

Beyond the Witness: Bringing a Process Perspective to Modern Evidence Law

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I. Introduction

For centuries, the foundation of the Anglo-American trial has been the witness.¹ Witnesses report on their personal observations, provide opinions of character, offer scientific explanations, and in the case of parties, narrate their own story.² Indeed, even for documentary and other physical evidence, witnesses often provide the conduit through which such evidence reaches the factfinder.³ Documentary or physical evidence rarely stands on its own.⁴

The law of evidence has thus unsurprisingly focused on—or perhaps obsessed over—witnesses. The hearsay rule and the Confrontation Clause demand that declarants be available witnesses at trial so that they may be subject to cross-examination.⁵ Expert evidence rules emphasize an expert witness’s qualifications, bases, and methods.⁶ Even the framework for admitting photographs—evidence that is often self-explanatory—is witness-centric. Trial practice commonly treats photographs as demonstrative

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1. See generally George Fisher, *The Jury’s Rise as Lie Detector*, 107 YALE L.J. 575, 583–84 (1997) (discussing the importance of witnesses throughout history, beginning with thirteenth-century English criminal trials).

2. For the modern evidentiary rules governing these forms of witness testimony, see FED. R. EVID. 607–609, 701–704.

3. See FED. R. EVID. 803(18) (requiring an expert to read scientific articles to the jury rather than allowing the article to stand on its own); *Melendez-Diaz v. Massachusetts*, 557 U.S. 305, 308–09, 311, 329 (2009) (requiring lab technicians to testify about forensic lab results rather than allowing the reports to stand on their own).

4. FED. R. EVID. 803(18); *Melendez-Diaz*, 557 U.S. at 311, 329 (holding exhibits and reports are inadmissible unless the witness is subject to cross-examination); see also *Bullcoming v. New Mexico*, 564 U.S. 647, 659 (2011) (requiring the opportunity to cross-examine the analyst producing evidence before a report is admissible).

5. U.S. CONST. amend. VI, cl. 3; FED. R. EVID. 801–802; see *Michigan v. Bryant*, 562 U.S. 344, 358 (2011) (“[T]he basic objective of the Confrontation Clause . . . is to prevent the accused from being deprived of the opportunity to cross-examine the declarant”); *Davis v. Washington*, 547 U.S. 813, 821–22 (2006) (distinguishing between statements that are nontestimonial and not subject to the Confrontation Clause, and statements that are testimonial and subject to the Confrontation Clause).

6. FED. R. EVID. 702–704.

evidence, reducing them to a mere illustration of the vouching witness's testimony.⁷

Our contention is that this witness-centered perspective is antiquated and counterproductive. It is a deeply limited and ultimately distortive lens through which the legal system views the evidence available in the modern world. Historically, focusing on individual witnesses may have made sense. In a world without mechanization, industrial processes, and corporate policies, individuals made observations, took actions, and made decisions on a case-by-case, subjective basis.⁸ Calling those persons to testify in court was then a natural way of clarifying and testing those individualized observations, actions, or decisions.⁹ For example, if the issue was whether a furniture maker was negligent in constructing a chair, the plaintiff might call the artisan. The artisan would testify about his craftsmanship, his suppliers and materials, and his various design choices. Although an artisan's choices perhaps became routinized over time, those decisions were specific to him, often subjective, and unlikely to be memorialized elsewhere. The person's testimony was therefore a critical way of gauging whether he acted properly.¹⁰

In the modern world, particularly in commercial and technological contexts, systems and processes have replaced individual judgment.¹¹ Some processes are entirely computerized or mechanical.¹² Others involve human activity so regularized that the process itself is far more important to reliability than the specific human actor.¹³ In this latter case, the person is

7. FED. R. EVID. 1002; see also Jennifer L. Mnookin, *The Image of Truth: Photographic Evidence and the Power of Analogy*, 10 YALE J.L. & HUMAN. 1, 73 (1998).

8. See generally JOHN LANGBEIN ET AL., HISTORY OF THE COMMON LAW: THE DEVELOPMENT OF ANGLO-AMERICAN LEGAL INSTITUTIONS 297–98, 366, 376–77 (2009) (describing eighteenth-century English Chancery's testimony practices, which focused on individual answers and accounts and saw the acceptance of cross-examination by lawyers).

9. John H. Wigmore, *A General Survey of the History of the Rules of Evidence* (“By the 1500s, the constant employment of witnesses, as the jury's chief source of information, brings about a radical change. Here enter, very directly, the possibilities of our modern system.”), in 2 SELECT ESSAYS IN ANGLO-AMERICAN LEGAL HISTORY 691, 692 (1908); see also John Langbein, *The Historical Foundations of the Law of Evidence: A View from the Ryder Sources*, 96 COLUM. L. REV. 1168, 1169–72 (1996) (discussing the development of the law of evidence around the necessity of providing jurors accurate oral testimony).

10. See Joel N. Bodansky, *The Abolition of the Party-Witness Disqualification: An Historical Survey*, 70 KY. L.J. 91, 96 (1981) (describing cross-examination as “the most perfect and effectual system for the unraveling of falsehood ever devised by the ingenuity of mortals”).

11. See generally Andrew L. Russell, *Standardization in History: A Review Essay with an Eye to the Future* (discussing the standardization of international processes), in THE STANDARDS EDGE: FUTURE GENERATIONS 247–60 (Sherrie Bolin ed., 2005); THE LAW, ECONOMICS AND POLITICS OF INTERNATIONAL STANDARDISATION (Panagiotis Delimatsis ed., 2015) [hereinafter INTERNATIONAL STANDARDISATION].

12. For instance, photographic evidence constitutes an entirely mechanical form of process-based evidence. See *infra* subpart III(C).

13. Consider, here, a forensic lab technician overseeing a DNA test. Although the technician

reduced to a cog who exercises limited, if any, independent judgment. In these instances involving systems and processes, the focus of the legal system should no longer be on individuals and their testimony. After all, the reliability inquiry itself no longer depends on their actions or observations.

Revisiting the defective chair example illustrates the point. The safety of chairs emerging from a mass production line is no longer about the individual line workers. To be sure, for any given chair, an individual line worker may be inattentive or otherwise negligent. But there are too many chairs and too many line workers, so modern practice treats the entire system as a single entity. The focus is on the reliability of the design and manufacturing process as a whole, the quality control checks, and other company policies and practices.¹⁴ Any individual witnesses are beside the point. Yes, one could call an employee to testify about the policies, but the key evidence is the policies themselves, not the employee's testimony. Whereas the policies and quality controls reveal important details about the appropriateness of the company's manufacturing process, the employee is only important if there exist questions about the employee's individual conduct, which seldom is the inquiry.¹⁵

Such process-based evidence needs a process-based evidentiary framework, but the legal system has largely jammed process-based evidence into the traditional witness-based scheme with poor results. The traditional framework hampers the use of process evidence, distorts its presentation, and fails to ensure its reliability. For example, the pictorial testimony theory of photographs,¹⁶ the Confrontation Clause rejection of certified lab results

must prepare a sample for testing, the probative force of DNA evidence—particularly a DNA match—stems from an objective, nonpersonal process known as DNA typing that removes human subjectivity altogether. 4 DAVID L. FAIGMAN ET AL., *MODERN SCIENTIFIC EVIDENCE* § 30:2 (2018) (providing an introduction to DNA terminology and taxonomy of typing systems); see also *infra* subpart III(A).

14. The focus of lawsuits alleging a manufacturing defect, for example, often centers on problems arising from standardized production lines rather than the subjective actions of any one individual. See JAMES R. BENIGER, *THE CONTROL REVOLUTION: TECHNOLOGICAL AND ECONOMIC ORIGINS OF THE INFORMATION SOCIETY* 278–79 (1986) (detailing how processes provided a needed response to a crisis of control that stemmed from the significant rise of production capabilities in the nineteenth century); David G. Owen, *Manufacturing Defects*, 53 S.C. L. REV. 851, 865–82 (2002) (discussing the development of doctrines that allow for product liability resulting from deviations from the intended design, even where all possible care was taken in production).

15. See Owen, *supra* note 14, at 875–78 (exploring the application of the malfunction doctrine in various manufacturing defect cases, none of which considered employee conduct as central to the case).

16. See FED. R. EVID. 1002 Notes of Advisory Committee on Proposed Rules (discussing the practice of having a witness use a picture to illustrate testimony); Mnookin, *supra* note 7, at 73 (discussing the nineteenth-century consideration of photographic evidence as mere illustration of oral testimony).

under *Melendez-Diaz v. Massachusetts*,¹⁷ and the learned treatise exception to the hearsay rule¹⁸ are arguably all anomalies caused by the law's traditional focus on witnesses. Some doctrines, notably the business records exception to the hearsay rule, have shown a great awareness of the importance of processes.¹⁹ But they are the exception, and they are merely temporary fixes to the fundamental tension between process-based and witness-based evidence.

The witness focus of traditional evidence rules leaves the legal system ill-equipped to handle process evidence, and this deficiency engenders considerable costs. Process evidence is not only widespread in today's world, but it is often also highly probative.²⁰ Yet the witness-based evidence rules impede the admission of this process evidence, and they do not ensure its reliability.

The goal of this Article is therefore not to propose discrete patches like the business records exception. The goal instead is to create an appropriate framework for testing and challenging process evidence comparable to the one we have for witnesses. Such a structure requires both analogical and creative thinking. For example, cross-examination may be the "greatest legal engine ever invented for the discovery of truth" with regard to witnesses,²¹ but it is a poor instrument for probing processes. A process framework may therefore require broadening our conception of confrontation or rethinking what constitutes hearsay. Rather than compulsory process and cross-examination, process evidence may instead require enhanced discovery rules facilitating access to and testing of the process.²² Ultimately, our legal system

17. 557 U.S. 305, 308, 329 (2009).

18. FED. R. EVID. 803(18).

19. FED. R. EVID. 803 Notes of Advisory Committee on Proposed Rules. The Notes expound: The element of unusual reliability of business records is said variously to be supplied by systematic checking, by regularity and continuity which produce habits of precision, by actual experience of business in relying upon them, or by a duty to make an accurate record as part of a continuing job or occupation.

Id.

