to improve their witnessing techniques[131] and prospective experts advertise their services in journals and other legal periodicals.[132] Recognizing the importance of scientific evidence, the American Trial Lawyer's Association Reporter notes the names of both winning attorneys and their hired experts.[133] Unfortunately, there is a cadre of scientists willing to provide any evidence attorneys need, despite the invalidity and unreliability of the information.[134]

Finally, those who suffer injuries are quick to place blame upon others.[135]

Liability and Torts, 14 J. LEGAL STUDY 585, 589 (discussing need to determine cheapest cost avoider).

129. *Ealy*, 897 F.2d at 1160 (describing expert's research effort to substantiate his own testimony). *See generally* PETER W. HUBER, GALILEO'S REVENGE 112 (1991) (describing expert's research center).

130. Expert testimony is almost indispensable and is absolutely required in complex technical litigation. Natural Soda Prods. Co. v. City of Los Angeles, 240 P.2d 993, 994 (Cal. App. 1952); *accord* Schackow v. Medical-Legal Consulting Serv., 416 A.2d 1303, 1313 (Md. App. 1990). However an expert's fee can be very significant. *See* Illinois v. Sangamo Constr. Co., 657 F.2d 855, 863 (7th Cir. 1981) (paying $9,778.98 for anti-trust expert); Burgess v. Williamson, 506 F.2d 870, 879-80 (5th Cir. 1975) (paying $20,000 for accountant); Osguthorpe v. Anschutz Land & Livestock Co., 456 F.2d 996, 1004 (10th Cir. 1972) (paying $25,000 for veterinarian). *See generally* David L. Bernstein, *Out of the* Fryeing *Pan and Into the Fire: The Expert Witness Problem in Toxic Tort Litigation*, 10 REV. LITIG. 117, 124 (1990) (stating that scientific experts important in toxic tort cases).

131. *See generally* PETER W. HUBER, GALILEO'S REVENGE 19 (1991). Huber points out that trial lawyers attempt to encourage expert witnesses to make themselves more useful. *Id.* One way to do this is to help the expert witness learn to communicate more effectively. *Id.* Huber also notes that expert witnesses often attend seminars "where scruffy academics and disheveled doctors learn how to speak, act, and handle themselves on the stand." *Id.* (citing Bredemeier, *Trial by Expert*, WASH. POST, Nov. 28, 1982, p. 19).

132. David L. Bernstein, *Out of the* Fryeing *Pan and Into the Fire: The Expert Witness Problem in Toxic Tort Litigation*, 10 REV. LITIG. 117, 126 (1990) (observing that experts advertise); Peter Huber, *Law and Sciosophy*, 24 VAL. U. L. REV. 319, 350 (1990) (stating that experts advertise in bar journals); TRIAL, Jan. 1990, at 108-14 (displaying advertisements for expert witness and expert witness locating services).

133. *See* PETER W. HUBER, GALILEO'S REVENGE 19 (1991) (describing how magazine lists prevailing attorneys and experts).

134. Many contend that the process is one of seduction. *See* Rohrbough v. Wyeth Lab., 719 F. Supp. 470, 475-76 (N.D. W. Va. 1989) (observing that expert contradicted his former testimony to prevent summary judgment); *Virginia Tech Found., Inc.*, 666 F. Supp. at 858 (opining that expert said what expert was hired to say); Ladner v. Higgins, Inc., 71 So. 2d 242, 244 (La. App. 1954) (noticing that witness' opinion varies with client). *See generally* R.J. Gerber, *Victory v. Truth: The Adversary System and its Ethics*, 19 ARIZ. ST. L.J. 3, 11 (1987) (comparing expert witnesses to prostitutes); Jack B. Weinstein, *Improving Expert Testimony*, 20 U. RICH. L. REV. 472, 482 (1986) (contending that experts will tailor testimony to client).

135. *See* Cipollone v. Liggett Group, Inc., __ U.S. __, 112 S. Ct. 2608, 2611, 120 L. Ed. 2d 407 (1992) (blaming cigarette manufacturers for lung cancer); *Richardson*, 649 F. Supp. at 801 (blaming Bendectin for child's deformities); Norris v. Gatts, 738 P.2d 344, 346 (Ala.

There are several reasons for this phenomenon. First, the judicial process has become more available and attractive to the general public.[136] Attorneys encourage individuals to file personal injury claims.[137] The press heralds huge jury awards.[138] They report flawed scientific conclusions, leading the public to believe that certain drugs and structural designs are defective.[139]

1987) (blaming sudden acceleration for injuring innocent motorcyclist). *See generally* Ronald B. Lansing, *The Motherless Calf, Aborted Cow Theory of Cause*, 15 ENVTL. L. 1, 1 (1984) (supporting loose application of blame and causation to ensure that those harmed will be remunerated). Many courts have recognized this problem in terms of medical malpractice. *See* Fein v. Permanente Medical Group, 175 Cal. Rptr. 177, 186 (Cal. App. 1981) (stating that there has been an increase in malpractice suits against medical workers), *vacated*, 695 P.2d 665 (Cal.), *and appeal dismissed*, 474 U.S. 892 (1985). This phenomenon has also been exemplified in accounting malpractice cases. Alex Andrews, *Potential Liability of Accountants to Third Parties for Negligence*, 41 ST. JOHN'S L. REV. 588, 596 (1967) (stating that there were 80 accountant malpractice lawsuits in 1906); T.J. Fiflis, *Current Problems of Accountants' Responsibilities to Third Parties*, 28 VAND. L. REV. 31, 33 (1975) (indicating there were 500 lawsuits pending). By 1985, there had been 80 million lawsuits in state and local courts dealing with accountant liability. Adam Mednick, *Accountants Liability: Coping With the Stampede to the Courtroom*, 164 J. ACCT., Sept. 1987, at 118-19.

136. *See generally* Glen O. Robinson, *The Medical Malpractice Crisis of the 70's: A Retrospective*, 49 LAW & CONTEMP. PROBS. Spring 1986, at 16 (explaining that increased expected pay-out makes malpractice claims more attractive to plaintiffs). Professor Robinson lists several reasons why tort reform can be considered pro-plaintiff. *Id.* at 16. This includes the abrogating of the locality rule, the easing of informed consent standards, and increased applications of the doctrine of *respondeat superior*. *Id.* Professor Robinson also states that the abrogation of the charitable immunity concept and changes in the statutes of limitations have increased the amount of lawsuits brought by plaintiffs. *Id.* at 17. *But see* Ronald J. Allen, Comment, *Rationality, Mythology, and the "Acceptability of Verdicts Thesis"*, 66 B.U. L. REV. 541, 553 (1986) (contending that litigation process should not be used to manipulate plaintiff, but plaintiff should be told of pitfalls in system).

137. *See* Zauderer v. Office of Disciplinary Council of the Sup. Ct. of Ohio, 471 U.S. 626, 631 (1989) (observing that attorney who advertised he would represent women who had used Dalcon Shield received over 200 inquiries). *See generally* Leslie Bender, *Frontier of Legal Thought III: Feminist (Re)torts: Thoughts on the Liability Crisis, Mass Torts, Power, and Responsibilities*, 1990 DUKE L.J. 848, 853-54 (1990) (stating that tort system criticized because motivated by greed); Robert S. Murphy, Comment, *Arizona RICO, Treble Damages, and Punitive Damages: Which One Does Not Belong?*, 22 ARIZ. ST. L.J. 299, 299-300 (reasoning that many plaintiffs who are normally reluctant to file RICO claim are encouraged by treble damages aspect of statute).

138. *See generally* PETER W. HUBER, GALILEO'S REVENGE 248-49 (1991) (citing Perl, *$750,000 Judgment Found Against Maker of Bendectin*, WASH. POST, May 28, 1983, at A1; Mintz, *Deformed D.C. Boy Awarded $95 Million; Bendectin Maker Penalized*, WASH. POST, July 15, 1987, at A1); Patricia Zimand, Comment, *National Asbestos Litigation: Procedural Problems Must Be Solved*, 69 WASH. U. L.Q. 899, 903 n.23 (1991) (noting that publicity of high jury awards led to increased asbestos litigation).

139. *See generally* PETER W. HUBER, GALILEO'S REVENGE 243, 246 (1991) (citing Merewood, *Surgical Births: Are Physicians Performing Unnecessary Caesareans?*, CHI. TRIB., May 7, 1989, zone 3, at 3; Hales, *Has Man Created a New "Allergy?"*, N.Y. TIMES, Aug. 19, 1980,

Consequently, the public has become adept at Calabresian analysis.[140] The public believes that it is never at fault and that the responsible parties must be held financially accountable.[141] In short, Americans have embraced the notion that someone else is always to blame.

Comforted by the notion that any tragedy is not their fault, and mesmerized by the huge judgments awarded other plaintiffs, many more individuals are filing suit.[142] They are willing to become embroiled in the judicial process hoping that their case will result in a large award.[143] Consequently, those who would normally accept their misfortune or amicably settle the dispute are seduced by the prospect of finding a "cheapest cost avoider" with

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§ C, at 1; *Experts Reveal... Common Drug Causing Deformed Babies*, NAT'L ENQUIRER, Oct. 9, 1979 at 20).

