

The National Commission on Forensic Science: Impactful or Ineffectual?

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The Commission lacked adequate representation from the state and local practitioner community, was dominated by the defense community, and failed to produce work products of significance for the forensic science community.¹ The importance of the NCFS [was] as a ‘forensic science sandbox’ where all interested stakeholders and the broader scientific community can come together.²

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I. INTRODUCTION

In April 2017, the National Commission on Forensic Science (NCFS or “the Commission”) was forced to disband as a result of Attorney General Jeff Sessions’s decision to not renew the Commission’s charter. The

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¹ Press Release, Nat’l Dist. Attys. Ass’n, National District Attorneys Association Applauds Expiration of National Commission on Forensic Science (Apr. 10, 2017), <http://www.ndaa.org/pdf/NDAA%20Statement%20on%20Expiration%20of%20National%20Commission%20on%20Forensic%20Science.pdf>.

² Betty Layne DesPortes, *The National Commission on Forensic Science April 10-11, 2017, Meeting*, AM. ACAD. OF FORENSIC SCI. (Apr. 13, 2017), <https://news.aafs.org/aafs-news/the-national-commission-on-forensic-science-april-10-11-2017-meeting/>.

NCFS's demise raises the question: did the NCFS effect actual improvements in forensic science, merely redirect and change the conversation, or prove ineffectual? Perhaps peculiarly in regard to a body that was devoted to ensuring that forensic evidence should be data-based and data-reported, the response to these questions will be in part anecdotal, in part intuitive, and in part speculative. The over-arching conclusion will be "some of each"—with some actual improvements and substantial changes in the conversation but with significant failure or inadequacy mixed in.

This Article will trace the NCFS from its immediate antecedent roots—in particular, the 2009 National Academy of Sciences Report STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD³ ("NAS Report" or "the Report")—showing the Commission's origin was a product of a legislative failure to enact reforms proposed by the National Research Council (NRC). It will then survey the work product of the Commission and attempt to assess the impact of some of the "views"⁴ and "recommendation"⁵ documents that were adopted. This Article then turns to the judicial response to both the STRENGTHENING FORENSIC SCIENCE Report and the work of the NCFS. It thereafter attempts to trace the impact of one particular aspect of NCFS work, its "human factors"⁶ focus on issues relating to cognitive bias. This Article concludes with a limited attempt to predict the future, specifically in the context of the current Department of Justice's intent to "advance forensic science and help combat the rise in violent crime."⁷

II. THE ANTECEDENTS OF THE COMMISSION AND THE BIRTH OF THE NCFS

Debates may never resolve when science—or what was believed in its time to be science—was first used to assist in resolving a criminal investigation; but by one account, this occurred in roughly 1200 A.D. when principles were suggested to aid in the determination of whether a death occurred as a result of strangulation or an accidental drowning.⁸ Whatever

³ NAT'L RES. COUNCIL OF THE NAT'L ACAD. OF SCIS., STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD (2009), <https://www.ncjrs.gov/pdffiles1/nij/grants/228091.pdf> [hereinafter NAS REPORT].

⁴ See text *infra* note 47.

⁵ *Id.*

⁶ See text *infra* notes 115–46.

⁷ Press Release, Dep't of Justice, Attorney General Jeff Sessions Announces New Initiatives to Advance Forensic Science and Help Counter the Rise in Violent Crime (Apr. 10, 2017), <https://www.justice.gov/opa/pr/attorney-general-jeff-sessions-announces-new-initiatives-advance-forensic-science-and-help>.

⁸ This application of then-understood science to a forensic purpose was recorded in the book Hsi Duan Yu (*The Washing Away of Wrongs*), which appeared in 1248. José R. Almíral & Kenneth G. Furton, *The Importance of Standards in Forensic Science*,

the start date is, it cannot be denied that by the twentieth century, police crime labs and crime scene investigation units became prevalent.⁹

The recognition of the risk of error¹⁰ and the acknowledgment of limits in forensic discipline analysis and testimony in the United States came more slowly. Focus came first to the issue of underfunding and the consequences thereof—inadequate equipment and the inability to hire qualified personnel.¹¹ What came next were proficiency concerns, with a report in 1978 concluding that “[a] wide range of proficiency levels among the nation’s laboratories exists, with several evidence types posing serious difficulties for the laboratories.”¹² A subsequent review, addressing results of proficiency tests conducted between 1978 and 1991, concluded that proficiency varied significantly depending upon the discipline at issue.¹³

It was under the leadership of then-Attorney General Janet Reno that attention was drawn to forensic *error* in terms of erroneous conclusions or scientific evidence being relied on for more than it could properly prove.¹⁴ The Report was a *post-mortem* assessment of what went wrong in the first twenty-eight cases where individuals were convicted of crimes and subsequently exonerated by DNA evidence. Regarding the use of forensic evidence to support what proved to be erroneous convictions, the report concluded that:

[i]n many of the study cases, according to documentation examined and those interviewed, scientific experts had convinced juries that non-DNA analyses of blood or hair were reliable

STANDARDIZATION NEWS (Phila. Apr. 1995), <http://www.scafo.org/library/140502.html>.

⁹ *Id.*

¹⁰ The term “error” here references when application of a forensic discipline has linked crime scene or other evidence to a particular individual but that association is wrong or without sufficient foundation to support the conclusion.

¹¹ Kenneth E. Melson, *Embracing the Path Forward: The Journey to Justice Continues*, 36 NEW ENG. J. CRIM. & CIV. CONFINEMENT 197, 199 (2010) (discussing the 1967 report “The Challenge of Crime in a Free Society” and the 1973 report “National Advisory Commission on Criminal Justice Standards & Goals—Task Force on Police”).

¹² JOSEPH L. PETERSON ET AL., LABORATORY PROFICIENCY TESTING RESEARCH PROGRAM 3 (1978).

¹³ Joseph L. Peterson et al., *Crime Laboratory Proficiency Testing Results, 1978–1991, II: Resolving Questions of Common Origin*, 40 J. FORENSIC SCI. 1009, 1011 (1995).

¹⁴ EDWARD CONNORS ET AL., NAT’L INST. OF JUSTICE, CONVICTED BY JURIES, EXONERATED BY SCIENCE: CASE STUDIES IN THE USE OF DNA EVIDENCE TO ESTABLISH INNOCENCE AFTER TRIAL (1996), <https://www.ncjrs.gov/pdffiles/dnaevid.pdf>. Another concern, that of malfeasance by laboratory personnel, also became of note in the 1990s. See, e.g., Paul C. Giannelli, *The Abuse of Scientific Evidence in Criminal Cases: The Need for Independent Crime Laboratories*, 4 VA. J. SOC. POL’Y & L. 439 (1997). The problem was not limited to the United States. David E. Bernstein, *Junk Science in the United States and the Commonwealth*, 21 YALE J. INT’L L. 123 (1996) (discussing cases in Canada, Australia, New Zealand, and England).

enough to clearly implicate the defendants. Scientific conclusions based on non-DNA analyses, however, were proven less discriminating and reliable than those based on DNA tests. These findings point to the need for the scientific community to take into account the reliability of non-DNA forensic analyses vis-à-vis DNA testing in identifying the sources of biological evidence.¹⁵

Others were not so muted. The book *CONVICTED BY JURIES* included commentaries by “prominent experts from a variety of disciplines.”¹⁶ that were more explicit and pointed. Professor Edward Imwinkelreid asserted that “[i]n roughly two-thirds of the cases, the triers heard testimony based on traditional forms of expertise, such as hair analysis—testimony that passes muster under the *Frye* standard but that, again, turned out to be erroneous.”¹⁷ Professor Walter Rowe emphasized that “[a] second important issue is the number of cases in which there was misconduct on the part of the prosecution’s scientific experts.”¹⁸

Yet, DNA exonerations continued apace¹⁹ So, too, did awareness of the risk of error and the corresponding limits of forensic disciplines. Most telling in this regard was the FBI latent print debacle involving Brandon Mayfield. After a March 2004 terrorist bombing in Spain, Spanish authorities sought the assistance of law enforcement, and in particular the FBI, to seek a suspect based upon fingerprints found on a bag of detonators found near the scene.²⁰ A search for similar prints through the latent print database led to the identification of Mayfield as the bomber. As described in subdued terms by the post-debacle report,

[a]pproximately two weeks after Mayfield was arrested, the Spanish National Police (SNP) informed the FBI that it had identified an Algerian national as the source of the fingerprint on the bag. After the FBI Laboratory examined the fingerprints of the Algerian, it withdrew its identification of Mayfield and he was released from custody.²¹

¹⁵ CONNORS ET AL., *supra* note 14, at 25.

¹⁶ *Id.* at iv.

¹⁷ *Id.* at xiv.

¹⁸ *Id.* at xvi.

¹⁹ *See Exonerated: Cases by the Numbers*, CNN (Dec. 4, 2013), <https://www.cnn.com/2013/12/04/justice/prisoner-exonerations-facts-innocence-project/index.html>.

²⁰ OFF. OF THE INSPECTOR GEN., U.S. DEP’T OF JUST., *A REVIEW OF THE FBI’S HANDLING OF THE BRANDON MAYFIELD CASE 1* (Jan. 2006), <https://oig.justice.gov/special/s0601/exec.pdf>.