20. See, e.g., Edward J. Imwinkelried, *Computer Source Code: A Source of the Growing Controversy over the Reliability of Automated Forensic Techniques*, 66 DEPAUL L. REV. 97, 97–102 (2016) (discussing the proliferation of automated forensic techniques and arguing that defendants should have the right to test the source code of programs that match genetic information); Andrea Roth, *Machine Testimony*, 126 YALE L.J. 1972, 2000–22 (2017) (examining "which machine acts and utterances implicate credibility, and how courts have attempted to regulate them").

21. 5 JOHN H. WIGMORE, A TREATISE ON THE ANGLO-AMERICAN SYSTEM OF EVIDENCE IN TRIALS AT COMMON LAW § 1367, at 32 (4th ed. 1974); see also *Lilly v. Virginia*, 527 U.S. 116, 124 (1999).

22. See, e.g., Imwinkelried, *supra* note 20, at 128–30 (proposing a discovery regime that balances machine access with protection of trade secrets by allowing for testing of the program before source code disclosure); Roth, *supra* note 20, at 2027–30 (considering and proposing potential ways in which jurisdictions might approach pretrial disclosure and access to the source code for machine evidence).

demands a means of assessing the reliability of process-based evidence that does not rely on the persistent fiction that process reliability is fully assessable from the witness stand alone.

The Article proceeds as follows. After this Introduction, Part II begins with the witness fixation that pervades the modern courtroom. Regardless of the nature of the evidence at issue—be it eyewitness testimony, documentary evidence, or forensic lab results—the overwhelming trend in courtrooms today is for parties to examine evidence indirectly through a surrogate witness.²³ Witnesses serve as conduits through which the reliability of almost all evidence is assessed.²⁴ As noted, this witness-centric adjudicatory regime may have made historical sense. The reliability of evidence was, for centuries, inextricably intertwined with human observation, action, and subjectivity. Early cases often turned entirely on the testimony of eyewitnesses, and while physical evidence did play a role at trial, its reliability often depended on an artisan's skill.²⁵ In a world driven by subjective, ad hoc actions, centering trial practice and procedure around the witness stand was the natural choice.²⁶

However, the emergence of standardization marked the beginning of the end for an era focused exclusively on so-called person-based evidence.²⁷ In recent decades, evidentiary reliability has become increasingly dependent not on the subjective observation or skill of particular individuals but instead on

23. See Nicholas Klaiber, Note, *Confronting Reality: Surrogate Forensic Science Witnesses Under the Confrontation Clause*, 97 VA. L. REV. 199, 228 (2011) (discussing recent changes in forensic laboratory protocol enabling surrogate witnesses to fully testify as to forensic methods, results, and analysis).

24. See generally Fisher, *supra* note 1, at 624–56 (recounting the historical development and legal treatment of witness credibility conflicts); Langbein, *supra* note 9, at 1169–72 (examining the development of the law of evidence and the role of witnesses for introducing the jury to relevant facts of the trial).

25. See LANGBEIN ET AL., *supra* note 8, at 34–35, 48–49 (providing examples of thirteenth-century cases centering on the importance of the influence of eyewitness testimony and its consistency); Robert J. Kaczorowski, *The Common-Law Background of Nineteenth-Century Tort Law*, 51 OHIO ST. L.J. 1127, 1131 (1990) (pointing to the relevance of a carpenter–defendant's skill in pre-eighteenth century negligence cases).

26. See generally Fisher, *supra* note 1, at 602–24 (recounting the development of jury trials and the usage of witnesses in early English law and providing specific instances where witnesses testified to subjective experiences); Langbein, *supra* note 9, at 1169–72 (describing the development of the instructional jury, whereby witnesses would inform the jurors of relevant facts).

27. See Imwinkelried, *supra* note 20, at 97–98 (contrasting modern automated forensic procedures against early twentieth-century individual inspections); Roth, *supra* note 20, at 2009–20 (describing the development of standardized evidence, beginning with basic scientific instruments and progressing to biometric machinery). See also generally INTERNATIONAL STANDARDISATION, *supra* note 11, at 1 (compiling articles discussing the foundations of international standard-setting); Russell, *supra* note 11, at 247–56 (discussing recent academic works on standardization in politics, business, economics, science, technology, labor, and culture, and speculating on the impact of globalization and convergence on possible future trends in international standardization).

standardized and often objective and mechanical processes that largely eliminate human subjectivity.²⁸

Part III demonstrates how our person-based adjudicatory regime has hereto failed to appropriately respond to the rise of process-based evidence. Rather than attempting to scrutinize process-based evidence on its own terms, modern evidentiary rules governing process-based evidence rely on uneasy fictions to try to test its reliability from the witness stand. Essentially, process-based evidence is crammed into the entrenched person-based system. As Part III will detail, this type mismatch has led to significant missteps in the evidentiary treatment of forensic lab results, photographs, scientific articles, and business records.

Part IV, therefore, proposes a new conceptual approach for handling process-based evidence, recasting the traditional witness-based ideas of appearance, cross-examination, and credibility into the process-based context. As a baseline matter, Part IV argues in favor of expanding the compulsory process and subpoena powers to allow litigants increased access to the underlying processes generating evidence in particular cases, thereby enabling them to assess the reliability of the evidence directly rather than through a surrogate witness. Complementing this reform is a proposed reconceptualization of the Confrontation Clause and hearsay rule that would tailor these doctrines to the specific contours of process-based evidence while staying true to their worthwhile normative aims. Having settled the preliminaries, Part IV then addresses the overarching, pressing question: If the reliability of process-based evidence is not assessed through the witness stand, how is it to be measured instead?

Finally, Part V concludes the discussion, asking whether acknowledging the process shift fundamentally changes the nature of trial. For example, will greater acceptance of process evidence lead to a more documentary-based trial process, as opposed to the traditional witness-based one? Will it destroy the celebrated narrative structure of trial? And will it lead to less individualized justice?

28. See Imwinkelried, *supra* note 20, at 98 (stating that 85% of DNA laboratories use automated forensic-analysis techniques because the computerization results in uniform analysis); Roth, *supra* note 20, at 2044 (quoting Justice Liu's dissenting opinion in *People v. Lopez* that contrasts the use of standard methods to measure blood-alcohol levels against "less accurate or more subjective methods" of making that determination, 286 P.3d 469, 494 (Cal. 2012) (Liu, J., dissenting)).

II. Process-Based Evidence

A. *The Rise of the Witness*

The witness is the focal point of the modern trial.²⁹ In determining guilt or innocence, liability or the absence thereof, factfinders often turn to the witness-box to receive and weigh information from knowledgeable persons. Did a defendant possess the requisite *mens rea* for a particular crime? Did a tort victim's own actions contribute to her injury? Witnesses usually provide the answer.

Witnesses relay eyewitness accounts of the events in question, providing factfinders pertinent, firsthand information.³⁰ They offer opinions about character—claims that an individual is trustworthy or dishonest, aggressive or peaceful.³¹ They impart expert knowledge to factfinders, distilling complex topics down to a more palatable form.³² And, in many cases, they are the conduit through which certain forms of admissible hearsay enter the courtroom, informing factfinders of a third party's excited utterance or dying declaration.³³

But despite the witness's prominence in criminal and civil adjudication, it is important to recognize that our witness fixation is generally not the product of modern planning and deliberation. That is, adjudication via the witness-box does not enjoy mainstream acceptance because of a modern belief that, relative to its alternatives, witness testimony is the best means of

29. See generally Fisher, *supra* note 1, at 602–24 (chronicling the rise of defense witnesses). Sir William Blackstone and Sir Matthew Hale also spoke highly of the witness-focus of pre-modern trials. See Raymond LaMagna, *(Re)constitutionalizing Confrontation: Reexamining Unavailability and the Value of Live Testimony*, 79 S. CAL. L. REV. 1499, 1526–27 (2006). Hale, for example, wrote, “[T]he very Manner of a Witness’s delivering his Testimony will give a probable Indication whether he speaks truly or falsely . . .” *Id.* at 1526 (quoting MATTHEW HALE, *THE HISTORY AND ANALYSIS OF THE COMMON LAW OF ENGLAND* 252 (1713)).

30. Richard A. Wise et al., *How to Analyze the Accuracy of Eyewitness Testimony in a Criminal Case*, 42 CONN. L. REV. 435, 441 (2009) (noting that eyewitness testimony “is one of the most powerful types of evidence that can be presented against a criminal defendant”); see also Matthew J. Reedy, *Witnessing the Witness: The Case for Exclusion of Eyewitness Expert Testimony*, 86 NOTRE DAME L. REV. 905, 906 (2011) (providing an example of eyewitness testimony being given).

31. See FED. R. EVID. 607–608 (allowing witnesses to question another witness’s credibility or character).

32. See FED. R. EVID. 702–704 (providing for expert witness testimony and allowing for potentially inadmissible facts where their probative value outweighs their prejudicial effect); see also Ronald J. Allen & Joseph S. Miller, *The Common Law Theory of Experts: Deference or Education?*, 87 NW. U. L. REV. 1131, 1137–42 (1993) (discussing the tension between two conceptions of the role of expert witness testimony: deference and education).

33. See FED. R. EVID. 803–804 (listing exceptions to the rule against hearsay).

exploring all evidentiary issues at trial. Rather, the witness-box continues to occupy a preeminent place at trial because it is a product of history.³⁴

A brief examination of the roots of witness testimony helps explain its entrenchment today. In its earliest form, the jury's role was largely unrecognizable as compared to its modern function. At the turn of the twelfth century, the English legal system was in desperate need of a viable dispute-resolution tool. The legitimacy of the infamous ordeal was in rapid decline, and a process known as "appeal of felony," essentially trial by combat, was highly unpopular for obvious reasons.³⁵ Thus, in 1166, Henry II issued the Assize of Clarendon, which established the first formalized witness-jury system.³⁶ The early jury was a self-informed group, as jurors' place in tight-knit agrarian communities enabled them to have intimate knowledge about relevant trial facts or, at a minimum, put jurors in the best position to uncover the necessary facts.³⁷ Rather than assuming a passive, evaluative role, the early jury was expected to have pretrial knowledge of the events at issue and come "upon oath" to trials to speak as to whether anyone in their area was "accused" or "notoriously suspect[ed]" of certain serious offenses—including murder, robbery, theft, or harboring.³⁸ Essentially, then, the first form of witness testimony was offered by the jury itself. Even at the inception point of jury-based adjudication, procedure centered around the testimony of knowledgeable individuals.