140. *Cf.* Union Oil Co. v. Oppen, 501 F.2d 558, 569-70 (9th Cir. 1974). In *Union*, the court applied Calabresian analysis to hold the defendants liable. *Id.* Commercial fishermen sued because they suffered economic losses as a result of an oil spill. *Id.* at 569. The plaintiffs argued that the defendant, Union Oil Company, had the most economic power to pay for their losses. *Id.* at 570. Therefore, the court forced the defendants to pay damages. *Union Oil Co.*, 501 F.2d at 570. *See generally* Glen O. Robinson, *Multiple Causation in Tort Law: Reflections on the DES Cases*, 68 VA. L. REV. 713, 736-37 (1982) (stating that under Calabresian analysis, objective is to compensate as many people as possible by finding deep pocket not hurt by large judgment).

141. This is exemplified by the development of new means of dealing with causation that weaken the former strong causation standard. *Cf.* Sindell v. Abbott Lab., 607 P.2d 924, 936-38 (Cal.) (developing market share liability theory), *cert. denied*, 449 U.S. 912 (1980); Barker v. Lull Eng'g Co., 573 P.2d 443, 455-56 (Cal. 1978) (changing burden of proof to enable plaintiff to recover); Greenman v. Uba Power Prod. 377 P.2d 897, 900 (Cal. 1962) (developing strict liability).

142. This trend is clearly evidenced by the actions of plaintiffs in the 1980's who sought to bring product design liability cases against a number of different products. *See* Hon v. Stroh Brewery Co., 835 F.2d 510, 510 (3d Cir. 1987) (claiming alcoholic beverages defectively designed); *Cipollone*, __ U.S. __, 112 S. Ct. at 2611, 120 L. Ed. 2d at 407 (considering product liability case against cigarette manufacturers); Kelley v. R.G. Indus. Inc., 497 A.2d 1143, 1145 (Md. 1985) (argued handguns defectively designed); O'Brien v. Muskin Corp., 463 A.2d 298, 301 (N.J. 1983) (alleging that swimming pool defectively designed); Baughn v. Honda Motor Co., Ltd., 727 P.2d 655, 659 (Wash. 1986) (contesting design of all terrain vehicles). *See generally* Nina H. Compton & J. Douglas Compton, *DPT Vaccine Manufacturer Liability: Chipping Away at Strict Liability to Save the Product*, 20 N.M. L. REV. 531, 534 (explaining that DPT manufacturers noticed sixfold increase in claims brought against them); James A. Henderson, Jr., *Renewed Judicial Controversy Over Defective Product Design: Toward the Preservation of an Emerging Consensus*, 63 MINN. L. REV. 773, 782-783 (1979) (showing that courts are easing plaintiff's burden to allow more defective design product cases to go to the jury).

143. *Ealy*, 897 F.2d at 1159; *Richardson*, 649 F. Supp. at 801; *Oxendine*, 506 A.2d at 1100; *see* PETER W. HUBER, GALILEO'S REVENGE 3 (1991) (stating that goal is to obtain money); *see* Patricia Zimand, Comment, *National Asbestos Litigation: Procedural Problems Must Be Solved*, 69 WASH. U. L.Q. 899, 903 n.23 (1991) (stating that high jury awards spurred litigation). *See generally* Aaron Small, *Gaffing at a Thing Called Cause: Medico-Legal Conflicts in the Concept of Causation*, 31 TEX. L. REV. 630, 632 (1953) (quipping that it looks like lawyers know more about what causes cancer than doctors).

a very deep pocket.[144]

Like an infectious disease, Calabresian analysis has invaded the judicial process through lawyers, scientists, and plaintiffs. Flawed scientific evidence is proffered by those who search for the cheapest cost avoider.[145] Jurors are lulled by the evidence into accepting and adopting Calebresian rationalizations.[146] Consequently, the jurors leave the courtroom feeling as if they have furthered social justice.[147] Lawyers, scientists, and plaintiffs leave the courtroom wealthier.

III. SOLVING THE QUANDARY

Through misunderstanding and abuse, scientific evidence has created significant evidentiary problems. Courts admit flawed scientific evidence,[148] or

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144. *Cf. Martin*, 678 F.2d at 1327 (demonstrating that damages minimal without emotional distress claim); *Glenn*, 129 N.E.2d at 189 (granting award for cancer purportedly caused by blow).

145. *See Sindell*, 607 P.2d at 936-38 (not requiring plaintiff to conclusively prove plaintiff used defendant's product); Bichler v. Ely Lilly & Co., 436 N.E.2d 182, 186 (N.Y. 1982) (establishing concerted action theory for DES manufacturers). *See generally* Edwin J. Jacob, *Of Causation in Science and Law: Consequences of the Erosions of Safeguards*, 40 BUS. LAW. 1229, 1239 (1985). Jacobs quoted The Wall Street Journal which stated:

> But there's something terribly askew with a legal system that cannot distinguish between a thalidomide and a Bendectin. Let us hope that the withdrawal of Bendectin is not a harbinger of other products being driven from the market by legal costs, even when the weight of medical evidence suggests they haven't been at fault.

Id.

146. *See Bichler*, 436 N.E.2d at 185 (stating that although some defendants may not be liable in traditional sense, important for society and plaintiff that plaintiff recover); Martin v. Abbott Labs., 689 P.2d 368, 371, 381 (Wash. 1984). In *Martin*, the court was caught between the needs of the victims and traditional causation analysis. *Id.* at 371. In response, the court said, "we are presented with a conflict between the familiar principle that a tortfeasor may be held liable only for damages that it has caused, and the sense of justice which urges that the victims of this tragedy should not be denied compensation." *Id.* at 381. However, some courts apply a Calabresian philosophy to tort law in an acceptable manner. *See* Oleson v. Sweiger, 527 N.Y.S.2d 935, 936 (N.Y. App. Div. 1988). In *Oleson* the plaintiff was injured when given a permanent by employees of Helene Curtis during a beauty trade show. *Id.* The plaintiff sued both the sponsor of the show and the hair care manufacturer, but the court allowed the plaintiff to recover only against Helene Curtis. *Id.* Using Calabresian analysis, the court determined which party could more cheaply take precautions to avoid the accident. *Id.* The court reasoned that Helene Curtis' employees could more easily administer the hair treatment correctly than the sponsor could inform all the models in the show about the dangers of the chemical treatments. *Oleson*, 527 N.Y.S.2d at 936. *See generally* GUIDO CALEBRESI, THE COST OF ACCIDENTS, 69-73 (1970) (explaining that if activity causes harm but harm not reflected in cost of product, society must decide if it really wants the product).

147. *Cf. Bichler*, 436 N.E.2d at 185 (allowing indeminifaction of plaintiff); *Martin*, 689 P.2d at 381 (granting plaintiff money even without full proof of causation).

148. *See* National Dairy Prod. v. Durham, 154 S.E.2d 752, 755 (Ga. App. 1967) (finding for plaintiff based on flawed evidence); Daly v. Bergstead, 126 N.W.2d 242, 247 (Minn. 1964)

in the name of caution, exclude valid scientific evidence.[149] Some courts avoid scientific analysis altogether.[150] Clearly, this evidentiary crisis requires an immediate solution.

The only feasible solution is to refashion the rules of evidence to effectively strain out junk science.[151] To succeed, any test must treat the causes for the quandary, rather than the symptoms, by resolving the differences between the disciplines of law and science.[152] First, the court must test the validity of

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(admitting scientific testimony concerning traumatic cancer); Baker v. DeRosa, 196 A.2d 387, 390 (Pa. 1964) (awarding for plaintiff based on flawed scientific evidence).

149. *See* United States v. Tranowski, 659 F.2d 750, 753-55 (7th Cir. 1981) (disallowing sun chart); United States v. Brown, 557 F.2d 541, 558 (6th Cir. 1977) (refusing to admit valid scientific technique detecting traces of drugs); People v. Owens, 508 N.E.2d 1088, 1094 (Ill. App. 1987) (holding valid evidence inadmissible based on *Frye*).

150. United States v. Franks, 511 F.2d 25, 33 (6th Cir. 1975) (relying upon precedent to consider scientific evidence); Ohio v. Olderman, 336 N.E.2d 442, 445-46 (Ohio 1975) (analyzing scientific evidence based on precedent). *See generally* John W. Osborne, Comment, *Judicial/Technical Assessment of Novel Scientific Evidence*, 1990 U. ILL. L. REV. 497, 520 (asserting that courts look to precedent instead of validity).