²¹ *Id.*

The Mayfield error was of particular significance because the FBI had maintained that the latent print examination methodology it applied had a “zero” error rate.²² It also was a highly publicized error.²³ The highly publicized error was a significant event in the lead-up to the National Academy of Science review of the state of forensic discipline practice and testimony.

The origins of the NAS Report have been detailed elsewhere by this author.²⁴ The February 2009 release confirmed several problems with forensic discipline evidence:

- “Often there are no standard protocols governing forensic practice in a given discipline.”²⁵
- “[E]ven when protocols are in place[,] . . . they often are vague and not enforced in any meaningful way.”²⁶
- “With the exception of nuclear DNA analysis, . . . no forensic method has been rigorously shown to have the capacity to consistently, and with a high degree of certainty, demonstrate a connection between evidence and a specific individual or source.”²⁷

Of significance to this article was the call for forensic discipline governance. As expressed in the report’s Executive Summary,

The committee believes that what is needed to support and oversee the forensic science community is a new, strong, and independent entity that could take on the tasks that would be assigned to it in a

²² See, e.g., NAS REPORT, *supra* note 3, at 143. Indeed, the FBI persisted in making such statements. “Mr. Meagher testified that the rate of error for latent fingerprint identifications is zero.” *United States v. Baines*, 573 F.3d 979, 987 (10th Cir. 2009).

²³ See, e.g., Susan Schmidt & Blaine Harden, *U.S. Frees Oregon Lawyer Jailed in Madrid Bombings*, WASH. POST (MAY 21, 2004), <http://www.washingtonpost.com/wp-dyn/articles/A43732-2004May20.html>; Sarah Kershaw & Eric Lichtblau, *Bomb Case Against Lawyer is Rejected*, N.Y. TIMES (May 25, 2004), <http://www.nytimes.com/2004/05/25/us/bomb-case-against-lawyer-is-rejected.html>; Sharon Begley, *Fingerprint Matches Come Under More Fire As Potentially Fallible*, WALL ST. J. (Oct. 7, 2005), <https://www.wsj.com/articles/SB112864132376462238>.

²⁴ See Jules Epstein, *Preferring the “Wise Man” to Science: The Failure of Courts and Non-Litigation Mechanisms to Demand Validity in Forensic Matching Testimony*, 20 WIDENER L. REV. 81, 85 (2014).

²⁵ NAS REPORT, *supra* note 3, at 6.

²⁶ NAS REPORT, *supra* note 3, at 6.

²⁷ NAS REPORT, *supra* note 3, at 7.

manner that is as objective and free of bias as possible—one with no ties to the past and with the authority and resources to implement a fresh agenda designed to address the problems found by the committee and discussed in this report.²⁸

Legislative efforts to create such an institute proved for naught. 2011 saw the introduction of the Criminal Justice and Forensic Science Reform Act, described by its principal sponsor, Senator Patrick Leahy, as intended to establish “an Office of Forensic Science in the Office of the Deputy Attorney General within the Department of Justice[] . . . [and] a Forensic Science Board composed of forensic and academic scientists, prosecutors and defense attorneys, and other key stakeholders . . . [with] a majority of its members . . . be[ing] scientists.”²⁹

Leahy’s Bill died in committee.³⁰ Additional efforts in Congress also failed. These were the Forensic Science and Standards Act of 2013 (Standards Act) and its 2012 predecessor—each “intend[ed] to create a national forensic science research program to improve, expand, and coordinate Federal research in the forensic sciences.”³¹ In this vacuum, the NCFS was birthed.

A. *The NCFS, 2013–2017*

On February 22, 2013, the Federal Register carried a “Notice of Establishment of the National Commission on Forensic Science and Solicitation of Applications for Commission Membership.”³² Issued pursuant to the Federal Advisory Committee Act, members were sought by the United States Department of Justice for a Commission to

recommend strategies for enhancing quality assurance in forensic science units. The duties of the Commission will include: (a) Recommending priorities for standards development; (b) reviewing and recommending endorsement of guidance identified or developed by subject-matter experts; (c) developing proposed guidance concerning the intersection of forensic science and the

²⁸ NAS REPORT, *supra* note 3, at 18.

²⁹ Press Release, Sen. Patrick Leahy, Leahy Proposes Landmark Forensics Reform Legislation (Jan. 25, 2011), <https://www.leahy.senate.gov/press/leahy-proposes-landmark-forensics-reform-legislation>.

³⁰ Criminal Justice and Forensic Science Reform Act, S. 2177, 113th Cong. (2014), <https://www.govtrack.us/congress/bills/113/s2177>.

³¹ Jessica D. Gabel, *Realizing Reliability in Forensic Science from the Ground Up*, 104 J. CRIM. L. & CRIMINOLOGY 283, 312–13 (2014) (internal quotations omitted).

³² Notice of Establishment of the National Commission on Forensic Science and Solicitation of Applications for Commission Membership, 78 Fed. Reg. 12355 (Feb. 22, 2013), <https://www.gpo.gov/fdsys/pkg/FR-2013-02-22/pdf/2013-04140.pdf>.

courtroom; (d) developing policy recommendations, including a uniform code of professional responsibility and minimum requirements for training, accreditation and/or certification; and (e) identifying and assessing the current and future needs of the forensic sciences to strengthen their disciplines and meet growing demand.³³

The Commission was designed to be a joint effort with the National Institute of Standards and Technology (NIST) with a membership like that urged by Senator Leahy for his proposed Forensic Science Board.³⁴ As stated, the objective was to achieve “a diversity of experiences, including Federal, State, and Local forensic science service providers; research scientists and academicians; Federal, State, Local prosecutors, defense attorneys and judges; law enforcement; and other relevant stakeholders.”³⁵ One year later, the Commission was formed³⁶ and held its first meeting.³⁷ This Article will not track the history of the Commission meeting by meeting. Importantly, the Commission’s membership met the standards set by both Senator Leahy and the Federal Register announcement, with pattern and impression discipline experts and advocates notably absent, and “hard” scientists—from chemistry, physics, and medicine—and a statistician at the table.³⁸

Suffice it to say, the first year was one of some conflict and only modest productivity. As described by NCFS Vice-Chair John Butler in a more circumspect fashion, “[w]ith the wide range of experiences among the Commissioners (many of whom come from outside the forensic science community), time was required in the first few meetings to provide context and background information on many of the topics under discussion.”³⁹ In

³³ *Id.*

³⁴ *See supra* note 30.

³⁵ *See supra* note 30.

³⁶ For a full listing of all Committee Members and Ex-Officio Members, see Press Release, U.S. Dep’t of Just., U.S. Departments of Justice and Commerce Name Experts to First-Ever National Commission on Forensic Science (Jan. 10, 2014), <https://www.justice.gov/opa/pr/us-departments-justice-and-commerce-name-experts-first-ever-national-commission-forensic>.

³⁷ U.S. Dep’t of Just., *Nat’l Comm’n on Forensic Sci. Meetings: Term 1—Meetings 1–7*, <https://www.justice.gov/archives/ncfs/term-1-meetings-1-7> (last visited Mar. 2, 2018).

³⁸ The decision to exclude forensic discipline practitioners from Commission membership, and to instead rely on scientists and statisticians, was—whether intended or not—subversive. It upended a tradition of letting forensic disciplines self-define and instead made them subject to scientific scrutiny.

³⁹ JOHN M. BUTLER, THE NATIONAL COMMISSION ON FORENSIC SCIENCE AND THE ORGANIZATION OF SCIENTIFIC AREA COMMITTEES 4 (2014), https://strbase.nist.gov/pub_pres/Butler-ISHI-Proceedings2014.pdf.

practice, this meant that time was spent forming subcommittees⁴⁰ to generate work-product for the Commission as a whole to weigh in on. By way of illustration, by the third Commission meeting, the Reporting and Testimony Subcommittee divided its focus into five topics and working groups: “(1) Report Content; (2) General Issues of Terminology; (3) Probabilistic Statements; (4) Problematic or Misleading Terms; and (5) Legal Issues Inherent in Reporting.”⁴¹

As to conflict, a fundamental question of definition had to be resolved. The Interim Solutions Subcommittee sought to generate a definition, one that would be foundational for all Commission work products, of forensic discipline analysts or, as the subcommittee described them, “Forensic Science Service Providers” (FSSPs)⁴² Agreement could not be quickly reached, with at least one comment focusing on the “[c]oncern . . . that the definition does not include the methodology or expectation of science.”⁴³ Put more simply, putting the term “science” into the definition was a “cart before the horse” approach that tacitly accepted many forensic disciplines as legitimately scientific. This was made explicit when the issue was addressed at Meeting 4. As noted in the Meeting Summary, “[o]ne Commissioner offered an explanation for abstaining from voting on this item because of the word ‘science’ in the definition. It was further explained that some disciplines haven’t demonstrated that they have adequate foundational scientific research. It was suggested to strike the word ‘science.’”⁴⁴ It was not until Meeting 5 that acceptable terminology was identified.⁴⁵ At Meeting 6, a definition that at least implicitly acknowledged that not all disciplines were scientific was approved. For the Commission’s work, “forensic

⁴⁰ By the second NCFS meeting, six subcommittees were in existence: Accreditation and Proficiency Testing; Interim Solutions; Medico-legal Death Investigation; Reporting and Testimony; Scientific Inquiry and Research; and Training on Science and Law. NAT’L COMM’N ON FORENSIC SCI., AGENDA—MAY 12, 2014 2 (2014), <https://www.justice.gov/sites/default/files/ncfs/legacy/2014/05/30/agenda2.pdf>. A seventh subcommittee, that on Human Factors, was approved at the second Commission meeting, initially as a subcommittee on “cognitive bias.” NAT’L COMM’N ON FORENSIC SCI., MEETING SUMMARY MAY 12–13, 2014 (2014), <https://www.justice.gov/sites/default/files/ncfs/legacy/2014/07/29/meeting2-summary.pdf>.

