SCIENTIFIC EXCELLENCE IN THE FORENSIC SCIENCE COMMUNITY

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INTRODUCTION

The practice of forensic science has existed for centuries. Each year, hundreds of thousands of cases are closed, suspects cleared, and offenders convicted through routine, accurate, and reliable forensic testing. Forensic testing includes chemical analysis to determine the nature of seized drugs; examinations performed on physical materials such as fibers, glass, and spent bullet casings; and examination of biological materials such as DNA.[1] Tests performed for each of these examinations, regardless of the materials examined, are strictly prescribed by laboratory policies, supported by peer-reviewed research, and lead to accurate and reliable results.[2]

A casual reader of recent media reports might be led to believe that forensic science lacks any scientific credibility.[3] However, this narrative is completely inaccurate and at odds with the scientific excellence that exists throughout the forensic science community. Forensic disciplines are grounded in diverse sciences such as chemistry, biology, and physics, and every forensic discipline practiced in an accredited forensic laboratory must demonstrate that it is reliable, accurate, and fit for its intended use.

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1. *See* *Laboratory Services*, FBI, https://www.fbi.gov/services/laboratory [https://perma.cc/6NQP-7YQ7] (last visited Feb. 26, 2018).
2. *Id.*
3. *See* 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/5FV8-BE4M].

I. ACCREDITATION AND ITS REQUIREMENTS

Accreditation and quality assurance systems assure the public that accredited organizations are competent and their results can be relied upon.[4] Many groups—such as the National Commission on Forensic Science,[5] the National Academy of Sciences,[6] the President's Council of Advisors on Science and Technology (PCAST),[7] and the Department of Justice (DOJ)—recognize that accreditation is critically important. In fact, in December 2015, the Attorney General directed that all DOJ forensic laboratories must obtain or maintain accreditation.[8]

Accreditation is an external assessment of a laboratory's technical competence to perform specific types of testing.[9] Accreditation demonstrates that a laboratory is performing its work correctly and consistent with appropriate standards.[10] To maintain this recognition, a laboratory is periodically reevaluated to ensure its ongoing compliance with accreditation requirements.[11] Laboratory accreditation is internationally regarded as a reliable indicator of technical competence, and it provides credibility and public confidence in laboratory operations.[12] An accredited laboratory's quality assurance system must include written standard operating procedures, proficiency testing, training programs, processes for technical review of reports, testimony monitoring, and many other requirements.[13]

4. *See* *Forensic Accreditation*, ANSI-ASQ NAT'L ACCREDITATION BD., https://www.anab.org/forensic-accreditation [https://perma.cc/E4WG-DHYC] (last visited Feb. 26, 2018).

5. *See* NAT'L COMM'N ON FORENSIC SCI., RECOMMENDATION ON UNIVERSAL ACCREDITATION (2015), https://www.justice.gov/archives/ncfs/file/477851/download [https://perma.cc/24BX-93RG].

6. *See* NAT'L RESEARCH COUNCIL, NAT'L ACADS., STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD 6 (2009), https://www.ncjrs.gov/pdffiles1/nij/grants/228091.pdf [https://perma.cc/9Q84-RC6S].

7. *See* President's Council of Advisors on Sci. & Tech., *An Addendum to the PCAST Report on Forensic Science in Criminal Courts*, WHITE HOUSE 4 (Jan. 6, 2017), https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_forensics_addendum_finalv2.pdf [https://perma.cc/8A4D-57HX] ("Forensic scientists cite the role of professional organizations, certification, accreditation, best practices manuals, and training within their disciplines. PCAST recognizes that such practices play a critical role in any professional discipline.").

8. Press Release, U.S Dep't of Justice, Justice Department Announces New Accreditation Policies to Advance Forensic Science (Dec. 7, 2015), https://www.justice.gov/opa/pr/justice-department-announces-new-accreditation-policies-advance-forensic-science [https://perma.cc/YFK7-NEYL].

9. *Forensic Accreditation*, *supra* note 4.

10. *See id.*

11. *See Laboratory Services*, *supra* note 1.

12. *The Advantages of Being Accredited*, INT'L LAB. ACCREDITATION COOPERATION (2015), http://ilac.org/?ddownload=898 [https://perma.cc/X9X8-ZLPZ].

13. *See Laboratory Services*, *supra* note 1.

