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Forensic Science: *Daubert's* Failure

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FORENSIC SCIENCE: DAUBERT'S FAILURE

Paul C. Giannelli

“The man who discovers a new scientific truth has previously had to smash to atoms almost everything he had learnt, and arrives at the new truth with hands bloodstained from the slaughter of a thousand platitudes.”¹

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1. JOSE ORTEGA Y GASSET, *THE REVOLT OF THE MASSES* 157 (W.W. Norton & Co. 1960) (1930).

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INTRODUCTION

In 2015, Judge Alex Kozinski of the Ninth Circuit Court of Appeals noted that “[m]any defendants have been convicted and spent countless years in prison based on evidence by arson experts who were later shown to be little better than witch doctors.”² In the same year, Dr. Jo Handelsman, a White House science advisor, observed: “Suggesting that bite marks [should] still be a seriously used technology is not based on science, on measurement, on something that has standards, but more of a gut-level reaction.”³ According to Judge Catharine Easterly of the D.C. Court of Appeals, “[a]s matters currently stand, a certainty statement regarding toolmark pattern matching has the same probative value as the vision of a psychic.”⁴ A *New York Times* editorial echoed these sentiments:

[C]ourts have only made the problem worse by purporting to be scientifically literate, and allowing in all kinds of evidence that

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- Alex Kozinski, *Preface: Criminal Law 2.0*, 44 GEO. L.J. ANN. REV. CRIM. PROC. iii, v (2015); see also *Almeciga v. Ctr. for Investigative Reporting, Inc.*, 185 F. Supp. 3d 401, 415 (S.D.N.Y. 2016) (Rakoff, J.) (“There have been too many pseudo-scientific disciplines that have since been exposed as profoundly flawed, unreliable, or baseless for any Court to take this [gatekeeping] role lightly.”).
 - See Radley Balko, *A High-Ranking Obama Official Just Called for the “Eradication” of Bite Mark Evidence*, WASH. POST (July 22, 2015), https://www.washingtonpost.com/news/the-watch/wp/2015/07/22/a-high-ranking-obama-official-just-called-for-the-eradication-of-bite-mark-evidence/?utm_term=.449f38b65769 [<https://perma.cc/F9ES-B79J>] (quoting Handelsman’s remarks presented at the International Symposium on Forensic Science Error Management: Detection, Measurement and Mitigation, Arlington, Virginia (July 20–24, 2015), organized by the National Institute of Standards and Technology (NIST)).
 - Williams v. United States*, 130 A.3d 343, 355 (D.C. 2016) (Easterly, J., concurring).

would not make it within shouting distance of a peer-reviewed journal. Of the 329 exonerations based on DNA testing since 1989, more than one-quarter involved convictions based on “pattern” evidence—like hair samples, ballistics, tire tracks, and bite marks—testified to by so-called experts.⁵

These criticisms are valid—which raises a puzzling and consequential question: Why didn’t the Supreme Court’s “junk science” decision, *Daubert v. Merrell Dow Pharmaceuticals, Inc.*,⁶ prevent or restrict the admissibility of testimony based on flawed forensic techniques? After all, *Daubert* was decided in 1993, twenty-five years ago.

A. *Daubert and Rule 702*

Daubert was considered a revolutionary decision.⁷ It “radically changed the standard for admissibility of scientific testimony”⁸ by sweeping away the *Frye v. United States*⁹ “general acceptance” test,¹⁰ which had been the majority rule in both federal and state cases.¹¹ The *Frye* standard gave great deference to the views of forensic practitioners and not to empirical testing.¹² *Daubert* promised to be different. The Supreme Court held that “[p]roposed testimony must be supported by

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5. Editorial, *Junk Science at the F.B.I.*, N.Y. TIMES (Apr. 27, 2015), <https://www.nytimes.com/2015/04/27/opinion/junk-science-at-the-fbi.html> [<https://perma.cc/6PH3-8SPL>]; see also Eric S. Lander, *Fix the Flaws in Forensic Science*, N.Y. TIMES (Apr. 21, 2015), <https://www.nytimes.com/2015/04/21/opinion/fix-the-flaws-in-forensic-science.html> [<https://perma.cc/8LPZ-BWHX>] (“No expert should be permitted to testify without showing three things: a public database of patterns from many representative samples; precise and objective criteria for declaring matches; and peer-reviewed published studies that validate the methods.”).
 6. 509 U.S. 579 (1993).
 7. See David L. Faigman, *Is Science Different for Lawyers?*, 297 SCI. 339, 340 (2002) (“*Daubert* initiated a scientific revolution in the law.”).
 8. *United States v. Barnette*, 211 F.3d 803, 815 (4th Cir. 2000); see also *United States v. Alatorre*, 222 F.3d 1098, 1100 (9th Cir. 2000) (“*Daubert* has become ubiquitous in federal trial courts.”).
 9. 293 F. 1013 (D.C. Cir. 1923).
 10. *Id.* at 1014 (stating that a technique “must be sufficiently established to have gained general acceptance in the particular field in which it belongs”).
 11. See Paul C. Giannelli, *The Admissibility of Novel Scientific Evidence: Frye v. United States, a Half-Century Later*, 80 COLUM. L. REV. 1197, 1228 (1980).
 12. See Michael J. Saks, *Merlin and Solomon: Lessons from the Law's Formative Encounters with Forensic Identification Science*, 49 HASTINGS L.J. 1069, 1138 (1998) (“*Frye* does not work because its measure of validity is the judgment of ‘the field,’ and the field may consist of nonsense. For example, the *Frye* doctrine cannot exclude astrology.”).

appropriate validation—i.e., ‘good grounds,’ based on what is known. In short, the requirement that an expert’s testimony pertain to ‘scientific knowledge’ establishes a standard of evidentiary reliability.”¹³ In making this reliability determination, the *Daubert* Court highlighted five factors: (1) empirical testing, (2) peer review and publication, (3) error rate, (4) maintenance of standards, and (5) general acceptance.¹⁴ The first and *most important factor* is empirical testing. The other factors are supplementary.¹⁵ Peer review and publication are designed to expose defects in testing. Acceptance of a technique within the scientific community is achieved through the publication of valid test results. Similarly, both error rates and standards are derived from testing.

Daubert was followed in 1999 by *Kumho Tire Co. v. Carmichael*,¹⁶ which held that *Daubert*’s reliability standard applied to all expert testimony, not only scientific evidence.¹⁷ By 2000, the Supreme Court was describing *Daubert* as establishing an “exacting” standard.¹⁸ In the same year, Federal Rule of Evidence 702 was amended to incorporate the *Daubert-Kumho* standard.¹⁹ Although a handful of jurisdictions continue to apply the *Frye* test, about forty jurisdictions have adopted the *Daubert* standard in one form or another.²⁰

During this time, there was no shortage of commentary on the lack of empirical research in forensic science.²¹ For example, shortly after

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13. *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 590 (1993) (emphasis added).
 14. *Id.* at 593–94.
 15. *Id.*
 16. 526 U.S. 137 (1999).
 17. *Id.* at 141.
 18. *Weisgram v. Marley Co.*, 528 U.S. 440, 455 (2000).
 19. After *Daubert*, the Court decided *General Electric Co. v. Joiner*, 522 U.S. 136 (1997). *Joiner* established the standard for appellate review—abuse of discretion—for applying the *Daubert* factors. *Id.* at 139. *Daubert*, *Joiner*, and *Kumho* make up what is known as the *Daubert* Trilogy.
 20. See 1 PAUL C. GIANNELLI ET AL., SCIENTIFIC EVIDENCE § 1.11 (5th ed. 2012).
 21. A few perceptive scholars had noted the lack of empirical testing prior to *Daubert*. See Randolph N. Jonakait, *Forensic Science: The Need for Regulation*, 4 HARV. J.L. & TECH. 109, 137 (1991) (“Forensic science is supported by almost no research. The laboratory practices are based on intuitions and deductions, not on empirical proof.”); D. Michael Risinger et al., *Exorcism of Ignorance as a Proxy for Rational Knowledge: The Lessons of Handwriting Identification “Expertise,”* 137 U. PA. L. REV. 731, 738 (1989) (“Our literature search for empirical evaluation of handwriting identification turned up one primitive and flawed validity study from nearly 50 years ago, one 1973 paper that raises the issue of consistency among examiners but that presents only uncontrolled impressionistic and anecdotal information not qualifying as data in any rigorous sense, and a summary of

Daubert was decided, Professor Margaret Berger wrote: “Considerable forensic evidence made its way into the courtroom without empirical validation of the underlying theory and/or its particular application.”²² After *Kumho*, two commentators—citing bite mark, hair, and firearm analysis—observed that “little rigorous, systematic research has been done to validate the discipline’s basic premises and techniques, and in each area there was no evident reason why such research would be infeasible.”²³

Notwithstanding *Daubert*’s promise, scholars soon discerned its uneven application in civil and criminal cases: “[T]he heightened standards of dependability imposed on expertise proffered in civil cases has continued to expand, but . . . expertise proffered by the prosecution in criminal cases has been largely insulated from any change in pre-*Daubert* standards or approach.”²⁴ The title of a 2005 article summed up the state of the law—“*The (Near) Irrelevance of Daubert to Criminal Justice*.”²⁵ In short, in the criminal context, courts applied *Daubert*-lite.

B. *National Academy of Sciences Forensic Report (2009)*

In 2006 Congress entered the picture by authorizing the National Academy of Sciences (“NAS”) to conduct a study of forensic science. After a three-year investigation, NAS issued a landmark report. One of

one study in a 1978 government report. Beyond this, nothing.”); Michael J. Saks & Jonathan J. Koehler, *What DNA “Fingerprinting” Can Teach the Law About the Rest of Forensic Science*, 13 CARDOZO L. REV. 361, 372 (1991) (“[F]orensic scientists, like scientists in all other fields, should subject their claims to methodologically rigorous empirical tests. The results of these tests should be published and debated. Until such steps are taken, the strong claims of forensic scientists must be regarded with far more caution than they traditionally have been.”).

22. Margaret A. Berger, *Procedural Paradigms for Applying the Daubert Test*, 78 MINN. L. REV. 1345, 1354 (1994) (“Courts never required some of the most venerable branches of forensic science—such as fingerprinting, ballistics, and handwriting—to demonstrate their ability to make unique identifications.”).
23. Paul Giannelli & Edward Imwinkelried, *Scientific Evidence: The Fallout from Supreme Court’s Decision in Kumho Tires*, CRIM. JUST., Winter 2000, at 12, 40. For an insightful analysis of how identification science was accepted by the courts, see Saks, *supra* note 12.
24. D. Michael Risinger, *Navigating Expert Reliability: Are Criminal Standards of Certainty Being Left on the Dock?*, 64 ALB. L. REV. 99, 149 (2000). In addition, an extensive study of reported criminal cases found that “the *Daubert* decision did not impact on the admission rates of expert testimony at either the trial or the appellate court levels.” Jennifer L. Groscup et al., *The Effects of Daubert on the Admissibility of Expert Testimony in State and Federal Criminal Cases*, 8 PSYCHOL. PUB. POL’Y & L. 339, 364 (2002).
25. Peter J. Neufeld, *The (Near) Irrelevance of Daubert to Criminal Justice and Some Suggestions for Reform*, 95 AM. J. PUB. HEALTH S107, S107 (2005).

its most riveting passages concluded: “Among existing forensic methods, only nuclear DNA analysis has been rigorously shown to have the capacity to consistently, and with a high degree of certainty, demonstrate a connection between an evidentiary sample and a specific individual or source.”²⁶ The report went on to state that “some forensic science disciplines are supported by little rigorous systematic research to validate the discipline’s basic premises and techniques.”²⁷ Such common forensic techniques as fingerprint examinations,²⁸ firearm (“ballistics”) and toolmark identifications,²⁹ handwriting examinations,³⁰ microscopic hair analysis,³¹ and bite mark comparisons³² fell into this category.

Not only did the NAS report highlight flaws in forensic science, it sharply criticized the judiciary for failing to demand the validation that *Daubert* required: “The bottom line is simple: In a number of forensic science disciplines, forensic science professionals have yet to establish either the validity of their approach or the accuracy of their conclusions, and the courts have been utterly ineffective in addressing this problem.”³³ In a later passage, the report declared that “*Daubert* has done little to improve the use of forensic science evidence in criminal cases.”³⁴ The disparate treatment of civil actions and criminal prosecutions was also noted. After finding that “trial judges rarely exclude or restrict expert testimony offered by prosecutors,” the report commented: “ironically, the appellate courts appear to be more willing to second-guess

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26. COMM. ON IDENTIFYING THE NEEDS OF THE FORENSIC SCI. CMTY., NAT’L RESEARCH COUNCIL, STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD 100 (2009) [hereinafter NAS FORENSIC REPORT].
27. *Id.* at 22. At another point, the Report stated: “The simple reality is that the interpretation of forensic evidence is not always based on scientific studies to determine its validity. This is a serious problem.” *Id.* at 8; see also *id.* at 6 (“Often there are no standard protocols governing forensic practice in a given discipline. And, even when protocols are in place . . . , they often are vague and not enforced in any meaningful way.”).
28. *Id.* at 144 (noting that research is needed “[t]o properly underpin the process of friction ridge [fingerprint] identification”).
29. *Id.* at 154 (“Sufficient studies [on firearms identification] have not been done to understand the reliability and repeatability of the methods.”).
30. *Id.* at 166 (“The scientific basis for handwriting comparisons needs to be strengthened.”).
31. *Id.* at 161 (“[T]estimony linking microscopic hair analysis with particular defendants is highly unreliable.”).
32. *Id.* at 174 (“No thorough study has been conducted of large populations to establish the uniqueness of bite marks . . .”).
33. *Id.* at 53 (emphasis added).
34. *Id.* at 106.

trial court judgments on the admissibility of purported scientific evidence in civil cases than in criminal cases.”³⁵ Despite the NAS report, courts continued to admit the same evidence. Only a handful of courts applied the “exacting” standard that the Supreme Court said *Daubert* demanded.³⁶

This Article examines the justice system’s failure by reviewing the status of two categories of forensic techniques. The first category involves discredited techniques: (1) bite mark analysis, (2) microscopic hair comparisons, (3) arson evidence, and (4) comparative bullet lead analysis. The second category involves techniques that have been misleadingly presented, including firearm and toolmark identifications and fingerprint examinations. Both categories present *Daubert* issues. The Article argues that the system’s failure can be traced back to its inability to demand and properly evaluate foundational research—i.e., *Daubert*’s first factor, empirical testing. Indeed, the justice system may be institutionally incapable of applying *Daubert* in criminal cases.

A different paradigm is needed, one that assigns an independent agency the responsibility of evaluating foundational research. As discussed in Part IV, this approach was recently recommended by the National Commission on Forensic Science³⁷ and the President’s Council of Advisors on Science and Technology (“PCAST”).³⁸ Both recommended that the National Institute of Standards and Technology (“NIST”) evaluate all forensic disciplines on a continuing basis, thereby injecting much needed scientific expertise into the criminal justice system. The recent reports on latent fingerprints³⁹ and arson

35. *Id.* at 11.

36. *See, e.g.*, *Weisgram v. Marley Co.*, 528 U.S. 440, 455 (2000). A former federal district judge, Nancy Gertner, noted, “a busy trial judge can rely on the decades of case law to legitimize decisions rejecting a hearing or motions in limine. And the trial judge can count on the Court of Appeals likely concluding that rejecting the challenge was not an abuse of the judge’s discretion.” Nancy Gertner, *Commentary on The Need for a Research Culture in the Forensic Sciences*, 58 U.C.L.A. L. REV. 789, 790 (2011).

37. In 2013, the Department of Justice (“DOJ”), in partnership with the National Institute of Standards and Technology (“NIST”), established the National Commission on Forensic Science to enhance the practice and improve the reliability of forensic science. The author served on the Commission. NAT’L COMM’N ON FORENSIC SCI., U.S. DOJ, REFLECTING BACK—LOOKING TOWARD THE FUTURE 1, app. A at 1 (2017).

38. PRESIDENT’S COUNCIL OF ADVISORS ON SCI. & TECH., REPORT TO THE PRESIDENT: FORENSIC SCIENCE IN CRIMINAL COURTS: ENSURING SCIENTIFIC VALIDITY OF FEATURE-COMPARISON METHODS (2016) [hereinafter WHITE HOUSE PCAST REPORT].

39. *See* WILLIAM THOMPSON ET AL., AM. ASS’N FOR THE ADVANCEMENT OF SCI., FORENSIC SCIENCE ASSESSMENTS: A QUALITY AND GAP ANALYSIS: LATENT FINGERPRINT ANALYSIS 7–8, 43–44 (2017) [hereinafter AAAS

investigations,⁴⁰ which were published by the American Association for the Advancement of Science (“AAAS”), buttress the need for independent scientific evaluations.

I. DISCREDITED TECHNIQUES

A. Bite Mark Comparisons

For decades, bite-mark evidence has been admitted in hundreds of trials,⁴¹ many of which were capital prosecutions.⁴² No reported American case has rejected bite mark testimony. Moreover, it is not uncommon for courts to speak of bite mark comparisons as a “science”⁴³—even an “exact science.”⁴⁴ Acceptance of the technique is so deeply entrenched that some courts have taken judicial notice of its validity,⁴⁵ which means its reliability is indisputable.⁴⁶

Distinctive characteristics of a person’s dentition were first used to identify skeletonized remains and individuals in mass disasters such a

FINGERPRINT REPORT] (discussing cognitive bias, recommending remedies, and arguing for the need of scientific validation studies).

40. See JOSÉ ALMIRALL ET AL., AM. ASS’N FOR THE ADVANCEMENT OF SCI., FORENSIC SCIENCE ASSESSMENTS: A QUALITY AND GAP ANALYSIS: FIRE INVESTIGATION 8–9 (2017) [hereinafter AAAS FIRE REPORT] (discussing cognitive bias and recommending remedies).
41. See 1 GIANNELLI ET AL., *supra* note 20, § 13.05 (discussing the admissibility of bite mark evidence). In *Doyle v. State*, 263 S.W.2d 779, 779 (Tex. Crim. App. 1954), a bite mark was left in a piece of cheese in a burglary case. Two decades later, in *Patterson v. State*, 509 S.W.2d 857, 861 (Tex. Crim. App. 1974), a prosecution expert matched the defendant’s teeth to a mark found on a murder victim.
42. See, e.g., Tucker Carrington, *Mississippi Innocence: The Convictions and Exonerations of Levon Brooks and Kennedy Brewer and the Failure of the American Promise*, 28 GEO. J. LEGAL ETHICS 123, 134–35, 142–45, 149–50 (2015).
43. See, e.g., *People v. Marsh*, 441 N.W.2d 33, 35 (Mich. Ct. App. 1989) (“[T]he science of bite-mark analysis has been extensively reviewed in other jurisdictions.”).
44. See, e.g., *State v. Sager*, 600 S.W.2d 541, 569 (Mo. Ct. App. 1980).
45. See *State v. Richards*, 804 P.2d 109, 112 (Ariz. 1990) (“[B]ite mark evidence is admissible without a preliminary determination of reliability”); *People v. Middleton*, 429 N.E.2d 100, 101 (N.Y. 1981) (“The reliability of bite mark evidence as a means of identification is sufficiently established in the scientific community to make such evidence admissible in a criminal case, without separately establishing scientific reliability in each case”); *State v. Armstrong*, 369 S.E.2d 870, 877 (W. Va. 1988) (holding that trial court may take judicial notice of general reliability of bite mark evidence).
46. See FED. R. EVID. 201(b) (limiting judicial notice to a “fact that is not subject to reasonable dispute”).

plane crashes.⁴⁷ Courts assumed that these distinctive characteristics can be transferred to another person's skin during a violent crime—e.g., homicides, rapes, and child abuse⁴⁸—an assumption that overlooked some obvious problems. First, bite marks typically involve no more than the edges of six to eight front teeth, not thirty-two teeth with five anatomical surfaces that can be used when comparing a deceased person's dentition with X-rays. Second, bite marks do not reveal artifacts such as fillings, crowns, etc., all of which assist in associating human remains with a person's dental records.⁴⁹ Moreover, human skin is extremely malleable and thus subject to various types of distortion.⁵⁰ In addition, bite mark analysis is a subjective technique with no agreed-upon methodology.

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47. 1 GIANNELLI ET AL., *supra* note 20, § 13.02 (discussing the admissibility of dental identifications).
48. *See* *People v. Milone*, 356 N.E.2d 1350, 1358 (Ill. App. Ct. 1976) (“The concept of identifying a suspect by matching his dentition to a bite mark found at the scene of a crime is a logical extension of the accepted principle that each person’s dentition is unique.”); *People v. Smith*, 443 N.Y.S.2d 551, 556–57 (Cty. Ct. 1981) (“The basic premise is the unique nature of individual dentition and the virtually infinite number of individual bite configurations.”) (citations omitted).
49. “Restorations alone, with varying shapes, sizes, and restorative materials, may offer numerous points for comparison. In addition to restorations, the number of teeth, prostheses, decay, malposition, malrotation, peculiar shapes, root canal therapy, bone patterns, bite relationship, and oral pathology may all provide identifying characteristics.” 1 GIANNELLI ET AL., *supra* note 20, § 13.02.
50. *See* I.A. Pretty & D. Sweet, *The Scientific Basis for Human Bitemark Analyses—A Critical Review*, 41 SCI. & JUST. 85, 87 (2001) (“Skin is a poor registration material since it is highly variable in terms of anatomical location, underlying musculature or fat, curvature, and looseness or adherence to underlying tissues. Skin is highly visco-elastic, which allows stretching to occur during either the biting process or when evidence is collected.”).

One study classified different types of distortion: Primary distortion occurs at the time of biting and results (1) from the dynamics of the biting process (dynamic distortion) and (2) from the features of the tissue bitten (tissue distortion). Secondary distortion occurs at a subsequent time. It can be subdivided into three categories. The first is time-related distortion, e.g., caused by subsequent healing or decomposition. “Posture distortion results when the bite mark is viewed or recorded in a position that differs from the position at the time of biting.” Photographic distortion results from the angle of the camera and the curvature of the body. D.R. Sheasby & D.G. MacDonald, *A Forensic Classification of Distortion in Human Bite Marks*, 122 FORENSIC SCI. INT’L 75, 75–77 (2001).

1. Foundational Research

Despite overwhelming judicial approval, bite mark evidence is not supported by foundational research.⁵¹ Indeed, the only rigorous studies are recent—and undercut the technique's validity.⁵² The 2009 NAS forensic report concluded that “the scientific basis is insufficient to conclude that bite mark comparisons can result in a conclusive match.”⁵³ Despite the NAS Report, courts continued to permit expert testimony on the subject. For example, in *State v. Prade*,⁵⁴ decided in 2014, the expert testified that “bite mark evidence is generally accepted within the scientific community”⁵⁵ Similarly, in *Coronado v. State*,⁵⁶ a different expert stated that he did not “agree with the NAS Report’s conclusion that bite mark analysis cannot result in a conclusive match,” adding, “you do not have to be a ‘rocket scientist’ to see that, in some cases, there is a unique and distinct pattern of teeth that can be identified.”⁵⁷ In addition, these experts rejected the valid research

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51. See Saks, *supra* note 12, at 1120 (“[R]ather than the field convincing the courts of the sufficiency of its knowledge and skills, admission by the courts apparently convinced the forensic odontology community that, despite their doubts, they really were able to perform bite mark identifications.”).
52. Dr. Mary Bush and her colleagues at the Laboratory for Forensic Odontology, State University of New York at Buffalo, have published over a dozen studies that have undermined the assumptions underpinning bite mark evidence. *E.g.*, Mary A. Bush et al., *Statistical Evidence for the Similarity of the Human Dentition*, 56 J. FORENSIC SCIS. 118, 122 (2011) (“Our results show that given our measurement parameters, statements concerning dental uniqueness with respect to bitemark analysis in an open population are unsupportable. . . . Confidence in the notion of dental uniqueness in bitemark analysis has been based on anecdotal knowledge, the use of inappropriate statistics, and precedence of admission in the courtroom.”). Bush and her team also reported the results of a study where twenty-three bites were made in cadaver skin with the *same* dentition using an instrumented-biting machine. The cadavers were moved and re-photographed in different positions. Subsequent measurements showed differences between all bite marks. In addition, postural distortion was significant. See Mary A. Bush et al., *Biomechanical Factors in Human Dermal Bitemarks in a Cadaver Model*, 54 J. FORENSIC SCIS. 167, 169–170, 174 (2009). One survey of fifteen odontologists involved their opinions of six images of supposed bite marks. The “practitioner agreement was at best fair, with wide-ranging opinions on the origin, circumstance, and characteristics of the wound given for all six images.” Mark Page et al., *Expert Interpretation of Bitemark Injuries—A Contemporary Qualitative Study*, 58 J. FORENSIC SCIS. 664, 664 (2013).
53. NAS FORENSIC REPORT, *supra* note 26, at 175.
54. 9 N.E.3d 1072 (Ohio Ct. App. 2014).
55. *Id.* at 1097.
56. 384 S.W.3d 919 (Tex. Crim. App. 2012).
57. *Id.* at 926.

mentioned above,⁵⁸ and both prosecutors and their experts attacked researchers without offering any foundational research.⁵⁹

Unfortunately, the American Board of Forensic Odontology (“ABFO”) has fiercely defended bite mark analysis. To bolster its position, the ABFO conducted a study that was presented at a forensic conference in 2015.⁶⁰ As it turned out, the study undercut the ABFO’s own position. Thirty-nine ABFO-certified bite mark experts—with an average of twenty years’ experience—examined one hundred bite mark photographs.⁶¹ Each was asked three questions:

1. Is there sufficient evidence in the presented materials to render an opinion on whether the patterned injury is a human bite mark?