⁴¹ NAT’L COMM’N ON FORENSIC SCI., MEETING SUMMARY AUGUST 26–27, 2014 (2014), https://www.justice.gov/sites/default/files/pages/attachments/2014/10/16/ncfs_summary_-_meeting_three_final.pdf.

⁴² *Id.* at 14–15.

⁴³ *Id.* at 15.

⁴⁴ NAT’L COMM’N ON FORENSIC SCI., MEETING SUMMARY OCTOBER 28–29, 2014 17 (2014), https://www.justice.gov/sites/default/files/ncfs/pages/attachments/2015/01/15/ncfs_meeting_4_summary_final.pdf.

⁴⁵ NAT’L COMM’N ON FORENSIC SCI., MEETING SUMMARY JANUARY 29–30, 2015 7 (2015), <https://www.justice.gov/sites/default/files/ncfs/pages/attachments/2015/05/04/ncfs-meeting-5-summary.pdf>.

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science” was “[t]he application of scientific or technical practices to the recognition, collection, analysis, and interpretation of evidence for criminal and civil law or regulatory issues.”⁴⁶

Notwithstanding the year and a half that passed until a foundational definition was approved, the Commission went full steam ahead over the balance of its existence. As explained in a “business record” report approved by the Commission at its final meeting,

[t]he Commission has adopted 43 work products: 20 Recommendation documents and 23 Views documents. Recommendation documents propose specific requests to the Attorney General and describe actions for consideration and implementation within the Federal system. Views documents represent the collective views of the Commissioners and do not request specific action by the Attorney General. Views documents are designed to comment generally on particular subjects and serve as guidance for all forensic and criminal justice communities, whether Federal, state, or local.⁴⁷

Among the Recommendations were the following:

- That all FSSPs be accredited, a recommendation adopted in part by the Department of Justice;⁴⁸
- That FSSPs use a “root cause analysis” to identify causes of and offer forward-looking changes after an unusual event or severe error, a recommendation endorsed in part;⁴⁹
- “[T]hat the Attorney General require DOJ FSSPs to develop written policies for documenting the examination, testing, and interpretation of evidence and for reporting results,” a recommendation placed under review but never resolved;⁵⁰

⁴⁶ NAT’L COMM’N ON FORENSIC SCI., VIEWS OF THE COMMISSION: DEFINING FORENSIC SCIENCE AND RELATED TERMS (2015), <https://www.justice.gov/ncfs/file/786571/download>.

⁴⁷ NAT’L COMM’N ON FORENSIC SCI., REFLECTING BACK—LOOKING TOWARD THE FUTURE 4 (2017), <https://www.justice.gov/archives/ncfs/page/file/952316/download> [hereinafter REFLECTING BACK].

⁴⁸ *Id.* at 3, App. C. The DOJ agreed to require “its non digital DOJ-run forensic labs to obtain and maintain accreditation [and for] DOJ prosecutors to use accredited labs to process forensic evidence when practicable.” *Id.* The DOJ also stated its intent “to encourage other labs around the country to pursue accreditation.” *Id.*

⁴⁹ *Id.* at 5, App. C.

⁵⁰ *Id.*

- That the Attorney General ensure that DOJ employees do not use the phrases “to a reasonable degree of scientific certainty” or “to a reasonable degree of [discipline] certainty,” a recommendation adopted in part,⁵¹ and
- That the Attorney General direct federal prosecutors who intend to offer forensic expert testimony to provide a detailed expert report and allow access to the expert’s case record,⁵² a recommendation adopted in part in a January 2017 directive for prosecutors to provide a detailed summary and access to the case record.⁵³

One more adopted recommendation that the Department did respond to merits special discussion. The Commission, with much debate and collaboration, approved a proposed National Code of Ethics for FSSPs.⁵⁴ The proposed Code imposed two particular obligations:

“Once a report is issued and the adjudicative process has commenced, communicate fully when requested with the parties through their investigators, attorneys, and experts, except when instructed that a legal privilege, protective order or law prevents disclosure.”⁵⁵

“Appropriately inform affected recipients (either directly or through proper management channels) of all nonconformities or breaches of law or professional standards that adversely affect a previously issued report or testimony and make reasonable efforts to inform all relevant stakeholders, including affected professional and legal parties, victim(s) and defendant(s).”⁵⁶

⁵¹ *Id.* at 7.

⁵² *Id.*

⁵³ SALLY Q. YATES, U.S. DEP’T OF JUSTICE, MEMORANDUM FOR DEPARTMENT PROSECUTORS: DEPARTMENT FORENSIC SCIENCE PERSONNEL (Jan. 5, 2017), <https://www.justice.gov/ncfs/page/file/930411/download>.

⁵⁴ NAT’L COMM’N ON FORENSIC SCI., RECOMMENDATION TO THE ATTORNEY GENERAL NATIONAL CODE OF PROFESSIONAL RESPONSIBILITY FOR FORENSIC SCIENCE AND FORENSIC MEDICINE SERVICE PROVIDERS (2016), <https://www.justice.gov/ncfs/file/839711/download>.

⁵⁵ *Id.* ¶ 15.

⁵⁶ *Id.* ¶ 16.

In adjudicating this Recommendation, the Department limited the disclosure duty in the latter provision to providing notice to prosecutors rather than all affected parties, and watered down the former by requiring discussion with defense counsel “when communications are permitted by law *and agency practice*.”⁵⁷

The approval in whole or in part of recommendations was not uniform; rather, the Department failed to respond to several others. These included Commission recommendations to: (1) encourage the NIST to establish an in-house entity “to evaluate the technical merit of test methods and practices used in forensic science disciplines;” (2) require all Department FSSPs to undergo rigorous proficiency testing and encourage proficiency test vendors to share aggregate data with researchers; and (3) require all Department FSSPs to “develop written policies for documenting the examination, testing and interpretation of evidence and for reporting results.”⁵⁸

The Department’s silence on several recommendations was exacerbated by the Commission itself at its final meeting in April 2017 when it failed to approve two “Views” documents—one addressing with specificity and setting minimum content standards for case reports and files⁵⁹ and the second supporting the use of statistical statements when reporting forensic results “because mathematical analyses provide a useful framework for assessing and expressing uncertainty.”⁶⁰

The Commission’s “business record” summarized the ample work left undone, including to:

- Undertake a survey of law enforcement agencies conducting forensic science analysis;
- Develop implementation and enforcement recommendations for the uniform code of professional responsibility;
- Provide guidance on evidence preservation and retention;

⁵⁷ U.S. DEP’T OF JUST., CODE OF PROFESSIONAL RESPONSIBILITY FOR THE PRACTICE OF FORENSIC SCIENCE, *in* MEMORANDUM FOR THE HEADS OF DEPARTMENT COMPONENTS (Sept. 6, 2016), <https://www.justice.gov/opa/file/891366/download> (emphasis added).

⁵⁸ REFLECTING BACK, *supra* note 47, at 1, 3, 5, App. C.

⁵⁹ See NAT’L COMM’N ON FORENSIC SCI., MEETING #13: APRIL 10–11, 2014 2 (2017), <https://www.justice.gov/ncfs/page/file/976566/download>; NAT’L COMM’N ON FORENSIC SCI., VIEWS OF THE COMMISSION: REPORT AND CASE RECORD CONTENTS (2017), <https://www.justice.gov/ncfs/page/file/952696/download>.

⁶⁰ NAT’L COMM’N ON FORENSIC SCI., VIEWS OF THE COMMISSION: STATISTICAL STATEMENTS IN FORENSIC TESTIMONY (2017), <https://www.justice.gov/ncfs/page/file/952466/download>.

- Consider examiner certification: is this feasible, and [whether this] should . . . be a requirement for Federal examiners;
- Consider recommendations regarding how to address human factors issues in [medical death investigations], especially around cases involving child death, in-custody death, and police shootings;
- Train forensic science users—law enforcement, lawyers, judges, and the public; [and]
- Establish research-based means of effectively and accurately communicating forensic science information with the judicial system and the public.⁶¹

Notwithstanding the list of unfinished work, the Commission left as its heritage a body of documents and its presence on the national stage as a voice for forensic reform. This article now turns to assessing the efficacy of that presence in two regards. First, it examines whether there is any measurable or potentially attributable impact in the courts; and second, it looks at the related issues of “human factors” and cognitive bias to see whether appreciation of those issues correlates with their prominence in the Commission’s work.

III. THE NCFS, FORENSIC EVIDENCE, AND THE COURTS: A HISTORY OF ABDICATION

At the most rudimentary level of analysis, from a data-driven perspective, the Commission’s work and indeed its existence can be seen as having had no relevance to the judiciary. As of June 4, 2017, only one reported decision⁶² even mentions the Commission’s existence, and even then, only noting that an expert witness mentioned the Commission while describing his credentials, stating he was invited to serve on one of its subcommittees.⁶³

⁶¹ REFLECTING BACK, *supra* note 47, at 7–9.

