CRIMINAL LAW SYMPOSIUM

THE DEBATE IN THE DNA CASES OVER THE FOUNDATION FOR THE ADMISSION OF SCIENTIFIC EVIDENCE: THE IMPORTANCE OF HUMAN ERROR AS A CAUSE OF FORENSIC MISANALYSIS

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"It is no more correct to say that neutron activation analysis detects the presence of barium and antimony than to say that a violin produces music."

— Professor Melvin Lewis[1]

The advent of DNA typing evidence has been much heralded.[2] Some proponents of DNA typing have claimed that this new forensic technique will "revolutionize law enforcement."[3] A massive body of scientific literature on DNA evidence now exists,[4] and the number of law review arti-

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1. Lewis, *The Element of Subjectivity in Interpreting Instrumental Test Results*, in SCIENTIFIC AND EXPERT EVIDENCE 409, 430 (2d ed. 1981).

2. Moss, *DNA—The New Fingerprints*, 74 A.B.A. J. 66 (1988). *See generally* Thompson & Ford, *DNA Typing: Acceptance and Weight of the New Genetic Identification Tests*, 75 VA. L. REV. 45 (1989).

3. Moss, *supra* note 2, at 66.

4. *See* P. GIANNELLI & E. IMWINKELRIED, SCIENTIFIC EVIDENCE § 17-8, at 110 n.196.2 (Supp. 1990); Bar, Kratzer, Machler & Schmid, *Postmortem Stability of DNA*, 39 FORENSIC SCI. INT'L 59 (1988); Fowler, Burgoyne, Scott & Harding, *Repetitive Deoxyribonucleic Acid (DNA) and Human Genome Variation—A Concise Review Relevant to Forensic Biology*, 33 J. FORENSIC SCI. 1111 (1988); Fukushima, Hasekura & Nagai, *Identification of Male Bloodstains by Dot Hybridization of Human Y Chromosome-Specific Deoxyribonucleic Acid (DNA) Probe*, 33 J. FORENSIC SCI. 621 (1988); Giusti, Baird, Pasquale, Balazs & Glassberg, *Application of Deoxyribonucleic Acid (DNA) Polymorphisms to the Analysis of DNA Recovered from Sperm*, 31 J. FORENSIC SCI. 409 (1986); Haglund, Reay & Tepper, *Identification of Decomposed Human Remains by Dexoyribonucleic Acid (DNA) Profiling*, 35 J. FORENSIC SCI. 724 (1990); He, Jiang, Lu, Wang, Zhu, Wang, Shen, Gao, Liu & Wu, *A Study of Sex Identification of Trace, Dried Bloodstains Using a Y Chromosome-Specific*

cles analyzing DNA typing is increasing exponentially.[5] The controversy over the admissibility of DNA evidence has even surfaced on the front page of major metropolitan newspapers.[6]

For the most part, courts have been receptive to DNA evidence.[7] The overwhelming majority of courts that have passed on DNA typing have held the evidence admissible.[8] Some courts have already gone to the length of declaring that the general reliability of DNA typing is judicially

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Deoxyribonucleic Acid (DNA) Probe, 34 J. FORENSIC SCI. 346 (1989); Honma, Yoshi, Ishiyamama, Mitani, Kominami & Muramatsu, *Individual Identification from Semen by the Deoxyribonucleic Acid (DNA) Fingerprint Technique*, 34 J. FORENSIC SCI. 222 (1989); Kantner, Baird, Shaler & Balazs, *Analysis of Restriction Fragment Length Polymorphisms in Deoxyribonucleic Acid (DNA) Recovered from Dried Bloodstains*, 31 J. FORENSIC SCI. 403 (1986); Kobayashi & Marsuzawa, *Sex Determination of Bloodstains by the Use of a Ribonucleic Acid (DNA) Probe*, 34 J. FORENSIC SCI. 1078 (1989); Kobayashi, Nakauchi, Nakahori, Nakagome & Matsuzawa, *Sex Identification in Fresh Blood and Dried Bloodstains by a Nonisotopic Deoxyribonucleic Acid (DNA) Analyzing Technique*, 33 J. FORENSIC SCI. 613 (1988); McNally, Shaler, Baird, Balazs, DeForest & Kobilinsky, *Evaluation of Deoxyribonucleic Acid (DNA) Isolated from Human Bloodstains Exposed to Ultraviolet Light, Heat, Humidity, and Soil Contamination*, 34 J. FORENSIC SCI. 1059 (1989); Mederiros, Macedo & Pena, *M13 Bioprints: Non-Isotopic Detection of Individual-Specific Human DNA Fingerprints with Biotinylated M13 Bacteriophage*, 43 FORENSIC SCI. INT'L 275 (1989); Odelberg, Demers, Westin & Hossaini, *Establishing Paternity Using Minisatellite DNA Probes When the Putative Father is Unavailable for Testing*, 33 J. FORENSIC SCI. 921 (1988); Sensabaugh, *Forensic Biology—Is Recombinant DNA Technology in its Future?*, 31 J. FORENSIC SCI. 393 (1986); Schacker, Schneider, Holtkamp, Bohnke, Fimmers, Sonneborn & Rittner, *Isolation of the DNA Minisatellite Probe MZ 1.3 and Its Application to DNA "Fingerprinting" Analysis*, 44 FORENSIC SCI. INT'L 209 (1990); Westwood & Werrett, *An Evaluation of the Polymerase Chain Reaction Method for Forensic Applications*, 45 FORENSIC SCI. INT'L 201 (1990); Yokoi & Sagisaka, *Haptoglobin Typing of Human Bloodstains Using a Specific DNA Probe*, 45 FORENSIC SCI. INT'L 39 (1990); Yokoi & Sagisaka, *Sex Determination of Blood Stains with a Recombinant DNA Probe: Comparison with Radioactive and Non-Radioactive Labeling Methods*, 41 FORENSIC SCI. INT'L 117 (1989).

5. *E.g.*, Pearsall, *DNA Printing: The Unexamined "Witness" in Criminal Trials*, 77 CALIF. L. REV. 665 (1989); Thompson & Ford, *DNA Typing: Acceptance and Weight of the New Genetic Identification Tests*, 75 VA. L. REV. 45 (1989); Note, *DNA Fingerprinting and the Need for a National Data Base*, 17 FORDHAM URB. L.J. 323 (1989); Note, *The Admissibility of DNA Typing: A New Methodology*, 79 GEO. L.J. 313 (1990); Note, *The Dark Side of DNA Profiling: Unreliable Scientific Evidence Meets the Criminal Defendant*, 42 STAN. L. REV. 465 (1990); Note, *The Admissibility of Scientific Evidence: DNA Print Identifications*, 19 STETSON L. REV. 245 (1989); Comment, *DNA Fingerprinting and Paternity Testing*, 22 U.C. DAVIS L. REV. 609 (1989); Comment, *DNA Identification Tests and the Courts*, 63 WASH. L. REV. 903 (1988).

6. Kolata, *Scientists Voice Doubts About DNA Tracking*, San Francisco Chron., Jan. 29, 1990, at A-1, col. 3. This article was published by the New York Times News Service and was reprinted in newspapers throughout the United States. *E.g.*, Kolata, *Scientists: DNA Fingerprinting Not Reliable in Court*, Davis Enterprise, Jan. 29, 1990, at A-1, col. 1.

7. *See generally* Harmon, *How Has DNA Evidence Fared? Beauty Is in the Eye of the Beholder*, 1 Expert Evidence Rep. (Shep./McG.-Hill) 149 (Feb. 1990).

8. P. GIANNELLI & E. IMWINKELRIED, *supra* note 4, at § 17-8, at 82-83 ("In testimony before the United States Senate Subcommittee on the Constitution of the Judiciary Committee, Professor James Starrs has stated that '[b]y all reports some twenty or so criminal cases have been concluded

noticeable.[9] Moreover, courts have tended to rule that any deficiencies in the specific manner in which the analyst conducts the DNA typing test affect the weight but not the admissibility of the evidence.[10]

Although courts are virtually unanimous in finding DNA typing to be a generally trustworthy technique,[11] two courts have excluded DNA evidence.[12] In a highly publicized New York trial court case,[13] *People v. Castro*,[14] the court not only acknowledged that "there is general scientific acceptance of the theory underlying DNA identification,"[15] the court added that "DNA forensic identification tests . . . are reliable and meet the . . . standard of admissibility."[16] In a later Minnesota appellate case, *State v. Schwartz*,[17] the court similarly conceded that "DNA typing is generally acceptable."[18] However, in both cases, the defense counsel were not content merely to cross-examine the prosecution's forensic experts; rather, the counsel called their own experts to attack aggressively the manner in which the prosecution experts had applied DNA typing.[19] Both courts excluded the evidence for the stated reason that the prosecution had failed to establish that the analysts followed proper scientific procedures on the specific occasion when they conducted the DNA test in question.[20]

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at the trial level in some seven states where DNA matching has been welcomed, with nary a word of judicial dissent anywhere.' ").

9. State v. Woodall, 385 S.E.2d 253 (W. Va. 1989).

10. Harmon, *supra* note 7, at 149, 150-51; People v. Castro, 545 N.Y.S.2d 985, 987 (Sup. Ct. 1989)(Some courts "have indicated that [this] question goes to the weight of the evidence not the admissibility.").

11. Jonakait, *DNA and the Courts: Cases and First Impressions*, 1 Expert Evidence Rep. (Shep./McG.-Hill) 121 (Jan. 1990).

12. *Id.* at 123; State v. Schwartz, 447 N.W.2d 422 (Minn. 1989); People v. Castro, 545 N.Y.S.2d 985 (Sup. Ct. 1989).