In the centuries that followed, social change necessitated a radical reinvention of this early model. The Black Death saw open-fields agriculture, the essential predicate for the self-informing jury, become nonviable as drastic reductions in population size forced workers to embrace independent, enclosure-based farming.³⁹ Communal life faded away and with it the

34. See Fisher, *supra* note 1, at 585–602 (chronicling the history of the jury trial and noting that "[b]y the middle of the fifteenth century . . . the English trial system had come to stake great importance on the evidence of witnesses sworn under oath").

35. See LANGBEIN ET AL., *supra* note 8, at 28–35 (discussing appeal of felony and its shortcomings).

36. As will be discussed in full above, the early jury was often comprised of firsthand witnesses to the event in question. 2 ENGLISH HISTORICAL DOCUMENTS: 1042–1189, at 440–43 (David C. Douglas & George W. Greenaway eds., 2d ed. 1981); LANGBEIN ET AL., *supra* note 8, at 35–37.

37. Langbein, *supra* note 9, at 1170–71.

38. 2 ENGLISH HISTORICAL DOCUMENTS: 1042–1189, *supra* note 36, at 440–41.

39. LANGBEIN ET AL., *supra* note 8, at 224–27. Although the Black Death spurred on the first stages of the era of non-juror witnesses, remnants of the jury's previous self-informing witness function remained. For example, in 1598, the Queen's Bench refused to overturn a *nisi prius* jury verdict, even after one of the jurors produced evidence not admitted at trial and "shewed it to inform himself and his fellows." *Graves v. Short* (1598) 78 Eng. Rep. 857, Cro. Eliz. 616 (QB); LANGBEIN ET AL., *supra* note 8, at 245. Nonetheless, the rise of the non-juror witness is marked by a number of key factors. First, Anthony Musson identified the transition to an instructional rather than pre-informed jury by noting the rise of unsworn statements (both by the defendant and witnesses) in the courtroom during the fourteenth century. See ANTHONY MUSSON, PUBLIC ORDER AND LAW

Crown's ability to tap into local knowledge. The original witness–jury was in danger of extinction, as “[w]ithout the village, the jury, as contemporaries knew it, would have been impossible.”⁴⁰ Yet, despite radical socioeconomic changes—changes that caused the jury’s initial proactive, self-informing witness function to gradually transition into passive, evaluative responsibilities—the witness stand did not become obsolete.⁴¹ Instead, trials centered around non-juror, third-party witnesses became increasingly common.

Sir Thomas Smith’s *De Republica Anglorum* provides an example of the emerging witness-centric trial.⁴² Smith’s sixteenth-century account, the “earliest window we have on the early modern trial,”⁴³ depicts a victim and accusing witnesses engaging with a defendant in an adversarial dialogue about the circumstances of an assault.⁴⁴ No physical evidence is presented. No experts offer opinions. No lawyers make arguments to the jury. Instead, Smith depicts a courtroom in which the jury is simply to adjudicate guilt on the basis of the testimonial exchange between third-party witnesses and the defendant.⁴⁵ The trial begins with the victim speaking to the defendant under oath that “thou robbest me in such a place, thou beatest me[], thou tookest my horse from me[], and my purse”⁴⁶ The victim’s testimony is followed by that of other accusing witnesses who provide, under oath, testimonial “evidence against the malefactor.”⁴⁷ The defendant then responds, denying the charges and demonstrating that the “accused’s merged

ENFORCEMENT: THE LOCAL ADMINISTRATION OF CRIMINAL JUSTICE 1294–1350, at 201–05 (1996) (“In the early fourteenth century, . . . the self-informing character of trial juries was tempered by the recognition that witnesses . . . were an acceptable and sometimes essential part of medieval criminal trials.”). Third-party witness statements also marked the rise of the ignorant jury, as it constituted a significant departure from the trials with self-informing juries in which, as noted by Daniel Klerman, third-party “testimony was quite uncommon.” Daniel Klerman, *Was the Jury Ever Self-Informing?*, 77 S. CAL. L. REV. 123, 142 (2003). Second, as Langbein notes, the vicinage requirement that jurors be composed of individuals from specific hundreds steadily declined. See LANGBEIN ET AL., *supra* note 8, at 243–44. The purpose of the vicinage requirement was to ensure that a jury constituted of self-informed witnesses give their proximity to the crime and parties; the removal of the requirement, therefore, signaled a transition into a new era in which an ignorant jury would need to be informed of the details of a case via others on the witness stand.

40. R.B. Goheen, *Peasant Politics? Village Community and the Crown in Fifteenth-Century England*, 96 AM. HIST. REV. 42, 53 (1991).

41. See LANGBEIN, *supra* note 8, at 238–48 (describing the development of jury-informing practices and compulsory process, which maintained the relevancy of the witness).

42. THOMAS SMITH, *DE REPUBLICA ANGLORUM* 112–14 (Mary Dewar ed., 1982); accord JOHN LANGBEIN, *THE ORIGINS OF ADVERSARY CRIMINAL TRIAL* 13 (2003).

43. LANGBEIN, *supra* note 42, at 13.

44. *Id.* at 13–16.

45. *Id.* at 13–14.

46. SMITH, *supra* note 42, at 114; accord LANGBEIN, *supra* note 42, at 13.

47. SMITH, *supra* note 42, at 114; accord LANGBEIN, *supra* note 42, at 13.

roles as defender and witness were inextricable.”⁴⁸ After all the witnesses provided their accounts, the jury dispensed justice purely on the basis of the oral exchange they had observed. As John Langbein puts it, the jury was told to “decide the case based on what they had learned from the exchange, usually with little instruction.”⁴⁹ In-court testimony was both necessary and sufficient for a conviction.

As time marched on, the focus on the witness in the courtroom evolved from practical necessity to central obsession. Much of this was due to a sort of institutional path dependency. As witnesses became a mainstay of adjudication, rules and practices naturally emerged to encourage the production and scrutiny of their testimony.⁵⁰ The Marian Committal Statute of 1555 was the first decree to afford justices of the peace (effectively, prosecutors) compulsory process, granting them the authority to require that accusing witnesses attend a proceeding to proffer testimony.⁵¹ John Henry Wigmore asserted that there existed “by the beginning of the 1700s, a general and settled acceptance of [the hearsay exclusionary] rule as a fundamental part of the law.”⁵² Forced into the courtroom by compulsory process or the hearsay rule, witnesses found their testimony subject to an increasingly robust set of procedures designed to test the weight of their words. The oath, of course, sought to ensure witness veracity by relying on the threat of divine retribution. Cross-examination emerged as “the most perfect and effectual system for the unraveling of falsehood ever devised by the ingenuity of mortals.”⁵³ In Jeremy Bentham’s words: “Against erroneous or mendacious testimony, the grand security is cross-examination”⁵⁴ As these practices and procedures became normalized and refined over time, the prospect of adjudication without an emphasis on the witness-box gradually faded.⁵⁵

48. LANGBEIN ET AL., *supra* note 42, at 13.

49. *Id.* at 14.

50. See generally LANGBEIN ET AL., *supra* note 8, at 559–728 (exploring the shift of sixteenth-century trial practices forbidding defense witnesses to an adversarial system allowing for witnesses and cross-examination as a result of legislation as well as improvements in investigation procedure); Fisher, *supra* note 1, at 624–55 (outlining procedural developments that guided juries in witness-centric trials).

51. LANGBEIN, *supra* note 42, at 51; John H. Langbein, *The Privilege and Common Law Criminal Procedure: The Sixteenth to the Eighteenth Centuries*, in THE PRIVILEGE AGAINST SELF-INCRIMINATION: ITS ORIGINS AND DEVELOPMENT 82, 91 (Helmholz et al. eds., 1997).

52. 3 JOHN HENRY WIGMORE, A TREATISE ON THE ANGLO-AMERICAN SYSTEM OF EVIDENCE IN TRIALS AT COMMON LAW § 1364, at 25 (2d ed. 1923).

53. Bodansky, *supra* note 10, at 96 (citing *Of the Disqualification of Parties as Witnesses*, 5 AM. L. REG. 257, 263–64 (1857)).

54. 5 JEREMY BENTHAM, RATIONALE OF JUDICIAL EVIDENCE SPECIALLY APPLIED TO ENGLISH PRACTICE 212 (Fred B. Rothman & Co. 1955) (1827).

55. Institutional entrenchment is not a phenomenon isolated to witness-centric trials. The primary competitor to modern trials is of course plea bargaining, a practice that itself has undergone a similar entrenchment process in our juridical system over the past century. See generally

Instead, an entire trial system built upon the assumption that witnesses would relay evidence into the courtroom increasingly demanded just that.

Of course, in this early era, establishing the witness as the focal point of trial practice and procedure was entirely sensible. Documentary, forensic, and even physical evidence were in relatively short supply.⁵⁶ Instead, almost all evidence was “person-based.” As demonstrated by *De Republica Anglorum*, cases often turned entirely on the weighing of competing witness testimony or evidence that was at least the product of ad hoc, subjective human actions.⁵⁷ Because the reliability of evidence was primarily dependent on the particular person who brought information to the court’s attention, it was a natural and necessary approach for the Anglo-American legal system to funnel scrutiny of evidence through the witness-box. Yet as the following sections will show, this traditional system failed to anticipate the rise of non-person-based evidence.⁵⁸ By the time the pre-industrial era came to an end, a mere preference for trial-by-witness in the Anglo-American legal system had become a mandate, rendering the system ill-equipped to respond to a new era of evidence.

B. *The Rise of Process*

Socioeconomic conditions have drastically changed since the time when witness-centric adjudication arose as the primary means of determining cases. Whereas the witness-focused trial emerged in an era when individuals made observations, took actions, and made decisions on an ad hoc, subjective basis, modern society is instead characterized by a phenomenon overlooked by the early designers of the Anglo-American trial system—standardization.⁵⁹

Jacqueline E. Ross, *The Entrenched Position of Plea Bargaining in United States Legal Practice*, 54 AM. J. COMP. L. 717 (2006) (arguing that the prevalence of and institutional preference for resolving criminal proceedings through plea bargains constitute institutional entrenchment).