⁶² A LEXIS search with the terms “national w/2 commission w/2 forensic” conducted June 4, 2017, resulted in only one case result. *See infra* note 63.

⁶³ *State v. Hightower*, 511 S.W.3d 454, 458 n.4 (Mo. Ct. App. 2017) (“Dr. Haber also discussed the newly formed National Commission on Forensic Science (‘National Commission’). He explained the National Commission will consist of leading experts in various fields of forensic sciences, and it will partner with the National Institute to develop uniform standards for scientists in all forensic fields. Dr. Haber testified he has been asked to serve on the National Commission committee responsible for developing standards for fingerprint analysis.”).

The same can be said, at least in terms of relevance to litigation outcome, regarding the Commission's antecedent, the previously-discussed NAS Report.⁶⁴ In the eight-plus years since its release, the Report has been mentioned in only 154 court decisions.⁶⁵ Many of those involve passing references⁶⁶ or discussions of whether the Report, when relied upon in a post-conviction proceeding, constitutes newly-discovered evidence.⁶⁷ Most importantly, the Report has had minimal impact on the admissibility or scope of forensic discipline testimony or the conclusions an expert is permitted to present.⁶⁸ Courts have either let the experts continue their testimony in the same form as before the Report was issued⁶⁹ or "toned it down" in form but not in substance, as when an expert would have to testify only that it was his or her "opinion" that the fingerprint came from the defendant and no other source⁷⁰ or use the term "reasonable ballistic certainty" rather than "reasonable *scientific* certainty."⁷¹ Strangely, one of the rare cases where the

⁶⁴ NAS REPORT, *supra* note 3.

⁶⁵ A LEXIS search with the terms "strengthening w/3 forensic w/3 science" conducted June 4, 2017, produced a list of cases mentioning the report.

⁶⁶ *See, e.g.,* Motorola Inc. v. Murray, 147 A.3d 751, 759 (D.C. Cir. 2016) (Easterly, J., concurring) ("[I]n assessing the admissibility of forensic expert testimony, courts will have the aid of landmark reports that examine the scientific underpinnings of certain forensic disciplines routinely admitted under *Dyas/Frye*, most prominently, the National Research Council's congressionally-mandated 2009 report *Strengthening Forensic Science in the United States: A Path Forward*. . . .") (emphasis in original).

⁶⁷ *See, e.g.,* Anderson v. State, 220 So.3d 1133, 1150 (Fla. 2017) ("we have repeatedly held that HN12 the 2009 NAS report does not constitute newly discovered evidence"); Commonwealth v. Smallwood, 155 A.3d 1054, 1066 (Pa. Super. Ct. 2017) (discussing Pennsylvania decisional law to the same effect).

⁶⁸ For a detailed review of judicial rejection of calls to limit forensic testimony in response to claims based on the findings in the book STRENGTHENING FORENSIC SCIENCE: A PATH FORWARD, see Epstein, *supra* note 24, at 105–07.

⁶⁹ *See, e.g.,* United States v. Bonds, No. 15-cr-573-2, 2017 U.S. Dist. LEXIS 166975, at *10 (N.D. Ill. Oct. 10, 2017) (citing the report and rejecting a motion to "prevent [the examiner] from testifying to a match between the latent print and the suspect print and] instead limiting her to describing similarities and differences between the prints"); State v. Allen, No. 2017-KA-0306, slip op. at 14 (La. Ct. App. Nov. 1, 2017), <https://cases.justia.com/louisiana/first-circuit-court-of-appeal/2017-2017ka0306.pdf?ts=1509559751> (discussing the Report but approving traditional matching testimony because of "the firmly established reliability of fingerprint evidence and firearm examination analyses").

⁷⁰ *See, e.g.,* Commonwealth v. Fulgiam, 73 N.E.3d 798 (Mass. 2017) (alteration in original) ("[t]estimony to the effect that a latent print matches, or is 'individualized' to, a known print, if it is to be offered, should be presented as an opinion, not a fact, and opinions expressing absolute certainty about, or the infallibility of, an 'individualization' of a print should be avoided." (quoting Commonwealth v. Gambora, 933 N.E.2d 50, 61 n.22 (Mass. 2010))).

⁷¹ Commonwealth v. Heang, 942 N.E.2d 927, 947 (Mass. 2011) ("[W]here an opinion matching a particular firearm to recovered projectiles or cartridge casings is limited to a 'reasonable degree of ballistic certainty,' a jury will be assisted in reaching a verdict by having

Report was acknowledged as having shown the deficiency of a discipline [handwriting comparison], the Report was wielded as a sword *against* a criminal defendant. When challenging trial counsel's performance as inadequate, the reviewing court concluded that counsel performed capably when he cross-examined agents on their failure to conduct any handwriting analysis of a relevant document. The court then added, apparently to indicate that the defendant/petitioner actually benefitted from the cross-examination, that

[h]andwriting analysis is a form of forensic science that the National Research Council has deemed in need of additional research to quantify the reliability and replicability of the methods employed by document examiners. Had the government performed any type of document analysis, it is likely that the results would not have been given much weight in the consideration of Petitioner's arguments.⁷²

This is not to say that no court has tracked the conclusions of the Report and applied them. Two such instances are discussed below. But before those rare, if not anomalous, decisions are analyzed, it is necessary to scrutinize the factors that contribute to the failure to seek and then secure application of a more stringent screening standard for forensic discipline testimony.

The first is what can fairly be dubbed scientific illiteracy of lawyers,⁷³

the benefit of the opinion, as well as the information needed to evaluate the limitations of such an opinion and the weight it deserves.”)

⁷² United States v. Wallace, No. 00-cr-122, 2017 U.S. Dist. LEXIS 9708, at *67 n.25 (D.R.I. Jan. 24, 2017) (citing NAS REPORT, *supra* note 3, at 166–67).

⁷³ The term and its application are not new. David Faigman has written of judges deploying “an affirmative illiteracy regarding basic scientific concepts.” David L. Faigman, *Admissibility Regimes: The “Opinion Rule” and Other Oddities and Exceptions to Scientific Evidence, the Scientific Revolution, and Common Sense*, 36 SW. U. L. REV. 699, 718 (2008). Two decades earlier, the same epithet was applied. ANDRE A. MOENSSENS ET AL., SCIENTIFIC EVIDENCE IN CRIMINAL CASES 7 (3d ed. 1986) (footnote omitted) (“[L]awyers as a group evidence an appalling degree of scientific illiteracy, which ill equips them to educate and guide the bench in its decisions on admissibility of evidence proffered through expert witnesses.”). The concern persists. Barbara P. Billauer, *Daubert Debunked: A History of Legal Retrogression and the Need to Reassess “Scientific Admissibility,”* 21 SUFFOLK J. TRIAL & APP. ADVOC. 1, 2 (2015) (describing “scientific/mathematical illiteracy of the current legal community”). As David Faigman recently summarized, “any blanket statements about the scientific illiteracy of the legal profession are inevitably overly broad and many exceptions might be found, with Judge Weinstein being an exemplary instance. Nonetheless, the general state of affairs with regard to the law’s understanding of the methods of science creates substantial obstacles to the coherent use of empirical knowledge gleaned from complex research studies.” David L. Faigman & Claire Lesikar, *Organized Common Sense: Some Lessons From Judge Jack Weinstein’s Uncommonly Sensible Approach to Expert Evidence*, 64 DEPAUL L. REV. 421, 434 (2015).

the source of any motions that would raise challenges to forensic evidence. It is not enough to simply quote the conclusions of the NRC that “the interpretation of forensic evidence is not infallible [and] . . . [t]his reality is not always fully appreciated or accepted by many forensic science practitioners, judges, jurors, policymakers, or lawyers and their clients.”⁷⁴ That Report continued with the observation that “forensic science evidence is not routinely scrutinized pursuant to the standard of reliability enunciated in *Daubert*.”⁷⁵

Studies have shown an appalling lack of understanding of *Daubert*/Rule 702 terms such as “error rate.” Judges, when surveyed, have acknowledged “that their [scientific] education had left them inadequately prepared to serve as gatekeepers under *Daubert*[:]”⁷⁶ and on specifics such as the scientific concept of “falsifiability,” at best, thirty-five percent of those surveyed grasped the essence of the term, while only four to six percent were able to clearly articulate the meaning of the term.⁷⁷

At even a more fundamental level, judges and practitioners are often unaware of the NAS Report, even seven to eight years after its release. Confirmation of this is anecdotal, but derived from the experience of this author when conducting basic forensic science education at judicial and attorney trainings. Two questions posed to each audience—“How many of you have a science background?” and “Have you at least heard of the Report STRENGTHENING FORENSIC SCIENCE?”—draw a low response rate; for the former question, it is typically at a level of fewer than ten percent of the audience, while the latter rarely exceeds fifty percent.

As a consequence of this scientific illiteracy (or unawareness), neither the specific work of the Commission nor the message(s) of the Report can be found in common motion practice for the average⁷⁸ attorney. That there are exceptions, with some lawyers using either as a source to challenge forensic discipline testimony, is of little solace, as the discussion of the next two decisions shows only a rare combination of circumstances brings science

⁷⁴ NAS REPORT, *supra* note 3, at 87–88.

⁷⁵ NAS REPORT, *supra* note 3, at 106.