According to the Bureau of Justice Statistics, 88 percent of the 409 publicly-funded forensic crime labs in the United States are accredited.[14] Unaccredited labs are often very small—less than ten people—and offer services in a limited number of disciplines. In addition to forensic laboratories, laboratories performing other types of tests are accredited according to the same international standard.[15] This includes environmental labs checking for levels of lead in groundwater, chemistry labs preparing chemicals for consumer use, or food labs ensuring the safety of our food supply.[16]

The validation of test methods is also an accreditation requirement. Validation is the "confirmation, through the provision of objective evidence (3.8.3), that the requirements (3.6.4) for a specific intended use or application have been fulfilled."[17] Validation experiments are designed to determine whether a method yields correct results when the right answer—the ground truth—is known. These are empirical tests that are conducted prior to laboratory implementation of a method.

Validation experiments are fundamentally different than equipment checks, which simply ensure that a particular piece of equipment is operating within defined parameters.[18] Validation may test the limitations of a method by analyzing a wide range of factors that are relevant and appropriate to a given application.[19] When validation provides insight regarding the limitations of a method, these limitations should be shared in legal proceedings.[20] The focus of validation is to confirm, through objective data, that the requirements for a specific intended use are fulfilled.[21] In contrast, method verification is the confirmation that the laboratory can properly use the method prior to its implementation.[22] However, neither method validation nor verification can produce an error rate for an entire discipline or an individual examiner.

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14. ANDREW M. BURCH ET AL., U.S. DEP'T OF JUSTICE, PUBLICLY FUNDED FORENSIC CRIME LABORATORIES: QUALITY ASSURANCE PRACTICES, 2014, at 1 (2016), https://www.bjs.gov/ content/pub/pdf/pffclqap14.pdf [https://perma.cc/MYS4-L6JS].

15. *See ISO/IEC 17025:2017*, ISO, https://www.iso.org/obp/ui/#iso:std:iso-iec: 17025:ed-3:v1:en [https://perma.cc/27J4-Y43U] (last visited Feb. 26, 2018). The International Organization for Standardization (ISO) is an independent, non-governmental international organization with a membership of 161 national standards bodies. *All About ISO*, ISO, https://www.iso.org/about-us.html [https://perma.cc/CP5P-BE7M] (last visited Feb. 26, 2018). The members develop voluntary, consensus-based market-relevant standards. *Id.* The ISO/IEC 17025:2017 standard focuses specifically on requirements for the competence, impartiality, and consistent operation of testing and calibration laboratories. *See ISO/IEC 17025:2017*, *supra*.

16. *Forensic Accreditation*, *supra* note 4.

17. *ISO 9000:2015*, ISO, https://www.iso.org/obp/ui/#iso:std:iso:9000:ed-4:v1:en [https://perma.cc/ZLW3-RG7L] (last visited Feb. 26, 2018).

18. *See Validation Information for Public DNA Laboratories*, NAT'L INST. JUST., https://www.nij.gov/topics/forensics/lab-operations/Pages/validation.aspx [https://perma.cc/74J5-Q97C] (last visited Feb. 26, 2018).

19. *See id.*

20. *See id.*

21. *See id.*

22. *ISO/IEC 17025:2017*, *supra* note 15.

Forensic examiners must complete extensive training to be qualified to perform casework in accredited laboratories.[23] Training programs can be one to two years, or longer, and require examiners to perform analyses on samples with a known correct answer.[24] The examiner must also demonstrate a thorough understanding of the science behind the method employed and an understanding of lab policies, procedures, legal rules, evidence handling, etc.[25] The examiner must undergo oral examinations, mock trials, and competency tests for which the correct answer is known.[26] In addition, all examiners must demonstrate competency to apply the processes accurately and reliably before they are assigned actual cases.[27] Once qualified to conduct casework in an accredited laboratory, every examiner undergoes continual competency monitoring through proficiency tests administered at least once per year.[28]

Testimony monitoring is also a requirement for accredited laboratories.[29] The Federal Bureau of Investigation (FBI) Laboratory requires that examiners request a transcript for each testimony provided.[30] FBI examiners also must follow approved standards for scientific testimony and reports,[31] which document the acceptable range of conclusions expressed in both laboratory reports and testimony.[32] The DOJ is developing similar documents called Uniform Language for Testimony and Reports,[33] as well as a testimony-monitoring framework, which will apply to all DOJ laboratories.[34] The purpose of these testimony-monitoring activities is to prevent examiner testimony from exceeding scientific limitations.[35]