151. Clearly, the current modes of analyzing scientific evidence have been inadequate. *See* Symposium Report, Rules for Admissibility of Scientific Evidence, 115 F.R.D. 79, 81 (1987). In 1987, the National Conference of Lawyers and Scientists considered the different analyses used to deal with scientific evidence. The conferees agreed that the rule dealing with scientific evidence should be changed, but the conferees could not agree on the method of change. Four proposals were offered at the conference. One proposal was primarily procedural. Paul C. Giannelli, Scientific Evidence: A Proposed Amendment to Federal Rule 702, 115 F.R.D. 102, 102-07 (1987). The second was a reliability test. Fredric I. Lederer, Resolving the *Frye* Dilemma-A Reliability Approach, 115 F.R.D. 84, 84-88 (1987). The third analysis was a relevancy test. Margaret A. Berger, A Relevancy Approach to Novel Scientific Evidence, 115 F.R.D. 89, 89-91 (1987). And a fourth was a validity test. James E. Starrs, *Frye v. United States* Restructured and Revitalized: A Proposal to Amend Federal Evidence Rule 702, 115 F.R.D. 92, 92-101 (1987). However, all the test are unsatisfactory alternatives because none of the tests restructure Rule 702 to consider both reliability and validity. *See generally* PETER W. HUBER, THE REVENGE OF GALILEO 15-17 (1991) (arguing that because *Frye* test rarely used, courts admit more junk science); Logan Ford & James H. Holmes, III, *The Professional Medical Advocate*, 17 SW. L.J. 551, 552 (1963) (stating that expert medical testimony is most "unsatisfactory and unreliable part of judicial administration"); Edward J. Imwinkelried, *Judge Versus Jury: Who Should Decide Questions of Preliminary Facts Conditioning the Admissibility of Scientific Evidence?*, 25 WM. & MARY L. REV. 577, 606-16 (1984) (suggesting use of FED. R. EVID. 901, 611, and 403 to consider scientific evidence); Sheila Jasanoff, *Science and the Courts: Advice a for Troubled Marriage*, NAT. RESOURCES ENVT., Fall 1986, at 3 (inferring that courts have dealt with scientific and technological evidence haphazardly).

152. *See* Christophersen v. Allied-Signal Corp., 939 F.2d 1106, 1111 n.9 (5th Cir. 1991) (describing Rule 702 as including both validity and reliability test); Mercado v. Ahmed, 756 F. Supp. 1097, 1101 (N.D. Ill. 1991) (explaining that law needs to consider both reliability and validity of scientific evidence). *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 599 (1988) (noting that any new analysis needs to solve problems of both validity and reliability); Edward J. Imwinkelried, *Judge Versus Jury: Who Should Decide Questions of Preliminary Facts Conditioning the Admissibility of Scientific Evi-*

the evidence.[153] The court must carefully evaluate the scientist's opinion to determine if the methodology the scientist employed conforms to the standards of his professional community.[154] Second, the trier of fact should determine if the scientist's conclusion is probable enough to be considered reliable.[155] However, any evidentiary rule must also address the possibility that scientific evidence can be misconstrued by the trier of fact.[156] Because the scientist's information may be used to prove more than it should, any admissibility standard must require that the court explain the true nature of the testimony to the trier of fact.[157]

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dence?, 25 WM. & MARY L. REV. 577, 606-16 (1984) (advocating use of FED. R. EVID. 901, 611, 403).

153. The validity of the evidence must be determined. Otherwise the courts may erroneously find liability. *See National Dairy Prod.*, 154 S.E.2d at 755 (admitting evidence of traumatic cancer); *Daly*, 126 N.W.2d at 247 (hearing scientific testimony concerning traumatic cancer); *Baker*, 196 A.2d at 390 (awarding based on flawed scientific evidence).

154. By applying careful analysis, the court can ensure that the scientific evidence will not be given weight it does not deserve. *See* United States v. Wilson, 361 F. Supp. 510, 513 (Md. 1973) (realizing juries misunderstand expert testimony); Watson v. State, 219 N.W.2d 398, 403 (Wis. 1974) (opining that juries can misunderstand invalid evidence as being valid). *See generally* John W. Wesley, Note, *Scientific Evidence and the Question of Judicial Capacity*, 25 WM. & MARY L. REV. 675, 682 (1984) (noting juries often "believe ahead of the evidence"). Because scientific evidence is so powerful, the courts must be certain that the evidence submitted to the jury is valid. *Id.*

155. *See Christophersen*, 939 F.2d at 1111 (establishing test reviewing experts' methodology for acceptance); United States v. Addison, 498 F.2d 741, 743-44 (D.C. Cir. 1974) (stating that expert must show that method or theory is supported by scientific community); Marder v. G.D. Searle & Co., 630 F. Supp 1087, 1090 (D. Md. 1986) (refusing to admit expert testimony because not supported by sound scientific evidence). *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 600 (1988) (arguing that validity is reflected in coherent and sound methodology or reasoning); Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1200-02 (1980) (opining that valid scientific principle is accepted by other scientists); Charles Nesson, *Agent Orange Meets the Blue Bus: Factfinding at the Frontier of Knowledge*, 66 B.U. L. REV. 521, 527 (1986) (describing traditional standard that experts should use respected methodology).

156. *See* United States v. Fosher, 590 F.2d 381, 383 (1st Cir. 1979) (noticing deference by juries to scientific evidence); *Brown*, 557 F.2d at 556 (noting jury may put too much weight upon scientific evidence); Smith v. United States, 389 A.2d 1356, 1359 (D.C.) (explaining that expert opinions often appears more authoritative to juror), *cert. denied*, 439 U.S. 1048 (1978). *See generally* Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1237 (1980) (noting significant danger that scientific evidence will mislead jury); John E.B. Myers et al., *Expert Testimony in Child Sexual Abuse Litigation*, 68 NEB. L. REV. 1, 20 (1989) (noticing that juries do not assess scientific evidence easily); John W. Wesley, Note, *Scientific Evidence and the Question of Judicial Capacity*, 25 WM. & MARY L. REV. 675, 684 (asserting that jurors sometimes find scientific evidence too credible).

157. *Cf. Brown*, 557 F.2d at 556 (realizing jury may not comprehend nature of scientific evidence); *Wilson*, 361 F. Supp. at 513 (court noting that jury can misunderstand scientific

A. *Past Attempts to Solve the Quandary*

1. Traditional *Frye* Analysis

Most courts have adopted the evidentiary standard developed in *Frye v. United States*.[158] In the 1923 murder case, Frye sought to enter the testimony of an expert witness concerning a crude polygraph test.[159] Frye contended that the lie detector would prove his innocence.[160] The court held that the technique had not yet gained sufficient acceptance in the scientific community to be admissible.[161] This holding, which is commonly referred to as the general acceptance test,[162] has been applied to both novel and established scientific evidence.[163]

Since its inception, courts have grappled with the ramifications of the *Frye* evidentiary standard. Courts muddle through defining the scientific community.[164] Some courts require that appropriate scientific peers accept the sci-

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information). *See generally* Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1237 (1980) (stating that jury may be misled by scientific evidence).

158. Frye v. United States, 293 F. 1013, 1013 (D.C. Cir. 1923); *see* Mercado v. Ahmed, 756 F. Supp. 1097, 1100 (N.D. Ill. 1991) (noting that reliability and validity tests not developed because courts use *Frye* test).

159. *Frye*, 293 F. at 1013.

160. *Id.* at 1014.

161. *Id.*

162. Barrel of Fun, Inc., v. State Farm & Fire Casualty Co., 739 F.2d 1028, 1031 (5th Cir. 1984); United States v. Distler, 671 F.2d 954, 961 (6th Cir.), *cert. denied*, 454 U.S. 827 (1981); United States v. Tranowski, 659 F.2d 750, 756 (7th Cir. 1981); United States v. McDaniel, 538 F.2d 408, 412 (D.C. Cir. 1976). The *Frye* test has been used to determine the admissibility of a number of scientific techniques. *See, e.g.*, United States v. Brady, 595 F.2d 359, 362-63 (6th Cir.) (microscopic hair analysis), *cert. denied*, 444 U.S. 862 (1979); Hughes v. Mathews, 576 F.2d 1250, 1258 (7th Cir.) (psychiatric testimony), *cert. denied*, 439 U.S. 801 (1978); United States v. Brown, 557 F.2d 541, 556-58 (6th Cir. 1977) (ion microprobic analysis); United States v. Addison, 498 F.2d 741, 743 (D.C. Cir. 1974) (spectrogram analysis). *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 629 (1988) (referring to *Frye* test as general acceptance rule); Kenneth R. Kreiling, *Scientific Evidence: Toward Providing the Lay Trier with the Comprehensible and Reliable Evidence Necessary to Meet the Goals of the Rules of Evidence*, 32 ARIZ. L. REV. 915, 919 (1990) (asserting that *Frye* test is known as general acceptance standard).

163. Hines v. Consolidated Rail Corp., 926 F.2d 262, 273 (3d Cir. 1991) (stating that general acceptance test should be applied to more than novel scientific evidence); DeLuca v. Merrell Dow Pharmaceuticals, 911 F.2d 941, 955 n.13 (3d Cir. 1990) (applying form of general acceptance test to established scientific evidence). *See generally* Kenneth R. Kreiling, *Scientific Evidence: Toward Providing the Lay Trier with the Comprehensible and Reliable Evidence Necessary to Meet the Goals of the Rules of Evidence*, 32 ARIZ. L. REV. 915, 918 (1990) (stating that *Frye* method used by many jurisdictions).