13. Schmeck, *DNA Findings Are Disputed by Scientists* N.Y. Times, May 25, 1989, at B-1 col. 5.

14. 545 N.Y.S.2d 985 (Sup. Ct. 1989).

15. *Id.* at 989.

16. *Id.* at 995.

17. 447 N.W.2d 422 (Minn. 1989).

18. *Id.* at 426.

19. Jonakait, *supra* note 11, at 123; Lewin, *DNA Typing on the Witness Stand*, 244 SCIENCE 1033 (June 1, 1989)(In earlier DNA cases, "[m]ostly the evidence has come in without any objections."); Williams, *Conviction by Chromosome: DNA Faces Its Day in Court*, 18 STUDENT L. 26, 29 (Dec. 1989); Note, *DNA Typing: A Rush to Judgment*, 24 GA. L. REV. 669, 688 (1990).

20. 447 N.W.2d at 428 ("While we agree with the trial court that forensic DNA typing has gained general acceptance in the scientific community, we hold that admissibility of specific test results in a particular case hinges on the laboratory's compliance with appropriate standards and controls . . . ."); People v. Castro, 545 N.Y.S.2d 985, 997 (Sup. Ct. 1989)("the credible testimony . . . clearly established that the testing laboratory failed to conduct the necessary and scientifically ac-

In excluding DNA evidence for that reason, the Minnesota and New York courts highlighted a critical, sadly neglected issue in the law of scientific evidence: whether the proponent of scientific evidence must present foundational testimony that the analyst complied with correct scientific protocol in conducting the test offered in court.[21]

In part, the issue is so critical because the use of scientific evidence is widespread and expanding.[22] Modernly, the use of scientific evidence is increasing at a rapid rate.[23] The significant relaxation of the admissibility standards for scientific testimony is one reason for the increase. As recently as the mid-1970s, almost all American jurisdictions[24] subscribed to the conservative *Frye*[25] test, requiring the proponent to demonstrate that the scientific technique has gained general acceptance within the relevant specialty.[26] Since that time, one-third of the American jurisdictions have shifted to a more liberal standard of admissibility.[27]

The issue is also vital because there is mounting evidence of a significant margin of error in scientific analysis.[28] One authority estimates that fifteen percent of all medical laboratory tests are in error.[29] Several government-sponsored studies of laboratory proficiency[30] have documented shockingly high error rates.[31] Significantly, many of the same studies have found that the analyst's failure to follow sound procedure in con-

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cepted tests . . . ."); Jonakait, *supra* note 11, at 123-24. *See also* United States v. Two Bulls, 918 F.2d 56, 59, 61 (8th Cir. 1990) (approvingly citing *Castro* and *Schwartz*); United States v. Jakobetz, 747 F. Supp. 250, 258 n.16 (D.Vt. 1990); Caldwell v. State, 260 Ga. 278, 393 S.E.2d 436, 441-42 (1990) (approvingly citing *Castro* and *Schwartz*).

21. *See generally* Harmon, *supra* note 7, at 150-51.

22. In 1980, the National Center for State Courts published the results of a nationwide survey of litigators. *Study to Investigate use of Scientific Evidence*, 7 NAT'L CENTER FOR STATE CTS. REP. 1 (Aug. 1980). The center reported that roughly half the litigators surveyed encountered scientific testimony in approximately one-third of their trials. *Id.*

23. Giannelli, *The Admissibility of Laboratory Reports in Criminal Trials: The Reliability of Scientific Proof*, 49 OHIO ST. L.J. 671 (1988).

24. Imwinkelried, *A New Era in the Evolution of Scientific Evidence—A Primer on Evaluating the Weight of Scientific Evidence*, 23 WM. & MARY L. REV. 261, 264 (1981).

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

26. *See generally* Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197 (1980).

27. Imwinkelried, *The Standard for Admitting Scientific Evidence: A Critique from the Perspective of Juror Psychology*, 28 VILL. L. REV. 554, 557-59 (1983).

28. *See infra* notes 50-65 and accompanying text.

29. Bechtel, *Medical Tests: Don't Bet Your Life on Them*, PREVENTION, Jan. 1983, at 55.

30. J. PETERSON, E. FABRICANT & K. FIELD, CRIME LABORATORY PROFICIENCY TESTING RESEARCH PROGRAM (1978); Hansen, Caudill & Boone, *Crisis in Drug Testing: Results of CDC Blind Study*, 253 J. A.M.A. 2382 (1985).

31. Giannelli, *supra* note 23, at 688-95.

ducting the test is one of the most common causes of laboratory misanalysis.[32]

Despite the crucial importance of the issue, the commentators and courts have largely neglected the question of whether the proponent should be required to make an affirmative foundational showing that the analyst complied with proper scientific protocol during the test in question. Many leading treatises on scientific evidence concentrate on the foundational element of proof of the general trustworthiness of the scientific technique while slighting the question of whether the analyst properly applied the technique in the instant case.[33] The treatises that address the question typically make short shrift of it.[34]

Like the treatise writers, the courts often neglect the issue. Worse still, the courts that have addressed the issue are badly divided. In some jurisdictions, deficiencies in the manner of conducting the test affect only the weight of the evidence.[35] In the words of one court, "Careless testing affects the weight of the evidence and not its admissibility . . . ."[36] In contrast, other jurisdictions require that the proponent make a foundational showing that the analyst correctly applied the scientific technique in the case at bar.[37] Some of these courts demand strict compliance with correct test protocol,[38] while other courts are content with proof of substantial compliance.[39] Unfortunately, in many, if not most of the decided cases, the courts' analyses are conclusory in the extreme. Courts not

32. *See infra* notes 90-94 and accompanying text.

33. *E.g.*, A. MOENSSENS, F. INBAU & J. STARRS, SCIENTIFIC EVIDENCE IN CRIMINAL CASES § 1.03 (3d ed. 1986); J. RICHARDSON, MODERN SCIENTIFIC EVIDENCE §§ 6.1-.3 (2d ed. 1961).

34. J. TARANTINO, STRATEGIC USE OF SCIENTIFIC EVIDENCE § 1.05, at 6 (1988) devotes a single, brief paragraph to "[t]he validity of the application of a scientific technique . . . ."

35. *Id.*; 1 D. NICHOLS, DRINKING/DRIVING LITIGATION § 14.42, at 48-49 (1985); Harmon, *supra* note 7, at 150-51; Note, *supra* note 19, at 686.

36. People v. Farmer, 47 Cal. 3d 888, 913, 765 P.2d 940, 956, 254 Cal. Rptr. 508, 524 (1989).

37. *Id.*; State v. Lowther, 740 P.2d 1017, 1020 n.5 (Haw. App. 1987); Romano v. Kimmelman, 96 N.J. 66, 474 A.2d 1 (1984); State v. Johnson, 42 N.J. 146, 199 A.2d 809 (1964); State v. Rimmasch, 775 P.2d 388, 398 n.7 (Utah 1989) ("Of course, even if the court ultimately decides, either on grounds of judicial notice or after an evidentiary hearing, that there is an adequate foundational basis for finding that the scientific principles or techniques are inherently reliable, that determination will not resolve the question of whether a particular piece of expert testimony may be admitted. The trial court must still make a separate determination that there is an adequate foundation for the proposed testimony, i.e., that the scientific principles or techniques have been properly applied to the facts of the particular case . . . ."); 2 R. ERWIN, DEFENSE OF DRUNK DRIVING CASES: CRIMINAL-CIVIL § 22.06 [4] (3d ed. 1989); 1 D. NICHOLS, *supra* note 35, at § 14.42.

38. E. IMWINKELRIED, THE METHODS OF ATTACKING SCIENTIFIC EVIDENCE § 5-6(A), at 177-79 (1982).

39. *Id.*

only neglect the merits of the policy question of whether the proponent should be obliged to make a foundational showing of proper test procedure; courts do not even acknowledge the existence of a sharp split of authority over the issue.[40]

The purpose of this Article is to evaluate that split of authority. The first part of the Article addresses the threshold question of whether deficiencies in test protocol should affect the admissibility as well as the weight of scientific testimony. After surveying the empirical studies of laboratory proficiency, the Article concludes that correct test procedure is such a fundamental concern that it should impact the admissibility of scientific evidence. The second part of the Article turns to the question of whether the proponent or opponent should be allocated the burden of showing the analyst's compliance with proper scientific protocol. Analogizing to Federal Rule of Evidence 803(8) governing the hearsay exception for official records,[41] the Article advances the novel proposal that the party opposing the admission of scientific testimony should be assigned the burden on this issue.

I. SHOULD DEFICIENCIES IN TEST PROCEDURE AFFECT THE ADMISSIBILITY AS WELL AS THE WEIGHT OF SCIENTIFIC EVIDENCE?

For several reasons, in structuring the admissibility standard for scientific evidence, courts should treat the question of the use of proper test procedures as a factor affecting the admissibility and not merely the weight of the evidence.

A. The General Requirement for a Foundation for Admitting Scientific Evidence

In some cases, although a factor is relevant to assessing the trustworthiness of evidence, evidence law treats the factor as affecting only the weight of the item of evidence. A classic example is a brief gap in the proof of a chain of custody for an item of physical evidence. Suppose, for instance, that for a small part of the accountable period, there is no affirmative showing of the safeguarding of an item of physical evidence which a party desires to introduce at trial. No facts indicate that there

40. *E.g.*, State v. Schwartz, 447 N.W.2d 422 (Minn. 1989).