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58. *See, e.g., Prade*, 9 N.E.3d at 1098 (“As to Dr. Bush’s cadaver studies, Dr. Wright testified that cadaver skin simply cannot compare with living skin. Dr. Wright explained that cadaver skin only distorts after a bite for two to three minutes at most because, unlike live skin, no bruising, contusions, or lacerations occur. Dr. Wright also testified that using a mechanical jaw to bite is problematic because the jaw operates on a fixed hinge that cannot mimic the wider range of movement that an actual jaw is capable of.”). *But see* Iain A. Pretty & David Sweet, *A Paradigm Shift in the Analysis of Bitemarks*, 201 FORENSIC SCI. INT’L 38, 40 (2010) (noting that, while cadaver models have limitations, “there is little alternative for researchers to produce bitemarks of known origin” and the use of anesthetized pigs to create peri-mortem injuries raises a different issue—i.e., differences between pigskin and human skin).
 59. *See* Radley Balko, *In Angry, Defensive Memo, Manhattan DA’s Office Withdraws Bite Mark Evidence*, WASH. POST (Jan. 13, 2016), https://www.washingtonpost.com/news/the-watch/wp/2016/01/13/in-angry-defensive-memo-manhattan-das-office-withdraws-bite-mark-evidence/?utm_term=.48e8ac4cc71e [<https://perma.cc/CMD7-6GM4>]; Radley Balko, *Attack of the Bite Mark Matchers*, WASH. POST (Feb. 18, 2015), https://www.washingtonpost.com/news/the-watch/wp/2015/02/18/attack-of-the-bite-mark-matchers-2/?utm_term=.3455206afa8d [<https://perma.cc/T3R3-T7ZH>]; Radley Balko, *The Path Forward on Bite Mark Matching—and the Rearview Mirror*, WASH. POST (Feb. 20, 2015), https://www.washingtonpost.com/news/the-watch/wp/2015/02/20/the-path-forward-on-bite-mark-matching-and-the-rearview-mirror/?utm_term=.41c6a22faa7d [<https://perma.cc/9GFw-NABV>].
 60. The study is known as Construct Validity Bitemark Assessments Using the ABFO Bitemark Decision Tree (“Freeman/Pretty Study”). *See* AM. ACAD. OF FORENSIC SCIS., ADVANCE PROGRAM 67TH ANNUAL SCIENTIFIC MEETING: CELEBRATING THE FORENSIC SCIENCE FAMILY 175 (2015).
 61. Radley Balko, *A Bite Mark Matching Advocacy Group Just Conducted a Study that Discredits Bite Mark Evidence*, WASH. POST (Apr. 8, 2015), https://www.washingtonpost.com/news/the-watch/wp/2015/04/08/a-bite-mark-matching-advocacy-group-just-conducted-a-study-that-discredits-bite-mark-evidence/?utm_term=.b752ad99e635 [<https://perma.cc/EB2B-CDYD>].

2. Is it a human bite mark, not a human bite mark, or suggestive of a human bite mark?
3. Does the bite mark have distinct, identifiable arches and individual tooth marks?⁶²

The results to the first question were not reassuring. The thirty-nine experts agreed unanimously in only four out of the one hundred cases.⁶³ In only twenty cases was there 90 percent or more agreement.⁶⁴ At the end of question two—whether the mark is a human bite mark—there were only sixteen cases with 90 percent or more agreement.⁶⁵ At the end of the third question, there were only eight cases in which at least 90 percent of the analysts agreed.⁶⁶ Equally disturbing was the ABFO's decision to postpone publishing the results “until the organization can tweak the design of the study and conduct it again, a process that's expected to take at least a year.”⁶⁷ In effect, ABFO wanted a do-over. Meanwhile, an Associated Press analysis reported that at least twenty-four men convicted or charged with murder or rape based on bite marks have been exonerated since 2000.⁶⁸

2. Texas Forensic Science Commission (2016)

Steven Chaney spent twenty-eight years in prison for murder based largely on bite mark evidence. When his conviction was overturned,⁶⁹ the Innocence Project filed a complaint on his behalf with the Texas Forensic Science Commission (“TFSC”).⁷⁰ In 2016, after a six-month

62. *Id.*

63. *Id.*

64. *Id.*

65. *Id.*

66. *Id.*

67. *Id.*

68. Amanda Lee Myers, *Once Key in Some Cases, Bite-Mark Evidence Now Derided as Unreliable*, YAHOO (June 16, 2013), <https://www.yahoo.com/news/ap-impact-bites-derided-unreliable-court-150004412.html> [<https://perma.cc/875Q-9RB6>].

69. Sarah Kaplan, *Texas Inmate's 1989 Conviction Overturned After Bite Mark Evidence Discredited*, WASH. POST (Oct. 13, 2015), https://www.washingtonpost.com/news/morning-mix/wp/2015/10/13/texas-mans-conviction-overturned-after-bite-mark-evidence-discredited/?utm_term=.d3513f42c699 [<https://perma.cc/T6UX-XETE>].

70. *Texas Forensic Science Commission Steps Up to Investigate Bite Mark Analysis*, INNOCENCE PROJECT (Dec. 14, 2015), <https://www.innocenceproject.org/texas-forensic-science-commission-steps-up-to-investigate-bite-mark-analysis/> [<https://perma.cc/BC95-HGB8>]. Texas created the Texas Forensic Science Commission (TFSC) in 2005 after a scandal required Houston to close its crime lab. Michael Hall, *False Impressions*, TEX.

investigation, the TFSC recommended a moratorium on the admission of bite mark testimony. It found that there is no scientific basis for claiming that a particular mark can be associated to a person's dentition: "Any testimony describing human dentition as 'like a fingerprint' or incorporating similar analogies lacks scientific support."⁷¹ Similarly, "there is no scientific basis for assigning probability or statistical weight to an association, regardless of whether such probability or weight is expressed numerically (e.g., 1 in a million) or using some form of verbal scale (e.g., highly likely/unlikely)."⁷²

TFSC was also alarmed that the ABFO study was not published due to "political and organizational pressures."⁷³ In the Commission's view, "such a resistance to publish scientific data contradicts the ethical and professional obligations of the profession as a whole, and is especially disconcerting when one considers the life and liberty interests at stake in criminal cases."⁷⁴

3. White House PCAST Report (2016)

In September 2016, the White House released its report on forensic science.⁷⁵ Regarding bite mark analysis, it concluded that (1) appropriately designed validation studies are lacking, (2) the few available studies had "very high" false-positive rates, (3) "inappropriate closed-set designs . . . are likely to *underestimate* the true false positive rate," and (4) the studies show that experts "cannot even consistently agree

MONTHLY (Jan. 2016), <https://www.texasmonthly.com/articles/false-impressions/> [<https://perma.cc/6JJR-GA9Y>]. Accordingly, TEX. CODE CRIM. PROC. ANN. art. 38.01, § 4(a)(3) (Supp. 2015), provides that the Commission should "investigate, in a timely manner, any allegation of professional negligence or misconduct that would substantially affect the integrity of the results of a forensic analysis conducted by a crime laboratory."

71. TEX. FORENSIC SCI. COMM'N, FORENSIC BITEMARK COMPARISON COMPLAINT FILED BY NATIONAL INNOCENCE PROJECT ON BEHALF OF STEVEN MARK CHANEY—FINAL REPORT 11-12 (2016).

72. *Id.* at 12.

73. *Id.* at 13.

74. *Id.*; see also Brandi Grissom, *Arguments Over Bite Marks Get Testy at Texas Forensic Science Commission Meeting*, DALLAS MORNING NEWS (Nov. 17, 2015), <https://www.dallasnews.com/news/politics/2015/11/17/arguments-over-bite-marks-get-testy-at-forensic-science-commission-meeting> [<https://perma.cc/V536-3RB8>] (reporting on a 2015 TFSC meeting discussing bitemark evidence).

75. See generally WHITE HOUSE PCAST REPORT, *supra* note 38.

on whether an injury *is* a human bitemark.”⁷⁶ Numerous cases support the last observation.⁷⁷

In sum, the courts have yet to reject bite mark evidence—a subjective method that is not supported by foundational research and lacks agreed-upon standards.⁷⁸ “Perhaps no discredited forensic assay has benefitted more from criminal courts’ abdication of gatekeeper responsibilities than bite mark analysis.”⁷⁹ Instead, it was the Innocence Project that spearheaded the challenges in this area, and in 2016 the Texas Forensic Science Commission became the first governmental body to seriously scrutinize the technique. Notwithstanding the NAS, PCAST, and TFSC reports, courts continue to admit bite mark evidence.⁸⁰

76. *Id.* at 9. “PCAST finds that bitemark analysis is far from meeting the scientific standards for foundational validity.” *Id.*

77. *See, e.g.*, *Ege v. Yukins*, 380 F. Supp. 2d 852, 878 (E.D. Mich. 2005) (“[T]he defense attempted to rebut Dr. Warnick’s testimony with the testimony of other experts who opined that the mark on the victim’s cheek was the result of *livor mortis* and was not a bite mark at all.”); *Czapleski v. Woodward*, No. C-90-0847 MHP, 1991 WL 639360, at *1–2 (N.D. Cal. Aug. 30, 1991) (noting that, while a dentist’s initial report concluded that “bite” marks found on child were consistent with dental impressions of mother, several experts later established that the marks on child’s body were postmortem abrasion marks and not bite marks); *Kinney v. State*, 868 S.W.2d 463, 464–65 (Ark. 1994) (noting disagreement between expert witnesses about whether injuries were from human bite marks); *People v. Noguera*, 842 P.2d 1160, 1165 n.1 (Cal. 1992) (“At trial, extensive testimony by forensic odontologists [sic] was presented by both sides, pro and con, as to whether the wounds were human bite marks and, if so, when they were inflicted.”); *State v. Duncan*, 802 So. 2d 533, 553 (La. 2001) (“Both defense experts testified that these marks on the victim’s body were not bite marks.”); *Stubbs v. State*, 845 So. 2d 656, 668 (Miss. 2003) (“Dr. Galvez denied the impressions found on Williams were the results of bite marks.”).

78. *See* Michael J. Saks et al., *Forensic Bitemark Identification: Weak Foundations, Exaggerated Claims*, 3 J.L. & BIOSCIENCES 1, 29 (2016) (“[R]ecent reviews of the field’s claims, as well as recent empirical findings, have underscored the lack of reliability and validity of the most fundamental claims about the ability of forensic dentists to identify the source of bite marks on human skin.”).

79. M. Chris Fabricant & Tucker Carrington, *The Shifted Paradigm: Forensic Science’s Overdue Evolution from Magic to Law*, 4 VA. J. CRIM. L. 1, 38 (2016).

80. In *Commonwealth v. Ross*, No. CP-07-CR 2038-2004, slip op. at 5 (Ct. Com. Pl. Blair Cty., Pa., filed Mar. 8, 2017), the court admitted bite mark evidence, albeit limited, noting that “[t]he Commonwealth notes that no state or federal court has suppressed expert testimony in a criminal case based upon the NAS Report, and that no courts have prohibited bite mark evidence based upon the PCAST and TFSC reports.” *See also* Radley Balko, *Incredibly, Prosecutors Are Still Defending Bite Mark Evidence*, WASH. POST (Jan 30, 2017), <https://www.washingtonpost.com/news/the-watch/wp/2017/01/30/incredibly-prosecutors-are-still-defending-bite-mark-evidence/> [https://perma.cc/V6TF-HTU9].

At the April 10, 2017 meeting of the National Commission on Forensic Science, Keith Harward described how bite mark evidence resulted in his thirty-three years of imprisonment before he was exonerated by DNA evidence.⁸¹ Incredibly, the next day the chairman of the National District Attorneys Association stated that his organization believes that bite mark evidence is a “reliable science.”⁸²

B. *Microscopic Hair Analysis*

In this examination, samples are first analyzed to identify features visible to the naked eye such as color and form, i.e., whether it is straight, wavy, or curved. Next, the sample is viewed microscopically to determine characteristics such as shaft form, hair diameter, and pigment size.⁸³

Experts have long acknowledged that a positive identification is not possible with microscopic hair analysis. Instead, examiners testify that a crime scene exemplar was “consistent with” a hair sample from the defendant. The probative value of this conclusion would, of course, vary if only a hundred people had microscopically indistinguishable hair as opposed to several million. Due to a lack of research, no one knows whether the crime scene hair could have come from 10 other persons or 100, 10,000, and so forth.⁸⁴ This important qualifying information was

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81. See NAT'L COMM'N ON FORENSIC SCI., U.S. DOJ, MEETING #13, at 61–63 (2017) [hereinafter MEETING #13]; Frank Green, *DNA Proves Man Innocent of 1982 Rape and Murder in Famous 'Bite-Mark' Case*, *Lawyers Say*, RICHMOND TIMES-DISPATCH (Mar. 12, 2016), http://www.richmond.com/news/dna-proves-man-innocent-of-rape-and-murder-in-famous/article_05ab68ce-064c-58bb-b57a-211e2bb51ecd.html [https://perma.cc/WUW4-3R57] (discussing the Keith Harward case); Spencer S. Hsu, *Va. Exoneration Underscores Mounting Challenges to Bite-Mark Evidence*, WASH. POST (Apr. 8, 2016), https://www.washingtonpost.com/local/public-safety/va-exoneration-underscores-to-mounting-challenges-to-bite-mark-evidence/2016/04/08/55bbfe98-fd9a-11e5-886f-a037dba38301_story.html?utm_term=.262f4d5c302d [https://perma.cc/263G-QK5E] (same).
82. MEETING #13, *supra* note 81, at 111; e.g., Pema Levy, *Sessions' New Forensic Science Adviser Has a History of Opposing Pro-Science Reforms*, MOTHER JONES (Aug. 10, 2017), <http://www.motherjones.com/crime-justice/2017/08/sessions-new-forensic-science-adviser-has-a-history-of-opposing-pro-science-reforms/> [https://perma.cc/R3AR-DJSQ].
83. See generally 2 GIANNELLI ET AL., *supra* note 20, § 24.02[l] (discussing the techniques used to identify the human source of a hair sample, including conventional microscopy).
84. As one hair examiner wrote, “[i]f a pubic hair from the scene of a crime is found to be similar to those from a known source, [the courts] do not know whether the chances that it could have originated from another source are one in two or one in a billion.” B.D. Gaudette, *Probabilities and Human Pubic Hair Comparisons*, 21 J. FORENSIC SCI. 514, 514 (1976).

often omitted from the experts' testimony, thus making marginal evidence appear misleadingly convincing.⁸⁵

Experts frequently went way beyond the "consistent with" language in their testimony, however, often suggesting a rare association. For example, in the Edward Honaker case, the expert testified that the crime scene hair sample "was unlikely to match anyone" other than the defendant.⁸⁶ Honaker spent ten years in prison before DNA proved him innocent.⁸⁷ In another case, an expert testified that matching hair samples were "consistent microscopically" but then elaborated: "In other words, hairs are not an absolute identification, but they either came from this individual or there is—could be another individual *somewhere in the world* that would have the same characteristics to their hair."⁸⁸ This is an implicit—and extreme—probability statement that lacks any empirical support.

Although microscopic hair analysis had long been judicially accepted,⁸⁹ its validity was suspect.⁹⁰ In 1995, a federal district court in

85. Professor Berger explained the problem:

We allow eyewitnesses to testify that the person fleeing the scene wore a yellow jacket and permit proof that a defendant owned a yellow jacket without establishing the background rate of yellow jackets in the community. Jurors understand, however, that others than the accused own yellow jackets. When experts testify about samples matching in every respect, the jurors may be oblivious to the probability concerns if no background rate is offered, or may be unduly prejudiced or confused if the probability of a match is confused with the probability of guilt, or if a background rate is offered that does not have an adequate scientific foundation.

Berger, *supra* note 22, at 1357.

86. EDWARD CONNORS ET AL., CONVICTED BY JURIES, EXONERATED BY SCIENCE: CASE STUDIES IN THE USE OF DNA EVIDENCE TO ESTABLISH INNOCENCE AFTER TRIAL 58 (1996).

87. *Id.* at 59.

88. Williamson v. Reynolds, 904 F. Supp. 1529, 1554 (E.D. Okla. 1995) (emphasis added), *rev'd sub nom.* Williamson v. Ward, 110 F.3d 1508, 1523 (10th Cir. 1997) (holding that due process—not *Daubert*—controls in federal habeas review).

89. See Edward J. Imwinkelried, *Forensic Hair Analysis: The Case Against the Underemployment of Scientific Evidence*, 39 WASH. & LEE L. REV. 41, 62 (1982) (stating that "[t]he massive body of case law, liberally admitting even hair evidence of low probative value, dwarfs the handful of cases excluding hair evidence").

90. See Clive A. Stafford Smith & Patrick D. Goodman, *Forensic Hair Comparison Analysis: Nineteenth Century Science or Twentieth Century Snake Oil?*, 27 COLUM. HUM. RTS. L. REV. 227, 231 (1996) ("If the purveyors of this dubious science cannot do a better job of validating hair analysis than they have done so far, forensic hair comparison analysis should be excluded altogether from criminal trials.").

*Williamson v. Reynolds*⁹¹ observed: “Although the hair expert may have followed procedures accepted in the community of hair experts, the human hair comparison results in this case were, nonetheless, scientifically unreliable.”⁹² The court also noted that the “expert did not explain which of the ‘approximately’ 25 characteristics were consistent, any standards for determining whether the samples were consistent, how many persons could be expected to share this same combination of characteristics, or how he arrived at his conclusions.”⁹³ Williamson, who was five days from execution when the district court issued a stay, was subsequently exonerated by DNA testing.⁹⁴

The *Williamson* opinion—perhaps the only thorough judicial analysis of microscopic hair comparisons—was all but ignored by other courts. In 1999 in *Johnson v. Commonwealth*,⁹⁵ the Kentucky Supreme Court upheld the admissibility of hair evidence, taking “judicial notice” of its reliability⁹⁶ and thus implicitly finding its validity indisputable.⁹⁷ Other courts echoed *Johnson*, not *Williamson*.⁹⁸ Indeed, ten years after *Williamson* was decided, a 2005 decision by the Connecticut Supreme Court observed—correctly—that “[t]he overwhelming majority of courts have deemed such evidence admissible.”⁹⁹

Once again, the courts abdicated their responsibility. Indeed, hair evidence only began to be carefully scrutinized after a startling number of DNA exonerations were reported.¹⁰⁰ A 2008 study of 200 DNA

91. 904 F. Supp. 1529 (E.D. Okla. 1995), *rev'd sub nom.* *Williamson v. Ward*, 110 F.3d 1508, 1523 (10th Cir. 1997).

92. *Id.* at 1558.

93. *Id.* at 1554.

94. See JIM DWYER ET AL., ACTUAL INNOCENCE: FIVE DAYS TO EXECUTION AND OTHER DISPATCHES FROM THE WRONGLY CONVICTED 146 (2000) (noting that the hair evidence was shown to be “patently unreliable”). See also JOHN GRISHAM, THE INNOCENT MAN: MURDER AND INJUSTICE IN A SMALL TOWN 166–87 (2006) (examining Williamson’s trial, including the role played by hair analysis).

95. 12 S.W.3d 258 (Ky. 1999).

96. *Id.* at 263.

97. See FED. R. EVID. 201(b) (limiting judicial notice to a “fact that is not subject to reasonable dispute”).

98. See 2 GIANNELLI ET AL., *supra* note 20, § 24.03, at 825 (noting the “limited impact of *Daubert*”).

99. *State v. West*, 877 A.2d 787, 808 (Conn. 2005).

100. In 1998, a Canadian judicial inquiry into the wrongful conviction of Guy Paul Morin was released. Morin’s original conviction was based, in part, on hair evidence. The judge conducting the inquiry recommended that “[t]rial judges should undertake a more critical analysis of the admissibility of hair comparison evidence as circumstantial evidence of guilt.” FRED KAUFMAN, MINISTRY OF THE ATTORNEY GENERAL, REPORT OF THE KAUFMAN COMMISSION ON PROCEEDINGS INVOLVING GUY PAUL MORIN 312 (1998);

exonerations found that forensic evidence was the second leading type of evidence, at 57 percent—after eyewitness identifications at 79 percent—used in wrongful conviction cases.¹⁰¹ A subsequent investigation of trial transcripts underscored the role of hair analysis in the exoneration cases: “Of the 65 cases involving microscopic hair comparison in which transcripts were located, 25 cases, or 38%, had invalid forensic science testimony.”¹⁰² The 2009 NAS Report observed that “testimony linking microscopic hair analysis with particular defendants is highly unreliable.”¹⁰³

1. FBI Hair Review

In April 2013, the Mississippi Supreme Court, in a five-to-four decision, rejected Willie Jerome Manning’s request for a stay of execution to permit DNA testing—“potentially setting up what experts said would be a rare case in recent years in which a person is put to death with such requests unmet.”¹⁰⁴ A week later, the court unexpectedly stayed Manning’s execution after the Department of Justice (“DOJ”) notified state officials that FBI experts had presented misleading testimony at his trial, including hair and firearms evidence.¹⁰⁵

Soon after, the DOJ announced that Manning was but one of 120 cases—including twenty-seven death penalty prosecutions—in which improper microscopic hair analysis had been introduced in evidence.¹⁰⁶

see also EDWARD CONNORS ET AL., *supra* note 86, at 3334–76 (discussing cases in which hair samples played a role in convicting defendants who were later exonerated by DNA evidence).

101. *See* Brandon L. Garrett, *Judging Innocence*, 108 COLUM. L. REV. 55, 81 (2008).
102. Brandon L. Garrett & Peter J. Neufeld, *Invalid Forensic Science Testimony and Wrongful Convictions*, 95 VA. L. REV. 1, 14–15 (2009).
103. NAS FORENSIC REPORT, *supra* note 26, at 161.
104. Campbell Robertson, *Mississippi Inmate's Bid for DNA Tests Is Denied with Tuesday Execution Set*, N.Y. TIMES (May 3, 2013), <http://www.nytimes.com/2013/05/04/us/dna-tests-rejected-for-inmate-facing-tuesday-execution.html> [<https://perma.cc/58JT-VN35>]; *see also* Andrew Cohen, *A Ghost of Mississippi: The Willie Manning Capital Case*, ATLANTIC (May 2, 2013), <https://www.theatlantic.com/national/archive/2013/05/a-ghost-of-mississippi-the-willie-manning-capital-case/275442/> [<https://perma.cc/Q724-2K7U>].
105. *See* Campbell Robertson, *With Hours to Go, Execution Is Postponed*, N.Y. TIMES (May 7, 2013), <http://www.nytimes.com/2013/05/08/us/willie-j-manning-granted-stay-of-execution.html> [<https://perma.cc/J84G-LPX2>] (noting that the DOJ “disavow[ed] the degree of certainty expressed by F.B.I. forensic experts at the man’s trial”).
106. *See* Jack Nicas, *Flawed Evidence Under a Microscope: Disputed Forensic Techniques Draw Fresh Scrutiny; FBI Says It Is Reviewing Thousands of Convictions*, WALL ST. J. (July 18, 2013), <https://www.wsj.com/articles/>

For example, examiners claimed to connect a hair sample to a single person “to the exclusion of all others” or stated or suggested a probability for such a match from past casework.¹⁰⁷ The FBI review came after three District of Columbia men, who had been convicted of rape or murder in the early 1980s, were exonerated through DNA testing.¹⁰⁸ In one of these cases, the prosecutor claimed that, based on an FBI expert’s testimony, the chances that the sample came from someone else were “one in 10 million.”¹⁰⁹

After further investigation, DOJ reported in 2015 that “FBI examiners had provided scientifically invalid testimony in more than 95 percent of cases where that testimony was used to inculcate a defendant at trial.”¹¹⁰ *Commonwealth v. Perrot*¹¹¹ was one of the first cases to reach the courtroom as a consequence of the DOJ review. A superior court granted Perrot a new trial in 2016, criticizing the misleading use of hair evidence. The court noted: “In discussing the ‘microscopic characteristics’ of hair, [the expert] stated that these characteristics ‘make that hair somewhat unique.’ He likened the ‘subtle’ characteristics of

SB10001424127887324263404578614161262653152 [https://perma.cc/37WN-MRCZ].