56. See generally LANGBEIN ET AL., *supra* note 8, at 51 (discussing the development of “rational means of proof” based on “evidence from witnesses, the analysis of [circumstantial evidence], and the inspection of written documents” (alteration in original)).

57. SMITH, *supra* note 42, at 114; LANGBEIN, *supra* note 42, at 14.

58. See generally Fisher, *supra* note 1, at 585–602 (detailing how juries’ significant power was supported through a quasi-divine belief in the power of a witness’s oath).

59. See generally INTERNATIONAL STANDARDISATION, *supra* note 11 (compiling scholarship examining the “complex phenomena that lead to the creation of technical standards,” “institutional structures,” and “decision-making processes”); Russell, *supra* note 11, at 247–60 (providing a survey of standardization in various areas and tracing the development from nineteenth- and early twentieth-century advancements). Machine learning presents an ideal illustration of how the rise of mechanization is beginning to dominate spheres traditionally considered the exclusive domain of humans. John O. McGinnis & Russell G. Pearce, *The Great Disruption: How Machine Intelligence Will Transform the Role of Lawyers in the Delivery of Legal Services*, 82 FORDHAM L. REV. 3041, 3043–46 (2014); see also generally BENIGER, *supra* note 14, at 254–398 (detailing how processes

The inception of standardization is found in the Industrial Revolution.⁶⁰ Beginning in the eighteenth century, the Industrial Revolution upended economies by rejecting individualistic artisan skill in favor of replicable processes.⁶¹ Assembly lines systematically piecing together parts replaced workshops crafting items holistically; strict adherence to guidelines started to displace individual judgment and discretion. Ultimately, the “Industrial Revolution augmented and replaced human effort by machines in manufacturing, farming, and transportation.”⁶² Consider, for example, the transformation of the textile industry. In the pre-industrial world, the quality of an article of clothing was largely dependent on the skill of the worker who made it.⁶³ The finest materials would go to waste if a worker lacked the necessary skill to craft a garment.⁶⁴ The Industrial Revolution, however, standardized clothing production. Mechanical innovation made the quality of cloth dependent on the attributes of a particular machine rather than on the skill of a worker.⁶⁵

Standardization has grown into a staple of modern society. Today, computers deliver information according to their internal code.⁶⁶ Cameras produce high-definition digital images mechanistically.⁶⁷ No longer is human skill required to complete complex tasks, as standardized procedures are now invoked to land large aircraft, perform certain surgeries, and optimize logistical networks.⁶⁸ Interactions among humans are also becoming

provided a needed response to a crisis of control that stemmed from the significant rise of production capabilities in the nineteenth century).

60. See, e.g., Douglas W. Allen & Yoram Barzel, *The Evolution of Criminal Law and Police During the Pre-modern Era*, 27 J.L. ECON. & ORG. 540, 542–43 (2011) (“The Industrial Revolution began to change the degree to which variability interfered in life. For the first time it became possible to leave nature outside the production process . . . variability was reduced enough to allow sufficient measurement and reliable replication at a reasonable cost, that is, the beginning of standardization.”).

61. See *id.* at 542–43, 546–47 (analyzing how the proliferation of standardized transportation enabled the proliferation of manufactured goods over artisan productions).

62. Daniel F. Spulber, *Should Business Method Inventions Be Patentable?*, 3 J. LEGAL ANALYSIS 265, 313 (2011).

63. See THE CAMBRIDGE HISTORY OF WESTERN TEXTILES 1–2, 4 (David Jenkins ed., 2003).

64. See *id.* at 1–4 (describing various types of traditional and experimental materials while noting that early textiles were “homespun” and “homemade”).

65. See *id.* at 4–6 (noting the diversity of materials and textiles developed by later industrializing countries’ textile industries).

66. VAKUL SHARMA, INFORMATION TECHNOLOGY: LAW AND PRACTICE 168 (3d ed. 2011).

67. ELIZABETH ALLEN & SOPHIE TRIANTAPHILIDOU, THE MANUAL OF PHOTOGRAPHY 1–2 (2009).

68. See Roth, *supra* note 20, at 2003 (providing examples of complex tasks completed by mechanical procedures); see also Richard M. Satava, *Emerging Technologies for Surgery in the 21st Century*, 134 ARCH SURG 1197, 1197–1202 (1999) (detailing the technological advancements in surgery); *Future Technology and Airplane Types*, STANFORD (2015), <http://adg.stanford.edu/aa241/intro/futureac.html> [<https://perma.cc/34HX-74FH>] (highlighting the technological sophistication of modern airplanes); Adam Robinson, *The Future of Logistics: Are 3PL Companies*

increasingly standardized. College admissions are no longer primarily dependent on a particular committee's subjective decisions but instead on a rubric of set factors aimed at ensuring a capable and diverse student body.⁶⁹ Many business decisions—say, the termination of a corporate employee for substance abuse—are usually settled not by a supervisor's whim but instead by a pre-determined policy applicable to all employees.⁷⁰

The social change brought on by standardization has had a profound effect on the types of evidence introduced in modern courtrooms. Namely, standardization has caused the emergence of a new category of evidence best described as “process-based.” Process-based evidence arises from a system, allowing us to inquire into its reliability through a general, rather than specific, inquiry. Indeed, the reliability of process-based evidence depends far more on a standardized procedure than it does on any particular person.⁷¹ For example, taking the *De Republica Anglorum* account into the twenty-first century, if there had been a video camera at the scene of the assault described by Sir Thomas Smith, our confidence in the video footage would come from our background knowledge of video cameras rather than any particular person.⁷² We know that video cameras typically record scenes mechanically and accurately, and absent extraordinary circumstances, we are likely to believe their content regardless of who set up or maintained the camera or who offers the video in court.⁷³ Whereas the person-based testimony offered in Smith's original account involved evidence both observed and related by an individual, the process-based video example involves process-based evidence observed by and ultimately related by machines.⁷⁴ Figure 1 lists some of the attributes that characterize the person–process distinction.

Ready to Adopt These 4 Emerging Technologies?, CERASIS (Jan. 14, 2015), <http://cerasis.com/2015/01/14/future-of-logistics/> [<https://perma.cc/TXX8-7K6A>] (reviewing key technological advances in logistics).

69. See, e.g., WARREN W. WILLINGHAM & HUNTER M. BRELAND, PERSONAL QUALITIES AND COLLEGE ADMISSIONS 2–3, 19 (1982) (explaining the increased emphasis placed on personal qualities in college admissions).

70. JOHN P. HOFFMANN ET AL., AN ANALYSIS OF WORKER DRUG USE AND WORKPLACE POLICIES AND PROGRAMS 1 (1997) (evaluating “the presence of written policies and employee assistance programs for workers with alcohol or drug problems”).

71. See generally MARVIN RAUSAND & ARNLJOT HØYLAND, SYSTEM RELIABILITY THEORY: MODELS, STATISTICAL METHODS, AND APPLICATIONS (2d ed. 2004) (discussing conceptual approaches for testing the reliability of various forms of standardized systems).

72. Cf. SMITH, *supra* note 42, at 114. Recall that, in Thomas Smith's original account discussed above, the plaintiff and a series of accusing witnesses alleged that the defendant had beaten and robbed the plaintiff. In the original version, the trial constituted nothing more than a series of testimonial exchanges among the witnesses.

73. See Jordan S. Gruber et al., *Video Technology*, 58 AM. JUR. TRIALS 481, 502 (1996) (“In addition to being pervasive, video technology and television is extremely persuasive.”).

74. *Id.* at 500 (describing the video playback process as involving “the transmission of visual images of moving and stationary objects, generally with accompanying sound, as electromagnetic waves, and the reconversion of those received waves into reliable representations of the original visual images and accompanying sound”).

Figure 1: Attributes distinguishing person-based and process-based evidence inquiries.

| <u>Person-Based</u> | <u>Process-Based</u> |
|---|--|
| Human One-off Subjective Specific Individual Conscious Clinical Custom | Mechanistic Regular Activity Objective General Institutional Automatic Actuarial Standardized |

Eyewitnesses, testimony, and video recordings serve as convenient examples for contrasting person-based and process-based evidence. In some instances, however, a piece of evidence might possess both person and process elements.⁷⁵ Where this occurs, the proper classification of a piece of evidence depends on whether the value of the evidence is contingent on our assessment of a specific, individual person and her personal qualities, or whether the value stems from the generic quality of the process.

For example, consider a business record, such as a sales receipt, offered to show that the defendant purchased certain items from a store.⁷⁶ The sales process involves a human actor—the sales clerk entering or scanning item numbers—but the source of the reliability comes from the standardized process, not the specific individual.⁷⁷ We trust the sales receipt because the store produces these receipts as a matter of course, and it is that standardized process that deserves our scrutiny rather than the specific clerk.⁷⁸ The clerk,

75. As we will discuss below, forensic lab results, business records, and some learned treatises (such as scientific articles) all constitute examples of process-based evidence, despite the involvement of human actors. The individuals involved in the production of this evidence are not exercising subjective discretion or engaging in ad hoc actions but instead simply accomplishing preset, standardized tasks. *See infra* Part III.

76. For background on the operation of systems that generate and store business records, see generally David Bearman, *Record-Keeping Systems*, 36 ARCHIVARIA 16 (1993).

77. *See id.* at 31 (describing the functional requirements of a record-keeping system, which sees reliability as stemming from the objective controls employed by a system rather than the subjective actions of a document's creator).

78. *Id.* (“Records must have been created and maintained in the normal course of business, and

absent some extraordinary circumstance, is interchangeable with any other and for our assessment purposes, nothing but a cog in the process. Thus, the mere presence of a person in the production of the evidence does not necessarily mean that evidence is person-based.

Similarly, the mere involvement of a machine does not automatically mean that the evidence is process-based. For example, suppose a person takes a series of photographs to show how a structure deteriorated over time. Photographs of course involve the mechanical or electronic operation of a camera.⁷⁹ Assessing whether the camera's photographs are an accurate representation of the scene is thus a process-based question. However, whether the pictures were in fact taken at the time intervals claimed depends on the truthfulness and reliability of the photographer. This latter inquiry would be person-based.