41. FED. R. EVID. 803(8).

has been any tampering with the item,[42] but there is a technical break in the chain[43] in the sense that evidence of safekeeping during the time gap is missing.[44] In this scenario, a legion of cases holds that the gap affects only the weight of the physical evidence and not its admissibility.[45] Courts uphold the chain and admit the physical evidence even when the undisputed facts indicate that for a short period of time the object was left unattended[46] or in an insecure area.[47] The rationale for the result in these cases is straightforward: the courts reason that the gap creates a mere theoretical possibility that the evidence offered at trial is untrustworthy.[48] Handling physical evidence is a simple, "mechanical" function,[49] and without more, the gap gives rise to only a remote risk of mishandling.

When the issue, however, is the trustworthiness of scientific evidence, courts generally cannot dismiss the possibility of error as purely theoretical or minimal.[50] Studies have established impressive evidence of a substantial error margin in contemporary laboratory analysis. In the 1950s the American Academy of Forensic Sciences' Toxicology Section conducted a study of the accuracy of blood alcohol analyses. That study

42. United States v. Dickerson, 857 F.2d 1241, 1244-45 (9th Cir. 1988); United States v. Gatewood, 786 F.2d 821, 825 (8th Cir. 1986); United States v. Wood, 695 F.2d 459, 462 (10th Cir. 1982); United States v. Malone, 558 F.2d 435, 438 (8th Cir. 1977); Nash v. State, 267 Ark. 870, 872, 591 S.W.2d 670, 672 (App. 1979); Patterson v. State, 598 S.W.2d 265, 270 (Tex. Crim. App. 1980).

43. United States v. Casto, 889 F.2d 562, 569 (5th Cir. 1989), *cert. denied*, 110 S. Ct. 1164 (1990).

44. United States v. Lott, 854 F.2d 244, 250 (7th Cir. 1988).

45. *E.g.*, United States v. Roberson, 897 F.2d 1092, 1096 (11th Cir. 1990); United States v. Olson, 846 F.2d 1103, 1116-17 (7th Cir.), *cert. denied*, 109 S. Ct. 131 (1988); United States v. Wheeler, 800 F.2d 100, 106 (7th Cir. 1986); United States v. Lopez, 758 F.2d 1517, 1521 (11th Cir. 1985), *cert. denied*, 474 U.S. 1054 (1986); United States v. Shackleford, 738 F.2d 776, 785 (7th Cir. 1984); United States v. Sarmiento-Perez, 724 F.2d 898, 900 (11th Cir. 1984); Harmon v. Anderson, 495 F. Supp. 341 (E.D. Mich. 1980); Belcher v. State, 661 S.W.2d 230, 233 (Tex. Ct. App. 1983); McWherter v. State, 607 S.W.2d 531, 535 (Tex. Crim. App. 1980).

46. United States v. Von Roeder, 435 F.2d 1004 (10th Cir. 1970), *cert. denied*, 403 U.S. 934, *vacated sub nom.* Schreiner v. United States, 404 U.S. 67 (1971); State v. Smith, 284 Mo. 108, 222 S.W. 455 (1920).

47. State v. Huffman, 181 Neb. 356, 148 N.W.2d 321, *cert. denied*, 386 U.S. 1024 (1967); Wright v. State, 420 S.W.2d 411 (Tex. Crim. App. 1967).

48. United States v. White, 569 F.2d 263, 266 (5th Cir.), *cert. denied*, 439 U.S. 848 (1978); Giannelli, *Chain of Custody and the Handling of Real Evidence*, 20 AM. CRIM. L. REV. 527 (1983); Imwinkelried, *The Identification of Original, Real Evidence*, 61 MIL. L. REV. 145, 158-62 (1973).

49. Imwinkelried, *supra* note 48, at 157 (quoting Commonwealth v. Thomas, 448 Pa. 42, 50, 292 A.2d 352, 356 (1972)).

50. *See generally* Giannelli, *supra* note 23, at 688-95.

unearthed indications of "a great degree of error."[51] In the mid-1970s, Dinovo and Gottschalk undertook to evaluate the proficiency of laboratories conducting drug analyses. They too reported significant variations in the level of proficiency from laboratory to laboratory.[52]

Later in the same decade the Law Enforcement Assistance Administration funded a much larger test, the Laboratory Proficiency Testing Program.[53] Two hundred and forty laboratories participated. The researchers sent the participating laboratories twenty-one sets of blind samples for analysis.[54] On three of the twenty-one sets, fewer than half the participating laboratories reported correct, complete findings.[55] One of the lead researchers reluctantly concluded that the tests demonstrated that "a disturbingly high percentage of laboratories are not performing routine tests competently . . . ."[56]

In the early 1980s, other researchers administered a proficiency test to 105 toxicology laboratories in forty-nine states.[57] Like the Laboratory Proficiency Testing Program researchers, these researchers found the laboratories' performance "disappointing."[58] They discovered "considerable" variation in proficiency, especially in quantitative analysis.[59] On some samples, the coefficient of variation was 133 percent.[60]

In the mid-1980s, several organizations published proficiency studies of laboratories conducting immunoassay tests to detect the presence of contraband drugs in urine samples. The studies were conducted under the auspices of such respected organizations as the College of American Pathologists. Two researchers for the Office of Technology Assessment of the United States Congress bluntly summarized the studies by genera-

51. Niyogi, *Toxicology*, in SCIENTIFIC AND EXPERT EVIDENCE 343, 383 (2d ed. 1981).

52. Dinovo & Gottschalk, *Results of a Nine-Laboratory Survey of Forensic Toxicology Proficiency*, 22 CLIN. CHEM. 843 (1976).

53. J. PETERSON, E. FABRICANT & K. FIELD, *supra* note 30.

54. LEAA Newsletter, Sept. 1978, at 1, col. 1, at 5, col. 1.

55. *Id. See also* Garcia, *Expert Witness Malpractice?*, 1 Expert Evidence Rep. (Shep./McG.-Hill) 267 (June 1990) ("3% of the laboratories had less than 50% of their responses considered acceptable.").

56. *Symposium on Science and the Rules of Legal Procedure*, 101 F.R.D. 599, 645 (1984) (remarks of Professor Joseph Peterson), *quoted in* Giannelli, *supra* note 23, at 690.

57. Peat, Finnigan & Finkle, *Proficiency Testing in Forensic Toxicology: A Feasibility Study*, 28 J. FORENSIC SCI. 139, 141 (1983).

58. *Id.* at 139.

59. *Id.* at 157.

60. *Id.* at 156.

lizing that "error rates continue to be high."[61] A study conducted by the Centers for Disease Control yielded particularly disturbing findings.[62] One laboratory reported erroneous results on 66.5 percent of 160 samples analyzed.[63]

In 1987, Collaborative Testing Services made public the results of a proficiency test of laboratories engaged in electrophoretic analysis of enzymes and proteins.[64] Sixty-eight laboratories participated in the test. Sixteen of the laboratories (23.5%) erred on one or both samples.[65]

More recently, the Forensic Science Foundation released the results of proficiency tests of document examiners.[66] Like the studies described in the preceding paragraphs, these tests disclosed an alarmingly high incidence of misanalysis. The percentages of error were in the double figures.[67] The incidence of error was so high that it "should provide anyone with cause for concern."[68]

In sum, extensive hard evidence exists of a substantial margin of error in modern forensic analysis. When an opposing party points to a brief gap in chain of custody to challenge the trustworthiness of an item of physical evidence, a court plausibly can dismiss the challenge as raising only theoretical risks of error. However, when the challenge is directed at a forensic laboratory analysis, the court cannot reject the challenge summarily.

B. Proof of The Use of Correct Protocol During the Specific Test in Question as a Fundamental Guarantee of the Trustworthiness of Scientific Evidence

The preceding subsection marshalled the empirical evidence demonstrating that, as a general proposition, challenges to the trustworthiness

61. Miike & Hewitt, *Accuracy and Reliability of Urine Drug Tests*, 36 U. KAN. L. REV. 641, 651-57 (1988).

62. Hansen, Caudill & Boone, *Crisis in Drug Testing: Results of CDC Blind Study*, 253 J. A.M.A. 2382 (1985).

63. *Id.*

64. COLLABORATIVE TESTING SERVICES, INC., CRIME LABORATORY PROFICIENCY TESTING PROGRAM, PHYSIOLOGICAL FLUIDS ANALYSIS REPORT NO. 87-2 (1987).

65. Pearsall, *DNA Printing: The Unexamined "Witness" in Criminal Trials*, 77 CALIF. L. REV. 665, 673 (1989).

66. *See generally* Risinger, Denbeaux & Saks, *Exorcism of Ignorance as a Proxy for Rational Knowledge: The Lessons of Handwriting Identification "Expertise,"* 137 U. PA. L. REV. 731, 738-51 (1989).

67. *Id.*

68. *Id.* at 749.

of scientific testimony should not be treated as factors affecting only the weight of the testimony. Studies simply present too much proof of a high incidence of erroneous scientific analysis to treat scientific testimony in the same fashion as a minor gap in a chain of custody for physical evidence. The problem is identifying the specific facts that should condition the admissibility of scientific testimony. It is submitted that the nature of the particular error in question, namely, improper test protocol, calls the accuracy of the test result into question in such a fundamental sense that proof of that type of error ought to affect the admissibility and not merely the weight of scientific testimony.