Forensic science research plays a critical role in the culture of continuous improvement that is part of a rigorous quality assurance program. Such research seeks to develop new capabilities while providing enhancement and support for existing capabilities. For example, forensic science

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23. *See generally* AM. SOC'Y CRIME LAB. DIRS./LAB. ACCREDITATION BD., SUPPLEMENTAL REQUIREMENTS FOR THE ACCREDITATION OF FORENSIC SCIENCE TESTING LABORATORIES (2011), http://des.wa.gov/sites/default/files/public/documents/About/1063/RFP/Add7Item4 ASCLD.pdf [https://perma.cc/45LX-4NZU].

24. *Id.* at 21.

25. *See id.* at 11–13.

26. *Id.*

27. *Id.*

28. *Id.* at 18.

29. U.S. GOV'T ACCOUNTABILITY OFFICE, CHEMISTRY AND TRACE EVIDENCE UNITS GENERALLY ADHERE TO QUALITY STANDARDS, BUT COULD REVIEW MORE EXAMINER TESTIMONIES (2017), https://www.gao.gov/assets/690/685507.pdf [https://perma.cc/RS9V-XHKV].

30. *Id.*

31. *See Forensic Science*, U.S. DEP'T JUST., https://www.justice.gov/archives/dag/forensic-science#prop [https://perma.cc/APD8-AZLW] (last visited Feb. 26, 2018) (denoting laboratory standards and reporting requirements).

32. *Id.*

33. *See id.*

34. Press Release, U.S Dep't of Justice, Justice Department Announces Plans to Advance Forensic Science (Aug. 7, 2017), https://www.justice.gov/opa/pr/justice-department-announces-plans-advance-forensic-science [https://perma.cc/56VJ-F39E].

35. *See id.*

research and development in the 1980s provided the groundwork for monumental progress in the development and advancement of DNA testing.[36] In addition, the FBI's studies on latent print examinations have provided tremendous insight into the reliability of latent fingerprint examination and the decision-making process of latent print examiners.[37] The FBI recognizes the importance of these studies and has begun similar studies in three pattern-comparison disciplines.

Accreditation, validation, research, training, and testimony monitoring are important activities for demonstrating the reliable practice of forensic science. Together, they help ensure the overarching goals of finding the right answer, correctly communicating that answer, and continuously improving our ability to deliver quality results.

II. VALIDATION STUDIES

Validation is the process used to determine whether or not a method or technique is fit for a given application. The PCAST Report ("Report") asserts that a forensic discipline must demonstrate "foundational validity" and "validity as applied" for a discipline to be scientifically valid and reliable.[38] However, the Report conflates two disparate topics in its discussion of "validity."

The authors claim that foundational validity requires the performance of multiple "black box" studies.[39] However, black-box studies are decision-analysis experiments performed across a broad range of practitioners, and do not validate a specific methodology.[40] The authors do not offer any scientific basis to support their assertions. At the same time, the authors encourage federal judges to "take into account the appropriate scientific criteria for assessing scientific validity" in their "gatekeeper" role.[41] The authors use their unique criteria in their effort to discredit numerous validation studies.[42] They argue that, because the research reviewed did not

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36. *See* Peter Gill et al., *Forensic Application of DNA 'Fingerprints,'* 318 NATURE 577 (1985).

37. *See generally* R. Austin Hicklin et al., *Assessing the Clarity of Friction Ridge Impressions*, 226 FORENSIC SCI. INT'L 106 (2013); R. Austin Hicklin et al., *Latent Fingerprint Quality: A Survey of Examiners*, 61 J. FORENSIC IDENTIFICATION 385, 385–419 (2011); Bradford T. Ulery et al., *Changes in Latent Fingerprint Examiners' Markup Between Analysis and Comparison*, 247 FORENSIC SCI. INT'L 54 (2015); Bradford T. Ulery et al., *Measuring What Latent Fingerprint Examiners Consider Sufficient Information for Individualization Determinations*, 9 PLOS ONE 1 (2014); Bradford T. Ulery et al., *Repeatability and Reproducibility of Decisions by Latent Fingerprint Examiners*, 7 PLOS ONE 1 (2012); Bradford T. Ulery et al., *Understanding the Sufficiency of Information for Latent Fingerprint Value Determinations*, 230 FORENSIC SCI. INT'L 99 (2013).