107. Spencer S. Hsu, *U.S. Reviewing 27 Death Penalty Convictions for FBI Forensic Testimony Errors*, WASH. POST (July 17, 2013), https://www.washingtonpost.com/local/crime/us-reviewing-27-death-penalty-convictions-for-fbi-forensic-testimony-errors/2013/07/17/6c75a0a4-bd9b-11e2-89c9-3be8095fe767_story.html?utm_term=.d9ec6013dda8 [https://perma.cc/53Y4-C9MS] (“[O]n the witness stand, several agents for years went beyond the science and testified that their hair analysis was a near-certain match.”).
108. *See* Editorial, *FBI Lab Failures Should Lead to Reform*, WASH. POST (Apr. 20, 2012), https://www.washingtonpost.com/opinions/fbi-lab-failures-should-lead-to-reform/2012/04/20/gIQAe6lYWT_story.html?utm_term=.13c701fdc3c6 [https://perma.cc/637M-HY97] (“Kirk L. Odom was incarcerated for 20 years and Donald E. Gates for nearly 30 for crimes they did not commit. Santae A. Tribble spent 28 years behind bars, even though DNA evidence now shows he almost undoubtedly was not the culprit.”).
109. Martin Enserink, *Evidence on Trial*, 351 SCI. 1129, 1129 (Mar. 11, 2016), <http://science.sciencemag.org/content/sci/351/6278/1128.full.pdf> [https://perma.cc/6LXB-BR7B]. The prosecutor misstated the expert’s testimony.
110. WHITE HOUSE PCAST REPORT, *supra* note 38, at 3; *see also* Editorial, *Junk Science at the F.B.I.*, N.Y. TIMES (Apr. 27, 2015), <https://www.nytimes.com/2015/04/27/opinion/junk-science-at-the-fbi.html> [https://perma.cc/L5A3-THN2] (noting “a sweeping post-conviction review of 2,500 cases in which its hair-sample lab reported a match”); Hugh B. Kaplan, *DOJ Examiners Gave Bad Testimony in 90 Percent of Hair Comparison Cases*, 97 CRIM. L. RPT. 77, 77 (2015) (“[T]he review has revealed that FBI examiners made erroneous statements in 90 percent of the cases that have been re-examined so far.”).
111. Nos. 85–5415, 5416, 5418, 5420, 5425, 2016 WL 380123 (Mass. Super. Ct. Jan. 26, 2016).

hair that 'make it somewhat unique' to the subtle differences in a human face."¹¹²

2. White House PCAST Report (2016)

In June 2016, the DOJ released proposed guidelines concerning hair testimony. Documentation purporting to support the validity and reliability of hair evidence accompanied the guidelines.¹¹³ Listing several studies, the FBI concluded:

Based on these and other published studies, microscopic hair comparison has been demonstrated to be a valid and reliable scientific methodology. These studies have also shown that microscopic hair comparisons alone cannot lead to personal identification and it is crucial that this limitation be conveyed both in the written report and in testimony.¹¹⁴

The White House PCAST Report, however, challenged the supporting documentation, which discussed only a handful of studies from the 1970s and 1980s but did not comment on subsequent studies that found "substantial flaws in the methodology and results of the key papers."¹¹⁵ Moreover, "PCAST's own review of the cited papers [found] that these studies do not establish the foundational validity and reliability of hair analysis."¹¹⁶

112. *Id.* at *32. The court also noted:

[The expert] asserted that the hairs "matched" and showed a "strong association." In discussing the chance that the hair found on the victim's bed came from someone other than Perrot, [the expert] conceded the possibility, adding that during his ten years of experience "it's extremely rare that I will have known hair samples from two different people that I can't tell apart." [The expert] made these statements of confidence, despite being unable to recall at trial the length or diameter of the one hair found on the bed.

Id.

113. Press Release, Office of Pub. Affairs, DOJ, Justice Department Issues Draft Guidance Regarding Expert Testimony and Lab Reports in Forensic Science (June 3, 2016), <https://www.justice.gov/opa/pr/justice-department-issues-draft-guidance-regarding-expert-testimony-and-lab-reports-forensic> [<https://perma.cc/T3BK-5P9Q>]. These documents are known as the Uniform Language for Testimony and Reports. *Id.*

114. DOJ, SUPPORTING DOCUMENTATION FOR DEPARTMENT OF JUSTICE PROPOSED UNIFORM LANGUAGE FOR TESTIMONY AND REPORTS FOR THE FORENSIC HAIR EXAMINATION DISCIPLINE 4 (2016) [hereinafter DOJ SUPPORTING DOCUMENTATION], <https://www.justice.gov/archives/dag/file/877736/download> [<https://perma.cc/79FV-GCSK>].

115. WHITE HOUSE PCAST REPORT, *supra* note 38, at 13.

116. *Id.* DOJ cited Max M. Houck & Bruce Budowle, *Correlation of Microscopic and Mitochondrial DNA Hair Comparisons*, 47 J. FORENSIC SCIS. 964 (2002). DOJ SUPPORTING DOCUMENTATION, *supra* note 114, at 8. This FBI

The bottom line, again, is the judiciary's dereliction in failing to curb the misuse of hair microscopy testimony. The Innocence Project's track record of DNA exonerations brought this issue to the fore. Indeed, the three exonerations in the District of Columbia triggered the FBI review. Yet, DOJ's proposed guidelines were based on "foundational research" that PCAST questioned.

C. Arson Investigations

For decades, arson investigators came from the "old school" of investigators—those who used intuition and a number of rules of thumb to determine whether a fire was incendiary. Critics complained that instead of being rooted in science, the approach was based on folklore that had been passed down from generation to generation—without any empirical testing.¹¹⁷ A government report noted, as early as 1977, that common arson indicators had "received little or no scientific testing" and that "[t]here appears to be no published material in the scientific literature to substantiate their validity."¹¹⁸ Proponents of a science-based approach to arson investigations waged an uphill battle through the 1980s, finally winning a major victory when the National Fire Protection Association ("NFPA") published its *Guide for Fire and Explosion Investigations* ("NFPA 921") in 1992.¹¹⁹

1. Willingham Case

Although NFPA 921 would later become the bible for arson investigations,¹²⁰ Cameron Todd Willingham was convicted for the

study used mitochondrial DNA analysis to re-examine samples from previous FBI microscopic hair examination cases. Houck & Budowle, *supra*, at 964. The PCAST Report did not accept that this study supported validity and reliability because the study showed that in nine of eighty cases—11 percent—the microscopic examination found the hair indistinguishable but DNA analysis showed that the hairs came from different individuals. WHITE HOUSE PCAST REPORT, *supra* note 38, at 28.

117. See JOHN J. LENTINI, SCIENTIFIC PROTOCOLS FOR FIRE INVESTIGATION 471–505 (2d ed. 2013) (discussing myths of arson investigations); Paul C. Giannelli, *Junk Science and the Execution of an Innocent Man*, 7 N.Y.U. J.L. & LIBERTY 221, 225 (2013).

118. JOHN F. BOUDREAU ET AL., NAT'L INST. OF LAW ENF'T & CRIMINAL JUSTICE, DOJ, ARSON AND ARSON INVESTIGATION: SURVEY AND ASSESSMENT 88 (1977).

119. NAT'L FIRE PROT. ASS'N, NFPA 921: GUIDE FOR FIRE AND EXPLOSION INVESTIGATIONS, 2017 EDITION 1 (2016) [hereinafter NFPA 921]. The NFPA promotes fire prevention and safety. *Id.*; see also Giannelli, *supra* note 117.

120. See *United States v. Hebshie*, 754 F. Supp. 2d 89, 109 n.39 (D. Mass. 2010) ("NFPA 921 . . . is widely accepted as the standard guide in the field of fire investigation."); Thomas R. May, *Fire Pattern Analysis, Junk Science, Old Wives Tales, and Ipse Dixit: Emerging Forensic 3D Imaging Technologies to the Rescue?*, 16 RICH. J.L. & TECH. 1, 5 (2010) (noting that NFPA 921

arson-murders of his young children weeks before the guide was published. Willingham, who was executed twelve years later, is the poster boy for junk science in arson investigations.¹²¹

At trial, Deputy Fire Marshall Vasquez testified that “[t]he fire tells a story. I am just the interpreter And the fire does not lie. It tells me the truth.”¹²² He also testified that he had found numerous so-called “indicators” for arson during his post-fire investigation of Willingham’s house.¹²³ One such indicator was a low burning fire.¹²⁴ He told the jury that “[a]ll fire goes up,”¹²⁵ and thus, burn patterns on the floor and lower walls suggested that an accelerant was used.¹²⁶ This reasonable

has “become the *de facto* national standard for fire scene examination and analysis”).

121. See *Frontline: Death by Fire* (PBS television broadcast Oct. 19, 2010) (detailing the case of Cameron Todd Willingham); David Grann, *Trial by Fire: Did Texas Execute an Innocent Man?*, NEW YORKER (Sept. 7, 2009), <https://www.newyorker.com/magazine/2009/09/07/trial-by-fire> [<https://perma.cc/Z5PU-P7BS>] (noting that after Willingham’s execution, the Innocence Project commissioned a panel of fire experts that, after reviewing the evidence supporting the conviction, “concluded that ‘each and every one’ of the indicators of arson had been ‘scientifically proven to be invalid’”); Hall, *supra* note 70 (“The 893-page report [on the Willingham case], released in April 2011, was anticlimactic for people looking for proof that Texas had executed an innocent man.”); Steve Mills & Maurice Possley, *Texas Man Executed on Disproved Forensics: Fire that Killed His 3 Children Could Have Been Accidental*, CHI. TRIB. (Dec. 9, 2004), http://articles.chicagotribune.com/2004-12-09/news/0412090169_1_cameron-todd-willingham-arson-fire-scene [<https://perma.cc/2CLW-25SK>] (“[The fire investigators] used rules of thumb that have since been shown to be false. There was no evidence to support a conclusion that the fire was intentionally set. Just an unsupported opinion.”).
122. Statement of Facts at vol. XI, 244, *State v. Willingham*, No. 24,467-CR (Dist. Ct. Navarro Cty., Tex. 1992) [hereinafter *Willingham Transcript*], *aff’d*, 897 S.W.2d 351 (Tex. Crim. App. 1995) (en banc).
123. See *id.* at 224–68 (recording the direct examination of Manuel Vasquez). A second expert’s testimony essentially tracked Vasquez’s. See *id.* at 156–85 (recording the testimony of Douglas Fogg).
124. *Id.* at 248. Vasquez testified that there was “char burning, like, for example, this is the bottom here. It’s burned down here at the bottom. That is an indicator in my investigation of an origin of fire because it’s the lowest part of the fire.” *Id.* at 239; see also *Willingham*, 897 S.W.2d at 354 (“An expert witness for the State testified that the floors, front threshold, and front concrete porch were burned, which only occurs when an accelerant has been used to purposely burn these areas. This witness further testified that this igniting of the floors and thresholds is typically employed to impede firemen in their rescue attempts.”).
125. *Willingham Transcript*, *supra* note 122, at vol. XI, 232.
126. *Id.* at 256 (“So when I found that the floor is hotter than the ceiling, that’s backwards, upside down. It shouldn’t be like that. The only reason that the

notion, however, has its limitations—especially when a fire occurs in a contained area, such as a house with its windows shut:

Due to buoyancy, a thermal plume initially rises once a fire is ignited. As the fire continues, the plume reaches the ceiling, which causes it to spread outward towards the walls. When it reaches the walls, the combustion products press down from the ceiling creating an upper level, which continues to increase in depth and temperature. Eventually thermal radiation replaces convection as the principal method of heat transfer.¹²⁷

At this point, every combustible surface in the room will spontaneously burst into flames. This transition phenomenon, known as the onset of “flashover,” can occur within minutes.¹²⁸ After flashover, the entire room is burning, including the lower walls and floor. Flashover has been described as the point at which the fire transitions from a “fire in a room” to a “room on fire.”¹²⁹ At trial, prosecution witnesses acknowledged that there was an explosion, which could be explained by flashover.¹³⁰ Consequently, a low burning fire is not necessarily indicative of the use of an accelerant.¹³¹

Moreover, many of Vasquez’s other “indicators”—including what he called “pour patterns” and “puddle configurations,”¹³² which appear as splotchy areas on the floor—can appear after flashover in an accidental fire.¹³³ Additional indicators, such as alligatoring—large shiny

floor is hotter is because there was an accelerant.”); *see also* Giannelli, *supra* note 117, at 226.

127. Giannelli, *supra* note 117, at 227.

128. *Id.*

129. LENTINI, *supra* note 117, at 77.

130. *See* Willingham Transcript, *supra* note 122, at vol. XI, 75 (testimony of Mary Diane Barbe) (“The windows, the electricity started crackling and popping, and the top of the—well, I was facing the side of the house, and it just blew out. The flames just blew out . . . All the windows and the front room was engulfed.”); *id.* at 96 (testimony of Brandy Barbe) (“We was running towards the house, me and my mother, we was fixing to go and try to get in, and that’s when it was an explosion . . .”). Vasquez mentioned flashover in his testimony, but he did not appear to understand its implications. *See id.* at vol XII, 47–48.

131. Paul C. Giannelli & Kimberly Gawel, *Arson Evidence*, 47 CRIM. L. BULL. 1241, 1250–51 (2011) (identifying “flashover” as an alternative reason for “low burning” fires).

132. Willingham Transcript, *supra* note 122, at vol. XI, 244–45 (“You can see that on the burnt patterns on this puddle configuration on Exhibit No. 36. This is a strong indicator of a liquid. . . . [The sunlight] just lights up the puddle configurations, the burnt trailers, the pour patterns on that floor.”).

133. Giannelli & Gawel, *supra* note 131, at 1242–44.

charred blisters on burned wood—can also be explained by flashover.¹³⁴ The flashover phenomenon also accounts for another fact that Vasquez thought incriminatory. Willingham told investigators that he had attempted to save his daughters, but he was forced to run from his home without shoes because the heat was too great. According to Vasquez, the burn debris on the floor made it impossible that Willingham would not have had burns on his feet.¹³⁵ However, Willingham's feet would not have been burnt if he left his home before flashover.¹³⁶

Charring under an aluminum threshold of an interior door provided another clue according to Vasquez.¹³⁷ But again, this “indicator” may occur in a flashover. Other perceived “indicators”—melted bed springs,¹³⁸ multiple points of origins,¹³⁹ and brown stains on a concrete floor¹⁴⁰—were also consistent with an accidental fire.¹⁴¹ Finally, Vasquez relied on the presence of “crazed glass”—spider-web patterns on the

134. *Id.* at 1246.

135. “There was fire on the floor . . . He had no injuries on his feet.” Willingham Transcript, *supra* note 122, at 267.

136. Giannelli, *supra* note 127, at 228.

137. Willingham Transcript, *supra* note 122, at 251.

138. “[T]he springs were burned from underneath. This indicates there was a fire under this bed because of the burn underneath the bed.” *Id.* at 241.

139. *Id.* at 255 (“Multiple areas of origin indicate—especially if there is no connecting path, that they were intentionally set by human hands.”). There are two problems here. First, there could have been one origin, according to independent experts. DOUGLAS J. CARPENTER ET AL., REPORT ON THE PEER REVIEW OF THE EXPERT TESTIMONY IN THE CASES OF STATE OF TEXAS V. CAMERON TODD WILLINGHAM AND STATE OF TEXAS V. ERNEST RAY WILLIS 12 (2006). Second, even if the fire scene had shown multiple points of origin, this would not necessarily indicate an intentional fire. LENTINI, *supra* note 117, at 513–14.

140. Willingham Transcript, *supra* note 122, at vol. XI, 248–49. Fire experts reviewing the evidence from Willingham's trial pointed out that “[t]he behavior of concrete in fires, including the development of various colors, has been extensively studied.” CARPENTER ET AL., *supra* note 139, at 18. These experts concluded that there is simply “no scientific basis for Mr. Vasquez's statement about the brown discoloration being an indication of the presence of accelerants.” *Id.*

141. Vasquez's testimony also demonstrated other misconceptions. A common one is that arson fires burn hotter and faster than “normal” fires: “You know, [an accelerant] makes the fire hotter. It's not a normal fire.” Willingham Transcript, *supra* note 122, at vol. XI, 249. However, the temperature of burning wood and burning gasoline are nearly identical, so to claim that a fire using liquid accelerants burns “hotter” than a wood fire is wrong. LENTINI, *supra* note 117, at 501–02.

windows—as an indication of arson.¹⁴² Arson investigators long believed that crazed glass resulted from a fire that burned fast and hot and that the presence of crazed glass indicated that the fire was fueled by a liquid accelerant. Yet, subsequent research demonstrated that crazing occurs from rapid cooling—rather than rapid heating—when water from fire hoses is sprayed on heated windows.¹⁴³

In retrospect, one of the numerous debris samples submitted for laboratory analysis contributed the most damning piece of evidence.¹⁴⁴ The debris sample—collected from an area near the front door—was the *only* sample that tested positive for a chemical commonly used in charcoal lighter fluids.¹⁴⁵ This finding can be explained by the fact that a charcoal grill and lighter fluid were on the front porch at the time of the fire.¹⁴⁶ In fact, that the other samples yielded negative results supported Willingham's case.¹⁴⁷

Numerous nationally recognized experts reviewed the arson testimony presented at Willingham's trial and found it seriously flawed. The first examination of the record by an independent expert was part of Willingham's petition for habeas corpus and was also submitted to the governor and the Board of Pardons and Parole days before Willingham's execution. It concluded: "On first reading, a contemporary fire origin and cause analyst might well wonder how anyone

142. "The pieces of broken window glass on the ledge of the north windows to the northeast bedroom disclosed a crazed 'spider webbing' condition. This condition is an indication that the fire burned fast and hot." CARPENTER ET AL., *supra* note 139, at 18 (citing Vasquez's written report on the Willingham fire at 4).

143. LENTINI, *supra* note 117, at 478 ("It is unclear why anyone ever thought that crazing of glass indicated rapid heating.").

144. In closing argument, the defense counsel referred to a "dozen samples." Willingham Transcript *supra* note 122, at vol. XIII, 20.

145. *Id.* at vol. XI, 220–21 (documenting testimony by expert stating there was "no distinguishing characteristic" in the charcoal lighter fluid from plastic container on porch "that was not present" in the front-door threshold sample tested); *id.* at vol. XIII, 20–21 ("They sent [the samples] to the lab and what did they find? Nothing, not a trace of anything at all except on the very front of the front porch where the charcoal lighter fluid was."); *id.* at vol. XIII, 45 ("The [accelerant] is gone, except [on] the threshold; it burned away . . .").

146. *Id.* at vol. XII, 14–15 (noting that, although photographs show a grill, Vasquez apparently did not know of the grill's presence); *id.* at vol. XII, 16 (acknowledging that a fire-damaged charcoal lighter fluid container was found on the front porch).

147. The prosecutor would later say that he "never did understand why they weren't able to recover' positive tests in these parts." Grann, *supra* note 121. At trial, he argued that, except in the threshold, the "liquid . . . burned away in that destructive madness created by Cameron Todd Willingham." Willingham Transcript, *supra* note 122, at vol. XIII, 45.

could make so many critical errors in interpreting the evidence.”¹⁴⁸ Nevertheless, a stay was denied, and Willingham was put to death. Subsequent evaluators agreed that the trial evidence was junk science. For example, five independent experts prepared a forty-three-page report, finding that “each and every one of the indicators relied upon have since been scientifically proven to be invalid.”¹⁴⁹

In May 2006, the Innocence Project petitioned the Texas Forensic Science Commission to review the arson testimony in Willingham’s and Ernest Ray Willis’ cases.¹⁵⁰ The TFSC is not authorized to determine guilt or innocence. Instead, the Innocence Project argued that the State Fire Marshall Office should have reinvestigated arson cases in which its experts testified after NFPA 921 was published in 1992—a full twelve years before Willingham’s execution.¹⁵¹ TFSC retained its own independent consultant, Dr. Craig Beyler, another nationally-recognized expert, to review the arson evidence. His fifty-one-page report dissected the expert testimony, concluding:

The investigations of the Willis and Willingham fires did not comport with either the modern standard of care expressed by NFPA 921, *or the standard of care expressed by fire investigation texts and papers in the period 1980-1992*. The investigators had poor understandings of fire science and failed to acknowledge or apply the contemporaneous understanding of the limitations of fire indicators. Their methodologies did not comport with the scientific method or the process of elimination. A finding of arson could not be sustained based upon the standard of care expressed by NFPA 921, or the standard of care expressed by fire investigation texts and papers in the period 1980–1992.¹⁵²

148. Report of Dr. Gerald Hurst at 1, *Ex parte* Willingham, No. 24,4670(B), (Dist. Ct. Navarro Cty., Tex., Feb. 13, 2004).

149. CARPENTER ET AL., *supra* note 139, at 3.

150. The expert evidence in both cases was comparable, but Willis was lucky. His death penalty conviction was overturned on procedural grounds, and the prosecutor subsequently refused to reindict him after Dr. Hurst wrote the same type of critical report in Willis’s case that he had written in Willingham’s. Willis, who had spent seventeen years on death row, was subsequently exonerated on actual innocence grounds. See Mary Alice Robbins, *New-York Based Innocence Project Attacks Texas Arson Convictions*, TEX. LAW., May 8, 2006, Factiva, Doc. No. TEXASL0020060508e25800001.

151. See Letter from Innocence Project to Tex. Forensic Sci. Comm’n (Aug. 20, 2010) (on file with Case Western Reserve Law Review).

152. Craig L. Beyler, Analysis of the Fire Investigation Methods and Procedures Used in the Criminal Arson Cases Against Ernest Ray Willis and Cameron Todd Willingham 51 (Aug. 17, 2009) (unpublished report) (on file with Case Western Reserve Law Review).