A factor should condition the admissibility of an item of evidence and not merely affect the weight of the item when the factor directly relates to the essential guarantee of the the evidence's trustworthiness. The foundation for the business entry exception under the hearsay rule is illustrative. The basic guarantee of the trustworthiness of business entries is the business' motivation to maintain accurate records—documents on the basis of which it pays its debts and bills its customers.[69] That basic guarantee accounts for many of the restrictions on the admissibility of documents under the exception. The landmark case of *Palmer v. Hoffman*[70] imposes one restriction: A document does not qualify under the exception if the primary motivation for generating the document was to prepare for trial.[71] When preparation for litigation is the moving force behind the creation of a document, the document lacks the basic guarantee of trustworthiness. *Johnson v. Lutz*[72] announced another restriction on the scope of the doctrine: An entry does not fall within the exception if the ultimate source of the information was not a part of the business entity.[73] Once again the basic guarantee is absent; the person who is the real source of the information had no business duty to transmit accurate information and consequently lacks the requisite motivation. These considerations, the presence of a litigation motivation and the lack of a business duty, condition the admissibility of the evidence precisely because they both bear directly on the essential guarantee of the trustworthiness of the evidence.

By parity of reasoning, the use of proper test protocol should condition

69. C. MCCORMICK, EVIDENCE §§ 304, 306, 308 (3d ed. 1984).
70. 318 U.S. 109 (1943).
71. C. MCCORMICK, *supra* note 69, at § 308.
72. 253 N.Y. 124, 170 N.E. 517 (1930).
73. C. MCCORMICK, *supra* note 69, at § 310.

the admissibility of scientific evidence. In the case of scientific evidence, the essential guarantee of trustworthiness is that the forensic analyst employs a test which has been experimentally verified.[74] The research scientist initially formulates an hypothesis, for example, a theory about the behavior of atoms or human beings.[75] The researcher then designs and conducts an experiment to validate or disprove the hypothesis.[76] During the experiment, the research scientist attempts to control all the relevant variables[77] to minimize the risk that chance factors will influence the outcome of the experiment.[78] Assume that the experiment validates the hypothesis[79] by accounting for the results in the experiments.[80] In that event, at a later point in time a forensic scientist can use the validated theory to resolve factual questions in legal disputes.[81] To do so, the forensic scientist controls for and replicates the conditions in the earlier experiments. If the forensic scientist does so properly, the forensic test should duplicate the results attained in the earlier experiments.

Once the process of validating a scientific hypothesis and putting the validated hypothesis to forensic use is understood, it becomes clear that the use of correct protocol during the forensic test directly relates to the essential guarantee of the trustworthiness of scientific evidence. While proof of the general validity of the hypothesis and a showing of correct protocol are distinct factors affecting the trustworthiness of scientific evidence, the factors are closely related. An essential objective of proper forensic test procedure is replicating the conditions of the earlier experiments.[82] No matter how impressive the validity rates achieved in the

74. A. MOENSSENS, F. INBAU & J. STARRS, *supra* note 33, at § 1.03, at 7-8; E. SNYDER, HISTORY OF THE PHYSICAL SCIENCES 38 (1969); Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 621, 623-24 (1988).

75. Black, *supra* note 74, at 644; A. MOENSSENS, F. INBAU & J. STARRS, *supra* note 33, at § 1.03, at 7.

76. A. MOENSSENS, F. INBAU & J. STARRS, *supra* note 33; Black, *supra* note 74, at 621, 623-24.

77. Imwinkelried, *supra* note 27, at 566.

78. *See generally* Osterburg, *The Scientific Method and Criminal Investigation*, 9 J. POL. SCI. & ADMIN. 135 (1981).

79. A. MOENSSENS, F. INBAU & J. STARRS, *supra* note 33, at § 1.03, at 7.

80. Osterburg, *supra* note 78, at 136.

81. A. MOENSSENS, F. INBAU & J. STARRS, *supra* note 33, at § 1.03, at 8.

82. Of course, proper test protocol entails more than merely duplicating the earlier experimental conditions. If the scientific technique in question is vulnerable to contamination, accepted protocol may include running a confirmatory test. E. IMWINKELRIED, *supra* note 38, at § 12-5(A). For example, atomic absorption test procedures are susceptible to contamination. Krishnan, *Detection of Gunshot Residues on the Hands by Trace Element Analysis*, in SCIENTIFIC AND EXPERT EVIDENCE

earlier research, the earlier experiments do not afford any assurance of the trustworthiness of the result of the instant forensic test unless the forensic scientist follows the correct procedure.

The importance of complying with sound protocol is obvious when the scientific technique in question is a complex, multi-step procedure such as gas chromatography/mass spectrometry (GC/MS).[83] The more complex the forensic test, the more critical it is that the forensic scientist scrupulously comply with proper protocol. The more complex the test, the greater is the number of variables that the forensic scientist must attempt to control. However, even in the case of relatively simple forensic techniques such as thin layer chromatography (TLC), it is vital that the forensic scientist follow correct procedure. In a TLC test, the analyst extracts a small portion of an unknown drug and places the extract on a glass plate.[84] The plate is coated with an adsorbent such as silica gel.[85] The analyst spots the unknown near the bottom of the plate. The plate is then placed in a tank containing a solution.[86] The analyst places only the lower edge of the plate in the solution. The solution creeps up the plate by capillary action in much the same way as a liquid moves up a blotter.[87] After a predetermined period of time elapses, the analyst removes the plate from the tank. The analyst then sprays the plate with a visualizing agent. After the spray, a streak of a particular length and color appears on the plate.[88] The distance can be stated as an Rf value—the ratio to front.[89] In computing the Rf value the analyst compares the distance traveled by the known solution (the front) and the distance traveled by the unknown solution. For instance, if the unknown traveled half

315, 320 (2d ed. 1981). For that reason, many experienced AAS experts advise doing confirmatory tests. *Id.*

Alternatively, when there is a large element of subjectivity in interpreting the test result, sound protocol may include the use of positive controls or standards. E. IMWINKELRIED, *supra* note 38, at § 12-5(B). Some of the wet chemical color tests used for drug identification are somewhat subjective; while one person might characterize a color as red, another might describe it as pink. To minimize the element of subjectivity in test interpretation, the analyst will test a known drug at the same time as the unknown. For instance, if the analyst suspects that the unknown is marijuana, she would test a sample of known marijuana simultaneously. She could then compare the colors yielded by the two tests. Bradford, *Credibility of Drug Analysis Evidence*, TRIAL 90 May/June 1975, at 90.

83. P. GIANNELLI & E. IMWINKELRIED, SCIENTIFIC EVIDENCE § 23-3(C), at 985-99 (1986).

84. *Id.* at § 23-2(D), at 940.

85. *Id.* at § 23-2(D), at 940-41.

86. *Id.* at § 23-2(D), at 942.

87. *Id.*

88. *Id.*

89. *Id.*

as far as the solution, the Rf value would be .50. By consulting a database of Rf values, the analyst can identify the unknown as, for example, cocaine.

Suppose that the research scientist who generated the database of Rf values allowed the unknown to migrate up the plate for thirty minutes. Permitting the unknown to migrate for only thirty minutes would be an element of proper scientific protocol for conducting that type of TLC test. If the forensic scientist who tested the unknown in the pending lawsuit allowed the unknown to migrate for thirty-five minutes, the forensic scientist's conclusion that the unknown was cocaine would be untrustworthy. The time lapse variable determines the length of the unknown's migration up the plate, and the forensic scientist relies on the length of the migration in identifying the unknown drug. The forensic scientist neglected to replicate the conditions of the earlier experiments; a deviation from correct test procedure in that respect renders the earlier database worthless as an aid in identifying this unknown.

Or suppose that while the research scientist employed one chemical solution in the tank, the forensic scientist used a different solution. "Rf values are valid only for particular sets of conditions, namely, particular combinations of adsorbent and solvent front."[90] Once again, by carelessly using another solution, the forensic scientist has failed to reproduce the conditions that existed during the earlier experiments. Hence, the forensic scientist has no right to rely on the Rf values in the earlier database. The deviation from proper protocol renders the forensic scientist's opinion at best untrustworthy.

The same point can be illustrated with a scientific procedure of intermediate complexity such as gas chromatography (GC). In this procedure, the forensic scientist reduces the unknown to gaseous form and then sends the unknown through a specially coated column.[91] The unknown is heated to a certain temperature before insertion in the column, and a gas carries the unknown through the column. Different drugs migrate through the column at different retention times or speeds. Like the Rf value in a TLC test, the retention time in a GC test is an important clue to the identity of the unknown. However, before comparing the retention time in a given test with a published database of retention times achieved in earlier experiments, the forensic scientist must ensure that

90. *Id.* at § 23-2(D), at 944.

91. *Id.* at § 23-2(D), at 945.

she controls for the variables in the earlier experiments. If the unknown was heated to a different temperature, if the column was coated with different material, or if the forensic scientist had used a different carrier gas, it would be improper to use the earlier database to interpret the retention time which the GC procedure yielded in the instant test.[92] No matter how well-designed the earlier experiments validating the GC procedure, the forensic scientist cannot rely on that experimental data unless she follows correct test protocol by replicating the conditions of the preceding experiments.

The empirical studies of laboratory proficiency confirm the importance of proper test protocol. After identifying accurate test results by the participating laboratories, the Laboratory Proficiency Testing Program followed up on inaccurate test results and attempted to identify the causes of the inaccuracies. The final report on the program repeatedly lists the analyst's use of improper test procedure as a contributing cause of inaccurate test results.[93] Indeed, the report lists that factor more frequently than any other cause. In its studies of the proficiency of drug testing laboratories, the Centers for Disease Control has likewise pointed to unsound test protocol as a cause for erroneous test results.[94]

Admittedly, only a minority of published DNA cases explicitly hold that the factor of proper test procedure affects the admissibility of DNA evidence.[95] Those cases offer little policy justification for elevating proof of correct test procedure to the status of a condition to admissibility. Nevertheless, those cases represent the better view and come to the right result. The Minnesota Supreme Court correctly observed in *Schwartz* that "specific DNA test results are only as reliable and accurate as the testing procedures used by the particular laboratory."[96] As scientific evidence, a DNA test by a forensic scientist derives its trustworthiness from the earlier research experiments validating the hypothesis that the test accurately analyzes a person's DNA. Those experiments, however, af-

92. *Id.* at § 23-2(D), at 950.