164. *See* United States v. Zeiger, 350 F. Supp. 685, 687 (D.D.C.) (questioning application of *Frye*), *rev'd*, 475 F.2d 1280 (D.C. Cir. 1972); Reed v. State, 391 A.2d 364, 368 (Md. 1978) (commenting that appropriate scientific community varies with type of scientific evidence prof-

entific opinion, technique, or conclusion.[165] Other courts require acceptance of the expert's methodology as well.[166] Critics of the *Frye* test point to disparate application of the doctrine.[167] Critics contend that the test includes too many variables, allowing judges to indiscriminately admit or bar scientific evidence.[168] Yet, despite criticism, the *Frye* analysis has continued as the dominant evidentiary standard.[169]

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fered); People v. Collins, 405 N.Y.S.2d 365, 368 (N.Y. Sup. Ct. 1978) (noting difficulty determining what exactly constitutes scientific community). *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 625-27 (1988) (discussing how one chooses appropriate field for general acceptance); Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1208 (1980) (discussing problems with *Frye* analysis).

165. Some question whether the *Frye* test reviews the scientific technique or the reasoning and methodology used to establish that technique. Some courts look only at the scientific procedure technology or technique. *See* United States v. Stifel, 433 F.2d 431, 435-37 (6th Cir. 1970) (reviewing only technology), *cert. denied*, 401 U.S. 994 (1971); People v. Roehler, 213 Cal. Rptr. 353, 376 (Cal. App. 1985) (reviewing scientific procedure); Commonwealth v. Fatalo, 191 N.E. 2d 479, 481 (Mass. 1963) (reviewing scientific instrument). *See generally* Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1208 (1980) (explaining analysis problems with *Frye* test).

166. Other courts, though, require that the scientific community accept the methodology. *See* Peteet v. Dow Chem. Co., 868 F.2d 1428, 1433-34 (5th Cir. 1989) (analyzing expert's methodology); Osburn v. Anchor Lab., Inc., 825 F.2d 908, 915-16 (5th Cir. 1987) (reviewing only methodology), *cert. denied*, 485 U.S. 1009 (1988); United States v. Kozminski, 821 F.2d 1186, 1199 (6th Cir. 1987) (requiring acceptance of scientist's principles). *See generally* 22 CHARLES ALAN WRIGHT & KENNETH W. GRAHAM, JR., FEDERAL PRACTICE AND PROCEDURES § 5168, at 95 (1978) (noting that most courts required acceptance of theory behind polygraph evidence).

167. *Compare* Commonwealth v. A Juvenile, 313 N.E.2d 120, 123-24 (Mass. 1974) (ignoring *Frye* to accept polygraph evidence though such evidence not generally accepted by scientific community) *with Fatalo*, 191 N.E.2d at 480-81 (using *Frye* to deny admission of polygraph evidence). *See generally* EDWARD W. CLEARY, MCCORMICK ON EVIDENCE § 210, at 490 (2d ed. 1974) (observing that courts selectively apply general acceptance test); Ronald N. Boyce, *Judicial Recognition of Scientific Evidence in Criminal Cases*, UTAH L. REV. 313, 314 (1962) (noting that judges have not consistently applied *Frye*).

168. *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 628 (1988) (contending that variables of *Frye* test cause courts to apply test unevenly); Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1221 (1980) (stating that *Frye* can be used as guise by judges to admit evidence subjectively); Kenneth R. Kreiling, *Scientific Evidence: Toward Providing the Lay Trier with the Comprehensible and Reliable Evidence Necessary to Meet the Goals of the Rules of Evidence*, 32 ARIZ. L. REV. 915, 922 (1990) (asserting that variables of *Frye* enable courts to use intuition to determine admissibility).

169. *E.g.*, Rivers v. Black, 68 So. 2d 2, 4 (Ala. 1953); State v. Valdez, 371 P.2d 894, 896 (Ariz. 1962); Brooke v. People, 339 P.2d 993, 996 (Colo. 1959); State v. Lowry, 185 P.2d 147, 152 (Kan. 1947); State v. Steel, 219 S.E.2d 540, 542-43 (N.C. App. 1975); State v. Woo, 527 P.2d 271, 272 (Wash. 1974); *see also* Commonwealth v. Vitello, 381 N.E.2d 582, 586 (Mass. 1978) (refusing to overrule *Frye*). *See generally* Joseph G. Petrosinelli, Comment, *The Admis-*

However, *Frye* merely addresses the symptoms of the problem instead of neutralizing the cause. The *Frye* standard only ensures that the scientific evidence is valid.[170] The standard does not analyze the reliability of the scientific conclusion presented in court.[171] Consequently, courts can still admit "junk science" if the invalid evidence is clothed in the characteristics of scientific truth.[172] This creates several problems. For example, supported by their own epidemiological studies, until the late 1950's doctors routinely testified that cancer could develop from a traumatic blow.[173] Because courts required only that the doctors' peers accept the doctors' professional judgments, courts admitted erroneous scientific evidence and that evidence became the basis of jury awards.[174]

2. Federal Rule of Evidence 702 Analysis

In 1975, the United States Congress adopted Federal Rule of Evidence

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sibility of DNA Typing: A New Methodology, 79 GEO. L.J. 313, 317 (1990) (stating that *Frye* method still has many adherents).

170. *See* Christophersen v. Allied-Signal Corp., 939 F.2d 1106, 1111 (5th Cir. 1991) (using *Frye* test to determine validity of expert's testimony); *Osburn*, 825 F.2d at 915 (determining validity of scientific evidence by considering expert's methodology); *Reed*, 391 A.2d at 368 (recognizing that *Frye* test determines validity of scientific technique). *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 632 (1988) (asserting that *Frye* test is best used to determine validity of evidence); Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1212 (1980) (noting that *Frye* test determines validity).

171. *See* United States v. Franks, 511 F.2d 25, 33 (6th Cir. 1975) (noting that even some evidence not generally accepted may be admissible); Henderson v. State, 230 P.2d 495, 501-04 (Okla. Crim.) (applying reliability standard although quoting *Frye*), *cert. denied*, 342 U.S. 898 (1951). *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 632 (1988) (asserting that *Frye* test more effectively evaluates validity than reliability).

172. Therefore, if the scientific community seems to support a proposition and the court relies only upon this criteria to establish validity, recovery can occur even though the evidence to prove causation is flawed. *See, e.g.*, National Dairy Prod. v. Durham, 154 S.E.2d 752, 755 (Ga. App. 1967) (admitting evidence of traumatic cancer because accepted by doctors); Daly v. Bergstead, 126 N.W.2d 242, 247 (Minn. 1964) (hearing scientific testimony concerning traumatic cancer based on approval by medical community); Baker v. De Rosa, 196 A.2d 387, 390 (Pa. 1964) (awarding recovery based on flawed scientific evidence because evidence accepted by general scientific community).

173. *See National Dairy Prod.*, 154 S.E.2d at 755 (doctor testified that trauma could induce cancer); *Daly*, 126 N.W.2d at 247 (doctor opined that plaintiff's accident could cause or worsen cancer); *Baker*, 196 A.2d at 390 (expert introduced erroneous scientific evidence).

174. *See National Dairy Prod.*, 154 S.E.2d at 755 (admitting scientific evidence of traumatic cancer); *Daly*, 126 N.W.2d at 247 (considering testimony explaining traumatic cancer because medical community approved testimony); *Baker*, 196 A.2d at 390 (basing judgment on flawed scientific evidence because evidence accepted by general scientific community).

702 (Rule 702).[175] Rule 702 is very succinct and states only that scientific evidence is admissible if the evidence will help the trier of fact understand or determine facts in the case.[176] The Advisory Committee of the Supreme Court (the Advisory Committee) explained Rule 702 and indicated that courts should admit scientific evidence if the information will help the trier of fact.[177] Therefore, courts should not admit unhelpful scientific evidence.[178]

Despite the Advisory Committee's guidance, courts have not interpreted Rule 702 uniformly.[179] Some courts view Rule 702 as a codification of the *Frye* standard.[180] Other courts see Rule 702 as a repudiation of *Frye*.[181] Because Rule 702 has aroused rather than calmed the scientific evidence

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175. Act of Jan. 2, 1975, Pub. L. No. 93-595, 88 Stat. 1926 (codified at 28 U.S.C. app. (1976)).

176. FED. R. EVID. 702; United States v. Butt, 955 F.2d 77, 85 n.12 (1st Cir. 1992) (quoting test of Rule 702); Vang v. Toyed, 944 F.2d 476, 481 n.2 (9th Cir. 1991) (quoting text of Rule 702 stating that information must be helpful to trier); Tatman v. Collins, 938 F.2d 509, 512 (4th Cir. 1991) (noting that district courts should follow Rule 702 to admit helpful scientific evidence). *See generally* Charles Bleil, *Evidence of Syndromes: No Need for a "Better Mousetrap"*, 32 S. TEX. L. REV. 37, 44-46 (explaining standard established by Rule 702); John W. Osborne, Comment, *Judicial/Technical Assessment of Novel Scientific Evidence*, 1990 U. ILL. L. REV. 497, 518 (discussing Rule 702 and accompanying advisory committee notes).