Sensible methods for testing and verifying person-based evidence are not the same as those for process-based evidence. Because person-based evidence is dependent on the reliability of the source, traditional witness-focused methods of proof are the most natural option.⁸⁰ The person responsible for the evidence—whether because the person is the eyewitness to the event or the source of expertise—should appear in court, give testimony, and be subject to cross-examination.⁸¹

Critical evaluation of process-based evidence is sharply different. Because the source of reliability arises from the process, the court needs information on that process, which may or may not come from a witness. We *could* learn about the operation of a video camera via an engineering expert from a leading manufacturer, but it may be far more convenient (and comprehensive) to learn about video cameras from a book. We *could* learn about a bank deposit from the teller who accepted it, but it may be more reliable to look at the computer database that recorded the transaction.

Alternatives to witnesses—documents, electronic databases, and the like—are by no means second-best in the process-based context. Indeed, those alternatives will often be more sensible, efficient, and reliable than their witness-based counterparts. The engineering expert is unlikely to have the same breadth of knowledge and expertise as the author(s) of the book.⁸² The

documented procedures that were followed should conform to common practices in the industry.”).

79. ALLEN & TRIANTAPHILIDOU, *supra* note 67, at 2–3.

80. As discussed above, for traditional person-based evidence, the witness stand is the natural crucible through which evidentiary evaluation should run as it subjects the testifying individual to the oath, cross-examination, and direct observation by the jury. GEORGE FISHER, EVIDENCE 378 (3d ed. 2013).

81. *See id.*

82. Moreover, adversarial experts can sometimes play an obfuscating, rather than clarifying, role. Rebecca Haw, *Adversarial Economics in Antitrust Litigation: Losing Academic Consensus in the Battle of Experts*, 106 NW. L. REV. 1261, 1262 (2012) (“The adversarial presentation of expert

bank teller is highly unlikely to remember a routine deposit transaction. In some cases, the live witness will be preferable—for example, if the case involves some specific aspect of the video camera not found in the book or something unusual happened during the bank transaction. But in most cases, the process-based evidence is more objective and transparent and less prone to bias than the person. Ultimately, in the process-based context, witnesses are far from the be-all and end-all.

III. Person-Focus and Its Evidentiary Consequences

The American trial system has hereto failed to effectively adapt to the rise of standardization and the emergence of process-based evidence in courtrooms. As explored above, traditional evidence law envisions trials in which almost every piece of evidence has a significant human connection, and in which evidentiary weight is intrinsically intertwined with witness reliability. The outcome of trials and the drama of the courtroom hinges on the performance of witnesses—their narratives, their credibility, and their ability to withstand cross-examination.⁸³ Indeed, trials are nothing but a series of witnesses—a trial without witnesses is not only unthinkable but arguably not a trial at all.⁸⁴

The evidentiary rules demonstrate this focus on witnesses.⁸⁵ The Hearsay Rule strongly preferences having live witnesses—ones who can swear oaths, exhibit their nervousness on the stand, and be potentially torn apart on cross-examination.⁸⁶ The expert evidence rules, contained in FRE 702–704, contemplate expert witnesses (as opposed to books or articles) being the primary conduit for specialized information.⁸⁷ And then there is the Confrontation Clause,⁸⁸ which, as currently interpreted, emphatically requires that accusatory evidence in criminal cases be presented by a live witness.⁸⁹

evidence can exaggerate the importance of a minority view on a scientific question.”); *see also* David E. Bernstein, *Expert Witnesses, Adversarial Bias, and the (Partial) Failure of the Daubert Revolution*, 93 IOWA L. REV. 451, 453–55 (2008) (positing that modern rules for expert testimony can lead to “adversarial bias”); Samuel R. Gross, *Expert Evidence*, 1991 WIS. L. REV. 1113, 1130 (1991) (explaining that litigation can often devolve into “courtroom battles between experts,” which leads to “unnecessary, excessive confusion”).

83. *See supra* text accompanying notes 42–58.

84. *See* SMITH, *supra* note 42, at 110–16 (depicting an early sixteenth-century trial as nothing more than a testimonial exchange between witnesses).

85. Langbein, *supra* note 9, at 1171–72.

86. FED. R. EVID. 801(c), 802 (barring from the courtroom statements which “the declarant does not make while testifying at the current trial or hearing” and “a party offers in evidence to prove the truth of the matter asserted in the statement”).

87. FED. R. EVID. 702–704.

88. U.S. CONST. amend. VI, cl. 3.

89. *Michigan v. Bryant*, 562 U.S. 344, 358 (2011); *Davis v. Washington*, 547 U.S. 813, 821–22 (2006); *Crawford v. Washington*, 541 U.S. 36, 68–69 (2004).

Yet given the rise of standardization and process-based evidence, the overwhelming preoccupation on witnesses makes little sense. In many instances, witnesses are no longer the chief source of information for legal decision-making, both empirically and normatively. Instead, reliability is dependent on a broader system, a series of processes in which human involvement is either nonexistent or routinized to the point that case-by-case subjectivity (the necessary predicate for worthwhile witness testimony) is eliminated.

What has emerged, therefore, is a type mismatch. Given the absence of a process-based framework for scrutinizing process-based evidence, our legal system has resorted to evaluating process-based evidence with the only toolset available to it: witness-centric countermeasures. In the subparts below, we will detail key areas in which the person-based treatment of process-based evidence has become both wasteful and distortive: wasteful for being overly concerned with witness testimony when other types of evidence should take precedence, and distortive for distracting courts from process-based evidence's independent evidentiary worth.

A. *Confrontation Clause*

Consider, first, the puzzling treatment of process-based evidence in Confrontation Clause jurisprudence. The Confrontation Clause states, "In all criminal prosecutions, the accused shall enjoy the right . . . to be confronted with the witnesses against him" ⁹⁰ Stated succinctly in its modern interpretation, in criminal cases in which the prosecution introduces accusatory testimonial evidence, the defendant has the right to test (or "confront") his accuser through cross-examination. ⁹¹

From a baseline level of justice, the Confrontation Clause is both sensible and appealing—few would discount the normative value of subjecting one's accusers to scrutiny. ⁹² But recent Supreme Court decisions have encouraged the conceptualization of the Confrontation Clause as a rule primarily aimed at the production and testing of witnesses, even when the accusatory evidence at issue is process-based. ⁹³ The treatment of DNA

90. U.S. CONST. amend. VI, cl. 3.

91. *Id.*

92. *Danforth v. Crist*, No. Civ. 01–2137JRTRLE, 2005 WL 2105502, at *4 (D. Minn. Aug. 26, 2005) ("The Supreme Court has repeatedly discussed the significance of cross-examination in the criminal justice system."); *see also White v. Illinois*, 502 U.S. 346, 356 (1992) (noting that cross-examination is "the greatest legal engine ever invented for the discovery of truth" (quoting *California v. Green*, 399 U.S. 149, 158 (1970))); *Pointer v. Texas*, 380 U.S. 400, 403–04 (1965) (holding that cross-examination of an accuser is a "fundamental right" essential to a fair trial).

93. *E.g.*, *Bullcoming v. New Mexico*, 564 U.S. 647, 659 (2011); *Bryant*, 562 U.S. at 358; *Melendez-Diaz v. Massachusetts*, 557 U.S. 305, 329 (2009); *Davis*, 547 U.S. at 821–22; *Crawford*, 541 U.S. at 68–69.

evidence, for example, provides an immediate display of suboptimal person-based rules. Evaluating DNA invokes a quintessential process. Unlike other forensic examiners, a DNA lab custodian does not primarily rely on his subjective judgment. Rather, a process determines the defendant's DNA profile and the probability that it would randomly have the same characteristics as the crime scene sample.⁹⁴ Recent technology such as TrueAllele further reduce human involvement in the DNA typing process.⁹⁵

Conceptually, then, DNA evidence can be viewed from two different perspectives. First, in accordance with its process-based nature, DNA evidence can be seen as the product of an impersonal, standardized procedure (i.e., DNA typing) that is accomplished primarily through procedures, machines, and computers. Alternatively, DNA evidence might be seen as the product of the human actor—the lab technician—despite the fact that this individual is acting largely mechanically (putting the samples into the machine, starting the test, evaluating the results, etc.) and is arguably nonessential in the grand scheme of DNA typing. The first view is unquestionably the appropriate approach, as the reliability of DNA typing comes from its standardized processes, not the decisions of any individual technician.⁹⁶

But how does our witness-based evidentiary regime treat this evidence? Lamentably, the forest is lost as we fixate upon a tree. In *Melendez-Diaz v. Massachusetts*, the Supreme Court held that certified forensic lab reports are testimonial, and thus inadmissible unless accompanied by a technician—a human witness—who can certify and attest to the report.⁹⁷

The basic result from cases like *Melendez-Diaz* is that the Confrontation Clause demands that a forensic analyst appear in court and be available for

94. Evaluating DNA is almost entirely process-driven. That is, the method by which one derives probative value from either a DNA match or the lack thereof is objective; there is no subjective determination as to whether sample DNA matches a target. DNA typing involves the comparison of high-variance loci in the human genome. Each of these loci will possess a code sequence that—at certain areas in the human genome—vary widely from one person to the next. Thus, the process of confirming a DNA match works as follows: at the first locus, genetic material acquired from a crime scene will be compared to sample DNA provided by a defendant. If the code sequences at this first locus are *exactly the same* in both the defendant's DNA and the DNA recovered from the crime scene, then it becomes somewhat more likely that the crime scene DNA belongs to the defendant. However, if there is variance between the crime scene DNA and the defendant's DNA at the first locus, the defendant can be ruled out as a suspect for the crime. By repeating this process across many loci, DNA typing techniques can drive the probability that multiple individuals possess the same DNA to a vanishingly small figure. 4 DAVID L. FAIGMAN ET AL., MODERN SCIENTIFIC EVIDENCE § 30:3 (2018) (providing an introduction to DNA terminology and a taxonomy of typing systems).