93. J. PETERSON, E. FABRICANT & K. FIELD, *supra* note 30, at 203-06, 223, 230, 239, 258.

94. *See generally* Hansen, Caudill & Boone, *Crisis in Drug Testing: Results of CDC Blind Study*, 253 J. A.M.A. 2382 (1985); Jain, Sneath & Budd, *Blind Proficiency Testing in Urine Drug Screening: The Need for an Effective Quality Control Program*, 1 J. ANAL. TOXICOL. 142 (1977); Mason, *Some Realities and Results of Proficiency Testing of Laboratories Performing Toxicological Analyses*, 5 J. ANAL. TOXICOL. 201 (1981); Shoemaker, Klein & Sideman, *Drug Abuse Proficiency Testing in Pennsylvania 1972-1976*, 1 J. ANAL. TOXICOL. 130 (1977).

95. Harmon, *supra* note 7, at 150-51. *See also* United States v. Two Bulls, 918 F.2d 56 (8th Cir. 1990).

96. State v. Schwartz, 447 N.W.2d 422, 426 (Minn. 1989).

ford no assurance of the trustworthiness of the forensic test offered at trial unless the forensic scientist replicated the conditions in effect during the earlier experiments. A *sine qua non* for correct protocol is duplicating all the controlled variables in the earlier experiments. Just as the considerations of a lack of a business duty or the presence of a litigation motivation are highly germane to the essential guarantee of the trustworthiness of business entries, sound test procedure relates directly to the trustworthiness of scientific evidence. *Palmer v. Hoffman*[97] and *Johnson v. Lutz*[98] properly concluded that the factors at work in those cases should impact the admissibility of the proffered business entries and not merely weight. *A fortiori*, *Schwartz* correctly concluded that a deviation from proper test protocol can render scientific evidence inadmissible.

II. If Deficiencies in Test Procedure Should Affect The Admissibility of Scientific Evidence, Who Should Have the Burden on the Question of Whether the Forensic Analyst Followed Correct Procedure?

Section I demonstrated that the factor of correct test protocol should affect the admissibility as well as the weight of scientific evidence. At this juncture, the temptation is to leap to the conclusion that the proponent of scientific evidence must therefore make an affirmative, foundational showing that on the occasion in question, the forensic analyst followed correct protocol. To use the terminology of the Federal Rules of Evidence, proof of proper test procedure would be a "preliminary" or foundational fact conditioning the admissibility of scientific evidence.[99] The proponent of evidence ordinarily has the burden of persuading the trial judge that the preliminary fact exists.[100] The proponent must establish the fact by a preponderance of the evidence.[101] For example, to bring a hearsay statement within the excited utterance exception,[102] the proponent of the statement must show that the declarant made the statement spontaneously in a state of nervous excitement.[103] If we applied the nor-

97. 318 U.S. 109 (1943).

98. 253 N.Y. 124, 170 N.E. 517 (1930).

99. Fed. R. Evid. 104.

100. R. Carlson, E. Imwinkelried & E. Kionka, Materials for the Study of Evidence 110-15 (2d ed. 1986).

101. Bourjaily v. United States, 483 U.S. 171, 175-76 (1987).

102. Fed. R. Evid. 803(2).

103. R. Carlson, E. Imwinkelried & E. Kionka, *supra* note 100, at 113.

mal practice to the factor of proper test procedure, we would assign the proponent the burden of proving that the forensic scientist followed correct protocol in conducting the test in question—the conclusion reached by the *Castro*[104] and *Schwartz*[105] courts.

However, this Section proposes that the normal practice should not be applied to the issue of compliance with sound scientific protocol. This section contends that while *Castro* and *Schwartz* correctly treat the question of compliance with proper test procedure as a factor affecting admissibility, they err in allocating the burden on the issue to the proponent. Initially, this section argues that as a matter of policy, it is neither necessary nor desirable to assign the burden to the proponent. Concededly, the argument advanced in this section is a novel one; to date, no court has held that the party opposing the admission of scientific evidence should bear the burden of showing noncompliance with correct test procedure. However, allocating the burden on a preliminary fact to the opponent is not unprecedented. As we shall see later in this section, in another context the Federal Rules of Evidence assign the burden on a preliminary fact to the opponent.[106] This section argues that the burden of showing compliance with correct test procedure is analogous to that context. Thus, the soundest solution is to treat the compliance issue as a factor affecting admissibility, but shift the burden to the opponent.

A. In Principle, Allocating the Burden on the Issue of Proper Test Protocol to the Opponent of Scientific Evidence Is Sound.

1. Substantively, allocating the burden to the proponent is neither necessary nor desirable.

Section I canvassed the empirical studies establishing a significant margin of error in modern forensic analysis. However, those studies do not dictate the conclusion that it is necessary to assign the proponent of scientific evidence the burden on the issue of correct test protocol.

In determining the allocation of a burden, the court should consider several factors.[107] In the vast majority of cases, the most "significant consideration [guiding the court's decision] is the judicial estimate of the probabilities of the situation. The risk of failure of proof [should] be

104. People v. Castro, 545 N.Y.S.2d 985, 995-97 (N.Y. Sup. Ct. 1989).

105. State v. Schwartz, 447 N.W.2d 422, 426-28 (Minn. 1989).

106. *See infra* notes 139-47 and accompanying text.

107. C. MCCORMICK, *supra* note 69, at § 337.

placed upon the party who contends that the more unusual event has occurred."[108] Courts usually assign the burden to the party whose "contention departs from what would be expected in the light of ordinary human experience."[109]

This factor cuts in favor of allocating the burden on the issue of test protocol to the party opposing the admission of scientific evidence. Although the available proficiency studies demonstrate the existence of a significant margin of error in forensic testing, we must not overstate the findings of those studies. As a leading critic of the indiscriminate admission of scientific testimony concedes, "The point is not that most laboratory test results are erroneous . . . . Indeed, the opposite is true."[110] The results of the Laboratory Proficiency Testing Program[111] are often cited as proof that a "significant"[112] margin of error in laboratory analyses exists. Yet those very results demonstrate that most laboratory tests are properly conducted and trustworthy. On most of the twenty-one sets of samples, the overwhelming majority of laboratories accurately analyzed the samples.[113] For many sets, the accuracy rate was well into the ninety percent range.[114]

The documented margin of error in laboratory analysis is too substantial to dismiss it lightly as a factor that should affect only the weight of scientific testimony. However, when a party offers evidence based on a forensic test at trial, it is highly probable that the test was properly conducted and the evidence trustworthy.[115] If the probabilities favored the conclusion that the test had been improperly conducted, it would arguably be necessary to assign the proponent the burden; the assignment would serve as a means of shielding the trier of fact from untrustworthy

108. *Id.* at § 337, at 950.

109. F. JAMES & G. HAZARD, CIVIL PROCEDURE § 7.8, at 252 (2d ed. 1977).

110. Giannelli, *supra* note 23, at 692.

111. *Id.* at 688-90.

112. *Id.* at 692.

113. *Id.* at 689 n.155.

114. *Id.* (test sample #1—92.2%, test sample #3—96.2%, test sample #4—95.2%, test sample #6—98.3%, test sample #7—94.7%, test sample #12—98.3%, test sample #13(A)—97.7%, test sample #13(B)—98.4%, and test sample #20(A)—94.6%).

115. Assume an extreme fact situation: In the case of a particular "scientific" technique, it is demonstrable that incorrect protocol is so widespread that the test was probably conducted improperly. On that assumption, at the very least the court would be justified in allocating the burden to the proponent. The Federal Rules of Evidence permit the admission of expert testimony only when the testimony will "assist the trier of fact . . . ." FED. R. EVID. 702. If the technique in question suffers from such an extensive problem of improper test protocol, it is doubtful whether the admission of the testimony would assist the trier.

test results. However, "the opposite is true."[116] The probability favors the forensic analyst's compliance with sound protocol, and it is consequently unnecessary to allocate the proponent the burden. The analyst ordinarily follows correct procedure, and it is therefore appropriate to assign the opponent the burden of showing something extraordinary about the instant test.

It is also undesirable to allocate the burden to the proponent. One of the constant complaints about the use of scientific evidence is that its presentation at trial can be extremely time-consuming. The horror stories about scientific testimony abound. In one case, the opposing party objected to the admission of an electrophoretic analysis of dried bloodstains.[117] The testimony about the trustworthiness of electrophoresis required eight days of court time.[118] In another case, scientific testimony about the trustworthiness of a moving radar speedmeter consumed "over 2,000 pages" of transcript.[119] In the *Castro* case, the parties presented "approximately five thousand pages" of testimony and argument over the trustworthiness of the DNA evidence, notably the specific manner in which the laboratory technicians had applied DNA typing technology in that case.[120] The presentation of this testimony and argument required twelve weeks of court time.[121]

Assigning the proponent the burden on the issue of correct test protocol lengthens the foundation the proponent must lay and increases the amount of court time needed to present scientific evidence. If the probability favored the assumption that the evidence was flawed, the expenditure of additional court time might be warranted. However, the probability favors the contrary assumption. A cost/benefit analysis therefore suggests that in the typical case the consumption of additional court time is unwarranted. In most metropolitan areas, court calendars are already backlogged.[122] Court time is a precious commodity. In the

116. Giannelli, *supra* note 23, at 692.

117. People v. Reilly, 196 Cal. App. 3d 1127, 242 Cal. Rptr. 496 (1987).

118. 196 Cal. App. 3d at 1135, 242 Cal. Rptr. at 501.