⁷⁶ Edward J. Imwinkelried, *Expert Testimony Trends in State Practice and the Uniform Rules of Evidence*, in OPINION AND EXPERT TESTIMONY IN FEDERAL AND STATE COURTS 417 (2008), <https://www.ali-cle.org/doc/courseware/pdf/toc/CN058.pdf>.

⁷⁷ Mara L. Merlino & Victoria Springer, *Context and Controversy: Why Questions of Validity and Reliability Are Seldom Resolved in an Adversarial Setting*, 45 TULSA L. REV. 133, 141 n.29 (2009).

⁷⁸ The designation “average” attorney does not apply to institutional public defender offices or lawyers litigating federal death penalty cases. For the former, targeted and well-resourced litigation has raised the concerns with forensic discipline testimony, as is best illustrated by the work of Washington D.C.’s Public Defender Service, which has litigated well-funded and comprehensive challenges. See, e.g., *Pettus v. United States*, 37 A.3d 213 (D.C. 2012) (handwriting challenge).

to the fore in cases involving forensic evidence.

In the first, *Almeciga v. Center for Investigative Reporting, Inc.*,⁷⁹ the issue was “whether the . . . method of handwriting analysis, as described by [the expert], meets the common indicia of admissible scientific expertise as set forth in *Daubert*.”⁸⁰ The opinion cites to the NAS Report⁸¹ and proceeds with an exhaustive review, assessing the purported science with strict scrutiny of the various Rule 702 and *Daubert* factors including, *inter alia*, whether the method had been tested,⁸² had been subjected to meaningful peer review,⁸³ had a reasonable error rate,⁸⁴ had controlling standards within and across the field,⁸⁵ and had general acceptance in the field.⁸⁶ In each aspect, the testimony and its underlying expertise was found wanting.⁸⁷

Why is *Almeciga* then not proof of the impact of the NAS Report and therefore, by extension, the work of the Commission? Beyond it being a civil matter, and not a criminal case where forensic evidence is more common and the stakes generally higher, the answer is simple—the fortuity that the matter was before Federal District Judge Jed Rakoff. Judge Rakoff was an *ex officio* member of the Commission, and took it upon himself to analyze the case through the lens(es) of his experience with the NCFS and the lessons of the Report.

The second case of note, also from 2016, is *State v. Romero*,⁸⁸ where the Arizona Supreme Court held it was an abuse of discretion to exclude an expert who would have contested whether a forensic discipline—firearms toolmark analysis—applied scientific methodology. As the Court explained in reversing the lower court’s exclusion, the question was not

whether Dr. Haber was qualified as an expert in firearms identification, but instead whether he was qualified in the area of his proffered testimony—experimental design. Here, the trial court determined that [prosecution expert] Powell was qualified to offer an expert opinion that the shell casings were all fired from the same Glock. But *Romero* did not offer Dr. Haber as an expert in firearms identification to challenge whether Powell had correctly performed his analysis or formed his opinions. Instead,

⁷⁹ 185 F. Supp. 3d 401 (S.D.N.Y. 2016).

⁸⁰ *Id.* at 419.

⁸¹ *Id.* at 420.

⁸² *Id.* at 419.

⁸³ *Id.* at 420–21.

⁸⁴ *Id.* at 421.

⁸⁵ *Almeciga*, 185 F. Supp. 3d at 422–23.

⁸⁶ *Id.* at 423–24.

⁸⁷ *See id.* at 420–24.

⁸⁸ 365 P.3d 358 (Ariz. 2016).

Dr. Haber's testimony was proffered to help the jury understand how the methods used by firearms examiners in performing toolmark analysis differ from the scientific methods generally employed in designing experiments.⁸⁹

This was a holding permitting a “this is not science” expert, itself anomalous, as a similar attempt had been rejected in California years earlier.⁹⁰ There, the defense was prevented from calling an expert to explain that fingerprint analysis was not a scientific methodology.⁹¹ But it is not merely the anomaly that confirms the limited impact of the NCFS and the predecessor NAS Report. *Romero* is a case brought by an institutional public defender office; it was before a state Supreme Court that has regularly included forensic science issues in its continuing legal education curriculum;⁹² and it actually changed very little. *Romero* does not restrict the evidence that the prosecution may offer; rather, it permits a defense expert to offer testimony urging caution on the reliability of forensic discipline, evidence costly to procure and available from a limited number of sources. While undeniably important in acknowledging the existence and legitimacy of views critical of the underpinnings of forensic discipline testimony, *Romero* goes but a brief distance in affecting the presentation of putative science testimony.

This discussion cannot end without a review of the United States Supreme Court's treatment of forensic evidence in the years since the NAS Report and during and immediately after the lifetime of the Commission. The Court has cited to the Report in two decisions, acknowledging its existence and some awareness of the limits and risks of forensic discipline evidence.

In the first instance, the Court majority in *Melendez-Diaz v. Massachusetts* used the Report to support its determination that forensic lab reports were “testimonial” documents that could not be presented without the guarantee of the Confrontation Clause—the right to cross-examine the analyst.⁹³ Forensic reports and results were viewed with some skepticism.

⁸⁹ *Id.* at 361–62.

⁹⁰ *See* *People v. Gonzalez*, No. E052000, 2012 Cal. App. Unpub. LEXIS 1294, at *9 (Cal. Ct. App. Feb. 22, 2012).

⁹¹ *Id.*

⁹² This author has assisted in planning, and presented at, Arizona judicial education programs focused on forensic science issues and, more particularly, the limits of and concerns regarding forensic discipline testimony.

⁹³ *Melendez-Diaz v. Massachusetts*, 557 U.S. 305, 318 (2009). The requirement that it be the analyst who testifies was later muted by finding that the Confrontation Clause right was satisfied if a supervisor of the testing process appeared at trial. *Bullcoming v. New Mexico*, 564 U.S. 647, 131 S. Ct. 2705 (2011). The vitality of either protection has since been called into question. *Williams v. Illinois*, 567 U.S. 50, 132 S. Ct. 2221 (2012).

Forensic evidence is not uniquely immune from the risk of manipulation. According to a recent study conducted under the auspices of the National Academy of Sciences, “[t]he majority of [laboratories producing forensic evidence] are administered by law enforcement agencies, such as police departments, where the laboratory administrator reports to the head of the agency.” And “[b]ecause forensic scientists often are driven in their work by a need to answer a particular question related to the issues of a particular case, they sometimes face pressure to sacrifice appropriate methodology for the sake of expediency.” A forensic analyst responding to a request from a law enforcement official may feel pressure—or have an incentive—to alter the evidence in a manner favorable to the prosecution.⁹⁴

This view, however, was not uniform. The dissent—Justice Kennedy, joined by Chief Justice Rehnquist and Justices Breyer and Alito—contended that the Report was for the legislature and not the courts, as Congress and state legislatures “have the power and competence to determine whether scientific tests are unreliable and, if so, whether testimony is the proper solution to the problem.”⁹⁵

Intriguingly, the second time the Court cited to the Report was in a case⁹⁶ where the challenge was to trial counsel’s ineffectiveness in failing to secure a proper expert, a case in which it was ultimately shown that the death-sentenced defendant, Anthony Hinton, could not be proved culpable.⁹⁷

Hinton was allegedly involved in three robberies, two of which resulted in death. At his trial, the prosecution used ballistics evidence—the fired cartridge cases from all three incidents—along with an eyewitness survivor of the third crime, to prove Hinton’s guilt, matching the six ballistic items to a gun found in his home. Hinton’s post-conviction challenge was to trial counsel’s hiring of an incompetent expert, a choice driven by the lawyer’s mistaken understanding of the financial cap imposed on expert services for indigent defendants.⁹⁸

⁹⁴ *Melendez-Diaz*, 557 U.S. at 318 (alteration in original) (citations omitted).

⁹⁵ *Id.* at 351 (Kennedy, J., dissenting).

⁹⁶ *Hinton v. Alabama*, 134 S. Ct. 1081, 1084 (2014) (citing NAS REPORT, *supra* note 3).

⁹⁷ *Anthony Ray Hinton Exonerated After 30 Years On Death Row*, EQUAL JUST. INITIATIVE, <https://eji.org/anthony-ray-hinton-exonerated-from-alabama-death-row> (last visited Mar. 2, 2018).

⁹⁸ *Hinton*, 134 S. Ct. at 1083–85.

The Court began by emphasizing that it did not approve of *post-hoc* assessments of the quality of expert witnesses.⁹⁹ Here, the inquiry was different, counsel's misapprehension of the legal cap on funding, described as an "inexcusable mistake of law."¹⁰⁰

In discussing the prejudice caused by counsel's error, the Court—this time unanimously—repeated the concerns first stated by the *Melendez-Diaz* majority.¹⁰¹ Yet the Court made two statements that show a continued lack of understanding of the risk of forensic error. First, it emphasized that the general corrective is not judicial scrutiny of forensic evidence but the adversarial response—a competent defense expert against the prosecution's expert witness(es). To the Court, the "threat" of flawed forensic testimony "is minimized when the defense retains a competent expert to counter the testimony of the prosecution's expert witnesses; it is maximized when the defense instead fails to understand the resources available to it by law."¹⁰² This judicial abdication of a supervisory or regulatory function when forensic discipline evidence is presented was one problem; the second was the Court's misreading of the NAS Report.