95. Imwinkelried, *supra* note 20, at 98.

96. See 4 DAVID L. FAIGMAN ET AL., MODERN SCIENTIFIC EVIDENCE § 30:3 (2018).

97. *Melendez-Diaz*, 557 U.S. at 308, 311, 329. *Melendez-Diaz* focused on laboratory identification of cocaine, rather than DNA typing, but the opinion's reasoning extends to all forensic reports.

cross-examination.⁹⁸ From a textual or originalist standpoint, perhaps this line of precedent is justified since, pursuant to the Sixth Amendment, “the accused [must] enjoy the right . . . to be confronted with the witnesses against him”⁹⁹ But from a functional perspective, does the analyst’s mere presence on the witness stand truly satisfy the Confrontation Clause? After all, given the systematic, repetitive nature of her work, the analyst is highly unlikely to remember the specifics of a particular sample processed. And at least among more scientific forensic techniques—such as DNA testing,¹⁰⁰ blood tests,¹⁰¹ and chemical identification¹⁰²—any serious laboratory will have tight controls.¹⁰³ Excepting extraordinary cases, the technician will follow some preset laboratory procedure.¹⁰⁴ The appropriate target for confrontation is therefore the standardized process, not the specific technician. It is the process, not the individual technician, that establishes or proves a fact for trial. It is the process, not the technician, that is accusatory towards the defendant. Yet, the current evidentiary framework only sees the witness. Process-based evidence is forced into a witness-centric system.¹⁰⁵

98. *Id.*; *Melendez-Diaz*, 557 U.S. at 319–20, 329.

99. U.S. CONST. amend. VI, cl. 3.

100. DNA evidence was considered in the Confrontation Clause context in *Williams v. Illinois*, 567 U.S. 50, 58 (2012).

101. Blood tests were considered in the Confrontation Clause context in *Bullcoming v. New Mexico*, 564 U.S. 647, 653, 659 (2011).

102. Chemical identification was considered in the Confrontation Clause context in *Melendez-Diaz v. Massachusetts*, 557 U.S. 305, 308, 329 (2009).

103. See generally NAT’L RESEARCH COUNCIL, THE EVALUATION OF FORENSIC DNA EVIDENCE (1996) (discussing quality control and quality assistance guidelines for forensic laboratories).

104. See, e.g., *id.* at 9–46 (providing examples of procedures followed in analyzing DNA).

105. One of the more remarkable aspects of the current treatment of DNA evidence (and like process-based evidence) is that the Supreme Court was required to make a retreat—or, at a bare minimum, a shift—from prior Confrontation Clause jurisprudence simply to ensure the centrality of the witness stand was not lost. Consider the year 1970, when a plurality of the Supreme Court wrote in *Dutton v. Evans* that: “[t]he decisions of this Court make it clear that the mission of the Confrontation Clause is to advance a practical concern for the accuracy of the truth-determining process in criminal trials by assuring that ‘the trier of fact [has] a satisfactory basis for evaluating the truth of the prior statement.’” 440 U.S. 74, 89 (1970) (plurality opinion) (quoting *California v. Green*, 399 U.S. 149, 161 (1970)).

During the *Dutton* era, then, Confrontation was largely aimed at improving the accuracy of the truth-finding process. See *id.* (stating the mission of the Clause). The witness stand was simply one means to that end. Reliable and accurate truth finding was sought, and cross-examination via the witness stand was a natural way to achieve such a goal when person-based evidence was at issue. But just as process-based evidence became increasingly common in the courtroom, a new justification for Confrontation emerged. *Michigan v. Bryant*, 562 U.S. 344, 358 (2011); *Davis v. Washington*, 547 U.S. 813, 822 (2006) (“[Statements] are testimonial when the circumstances objectively indicate that there is no such ongoing emergency, and that the primary purpose of the interrogation is to establish or prove past events potentially relevant to later criminal prosecution.”); *Crawford v. Washington*, 541 U.S. 36, 59 (2004) (“Testimonial statements of witnesses absent from trial have been admitted only where the declarant is unavailable, and only where the defendant has

Significant tradeoffs result from this misplaced reliance on the witness stand; in many ways, *Melendez-Diaz* and its progeny have worked against rather than for an effective trial system. The first notable loss comes by way of decreased efficiencies.¹⁰⁶ Requiring the analyst to appear in court to vouch for every report necessarily removes him from the lab, where he could be processing samples,¹⁰⁷ and creates complexities in court scheduling.¹⁰⁸ More fundamentally, cross-examining the witness constitutes a weak test of the evidence at best, because the technician is merely a proxy. In some instances, the analyst may be able to explain the nuances of DNA typing, and the process can be attacked through cross-examination of the witness. More often, the lab custodian may have an incomplete (or worse, inaccurate) understanding of DNA typing or otherwise avoid testifying about anything other than the computerized test result.¹⁰⁹ Indeed, scholars have recognized that “[t]oday, a forensic scientist witness often does not appear at trial to describe a manual scientific analysis. Rather, the witness will [simply] testify

had a prior opportunity to cross-examine.”). Rapidly, the witness stand lost its status as a mere means to a greater truth-centric end and wholly became the end in and of itself. *See Bryant*, 562 U.S. at 358 (stating the “basic objective” of the Confrontation Clause is to provide the defendant with the opportunity to cross-examine witnesses); *Davis*, 547 U.S. at 822 (focusing on the testimonial or nontestimonial nature of a statement rather than its veracity); *Crawford*, 541 U.S. at 59 (holding that statements made by a declarant absent from trial can be admitted only if the defendant had previously cross-examined the witness). Indeed, the lengths to which the Supreme Court has gone to entrench its relatively new witness-centric view of Confrontation is startling, as the most recent Confrontation cases unequivocally state that the Confrontation Clause “commands, not that evidence be reliable, but that reliability be assessed in a particular manner: by testing [a witness] in the crucible of cross-examination.” *Crawford*, 541 U.S. at 59 (“To be sure, the Clause’s ultimate goal is to ensure reliability of evidence, but it is a procedural rather than a substantive guarantee.”).

106. This concern was a major focus of the dissenting opinion in *Melendez-Diaz v. Massachusetts*, 557 U.S. 305, 340–41 (2009) (Kennedy, J., dissenting), as well as Justice Breyer’s concurring opinion in *Williams v. Illinois*, 567 U.S. 50, 89–90 (2012) (Breyer, J., concurring). Justice Breyer, in particular, noted that there exists “no logical stopping place between requiring the prosecution to call as a witness one of the laboratory experts who worked on the matter and requiring the prosecution to call *all* of the laboratory experts who did so.” *Williams*, 567 U.S. at 89 (Breyer, J., concurring).

107. *Melendez-Diaz*, 557 U.S. at 340–41 (Kennedy, J., dissenting) (noting that “analysts already spent considerable time appearing as witnesses in those few cases where the defendant . . . contested the analyst’s result and subpoenaed the analyst” and that the *Melendez-Diaz* mandate that an analyst “appear in the far greater number of cases where defendants do not dispute the analyst’s result [will] impose[] enormous costs on the administration of justice”); *see also infra* notes 211–26. *But see* Catharine L. Bonventre, *The Implementation of Judicial Policy in Crime Laboratories: An Examination of the Impact of Melendez-Diaz v. Massachusetts* (Ph.D. dissertation) (2015) (finding that *Melendez-Diaz*’s requirement did not create practical difficulties in a number of jurisdictions for a variety of reasons).

108. *See Melendez-Diaz*, 557 U.S. at 341 (Kennedy, J., dissenting) (considering the effect of mandatory analyst testimony on case scheduling).

109. *See Imwinkelried, supra* note 20, at 97–98 (stating that witnesses are rarely called about personally conducted analyses and instead are called upon to testify about operating equipment or computer programs).

about the results of an automated forensic technique that he or she oversaw.”¹¹⁰ Of course, this problem is not limited to DNA tests. In-court scrutiny of breathalyzer tests also often neglects the internal, mechanical processes that actually generated the result and instead focuses on the surrogate witness.¹¹¹ Imwinkelried describes a common scenario:

In a drunk driving case, the witness is rarely a toxicologist testifying about a manual oxidative analysis of the alcohol concentration in a blood sample that he or she personally drew from the suspect. It is far more likely that the witness will be a police officer trained to use an Intoxilyzer that samples the suspect’s breath and contains a computer program that reads out an estimate of the suspect’s breath alcohol concentration.¹¹²

A final loss that comes from the fixation on the witness stand is seen by the penalty for failing to meet the witness requirement: exclusion. In *Melendez-Diaz*, the absence of the analyst rendered the entire test inadmissible.¹¹³ The drastic remedy is entirely disproportionate to the “offense.”¹¹⁴

Part IV outlines an alternative method for scrutinizing forensic lab results without resort to traditional cross-examination.¹¹⁵ These alternative tools will not only make sense from an efficiency standpoint, but will also produce more legitimate trials through increased assurances of reliability and accurate truth finding.

B. *Expert Evidence and the Learned Treatise Exception*

A similar type mismatch is found in the “learned treatise” exception to hearsay under Rule 803(18).¹¹⁶ The reliability of most academic publications come as the result of a process. Take, for example, a scientific peer-reviewed article. Scientific articles are subject to peer review and editorial scrutiny prior to acceptance, proofreading prior to publication, and community scrutiny and comment after publication.¹¹⁷ While this system necessarily

110. *Id.* at 97.

111. *See id.* at 97–98.

112. *Id.*

113. *Bullcoming v. New Mexico*, 564 U.S. 647, 652 (2011); *Melendez-Diaz*, 557 U.S. at 329.

114. *See Melendez-Diaz*, 557 U.S. at 340–41 (Kennedy, J., dissenting) (arguing that the *Melendez-Diaz* majority opinion “threatens to disrupt forensic investigations across the country and to put prosecutions nationwide at risk of dismissal based on erratic, all-too-frequent instances when a particular laboratory technician, now invested by the Court’s new constitutional designation as the analyst, simply does not or cannot appear”).

115. *See infra* subpart III(B).