119. State v. Aquilera, 25 Crim. L. Rep. (BNA) (Fla. Cir. Ct.) 2189 (May 7, 1979).

120. People v. Castro, 144 Misc. 2d 956, 957, 545 N.Y.S.2d 985, 986 (N.Y. Sup. Ct. 1989).

121. Note, *supra* note 19, at 691.

122. REPORT OF THE FEDERAL COURTS STUDY COMMITTEE, 5-6 (1990); R. POSNER, THE FEDERAL COURTS: CRISIS AND REFORM 64 (1985); Marvell, *Caseload Growth—Past and Future Trends*, 71 JUDICATURE 151 (Oct.-Nov. 1987); Marvell, *Are Caseloads Really Increasing? Yes*, 25 THE JUDGES' J. 35 (Sum. 1986); Marvel, *Civil Caseloads: The Impact of the Economy and Trial Judgeship Increases*, 69 JUDICATURE 153 (Oct.-Nov. 1985); *The Drugging of the Courts: How Sick Is the Patient, and What Is the Treatment?*, 73 JUDICATURE 314 (Apr.-May 1990).

normal case, requiring the proponent to make an affirmative showing that the forensic analyst complied with proper scientific protocol in conducting the test wastes that commodity.

2. Procedurally, allocating the burden to the opponent is fair when the opponent has an adequate opportunity for pretrial discovery.

The judicial estimate of the probabilities is not the only consideration pertinent to the allocation of the burden.[123] Another consideration is the parties' relative access to the relevant information.[124] If one party has readier access to the information, it may be fairer in a procedural sense to allocate that party the burden; it is easier for that party to gather and present the evidence relevant to the factual issue.

This consideration is particularly important when allocating burdens on issues related to scientific evidence:

> [M]any attorneys lack the scientific background necessary to evaluate the [scientific] evidence at first glance [at trial]. If the [proponent's] scientific analyses remain undisclosed until trial, most [opposing] attorneys would be unable to detect any errors in the [scientific] report. The opposing attorney needs a pretrial opportunity to study the report and to learn enough about the relevant scientific discipline to critique the report.[125]

Unfortunately, some jurisdictions limit pretrial discovery of scientific evidence, particularly in criminal cases.[126] Before trial, the opposing attorney may receive a scientific report stating only the analyst's ultimate findings.[127] The opponent may be unable to force the analyst to disclose the particular tests she used to reach the findings[128]—much less the specific procedures the analyst employed in conducting the test. In jurisdictions granting such paltry discovery, the proponent should probably have the burden at trial on the issue of correct test protocol. Fortunately, in other jurisdictions, pretrial discovery of scientific evidence is more ample.[129] In several of the DNA cases, the courts have been insistent that the defense be accorded "extensive" pretrial discovery of the prosecu-

123. C. MCCORMICK, *supra* note 69, at § 337.

124. *Id.* at § 337, at 950.

125. Imwinkelried, *The Worst Surprise of All: No Right to Pretrial Discovery of the Prosecution's Uncharged Misconduct Evidence*, 56 FORDHAM L. REV. 247, 258-59 (1987).

126. *See generally* P. GIANNELLI & E. IMWINKELRIED, *supra* note 83, at Ch. 3.

127. Giannelli, *supra* note 23, at 692.

128. *Id.* at 692-93.

129. *See* P. GIANNELLI & E. IMWINKELRIED, *supra* note 83.

tion's DNA testing evidence.[130] Federal[131] and state[132] courts alike have recognized the defense's entitlement to ample discovery in DNA cases.

The *Castro*[133] and *Schwartz*[134] cases illustrate the type of effective, successful attack on test protocol that an opposing attorney can mount when she is afforded adequate pretrial discovery. In many of the prior DNA cases, the defense counsel had not called any witnesses to rebut the prosecution expert's testimony.[135] In contrast, the defense attorneys in *Castro* and *Schwartz* presented expert testimony that acutely critiqued the manner in which the prosecution experts had conducted their DNA tests.[136] As these cases demonstrate, adequate pretrial discovery is the essential tool which the opponent needs to unmask untrustworthy forensic analyses at trial. So long as the opponent is granted adequate discovery in a practical as well as a formal sense,[137] assigning the opponent the

130. Jonakait, *supra* note 11, at 123. *See also* Pearsall, *DNA Printing: The Unexamined "Witness" in Criminal Trials*, 77 CALIF. L. REV. 665, 678 (1989); *The Fairy Tale is Over: DNA Enters the Very Adversarial World of the Law*, 13 SCI. SLEUTHING REV. 10, 10-11 (Fall 1989) (describing the discovery granted in the *Kiles* case in Arizona).

131. United States v. Yee, 129 F.R.D. 629 (N.D. Ohio 1990).

132. State v. Schwartz, 447 S.W.2d 422, 427-28 (Minn. 1989). *See also* Debbs v. Vergari, 59 U.S.L.W. 2418 (N.Y. Sup. Ct., Nov. 29, 1990) (post-conviction discovery); *The Fairy Tale is Over: DNA Enters the Very Adversarial World of the Law*, 13 SCI. SLEUTHING REV. 10, 11 (Fall 1989) (in the *Kiles* case, in Yuma Arizona, the "trial court judge granted the defense's discovery requests in its substantial particulars .... [Defense] discovery requests are being made for box-car loads of DNA items from the testing agency, and [c]ourt orders are being entered requiring compliance with substantial parts of these requests. The F.B.I., for its part, is routinely acquiescing in these orders").

133. People v. Castro, 144 Misc. 2d 956, 545 N.Y.S.2d 985 (N.Y. Sup. Ct. 1989).

134. State v. Schwartz, 447 N.W.2d 422 (Minn. 1989).

135. Jonakait, *supra* note 11, at 122-23; Lewin, *DNA Typing on the Witness Stand*, 244 SCIENCE 1033 (June 1, 1989).

136. Jonakait, *supra* note 11, at 123-24.

137. Suppose that the proponent's expert has maintained such poor records of the forensic test that it is impossible for the opponent to reconstruct the manner in which the test was conducted. On the one hand, even when this situation arises in a criminal context, it is probably constitutional to admit the evidence against an accused. In Delaware v. Fensterer, 474 U.S. 15 (1985), the State's expert subjected a hair strand to forensic analysis. At the time of trial, the expert testified to his finding that the strand had been forcibly removed. However, the expert conceded that he could not recall which scientific techniques he had used to reach that finding. The defense argued that the admission of the expert's testimony ran afoul of the confrontation clause. In a per curiam opinion, the Court rejected the argument. *Fensterer* is a more extreme case than our hypothetical; in *Fensterer*, the expert could not identify the scientific techniques he had employed—much less describe the manner in which he had applied those techniques.

On the other hand, as a matter of evidentiary policy, in this situation it seems preferable to shift the burden to the witness' proponent. It is true that in a formal sense, the opponent has been accorded discovery. However, in a practical sense, the opponent has been denied discovery; the expert's poor documentation makes it impossible for the opponent affirmatively to show that there has been a material deviation from sound test protocol. Note, *The Dark Side of DNA Profiling: Unrelia-*

burden on the issue of correct test protocol is not unfair.

B. *In the Analogous Setting of the Official Record Exception to the Hearsay Rule, Federal Rule of Evidence 803(8)(C) Allocates the Opposing Party the Burden on the Issue of Whether "the Sources of Information or Other Circumstances Indicate Lack of Trustworthiness."*

At the beginning of Section II, we noted the normal practice of assigning the proponent of evidence the burden on all factors conditioning the admissibility of the evidence. Interestingly enough, the drafters of the Federal Rules of Evidence abandoned the orthodox practice[138] in Rule 803(8)(C). In pertinent part, the rule reads:

> The following are not excluded by the hearsay rule, even though the declarant is available as a witness: (8) Public records and reports. Records, reports, statements, or data compilations, in any form, of public offices or agencies, setting forth . . . (C) in civil actions and proceedings and against the Government in criminal cases, factual findings resulting from an investigation made pursuant to authority granted by law, unless the sources of

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ble Scientific Evidence Meets the Criminal Defendant, 42 STAN. L. REV. 465, 492-93 (1990). *Ex hypothesis*, the expert in question is the proponent's witness; the witness is either an employee of the proponent or a hired consultant. Because the proponent has selected the expert, it seems fairer to allocate the risk of the expert's shoddy documentation to the proponent. A similar risk allocation underlies the well-settled "missing witness" doctrine. If the posture of the case indicates that a particular person is likely to have relevant knowledge but a party fails to call the person as a witness, the opposition may invite the jury to draw an adverse inference from the failure when the party has a special relationship with the person. R. KLONOFF & P. COLBY, SPONSORSHIP STRATEGY: EVIDENTIARY TACTICS FOR WINNING JURY TRIALS 124-26 (1990). The doctrine applies to the employer-employee relationship. Jones v. Otis Elevator Co., 861 F.2d 655, 659 n.5 (11th Cir. 1988).

138. The Federal Rules allocate burdens to the opponent in several other instances as well. For example, under Federal Rule 403, the opponent has the burden of persuading the court that the probative dangers incident to the admission of an item of evidence outweigh the probative value of the item. *See* Imwinkelried, *The Need to Amend Federal Rule of Evidence 404(b): The Threat to the Future of the Federal Rules of Evidence*, 30 VILL. L. REV. 1465, 1474-79 (1985).