The Court used the Report as if it were an encyclopedia, citing it to explain how a firearms comparison works. "The theory is that minor differences even between guns of the same model will leave discernible traces on bullets that are unique enough for an examiner to conclude that the recovered bullet was or was not fired from a given weapon."¹⁰³ Yet the precise section of the Report the Court cited to emphasizes the lack of foundational validity of this discipline,¹⁰⁴ a point that, while not the focus of

⁹⁹ "The selection of an expert witness is a paradigmatic example of the type of 'strategic choic[e]' that, when made 'after thorough investigation of [the] law and facts,' is 'virtually unchallengeable.'" *Id.* at 1089 (alterations in original) (quoting *Strickland v. Washington*, 466 U.S. 668, 690 (1984)).

¹⁰⁰ *Id.*

¹⁰¹ *Id.* at 1090 ("Prosecution experts, of course, can sometimes make mistakes. Indeed, we have recognized the threat to fair criminal trials posed by the potential for incompetent or fraudulent prosecution forensics experts, noting that "[s]erious deficiencies have been found in the forensic evidence used in criminal trials. . . . One study of cases in which exonerating evidence resulted in the overturning of criminal convictions concluded that invalid forensic testimony contributed to the convictions in 60% of the cases.") (alterations in original) (quoting *Melendez-Diaz*, 557 U.S. at 319).

¹⁰² *Id.*

¹⁰³ *Id.* at 1084 (citing NAS REPORT, *supra* note 3, at 150–55).

¹⁰⁴ NAS REPORT, *supra* note 3, at 153–54 ("But even with more training and experience using newer techniques, the decision of the toolmark examiner remains a subjective decision based on unarticulated standards and no statistical foundation for estimation of error rates. . . . Toolmark and firearms analysis suffers from the same limitations discussed above for impression evidence. 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. The committee agrees that class

the *Hinton* holding, certainly deserved acknowledgment.

Yet perhaps the most important “message” regarding forensic evidence—and the duty of lawyers to study the evidence before its introduction in court—came one year later in *Maryland v. Kulbicki*.¹⁰⁵ On its face, *Kulbicki* posed a simple but provocative question: how is a court to judge a lawyer’s time-of-trial effectiveness retrospectively, particularly when the representation involved forensic evidence that was later discredited? *Kulbicki* involved comparative bullet lead analysis—a metallurgic comparison of bullets clearly linked to the accused and crime scene evidence.¹⁰⁶ At the time of trial, the discipline was seemingly reliable and not subject to substantial criticism; but a decade later, it was shown to have overstated findings.¹⁰⁷

The Court spoke unanimously, and indeed did so without having heard oral argument or even received briefing. In a *per curiam* opinion, the Court explained that “[c]ounsel did not perform deficiently by dedicating their time and focus to elements of the defense that did not involve poking methodological holes in a then-uncontroversial mode of ballistics analysis.”¹⁰⁸

It is in what was not said that the Court diminished the responsibility of counsel in a forensic evidence case. The expert in *Kulbicki* had authored an article four years before trial that contradicted the fundamental precept of his trial testimony—that every separate “batch” of metal melted down to manufacture bullets had a distinct metallurgic composition.¹⁰⁹ Trial counsel never uncovered the report.¹¹⁰

The Court never urged that lawyers consult an expert, read up on the discipline, or ask for a *curriculum vitae* of the expert and then read her or his publications. Rather, the standard was simple—if no one else is questioning the discipline, just “go along and ask no questions.”¹¹¹

characteristics are helpful in narrowing the pool of tools that may have left a distinctive mark. 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.”).

¹⁰⁵ 136 S. Ct. 2 (2015). For an expanded discussion on *Kulbicki* and the problems of retrospective analysis of criminal convictions after science has evolved, see Epstein, *The Role of the Courts in Improving Forensic Science: Looking Backwards at Old Cases: When Science Moves Forward*, 106 J. CRIM. L. & CRIMINOLOGY 49 (2016).

¹⁰⁶ *Kulbicki*, 136 S. Ct. at 3.

¹⁰⁷ *Id.* at 4.

¹⁰⁸ *Id.*

¹⁰⁹ *Id.* at 3–4.

¹¹⁰ *Id.*

¹¹¹ *See supra* note 97.

Kulbicki is easily explained in the context of the Court's *Strickland*¹¹² cases—the presumption is that of effective representation,¹¹³ and the commitment is to finality.¹¹⁴ And the outcome—reversing the state court's grant of a new trial—is easily defensible on alternative grounds; in particular, the lack of prejudice. But the Court's omission—the failure to remind lawyers of the duty to learn and sometimes question science—is the continuation of a disregard of the weaknesses of some forensic discipline testimony and a repudiation of any obligation for courts to police that problem. In this regard, the work of the Commission, on its own and as a reflection of the concerns of the NAS Report, shows little impact.

IV. THE NCFS AND “HUMAN FACTORS” CONSIDERATIONS: GENERATING/ EXPANDING THE DISCUSSION

“Human factors,” put most simply, is the study of “the interaction between humans and products, decisions, procedures, workspaces, and the overall environment encountered at work and in daily living.”¹¹⁵ Yet, the study of how human factors may contribute to error in forensic discipline analysis is of relatively recent origin.¹¹⁶ A seminal article raising one aspect of human factors in forensic analysis, cognitive bias, and the “observer effect,” posited that “[f]orensic science is one of a very few fields that has

¹¹² *Strickland v. Washington*, 466 U.S. 668 (1984).

¹¹³ Judicial scrutiny of counsel's performance must be highly deferential. It is all too tempting for a defendant to second-guess counsel's assistance after conviction or adverse sentence, and it is all too easy for a court, examining counsel's defense after it has proved unsuccessful, to conclude that a particular act or omission of counsel was unreasonable. *Id.* at 689.

¹¹⁴ *Id.* at 693–94 (“The standard also reflects the profound importance of finality in criminal proceedings.”). See also Christopher N. Lasch, *Redress in State Postconviction Proceedings for Ineffective Crimmigration Counsel*, 63 DEPAUL L. REV. 959, 1012 (2014) (analyzing the emphasis on finality for criminal proceedings).

¹¹⁵ NAT'L INST. OF STANDARDS & TECH., U.S. DEP'T OF COM., LATENT PRINT EXAMINATION AND HUMAN FACTORS: IMPROVING THE PRACTICE THROUGH A SYSTEMS APPROACH vi (2012), http://ws680.nist.gov/publication/get_pdf.cfm?pub_id=910745 [hereinafter LATENT PRINTS AND HUMAN FACTORS]. For a comparable definition, see WORLD HEALTH ORG., HUMAN FACTORS IN PATIENT SAFETY: REVIEW OF TOPICS AND TOOLS (Apr. 2009), http://www.who.int/patientsafety/research/methods_measures/human_factors/human_factors_review.pdf (“Human factors refer to environmental, organisational and job factors, and human and individual characteristics which influence behaviour at work in a way which can affect health and safety. A simple way to view human factors is to think about three aspects: the job, the individual and the organization and how they impact on people's health and safety-related behaviour.”).

¹¹⁶ Itiel E. Dror, *Cognitive Neuroscience in Forensic Science: Understanding and Utilizing the Human Element*, 370 PHIL. TRANSACTIONS ROYAL SOCIETY B 1 (2015), <http://rstb.royalsocietypublishing.org/content/roytpb/370/1674/20140255.full.pdf> (“Since forensic science emerged about 100 years ago, there has been a systematic neglect in considering the role of the human examiner in forensic science. This is despite the fact that the human examiner plays a critical role in forensic science.”).

not yet profited from this ‘science of science.’ The most obvious danger in forensic science is that an examiner’s observations and conclusions will be influenced by extraneous, potentially biasing information.”¹¹⁷

Additional focus on human factors is traceable to the NAS Report. The Report’s Executive Summary concluded that:

[a] body of research is required to establish the limits and measures of performance and to address the impact of sources of variability and potential bias. Such research is sorely needed, but it seems to be lacking in most of the forensic disciplines that rely on subjective assessments of matching characteristics. These disciplines need to develop rigorous protocols to guide these subjective interpretations and pursue equally rigorous research and evaluation programs.¹¹⁸

The Report thereafter had an extensive discussion of “sources of bias,”¹¹⁹ and cited specifically to the research of Professor Itiel Dror showing, *inter alia*, that manipulation of contextual information can cause examiners to alter their conclusions.¹²⁰

Just prior to the issuance of the Report, the NIST formed an “expert working group on human factors in latent print analysis” to conduct “a scientific assessment of the effects of human factors on latent print analysis.”¹²¹ The product, released in 2012, was a 200-plus-page report that assessed all aspects of latent print analysis and reporting from a human factors perspective, going beyond issues of cognitive bias to workplace management and environment and medical assessment of examiners.¹²² The Report urged consideration of measures to reduce the risk of bias, including reducing exposure to information that is not domain relevant,¹²³ and urged further study of the benefits and costs of implementing blind verification of analysts’ conclusions.¹²⁴ Again, the research of Professor Dror (a member of the working group) and others regarding cognitive bias concerns figured prominently throughout the report.¹²⁵

¹¹⁷ 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, 3, 9 (2002).

¹¹⁸ NAS REPORT, *supra* note 3, at 8.

¹¹⁹ *Id.* at 122–24.

¹²⁰ *Id.*

¹²¹ LATENT PRINTS AND HUMAN FACTORS, *supra* note 115, at vii.

¹²² *Id.*

¹²³ *Id.* at 43–44.

¹²⁴ *Id.* at 185.