116. FED. R. EVID. 803(18).

117. For background on the rise of scientific peer review, see generally Ray Spier, *The History of the Peer-Review Process*, 20 TRENDS IN BIOTECHNOLOGY 357, 357–58 (2002) and David R.

involves human actors, it is primarily process-based. The reliability of a scientific article stems from the quality assurances provided by the entire publication process rather than the *ipse dixit* of a particular author. The Advisory Committee Notes to Rule 803(18) acknowledge the process-based nature of learned treatises, specifically highlighting that the treatises' reliability stems from the fact that scientific articles are "subject to scrutiny and exposure for inaccuracy" through the existing publication regime.¹¹⁸

But while the Rules properly identify this evidence as process-based, they do not give it proper process-based treatment. Granted, Federal Rule of Evidence 803(18) carves out a hearsay exception for learned treatises,¹¹⁹ allowing a party to introduce any excerpt from a scientific article or similar publication without the typical restraints of the hearsay rule.¹²⁰ But then, Rule 803(18) requires a *person* (an expert) to appear in court to vouch for the reliability of the article.¹²¹ Moreover, Rule 803(18) forbids the use of the learned treatise as an exhibit; it may only be read aloud to the jury by a witness.¹²²

Once again, Rule 803(18) needlessly emphasizes the witness. Typically, the expert who reads a publication into the record is not the author of that article. As such, the expert is merely an "informed" third party, guiding jurors on how they should understand and apply the treatise.¹²³ In the absence of the expert, the parties themselves could fulfill that role. Presumably, having the expert might help, but the treatise expert's role is not so essential to warrant the present treatment, which *requires* that scientific articles be presented through an expert or not at all.¹²⁴

Guston, *The Expanding Role of Peer Review Processes in the United States*, in PROCEEDINGS FROM THE 2000 U.S.-EUROPEAN WORKSHOP ON LEARNING FROM SCIENCE AND TECHNOLOGY POLICY EVALUATION 4-31 (Philip Shapira & Stefan Kuhlmann eds., 2001).

118. FED. R. EVID. 803 Notes of Advisory Committee on Proposed Rules.

119. FED. R. EVID. 803(18).

120. FED. R. EVID. 803 Notes of Advisory Committee on Proposed Rules.

121. FED. R. EVID. 803(18) (noting that the learned treatise is only admissible if it is "called to the attention of an expert witness on cross-examination or relied on by the expert on direct examination" and "read into evidence" by the expert).

122. *Id.*

123. Charles J. Walsh & Beth S. Rose, *Increasing the Useful Information Provided by Experts in the Courtroom: A Comparison of Federal Rules of Evidence 703 and 803(18) with the Evidence Rules in Illinois, Ohio, and New York*, 26 SETON HALL L. REV. 183, 227-28 (1995) (stating the purpose of Rule 803(18) is to "prevent a fact finder from perusing [the learned treatise] without the assistance of the expert witness" to explain the text's meaning).

124. FED. R. EVID. 803(18).

The treatise expert is a source of potential distortion as well,¹²⁵ because the proponent chooses the expert.¹²⁶ Thus, the goal of the treatise expert is not to neutrally aid the jury in its understanding or application of the treatise.¹²⁷ Rather, the expert will undoubtedly interpret the treatise in line with the narrative advanced by his employer.¹²⁸ Such a slant stands in direct contrast to the treatise, whose trustworthiness derives from the publication process. Perhaps most importantly, Rule 803(18)'s insistence on an expert surrogate contradicts the rationale for the rule itself. Recall that proponents of the learned treatise exception primarily founded their support on the rigors of the process.¹²⁹ However, Rule 803(18) forbids the manuscript from being submitted to the jury as an exhibit—it may reach the ears of the jury only through a surrogate expert's mouth.¹³⁰ Such a move is again baffling, considering that it is the treatise, not the expert, that has undergone scrutiny to ensure trustworthiness.

The treatise is not mere support for an expert witness. The treatise *is* evidence, evidence that—in many instances—has assurances of trustworthiness far beyond the expert hired to read it to the jury.

C. Photographs

As a third example, consider photographs, an archetype of process-based evidence. Much of a photograph's evidentiary worth arises from the common knowledge that a camera will provide a reliable depiction of a scene regardless of the import *vel non* of any particular shot.¹³¹ Because of its

125. Jack B. Weinstein, *Improving Expert Testimony*, 20 U. RICH. L. REV. 473, 482 (1986) (“An expert can be found to testify to the truth of almost any factual theory, no matter how frivolous . . .”).

126. See BRUCE D. SALES & DANIEL W. SHUMAN, EXPERTS IN COURT: RECONCILING LAW, SCIENCE, AND PROFESSIONAL KNOWLEDGE 6 (2005) (“[M]any commentators have observed that lawyers often have a sufficient number of available expert witnesses to allow them to select one that will best represent a client’s partisan interests.”); see also Bernstein, *supra* note 82, at 453–55 (noting that the selection of expert witnesses by adversarial parties creates “adversarial bias”).

127. See Bernstein, *supra* note 82, at 453–54. Bernstein explains the distortion:
[T]he implicit rationale for the modern special rules for expert testimony is that such testimony is uniquely vulnerable to “adversarial bias.” Adversarial bias refers to witness bias that arises because a party to an adversarial proceeding retains experts to advance its cause. Adversarial bias has at least three sources: (1) conscious bias, (2) unconscious bias, and (3) selection bias.

Id.

128. *Id.* at 454–55 (“The problem of conscious bias arises when ‘hired guns’ adapt their opinions to the needs of the attorney who hires them.”).

129. FED. R. EVID. 803 Notes of Advisory Committee on Proposed Rules.

130. FED. R. EVID. 803(18) (noting that learned treatises “may be read into evidence but not received as an exhibit”).

131. See generally Jordan S. Gruber et al., *Video Technology*, 58 AM. JUR. TRIALS 481, 525–45 (1996) (describing various types of video and photographic technology and advising attorneys on their evidentiary potential).

internal electronics and mechanics, we know that a camera uses the same process to create a photograph every time.¹³² Questions about whether a picture provides an accurate representation of a scene, then, should focus on that internal process: for example, whether there is any systematic error in the camera that is replicated in each photograph produced therefrom.¹³³

But the legal system's prevailing treatment of photographic evidence does not account for its process-based nature. Again, our evidentiary regime keeps the jury's focus squarely on the witness stand.¹³⁴ In standard courtroom practice, a witness takes the stand and adopts a photograph as a "fair and accurate representation" of some object or location. The photograph is therefore an illustration of the witness's testimony, but is not evidence itself.¹³⁵ Rather than allowing a photograph to stand on its own as a highly probative depiction of a particular scene, our legal system relegates it to a once-removed role where it merely adds color to a witness's account of the same subject.¹³⁶ For example, a typical examination of photographic evidence in the courtroom goes as follows:

Attorney: I'm going to show you Government's Exhibit numbers 2 through 4. Take a look at those. Do you recognize those photographs?

Witness: I do.

Attorney: Do they fairly and accurately represent what you observed that day?

Witness: Yes.

Attorney: . . . Your Honor, we'd offer Government's Exhibits 2, 3, and 4 into evidence.

The Court: Any objection?

Opposing Counsel: No objection

132. *Id.* at 525–35.

133. For example, to consider how a systematic error affecting the hue of photographs might impact their probative worth, see Jessica M. Salerno, *Seeing Red: Disgust Reactions to Gruesome Photographs in Color (But Not in Black and White) Increase Convictions*, 23 PSYCHOL. PUB. POL'Y & L. 336, 345–47 (2017).

134. See Mnookin, *supra* note 7, at 67 (“[D]emonstrative evidence sounds like precisely the epistemic category that emerged from the judicial response to the photograph.”).

135. *Demonstrative evidence*, BLACK'S LAW DICTIONARY (6th ed. 1990); FED. R. EVID. 1002 Notes of Advisory Committee on Proposed Rules. The Notes describe common practice:

The usual course is for a witness on the stand to identify the photograph or motion picture as a correct representation of events which he saw or of a scene with which he is familiar. In fact he adopts the picture as his testimony, or, in common parlance, uses the picture to illustrate his testimony. Under these circumstances, *no effort is made to prove the contents of the picture*, and the rule is inapplicable.

Id. (emphasis added); see, e.g., Scarlett v. Ouellette, 948 So. 2d 859, 863 (Fla. Dist. Ct. App. 2007) (“[A]ny witness with knowledge that the photograph is a fair and accurate representation may lay the necessary foundation for admission of a photograph.”).

136. See Mnookin, *supra* note 7, at 67 (discussing the treatment of photographs as demonstrative and illustrative rather than conclusive).

The Court: They're admitted.

Attorney: Start with Government's Exhibit number 2?

Witness: Yes, this is a photograph of Mr. Nuckles.

Attorney: That[] depicts his clothing as well as his demeanor that day?

Witness: Correct.

Attorney: Okay. Government's Exhibit number 3?

Witness: This was the suitcase that I took out of the back seat of Mr. Nuckles'[s] Car.

Attorney: . . . Okay. And Government's Exhibit 4?

Witness: This is the open suitcase showing the drugs which were inside the suitcase.¹³⁷

Such treatment is again wasteful and potentially distortive. It is wasteful in unnecessarily requiring a witness to repeat what is plainly depicted in the photograph itself.¹³⁸ It is potentially distortive because at least technically, the law treats a photograph's evidentiary worth on par with other demonstrative evidence (such as graphs, charts, and posters) rather than recognizing its independent value—and more often than not, superiority—as evidence.¹³⁹ We all know though that a photograph's power lies not in its illustration of a witness's testimony, as if it were a mere sketch or drawing. Its power comes from the photograph being the result of a mechanical process that provides consistently reliable depictions of a scene. Creative camerawork can undoubtedly skew photographs, but only so much, and such skewing is far more constrained than with witness testimony.¹⁴⁰ Advocates do not introduce, and factfinders do not prefer and use, photographic evidence because it is illustrative. That photograph *is* evidence, indeed far better evidence than the words coming out of the witness's mouth. The witness provides important context, but she is not the star.

To be sure, despite their witness focus, the evidentiary rules have not entirely overlooked the process-based nature of photographs. For example, the silent witness theory admits photographs even when there is no one to adopt them as demonstrative evidence,¹⁴¹ a doctrine especially useful for

137. Transcript of Suppression Hearing at 21–22, *United States v. Nuckles*, Criminal Case No. 1:14-CR-218-ODE-AJB, 2015 WL 1600687 (N.D. Ga. Aug. 22, 2014), *aff'd*, 649 Fed. Appx. 834 (11th Cir. 2016).