Once Beyler's report became public, a political firestorm erupted, and the governor, who was in the midst of a reelection battle, abruptly replaced commission members two days before a meeting was scheduled to consider the Beyler report.¹⁵³ The newly appointed chair, a prosecutor, promptly cancelled the meeting,¹⁵⁴ raising the specter of a cover-up.¹⁵⁵ Next, the Attorney General issued an opinion finding that the TFSC was prohibited "from considering or evaluating specific items of evidence that were tested or offered into evidence prior to [its creation in 2005]."¹⁵⁶

The TFSC eventually produced a report—one that did not directly deal with the Willingham and Willis cases. Nevertheless, the Report's recommendations and statements indicated that the Willingham arson

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153. See Christy Hoppe, *Perry Defends Removal of 3 Before Arson Hearing*, DALL. MORNING NEWS (Oct. 2, 2009), <https://ejl.org/sites/default/files/dp-dallasmorning-perry-defends-removal-of-3-before-arson-hearing-10-02-09.pdf> [<https://perma.cc/DRP9-ZZE6>] (detailing the removal of the three members of the Texas Forensic Science Commission); Mary Alice Robbins, *Fired Up; Changes Sought for Texas Forensic Science Commission at Center of Heated Controversy*, TEX. LAW., Nov. 9, 2009, Factiva, Doc. No. TEXASL0020091109e5b900002 ("[Former Commissioner] Levy says he believes 'things went south' for the commission after [former Chair] Bassett released Beyler's report to the public in August 'as he was required by law to do.'"). The meeting was scheduled for October 2, 2009. *Agenda*, TEX. FORENSIC SCI. COMM'N (Oct. 2, 2009), http://www.fsc.texas.gov/sites/default/files/D_100209MeetingAgenda_000.pdf [<https://perma.cc/U8SZ-HQMY>].
154. Hoppe, *supra* note 153 (noting that the new chair was "known as one of the toughest law-and-order prosecutors in the state").
155. See Jennifer Emily, *Texas Forensic Science Commission Refuses to End Inquiry into Willingham Arson Case*, DALL. MORNING NEWS (Sept. 18, 2010), <https://www.dallasnews.com/news/crime/2010/09/18/Texas-Forensic-Science-Commission-refuses-to-5315> [<https://perma.cc/3RP5-GSH6>] ("Perry's replacements were seen by some as a political maneuver intended to change the outcome of the commission's decision."); Christy Hoppe, *Perry Ousts Officials Before Arson Hearing: He's Assailed as New Chair Delays Session on Flawed Case that Led to Execution*, DALL. MORNING NEWS, Oct. 1, 2009, at 1A; Dave Mann, *Fire and Innocence*, TEX. OBSERVER (Dec. 3, 2009), <https://www.texasobserver.org/fire-and-innocence/> [<https://perma.cc/SB7T-AGYB>] ("Then in late September, Perry booted three members off of the Texas Forensic Science Commission, which was investigating the Willingham and Willis cases, just three days before a crucial hearing on scientists' findings. Perry's new appointees promptly canceled the hearing and have yet to reschedule it. Even conservative commentators cried cover-up, suggesting that Perry, in a tough battle for re-election, was trying to subvert an investigation that might prove he oversaw the execution of an innocent man.").
156. Letter from Greg Abbott, Attorney Gen. of Tex., to the Honorable Nizam Peerwani, Presiding Officer, Tex. Forensic Sci. Comm'n (July 29, 2011), <https://texasattorneygeneral.gov/opinions/opinions/50abbott/op/2011/pdf/ga0866.pdf> [<https://perma.cc/9SMK-P5MY>].

investigation was seriously flawed. Its first recommendation was “that fire investigators adhere to the standards of NFPA 921.”¹⁵⁷ In addition, the report reviewed a number of arson indicators that were used in the Willingham and Willis cases. Citing Vasquez’s testimony, the report undermined his opinions concerning (1) V-patterns as an indicator of origin, (2) pour patterns, (3) low/deep burning, (4) multiple separate points of origin, (5) spalling, (6) burn intensity, and (7) crazed glass.¹⁵⁸ It also observed that “testimony, such as Vasquez’s response to a question regarding Willingham’s state of mind, is an example of the type of testimony that experts should avoid as falling outside of their field of expertise.”¹⁵⁹ The report even encouraged lawyers to “aggressively pursue admissibility hearings in arson cases.”¹⁶⁰

Despite the opinions of all the independent experts, the State Fire Marshal vigorously defended its investigation. In a breathtaking letter, the office asserted that “[i]n reviewing documents and standards in place then *and now*, we stand by the original investigator’s report and conclusions.”¹⁶¹ This left the TFSC incredulous.¹⁶²

2. Han Tak Lee Case

Unfortunately, Willingham’s case was not an outlier. In the 1989 trial of Han Tak Lee,¹⁶³ the expert also relied on the old “myths” to declare the fire incendiary: (1) greater intensity and heat, (2) burn patterns, (3) alligatoring, (4) melted metal in bed frames, and (5) crazed

157. REPORT OF THE TEXAS FORENSIC SCIENCE COMMISSION: WILLINGHAM/WILLIS INVESTIGATION 39 (2011) [hereinafter TFSC REPORT].

158. *Id.* at 22–28.

159. *Id.* at 36.

160. *Id.* at 48.

161. Letter from Paul Maldonado, State Fire Marshal, to Leigh Tomlin, Comm’n Coordinator, Tex. Forensic Sci. Comm’n (Aug. 20, 2010) (on file with Case Western Reserve Law Review) (emphasis added).

162. TFSC REPORT, *supra* note 157, at 16 (“This appears to be an untenable position in light of advances in fire science. The fires in these cases occurred two decades ago; there are few circumstances in which an investigation could not be improved with the benefit of twenty years of controlled scientific experiment and practical experience.”).

163. Lee petitioned for a writ of habeas corpus in 2010, based in part on “inaccurate and unreliable evidence.” *Lee v. Tennis*, No. 4:CV-08-1972, 2010 WL 3812160, at *2 (M.D. Pa. Sept. 22, 2010). Although the district court denied Lee’s petition, the Third Circuit reversed and remanded the case to the district court. *Lee v. Glunt*, 667 F.3d 397, 407–08 (3d Cir. 2012) (“If Lee’s expert’s independent analysis of the fire scene evidence—applying principles from new developments in fire science—shows that the fire expert testimony at Lee’s trial was fundamentally unreliable, then Lee will be entitled to federal habeas relief on his due process claim.”).

glass.¹⁶⁴ In addition, the investigation was “hobbled by an incomplete and inaccurate understanding” of flashover.¹⁶⁵ After serving twenty-five years, Lee was released from prison in 2014.¹⁶⁶

3. National Fire Protection Association Guidelines

After the publication of NFPA 921 in 1992, the kind of testimony presented in the Willingham and Lee cases should have vanished from the courtroom. But arson investigators balked. According to one expert, “[t]he initial response to NFPA 921 in the fire investigation community was overwhelmingly negative.”¹⁶⁷ *Babick v. Berghuis*¹⁶⁸ is illustrative. In that case, Andrew Babick was convicted of arson-murder for a 1995 house fire and was sentenced to two terms of life imprisonment without the possibility of parole.¹⁶⁹ He later sought habeas relief, claiming ineffective assistance of counsel and prosecutorial misconduct. In 2010, the Sixth Circuit rejected these claims.¹⁷⁰

In dissent, however, Judge Merritt chastised the defense attorney for not contesting the arson evidence in “this strange junk science case.”¹⁷¹ One prosecution expert testified that: (1) char marks on the porch were evidence of an accelerant, (2) a “line of demarcation” in a burn pattern on a carpet was “suspicious” because “it should not have burned the carpeting on these jagged edges,” and (3) the burns were “not normal” and were “unnatural.”¹⁷² Another prosecution expert

164. *Lee v. Tennis*, Civil No. 4:08-CV-1972, 2014 WL 3894306, at *2 (M.D. Pa. June 13, 2014), *adopted*, 2014 WL 3900230 (M.D. Pa. Aug. 8, 2014), *aff'd sub nom. Lee v. Superintendent Houtzdale SCI*, 798 F.3d 159 (3d Cir. 2015).

165. *Id.*

166. Mark Hansen, *Badly Burned: Long-Held Beliefs About Arson Science Have Been Debunked After Decades of Misuse and Scores of Wrongful Convictions*, A.B.A. J., Dec. 2015, at 37, 37, 43.

167. *Id.* at 40.

168. 620 F.3d 571 (6th Cir. 2010). *See generally* Marc Price Wolf, *Habeas Relief from Bad Science: Does Federal Habeas Corpus Provide Relief for Prisoners Possibly Convicted on Misunderstood Fire Science?*, 10 MINN. J.L. SCI. & TECH. 213 (2009) (detailing the shift of the principles in the field of fire investigation and how past convictions may use habeas relief).

169. *Id.* at 574.

170. *Id.* at 580.

171. 620 F.3d at 580, 582–83 (Merritt, J., dissenting).

172. *Id.* at 581 (quoting transcript).

stated that “low burning” and other “unnatural” patterns indicated the presence of an accelerant.¹⁷³ Both experts “testified—in direct contrast to the NFPA guide—that they were so confident in their reading of burn patterns that the absence of any laboratory confirmation of accelerant had no effect on their testimony.”¹⁷⁴

4. Dog-Sniff Evidence

More alarming, in Judge Merritt’s view, was dog-sniff evidence.¹⁷⁵ The NFPA guide provides: “Research has shown that canines have been alerted to pyrolysis products that are not produced by an ignitable liquid” and a positive canine alert without laboratory confirmation “should not be considered validated.”¹⁷⁶ The lab tests had not detected accelerants in the house debris. Yet, a dog handler testified that “his dog, Samantha, was ‘1000 times’ more effective at detecting fire starters or liquid accelerants than a laboratory test on burnt material.”¹⁷⁷ In short, the “jury was misled into trusting Samantha over the arson forensic lab.”¹⁷⁸

A more recent arson-dog case involved James Hebshie, who was convicted of arson and mail fraud in 2006. A federal district court granted his habeas petition based on ineffective assistance of counsel grounds.¹⁷⁹ In the court’s view, if a *Daubert* hearing had been requested on the canine evidence, there was a “‘reasonable probability’ that the Court would have excluded the canine testimony or severely limited it.”¹⁸⁰ Without a challenge from the defense, the dog handler testified

173. *Id.*

174. *Id.*

175. *Id.* at 580.

176. NFPA 921, *supra* note 119, § 17.5.4.7 (describing the role of canine investigations as “assisting with the location and collection of samples” for laboratory testing).

177. *Babick*, 620 F.3d at 580.

178. *Id.* at 581. *See also* United States v. Myers, No. 3:10-00039, 2010 WL 2723196, at *3-4 (S.D.W. Va. July 8, 2010) (granting motion in limine to prohibit expert testimony of a canine handler because the alert had not been confirmed by lab testing, conflicted with the Fire Guide, and did not meet the *Daubert* standards).

179. United States v. Hebshie, 754 F. Supp. 2d 89, 128 (D. Mass. 2010).

180. *Id.* at 124 (quoting *Strickland v. Washington*, 466 U.S. 668, 694 (1984)).

that his dog, Billy, “was 97% accurate.”¹⁸¹ Indeed, the handler testified to “an almost mystical account of Billy’s powers and her unique olfactory capabilities.”¹⁸² The court explained:

[The handler] went on and on about what he understood about Billy, as if his relationship with Billy somehow enhanced the reliability and probative value of the results—that she was unique, that he could “read her face,” that he was with her 365 days a year, that he knew her personality, “the way her eyes shifted,” the ways her ear shifted, etc.¹⁸³

Moreover, the handler focused on one area as the origin of the fire and testified that the dog had not alerted anywhere else on the premises. However, the handler had limited the dog’s access to that one area.¹⁸⁴ In addition, a dog’s failure to alert has no evidential value: “[T]he scientific literature cast doubt on the significance of the dog’s *failure* to alert (false negatives) and even raised concerns about canine ‘proficiency’ testing, concerns counsel never raised.”¹⁸⁵ Indeed, the term “accelerant-detection” dog was misleading because the dog is trained to alert to many common materials that are not accelerants; the site of the fire was a convenience store which sold lighter fluid and lighters.¹⁸⁶

5. Post-*Daubert* Cases

The courts’ response to bogus arson evidence is mixed.¹⁸⁷ It is not hard to find cases citing discredited arson indicators after *Daubert*, such

181. *Id.* at 102; see also Michael E. Kurz et al., *Effect of Background Interference on Accelerant Detection by Canines*, 41 J. FORENSIC SCIS. 868, 872 (1996) (noting the varying levels of reliability in accelerant detection depending on the substance in question and the canine handler); *Farm Bureau Mut. Ins. Co. of Ark. v. Foote*, 14 S.W.3d 512, 518, 520 (Ark. 2000) (affirming the trial court’s exclusion of a canine handler who sought to testify about “the alleged superior ability of his canine partner, Benjamin, to detect the presence of accelerants after a fire . . . [that he could] discriminate between different types of chemicals,” and that he had an “accuracy rate of 100 percent”).

182. *Hebshie*, 754 F. Supp. 2d at 93–94.

183. *Id.* at 120.

184. *Id.* at 94.

185. *Id.*

186. *Id.* at 93, 96–97.

187. 2 GIANNELLI ET AL., *supra* note 20, § 26.07[b], at 1102–03 (“Many appellate courts continue to routinely accept investigators’ testimony about experientially-based generalizations . . .”).

as pour patterns or puddle configurations,¹⁸⁸ melted bedsprings,¹⁸⁹ concrete spalling,¹⁹⁰ fire load,¹⁹¹ and “fast and hot” burn.¹⁹² Decided in 1998, *Michigan Millers Mutual Insurance Corp. v. Benfield*¹⁹³ is considered the “first serious challenge to the ‘old school’ of fire investigators.”¹⁹⁴ In that case, the Eleventh Circuit ruled that arson testimony “is subject

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188. *See, e.g.*, *State v. Allen*, No. 22835, 2009 WL 2096295, ¶ 114 (Ohio Ct. App. July 17, 2009) (noting that investigator testified to “an irregular burn pattern on the floor which through all my experience and training it appears to be an irregular pour patterns [sic], an ignitable liquid pour pattern”); *State v. Wolf*, 891 N.E.2d 358, 360 (Ohio Ct. App. 2008) (noting that a firefighter testified “he observed ‘pour patterns’ located on the floor throughout the mobile home; that pour patterns are burnt marks that look like puddles that result from ignitable liquids . . . being poured out of containers . . .”); *Colburn v. State*, 990 So. 2d 206, 209–10 (Miss. Ct. App. 2008) (“This pour pattern, [the fire investigator] explained, was indicative of flammable liquid being poured in the area On cross-examination [the fire investigator] did admit that the State Crime Laboratory was unable to identify ignitable liquids in the three debris samples taken from the pour pattern area.”); *State v. Henderson*, 125 P.3d 1132, 1137 (Mont. 2005) (finding that the trial court “did not err in allowing [a firefighter] to identify in the photographs and diagrams the pour patterns he had observed at the scene”).
189. *Simon v. State*, 633 So. 2d 407, 409 (Miss. 1993), *vacated*, 513 U.S. 956 (1994) (mem.).
190. *See, e.g.*, *State v. Amodio*, 915 A.2d 569, 576 (N.J. Super. Ct. App. Div. 2007) (“They washed the floor and observed areas of spalling in the concrete underneath the door. This was an indication that a flammable liquid had been employed in that area.”); *McCord v. Gulf Guar. Life Ins. Co.*, 698 So. 2d 89, 95 (Miss. 1997) (“The arson investigator . . . testified that he found five different areas of spalling and concluded arson to be the cause of the fire.”).
191. *See, e.g.*, *Wise v. State*, 719 N.E.2d 1192, 1200 (Ind. 1999) (noting that a fire investigator testified that a fire was intentionally set based on several factors, including that “the fire burned too fast for its fuel load”); *Carter v. State*, 516 S.E.2d 556, 560 (Ga. Ct. App. 1999) (“[The arson investigator] deduced there must have been an accelerant or some kind of extra fuel load.”).
192. *See, e.g.*, *People v. Klait*, No. 289522, 2010 WL 2076956, at *5 (Mich. Ct. App. May 25, 2010) (“[B]oth [investigators] testified that they believed, based on the fast and hot nature of the fire, that it was set intentionally.”); *State v. Walters*, 813 P.2d 857, 858 (Idaho 1990) (noting that a fire investigator testified that “it was a hot, fast fire as opposed to a small or as opposed to a slow, smoldering fire, yes, the evidence suggests to me that it was deliberately set”); *State v. Cutlip*, No. 99-L-149, 2001 WL 687493, at *2 (Ohio Ct. App. 2001) (noting that a fire department lieutenant testified to a list of factors including that “the fire was fast and hot” and “that such observations are typical of a fire started by someone pouring an accelerant and lighting it”).
193. 140 F.3d 915 (11th Cir. 1998).
194. John J. Lentini, *The Evolution of Fire Investigations and Its Impact on Arson Cases*, 27 CRIM. JUST. 12, 14 (2012).

to *Daubert's* inquiry regarding the reliability of such testimony.”¹⁹⁵ Some federal courts after *Benfield* cited NFPA 921.¹⁹⁶ Yet, a 2011 article on the subject began with the passage: “Fire researchers have shattered dozens of arson myths in recent years. So why do American courts still lag behind?”¹⁹⁷ And a 2013 survey of 586 public sector fire investigators found that some myths endure: “Nearly 40 percent did not know that crazed glass is caused by rapid cooling, not rapid heating. Twenty-three percent think puddle-shaped burns indicate the use of an accelerant. Eight percent still believe that alligator blistering implies that a fire burned fast and hot.”¹⁹⁸

The TFSC Report did more than the courts to curb flawed arson testimony. And it took the execution of an innocent man to trigger that report.¹⁹⁹ In addition, the resistance to change is all-too-familiar: Rules based on science “were slow to take hold, as veteran investigators clung to what now are considered disproven theories. In some police and fire departments, investigators were openly hostile to the updated science.”²⁰⁰

D. Comparative Bullet Lead Analysis

For more than three decades, FBI experts testified about Comparative Bullet Lead Analysis (“CBLA”), a technique first used in the investigation into President Kennedy’s assassination.²⁰¹ CBLA compares trace chemicals found in bullets at crime scenes with ammu-

195. *Benfield*, 140 F.3d at 920.

196. See e.g., *Fireman’s Fund Ins. Co. v. Canon U.S.A., Inc.*, 394 F.3d 1054, 1058 (8th Cir. 2005) (finding the district court did not abuse its discretion where the court concluded that evidentiary support of arson theory advanced by experts was inadequate because they did not examine their theory “against empirical data obtained from fire scene analysis and appropriate testing,” in violation of NFPA 921); *Ind. Ins. Co. v. Gen. Elec. Co.*, 326 F. Supp. 2d 844, 850–51 (N.D. Ohio 2004) (holding that cause-and-origin expert’s failure to properly collect evidence violated NFPA 921).

197. Douglas Starr, *Up in Smoke*, DISCOVER, Nov. 2011, at 36, 37.

198. Hansen, *supra* note 166, at 42–43.

199. For a fuller discussion of the Cameron Todd Willingham case, see Giannelli, *supra* note 117.

200. See Steve Mills, *Convicted Murderer Hopes Latest Fire Science Proves Innocence*, CHI. TRIB. (May 18, 2015), <http://www.chicagotribune.com/news/ct-arson-science-adam-gray-met-20150518-story.html> [<https://perma.cc/B4XF-FMTN>].

201. See generally Erik Randich & Patrick M. Grant, *Proper Assessment of the JFK Assassination Bullet Lead Evidence from Metallurgical and Statistical Perspectives*, 51 J. FORENSIC SCI. 717 (2006) (discussing the original analysis of the bullet fragments); Paul C. Giannelli, *Daubert and Forensic Science: The Pitfalls of Law Enforcement Control of Scientific Research*, 2011 U. ILL. L. REV. 53, 81 (2011).

dition found in a suspect's possession. This technique was used when firearms or "ballistics" identification could not be employed. FBI experts used various analytical techniques, first neutron activation analysis ("NAA"), and then inductively coupled plasma-atomic emission spectrometry ("ICP-AES"), to determine the concentration levels of seven elements—arsenic, antimony, tin, copper, bismuth, silver, and cadmium—in the bullet lead alloy of the suspect's bullets and those recovered from the crime scene. Statistical tests were then used to compare the elements in each bullet and determine whether the fragments and suspect's bullets were "analytically indistinguishable" for each of the elemental concentration averages. Exactly what the phrase "analytically indistinguishable" meant was the main issue—i.e., did such a finding mean that the bullet fragments came from a small or large universe? Obviously, the probative value of the test results would differ if only a hundred bullets had the same chemical composition as opposed to several million.

The published cases revealed disparate and often inconsistent interpretive conclusions provided by FBI experts. In some, experts testified that two exhibits were "analytically indistinguishable."²⁰² In other cases, examiners concluded that samples *could have* come from the same "source" or "batch."²⁰³ In still others, they stated that the samples *came* from the same source.²⁰⁴ The testimony in numerous cases went much further and referred to a "box" of ammunition—typically fifty loaded cartridges, sometimes twenty. For example, two specimens:

- (1) Could have come from the same box;²⁰⁵
- (2) Could have come from the same box or a box manufactured on the same day;²⁰⁶
- (3) Were consistent with their having come from the same box of ammunition;²⁰⁷
- (4) Probably came from the same box;²⁰⁸ or

202. *See* *Wilkerson v. State*, 776 A.2d 685, 689 (Md. Ct. Spec. App. 2001).

203. *See* *State v. Krummacher*, 523 P.2d 1009, 1012-13 (Or. 1974) (en banc).

204. *See* *United States v. Davis*, 103 F.3d 660, 673-74 (8th Cir. 1996); *People v. Lane*, 628 N.E.2d 682, 689-90 (Ill. App. Ct. 1993).

205. *See* *State v. Strain*, 885 P.2d 810, 817 (Utah Ct. App. 1994); *Jones v. State*, 425 N.E.2d 128, 131 (Ind. 1981).

206. *See* *State v. Grube*, 883 P.2d 1069, 1078 (Idaho 1994); *People v. Johnson*, 499 N.E.2d 1355, 1366 (Ill. 1986).

207. *See* *State v. Reynolds*, 297 S.E.2d 532, 534 (N.C. 1982).

208. *See* *Bryan v. State*, 935 P.2d 338, 360 (Okla. Crim. App. 1997).

(5) Must have come from the same box or from another box that would have been made by the same company on the same day.²⁰⁹

Several other statements that differ appear in the published opinions. An early case reported that the specimens “had come from the same batch of ammunition: they had been made by the same manufacturer on the same day and at the *same hour*.”²¹⁰ One case reports the expert’s conclusion with a statistic.²¹¹ In another case, the expert used the expressions “such a finding is rare”²¹² and “a very rare finding.”²¹³ In still another case, the expert “opined that the same company produced the bullets at the same time, using the same lead source. Based upon DOJ records, she opined that an overseas company called PMC produced the bullets around 1982.”²¹⁴

1. NAS Bullet Lead Report (2004)

The technique was not seriously challenged until a retired FBI examiner, William Tobin, began questioning the procedure in scientific

209. *See Davis*, 103 F.3d at 666 (“An expert testified that such a finding is rare and that the bullets must have come from the same box or from another box that would have been made by the same company on the same day.”); *Commonwealth v. Daye*, 587 N.E.2d 194, 207 (Mass. 1992); *State v. King*, 546 S.E.2d 575, 584 (N.C. 2001) (“[The expert] opined that, based on her lead analysis, the bullets she examined either came from the same box of cartridges or came from different boxes of the same caliber, manufactured at the same time.”).

210. *Brown v. State*, 601 P.2d 221, 224 (Alaska 1979) (emphasis added).

211. *Earhart v. State*, 823 S.W.2d 607, 614 (Tex. Crim. App. 1991) (en banc); *see also Giannelli*, *supra* note 201, at 83 n.200.

212. *Davis*, 103 F.3d at 666.

213. *Id.* at 667.