¹²⁵ *Id.* A search of “Latent Prints and Human Factors” using the term “Dror” resulted in

Thus, human factors concerns, and in particular, that of “bias,” were already being pressed before the creation of the NCFS. While it cannot be proved that the Commission thereafter caused further consideration of human factors, it is beyond doubt that the NCFS gave the subject great prominence, a prominence that correlates with recognition of its importance across the forensic domains.

By the conclusion of the Commission’s second meeting, human factors concerns were clearly of importance: at that meeting, the Commission (and thus the public) heard presentations on “Expert Systems and Cognitive Bias,”¹²⁶ “Human Factors and Cognitive Bias in Forensic Science,”¹²⁷ and “The Need For Sequential Unmasking;”¹²⁸ and a commitment was made to form a Human Factors Subcommittee.¹²⁹ The Commission’s third meeting continued the focus, with presentations titled “Human Factors and Forensic Science: A Lot of Talk But Not Enough Action”¹³⁰ and “Minimalizing Contextual Bias in Forensic Science.”¹³¹ The Human Factors Subcommittee was formally designated, and its two chairs appointed.¹³²

The Human Factors Subcommittee produced both formal and informal outcomes. The three Views documents submitted by the Subcommittee that were approved by the Commission called for, respectively: “research . . . to assess the performance of forensic science laboratories on routine analytic tasks such as comparison of samples to determine whether they have a common source;”¹³³ having FSSPs “rely solely on task-relevant information when performing forensic analyses . . . [and having] forensic laboratories . . . take appropriate steps to avoid exposing analysts to task irrelevant information through the use of context management procedures detailed in

38 “hits.” Other research regarding the risk of biasing and preventive measures appears throughout the document. See, e.g., LATENT PRINTS AND HUMAN FACTORS, *supra* note 115, at 44 n.147.

¹²⁶ MEETING SUMMARY MAY 12–13, 2014, *supra* note 40.

¹²⁷ DEBORAH A. BOEHM-DAVIS, CAN YOU CONTROL YOUR BIAS? SUBLIMINAL ACTIONS OF THE BRAIN THAT CAN AFFECT CASE WORK (2014) <https://www.justice.gov/sites/default/files/ncfs/legacy/2014/05/30/boehm-davis-ncfs.pdf>.

¹²⁸ D. MICHAEL RISINGER, THE NEED FOR SEQUENTIAL UNMASKING (2014) <https://www.justice.gov/sites/default/files/ncfs/legacy/2014/05/30/risinger-sequential-unmasking.pdf>.

¹²⁹ NAT’L COMM’N ON FORENSIC SCI., MAY 12–13 2014 MEETING SUMMARY (2014), <https://www.justice.gov/sites/default/files/ncfs/legacy/2014/07/29/meeting2sum.pdf>.

¹³⁰ ITIEL E. DROR, HUMAN FACTORS AND FORENSIC SCIENCE: A LOT OF TALK, BUT NOT ENOUGH ACTION (2014), <https://www.justice.gov/archives/ncfs/page/file/842526/download>.

¹³¹ WILLIAM C. THOMPSON, MINIMIZING CONTEXTUAL BIAS IN FORENSIC SCIENCE (Aug. 26, 2014), <https://www.justice.gov/sites/default/files/ncfs/legacy/2014/08/27/thompson-nat-comm.pdf>.

¹³² MEETING SUMMARY AUGUST 26–27, 2014, *supra* note 41, at 4–5.

¹³³ NAT’L COMM’N ON FORENSIC SCI., VIEWS OF THE COMMISSION: FACILITATING RESEARCH ON LABORATORY PERFORMANCE (2016), <https://www.justice.gov/ncfs/page/file/909311/download>.

written policies and protocols;¹³⁴ and encouraging research on the use of checklists as a tool “to ensure the precise performance of repetitive activities and avoid bias in all forensic activities.”¹³⁵

Human factors issues remain on the national forensics agenda despite the Commission’s demise. The 2016 Justice For All Act amendment included “contextual bias” as a proper subject for state expenditures of federal funds on “emerging forensic science issues[.]”¹³⁶ The NIST, having formed the Organization of Scientific Area Committees (OSAC) to “support[] the development and promulgation of forensic science consensus documentary standards and guidelines, determin[e] each forensic discipline’s research and measurement standards needs, and ensur[e] that a sufficient scientific basis exists for each discipline[.]”¹³⁷ specifically included a “Human Factors” Committee in its structure.¹³⁸ By February 2012, that Committee had developed five draft documents for OSAC internal use: (1) The Role of the Forensic Examiner; (2) Draft Primer on Cognitive Bias; (3) Forensic Science Culture Task Force Document; (4) Draft of Internal Guidance Document on Task Relevance; and (5) Ways to Minimize Contextual Bias.¹³⁹

¹³⁴ NAT’L COMM’N ON FORENSIC SCI., VIEWS OF THE COMMISSION: ENSURING THAT FORENSIC ANALYSIS IS BASED UPON TASK-RELEVANT INFORMATION (2015), <https://www.justice.gov/ncfs/file/818196/download>.

¹³⁵ NAT’L COMM’N ON FORENSIC SCI., VIEWS OF THE COMMISSION: USE OF CHECKLISTS IN FORENSIC SCIENCE (2016), <https://www.justice.gov/archives/ncfs/page/file/934416/download>.

¹³⁶ Justice for All Reauthorization Act of 2016, S. 2577, 114th Cong. (2016), <https://www.govtrack.us/congress/bills/114/s2577/text>.

¹³⁷ Nat’l Inst. of Standards & Tech., *NIST Organization of Scientific Area Committees Roles and Responsibilities* (Apr. 11, 2014), <https://www.nist.gov/sites/default/files/documents/2017/05/09/OSAC-Roles-Responsibilities-Updated.pdf>.

¹³⁸ *Id.* at 4. The Human Factors Group has extensive responsibilities: (1) it “[p]rovides guidance on the influence of systems design on human performance and ways to minimize cognitive and confirmation bias and mitigate errors in complex tasks,” including “[v]erification procedures (administrative, technical review); [b]inding processes; [and] [r]oot cause analysis strategies”; (2) it “[d]evelops case notes templates; (3) it “[d]evelops report templates”; (4) it “[p]repares human impact statements for draft standards submitted for review, if appropriate, addressing: [l]evel of subjectivity in the decision making, [i]dentify tasks that are error magnets, [c]ognitive load, [and] [e]rror identification and mitigation”; (5) it “[c]losely reviews standards related to expert testimony”; and (6) it “[w]orks with relevant SACs and subcommittees on discipline specific human factors issues (e.g. determining domain irrelevant information).” *Id.*

¹³⁹ ORG. OF SCI. AREA COMMS. (OSAC), ANNUAL REPORT FEBRUARY 2015–FEBRUARY 2016 36 (2016), https://www.nist.gov/sites/default/files/documents/2016/09/13/osac_annual_report_2015-2016.pdf.

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Professor William Thompson, chair of the OSAC Human Factors Committee and a member of the NCFS Human Factors Subcommittee, described the impact of the Commission's work and its continuation under the OSAC framework:

The work of our subcommittee has already had substantial impact on forensic science. The views document on Ensuring That Forensic Analysis is Based Upon Task-Relevant Information is the first and only pronouncement from an official body on the important issue of the proper basis for forensic science opinions—that is, what factors a forensic scientist should (and should not) consider when performing various analytic tasks. This question had previously been addressed in a few academic publications (mainly by Michael Risinger and me), but had never been addressed in a serious way by forensic scientists themselves.

The Human Factors Committee of OSAC . . . has been engaging the various OSAC subcommittees in discussions of what is task-relevant and task-irrelevant for various tasks performed within each discipline. These conversations are a necessary starting point for discussion of when and whether it makes sense to introduce context management procedures (blinding) in order to reduce potential bias resulting from exposure to task-irrelevant information. The term “task-relevant,” which was introduced in our Commission document, is now widely used within OSAC. More importantly, the framework introduced in the document (and the accompanying appendix) for distinguishing task-relevant from task-irrelevant information appears to have been accepted. So it is fair to say that the Commission document established the intellectual framework within which subsequent discussions of context management have occurred.

Some OSAC subcommittees have accepted the framework wholeheartedly and are currently working on lists of task-relevant and task-irrelevant information for specific analytic tasks, which will be incorporated into standards and guidelines emerging from those subcommittees. Others . . . resist performing this analysis on grounds that, for them, everything is task-relevant. But even for those groups, the analytic distinction introduced in the Commission document has taken hold. The intellectual framework introduced in our document is essential for holding these high-level and very important discussions. Without the concept of task-relevance (and an authoritative definition of it),

there would be no common frame of reference.¹⁴⁰

According to Professor Thompson, another NCFCS document on “performance testing”¹⁴¹ has been influential, leading one forensic science center to apply for NIJ funding for “blinded performance testing.”¹⁴²

That one forensic science center does not stand alone. Labs, prosecution and police agencies, and forensic science-related organizations have planned and presented trainings by Professor Dror on cognitive factors in forensic decision-making at least twenty times since 2013 just in the United States.¹⁴³

Finally, human factors is an agenda item both nationally and internationally. The July 2017 “Forensic Science Error Management International Forensics Symposium,” sponsored by the NIST, includes a human factors technical track to address “[w]hat is the right balance of information necessary for forensic testing and how can unnecessary information be sequentially unmasked to prevent subconscious bias[.]” and will “cover ways to identify and reduce cognitive, contextual, and confirmation bias in forensic casework.”¹⁴⁴ International forensics scholarship is also highlighting cognitive bias concerns, and has acknowledged the reports of the NCFCS as among those that have “drawn unprecedented attention to the need for forensic practitioners to engage with cognitive science and human factors.”¹⁴⁵ This “unprecedented attention” is an indisputable legacy of the NCFCS; and although other work of the Commission has not impacted judicial reasoning and decision-making, concerns about cognitive bias have at least been placed on the “radar” of the judiciary.¹⁴⁶

¹⁴⁰ Email from William C. Thompson, Professor Emeritus, Univ. of Cal., Irvine Sch. of Law, to Jules Epstein, Professor of Law & Dir. of Advocacy Programs, Temple Univ. Beasley Sch. of Law (Apr. 24, 2017, 14:18 EST) (on file with author).