Morever, the opponent also has a burden under the Federal Rules version of the best evidence rule. Under Federal Rule 1003, a duplicate is generally as admissible as an original. FED. R. EVID. 1003. However, the statute recognizes two exceptions to that general rule: when "(1) a genuine question is raised as to the authenticity of the original or (2) in the circumstances it would be unfair to admit the duplicate in lieu of the original." *Id.* The opponent has the burden on these exceptions. E. IMWINKELRIED, P. GIANNELLI, F. GILLIGAN & F. LEDERER, COURTROOM CRIMINAL EVIDENCE § 1506, at 46 (Supp. 1989); People v. Atkins, 210 Cal. App. 3d 47, 55, 258 Cal. Rptr. 113, 118 (1989) ("Under Federal Rule of Evidence 1003, which is identical to [California] Evidence Code section 1511, the burden is on the opponent to raise a genuine issue as to the authenticity of the original or to show that under the circumstances it would be unfair to use the duplicate in lieu of the original").

information or other circumstances indicate lack of trustworthiness.[139]

In construing Rule 803(8)(C), the courts have in effect divided the rule into two parts. The first part begins with "[r]ecords, reports, statements, or data compilations" and ends with "authority granted by law." That part prescribes the preliminary or foundational facts on which the proponent of the evidence has the burden. If the proponent establishes those facts, a "factual finding" in an official record is presumptively admissible.[140] The Supreme Court has construed the expression "factual finding" broadly as including opinionated findings about events which the government official did not witness. In its 1988 decision, *Beech Aircraft Corp. v. Rainey*,[141] the Court held that the statutory expression included an opinion by a Naval investigator that the most probable cause of an airplane accident was pilot error.[142]

The second part of the rule begins with "unless" and runs to the end of the rule. This part serves as a "provision for escape" for the party opposing the admission of the official record.[143] Like the first part of the rule, this part sets out factors conditioning the admissibility of official records;[144] but under the second part of the rule, the opponent has the burden.[145] The drafters' use of a separate clause, beginning with "unless," manifests their intent to shift the burden to the opponent. Thus, to exclude evidence under the second part of the rule, the opponent must come forward with evidence[146] affirmatively showing that the official record in question is untrustworthy.[147]

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139. FED. R. EVID. 803(8)(C).

140. SEC v. General Refractories Co., 400 F. Supp. 1248, 1255-56 (D.D.C. 1975).

141. 488 U.S. 153 (1988).

142. Dean McCormick has urged the courts to admit opinionated findings in reports of investigation prepared by impartial, expert government officials. McCormick, *Can the Courts Make Wider Use of Reports of Official Investigations?*, 42 IOWA L. REV. 363 (1957). The advisory committee approvingly cited Dean McCormick's article in its note to Rule 803(8)(C). FED. R. EVID. 803(8) advisory committee's note.

143. Beech Aircraft Corp. v. Rainey, 488 U.S. 1537 (1988).

144. The Supreme Court has distinguished an invocation of the "provision for escape" from a mere attack on the weight of the evidence. *Id.* at 167-68.

145. D. BINDER, HEARSAY HANDBOOK § 10.04, at 109 (2d ed. Supp. 1989); M. GRAHAM, HANDBOOK OF FEDERAL EVIDENCE § 803.8, at 880-81 (2d ed. 1986) (citing Ellis v. International Playtex, Inc., 745 F.2d 292 (4th Cir. 1984)); 4 D. LOUISELL & C. MUELLER, FEDERAL EVIDENCE § 456, at 766 (1980); G. WEISSENBERGER, FEDERAL EVIDENCE § 803.46, at 439 (1987); Haddad, *The Future of Confrontation Clause Developments: What Will Emerge When the Supreme Court Synthesizes the Diverse Lines of Confrontation Decisions?*, 81 J. CRIM. LAW & CRIMINOLOGY 77, 85 (1990).

146. Melville v. American Home Assurance Co., 584 F.2d 1306, 1315-16 (3d Cir. 1978).

147. M. GRAHAM, HANDBOOK OF FEDERAL EVIDENCE § 803.8, at 241 (2d ed. Supp. 1990)

The allocation of the burden to the opponent on a factor conditioning admissibility under the second part of Rule 803(8)(C) is novel. However, the rule is justifiable.

The opponent is entitled to more than a mere opportunity to attack the weight of the official record.[148] Rule 803(8)(C) dramatically expands the official record exception to encompass opinionated findings about events even when the government investigator lacks personal knowledge of the event.[149] At common law, the conventional view is that the exception is confined to factual statements resting on a government official's firsthand knowledge.[150] By expanding the exception in this fashion, Rule 803(8)(C) heightens the risk of the admission of untrustworthy evidence;[151] the rule allows the investigator to draw inferences from underlying facts, and the inferential step creates another potential source of error. The investigator is doing far more than relating factual observations; the investigator is also drawing conclusions from those observations. The limitations on lay and expert opinion testimony[152] exist because conclusions are frequently erroneous. The risk is significant enough to accord the opponent an opportunity to challenge the admissibility of these opinionated findings.

Yet the risk hardly approaches a probability that the factual finding is untrustworthy. As the Court of Appeals for the Fourth Circuit explained in a case involving Centers for Disease Control epidemiological studies, "Placing the burden on the opposing party makes considerable practical sense. Most government sponsored investigations employ well accepted methodological means of gathering and analyzing data."[153] The finding in an otherwise admissible official record is probably reliable, and that probability justifies a rebuttable presumption that the finding is admissible.[154] Citing the advisory committee note to Rule 803, the *Beech Aircraft Corporation* Court stated that the opportunity to rebut the pre-

(citing Bradford Trust Co. v. Merrill Lynch, Pierce, Fenner and Smith, Inc., 805 F.2d 49, 54 (2d Cir. 1986)).

148. *Beech Aircraft Corp.*, 488 U.S. at 167-68.

149. *Id.*

150. McCormick, *supra* note 142.

151. *See generally* Note, *The Trustworthiness of Government Evaluative Reports Under Federal Rule of Evidence 803(8)(C)*, 96 HARV. L. REV. 492 (1982); Comment, *The Admissibility of Evaluative Reports Under Federal Rule of Evidence 803(8)*, 68 KY. L.J. 197 (1979-80).

152. FED. R. EVID. 701-06.

153. Ellis v. International Playtex, Inc., 745 F.2d 292, 301 (4th Cir. 1984); D. BINDER, HEARSAY HANDBOOK § 10.04, at 109 (2d ed. Supp. 1989).

154. SEC v. General Refractories Co., 400 F. Supp. 1248, 1255-56 (D.D.C. 1975).

sumption affords the opponent "ample" protection.[155]

A powerful analogy exists between Rule 803(8)(C) and the approach to the admissibility of scientific evidence proposed in this article. Under the second part of Rule 803(8)(C), the opposing party can block the introduction of an otherwise admissible finding by showing "[particular] sources of information or other [specific] circumstances" surrounding the preparation of the report "indicat[ing] lack of trustworthiness."[156] Under the proposal advanced in this article, the party opposing the admission of testimony about a scientific test can prevent the admission of testimony based on a validated scientific technique by demonstrating that the forensic analyst deviated from sound protocol in conducting the test. In both instances, there is a significant risk of untrustworthiness—in the former case, arising from the investigator's inference from the underlying data, and in the latter case, caused by the forensic analyst's failure to replicate the essential conditions obtaining during the earlier experiments. In neither setting can the risk be dismissed as remote or fanciful. However, the parallel continues because in both instances, the risk of error falls short of a likelihood that the evidence is untrustworthy.

The case law construing Rule 803(8)(C) bears out the analogy between the rule and the proposal in this Article. In some cases, the courts have applied the rule to permit the admission of scientific reports. As previously stated, the Fourth Circuit has applied Rule 803(8)(C) to epidemiological studies by the Centers for Disease Control (C.D.C.).[157] The court emphasized that "[m]ost government sponsored investigations employ well accepted methodological means of gathering and analyzing data."[158] For that reason, the court, in effect, indulged in the presumption that the C.D.C. analysts who had conducted the studies in question had followed proper methodology in preparing those studies.

In other cases involving scientific reports proffered under Rule 803(8)(C), the opponent succeeded in making an affirmative showing that the forensic experts who prepared the reports deviated from sound protocol. For example, in an antitrust case, a party opposed the admission of a New Zealand task force finding on the chiropractic profession in that

155. *Beech Aircraft Corp.*, 488 at 167.

156. FED. R. EVID. 803(8)(C).

157. Ellis v. International Playtex, Inc., 745 F.2d 292, 301 (4th Cir. 1984).

158. *Id.*

country.[159] The opponent pointed out that the Office of Technology Assessment of the United States Congress had concluded that the New Zealand report was "not based upon well-designed, controlled clinical trials."[160] Consequently, the district court excluded the finding.

Allocating the burden to the opponent under Rule 803(8)(C) has proved to be workable. It is true that *Beech Aircraft Corp. v. Rainey*[161] presented the Supreme Court solely with a question of statutory construction; the Court was not called upon to formulate a common law rule governing the admissibility of evaluative findings in official records. However, the tenor of the opinion makes it evident that the majority believes that the compromise struck in Rule 803(8)(C) is both manageable and fair. When the source of the information for an official record or the peculiar circumstances surrounding the preparation of the report raise grave doubts about the trustworthiness of the report, Rule 803(8)(C) permits the opponent to mount admissibility as well as weight attacks on the report.[162] While the opponent has the burden to establish the facts about the source or other circumstances giving rise to such substantial doubts, the opponent has "ample" protection.[163] The existence of such facts is improbable; but when the improbable comes to pass, the opponent, assured of ample pretrial discovery, has a fair opportunity to prove that the improbable has occurred. This policy analysis persuaded both the advisory committee and the Supreme Court of the wisdom of Rule 803(8)(C). Identical reasoning supports the allocation of the burden to the opponent on the issue of the use of correct scientific test procedure.