214. *People v. Villarta*, No. H021354, 2002 WL 66887, at *6 (Cal. Ct. App. Jan. 17, 2002). In later years, the testimony became more limited. A 2002 FBI publication states the conclusion as follows: “Therefore, they *likely* originated from the same manufacturer’s source (melt) of lead.” Charles A. Peters, *The Basis for Compositional Bullet Lead Comparisons*, FORENSIC SCI. COMM’NS (July 2002) (emphasis added), <https://archives.fbi.gov/archives/about-us/lab/forensic-science-communications/fsc/july2002/peters.htm> [<https://perma.cc/889Y-4TGL>]. Testimony to the same effect has also been proffered. Transcript of Record at 6, *Commonwealth v. Wilcox*, No. 00CR2727 (Ky. Cir. Ct. Jefferson County Feb. 28, 2002) (trial testimony of Charles Peters, FBI examiner) (“Well, bullets that are analytically indistinguishable likely come from the same molten lead sources of lead, uh, as opposed to bullets that have different composition come from different, uh, melts of lead.”).

and legal journals²¹⁵ as well as in court testimony.²¹⁶ As a result, the FBI asked the National Academy of Sciences (“NAS”) to review the technique. The 2004 NAS Report undercut the FBI testimony, stating: “The available data do not support any statement that a crime bullet came from a particular box of ammunition. In particular, references to ‘boxes’ of ammunition in any form should be avoided as misleading under Federal Rule of Evidence 403.”²¹⁷ Perhaps the most disturbing case is *State v. Earhart*,²¹⁸ a capital murder case in which the CBLA evidence apparently played a significant role.²¹⁹ The transcript contains the following expert testimony: “We can—from my 21 years experience of doing bullet lead analysis and doing research on boxes of ammunition down through the years I can determine if bullets came from the same box of ammunition”²²⁰ However, the NAS Report found that the

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215. See Edward J. Imwinkelried & William A. Tobin, *Comparative Bullet Lead Analysis (CBLA) Evidence: Valid Inference or Ipse Dixit?*, 28 OKLA. CITY U. L. REV. 43 (2003); Erik Randich, Wayne Duerfeldt, Wade McLendon & William Tobin, *A Metallurgical Review of the Interpretation of Bullet Lead Compositional Analysis*, 127 FORENSIC SCI. INT’L 174 (2002); William A. Tobin & Wayne Duerfeldt, *How Probative Is Comparative Bullet Lead Analysis?*, CRIM. JUST., Fall 2002, at 26; Paul C. Giannelli, *Comparative Bullet Lead Analysis: A Retrospective*, 47 CRIM. L. BULL. 306 (2010).
216. *E.g.*, *Ragland v. Commonwealth*, 191 S.W.3d 569, 577 (Ky. 2006); *Clemons v. State*, 896 A.2d 1059, 1068–70 (Md. 2006); *State v. Behn*, 868 A.2d 329, 339–42 (N.J. Super. Ct. App. Div. 2005) (quoting Tobin’s affidavit submitted with motion for reconsideration).
217. COMM. ON SCI. ASSESSMENT OF BULLET LEAD ELEMENTAL COMPOSITION COMPARISON, NAT’L RESEARCH COUNCIL OF THE NAT’L ACADS., FORENSIC ANALYSIS: WEIGHING BULLET LEAD EVIDENCE 7 (2004) [hereinafter NAS REPORT]. The author served on the NAS Committee.
218. 823 S.W.2d 607, 614 (Tex. Crim. App. 1991) (en banc) (“[The expert] concluded that the likelihood that two .22 caliber bullets came from the same batch, based on *all* the .22 bullets made in one year, is approximately .000025 percent, ‘give or take a zero.’ He subsequently acknowledged, however, that the numbers which he used to reach the .000025 percent statistic failed to take into account that there are different types of .22 caliber bullets made each year—.22, .22 long, and .22 long rifle. [The expert] ultimately testified that there could be several hundred thousand bullets per batch, but with some variation in the elemental composition within the batch.”).
219. See *Earhart v. Johnson*, 132 F.3d 1062, 1067 (5th Cir. 1998) (“Given the significant role the bullet evidence played in the prosecution’s case, we shall therefore assume Earhart could have made a sufficient threshold showing that he was entitled to a defense expert under Texas law.”).
220. Transcript of Record at 5248–49, *State v. Earhart*, No. 4064, Dist. Ct. Lee County, 21st Judicial Dist., Texas (testimony of John Riley); see also *id.* at 5258 (“Well, bullets that are—that have analytically indistinguishable compositions or compositions that are generally similar typically are found within the same box of ammunition and that is the case that we have here. Now, bullets that are the same composition can also be found in other boxes of ammunition, but it’s most likely those boxes would have been

amount of bullets that can be produced from a melt “can range from the equivalent of as few as 12,000 to as many as 35 million 40-grain, .22 caliber longrifle bullets”²²¹ Earhart was executed before the report was published.²²²

2. Post-Report Developments

Much of the FBI testimony rested on a database, which the Bureau had built up over the span of several years. Although the NAS committee frequently asked for this data during its year-long investigation, the FBI did not turn it over until it was too late to analyze for its report.²²³ The two statisticians who served on the NAS committee later wrote that their subsequent inspection of the data “identified several peculiarities.”²²⁴ First, the database was incomplete. The FBI claimed to have a “complete data file” of some 71,000+ measurements, but it only turned over 64,869. Moreover, only ICP-AES’s measurements were included; a different analytical method—NAA—had been used before 1997. Both techniques measured the same elements, and thus the results from either technique would have been appropriate for comparison. Additionally, the numbering system for the bullets was “highly inconsistent and rather unexpected,” suggesting that some bullet measurements were deleted.²²⁵ Additionally, “a rough investigation of the

manufactured at the same place on or about the same date.”). *But see* testimony of Charles Peters, FBI examiner, *Commonwealth v. Wilcox*, Kentucky, Feb. 28, 2002 (testifying during a *Daubert* hearing: “We have never testified, to my knowledge, that that bullet came from that box. We’d never say that. All we are testifying is that bullet, or that victim fragment or something, the bullet, either came from that box or the *many* boxes that were produced at the same time.” Transcript at 1-2 (emphasis added)).

221. NAS REPORT, *supra* note 217, at 6.

222. *See James Earhart*, DEATH PENALTY INFO. CTR., <https://deathpenaltyinfo.org/james-earhart> [<https://perma.cc/2KUJ-QK7X>] (last visited Oct. 15, 2017).

223. *See* Clifford H. Spiegelman & Karen Kafadar, *Data Integrity and the Scientific Method: The Case of Bullet Lead Data as Forensic Evidence*, 19 CHANCE, no. 2, 2006, at 17, 22 (“During the open sessions of the committee meetings, the FBI claimed to have a ‘complete data file’ of some 71,000+ measurements. Following repeated requests from the Committee, the FBI submitted at its last meeting a CD-ROM that contained two data files with a combined total of 64,869 bullet (not 71,000+) measurement records. This data set could not be analyzed in time for the release of the report”); Giannelli, *supra* note 215.

224. Spiegelman & Kafadar, *supra* note 223, at 17, 22.

225. *Id.* (“[T]he numbering system of the bullets was highly inconsistent and rather unexpected (e.g., the bullets from a suspect in a particular case might be numbered Q13A, Q13B, Q13C, Q14A, Q14B, Q14C, . . . leading one to wonder what happened to bullets Q01, Q02, . . . Q12).” (omissions in original)). Other illustrations of incomplete data were noted: “[W]hile most of the bullets indicated three measurements, about 30 bullets had six or more

measurement error indicated many measurement errors that exceeded the FBI's claimed analytical precision of 2–5%.”²²⁶ Finally, “only 15% of the 1,079 cases listed in these two files had measurements from [National Institute of Standards and Technology] . . . making it impossible to determine the frequency of matches . . . in a case.”²²⁷ Accordingly, the “missing data and the inconsistent precisions” undermined the Bureau's public claims.²²⁸ These authors were puzzled by the FBI's failure to disclose data: “The scientific method is important for science generally; forensic science is no exception. . . . [T]he evidence in this paper suggests that, at least for [CBLA], forensic science failed in the requirement to share the material, methods, and data to reach conclusions with the scientific community.”²²⁹

The FBI's response to the NAS Report was also troubling. The Bureau quickly put out a press release, obscuring the report's findings.²³⁰ The release highlighted the committee's conclusion that the FBI was using appropriate instrumentation and suitable elements for comparison. Yet, these aspects of CBLA were never seriously questioned. Rather, the interpretation of the data was disputed. Only one sentence in the press release addressed this critical issue: “Recommendations by the [NAS] included suggestions to improve the statistical analysis, quality control procedures, as well as expert testimony.”²³¹ The news media read the report quite differently—e.g., “*Study Shoots Holes in Bullet Analyses by FBI*,”²³² “*Report Finds Flaws in FBI Bullet Analysis*,”²³³

measurements. . . . [O]nly about 50% of the bullets in this data set were identified as having come from one of the four major bullet manufacturers in the United States [i.e., Cascade Cartridge, Inc.; Federal; Remington; Winchester]; the ‘complete data file’ of 71,000 bullets may yield a higher proportion of bullets from these four manufacturers.” *Id.*

226. *Id.*

227. *Id.*

228. *Id.*

229. *Id.* at 24; see also Giannelli, *supra* note 215.

230. FBI Nat'l Press Office, *National Academy of Sciences Releases FBI-Commissioned Study on Bullet Lead Analysis*, FBI (Feb. 10, 2004), <https://archives.fbi.gov/archives/news/pressrel/press-releases/national-academy-of-sciences-releases-fbi-commissioned-study-on-bullet-lead-analysis> [<https://perma.cc/8SXR-2PSV>].

231. *Id.*

232. Maurice Possley, *Study Shoots Holes in Bullet Analyses by FBI*, CHI. TRIB. (Feb. 11, 2004), http://articles.chicagotribune.com/2004-02-11/news/0402110356_1_bullet-analysis-bullet-lead-analysis-bullet-comparisons [<https://perma.cc/Z59B-UZ5T>].

233. Charles Piller, *Report Finds Flaws in FBI Bullet Analysis: Changes Are Proposed for the Technique Often Cited in Expert Testimony in Criminal*

“*FBI Lab Under Scrutiny Again*,”²³⁴ and “*Report Questions the Reliability of an F.B.I. Ballistics Test*.”²³⁵

The Bureau also included the following passage in the press release: “The basis of bullet lead compositional analysis is supported by approximately 50 peer-reviewed articles found in scientific publications beginning in the early 1970’s. Published research and validation studies have continued to demonstrate the usefulness of the measurements of trace elements within bullet lead.”²³⁶ In contrast, the NAS Report pointed out that there were “very few peer-reviewed articles on homogeneity and the rate of false positive matches” and “[o]utside reviews have only recently been published.”²³⁷

Over a year later, the FBI discontinued CBLA testing²³⁸ and issued another, similar press release. Once again, the release minimized the problems, citing the following reason for its decision: “While the FBI Laboratory still firmly supports the scientific foundation of bullet lead analysis, given the costs of maintaining the equipment, the resources necessary to do the examination, and its relative probative value, the FBI Laboratory has decided that it will no longer conduct this exam.”²³⁹ Nevertheless, Dwight Adams, the laboratory director, had written a private memorandum to the FBI Director a month earlier specifying different reasons for abandoning the technique, including the following comments: (1) “We cannot afford to be misleading to a jury” and (2) “We plan to discourage prosecutors from using our previous results in future cases.”²⁴⁰ The press release did not reflect either concern.

Trials, L.A. TIMES (Feb. 11, 2004), <http://articles.latimes.com/2004/feb/11/science/sci-bullet11> [<https://perma.cc/4QHZ-G4QM>].

234. Bootie Cosgrove-Mather, *FBI Lab Under Scrutiny Again*, ASSOCIATED PRESS (Feb. 10, 2004, 1:26 PM), <https://www.cbsnews.com/news/fbi-lab-under-scrutiny-again/> [<https://perma.cc/PG9K-VGWL>].

235. Eric Lichtblau, *Report Questions the Reliability of an F.B.I. Ballistics Test*, N.Y. TIMES (Feb. 11, 2004), <http://www.nytimes.com/2004/02/11/us/report-questions-the-reliability-of-an-fbi-ballistics-test.html> [<https://perma.cc/N7JC-RF6P>].

236. FBI Nat’l Press Office, *supra* note 230.

237. NAS REPORT, *supra* note 217, at 100.

238. Eric Lichtblau, *F.B.I. Abandons Disputed Test for Bullets from Crime Scenes*, N.Y. TIMES (Sept. 2, 2005), <http://www.nytimes.com/2005/09/02/politics/fbi-abandons-disputed-test-for-bullets-from-crime-scenes.html> [<https://perma.cc/4JLF-GCWW>].

239. Press Release, FBI, FBI Laboratory Announces Discontinuation of Bullet Lead Examinations (Sept. 1, 2005), <https://archives.fbi.gov/archives/news/pressrel/press-releases/fbi-laboratory-announces-discontinuation-of-bullet-lead-examinations> [<https://perma.cc/QMY5-7MBF>].

240. John Solomon, *FBI's Forensic Test Full of Holes*, WASH. POST (Nov. 18, 2007), <http://www.washingtonpost.com/wp-dyn/content/article/2007/11/17/AR2007111701681.html> [<https://perma.cc/YGJ2-8ZK4>].

In the wake of the NAS Report, several state courts excluded CBLA evidence.²⁴¹ Surprisingly, the FBI supplied affidavits in several cases supporting prosecutors' efforts to sustain convictions based on the technique. In one affidavit, the FBI cited the NAS report but ignored that the report had faulted the Bureau's statistical methods. The chair of the NAS committee criticized the affidavit because it did "not discuss the statistical bullet-matching technique, which is key and probably the most significant scientific flaw found by the committee."²⁴² The affidavit was also misleading because it estimated that the maximum number of .22-caliber bullets in a batch of lead was 1.3 million, when the NAS committee found that the number could be as high as 35 million.²⁴³

On November 18, 2007, *60 Minutes* aired a segment on CBLA.²⁴⁴ In an interview, the now-retired FBI lab director acknowledged that testimony about boxes was "misleading and inappropriate."²⁴⁵ That broadcast, along with a *Washington Post* investigation, questioned the FBI's response to the NAS Report. The main problem was that only the FBI had records of all the cases in which its experts had testified, and the Bureau had declined to disclose the names of those cases.²⁴⁶

241. *See* *Ragland v. Commonwealth*, 191 S.W.3d 569, 580 (Ky. 2006) (noting that "[i]f the FBI Laboratory that produced the CBLA evidence now considers such evidence to be of insufficient reliability to justify continuing to produce it, a finding by the trial court that the evidence is both scientifically reliable and relevant would be clearly erroneous"); *Clemons v. State*, 896 A.2d 1059, 1070, 1078 (Md. 2006) ("CBLA is not admissible under the *Frye-Reed* standard because it is not generally accepted within the scientific community as valid and reliable."); "Based on the criticism of the processes and assumptions underlying CBLA, we determine that the trial court erred in admitting expert testimony based on CBLA because of the lack of general acceptance of the process in the scientific community."); *State v. Behn*, 868 A.2d 329, 331 (N.J. Super. Ct. 2005) (finding the technique was "based on erroneous scientific foundations"). *But see* *Commonwealth v. Fisher*, 870 A.2d 864, 871 (Pa. 2005) ("The CBLA evidence, at best, established a possible connection between Appellant and the bullets recovered from the victim's body."); *see also* *United States v. Davis*, 406 F.3d 505, 509 (8th Cir. 2005) ("Davis's trial counsel cannot be said to be ineffective for failing to challenge the FBI's methodology on a basis that was not advanced by the scientific community at the time of trial.").

242. John Solomon, *FBI's Forensic Test Full of Holes*, WASH. POST (Nov. 18, 2007), http://www.washingtonpost.com/wp-dyn/content/article/2007/11/17/AR2007111701681_5.html?sid=ST2007111701983 [<https://perma.cc/FKM4-L4WQ>] (quoting Kenneth MacFadden).

243. *Id.*

244. *60 Minutes: Evidence of Injustice* (CBS television broadcast, Nov. 16, 2007), <https://www.youtube.com/watch?v=H4g62cpRz7M> [<https://perma.cc/XC7E-E5HP>].

245. *Id.* at 5:26.

246. Solomon, *supra* note 242 ("Hundreds of defendants sitting in prisons nationwide have been convicted with the help of an FBI forensic tool that

Instead, the Bureau relied on the NAS Report, its own press releases, and pro forma letters sent to prosecution and defense organizations to notify defendants. This method of communication was grossly inadequate because the letters neither highlighted the problem, nor its significance.²⁴⁷ A few days after the *60 Minutes* expose, Senator Patrick Leahy, the Chairman of the Senate Judiciary Committee, sent a letter to the FBI Director noting that the Bureau's letters gave "the false impression that these discredited tests had continuing reliability."²⁴⁸

Here, the flaws are many: Lack of foundational research, failure to make a database available to outside scientists, and ignoring the FBI's own protocols by presenting inconsistent and misleading testimony. Moreover, the reluctance to confess error and take timely corrective action violated basic scientific norms. After decades of use, a federal district court in 2003 excluded CBLA evidence under the *Daubert* standard for the first time.²⁴⁹

II. MISLEADINGLY PRESENTED TECHNIQUES

A. *Firearms & Toolmark Identifications*

Firearms identifications, popularly known as "ballistics," is another long-established forensic discipline. It developed in the early part of the last century, and by the 1930s courts were admitting evidence based on this technique. "Subsequent cases have followed these precedents, admitting evidence of bullet, cartridge case, and shot shell iden-

was discarded more than two years ago. But the FBI lab has yet to take steps to alert the affected defendants or courts, even as the window for appealing convictions is closing . . .").

247. The Innocence Network and the National Association of Criminal Defense Lawyers formed a task force and worked with the FBI to contact defense attorneys and convicts. See Vesna Jaksic, *Faulty Bullet-Test Cases Finding Way to Court*, NAT'L L.J. (Feb. 25, 2008), <http://lethal-injection-florida.blogspot.com/2008/02/faulty-bullet-test-cases-finding-way-to.html> [<https://perma.cc/PH7J-LTY9>] ("The task force is lining up pro bono commitments from several law firms to handle the cases.").

248. John Solomon, *Leahy Pursues Forensic-Test Answers: Attorney General Is Told to Prepare For Senate Inquiry*, WASH. POST (Nov. 22, 2007), <https://www.pressreader.com/usa/the-washington-post/20071122/281539401609068> [<https://perma.cc/BKY5-SFFH>] (quoting Leahy). Leahy also wrote: "The new revelations about bullet-lead analysis are just the latest examples of the Department's inadequate efforts to ensure that sound forensic testing is utilized to the maximum extent to find the guilty rather than merely obtain a conviction. Punishing the innocent is wrong and allows the guilty party to remain free." *Id.*; see also Giannelli, *supra* note 215.

249. *United States v. Mikos*, No. 02 CR 137, 2003 WL 22922197, at *4-5 (N.D. Ill. Dec. 9, 2003).

tifications.”²⁵⁰ Toolmark comparison, a related discipline, was also accepted during this period.²⁵¹ At the time *Daubert* was decided, the FBI’s position was clear: “Firearms identification is the Forensic Science discipline that identifies a bullet, cartridge case or other ammunition component as having been fired by a particular firearm *to the exclusion of all other firearms*.”²⁵² Yet, the examination, by means of a comparison microscope, is subjective and without a meaningful standard.

1. Post-*Daubert* Cases

The courts gave short shrift to the initial post-*Daubert* challenges to firearms and toolmark identifications.²⁵³ In 2005, however, the legal landscape changed abruptly. In *United States v. Green*,²⁵⁴ the district judge questioned the foundational basis of firearms identifications. The court wrote that the expert “declared that this match could be made ‘to the exclusion of every other firearm in the world.’ . . . That conclusion, needless to say, is extraordinary, particularly given [his] data and methods.”²⁵⁵ Moreover, the expert could not cite any reliable error rates and admitted that he relied mainly on his subjective judgment. In addition, “[t]here were no reference materials of any specificity, no national or even local database on which he relied. And although he relied on his past experience with these weapons, he had no notes or pictures memorializing his past observations.”²⁵⁶ In the end, the court restricted the expert’s testimony; he could only explain the ways in which the casings were similar but not that they came from a specific weapon “to the exclusion of every other firearm in the world.”²⁵⁷ In the court’s view, that conclusion “stretches well beyond [the expert’s] data and methodology.”²⁵⁸

250. 1 GIANNELLI ET AL., *supra* note 20, § 14.06, at 772 (citations omitted).

251. *Id.* at § 14.12.

252. FBI HANDBOOK OF FORENSIC SCIENCE 57 (rev. ed. 1994) (emphasis added).

253. *See, e.g.*, *United States v. Hicks*, 389 F.3d 514, 526 (5th Cir. 2004) (stating that “the matching of spent shell casings to the weapon that fired them has been a recognized method of ballistics testing in this circuit for decades”); *United States v. Foster*, 300 F. Supp. 2d 375, 376 n.1 (D. Md. 2004) (“Ballistics evidence has been accepted in criminal cases for many years. . . . In the years since *Daubert*, numerous cases have confirmed the reliability of ballistics identification.”); *United States v. Santiago*, 199 F. Supp. 2d 101, 111 (S.D.N.Y. 2002) (“The Court has not found a single case in this Circuit that would suggest that the entire field of ballistics identification is unreliable.”).

254. 405 F. Supp. 2d 104 (D. Mass. 2005).

255. *Id.* at 107.

256. *Id.*

257. *Id.* at 109.

258. *Id.*

A few weeks later, a different district judge in *United States v. Monteiro*²⁵⁹ found that the technique “is largely a subjective determination based on experience and expertise.”²⁶⁰ Importantly, the court also concluded that the theory on which the expert relied was “tautological.”²⁶¹ The Association of Firearm and Toolmark Examiners (“AFTE”), the leading organization of examiners, proposed the theory.²⁶² Under this theory, the examiner may declare a positive identification if (1) there is “sufficient agreement” of marks between the crime scene and test bullets; and (2) there is “sufficient agreement” when the examiner says there is.²⁶³ In short, the “sufficient agreement” threshold is “in the minds eye of the examiner and is based largely on training and experience.”²⁶⁴ The court would not admit the evidence unless the expert could better document the examination.

Together, *Green* and *Monteiro* should have served as a shot across the bow. But they did not; courts continued to admit the same evidence as before.²⁶⁵

259. 407 F. Supp. 2d 351 (D. Mass. 2006).

260. *Id.* at 355.

261. *Id.* at 370.

262. *See Theory of Identification, Association of Firearm and Toolmark Examiners*, 30 AFTE J. 86, 86 (1998).

263. *See* Itiel E. Dror, *How Can Francis Bacon Help Forensic Science? The Four Idols of Human Biases*, 50 JURIMETRICS 93, 104 (2009) (“The potential problem here is the nonscientific nature of the identification criteria. If the comparison of toolmarks enables conclusions about common origin when the unique surface contours of two toolmarks are in ‘sufficient agreement,’ what is the scientific definition and measurement of what constitutes such ‘sufficient agreement’? It seems that it is more in the eye of the beholder than strict scientific measures because it is determined without specific quantification and criteria.”).

264. *Monteiro*, 407 F. Supp. 2d at 370 (quoting Richard Grzybowski et al., *Firearm/Toolmark Identification: Passing the Reliability Test Under Federal and State Evidentiary Standards*, 25 AFTE J. 209, 213 (2003)).

265. *See, e.g., United States v. Williams*, 506 F.3d 151, 161–62 (2d Cir. 2007) (upholding admissibility of firearms identification evidence); *United States v. Natson*, 469 F. Supp. 2d 1253, 1261 (M.D. Ga. 2007) (“According to his testimony, these toolmarks were sufficiently similar to allow him to identify Defendant’s gun as the gun that fired the cartridge found at the crime scene. He opined that he held this opinion to a 100% degree of certainty. . . . The Court also finds [the expert’s] opinions reliable and based upon a scientifically valid methodology. Evidence was presented at the hearing that the toolmark testing methodology he employed has been tested, has been subjected to peer review, has an ascertainable error rate, and is generally accepted in the scientific community.”).

2. NAS Ballistic Imaging Report (2008)

In 2008, NAS published a report on computer imaging of bullets.²⁶⁶ Although firearms identification was not the primary focus of the investigation, a section of the report commented on the subject.²⁶⁷ After surveying the literature on uniqueness, reproducibility, and permanence of individual characteristics, the report noted that “[m]ost of these studies are limited in scale and have been conducted by firearms examiners (and examiners in training) in state and local law enforcement laboratories as adjuncts to their regular casework.”²⁶⁸ The report found that the “validity of the fundamental assumptions of uniqueness and reproducibility of firearms-related toolmarks has not yet been fully demonstrated.”²⁶⁹ The report went on to caution:

Conclusions drawn in firearms identification should not be made to imply the presence of a firm statistical basis when none has been demonstrated. Specifically . . . examiners tend to cast their assessments in bold absolutes, commonly asserting that a match can be made “to the exclusion of all other firearms in the world.” Such comments cloak an inherently subjective assessment of a match with an extreme probability statement that has no firm grounding and unrealistically implies an error rate of zero.²⁷⁰

Citing this report, the district court in *United States v. Glynn*²⁷¹ ruled that the expert would only be permitted to testify that it was “more likely than not” that recovered bullets and cartridge cases came from a particular weapon.²⁷² The court also commented: “Based on the *Daubert* hearings . . . the Court very quickly concluded that whatever else ballistics identification analysis could be called, it could not fairly

266. NAT’L RESEARCH COUNCIL OF THE NAT’L ACADS., BALLISTIC IMAGING (Daniel L. Cork et al. eds., 2008).

267. The committee was asked to assess the feasibility, accuracy, reliability, and technical capability of developing and using a national ballistic database as an aid to criminal investigations. It concluded: (1) “A national reference ballistic image database of all new and imported guns is not advisable at this time;” and (2) the National Integrated Ballistics Information Network (NIBIN) “can and should be made more effective through operational and technological improvements.” *Id.* at 5, 239.

268. *Id.* at 70.

269. *Id.* at 81. The report also stated: “Additional general research on the uniqueness and reproducibility of firearms-related toolmarks would have to be done if the basic premises of firearms identification are to be put on a more solid scientific footing.” *Id.* at 82.

270. *Id.* at 82.

271. 578 F. Supp. 2d 567 (S.D.N.Y. 2008).

272. *Id.* at 575.

be called 'science.'"²⁷³ The court further noted that "[t]he problem is compounded by the tendency of ballistics experts . . . to make assertions that their matches are certain beyond all doubt, that the error rate of their methodology is 'zero,' and other such pretensions."²⁷⁴

3. NAS Forensic Science Report (2009)

As noted previously, NAS issued its forensic report the following year in 2009. That Report summarized the state of the research as follows:

Because not enough is known about the variabilities among individual tools and guns, we are not able to specify how many points of similarity are necessary for a given level of confidence in the result. Sufficient studies have not been done to understand the reliability and repeatability of the methods Individual patterns from manufacture or from wear might, in some cases, be distinctive enough to suggest one particular source, but additional studies should be performed to make the process of individualization more precise and repeatable.²⁷⁵

In a different passage, the report—citing firearm and toolmark identifications—observed that "[m]uch forensic evidence . . . is introduced in criminal trials without any meaningful scientific validation, determination of error rates, or reliability testing to explain the limits of the discipline."²⁷⁶

AFTE rejected these findings out of hand, arguing that NAS "ignore[d] extensive research supporting the scientific underpinnings of the identification of firearm and toolmark evidence"²⁷⁷ The court in *United States v. Otero*²⁷⁸ accepted the AFTE's position, citing studies which it was ill-equipped to evaluate.²⁷⁹ A subsequent review of the oft-cited studies by two scientists concluded:

273. *Id.* at 570.