¹⁴¹ See *supra* note 133.

¹⁴² Email from Prof. Thompson, *supra* note 136.

¹⁴³ Email of trainings list from Itiel E. Dror, Professor, Univ. Coll. London, to Jules Epstein, Professor of Law & Dir. of Advocacy Programs, Temple Univ. Beasley Sch. of Law (Apr. 23, 2017) (on file with author).

¹⁴⁴ FED. BUS. COUNCIL, INC., FORENSIC SCIENCE ERROR MANAGEMENT: INTERNATIONAL FORENSICS SYMPOSIUM AGENDA (2017), <https://www.fbcinc.com/e/nistifs/agendarow.aspx>.

¹⁴⁵ Gary Edmond et al., *Thinking Forensics: Cognitive Science for Forensic Practitioners*, 57 SCI. & JUST. J. 144 (2017).

¹⁴⁶ See, e.g., Itiel E. Dror et al., *Cognitive Bias and Its Impact on Expert Witnesses and the Court*, 54 JUDGES' J. 8 (2015).

CONCLUSION

What, then, is the measure of the National Commission on Forensic Science? There remain voices supporting its mission and either its resurrection or the creation of a similar, science-driven, independent advisory body, a call made forcefully by the American Association for the Advancement of Science, the American Chemical Society, the Federation of Associations in Behavioral and Brain Sciences, and the Human Factors and Ergonomics Society in a joint statement.¹⁴⁷ Should the NIST be able to continue funding the OSAC process, there may be progress on its stated goals of working “together to develop and evaluate forensic science standards via a transparent, consensus-based process.”¹⁴⁸ And in what can be described as heartening, at least one prosecutor has publicly bemoaned the Commission’s end, noting the need for the NCFS to assist in creating guidelines and procedures for rectifying lab errors once they are discovered.¹⁴⁹ Yet for the OSAC to work, there must be consensus between and among practitioners and the scientists and statisticians who are outside of the forensic disciplines, an achievement likely only with strong encouragement from the Department of Justice or direction from the courts.

That leadership and direction are currently in question. This Article has documented the judicial abstention from conforming forensic evidence to the standards of science. As of this writing, Attorney General Sessions has yet to decide what entity, if any, will replace the Commission, and two projects that were undertaken by the Obama Justice Department— “[a]n effort to set uniform standards for forensic testimony and . . . a review of FBI testimony in several techniques”—remain suspended by the current administration.¹⁵⁰

Beyond that, there remains a substantial gulf between science and what is expected of forensic discipline testimony. In a Pennsylvania capital case,

¹⁴⁷ Letter from the Am. Ass’n for the Advancement of Sci. et al. to Jeffrey Sessions, Att’y Gen., U.S. Dep’t of Just. (June 9, 2017), <https://mcmprodaaas.s3.amazonaws.com/s3fs-public/Scientific%20Society%20Comment%20on%20DOJ-LA-2017-0006-0001%20-%209%20June%202017.pdf> (commenting in response to Federal Register notice DOJ-LA-2017-0006-0001 published on April 13, 2017).

¹⁴⁸ Nat’l Inst. of Standards & Tech., *The Organization of Scientific Area Committees for Forensic Science* (Apr. 11, 2016), <https://www.nist.gov/topics/forensic-science/organization-scientific-area-committees-osac> (last updated Feb. 16, 2018).

¹⁴⁹ Rebecca McCray, *Jeff Sessions’ Rejection of Science Leaves Local Prosecutors in the Dark*, SLATE (June 7, 2017), http://www.slate.com/articles/news_and_politics/trials_and_error/2017/06/disbanding_the_ncfs_will_lead_to_worse_outcomes.html. The article quotes an Oregon prosecutor as saying that “[t]he [NCFS] was developing guidelines on how to retain evidence and on security procedures in crime labs[.] . . . Those would’ve been nice to have.” *Id.*

¹⁵⁰ 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=.5b9939d3c518.

a trial court issued a ruling that bitemark evidence shall be admissible at trial, relying solely on the lack of novelty of such evidence in its refusal to even hold a *Frye*¹⁵¹ hearing to assess its reliability,¹⁵² despite there being near-uniform rejection of forensic odontology “matching” testimony as invalid and without scientific foundation.¹⁵³ Perhaps more distressing, and further ground for pessimism, is the comment of Representative Trey Gowdy at a March 2017 committee hearing on the state of forensic science evidence in the United States. Discussing the term “reasonable degree of scientific certainty,” Gowdy stated:

There can be no definition for reasonable doubt in Federal Court. So, that is a phrase that juries hear, and no judge ever explains what it means. So, why not be able to use the phrase reasonable degree of scientific certainty, even though it does not have a great explanation or great definition?¹⁵⁴

Gowdy, a former federal prosecutor,¹⁵⁵ is wrong in his contention that jurors are denied a definition of the term “reasonable doubt.”¹⁵⁶ Beyond that,

¹⁵¹ A *Frye* hearing is used by the Pennsylvania Courts to determine the admissibility of expert testimony, utilizing the “general acceptance” standard accounted in *Frye v. United States*, 293 F. 1013 (D.C. Cir. 1923).

¹⁵² Radley Balko, *Another Judge Rules in Favor of Bite Mark Evidence, for the Same Misguided Reasons*, WASH. POST (Mar. 16, 2017), https://www.washingtonpost.com/news/the-watch/wp/2017/03/16/another-judge-rules-in-favor-of-bite-mark-evidence-for-the-same-misguided-reasons/?utm_term=.00cd052315df.

¹⁵³ *Id.* See also PRESIDENT’S COUNCIL OF ADVISORS ON SCI. & TECH., REPORT TO THE PRESIDENT: FORENSIC SCIENCE IN CRIMINAL COURTS: ENSURING SCIENTIFIC VALIDITY OF FEATURE-COMPARISON METHODS (Sept. 2016), https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_forensic_science_report_final.pdf. The Report concluded that “PCAST considers the prospects of developing bitemark analysis into a scientifically valid method to be low.” *Id.* at 87.

¹⁵⁴ *To Examine the State of Forensic Science in the United States: Hearing Before the Subcomm. on Crime, Terrorism, Homeland Security, & Investigations*, 115th Cong. 2:31 (2017), <https://judiciary.house.gov/wp-content/uploads/2017/03/115-8.pdf>.

¹⁵⁵ Trey Gowdy, *Biography*, <https://gowdy.house.gov/about/full-biography> (last visited Mar. 2, 2018).

¹⁵⁶ By way of example, the Third Circuit Court of Appeals Model Criminal Jury Instructions include the following language: “Proof beyond a reasonable doubt does not mean proof beyond all possible doubt or to a mathematical certainty. Possible doubts or doubts based on conjecture, speculation, or hunch are not reasonable doubts. A reasonable doubt is a fair doubt based on reason, logic, common sense, or experience. It is a doubt that an ordinary reasonable person has after carefully weighing all of the evidence, and is a doubt of the sort that would cause him or her to hesitate to act in matters of importance in his or her own life. It may arise from the evidence, or from the lack of evidence, or from the nature of the evidence.” U.S. COURT OF APPEALS FOR THE THIRD CIRCUIT, MODEL CRIMINAL JURY INSTRUCTIONS 3.06 (Apr. 2015), <http://www.ca3.uscourts.gov/sites/ca3/files/2012%20Chapter%203%20Rev.pdf>.

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asserting that it is proper for a term with no comprehensible meaning to be used by testifying experts is directly contrary to the Commission's goal "to promote scientific validity, reduce fragmentation, and improve federal coordination of forensic science."¹⁵⁷ Instead, it is evocative of Alice in Wonderland¹⁵⁸ and antithetical to science. It is reflective of the Attorney General's focus linking the advancement of forensic science to "help[ing] combat the rise in violent crime"¹⁵⁹ and not conducive to placing scientific validity first.

¹⁵⁷ U.S. Dep't of Just., *National Commission on Forensic Science*, <https://www.justice.gov/archives/nfs> (last visited Mar. 2, 2018).

¹⁵⁸ "'When I use a word,' Humpty Dumpty said, in rather a scornful tone, 'it means just what I choose it to mean—neither more nor less.' 'The question is,' said Alice, 'whether you **can** make words mean so many different things.' 'The question is,' said Humpty Dumpty, 'which is to be master—that's all.'" LEWIS CARROLL, *THROUGH THE LOOKING GLASS* (1871), http://sabian.org/looking_glass6.php.

¹⁵⁹ See *supra* note 10.