38. PRESIDENT'S COUNCIL OF ADVISORS ON SCI. & TECH., EXEC. OFFICE OF THE PRESIDENT, FORENSIC SCIENCE IN CRIMINAL COURTS: ENSURING SCIENTIFIC VALIDITY OF FEATURE-COMPARISON METHODS 44–56 (2016) [hereinafter PCAST REPORT], https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_forensic_science_report_final.pdf [https://perma.cc/VJB4-5JVQ].

39. *Id.*

40. *See id.* at 65–66.

41. *Id.* at 41, 142.

42. *See generally id.*

fit the authors' validation paradigm, these scientific disciplines lack empirical evidence to support PCAST's approval as valid science.[43] This position ignores much peer-reviewed research, overlooks critical aspects of many studies, and fails to acknowledge the empirical value of these studies.

For example, in the firearms discipline, PCAST ignores a large number of studies based on their criticism of the test designs. Two studies were discarded because for using a "within-set comparison" design in which the samples were examined in a pair-wise approach.[44] The Report asserted that it was "impossible to estimate the false positive rate among conclusive examinations, which is the key measure for consideration" as the reason for rejecting these studies.[45] However, these same studies showed that of 1037 different-source comparisons performed, *no* false identifications or false eliminations were reported.[46] PCAST dismissed four additional studies based on the use of a "closed-set" experimental design because the source gun was always present.[47] PCAST opined that "the closed-set design is problematic in principle," and was therefore "not appropriate for assessing scientific validity."[48] In these studies, the researchers utilized particularly challenging samples that employed consecutively-manufactured firearms.[49] This represents the worst-case scenario for toolmarks that carry over from one machined part to the next. Despite these challenging samples, all of these studies showed that firearms examiners reliably and accurately associated the questioned toolmarks with the correct source.[50] In a final example, PCAST ignored another study due to the partly open-set design, in which some of the questioned samples did not have a matching known standard.[51] Each of these studies provide important insights into the

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43. *See id.*

44. *Id.* at 107 & nn.319–20; *see also* Charles S. DeFrance & Michael D. Van Arsdale, *Validation Study of Electrochemical Rifling*, 35 ASS'N FIREARM & TOOLMARK EXAMINERS J. 1 (2003); Erich D. Smith, *Cartridge Case and Bullet Comparison Validation Study with Firearms Submitted in Casework*, 36 ASS'N FIREARM & TOOLMARK EXAMINERS J. 130 (2005).

45. PCAST REPORT, *supra* note 38, at 107.

46. *Id.* at 107 n.320.

47. *Id.* at 108–09 & nn.324–28; *see also* David J. Brundage, *The Identification of Consecutively Rifled Gun Barrels*, 30 ASS'N FIREARM & TOOLMARK EXAMINERS J. 438, 438–44 (1998); Thomas G. Fadul Jr. et al., *An Empirical Study to Improve the Scientific Foundation of Forensic Firearm and Tool Mark Identification Utilizing Ten Consecutively Manufactured Slides*, 45 ASS'N FIREARM & TOOLMARK EXAMINERS J. 376, 376–93 (2013); James E. Hamby et al., *The Identification of Bullets Fired from Ten Consecutively Rifled 9mm Ruger Pistol Barrels: A Research Project Involving 507 Participants from Twenty Countries*, 41 ASS'N FIREARM & TOOLMARK EXAMINERS J. 99, 99–100 (2009); Angela Stroman, *Empirically Determined Frequency of Error in Cartridge Case Examinations Using a Declared Double-Blind Format*, 46 ASS'N FIREARM & TOOLMARK EXAMINERS J. 157, 157–75 (2014).

48. PCAST REPORT, *supra* note 38, at 109.

49. *See supra* note 47 and accompanying text.

50. *See supra* notes 44–49 and accompanying text.

51. PCAST REPORT, *supra* note 38, at 108–09 & n.326; *see also* THOMAS G. FADUL JR. ET AL., MIAMI-DADE POLICE DEP'T CRIME LAB., AN EMPIRICAL STUDY TO IMPROVE THE SCIENTIFIC FOUNDATION OF FORENSIC FIREARM AND TOOL MARK IDENTIFICATION UTILIZING CONSECUTIVELY MANUFACTURED GLOCK EBIS BARRELS WITH THE SAME EBIS PATTERN (2013), www.ncjrs.gov/pdffiles1/nij/grants/244232.pdf [https://perma.cc/6UKW-6FYF].

science of firearms analysis and additional empirical support for the validity of the discipline.