177. FED. R. EVID. 702 advisory committee's note. *See* Christophersen v. Allied-Signal Corp., 939 F.2d 1106, 1116 (5th Cir. 1991) (stating that Advisory Committee changes focus of analysis to jury's inquiry rather than substantive testimony).

178. *See* United States v. Jakobetz, 955 F.2d 786, 796 (2d Cir. 1992) (explaining that jury should consider scientific evidence that aids jury in understanding issues in case); DeLuca v. Merrell Dow Pharmaceuticals, Inc., 911 F.2d 941, 954 (3d Cir. 1990) (explaining *Downing* approach to determining if evidence is helpful); Dowd v. Calabrese, 585 F. Supp. 430, 435 (D.D.C. 1984) (denying admission of polygraph evidence because of confusing effect of scientific evidence). *See generally* Andre A. Moenssens, *Admissibility of Scientific Evidence—An Alternative to the* Frye *Rule*, 25 WM. & MARY L. REV. 545, 559-60 (1984) (noting growth of technical evidence and need for expert testimony to better understand such evidence); John W. Osborne, Comment, *Judicial/Technical Assessment of Novel Scientific Evidence*, 1990 U. ILL. L. REV. 497, 538-39 (noting that helpfulness standard difficult to apply).

179. *Compare Jakobetz*, 955 F.2d at 796 (holding that Rule 702 and *Frye* test are same standard) *with* United States v. Downing, 753 F.2d 1224, 1234 (3d Cir. 1985) (ruling that Rule 702 replaced *Frye* test). *See generally* Vicki Christian, Comment, *Admissibility of Scientific Expert Testimony: Is Bad Science Making Law?*, 18 N. KY. L. REV. 21, 26 (1990) (discussing status of *Frye* after adoption of Rule 702); John W. Osborne, Comment, *Judicial/Technical Assessment of Novel Scientific Evidence*, 1990 U. ILL. L. REV. 497, 518 (noting controversy over applicability of *Frye* after adoption of Rule 702).

180. United States v. Tranowski, 659 F.2d 750, 755-56 (7th Cir. 1981); United States v. Hendershot, 614 F.2d 648, 654 (9th Cir. 1980); United States v. Brady, 595 F.2d 359, 362 (6th Cir.), *cert. denied*, 444 U.S. 862 (1979).

181. United States v. Williams, 583 F.2d 1194, 1197-1200 (2d Cir. 1978), *cert. denied*, 439 U.S. 1117 (1979); United States v. Baller, 519 F.2d 463, 465-66 (4th Cir.), *cert. denied*, 423 U.S. 1019 (1975).

controversy, it has not resolved the scientific evidence quandary.[182]

3. *Downing* Analysis

Critics of the *Frye* standard bristled under the conservative thumb of that test.[183] The critics noted that *Frye* created a cultural lag between the time the scientific community established reliable novel scientific information and when the legal community admitted the new information in court.[184] In response, the Third Circuit Court of Appeals developed its own standard under the guise of Rule 702.[185] In *United States v. Downing*,[186] the Third Circuit reviewed scientific evidence for 1) the reliability of the process used to produce the evidence, 2) the possibility that the evidence would confuse or overwhelm the jury, and 3) the relevance of the scientific information to the factual issues.[187] Unlike *Frye*, the tendency is to admit the scientific evidence.[188]

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182. *Cf.* Novak v. United States, 865 F.2d 718, 722-23 (6th Cir. 1989) (describing how district court improperly admitted evidence that swine flu causes dermatomyositis). *See generally* Vicki Christian, Comment, *Admissibility of Scientific Expert Testimony: Is Bad Science Making Law?*, 18 N. KY. L. REV. 21, 26 (1990) (stating that Rule 702 has caused controversy).

183. People v. Kelly, 549 P.2d 1240, 1245 (Cal. 1976) (describing conservative nature of *Frye*); Commonwealth v. Mendes, 547 N.E.2d 35, 42 (Mass. 1989) (Liacos, J., dissenting) (acknowledging that *Frye* test too conservative); Oregon v. Brown, 687 P.2d 751, 757 (Or. 1984) (noting that some courts contend that advantage of *Frye* test is its conservative nature). *See generally* Mark S. Ellinger, *DNA Diagnostic Technology: Probing the Problem of Causation in Toxic Torts*, HARV. J.L. & TECH., Spring 1990, at 48 (1990) (stating that some criticize *Frye* test for being too conservative).

184. *See* United States v. Downing, 753 F.2d 1224, 1236-37 (3d Cir. 1985) (realizing that *Frye* creates cultural lag between time valid new scientific discoveries established and when discoveries can be admitted in court); Andrews v. Florida, 533 So. 2d 841, 846 (Fla. Dist. Ct. App. 1988) (illustrating attempt by court to avoid cultural lag); Saint Louis v. Boecker, 370 S.W.2d 731, 734 (Mo. App. 1963) (noting *Frye* results in cultural lag). *See generally* Joseph G. Petrosinelli, Comment, *The Admissibility of DNA Typing: A New Methodology*, 79 GEO. L.J. 313, 322 (1990) (asserting that relevancy test resolves cultural lag caused by *Frye*).

185. *See Downing*, 753 F.2d at 1231-32 (3d Cir. 1985) (establishing analysis and admitting scientific evidence under guise of Rule 702). *See generally* Joseph G. Petrosinelli, Comment, *The Admissibility of DNA Typing: A New Methodology*, 79 GEO. L.J. 313, 322 (1990) (opining that *Downing* derived from helpfulness standard in Rule 702); W. Anthony Purcell, *Criminal Procedure—Match-game 1990's: The Admissibility of DNA Profiling*—State v. Pennington, 13 CAMPBELL L. REV. 209, 216 n.165 (1991) (recognizing that court interpreted Rule 702 in *Downing* to establish three-pronged approach).

186. 753 F.2d 1224 (3d Cir. 1985).

187. *Id.* at 1237.

188. *Cf. Andrews*, 533 So. 2d at 846-47 (stating that *Downing* test allows admission of more evidence); New Jersey v. Gunter, 554 A.2d 1356, 1362-63 (N.J. Super. Ct. 1989) (asserting that under *Downing* analysis, identification psychology testimony admitted for first time in federal courts). *Downing* apparently requires the trier of fact to consider the weight of the evidence rather than determining the admissibility of the evidence. United States v. Ferri, 778

Although the *Downing* approach more sufficiently reviews the basis for the scientist's opinion or technique,[189] the analysis does not resolve the quandary that develops when the judicial system does not recognize or distinguish the differences between scientific truth and a scientist's professional judgment.[190] In fact, the *Downing* test may blur this distinction even further. An analytical evaluation of the basis of a conclusion makes that conclusion appear objective.[191] By reviewing the methodological basis for the expert's conclusions, a court may be sending the wrong message that the scientific evidence is not influenced by the scientist's biases.[192] Consequently, juries may be seduced into believing that the scientific evidence is infallible.[193] Law's Achilles' heel will be clearly exposed and the opportun-

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F.2d 985, 989 (3d Cir. 1985). In *Ferri*, the prosecution attempted to admit a footprint identification test and the court complied. *Id.* at 985. The defendant argued that the test was unreliable but the court asserted that the evidence, though novel, should be admitted and the jury could determine the weight of the evidence. *Id.* at 989.

189. John W. Osborne, Comment, *Judicial/Technical Assessment of Novel Scientific Evidence*, 1990 U. ILL. L. REV. 497, 532 (contending that *Downing* approach preferable to relevancy approach). However, the *Downing* approach has no mechanism to ensure that the triers of fact realize the true nature of the expert's opinion. Instead, courts appear to realize that the trier of fact may allow the scientific evidence to prove too much. This is the same problem inherent in *Frye*. As stated by Professor Moenssens, in *Admissibility of Scientific Evidence—An Alternative to the* Frye *Rule*, 25 WM. & MARY L. REV. 545, 565 (1984), this type of mechanistic test exemplifies the scientific illiteracy that hampers courts. The trier of fact cannot adequately evaluate the scientific evidence if the trier misconstrues the nature of the evidence.

190. *See generally* Cathleen C. Herasimchuk, *A Practical Guide to the Admissibility of Novel Expert Evidence in Criminal Trials under Federal Rule 702*, 22 ST. MARY'S L.J. 181, 221-22 (1990). Ms. Herasimchuk lists several factors to consider when applying the *Downing* approach:

(1) the relationship of the methodology used to the other types of established scientific analyses;
(2) scientific literature dealing with the technique;
(3) the scientific expert's qualifications;
(4) the nonjudicial applications of the technique;
(5) how often the technique produced incorrect conclusions;
(6) the magnitude of the error if an error results; and
(7) how many other courts have admitted this technique.

Id.