274. *Id.* at 574.

275. NAS Forensic Report, *supra* note 26, at 154.

276. *Id.* at 107–08.

277. AFTE Comm. for the Advancement of the Sci. of Firearm and Tool Mark Identification, *The Response of the Association of Firearms and Tool Mark Examiners to the February 2009 National Academy of Science Report "Strengthening the Forensic Science in the United States: A Path Forward"*, 41 AFTE J. 204, 206 (2009).

278. 849 F. Supp. 2d 425, 437–38 (D.N.J. 2012) ("The Court's analysis of the proposed testimony according to the *Daubert* factors leads it to conclude that [the] expert report and opinion are admissible under Rule 702.").

279. *Id.* at 438; *see also* NAS FORENSIC REPORT *supra* note 26, at 153–55.

Exaggerated and unfounded implications relating to rates of error inferred from even the best of existing experiments in the field of firearms/toolmarks, generally self-described as ‘validation studies’, typically result from statistical, metallurgical and/or psychological (cognitive) deficiencies in the design and conduct of the experiments, and frequently lead to unjustified inferential extrapolation to universal assumption for the practice domain.²⁸⁰

Other courts took an important, but still limited, step of restricting examiner testimony by precluding the expert from making gross overstatements such as declaring a match to the exclusion, either practical or absolute, of all other weapons.²⁸¹ Similarly, some courts forbade experts from testifying that they hold their opinions to a “reasonable degree of scientific certitude.”²⁸² That term has long been required by courts in many jurisdictions for the admission of expert testimony. Incredibly, the phrase has no scientific meaning and the claim of certainty is unsupported by empirical research. Thus, it is grossly misleading. Indeed, the National Commission on Forensic Science rejected it.²⁸³ Still other courts went off on a quixotic tangent, substituting the phrase “reasonable degree of ballistic” certitude.²⁸⁴ Changing “scientific

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280. Clifford Spiegelman & William A. Tobin, *Analysis of Experiments in Forensic Firearms/Toolmarks Practice Offered as Support for Low Rates of Practice Error and Claims of Inferential Certainty*, 12 LAW, PROB. & RISK 115, 115 (2013).
281. *See, e.g.*, United States v. Ashburn, 88 F. Supp. 3d 239, 249 (E.D.N.Y. 2015) (“Nor can [the expert] testify that a match he identified is to ‘the exclusion of all other firearms in the world,’ or that there is a ‘practical impossibility’ that any other gun could have fired the recovered materials.”); United States v. Taylor, 663 F. Supp. 2d 1170, 1180 (D.N.M. 2009) (“[The expert] also will not be allowed to testify that he can conclude that there is a match to the exclusion, either practical or absolute, of all other guns.”).
282. *See, e.g.*, *Ashburn*, 88 F. Supp. 3d at 249 (“[T]he court joins in precluding this expert witness from testifying that he is ‘certain’ or ‘100%’ sure of his conclusions that certain items match.”); United States v. Willock, 696 F. Supp. 2d 536, 549 (D. Md. 2010) (“[The expert] shall state his opinions and conclusions without any characterization as to the degree of certainty with which he holds them.”); *People v. Robinson*, 2 N.E.3d 383, 402 (Ill. App. Ct. 2013) (“[T]he judicial decisions uniformly conclude toolmark and firearms identification is generally accepted and admissible at trial. Accordingly, we conclude the trial court did not err in ruling the testimony in this case was admissible . . . particularly where the trial judge barred the witnesses from testifying their opinions were ‘within a reasonable degree of scientific certainty.’”).
283. NAT’L COMM’N ON FORENSIC SCI., DOJ, VIEWS DOCUMENT ON USE OF THE TERM “REASONABLE SCIENTIFIC CERTAINTY” 1 (2016).
284. *Taylor*, 663 F. Supp. 2d at 1180 (“He may only testify that, in his opinion, the bullet came from the suspect rifle to within a reasonable degree of certainty in the firearms examination field.”); United States v. Cerna, No. CR 08-0730 WHA, 2010 WL 3448528, at *4 (N.D. Cal. 2010) (allowing

certainty” to “ballistic certainty” merely underscores the courts’ scientific incompetence.

However, even these modest limitations were rejected by other courts.²⁸⁵ For example, in *United States v. Casey*,²⁸⁶ the district court declined “to follow sister courts who have limited expert testimony based upon the 2008 and 2009 NAS reports and, instead, remains faithful to the long-standing tradition of allowing the unfettered testimony of qualified ballistics experts.”²⁸⁷

4. White House PCAST Report (2016)

The 2016 White House PCAST report agreed with the 2009 NAS Report’s characterization of the scientific research on firearms and toolmarks identification: “We find that many of these earlier studies were inappropriately designed to assess foundational validity and estimate reliability. Indeed, there is internal evidence among the studies themselves indicating that many previous studies underestimated the false positive rate by at least 100-fold.”²⁸⁸ In addition, PCAST found only one of the post-2009 studies sufficiently rigorous. The Defense Department’s Forensic Science Center commissioned the study, which was conducted by an independent testing lab—the Ames Laboratory, a Department of Energy national laboratory affiliated with Iowa State University. In this study, “[t]he false-positive rate was estimated at 1

experts “to testify that a particular bullet or cartridge case was fired from a particular firearm ‘to a reasonable degree of certainty in the ballistics field’” (quoting *United States v. Diaz*, No. 05-00167, 2007 WL 485967, at *14 (N.D. Cal. 2007)); *Commonwealth v. Pytou Heang*, 942 N.E.2d 927, 945 (Mass. 2011) (stating that “the expert may offer that opinion to a ‘reasonable degree of ballistic certainty’”).

285. *See, e.g.*, *Fleming v. State*, 1 A.3d 572, 590 (Md. Ct. App. 2010) (“[N]otwithstanding the current debate on the issue, courts have consistently found the traditional method [of firearms identification] to be generally accepted within the scientific community, and to be reliable.”); *People v. Givens*, 912 N.Y.S.2d 855, 857 (Sup. Ct. 2010) (“This Court was unable to find any cases where firearms and toolmark identification was found to be unreliable or no longer scientifically acceptable.”).

286. 928 F. Supp. 2d 397 (D.P.R. 2013).

287. *Id.* at 400; *see also* *United States v. Sebborn*, No. 10 Cr. 87(SLT), 2012 WL 5989813, at *7 (E.D.N.Y. Nov. 30, 2012); *State v. Langlois*, 2 N.E.3d 936, 950 (Ohio Ct. App. 2014) (“Our conclusion on this issue finds support in the decisions of other appellate districts in Ohio, notwithstanding the recent criticisms in scientific reports and the limitations some federal courts have imposed on the testimony of firearms experts. These decisions hold that the methodology of comparatively analyzing and testing bullets and shell cases recovered from crime scenes is reliable.”); *State v. Jones*, 303 P.3d 1084, at ¶ 75 (Wash. Ct. App. 2013) (expert testimony comparing bunter marks on the base of shell casings found at the crime scene to shell casings found in Jones’s home admissible under the *Frye* standard).

288. WHITE HOUSE PCAST REPORT, *supra* note 38, at 11.

in 66, with a confidence bound indicating that the rate could be as high as 1 in 46.”²⁸⁹ The study had not been published in a scientific journal. According to the PCAST Report, more than one study is required and studies should be published in peer-reviewed scientific literature. Consequently, “the current evidence still falls short of the scientific criteria for foundational validity.”²⁹⁰

AFTE quickly retorted, expressing their “disappointment in the PCAST’s choice to ignore the research that has been conducted” and claiming that “[d]ecades of validation and proficiency studies have demonstrated that firearm and toolmark identification is scientifically valid”²⁹¹ However, when PCAST later invited stakeholders to submit validation studies that it may have overlooked, no studies satisfying PCAST’s criteria were offered.²⁹²

The lessons here are familiar. For years, an entrenched forensic discipline vigorously guarded its turf by rejecting the conclusions of the outside scientific community.²⁹³ It published a journal which was “peer-reviewed” by other members of its discipline. The journal, which is advertised as “the Scientific Journal” of AFTE, was not generally available until 2016. The discipline claimed to be a “science” but did not hold itself to the normative standards of science. The AFTE “Theory of Identification” is “clearly not a scientific theory, which the National Academy of Sciences has defined as ‘a comprehensive explanation of some aspect of nature that is supported by a vast body of evidence.’ . . . More importantly, the stated method is circular.”²⁹⁴ Only recently, after two NAS reports, have some courts begun to limit misleading testimony. Many have not. Thus, the courts’ competence to deal with flawed research remains extant.²⁹⁵

289. *Id.*

290. *Id.*

291. *Association of Firearm and Tool Mark Examiners Response to PCAST Report on Forensic Science*, 48 AFTE J. 195, 195 (2016).

292. PRESIDENT’S COUNCIL OF ADVISORS ON SCI. AND TECH., AN ADDENDUM TO THE PCAST REPORT ON FORENSIC SCIENCE IN CRIMINAL COURTS 7 (2017) (“Several respondents wrote to PCAST concerning firearms analysis. None cited additional appropriately designed black-box studies similar to the recent Ames Laboratory study.”).

293. See William A. Tobin et al., *Absence of Statistical and Scientific Ethos: The Common Denominator in Deficient Forensic Practices*, 4 STAT. & PUB. POL’Y 1, 9 (2016) (“[P]ractitioners remain intractable even after years of critical scholarly papers, ad hoc committees of the National Academy of Sciences (NAS), position statements from the U.S. Department of Justice”) (citation omitted).

294. WHITE HOUSE PCAST REPORT, *supra* note 38, at 60.

295. Tobin et al., *supra* note 293, at 9 (“[T]he purported ‘validation studies’ typically proffered to courts are seriously flawed [and] have no external validity”).

In 2005, the district court in *Green* cautioned: “The more courts admit this type of toolmark evidence without requiring documentation, proficiency testing, or evidence of reliability, the more sloppy practices will endure; we should require more.”²⁹⁶ Over a decade later, a concurring opinion in *Williams v. United States*²⁹⁷ concluded: “As matters currently stand, a certainty statement regarding toolmark pattern matching has the same probative value as the vision of a psychic: it reflects nothing more than the individual’s foundationless faith in what he believes to be true.”²⁹⁸ In short, there is a “lost decade” during which the discipline summarily dismissed criticisms when it should have led the effort for more rigorous research.

B. Fingerprint Examinations

Before DNA analysis, fingerprint identification was the “gold standard” in forensics.²⁹⁹ Like many other forensic disciplines, it gained judicial acceptance decades before *Daubert* was decided. *People v. Jennings*,³⁰⁰ the first reported fingerprint case, was decided in 1911. In 1984, the FBI pronounced the technique “infallible” in its official publication, which also referred to the technique as a “science.”³⁰¹ Nevertheless, it is a subjective technique without an objective standard and typically involves partial prints with inevitable distortions.

1. Post-*Daubert* Cases

After *Daubert*, challenges to fingerprint comparison testimony were decidedly unsuccessful.³⁰² One infamous case, *United States v.*

296. *United States v. Green*, 405 F. Supp. 2d 104, 109 (D. Mass. 2005).

297. 130 A.3d 343 (D.C. 2016).

298. *Id.* at 355 (Easterly, J., concurring).

299. See Joseph L. Peterson & Anna S. Leggett, *The Evolution of Forensic Science: Progress Amid the Pitfalls*, 36 STETSON L. REV. 621, 654 (2007) (“The scientific integrity and reliability of DNA testing have helped DNA replace fingerprinting and made DNA evidence the new ‘gold standard’ of forensic evidence.”).

300. 96 N.E. 1077 (Ill. 1911). See generally 1 GIANNELLI ET AL., *supra* note 20, §16 (discussing the scientific and legal issues associated with fingerprint identification).

301. FEDERAL BUREAU OF INVESTIGATION, THE SCIENCE OF FINGERPRINTS: CLASSIFICATION AND USES iv (1984).

302. See, e.g., *United States v. Collins*, 340 F.3d 672, 682 (8th Cir. 2003) (“Fingerprint evidence and analysis is generally accepted.”); *United States v. Hernandez*, 299 F.3d 984, 991 (8th Cir. 2002); *United States v. Martinez-Cintrón*, 136 F. Supp. 2d 17, 20 (D.P.R. 2001) (discussing how flaws and difficulties surrounding fingerprint evidence do not exclude the evidence outright).

Havvard,³⁰³ illustrates the judiciary's lack of rigor in applying *Daubert*. Not only did the district court uphold the fingerprint testimony's admissibility, it styled the technique as "the very archetype of reliable expert testimony under [the *Daubert/Kumho*] standards."³⁰⁴ According to the court, latent print identification had been "tested" for nearly one hundred years in adversarial proceedings with the highest possible stakes—liberty and sometimes life. Yet, *Daubert* required scientific, not "adversarial," testing.³⁰⁵ Next, in citing "peer review," the court noted that a second fingerprint examiner also compared the prints: "In fact, peer review is the standard operating procedure among latent print examiners."³⁰⁶ This statement reveals a fundamental misunderstanding of "peer review" as used in *Daubert*. In that case, peer review meant refereed scientific journals in which validation research is published. An amici brief submitted in *Daubert* by the *New England Journal of Medicine* and other scientific publications explained that peer review's "role is to promote the publication of well-conceived articles so that the most important review, the consideration of the reported results by the scientific community, may occur after publication."³⁰⁷

Moreover, the court accepted the prosecution expert's astounding claim that the "error rate for the method is zero."³⁰⁸ Experts argued that, while individual examiners may make mistakes, the method itself is perfect. The dichotomy between "methodological" and "human" error rates in this context, however, is "practically meaningless"³⁰⁹ because

303. 117 F. Supp. 2d 848 (S.D. Ind. 2000), *aff'd*, 260 F.3d 597 (7th Cir. 2001).

304. *Id.* at 855; *see also* Paul C. Giannelli, *Daubert Challenges to Fingerprints*, 42 CRIM. L. BULL. 624, 628 (2006).

305. *See* Sandy L. Zabell, *Fingerprint Evidence*, 13 J.L. & POL'Y 143, 170 (2005) ("The argument that no latent print has ever been found to match the rolled print of a different person is . . . misleading because no systematic search for such pairs on the entire databank of millions of fingerprints has ever been performed.").

306. *Havvard*, 117 F. Supp. 2d at 854.

307. Brief of the New England Journal of Medicine, Journal of the American Medical Association, and Annals of Internal Medicine as Amici Curiae in Support of Respondent, *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579 (1993) (No. 92-102), 1993 WL 13006287, at *3.

308. *Havvard*, 117 F. Supp. 2d at 854.

309. Jennifer L. Mnookin, *Fingerprint Evidence in an Age of DNA Profiling*, 67 BROOK. L. REV. 13, 60 (2001). Professor Mnookin goes on to provide this analogy: "The same argument could be made of eyewitness testimony, a notoriously unreliable form of evidence. People are all distinct from one another in observable ways; therefore the theoretical error rate of eyewitness identification is zero, though in practice observers may frequently make errors." *Id.*; *see also* Simon A. Cole, *More Than Zero: Accounting for Error in Latent Fingerprint Identification*, 95 J. CRIM. L. & CRIMINOLOGY 985, 1040 (2005) (stating that while a "distinction can be drawn between

the examiner is the method.³¹⁰ Finally, the court turned *Daubert* on its head by requiring the defendant to prove the evidence was unreliable, a distortion that would be employed in later cases.³¹¹

Then, *United States v. Llera Plaza*³¹² “sent shock waves through the community of fingerprint analysts.”³¹³ In that 2002 case, Judge Pollak ruled that fingerprint experts would not be permitted to testify that two sets of prints “matched”—that is, a positive identification to the exclusion of all other persons. This was apparently the first time in over ninety years that such a decision had been rendered.³¹⁴ On rehearing, however, Judge Pollak reversed himself,³¹⁵ and later cases continued to uphold the admissibility of fingerprint evidence.³¹⁶ Nevertheless, the case captured the attention of the media with news reports,³¹⁷ main-

‘methodological’ and ‘practitioner’ error” in other areas, “in fingerprint practice the concept is vacuous”).

310. See Zabell, *supra* note 305, at 172 (“But, given its unavoidable subjective component, in latent print examination people *are* the process.”).
311. See Michael J. Saks, *The Legal and Scientific Evaluation of Forensic Science (Especially Fingerprint Expert Testimony)*, 33 Seton Hall L. Rev. 1167, 1173–76 (2003) (discussing the reversal of the burden of persuasion as one of several judicial responses employed to avoid confronting the lack of empirical testing); see also Giannelli, *supra* note 304, at 630.
312. 179 F. Supp. 2d 492 (E.D. Pa. 2002), *vacated*, 188 F. Supp. 2d 549 (E.D. Pa. 2002).
313. D.H. Kaye, *The Nonscience of Fingerprinting: United States v. Llera-Plaza*, 21 QUINNIPIAC L. REV. 1073, 1073 (2003).
314. As Professor Mnookin has noted, however, “fingerprints were accepted as an evidentiary tool without a great deal of scrutiny or skepticism.” Mnookin, *supra* note 309, at 17. She elaborated: “Even if no two people had identical *sets* of fingerprints, this did not establish that no two people could have a *single* identical print, much less an identical *part* of a print. These are necessarily matters of probability, but neither the court in *Jennings* nor subsequent judges ever required that fingerprinting identification be placed on a secure statistical foundation.” *Id.* at 19.
315. *Llera Plaza*, 188 F. Supp. 2d at 572.
316. See, e.g., *United States v. Abreu*, 406 F.3d 1304, 1307 (11th Cir. 2005) (“We agree with the decisions of our sister circuits and hold that the fingerprint evidence admitted in this case satisfied *Daubert*.”); *United States v. Janis*, 387 F.3d 682, 690 (8th Cir. 2004) (finding fingerprint evidence reliable); *United States v. Mitchell*, 365 F.3d 215, 244 (3d Cir. 2004) (finding that when assessed using the *Daubert* factors, the fingerprinting evidence “pass[ed] muster”); *United States v. Crisp*, 324 F.3d 261, 269 (4th Cir. 2003) (finding that the district court did not abuse its discretion by admitting fingerprint analysis as evidence); *United States v. Sullivan*, 246 F. Supp. 2d 700, 704 (E.D. Ky. 2003) (finding that the possibility that two fingers may have a portion of their print in common speaks to weight and not the admissibility of fingerprint evidence).
317. E.g., Joann Loviglio, *Trial Judge Reaffirms Fingerprint Usability; Hearing Shows Him Science Involved*, SAN ANTONIO EXPRESS-NEWS, Mar. 14, 2002;

stream publications,³¹⁸ scientific journals,³¹⁹ and television shows giving it substantial coverage.³²⁰ A spate of legal articles followed,³²¹ with some commentators believing that *Llera Plaza I* was more faithful to *Daubert* than *Llera Plaza II*.³²² In response, the FBI adopted a “circle the wagons” attitude, fiercely defending the technique. The head of the FBI fingerprint section told *60 Minutes* that the error rate was “zero,” examiners only testify to “hundred percent certainty,” and the FBI had won “forty-one out of forty-one” legal challenges to fingerprint evidence.³²³

The appellate opinion most faithful to *Daubert* appeared in *United States v. Crisp*³²⁴—unfortunately in dissent. The majority opinion upheld the admissibility of fingerprint evidence by shifting the burden of proof to the defendant and by grandfathering the technique.³²⁵ In dissent, Judge Michael conscientiously applied the *Daubert* factors. First, he noted that the “government did not offer any record of testing

Andy Newman, *Judge Who Ruled Out Matching Fingerprints Changes his Mind*, N.Y. TIMES, Mar. 14, 2002; Richard Willing, *Judge Challenges Fingerprint Identification*, USA TODAY, Jan. 10, 2002.

318. See, e.g., Michael Specter, *Do Fingerprints Lie? The Gold Standard of Forensic Evidence Is Now Being Challenged*, NEW YORKER (May 27, 2002), <https://www.newyorker.com/magazine/2002/05/27/do-fingerprints-lie> [<https://perma.cc/T873-TJA7>].
319. See, e.g., David L. Faigman, *Is Science Different for Lawyers?*, 297 SCIENCE 339, 339–340 (2002).
320. *60 Minutes: Fingerprints: Infallible Evidence?* (CBS television broadcast Jan. 5, 2003).
321. See, e.g., Simon A. Cole, *Grandfathering Evidence: Fingerprint Admissibility Rulings from Jennings to Llera Plaza and Back Again*, 41 AM. CRIM. L. REV. 1189, 1189 (2004); Robert Epstein, *Fingerprints Meet Daubert: The Myth of Fingerprint “Science” Is Revealed*, 75 S. CAL. L. REV. 605, 607 (2002); Kristin Romandetti, Note, *Recognizing and Responding to a Problem with the Admissibility of Fingerprint Evidence Under Daubert*, 45 JURIMETRICS 41, 53–56 (2004).
322. See Jennifer L. Mnookin, *Fingerprints: Not a Gold Standard*, ISSUES IN SCI. & TECH., Fall 2003, at 47 (“Judge Pollak’s first opinion [restricting latent fingerprint individualization testimony] was the better one.”); Recent Case, *United States v. Havvard*, 260 F.3d 597 (7th Cir. 2001), 115 HARV. L. REV. 2349, 2352 (2002) (“Fingerprint expert testimony does not survive application of the *Daubert* factors . . .”).
323. *60 Minutes*, *supra* note 320.
324. 324 F.3d 261 (4th Cir. 2003).
325. *Id.* at 269 (“Put simply, Crisp has provided us no reason today to believe that this general acceptance of the principles underlying fingerprint identification has, for decades, been misplaced. Accordingly, the district court was well within its discretion in accepting at face value the consensus of the expert and judicial communities that the fingerprint identification technique is reliable.”); see also Giannelli, *supra* note 304, at 632.

on the reliability of fingerprint identification. . . . [T]here have not been any studies to establish how likely it is that partial prints taken from a crime scene will be a match for only one set of fingerprints in the world.”³²⁶ Second, as for peer review:

[a]gain, the government offered no evidence on this factor at trial. Fingerprint examiners . . . have their own professional publications. . . . But unlike typical scientific journals, the fingerprint publications do not run articles that include or prompt critique or reanalysis by other scientists. Indeed, few of the articles address the principles of fingerprint analysis and identification at all³²⁷

Third, “an error rate must be demonstrated by reliable scientific studies, not by assumption.”³²⁸ Fourth, “the government did not establish that there are objective standards in the fingerprint examination field to guide examiners in making their comparisons.”³²⁹ Fifth, while acknowledging general acceptance in the fingerprint community, the judge remarked that “[n]othing in the record in this case shows that the fingerprint examination community has challenged itself sufficiently or has been challenged in any real sense by outside scientists.”³³⁰

2. Madrid Train Bombing

Llera Plaza was soon eclipsed by a more sensational event—the FBI’s misidentification of Brandon Mayfield as the source of the crime scene prints in the terrorist train bombing in Madrid on March 11, 2004.³³¹ More than any other event, the Mayfield affair exposed the myth of fingerprint infallibility. This debacle resulted in investigations

326. *Id.* at 273–74 (Michael, J., dissenting).

327. *Id.* at 274 (citing Epstein, *supra* note 321, at 644).

328. *Id.* The judge added: “In a 1995 test conducted by a commercial testing service, less than half of the fingerprint examiners were able to identify correctly all of the matches and eliminate the non-matches. On a similar test in 1998, less than sixty percent of the examiners were able to make all identifications and eliminations. . . . An error rate that runs remarkably close to chance can hardly be viewed as acceptable under *Daubert*.” *Id.* at 275 (citing Epstein, *supra* note 321, at 634–35).

329. *Id.* at 276.