III. CONCLUSION

The central focus of the publicity for the DNA cases has been the general trustworthiness of the DNA typing technology.[164] However, as we have seen, the DNA cases pose broader issues, which in the long term may prove to be even more important.

One issue posed by the DNA cases is who should bear the burden on

159. Wilk v. American Medical Ass'n, 671 F. Supp. 1465, 1471-73 (D.N.E. Ill. 1987), *aff'd*, 895 F.2d 352 (7th Cir.), *cert. denied*, 110 S. Ct. 2621 (1990).

160. *Id.* at 1472.

161. 488 U.S. 153 (1989).

162. *Id.* at 167-68.

163. *Id.* at 167.

164. P. GIANNELLI & E. IMWINKELRIED, *supra* note 4, at § 17-8.

the issue of correct scientific protocol. This Article proposes that the opponent shoulder the burden. Assuming that the opponent has adequate opportunity for pretrial discovery,[165] the allocation is procedurally fair. *Castro* and *Schwartz* exemplify the type of discerning, effective attack that the opponent can mount. The allocation is substantively sensible, since even the proficiency studies cited by the critics of scientific evidence demonstrate that in most instances forensic tests are properly conducted and trustworthy. The allocation is certainly desirable from a systemic perspective; shifting the burden to the opponent is likely to result in a net savings of trial time for an overtaxed system.

It would be a mistake to overstate the effect of implementing this proposal. In the short term, the time savings may be quite small. In many cases, to ensure that her evidence is comprehensible to the trier of fact, the proponent will still elicit some testimony about the manner in which the forensic analyst applied the scientific technique in the instant case.[166]

However, in the long term, this proposal can have a significant impact. As the Supreme Court's decision in *Beech Aircraft* [167] suggests, Federal Rule of Evidence 803(8)(C) has worked reasonably well despite its novel allocation of a burden to the opponent. To date, the experiment with the reallocation technique in Rule 803(8)(C) has been successful. The next

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165. The proposed allocation shares the same assumption as Federal Rule of Evidence 705. That rule provides:

> The expert may testify in terms of opinion or inference and give reasons therefor without prior disclosure of the underlying facts or data, unless the court requires otherwise. The expert may in any event be required to disclose the underlying facts or data on cross-examination.

The advisory committee defended Rule 705 in this fashion:

> If the objection is made that leaving it to the cross-examiner to bring out the supporting data is essentially unfair, the answer is that he is under no compulsion to bring out any facts or data except those unfavorable to the opinion. The answer assumes that the cross-examiner has the advance knowledge which is essential for effective cross-examination. This advance knowledge has been afforded, though imperfectly, by the traditional foundation requirement. Rule 26(b)(4) of the Rules of Civil Procedure, as revised, provides for substantial discovery in this area, obviating in large measure the obstacles which have been raised in some instances to discovery of findings, underlying data, and even the identity of the experts.

FED. R. EVID. 705 advisory committee's note.

166. Imwinkelried, *Evidence Law and Tactics for the Proponents of Scientific Evidence*, in SCIENTIFIC AND EXPERT EVIDENCE 33, 52-57, 66-67 (2d ed. 1981). The proponent is likely to devote a substantial amount of time to this foundational element when the ultimate expert opinion is a minute measurement. Neutron activation analysis is a sensitive technique, capable of precisely measuring small quantities of chemical elements. Watkins & Watkins, *Identification of Substances by Neutron Activation Analysis*, 15 AM. JUR. P.O.F. 115, 123-25 (1964).

167. Beech Aircraft Corp. v. Rainey, 488 U.S. 153 (1989).

logical step would be to extend the technique of shifting the burden to the opponent on issues such as the question of correct test protocol. As in the case of Rule 803(8)(C), the opponent is urging the improbable position; and laying the foundation for scientific testimony can be so exceptionally time-consuming that any saving of trial time would be helpful. In the past, courts have mechanically assumed that the proponent should have the burden on any factor impacting the admissibility of evidence. That assumption is not inexorable. Court calendars are now greatly backlogged in many jurisdictions.[168] This may be the right time to explore the use of reallocation of burdens to the opponent in the interest of judicial economy. The reallocation of burdens may ultimately prove to be an effective method of streamlining evidentiary foundations. Reallocating the burden to the opponent on the issue of correct scientific protocol would generate additional experience with this potentially promising technique.

The other issue raised by the DNA cases is the question of whether deficiencies in test procedure should affect the admissibility or merely the weight of scientific evidence.[169] While respectable authority for the proposition that test deficiencies affect only the weight of the evidence persists,[170] the *Castro*[171] and *Schwartz*[172] courts embraced the sounder, contrary view. Professor Melvin Lewis put the matter colorfully when he wrote that "[i]t is no more correct to say that neutron activation analysis detects the presence of barium and antimony than to say that a violin produces music."[173]

As powerful as a scientific technique such as neutron activation analysis or DNA typing may be, in the forensic world the technique must be applied by a fallible human being. The process of hypothesis formulation and experimental verification can yield highly trustworthy scientific techniques.[174] A well-designed experiment based on an extensive database supplies substantial assurance that the technique itself is trustworthy enough to serve as a basis for trial testimony. However, the earlier experiments furnish no assurance of the reliability of the specific forensic test

168. *See supra* authorities collected in note 122.

169. Harmon, *supra* note 7, at 150-51.

170. *Id.*

171. People v. Castro, 545 N.Y.S.2d 985, 995-97 (N.Y. Sup. Ct. 1989).

172. State v. Schwartz, 447 N.W.2d 422, 426-28 (Minn. 1989). *See also* United States v. Two Bulls, 918 F.2d 56 (8th Cir. 1990).

173. Lewis, *supra* note 1, at 430.

174. Black, *supra* note 74, at 621, 623-24.

proffered in court unless the forensic analyst replicated the conditions that the research scientist controlled for in the preceding experiments. An essential goal of correct forensic test protocol is duplicating the earlier conditions. Proper protocol is therefore directly related to the essential guarantee of the trustworthiness of scientific evidence. In principle, that factor should condition the admissibility of scientific testimony and not merely its weight. Courts should follow the lead of *Castro* and *Schwartz*, extrapolate from those cases, and treat deviations from correct test protocol as a factor affecting the admissibility of all types of scientific evidence.

Once again, it would be exaggerated to predict that the adoption of this view will have a dramatic, immediate effect. The adoption of this view will likely change the ruling on the admissibility of scientific evidence in only a small number of cases.[175] Common sense will lead courts to the conclusion that they should not automatically exclude scientific testimony whenever the forensic analyst deviates from correct test protocol in any minor respect. Like the investigator preparing an official report offered under Rule 803(8)(C), the analyst need not dot every *i* and cross every *t*. In most cases, to bar the admission of the evidence, the opponent will have to present persuasive expert testimony that the analyst deviated from accepted protocol and that the specific deviation could materially affect the test outcome. Judging on the basis of the published opinions,[176] the opponent will be able to make that showing in only a small percentage of cases.

However, like the allocation of the burden on test protocol to the opponent, the adoption of this view can have an important impact in the long term. To some extent the adoption of this view will refocus the attention of the judicial system. In the past, courts and commentators have concentrated on the general reliability of the scientific theory or technique. The battleground has been whether courts should continue to enforce the *Frye* test, requiring that the technique be generally accepted within the relevant scientific circle.[177]

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175. Although the opponent's evidence is always admissible "to impeach the particular procedures employed in a specific test," the evidence will render the test inadmissible only "[i]n extreme cases." State v. Woodall, 385 S.E.2d 253, 260 (W.Va. 1989).

176. *Id.*

177. *See* Bretz, *Scientific Evidence and the* Frye *Rule: The Case for a Cautious Approach*, 4 COOLEY L. REV. 506 (1987); Giannelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States, *a Half-Century Later*, 80 COLUM. L. REV. 1197 (1980); Starrs, *A Still Life Watercolor:* Frye v. United States, 27 J. FORENSIC SCI. 684 (1982); Note, United States v. Downing:

In part because of the concentration on general reliability, courts and commentators have largely overlooked the importance of the forensic analyst's compliance with proper scientific protocol in conducting the specific test proffered at trial.[178] However, as the published proficiency studies demonstrate, unsound test procedure may be the leading cause of laboratory misanalysis.[179] The problem of improper test protocol deserves closer scrutiny by the courts. Treating test procedure as a factor conditioning admissibility will not only redirect the courts' attention; it will also send an important signal to forensic analysts. The signal is that in court, their test protocols can be closely scrutinized and that in appropriate cases, their testimony will be excluded altogether if they deviate from sound test procedure. As Professor Lewis has reminded us, since we must rely on human beings to apply scientific techniques such as DNA typing, human error in forensic analysis is an inevitable possibility.[180] However, by elevating test protocol to the status of a factor affecting admissibility and not merely weight, evidence law can give forensic analysts an added incentive to adhere scrupulously to sound test procedures. In the long term, evidence law can affect the development of forensic science.[181] We must have faith that what attorneys and judges do in the courtroom can impact what scientists do in the laboratory.[182]

Novel Scientific Evidence and the Rejection of Frye, 1986 UTAH L. REV. 839. *See* P. GIANNELLI & E. IMWINKELRIED, *supra* note 83, at §§ 1, 5, 6 (collecting cases); A. MOENSSENS, F. INBAU & J. STARRS, *supra* note 33, at § 1.03 (collecting cases).

178. Harmon, *supra* note 7, at 150-51.

179. J. PETERSON, E. FABRICANT & K. FIELD, *supra* note 30, at 203-06, 223, 230, 239, 258.

180. Lewis, *supra* note 1, at 430-31.

181. *Id.* at 431.

182. *Id.*