191. *Cf.* Barefoot v. Estelle, 463 U.S. 880, 929 (Blackmun, J., dissenting) (contending that juries cannot distinguish between flawed and valid evidence); Oxendine v. Merrell Dow Pharmaceuticals, Inc., 506 A.2d 1100, 1103 (D.C. 1986) (illustrating danger of objective introduction of scientific evidence). *See generally* John W. Osborne, Comment, *Judicial/Technical Assessment of Novel Scientific Evidence*, 1990 U. ILL. L. REV. 497, 528-31 (disdaining jury competence).

192. *Cf.* Ferebee v. Chevron Chem. Co., 736 F.2d at 1534 (D.C. Cir.) (showing ease of misleading jury and burden to overturn erroneous finding), *cert. denied*, 469 U.S. 1062 (1984); Daly v. Bergstead, 126 N.W.2d 242, 247 (Minn. 1964) (illustrating that analytical approach may validate erroneous evidence).

193. *Cf.* Richardson v. Richardson-Merrell, Inc., 649 F. Supp. 799, 801 (D.D.C. 1986)

ists will strike.

4. Relevancy Analysis

Many jurisdictions have developed a very broad perspective toward scientific evidence.[194] Using the relevancy test, the judge balances the probative value of the scientific evidence against its prejudicial effect.[195] The scientific information must be reliable enough to counter the information's overwhelming, confusing, or misleading effect upon the jury.[196] Once admitted, the jury is left with the task of determining the weight to assign the scientific evidence.[197]

(illustrating how scientific evidence can mislead jury); National Dairy Prod. v. Durham, 154 S.E.2d 752, 755 (Ga. App. 1967) (showing that analytical presentation makes evidence appear valid). *See generally* Harold L. Korn, *Law, Fact, and Science in the Courts*, 66 COLUM. L. REV. 1080, 1104-05 (1966) (discounting ability of jury).

194. In fact, many jurisdictions apply a relevancy test. *E.g.*, United States v. Jakobetz, 955 F.2d 786, 794 (2d Cir. 1992); United States v. Baller, 519 F.2d 463, 466 (4th Cir.), *cert. denied*, 423 U.S. 1019 (1975); Andrews v. State, 533 So. 2d 841, 849 (Fla. Dist. Ct. App. 1988); Cornett v. State, 450 N.E.2d 498, 501 (Ind. 1983); State v. Williams, 388 A.2d 500, 504 (Me. 1978); State v. Wheeler, 496 A.2d 1382, 1388 (R.I. 1985). *See generally* EDWARD W. CLEARY, MCCORMICK ON EVIDENCE § 210, at 491 (2d. ed. 1974) (admitting any relevant conclusions); James M. Doyle, *Applying Lawyers' Expertise to Scientific Experts: Some Thoughts about Trial Court Analysis of the Prejudicial Effects of Admitting and Excluding Expert Scientific Testimony*, 25 WM. & MARY L. REV. 619, 630 (1984) (noting that *Frye* test more restrictive than relevancy test established by McCormick).

195. Under the relevancy approach, one or two experts must testify that the evidence is valid. *See Williams*, 388 A.2d at 504 (opining that reliability is tied to relevancy); United States v. Ridling, 350 F. Supp. 90, 94 (E.D. Mich. 1972) (holding that scientific evidence must be reliable to be relevant); *see also* Margaret A. Berger, A Relevancy Approach to Novel Scientific Evidence, 115 F.R.D. 89, 89 (1987) (asserting that testimony must be admitted unless prejudicial affect outweighs probative value). *See generally* EDWARD W. CLEARY, MCCORMICK ON EVIDENCE § 210, at 491 (2d ed. 1974); Kenneth R. Kreiling, *Scientific Evidence: Toward Providing the Lay Trier with the Comprehensible and Reliable Evidence Necessary to Meet the Goals of the Rules of Evidence*, 32 ARIZ. L. REV. 915, 924 (1990) (explaining that judge decides if probative value outweighs prejudicial effect).

196. *See* United States v. Luschen, 614 F.2d 1164, 1169 (8th Cir. 1980) (discounting *Frye* test and applying relevancy test); United States v. Williams, 583 F.2d 1194, 1198 (2d Cir. 1978) (applying relevancy approach and concluding that evidence would not mislead jury), *cert. denied*, 439 U.S. 1117 (1979). *See generally* JACK B. WEINSTEIN & MARGARET A. BERGER, WEINSTEIN'S EVIDENCE § 702(03) (1992) (observing that most significant danger with relevancy test is that evidence may mislead jury); Kenneth R. Kreiling, *Scientific Evidence: Toward Providing the Lay Trier with the Comprehensible and Reliable Evidence Necessary to Meet the Goals of the Rules of Evidence*, 32 ARIZ. L. REV. 915, 924-25 (1990) (asserting that if evidence misleads jury, evidence would be inadmissible under relevancy approach).

197. *See Williams*, 583 F.2d at 1200 (using relevancy approach and considering weight of evidence); *Baller*, 519 F.2d at 466 (stating that expert testimony goes to weight rather than admissibility); *Ridling*, 350 F. Supp. at 95-96 (noting that evidence admitted based on its worth and worth tested by cross examination). *See generally* Edward J. Imwinkelried, *Judge Versus Jury: Who Should Decide Questions of Preliminary Facts Conditioning the Admissibility of*

Critics of the relevancy test abound.[198] Using the relevancy test, the jury determines both the validity and the reliability of the scientific information.[199] However, jurors may not be equipped for the job.[200] Jurors may not recognize invalid scientific information. Consequently, the critics contend that the doors of the courtroom are opened to all science.[201] Because juries often are unfamiliar with the true nature of the scientific method, jurors may improperly conclude that the expert witness' testimony is solely based on an objective and reasoned analysis.[202] Because of this misconception, the jury cannot accurately determine the reliability of the evidence. Therefore, the relevancy approach does not adequately address the quandary of scientific evidence.[203]

Scientific Evidence?, 25 WM. & MARY L. REV. 577, 579 (1984) (discussing role of jury under relevancy approach).

198. *Cf.* Richardson v. Richardson-Merrell, Inc., 649 F. Supp. 799, 800-03 (D.D.C. 1986) (illustrating dangers of using relevancy approach). *See generally* Lucinda E. Minton, *Expert Testimony Based on Novel Scientific Techniques: Admissibility Under the Federal Rules of Evidence*, 48 GEO. WASH L. REV. 774, 784-85 (1980) (asserting that relevancy approach does not ensure availability of rebuttal witnesses); Mark L. Austrian, *Expert Evidence in Toxic Tort Litigation*, FOR THE DEF., Feb. 1989, at 17, 22 (noting that relevancy test increases opportunity for emotion to sway jury); Haskell Shelton, *The Need for Scientific Data in Chemical Exposure Litigation*, FOR THE DEF., Dec. 1989, at 18, 19 (stating that scientists should have to prove validity of their testimony).

199. *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 627-28 (1988) (arguing that relevancy approach does not consider validity of evidence).

200. *See* Barefoot v. Estelle, 463 U.S. 880, 929-30 (1983) (Blackmun, J., dissenting) (arguing that many juries incapable of "determining what is reliable scientific evidence"). *See generally* James M. Doyle, *Applying Lawyers' Expertise to Scientific Experts: Some Thoughts about Trial Court Analysis of the Prejudicial Effects of Admitting and Excluding Expert Scientific Testimony*, 25 WM. & MARY L. REV. 619, 631 (1984) (arguing that both *Frye* and relevancy tests determine validity and reliability of scientific information); Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1240 (1980) (asserting that studies do not indicate that jurors properly assess scientific evidence).

201. *Cf.* Osburn v. Anchor Lab., Inc., 825 F.2d 908, 915 (5th Cir. 1987) (holding that scientific witness' testimony need not be accepted by peers to be admissible in court), *cert. denied*, 485 U.S. 1009 (1988); Ferebee v. Chevron Chem. Co., 736 F.2d 1529, 1534 (D.C. Cir.) (illustrating role and importance of jury under relevancy test), *cert. denied*, 469 U.S. 1062 (1984).

202. *See Ferebee*, 736 F.2d at 1534 (illustrating predicament created by admitting scientific evidence without first determining validity). *See generally* Harold L. Korn, *Law, Fact, Science in the Courts*, 66 COLUM. L. REV. 1080, 1104-05 (1966) (noting jury may not have knowledge or perspective to deal with scientific evidence); John W. Osborne, Comment, *Judicial/Technical Assessment of Novel Scientific Evidence*, 1990 U. ILL. L. REV. 497, 528-31 (arguing that jurors do not have proper training or temperament to deal with scientific evidence).