330. *Id.*

331. See Sara Kershaw, *Spain and U.S. at Odds on Mistaken Terror Arrest*, N.Y. TIMES, June 5, 2004, at A1 (Spanish authorities cleared Brandon Mayfield and matched the fingerprints to an Algerian national); Flynn McRoberts & Maurice Possley, *Report Blasts FBI Lab: Peer Pressure Led to False ID of Madrid Fingerprint*, CHI. TRIB., Nov. 14, 2004, at 1.

by the FBI³³² and the Inspector General of the DOJ (“IG”).³³³ One of the more troubling aspects of these reports dealt with the culture in the laboratory. The FBI internal investigation found that “[t]o disagree was not an expected response,”³³⁴ and the IG reported that “FBI examiners did not attempt to determine the basis of the [Spanish National Police’s] doubts before reiterating that they were ‘absolutely confident’ in the identification on April 15, a full week before the FBI Laboratory met with the SNP.”³³⁵

In addition to highlighting the lack of foundational research, these events raised a host of other issues, including: (1) the role of cognitive bias in subjective techniques,³³⁶ (2) the lack of well-defined standards,³³⁷ (3) the failure to administer rigorous proficiency tests,³³⁸ (4) the

332. See Robert B. Stacey, *A Report on the Erroneous Fingerprint Individualization in the Madrid Train Bombing Case*, 54 J. FORENSIC IDENTIFICATION 707 (2004).

333. See OFFICE OF THE INSPECTOR GEN., DOJ, A REVIEW OF THE FBI’S HANDLING OF THE BRANDON MAYFIELD CASE: UNCLASSIFIED EXECUTIVE SUMMARY 7 (2006) (“Having found as many as 10 points of unusual similarity, the FBI examiners began to ‘find’ additional features in [the print] that were not really there, but rather were suggested to the examiners by features in the Mayfield prints.”).

334. Stacey, *supra* note 332, at 713.

335. OFFICE OF THE INSPECTOR GEN., *supra* note 333, at 10.

336. See Itiel E. Dror et al., *Contextual Information Renders Experts Vulnerable to Making Erroneous Identifications*, 156 FORENSIC SCI. INT’L 74, 75–76 (2006) (reporting an experiment that showed fingerprint examiners changed their opinions when provided with irrelevant information); Elizabeth F. Loftus & Simon A. Cole, Letter to the Editor, *Contaminated Evidence*, SCIENCE, May 2004, at 959, 959 (“[F]orensic scientists remain stubbornly unwilling to confront and control the problem of bias, insisting that it can be overcome through sheer force of will and good intentions.”); Stacey, *supra* note 332, at 713 (“confirmation bias”). See generally D. Michael Risinger et al., *The Daubert/Kumho Implications of Observer Effects in Forensic Science: Hidden Problems of Expectation and Suggestion*, 90 CAL. L. REV. 1, 39 (2002).

337. Examiners follow a procedure known as Analysis, Comparison, Evaluation, and Verification (ACE-V). See Zabell, *supra* note 305, at 178 (“ACE-V is an acronym, not a methodology. It is merely the common sense description of what anyone would do if they were examining a latent and a candidate source print.”).

338. See *United States v. Crisp*, 324 F.3d 261, 274 (4th Cir. 2003) (Michael, J., dissenting) (“Proficiency testing is typically based on a study of prints that are far superior to those usually retrieved from a crime scene.”); *United States v. Llera Plaza*, 188 F. Supp. 2d 549, 565 (E.D. Pa. 2002) (noting that “the FBI examiners got very high proficiency grades, but the tests they took did not. . . . [O]n the present record I conclude that the proficiency tests are less demanding than they should be.”); Jennifer L. Mnookin, Editorial, *A Blow to the Credibility of Fingerprint Evidence*, BOSTON GLOBE, Feb. 2,

manipulation of research,³³⁹ and (5) other instances of misidentifications.³⁴⁰ The FBI did not undertake a serious review of fingerprints until it was compelled to address the issue due to the negative publicity surrounding the Mayfield misidentification. Even then, however, the FBI still characterized the technique as “scientific.”³⁴¹

The scientific community continued to note the lack of research,³⁴² and the courts continued to ignore this fact.³⁴³ Indeed, in *United States*

2004 (“There are no systematic proficiency tests to evaluate examiners’ skill. Those tests that exist are not routinely used and are substandard.”).

339. See Donald Kennedy, Editorial, *Forensic Science: Oxymoron?*, SCIENCE, Dec. 5 2003, at 1625, 1625 (discussing the cancellation of a National Academies project designed to examine various forensic science techniques, including fingerprinting, because the DOJ and Defense insisted on a right of review that the Academy had refused to other grant sponsors); *United States v. Mitchell*, 365 F.3d 215, 255 (3d Cir. 2004) (“We are deeply discomfited by Mitchell’s contention—supported by Dr. Rau’s account of events, though contradicted by other witnesses—that a conspiracy within the DOJ intentionally delayed the release of the solicitation until after Mitchell’s jury reached a verdict. Dr. Rau’s story, if true, would be a damning indictment of the ethics of those involved.”). See generally Giannelli, *supra* note 201 (discussing the manipulation of forensic science research, including fingerprint research, by law enforcement).
340. See Simon A. Cole, *More Than Zero: Accounting for Error in Latent Fingerprint Identification*, 95 J. CRIM. L. & CRIMINOLOGY 985, 999 (2005) (discussing twenty-two cases involving misattribution of latent fingerprints). The misidentification cases include some that involved (1) verification by one or more other examiners, (2) examiners certified by the International Association of Identification, (3) procedures using a sixteen-point standard, and (4) defense experts who corroborated misidentifications made by prosecution experts. *Id.* at 1023–25; see also *CNN Presents: Reasonable Doubt* (CNN television broadcast Jan. 9, 2005) (discussing the misidentification of Ricky Jackson, who spent two years in prison).
341. See Bruce Budowle et al., *Review of the Scientific Basis for Friction Ridge Comparisons as a Means of Identification: Committee Findings and Recommendations*, FORENSIC SCI. COMM., Jan. 2006, at 1, https://www2.fbi.gov/hq/lab/fsc/backissu/jan2006/research/2006_01_research02.htm [<https://perma.cc/86NF-XSBQ>].
342. See Donald Kennedy & Richard A. Merrill, *Assessing Forensic Science*, ISSUES IN SCI. & TECH., Fall 2003, at 33, 34 (“The increased use of DNA analysis, which has undergone extensive validation, has thrown into relief the less firmly credentialed status of other forensic science identification techniques (fingerprints, fiber analysis, hair analysis, ballistics, bite marks, and tool marks). These have not undergone the type of extensive testing and verification that is the hallmark of science elsewhere.”); Zabell, *supra* note 305, at 164 (“Although there is a substantial literature on the uniqueness of fingerprints, it is surprising how little true scientific support for the proposition exists.”).
343. See, e.g., *United States v. Pena*, 586 F.3d 105, 110 (1st Cir. 2009) (“The district court did not abuse its discretion. Numerous courts have found expert testimony on fingerprint identification based on the ACE-V method to be sufficiently reliable under *Daubert*.”); *United States v. Abreu*, 406 F.3d

v. Baines,³⁴⁴ decided in 2009, the head of the FBI fingerprint section testified: “As to these ‘false positives’ . . . the FBI had ‘made, on average, about one erroneous identification every 11 years.’ The total number of identifications made has been about one million per year . . . so that the known actual error rate was about one per eleven million identifications.”³⁴⁵ Problematically, he merely assumed that all the other identifications were correct, thus disqualifying his analysis. Perhaps the most troubling aspect of this testimony was the lack of self-awareness for a person who claimed to be a scientist.³⁴⁶

3. NAS Forensic Science Report (2009)

Fingerprint examiners follow a procedure known as Analysis, Comparison, Evaluation, and Verification (ACE-V). The 2009 NAS report observed that since “the ACE-V method does not specify particular measurements or a standard test protocol . . . examiners must make subjective assessments throughout.”³⁴⁷ Thus, the ACE-V method is too “broadly stated” to “qualify as a validated method for this type of analysis.”³⁴⁸ The Report added that “[t]he latent print community in the United States has eschewed numerical scores and corresponding thresholds” and consequently relies “on primarily subjective criteria” in making the ultimate attribution decision.³⁴⁹ In making the decision, the examiner must draw on his or her personal experience to evaluate such factors as “inevitable variations in pressure,” but to date those factors have not been “characterized, quantified, or compared.”³⁵⁰ In addition, the Report gave short shrift to the zero-error-rate argument, finding that “claims that these analyses have zero error rates are not scien-

1304, 1307 (11th Cir. 2005) (“[T]he fingerprint evidence admitted in this case satisfied *Daubert*.”); *United States v. Janis*, 387 F.3d 682, 690 (8th Cir. 2004) (“We conclude the district court did not err in admitting the fingerprint expert’s testimony.”); *United States v. Mitchell*, 365 F.3d 215, 241 (3d Cir. 2004) (“We therefore accept that the error rate has been sufficiently identified to count this factor as strongly favoring admission of the [fingerprint] evidence.”).

344. 573 F.3d 979 (10th Cir. 2009).

345. *Id.* at 984.

346. See WHITE HOUSE PCAST REPORT, *supra* note 38, at 53 (“The fallacy is obvious: the expert simply *assumed without evidence* that every error in casework had come to light.”).

347. NAS FORENSIC REPORT, *supra* note 26, at 139.

348. *Id.* at 142.

349. *Id.* at 141.

350. *Id.* at 144. Moreover, examiners lack population frequency data to quantify the rarity or commonality of a particular type of fingerprint characteristic. *Id.*

tifically plausible.”³⁵¹ In conclusion, the Report outlined an agenda for the research it considered necessary “[t]o properly underpin the process of friction ridge identification”³⁵²

Several studies were published after the NAS Report.³⁵³ The most important was a FBI study published in 2011,³⁵⁴ which is discussed below.

4. White House PCAST Report (2016)

According to the White House PCAST report, “latent fingerprint analysis is a foundationally valid subjective methodology” and the FBI “has lead the way” by conducting the black-box study.³⁵⁵ Nevertheless,

[the] false positive rate . . . is substantial and is likely to be higher than expected by many jurors based on longstanding claims about the infallibility of fingerprint analysis. The false-positive rate could be as high as 1 error in 306 cases based on the FBI study and 1 error in 18 cases based on a study by another crime laboratory. In reporting results of [a] latent-fingerprint examination, it is important to state the false-positive rates based on properly designed validation studies³⁵⁶

Moreover, “testimony asserting any specific level of increased accuracy (beyond that measured in the studies) due to blind independent verification would be scientifically inappropriate, as speculation unsupported by empirical evidence.”³⁵⁷

351. *Id.* at 142; *see also id.* at 143 (“Some in the latent print community argue that the method itself, if followed correctly . . . has a zero error rate. Clearly, this assertion is unrealistic The method, and the performance of those who use it, are inextricably linked, and both involve multiple sources of error (e.g., errors in executing the process steps, as well as errors in human judgment).”).

352. *Id.* at 144.

353. *See* WHITE HOUSE PCAST REPORT, *supra* note 38, at 91–95.

354. Bradford T. Ulery et al., *Accuracy and Reliability of Forensic Latent Fingerprint Decisions*, 108 PROC. NAT’L ACAD. SCIS. 7733 (2011). The White House PCAST Report described the methodology of the report: “To attempt to ensure that the non-mated pairs were representative of the type of matches that might arise when police identify a suspect by searching fingerprint databases, the known prints were selected by searching the latent prints against the 58 million fingerprints in the [Automated Fingerprint Identification System] database and selecting one of the closest matching hits.” WHITE HOUSE PCAST REPORT, *supra* note 38, at 94.

355. WHITE HOUSE PCAST REPORT, *supra* note 38, at 9.

356. *Id.* at 9–10.

357. *Id.* at 96.

5. AAAS Fingerprint Report (2017)

In September 2017, the AAAS published an extensive report on fingerprint analysis.³⁵⁸ An accompanying news release, summarized the report's findings: "Courtroom testimony and reports stating or even those implying that fingerprints collected from a crime scene belong to a single person are indefensible and lack scientific foundation"³⁵⁹

The report reached a number of conclusions. First, claims that experts can identify the source of a latent print with 100 percent accuracy, are "clearly overstated and are now widely recognized as indefensible."³⁶⁰ Second, use of the term "identification" in reports and testimony even with qualifications "fail to deal forthrightly with the level of uncertainty that exists in latent print examination" and "cannot be justified scientifically."³⁶¹ Third, because of public misconceptions, experts:

should acknowledge: (1) that the conclusions being reported are opinions rather than facts (as in all pattern-matching disciplines), (2) that it is not possible for a latent print examiner to determine that two friction ridge impressions originated from the same source to the exclusion of all others; and (3) that errors have occurred in studies of the accuracy of latent print examination.³⁶²

The report went on to make several recommendations. Experts should "avoid statements that claim or imply that the pool of possible sources is limited to a single person. Terms like 'match,' 'identification,' 'individualization' and their synonyms, imply more than the science can sustain."³⁶³ In addition, experts should "be prepared to discuss forth-

358. See AAAS FINGERPRINT REPORT, *supra* note 39.

359. Anne Q. Hoy, *Fingerprint Source Identity Lacks Scientific Basis for Legal Certainty: More Research into Validity of Fingerprint Comparisons Needed, Forensic Report Says*, AAAS (Sept. 15, 2017), <https://www.aaas.org/news/fingerprint-source-identity-lacks-scientific-basis-legal-certainty> [<https://perma.cc/Z8SP-42KL>].

360. AAAS FINGERPRINT REPORT, *supra* note 39, at 9.

361. *Id.* at 10.

362. *Id.* at 11.

363. *Id.* The report suggested that:

[E]xaminers might say something like the following: "The latent print on Exhibit ## and the record fingerprint bearing the name XXXX have a great deal of corresponding ridge detail with no differences that would indicate they were made by different fingers. There is no way to determine how many other people might have a finger with a corresponding set of ridge features, but this degree of similarity is far greater than I have ever seen in non-matched comparisons."

rightly the results of research studies that tested the accuracy of latent print examiners on realistic known-source samples.”³⁶⁴

Despite the ruckus created by *Llera Plaza* and the Mayfield fiasco, examiner testimony remained unchanged. Testimony such as “zero error rates,” “matches to the exclusion of all other fingerprints,” and “100 percent certainty”—which had been used for decades—continued, while the fingerprint community remained oblivious that such statements were scientifically implausible. As with firearms identification, there is a “lost decade” during which more research could have been conducted. As one judge noted in a 2003 dissent: “The government has had ten years to comply with *Daubert*. It should not be given a pass in this case.”³⁶⁵ Those words were written fifteen years ago.

On a positive note, the Mayfield incident did trigger the FBI’s black box study, which was a significant achievement. Still, this study was released 100 years after the courts first admitted fingerprint evidence.³⁶⁶ The White House PCAST report found it “distressing” that properly constructed validation studies had only been conducted recently and only one study had been published in a peer-reviewed journal.³⁶⁷ *Daubert* has had little effect.³⁶⁸

III. FORENSIC SCIENCE RESEARCH

By now it is almost a truism that too many forensic disciplines are not grounded in science—and yet their adherents continue to claim the mantle of science. The 2009 NAS Report emphasized the “notable dearth of peer-reviewed, published studies establishing the scientific bases and validity of many forensic methods.”³⁶⁹ Indeed, the co-chair of the NAS committee, Judge Harry Edwards, later stated: “I think that the most important part of our committee’s report is its call for real

Id. at 11.

364. *Id.*

365. *United States v. Crisp*, 324 F.3d 261, 272 (4th Cir. 2003) (Michael, J., dissenting).

366. *See supra* note 300 and accompanying text.

367. WHITE HOUSE PCAST REPORT, *supra* note 38, at 95.

368. Some courts did, however, place limitations on the testimony. *See, e.g.*, *United States v. Mitchell*, 365 F.3d 215, 246 (3d Cir. 2004) (“Testimony at the *Daubert* hearing indicated that some latent fingerprint examiners insist that there is no error rate associated with their activities or that the examination process is irreducibly subjective. This would be out-of-place under Rule 702.”); *Commonwealth v. Gambora*, 933 N.E.2d 50, 61 n.22 (Mass. 2010) (“[O]pinions expressing absolute certainty about, or the infallibility of, an ‘individualization’ of a print should be avoided.”).

369. NAS FORENSIC REPORT, *supra* note 26, at 8.

science to support the forensic disciplines.”³⁷⁰ Not surprisingly, the report triggered extensive commentary.³⁷¹ One article cataloged the numerous ways in which forensic science has failed to develop a research culture³⁷² and argued that the “core values” of a scientific culture “are empiricism, transparency, and an ongoing critical perspective.”³⁷³ Another article documented the serious problems that have arisen when law enforcement controls forensic research.³⁷⁴

A. *National Commission on Forensic Science (2013-17)*

To its credit, the DOJ, in partnership with the National Institute of Standards and Technology (“NIST”), established the National Commission on Forensic Science in 2013. The commission’s task was to enhance the practice and improve the reliability of forensic science.³⁷⁵ Early on, the commission created a subcommittee on scientific inquiry and research, which undertook the task of reviewing bibliographies of foundational literature that had been compiled by various forensic disciplines.³⁷⁶ The subcommittee quickly concluded that even a “cursory review” of the bibliographies raised serious concerns. One basic problem involved the definition of foundational literature. According to the subcommittee, “[i]n some cases, it was unclear which literature citations are crucial to support the foundation of a particular forensic science

370. Honorable Harry T. Edwards, The National Academy of Sciences Report on Forensic Sciences: What it Means for the Bench and Bar, Address at Conference of Superior Court of the District of Columbia, Washington, D.C. (May 6, 2010), *in* 51 JURIMETRICS 1, 9 (2010).

371. See Paul C. Giannelli, *The 2009 NAS Forensic Science Report: A Literature Review*, 48 CRIM. L. BULL. 378 (2012) (listing numerous articles and conferences commenting on the report).

372. Jennifer L. Mnookin et al., *The Need for a Research Culture in the Forensic Sciences*, 58 U.C.L.A. L. REV. 725 (2011).

373. *Id.* at 742.

374. See Giannelli, *supra* note 201.

375. *National Commission on Forensic Science*, DOJ, <https://www.justice.gov/ncfs> [<https://perma.cc/AGU4-VDR8>] (last visited Oct. 19, 2017).

376. As a result of the 2009 NAS report, an Interagency Working Group—the Research Development Technology and Evaluation (RDT&E) of the National Science and Technology Council’s Subcommittee on Forensic Science—was tasked with identifying foundational research in the forensic sciences. The RDT&E committee requested Scientific Working Groups (SWGs) to address a series of discipline-specific questions. In response, literature compendiums were submitted to the RDT&E committee by several forensic working groups. NAT’L SCI. & TECH. COUNCIL, COMM. ON SCI., SUBCOMM. ON FORENSIC SCI., STRENGTHENING THE FORENSIC SCIENCES (2014).

discipline.”³⁷⁷ This finding led the subcommittee to define the term. Foundational, scientific literature should consist of “original research, substantive reviews of the original research, clinical trial reports, or reports of consensus development conferences.”³⁷⁸ Tellingly, the subcommittee felt compelled to add: “While other forms of dissemination of research and practice (e.g., oral and poster presentations at meetings, workshops, personal communications, editorials, dissertations, theses, and letters to editors) play an important role in science, the open, peer-reviewed literature is what endures and forms a foundation for further advancements.”³⁷⁹

The subcommittee’s second concern was that “[s]ome of the cited literature had not undergone a rigorous peer-review process.”³⁸⁰ Peer review by other members of a forensic discipline is not sufficient.³⁸¹ Many of the reviewers are not scientists, and there is the problem with role bias. According to the subcommittee, foundational research should be subjected to “rigorous peer review with independent external reviewers to validate the accuracy . . . [and] overall consistency with scientific norms of practice”³⁸² and “[p]ublished in a journal that is searchable using free, publicly available search engines”³⁸³ With few

377. NAT’L COMM’N ON FORENSIC SCI., DOJ, SCIENTIFIC LITERATURE IN SUPPORT OF FORENSIC SCIENCE AND PRACTICE 2 (2015).

378. *Id.*

379. *Id.*

380. *Id.*

381. *See* United States v. Crisp, 324 F.3d 261, 274 (4th Cir. 2003) (Michael, J., dissenting) (“Fingerprint examiners . . . have their own professional publications. . . . But unlike typical scientific journals, the fingerprint publications do not run articles that include or prompt critique or reanalysis by other scientists. Indeed, few of the articles address the principles of fingerprint analysis and identification at all”). *See also* Zabell, *supra* note 305, at 164 (“Although there is a substantial literature on the uniqueness of fingerprints, it is surprising how little true scientific support for the proposition exists.”).

382. NAT’L COMM’N ON FORENSIC SCI., *supra* note 377, at 3 (“Published in a journal that maintains a clear and publicly available statement of purpose that encourages ethical conduct such as disclosure of potential conflicts of interest integral to the peer review process.”).

383. *Id.* at 2. Other publication requirements include being: (1) “[p]ublished in a journal or book that has an International Standard Number (ISSN for journals; ISBN for books) and recognized expert(s) as authors (for books) or on its Editorial Board (for journals);” and (2) “[p]ublished in a journal that is indexed in databases that are available through academic libraries and other services (e.g. JSTOR, Web of Science, Academic Search Complete, and SciFinder Scholar).” *Id.* at 2–3.

exceptions, the disciplines considered above have not satisfied these requirements.³⁸⁴

Another recommendation—one on technical merit—provides: “All forensic science methodologies should be evaluated by an independent scientific body to characterize their capabilities and limitations in order to accurately and reliably answer a specific and clearly defined forensic question.”³⁸⁵ Significantly, the commission recommended that NIST be the independent scientific evaluator within the justice system.

384. Another commission document provided guidance for evaluating scientific literature. NAT'L COMM'N. ON FORENSIC SCI., DOJ, VIEWS OF THE COMMISSION REGARDING IDENTIFYING AND EVALUATING LITERATURE THAT SUPPORTS THE BASIC PRINCIPLES OF A FORENSIC SCIENCE METHOD OR FORENSIC SCIENCE DISCIPLINE (2016). This guidance includes:

- Is the problem or hypothesis clearly stated?
- Is the scope of the article clearly stated as appropriate (article, case study, review, technical note, etc.)?
- Is the literature review current, thorough, and relevant to the problem being studied?
- Does this work fill a clear gap in the literature or is it confirmatory and/or incremental?
- Are the experimental procedures clear and complete such that the work could be easily reproduced?
- Are the experimental methods appropriate to the problem?
- Are the methods fully validated to the necessary level of rigor (fit for purpose)?
- Are the data analysis and statistical methodology appropriate for the problem, and explained clearly so it can be reproduced?
- Are the experimental results clearly and completely presented and discussed?
- Are omissions and limitations to the study discussed and explained?
- Are the results and conclusions reasonable and defensible based on the work and the supporting literature?
- Are the citations and references complete and accurate?
- Are the references original (primary) and not secondary?
- Are funding sources and other potential sources of conflict of interest clearly stated?

Id. at 3.

385. NAT'L COMM'N. ON FORENSIC SCI., DOJ, VIEWS OF THE COMMISSION: TECHNICAL MERIT EVALUATION OF FORENSIC SCIENCE METHODS AND PRACTICES 2 (2016); *see also* NAT'L COMM'N. ON FORENSIC SCI., DOJ,

B. White House PCAST Report (2016)

Unlike the commission, which had a broad mandate, the White House PCAST Report focused only on the validation issue. It took pains to explain the concept of validation, noting that forensic methods must be based on empirical studies and be “repeatable, reproducible, and accurate, at levels that have been measured and are appropriate to the intended application.”³⁸⁶ The report recognized that forensic methods may be either objective or subjective. Foundational validity for objective methods “can be established by studying [and] measuring the accuracy, reproducibility, and consistency of each of its individual steps.”³⁸⁷ By definition, this approach is not possible with subjective techniques because they involve significant human judgment. Consequently, validity and reliability for these methods must be based on “black-box studies”—as if a “black box” is in the examiner’s head—in which numerous examiners make decisions on many independent tests in order to determine error rates.³⁸⁸

Importantly, the report also specified what does *not* qualify as validation: “[N]either experience, nor judgment, nor good professional practices (such as certification programs and accreditation programs, standardized protocols, proficiency testing, and codes of ethics) can substitute for actual evidence of foundational validity and reliability.”³⁸⁹ Moreover, expressions of *confidence* by individual examiners or a consensus among practitioners about accuracy cannot substitute for “error rates estimated from relevant studies.”³⁹⁰ In sum, empirical evidence is the “*sine qua non*” for establishing foundational validity.³⁹¹

PCAST also recommended that NIST conduct scientific evaluations of the validity of current and new forensic technologies: “[t]o ensure the scientific judgments are unbiased and independent, such evaluations

RECOMMENDATION TO THE ATTORNEY GENERAL TECHNICAL MERIT
EVALUATION OF FORENSIC SCIENCE METHODS AND PRACTICES 1 (2016).