III. ERROR RATE STUDIES SHOULD NOT BE MISTAKEN FOR VALIDATION

The Report claimed that "the foundational validity of subjective methods can be established *only* through empirical studies of examiner's performance . . . such studies are referred to as 'black-box' studies."[52] Black-box studies are a way to analyze the decisions made by a range of examiners under defined conditions.[53] However, black-box studies should not be mistaken as a way to establish the validity of a specific method or *the* error rate for an entire discipline. The entire body of research and testing relative to a particular forensic method provides support for its scientific validity—not simply the number of black-box studies performed.

Some forensic commentators conflate distinct issues when criticizing the reliability of forensic disciplines.[54] These issues concern whether: (1) a forensic discipline is scientifically valid and based upon sound scientific principles; (2) individual practitioners can identify the right answer when that answer is known (personal error rate); (3) different practitioners obtain the same answer when reviewing the same materials and data; and (4) there is a universal error rate for a specific discipline.[55] The Report focuses on the fourth issue,[56] which has nothing to do with the method validity, but rather the decisions made by examiners under a defined range of conditions. Furthermore, it is problematic when scientific validity is confused with the legal standard for admissibility. Unfortunately, the Report only exacerbates the confusion.

Regarding microscopic hair analysis, PCAST discussed a 2002 paper by Max M. Houck and Bruce Budowle.[57] The study found that in 11 percent of cases in which hairs were microscopically associated, DNA analysis revealed that the samples originated from different individuals.[58] Unfortunately, many misinterpret the results of this study to mean that microscopic hair comparison has an 11 percent error rate. PCAST correctly noted that these associations may not have been incorrect but, instead, were simply characteristics that were shared by chance.[59] Because microscopic hair comparison involves class-level associations, hair cannot be used as a

52. PCAST REPORT, *supra* note 38, at 49.

53. *Id.*

54. *See generally* KELLY PYREK, FORENSIC SCIENCE UNDER SIEGE: THE CHALLENGES OF FORENSIC LABORATORIES AND THE MEDICO-LEGAL INVESTIGATION SYSTEM (2007).

55. *See id.* at 241–43 (discussing the need to disclose errors, error rates, and sources of errors in forensic science experiments to maintain confidence in the scientific integrity of the results).

56. *See generally* PCAST REPORT, *supra* note 38.

57. *Id.* at 28 & n.33; *see also* Max M. Houck & Bruce Budowle, *Correlation of Microscopic and Mitochondrial DNA Hair Comparisons*, 47 J. FORENSIC SCIS. 1, 1–4 (2002).

58. PCAST REPORT, *supra* note 38, at 28.

59. *Id.*

unique identifier.[60] One key point of the Houck and Budowle study that PCAST did not discuss was the combined power of discrimination by the joint use of microscopic and mitochondrial DNA analysis.[61] Instead, the Report characterized the false positive rate for microscopic hair comparison in the study as applicable to the technique in general.[62]

CONCLUSION

Science continuously evolves and is built upon observation, study, and experience that spans hundreds of years. The justice system would not be well served by the exclusion of reliable forensic methods and techniques that provide valuable information to a wide range of stakeholders. Critical reviews of past and current practices assist in the continual process of evaluation and improvement. However, they do not invalidate the entire body of past scientific research and achievement.[63]

60. Class-level evidence encompasses a group of objects or persons with characteristics that are shared by the group. The characteristics are not unique to a particular object or person but serve to place the evidence into a smaller group of objects.

61. Houck & Budowle, *supra* note 57, at 2–4. *See generally* PCAST REPORT, *supra* note 38.

62. *See generally* PCAST REPORT, *supra* note 38.

63. *See* ERNST MAYR, THE GROWTH OF BIOLOGICAL THOUGHT: DIVERSITY, EVOLUTION, AND INHERITANCE 831 (1982) ("All interpretations made by a scientist are hypotheses, and all hypotheses are tentative. They must forever be tested and they must be revised if found to be unsatisfactory. Hence, a change of mind in a scientist, and particularly in a great scientist, is not only not a sign of weakness but rather evidence for continuing attention to the respective problem and an ability to test the hypothesis again and again.").