203. *Ferebee*, 736 F.2d at 1534 (D.C. Cir.) (illustrating inadequacy of relevancy approach); Oxendine v. Merrell Dow Pharmaceuticals, Inc., 506 A.2d 1100, 1107 (D.C. 1986) (illustrating opportunity relevancy approach provides to admit erroneous evidence). *See gen-*

B. *Recent Attempts to Solve the Quandary*

1. Proposed Federal Rule of Evidence 702

On August 15, 1991, the Advisory Committee issued a proposed revision of Rule 702.[204] The proposed version refers to scientific evidence as information rather than as knowledge.[205] More importantly, the proposed rule requires that the information be (1) reasonably reliable and (2) substantially helpful to the trier of fact to aid them in understanding the evidence and determining the fact issues in the case.[206]

The Advisory Committee outlined the reasons for revising Rule 702. The committee concluded that the use of scientific evidence is often unhelpful, prejudicial, and costly.[207] The committee also stated that scientific evidence is posing more problems because attorneys are using this type of evidence more often.[208] However, the Advisory Committee endeavored to protect the use of helpful scientific evidence in the litigation process.[209]

The Advisory Committee directly repudiated the *Frye* analysis[210] and established a less conservative but analogous standard.[211] Under the proposed standard, the scientific premises of the testimony must be significantly supported by the scientific community.[212] The Advisory Committee concluded that the admissibility of the scientific evidence would be best determined before trial, with the court balancing the need and utility of the evidence against the time and expense required to admit it.[213]

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erally Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1231-32 (1980) (discussing relevancy approach); Vicki Christian, Comment, *Admissibility of Scientific Expert Testimony: Is Bad Science Making Law?*, 18 N. KY. L. REV. 21, 31-34 (1990) (outlining criticisms of relevancy standard).

204. Proposed Amendments to the Federal Rules of Evidence, 137 F.R.D. 156, 156-58 (1991).

205. *Id.* at 156.

206. *Id.*

207. *Id.* The Advisory Committee noted that many litigators abuse expert testimony. The Advisory Committee contended that these individuals use the high cost of the information to wear down opponents. *Id.*

208. Proposed Amendments to the Federal Rules of Evidence, 137 F.R.D. at 156-7.

209. *Id.* at 156. The Advisory Committee agreed that scientific and expert testimony can be crucial to some cases. *Id.*

210. *Id.* at 157. The Advisory Committee stated that the proposed rule was not a return to the *Frye* analysis. *Id.* The Advisory Committee specifically rejected the general acceptance test. *Id.*

211. *Id.* The Advisory Committee required that the premises of the testimony be significantly supported and accepted within the scientific community. *Id.*

212. Proposed Amendments to the Federal Rules of Evidence, 137 F.R.D. at 157.

213. *Id.* The Advisory Committee noted that the courts were authorized to make these pre-trial determinations based on Federal Rule of Civil Procedure 26(c)(4). *Id.*

Although the Advisory Committee valiantly attempts to develop an appropriate standard, that standard promises to be ineffective since the proposed rule does not address the reasons for the evidentiary crisis. The proposal does not clearly establish the two-pronged test of validity and reliability.[214] Therefore, it does not provide a bridge between legal and scientific reasoning. The proposed rule does not prevent the expert from interjecting her own values into her scientific testimony.[215] In addition, the proposal does not ensure that the trier of fact will appreciate the relativism of science.[216] Consequently, scientific evidence will still have the potential to mislead.[217]

2. *Christophersen v. Allied-Signal Corp.*

On the same day that the Advisory Committee proposed changes to Rule 702, the Fifth Circuit Court of Appeals, sitting en banc, issued its ruling in *Christophersen v. Allied-Signal Corp.*[218] This decision redefined the standard for admitting scientific evidence in civil cases heard in the Fifth Circuit.[219] In *Christophersen*, a surviving spouse brought a wrongful death action against her deceased husband's employer, a battery manufacturer.[220] Albert Christophersen had worked at the battery plant for fourteen years[221] and

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214. *See* Christophersen v. Allied-Signal Corp, 939 F.2d 1106, 1110 (5th Cir. 1991) (establishing validity and reliability test); Mercado v. Ahmed, 756 F. Supp. 1097, 1098 (N.D. Ill. 1991) (applying two-pronged test). *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 607 (1988) (describing two-pronged analytical framework).

215. *Cf.* Roe v. Wade, 410 U.S. 113, 120 (1973) (exemplifying court's erroneous belief that scientific evidence void of value influence); Reed v. State, 391 A.2d 364, 421 (Md. 1978) (Smith, J., dissenting) (showing that courts view scientific testimony as objective). *See generally* Howard T. Markey, *Law and Science: A Dialogue on Understanding*, 68 A.B.A. J. 154, 154-58 (1982) (stating that courts do not recognize subjective nature of science).

216. *See* United States v. Addison, 498 F.2d 741, 744 (D.C. Cir. 1974) (noting that jurors are swayed by "mystic infallibility" of science); State v. Schwartz, 447 N.W.2d 422, 428 (Minn. 1989) (fearing that jurors will defer to scientific evidence). *See generally* John W. Wesley, Note, *Scientific Evidence and the Question of Judicial Capacity*, 25 WM. & MARY L. REV. 675, 678 (stating that triers give too much credence to scientific testimony).

217. *See* United States v. Downing, 753 F.2d 1224, 1236 (3d Cir. 1985) (opining that juries may be mislead by scientific evidence); United States v. Barnard, 490 F.2d 907, 912 (9th Cir. 1973) (stating that juries may abandon common sense for scientific evidence); United States v. Wilson, 361 F. Supp. 510, 513 (D. Md. 1973) (noting that jury can be mislead by scientific evidence). *See generally* Edward J. Imwinkelried, *The Standard for Admitting Scientific Evidence: A Critique from the Perspective of Juror Psychology*, 28 VILL. L. REV. 554, 570 (1982-83) (stating that jurors overwhelmed by scientific evidence).

218. 939 F.2d 1106 (5th Cir. 1991).

219. *Id.* at 1122 (Reavely, J., dissenting) (contending that opinion changes evidence jurisprudence in Fifth Circuit).

220. *Id.* at 1108.

221. *Id.*

was exposed to both nickel and cadmium fumes.[222] Eventually, Christophersen developed a rare small-cell cancer in his colon which later metastasized to his liver.[223] Christophersen's wife claimed that her husband's inhalation of nickel and cadmium fumes at work proximately caused Christophersen's illness.[224] Mrs. Christophersen attempted to submit the testimony of an expert witness to prove that her husband's cancer was proximately caused by exposure to the toxic fumes.[225] However, the district court refused to admit the expert's testimony.[226] On appeal, a panel of the Fifth Circuit Court of Appeals reversed the district court's ruling, holding that the jury should hear the evidence because it was reliable enough to withstand summary judgment.[227] The defendants then petitioned the court for a rehearing en banc.[228]

The full court upheld the district court's determination and established four guideposts for analyzing scientific evidence.[229] First, the trial judge must determine if the expert is qualified based on Rule 702.[230] At this point, the court need only determine if the expert has the specific skill, knowledge, experience, or training in the topic which is the subject of the expert's testimony.[231] Second, the court must determine if the expert's opinion is based on facts normally relied upon by others in the field.[232] Next, the judge must examine the expert's methodology.[233] If the methodology is well-founded and normally used by others in the expert's field, the expert will have satis-

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222. *Christophersen*, 939 F.2d at 1108.

223. *Id.*

224. *Id.*

225. *Id.* at 1109.

226. *Christophersen*, 939 F.2d at 1109.

227. *Id.*

228. *Id.*

229. *Id.* at 1110. The court warned against formalistic application of the new standard. *Id.* The court stated that the first three requirements were threshold questions. *Id.* Only after passing those hurdles will the court attempt a Federal Rule of Evidence 403 balancing test, admitting the evidence unless the prejudicial affect substantially outweighs the probative value. *Id.*

230. *Christophersen*, 939 F.2d at 1110. This first requirement directs trial court judges to examine the background of the potential expert witness. *Id.* The focus is upon the expert's education, skills, and training. *Id.* The court does not intend to use this hurdle to exclude those witnesses that appear biased. *Id.* In fact, the standard does not address the issue of bias. *Christophersen*, 939 F.2d at 110. Consequently, the *Christophersen* standard leaves room for junk science to filter into the courtroom.

231. *Id.*

232. *Id.* Although the court notes that the origin of this aspect of the standard is Rule 703, the court purposely applies the analysis beyond any Rule 703 situation. *Id.*

233. *Id.* at 1111. The court refers to this aspect of the analysis as the *Frye* test. *Id.* However, because the court specifically mandates that trial court judges review both the validity and reliability of the scientific information, the hurdle is very different from the traditional *Frye* model.

fied this third requirement even though the expert's conclusion may be novel or not generally accepted.[234] Finally, the court must balance the evidence, allowing admission if the probative value of the evidence outweighs its prejudicial effect.[235]

The *Christophersen* analysis potentially cures the "junk science" disease. The Fifth Circuit correctly established a two-step approach to scientific evidence.[236] To determine the validity of the evidence, the court adopted a broad *Frye* analysis which requires the judge to evaluate the expert's methodology or reasoning.[237] Under this standard, the expert must utilize methodology or reasoning that is generally accepted in her scientific specialty.[238] In short, the court emphasized the methodology used rather than the conclusion derived.[239] The court also required experts to apply their valid methodology to the appropriate information.[240] In this manner, the court can prevent a "garbage in, garbage out" predicament.[241]

To determine the reliability of the evidence, the jury must analyze the expert's conclusion to determine if the conclusion is sufficiently probable.[242] Consequently, under the *Christophersen* standard, the judge determines the scientific veracity of the evidence and the jury determines the legal veracity.