386. WHITE HOUSE PCAST REPORT, *supra* note 38, at 4. Here, “repeatable” means an examiner reaches the same result when analyzing the same sample. “Reproducible” means that different examiners reach the same result when analyzing the same sample. The term “accurate” means that “an examiner obtains correct results both (1) for samples from the same source (true positives) and (2) for samples from different sources (true negatives).” Finally, “reliability” means “repeatability, reproducibility, and accuracy.” *Id.* at 47.

387. *Id.* at 5.

388. *Id.* at 5–6.

389. *Id.* at 6.

390. *Id.*

391. *Id.*

should be conducted by an agency which has no stake in the outcome.”³⁹²

In response, DOJ released a statement criticizing the report on the day of its release. According to DOJ, the PCAST Report “does not mention numerous published research studies which seem to meet PCAST’s criteria for appropriately designed studies providing support for foundational validity. That omission discredits the PCAST report as a thorough evaluation of scientific validity.”³⁹³ PCAST, in turn, invited all stakeholders to identify validity studies that it might have overlooked. “DOJ ultimately concluded that it had no additional studies for PCAST to consider.”³⁹⁴ Nor did the more than 400 papers submitted by twenty-six respondents cause PCAST to change its positions. The bottom line remained: “In science, empirical testing is the only way to establish the validity and degree of reliability of such an empirical method. Fortunately, empirical testing of empirical methods is feasible. There is no justification for accepting that a method is valid and reliable in the absence of appropriate empirical evidence.”³⁹⁵ However, most prior studies use “closed-set design.”³⁹⁶ In these studies, “the correct source of each questioned sample is always present; studies using the closed-set design have underestimated the false-positive and inconclusive rates by more than 100-fold.”³⁹⁷

IV. INDEPENDENT SCIENTIFIC REVIEW

As discussed above, the courts have too often failed to fulfill their “gatekeeper”³⁹⁸ function under *Daubert*. However, the *Daubert* Court

392. *Id.* at 14. The NAS report considered NIST before recommending an independent agency but rejected the idea because, at that time, NIST had limited ties to forensic science. *See* NAS Forensic Report, *supra* note 26, at 17.

393. FBI, COMMENTS ON PCAST REPORT TO THE PRESIDENT, FORENSIC SCIENCE IN FEDERAL CRIMINAL COURTS: ENSURING SCIENTIFIC VALIDITY OF PATTERN COMPARISON METHODS 1 (2016), <http://www.crime-scene-investigator.net/PDF/fbi-response-to-forensic-science-in-federal-criminal-courts-ensuring-scientific-validity-of-pattern-comparison-methods.pdf> [<https://perma.cc/DTF5-RJ5M>].

394. PRESIDENT’S COUNCIL OF ADVISORS ON SCI. AND TECH., AN ADDENDUM TO THE PCAST REPORT ON FORENSIC SCIENCE IN CRIMINAL COURTS 3 (2017), https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_forensics_addendum_finalv2.pdf [<https://perma.cc/68NX-6C6A>].

395. *Id.* at 4.

396. *Id.* at 7.

397. *Id.*

398. *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 597 (1993) (describing *Daubert* as prescribing “a gatekeeping role for the judge”).

also suggested that the adversary system would serve as a complementary safeguard, noting that “[v]igorous cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof are the traditional and appropriate means of attacking shaky but admissible evidence.”³⁹⁹

Yet, these “traditional” means have also proved inadequate. After the release of the NAS Report, some commentators focused on defense counsel’s incompetence.⁴⁰⁰ A 2009 study of the cases of 137 convicts exonerated by DNA profiling revealed that “[d]efense counsel rarely made any objections to the invalid forensic science testimony in these trials and rarely effectively cross-examined forensic analysts who provided invalid science testimony.”⁴⁰¹ One commentator summed it up this way:

Unlike the extremely well-litigated civil challenges, the criminal defendant’s challenge is usually perfunctory. Even when the most vulnerable forensic sciences—hair microscopy, bite marks, and handwriting—are attacked, the courts routinely affirm admissibility citing earlier decisions rather than facts established at a hearing. Defense lawyers generally fail to build a challenge with appropriate witnesses and new data. Thus, even if inclined to mount a *Daubert* challenge, they lack the requisite knowledge and skills, as well as the funds, to succeed.⁴⁰²

Although the defense bar bears some responsibility for *Daubert*’s failure, there are limits to what can be expected of overburdened and chronically underfunded public defenders when dealing with expert

399. *Id.* at 596 (citing *Rock v. Arkansas*, 483 U.S. 44, 61 (1987)).

400. See Gertner, *supra* note 36, at 790 (“[T]he NAS Report’s concerns will not be fully met until advocacy changes.”); D. Michael Risinger, *The NAS/NRC Report on Forensic Science: A Path Forward Fraught with Pitfalls*, 2010 UTAH L. REV. 225, 242 (2010) (“Criminal defense lawyers . . . are supposed to be the people who recognize bogus expert claims, challenge them, move to get them excluded, and undermine those that survive exclusion by knowledgeable, thorough, and telling cross-examination. On the whole, they don’t do any of these things very well.”).

401. Garrett & Neufeld, *supra* note 102, at 89.

402. Neufeld, *supra* note 25, at S110.

testimony. Better training for defense counsel—which is sorely needed—is not sufficient. Similarly, access to defense experts—also sorely needed—may not be adequate.⁴⁰³ Defense experts can challenge prosecution experts' methods and opinions but do not have the funds to conduct foundational research, nor can they act as independent evaluators of foundational research on an ongoing basis.⁴⁰⁴

An independent scientific review is required. NAS has published the most authoritative and independent reviews of forensic science. In addition to the forensic report, NAS issued reports on sound spectrometry (“voiceprints”),⁴⁰⁵ DNA profiling,⁴⁰⁶ polygraph testing,⁴⁰⁷ and bullet lead analysis.⁴⁰⁸ But NAS is not a governmental entity, and its work depends on outside funding. The justice system needs scientific expertise on a continuing basis—and thus institutionalized.

The National Commission's proposal, endorsed by PCAST, tasked NIST with the responsibility of evaluating forensic disciplines on an ongoing basis.⁴⁰⁹ It should be adopted. NIST has the expertise and independence for this task and has been increasingly involved in forensic research. There would be a cost, but litigating validity issues across the country at *Daubert* and *Frye* hearings also has a cost. Moreover, there

403. See generally Paul C. Giannelli, *Ake v. Oklahoma: The Right to Expert Assistance in a Post-Daubert, Post-DNA World*, 89 CORNELL L. REV. 1305 (2004) (discussing the legal disputes over the scope of *Ake*—e.g., whether it applied to non-capital cases and to non-psychiatric experts).

404. Although prosecutors are ethically obligated to avoid the use of flawed forensic testimony, the National District Attorneys Association recently asserted that bite mark evidence is a “reliable science”—an untenable position. See *supra* note 82 and accompanying text. See generally Paul C. Giannelli & Kevin C. McMunigal, *Prosecutors, Ethics, and Expert Witnesses*, 76 FORDHAM L. REV. 1493 (2007).

405. NAT'L RESEARCH COUNCIL, NAT'L ACAD. OF SCIS., ON THE THEORY AND PRACTICE OF VOICE IDENTIFICATION (1979).

406. NAT'L RESEARCH COUNCIL, NAT'L ACAD. OF SCIS., THE EVALUATION OF FORENSIC DNA EVIDENCE (1996); NATIONAL RESEARCH COUNCIL, NAT'L ACAD. OF SCIS., DNA TECHNOLOGY IN FORENSIC SCIENCE (1992).

407. NAT'L RESEARCH COUNCIL, NAT'L ACAD. OF SCIS., THE POLYGRAPH AND LIE DETECTION (2003).

408. NAT'L RESEARCH COUNCIL, NAT'L ACAD. OF SCIS., FORENSIC ANALYSIS: WEIGHING BULLET LEAD EVIDENCE (2004).

409. In 2005, Peter Neufeld proposed an institute of forensic science. Neufeld, *supra* note 25, at S113.

is a significant expense associated with rectifying the past mistakes that occurred with hair,⁴¹⁰ bullet lead,⁴¹¹ DNA,⁴¹² and arson cases.⁴¹³

Unfortunately, the current Attorney General did not renew the commission's charter in April 2017.⁴¹⁴ The independent scientists on the commission objected to this action, writing:

The Justice Department now proposes to improve forensic science by moving its oversight and development to an office within the department. This is precisely the opposite of what was recommended by the National Academy of Sciences report and the NCFS. It is a step backwards, because it reinforces the conditions that contributed to the current problems, namely, placing this discipline within the control of law enforcement and prosecutors. The Justice Department is home to many dedicated public servants including scientists whose passion for justice is unquestioned. However, DOJ is not a scientific body, and it is difficult to see how forensic science can become a true science in

410. See David R. Cameron, *Forum: Review of FBI Lab Suggests Huge Number of Wrongful Convictions*, NEW HAVEN REGISTER (April 26, 2015, 5:24 PM), <http://www.nhregister.com/opinion/article/Forum-Review-of-FBI-lab-suggests-huge-number-of-11353007.php> [<https://perma.cc/3NVM-2UN8>] (“The FBI review has identified roughly 2,500 cases that fit those criteria. The review is still in its early stages; thus far, it has considered 268 trials involving 284 defendants. It has found that lab examiners gave flawed testimony regarding the comparison of hairs in 257 of the 268 trials—more than 95 percent. Almost all of the examiners over that period—26 of 28—presented flawed testimony.”).

411. See *supra* note 248 and accompanying text.

412. See Lauren Kirchner, *Traces of Crime: How New York's DNA Techniques Became Tainted*, N.Y. TIMES (Sept. 4, 2017), <https://www.nytimes.com/2017/09/04/nyregion/dna-analysis-evidence-new-york-disputed-techniques.html> [<https://perma.cc/H46S-9AQF>] (explaining that two controversial techniques have been discontinued); Spencer S. Hsu, *FBI Notifies Crime Labs of Errors Used in DNA Match Calculations Since 1999*, WASH. POST (May 29, 2015), https://www.washingtonpost.com/local/crime/fbi-notifies-crime-labs-of-errors-used-in-dna-match-calculations-since-1999/2015/05/29/f04234fc-0591-11e5-8bda-c7b4e9a8f7ac_story.html?utm_term=.2eed2704c835 [<https://perma.cc/GUZ3-VC4E>] (“The FBI has notified crime labs across the country that it has discovered errors in data used by forensic scientists in thousands of cases to calculate the chances that DNA found at a crime scene matches a particular person, several people familiar with the issue said.”).

413. See *supra* Section 2.C.

414. See Spencer S. Hsu, *Sessions Orders Justice Dept. to End Forensic Science Commission, Suspend Review Policy*, WASH. POST (April 10, 2017), https://www.washingtonpost.com/local/public-safety/sessions-orders-justice-dept-to-end-forensic-science-commission-suspend-review-policy/2017/04/10/2dad-a0ca-1c96-11e7-9887-1a5314b56a08_story.html?utm_term=.f2d36117b56d [<https://perma.cc/XH7V-ZFWG>].

that environment. Science flourishes when free and independent; only then can the tools and technology that it creates be truly reliable.⁴¹⁵

The AAAS concurred, also stressing that independence “cannot be overstated” and expressing concern about the “inherent conflict of interest in having law enforcement overseeing the work of forensic labs on which police and prosecutors rely to win and defend convictions.”⁴¹⁶ The American Academy of Forensic Science also opposed the formation of an Office of Forensic Science within DOJ.⁴¹⁷ Instead of heeding this advice, the Attorney General appointed a prosecutor instead of a scientist to head the working group within the DOJ.⁴¹⁸

These recent events should be put in context. The 2009 NAS Report recommended the creation of an independent federal entity—the National Institute of Forensic Sciences—to oversee the field, including the establishment of a research agenda.⁴¹⁹ If adopted, this proposal would have wrest control of forensic science from law enforcement. The report provided the following justification: Some federal entities were “too wedded” to the status quo and “have failed to pursue a rigorous research agenda to confirm the evidentiary reliability of methodologies used in a number of forensic science disciplines.”⁴²⁰ As a result, these

415. Sunita Sah et al., *We Must Strengthen the “Science” in Forensic Science*, SCI. AM. (May 8, 2017), <https://blogs.scientificamerican.com/observations/we-must-strengthen-the-science-in-forensic-science/> [https://perma.cc/47YF-479M].

416. Spencer S. Hsu, *Science Organizations Renew Call for Independent U.S. Committee on Forensics*, WASH. POST (June 29, 2017), https://www.washingtonpost.com/local/public-safety/science-organizations-renew-call-for-independent-us-committee-on-forensics/2017/06/28/3ab8cdea-5b6a-11e7-9b7d-14576dc0f39d_story.html?utm_term=.802de0997045 [https://perma.cc/X46C-SY6U].

417. Betty Layne DesPortes, *Message from the AAFS President*, AM. ACAD. OF FORENSIC SCIS. (April 3, 2017), <https://news.aafs.org/presidents-message/message-from-the-aafs-president-april-2017/> [https://perma.cc/4T3K-34HA].

418. See Pema Levy, *Sessions' New Forensic Science Adviser Has a History of Opposing Pro-Science Reforms*, MOTHER JONES (Aug. 10, 2017, 8:38 AM), <http://www.motherjones.com/crime-justice/2017/08/sessions-new-forensic-science-adviser-has-a-history-of-opposing-pro-science-reforms/> [https://perma.cc/HAX9-QQDY] (“Attorney General Jeff Sessions has resisted efforts to rein in forensic science and hold it to higher standards. And this week, he appointed a senior adviser on forensics who has a history of opposing reforms that would bring more accountability and scientific rigor to forensic crime labs and expert testimony.”).

419. NAS FORENSIC REPORT, *supra* note 26, at 19 (Recommendation 1(c): “promoting scholarly, competitive peer-reviewed research and technical development in the forensic science disciplines”).

420. *Id.* at 18.

“agencies are not good candidates to oversee the overhaul of the forensic science community”⁴²¹ There is little question that the NAS was referring to National Institute of Justice and the FBI Laboratory. The report noted that, although both had provided “modest leadership” in forensic science, “neither entity has recognized, let alone articulated, a need for change or a vision for achieving it.”⁴²² Consequently, “advancing *science* in the forensic science enterprise is not likely to be achieved within the confines of DOJ.”⁴²³ In fact, law enforcement had manipulated science in the past by shaping the research agenda, limiting access to data, attacking experts who disagreed with its positions, and “spinning” negative reports.⁴²⁴

When Congress did not authorize the creation of the National Institute of Forensic Sciences, DOJ, to its credit, established the NCFCS. Most importantly, independent scientists were appointed to the commission.⁴²⁵ Placing science back under the DOJ now is a major and unjustified retreat.

CONCLUSION

This Article explained how the judiciary’s failure to fulfill its gatekeeper role can be traced back to its refusal to demand and properly evaluate foundational research—i.e., *Daubert’s* first factor, empirical testing. This failure has been systemic. Flawed forensic techniques such as bite mark analysis, microscopic hair comparisons, arson evidence, and comparative bullet lead analysis were routinely admitted into evidence without foundational research. In addition, firearms, toolmark, and fingerprint examiners repeatedly presented overstated and misleading conclusions. This Article also argued that the justice system may be institutionally incapable of applying *Daubert* in criminal cases because it does not have access to independent scientific expertise on an ongoing basis, and endorsed the NCFCS and PCAST recommendation that NIST should be tasked with this responsibility.

Even if an independent scientific review is not institutionalized, PCAST, NCFCS, and AAAS have provided guidance for courts dealing with admissibility challenges. First, the flawed techniques discussed in

421. *Id.*

422. *Id.* at 16. The Report also stated: “Neither has the full confidence of the larger forensic science community. And because both are part of a prosecutorial department of the government, they could be subject to subtle contextual biases that should not be allowed to undercut the power of forensic science.” *Id.*

423. *Id.* at 18.

424. See Giannelli, *supra* note 201.

425. Having served on the NCFCS, the Author believes that there should have been more independent scientists on the Commission.

this Article should be excluded. If used at all, bite mark analysis should be limited to exclusions and perhaps to closed universe situations.⁴²⁶ For hair analysis, mitochondrial DNA analysis is far superior to microscopy. Arson evidence should comport with NFPA 921 and the AAAS report. As noted above, the FBI has abandoned comparative bullet lead analysis.

Second, courts should focus, as *Daubert* requires, on foundational research. According to PCAST, “neither experience, nor judgment, nor good professional practices (such as certification programs and accreditation programs, standardized protocols, proficiency testing, and codes of ethics) can substitute for actual evidence of foundational validity and reliability.”⁴²⁷ The NCFS concurred.⁴²⁸

Third, subjective methods can be empirically tested. Such research has been conducted. PCAST identified studies in fingerprint and firearms identification that meet stringent standards.⁴²⁹ These studies show an error rate, which should be presented to the jury.⁴³⁰ However, more than one study is needed.

Fourth, in ruling on admissibility in firearms, toolmark, and fingerprint examination cases, courts should appreciate that there has been a “lost decade”—or two—during which rigorous research was not conducted.⁴³¹ Instead, the disciplines examined in this article vigorously

426. *See, e.g.*, *State v. Lambright*, No. M2012-02538-CCA-R3-CD, 2014 WL 46839, at *6 (Jan. 7, 2014) (“Dr. Tabor said that, considering the number of teeth that the victim’s sister had, she would not have been capable of producing the bite mark found on the victim’s nose and upper lip. It was Dr. Tabor’s expert medical opinion that a two-year-old was not capable of producing the nature, severity, number, and orientation of bites sustained by the victim.”).

427. WHITE HOUSE PCAST REPORT, *supra* note 38, at 6.

428. *See supra* note 379 and accompanying text (emphasizing the importance of published peer review research).

429. *See supra* note 367 and accompanying text (noting that closed-set studies are not sufficiently robust).

430. If examiners claim that there is no error rate, they should be required to explain why not. *See* WHITE HOUSE PCAST REPORT, *supra* note 38, at 19 (“In testimony, examiners should always state clearly that errors can and do occur, due both to similarities between features and to human mistakes in the laboratory.”).

431. This depends on when the clock started ticking. *Daubert* was decided in 1993. In 1995, the first challenge to handwriting testimony was decided. *United States v. Starzecpyzel*, 880 F. Supp. 1027 (S.D.N.Y. 1995). As noted above, the *Williamson* case on microscopic hair analysis was decided the same year. *See supra* notes 92–93 and accompanying text. *Llera Plaza* was decided in 2002. *See supra* notes 312–315 and accompanying text (addressing the admissibility of fingerprint testimony). And *Green* was decided in 2005. *See supra* notes 254–258 and accompanying text (addressing firearms identification testimony). Moreover, during this period numerous courts restricted the use of handwriting identification. *See, e.g.*, *United States v.*

resisted the views of independent scientists, and they were typically supported by prosecutors. For example, the wrongful execution of Cameron Todd Willingham, which triggered numerous scientific reviews, was not enough to persuade the Texas Fire Marshal Office that its evidence was flawed,⁴³² and it took a serendipitous event—the Madrid train bombing—to provoke fingerprint research.

In short, forensic evidence is in a “Catch-22” situation: Only the federal government has the resources to fund the needed independent research, but it has no incentive to do so as long as evidence continues to be admitted without proper limitations. Until more scientifically sound studies are published and peer-reviewed by independent scientists, courts should follow the approach adopted in *United States v. Glynn*,⁴³³ which permitted the expert to testify only that it was “more likely than not” that recovered bullets and cartridge cases came from a particular weapon.⁴³⁴

Fifth, the presentation of expert testimony needs to be controlled. Once again, PCAST made several recommendations, including:

Statements suggesting or implying greater certainty are not scientifically valid and should not be permitted. In particular, courts should never permit scientifically indefensible claims such as: “zero,” “vanishingly small,” “essentially zero,” “negligible,” “minimal,” or “microscopic” error rates; “100 percent certainty” or proof “to a reasonable degree of scientific certainty;” identification “to the exclusion of all other sources;” or a chance of error so remote as to be a “practical impossibility.”⁴³⁵

The NCFS also recommended against the use of the phrase “reasonable degree of scientific certainty”⁴³⁶ and the 2009 NAS report criticized the use of “zero error rates” and claims of infallibility.⁴³⁷ The recent AAAS fingerprint report found no scientific justification for statements of “identity” or “practical certainty” and cautioned against the use of terms such as “match,” “identification,” and “individualization.”⁴³⁸

Hines, 55 F. Supp. 2d 62, 73–74 (D. Mass. 1999) (holding that expert testimony concerning the general similarities and differences between a defendant’s handwriting exemplar and a stick up note was admissible but not the specific conclusion that the defendant was the author).

432. See *supra* note 161 and accompanying text.

433. 578 F. Supp. 2d 567 (S.D.N.Y. 2008).

434. *Id.* at 575.

435. WHITE HOUSE PCAST REPORT, *supra* note 38, at 19.

436. See *supra* note 283 and accompanying text.

437. See *supra* Section III.B.3.

438. AAAS FINGERPRINT REPORT, *supra* note 39, at 11.

Unfortunately, there is little reason to believe that examiners will give up their claims that there is a scientific foundation for their discipline. A subjective method without a meaningful protocol can hardly claim to be a science. This is not a new issue, as an editorial in the prestigious scientific journal, *Science*, entitled “*Forensic Science: Oxymoron?*” and written by the editor-in-chief, made the same point fifteen years ago.⁴³⁹ Similarly, the 2009 NAS Report commented: “The law’s greatest dilemma in its heavy reliance on forensic evidence . . . concerns the question of whether, and to what extent, there is *science* in any given forensic science discipline.”⁴⁴⁰ After *Daubert* hearings, one court “very quickly concluded that whatever else ballistics identification analysis could be called, it could not fairly be called ‘science.’”⁴⁴¹ The same is true of fingerprint examinations.

Courts should also guard against attempts to introduce claims of “science” through the backdoor by means of circumlocutions such as statements that firearms and fingerprint identifications are subjective techniques that are “based on science.” This is misleading. Many things are “based on science”—e.g., riding a bike, throwing a curve ball, and flying a kite.

Sixth, proficiency testing issues will continue to be litigated. These tests have long been suspect. They are not conducted blind and are not challenging.⁴⁴² The President of Collaborative Testing Services told the

439. See Kennedy, *supra* note 339 (discussing the cancellation of a National Academies project designed to examine various forensic science techniques, including fingerprinting, because the Departments of Justice and Defense insisted on a right of review that the Academy had refused to other grant sponsors).

440. NAS FORENSICS SCIENCES REPORT, *supra* note 26, at 9.

441. United States v. Glynn, 578 F. Supp. 2d 567, 570 (S.D.N.Y. 2008). See also United States v. Starzeczyzel, 880 F. Supp. 1027, 1038 (S.D.N.Y. 1995) (“[F]orensic document examination, despite the existence of a certification program, professional journals and other trappings of science, cannot, after *Daubert*, be regarded as ‘scientific . . . knowledge.’”); *id.* at 1041 (“[W]hile scientific principles may *relate* to aspects of handwriting analysis, they have little or nothing to do with the day-to-day tasks performed by [Forensic Document Examiners]. . . . [T]his attenuated relationship does not transform the FDE into a scientist.”).

442. For example, a fingerprint examiner from New Scotland Yard testified in one case that the FBI proficiency tests were deficient: “It’s not testing their ability. It doesn’t test their expertise. I mean I’ve set these tests to trainees and advanced technicians. And if I gave my experts these tests, they’d fall about laughing.” United States v. Llera Plaza, 188 F. Supp. 2d 549, 558 (E.D. Pa. 2002). The district court agreed, noting that “the FBI examiners got very high proficiency grades, but the tests they took did not. . . . [O]n the present record I conclude that the proficiency tests are less demanding than they should be.” *Id.* at 565. Similarly, in a trial involving handwriting comparisons, the court wrote:

NCFS “during its seventh meeting on August 10, 2015 that he has been under commercial pressure to make proficiency tests easier.”⁴⁴³

There were aspects of Mr. Cawley’s testimony that undermined his credibility. Mr. Cawley testified that he achieved a 100% passage rate on the proficiency tests that he took and that all of his peers *always* passed their proficiency tests. Mr. Cawley said that his peers *always* agreed with each others’ results and *always* got it right. Peer review in such a “Lake Woebegone” environment is not meaningful.

United States v. Lewis, 220 F. Supp. 2d 548, 554 (S.D.W. Va. 2002); *see supra* note 338 (discussing fingerprint proficiency testing).

443. NAT’L COMM. ON FORENSIC SCI., VIEWS OF THE COMMISSION: OPTIMIZING HUMAN PERFORMANCE IN CRIME LABORATORIES THROUGH TESTING AND FEEDBACK (May 27, 2016), <https://www.justice.gov/ncfs/file/864776/download> [<https://perma.cc/8BPS-DEER>].