Although the *Christophersen* standard properly views scientific evidence with some hesitancy, it may not go far enough in counteracting the misleading nature of science in the courtroom. The Fifth Circuit does not require the judge to clearly delineate to the jury and attorneys the difference between

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234. *Christophersen*, 939 F.2d at 1111. The court stresses that the purpose of this hurdle is to determine the validity of the underlying methodology or reasoning used by the expert. *Id.*

235. *Id.* at 1110.

236. *Id.* First, the court determines the validity of the expert's testimony. *Id.* Next, the jury assigns weight to the testimony by considering the probability that the expert's conclusion is correct. *Id.*

237. *Id.* at 1111. The court contended that a methodology would be valid if the methodology connects the facts of the case to the expert's conclusion in a manner generally accepted by the expert's peers. *Id.* at 1115.

238. *Christophersen*, 939 F.2d at 1111. However, the court does not provide the necessary guidelines for categorizing the evidence.

239. *Id.*

240. *Id.* at 1110-11. By this requirement, the *Christophersen* court divided the validity component into two parts: (1) valid data and (2) valid reasoning. To scientists, this type of delineation would seem redundant and frivolous. However, the court appreciates that most lawyers are not scientists and harbor a positivist view of science. Therefore, the court was wise to delineate these two subcategories to ensure that courts do not overlook data or reasoning.

241. *Id.* Valid reasoning cannot redeem invalid data. In *Christophersen*, the court used this component to question the basis of the expert's opinion. *Id.* The court concluded that the data used by the expert was so minimal that the expert's opinion could not be valid. *Id.* Therefore, the court of appeals upheld the trial court's determination. *Id.* at 1113.

242. *Christophersen*, 939 F.2d at 1111.

scientific truth and professional judgment.[243] Consequently, participants in the litigation may be left with the impression that the scientist's testimony, because it is science, is an objective statement.[244] This factor may create confusion within the process and thwart the Fifth Circuit's enlightened standard.

C. *Further Suggestions*

Although the *Christophersen* standard requires the court to review scientific evidence for validity and reliability, the standard could be improved by ensuring that the participants perceive science correctly.[245] Judges, attorneys, parties, and jurors often anticipate that scientific testimony will be objective and rationally based.[246] The participants must be informed that most scientific testimony is, in fact, value based, subjective, and inexact.[247] The system must stop being fooled by science. Through the use of limiting instructions and a neutrality requirement, the court must educate the triers of fact.

1. Utilizing Limiting Instructions

Assuming that a *Christophersen* analysis is applied to strain out invalid scientific evidence, the judge should give the jurors a limiting instruction denoting the nature of the evidence proffered. The court should explain the scientific method to the jurors, highlighting the fact that science views itself

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243. *Id.* However, the court did safeguard the validity determination by establishing a framework by which the trial judges can review both the data used and the reasoning applied by the expert. *Id.*

244. *See* Viterbo v. Dow Chem. Co., 646 F. Supp. 1420, 1426 (E.D. Tex. 1986) (noticing that scientific evidence creates aura of infallibility), *aff'd on other grounds*, 826 F.2d 420 (5th Cir. 1987). However, at least in terms of the jury, the *Christophersen* court did not address the concern noted in *Viterbo*.

245. By educating the participants of the true nature of science, the court can best ensure that the environment at trial is most conducive to the determination of truth. *See* Mercado v. Ahmed, 756 F. Supp. 1097, 1100 (N.D. Ill. 1991) (opining that though judicial system and scientific community both attempt to find truth, methods and purposes are different).

246. Many participants in the judicial process perceive science as objective and rationally based. *Cf.* Baker v. Selden, 101 U.S. 99, 100-01 (1879) (illustrating that courts hold view that science is conclusive); Newman v. Quigg, 877 F.2d 1575, 1580 (Fed. Cir. 1989) (stating that some laws of science are inviolable); United States v. Lopez, 328 F. Supp. 1077, 1085 (E.D.N.Y. 1971) (exemplifying attitude that science is objective). *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 615-16 (1988) (noting that under the traditional view, science is considered totally objective and conclusive).

247. The education process is slow but steady. *Cf.* Ake v. Oklahoma, 470 U.S. 68, 81 (1985) (appreciating that psychiatry is inexact); Carter-Wallace, Inc. v. Gardner, 417 F.2d 1086, 1092 (4th Cir. 1969) (recognizing that scientists can have many different theories to explain phenomena).

both as indefinite and conjectural.[248] The jurors' traditional perspective of science must be replaced by a modern view.[249] Consequently, courtroom science will be defrocked and the trier of fact will be abie to assign the appropriate weight to the evidence.

2. Requiring Professional Neutrality

Scientific evidence can be a powerful tool because it is so easily adulterated.[250] Therefore, the court must insist that scientific experts meet a modicum of neutrality. The professional witness could be disguising the witness' subjective intent as scientific evidence.[251] Therefore, courts should carefully scrutinize the credentials of the scientist to ensure that the scientist is more than just a "hired gun."[252] Courts should consider several factors including the fee arrangement, the percentage of the scientist's income derived from witnessing, the scientist's reputation among and involvement with peers, and the nature of the scientist's specialty.[253] If the scientist practices only as a witness, has a proprietary interest in the evidence, and is held in low esteem by peers, the court should exclude the scientist's testimony.[254] In short, courts should take an active role in moderating the effects of bias.

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248. Plenty of legal scholarship aids lawyers and judges in discovering the unique personality of science. *See generally* Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 618 (1988) (describing how scientists are influenced by their own preconceptions); James Boyle, *Is Subjectivity Possible? The Post-Modern Subject in Legal Theory*, 62 U. COLO. L. REV. 489, 498 (1991) (explaining that scientific method is not objective).

249. For a comprehensive discussion of the two-step approach and the positivist view of science, see generally Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 618 (1988) (explaining influence of scientists' preconceptions).

250. *See* Ealy v. Richardson-Merrell, Inc., 897 F.2d 1159, 1160 (D.C. Cir.) (illustrating how junk science can be used to invalidly prove causation), *cert. denied*, __ U.S. __, 111 S. Ct. 370, 112 L. Ed. 2d 332 (1990); Oxendine v. Merrell Dow Pharmaceuticals, Inc., 506 F.2d 1100, 1104 (D.C. Cir. 1986) (illustrating that using junk science can result in huge award).

251. *See* Raymark Industries, Inc., v. Stemple, No. 88-1014K, 1990 WL 72588 at 2-3 (D. Kan. May 30, 1990) (considering case where doctors and lawyers combined efforts to establish claim generating scheme).

252. *See* Virginia Tech Found., Inc. v. Family Group Ltd. V, 666 F. Supp. 856, 858 (W.D. Va. 1987) (illustrating how expert witnesses can play role of hired gun).

253. Several tendencies can indicate a bias. *See* Rohrbough v. Wyeth Lab., Inc., 719 F. Supp. 470, 475-76 (N.D. W. Va. 1989) (observing contradictions in expert's testimony); Ladner v. Higgins, Inc., 71 So. 2d 242, 244 (La. App. 1954) (noticing that witness' testimony would change if witness had been hired by opposition).

254. *See generally* R. J. Gerber, *Victory vs. Truth: The Adversary System and its Ethics*, 19 ARIZ. ST. L.J. 3, 11 (1987) (comparing expert witnesses to prostitutes); Jack B. Weinstein, *Improving Expert Testimony*, 20 U. RICH. L. REV. 473, 482 (1986) (stating that some experts will testify to almost anything).

IV. CONCLUSION

Because of its unique nature, scientific information creates significant evidentiary pitfalls. To avert these problems, lawyers and judges must realize that scientific evidence has two components: validity and reliability. To properly determine admissibility, the judicial system must assess scientific evidence by reviewing both components. The judge should review the methodology or reasoning which led to the scientific expert's conclusion. If the expert applied a methodology or reasoning commonly applied by the expert's peers, the scientific conclusion is valid.

With validity determined, the trier of fact can play its customary role of assessing the reliability of the evidence. However, the trier of fact faces another of scientific evidence's pitfalls. Laypersons often view science differently than scientists. Judges, jurors, and attorneys perceive science as an objective discipline characterized by inviolable laws and certain conclusions. Laypersons view science as a black box representing a clearly defined concept. To a scientist, though, the black box represents only the current interpretation of reality. Scientists believe that within the black box could be a white box. Under this relativist perspective, science is but a progression of revelation.

To effectively avoid the pitfalls of scientific evidence, the court must transform the trier of fact from scientific traditionalists to scientific modernists. Initially, using scientific evidence effectively will be an onerous task. However, by applying the two-step approach of analyzing the validity and reliability of the evidence and by educating the trier of fact, the legal system can be healed of the evidentiary disease and inoculated against future infection.