138. Note, for example, that in the representative transcript provided above, the witness's sole responsibility was to provide a characterization of the photographs provided to him by the attorney.

139. See Mnookin, *supra* note 7, at 67–70.

140. See Richard Zakia, *Perception, Evidence, Truth, and Seeing* (providing examples of photography techniques capable of influencing perception), in *THE CONCISE FOCAL ENCYCLOPEDIA OF PHOTOGRAPHY: FROM THE FIRST PHOTO ON PAPER TO THE DIGITAL REVOLUTION* 239, 239–50 (Michael R. Peres et al. eds., 2012).

141. *United States v. Rembert*, 863 F.2d 1023, 1026 (D.C. Cir. 1988) (recognizing the “‘silent witness’ model, under which the admissibility of a photograph is based on the reliability of the

surveillance footage.¹⁴² But the silent witness theory is a second-best, almost last-ditch effort to save critical and reliable evidence from exclusion. Indeed, courts have found the silent witness theory applicable only “where obviously no witness has viewed the scene portrayed.”¹⁴³ The silent witness theory was not the product of any recognition of the advantages of the process relative to the witness; it was merely the product of necessity.¹⁴⁴ The witness still reigns supreme.

D. Business Records Exception

The doctrine most responsive to process-based evidence still misses the mark. Federal Rule of Evidence 803(6) acknowledges that the regular, standardized records of a business are generally reliable and therefore should not be deemed inadmissible under the hearsay rule.¹⁴⁵ As noted by the Advisory Committee:

The element of unusual reliability of business records is said variously to be supplied by systematic checking, by regularity and continuity which produce habits of precision, by actual experience of business in relying upon them, or by a duty to make an accurate record as part of a continuing job or occupation.¹⁴⁶

Stated succinctly, the Rules recognize that a business record—despite potential human involvement—is quintessential process-based evidence that acquires its reliability from standardized procedures rather than from any one individual or declarant.¹⁴⁷ Applying the hearsay rule, a witness-based protection, to process-based evidence would give rise to inefficiencies and, therefore, such treatment has been avoided through an exception.

But the history of Rule 803(6) shows just how difficult it is to get the legal system to think outside the witness box. The business records exception was the product of a massive reform effort brought about by the sheer impracticality of calling all of the declarants involved in the creation of a

process by which it is made”); *see also* Teneille Brown & Emily Murphy, *Through a Scanner Darkly: Functional Neuroimaging as Evidence of a Criminal Defendant’s Past Mental States*, 62 STAN. L. REV. 1119, 1165 (2010) (discussing the “silent witness theory” as an option when no witness can personally testify as to the object of the photograph).

142. Natalie F. Pike, Note, *When Discretion to Record Becomes Assertive: Body Camera Footage As Hearsay*, 20 VAND. J. ENT. & TECH. L. 1259, 1256 n.32 (2018) (“Surveillance cameras are often silent witnesses because they record without human operation, input, or interference.”).

143. *Rembert*, 863 F.2d at 1026.

144. *See id.* (discussing the development of the silent witness theory to cover situations such as x-ray photography where it is impossible for a witness to personally view the object of interest).

145. FED. R. EVID. 803(6).

146. FED. R. EVID. 803 Notes of Advisory Committee on Proposed Rules.

147. *See id.*

single record, such as a bank statement.¹⁴⁸ As far back as 1927, studies by the Legal Research Committee of the Commonwealth Fund insisted that process-based standardization rendered business documents reliable,¹⁴⁹ and that the regularity and continuity of the processes provide unusual assurances of trustworthiness sufficient to outweigh the concerns underlying the hearsay exclusionary rule.¹⁵⁰ But despite its recognition of process-based reliability, the exception, for decades after it was adopted, still required the introduction of a custodian—a *witness*—to testify about the business procedure.¹⁵¹ Analogous to Rule 803(18)'s learned treatise exception, a witness had to take the stand and largely serve as a conduit for emphatically nonpersonal evidence.¹⁵² Only recently did the Advisory Committee finally amend the rule to allow a certification instead of the live custodian—a rare acknowledgment that reliability comes from the process, not any in-court human surrogate.¹⁵³

Although Rule 803(6) represents a step in the right direction towards the appropriate treatment of process-based evidence, it fails to provide a comprehensive procedure for handling standardized material in the courtroom. The hearsay rule is, of course, an admissibility rule.¹⁵⁴ It is a binary barrier that does not provide a means of adjusting evidentiary weight. To see how this presents a problem for business records, consider the following hypothetical. Imagine that a litigant wants to prove that because of the defendant's actions she had to draw extra electrical power for three weeks.¹⁵⁵ To prove this, she presents her electric bill. The bill shows the

148. Frank T. Read, *The Business Records Exception: Something Less Than Revolutionary*, LITIG., Fall 1975, at 25, 25.

149. See Sidney Kwestel, *The Business Records Exception to the Hearsay Rule—New Is Not Necessarily Better*, 64 MO. L. REV. 595, 595 & n.4 (1999) (discussing how the business records exception attained widespread support).

150. Anthony J. Dreyer, *When the Postman Beeps Twice: The Admissibility of Electronic Mail Under the Business Records Exception of the Federal Rules of Evidence*, 64 FORDHAM L. REV. 2285, 2305–07 (1996).

151. The decades-long approach allowed for:

[Business records] containing hearsay provided *foundation testimony is made by 'the custodian or other qualified witness,'* that: (1) the declarant in the records had personal knowledge to make accurate statements; (2) the declarant recorded the statements contemporaneously with the actions that were the subject of the reports; (3) the declarant made the record in the regular course of the business activity; and (4) such records were regularly kept by the business.

United States v. Pelullo, 964 F.2d 193, 200 (3d Cir. 1992) (emphasis added).

152. See *id.*

153. FED. R. EVID. 803(6) Notes of Advisory Committee on 2000 Amendment. Under the modern regime, the certification necessary for admitting a business record must be executed by a person who would otherwise be qualified to testify as a custodian. See, e.g., *Rambus, Inc. v. Infineon Techs.* AG, 348 F. Supp. 2d 698, 701 (E.D. Va. 2004).

154. See FED. R. EVID. 802 (rendering hearsay generally inadmissible).

155. For a similar, real-world example, consider *N.L.R.B. v. First Termite Control Co.*, 646

amount last year, the amount this year, and the increase. The difference provides an estimate of the damages. However, if there is human involvement in the creation of the bill, it is hearsay and inadmissible absent an exception. The litigant then must get a certification from the electric company to render the bill admissible (and of course, before certifications, she would have had to call a custodian from the electric company). But the kicker here is that certification is largely beside the point. What our evidentiary regime primarily needs is not a certification from the electric company but instead scrutiny of the electric company's systematic practices to ensure that the bill constitutes an accurate representation of the litigant's power usage, and specifically that those practices did not change since the previous year.

The business records exception is therefore an incomplete response to process-based evidence. Our evidentiary regime needs a toolset that does not merely manage the admissibility of process-based evidence but one that also offers an effective means of probing its evidentiary worth.

IV. Toward Process-Based Evidence Rules

How can courts best handle process-based evidence? As previously discussed, traditional evidence rules are not up to the task and unsurprisingly so. Our current system of evidentiary rules evolved under the assumption that witness-based evidence was both more prevalent and more normatively desirable than other forms of evidence.¹⁵⁶ It simply was not built with process-based evidence in mind.¹⁵⁷ In recent years, practical pressures have necessitated a series of workarounds, like the business records exception,¹⁵⁸ the learned treatise exception,¹⁵⁹ and the treatment of photographs as demonstrative evidence.¹⁶⁰ But these workarounds are just that. They are ad hoc patches that have propped up the traditional framework and, at great cost, maintained the focus on the witness. They do not contribute to its long-term survival or coherence.

Rather than trying to fit a round peg into a square hole, this Part attempts to develop a new approach for handling process-based evidence. Doing so, however, need not entail an outright rejection of traditional evidentiary principles. While the traditional rules are inappropriate for process-based evidence, we can learn much from their underlying philosophy. In essence, traditional evidence law can serve as a template for a new system regulating

F.2d 424, 426, 428–30 (9th Cir. 1981), in which an entire appeal centered around the difficulty of admitting a freight bill due to its proponent calling a supporting witness who, according to the Ninth Circuit, was not sufficiently qualified to vouch for the authenticity of the bill.

156. See generally Fisher, *supra* note 1, at 602–24; Langbein, *supra* note 9, at 1169–72.

157. See Fisher, *supra* note 1, at 602–24; Langbein, *supra* note 9, at 1169–72.

158. FED. R. EVID. 803(6).

159. FED. R. EVID. 803(18).

160. FED. R. EVID. 1002; Mnookin, *supra* note 7, at 67–70.

process-based evidence. For example, the three classical mechanisms used for ensuring reliable witness-based evidence are the oath, the ability of the factfinder to observe witness demeanor, and cross-examination.¹⁶¹ Obviously, none of these mechanisms are directly applicable to process-based evidence. Courts cannot put machines, business processes, or other standardized systems under oath, observe their demeanor, or cross-examine them. But courts can construct new mechanisms to achieve their functional equivalents. New rules can make the processes that underlie process-based evidence more transparent to the jury, provide opportunities for an opposing party to attack them, and give guidance on how to assess their reliability.

Thus, at a broad conceptual level, this Part advances a template for achieving those normative goals. The following sections provide a series of reforms and reconceptualizations that will bring our evidentiary regime into the twenty-first century, enabling it to efficiently and effectively scrutinize process-based evidence. Where the witness is no longer necessary, the witness should no longer be mandatory.

As an initial matter, we argue that the compulsory process power should be expanded to allow for increased access to the processes or standardized systems generating evidence in particular cases. Allowing litigants to test these systems firsthand brings much-needed transparency to the domain of process-based evidence and largely eliminates the risk that unnecessary witnesses might distort determinations of a process's reliability. Complementing this suggestion of increased access is a reconceptualization of hearsay and the Confrontation Clause with respect to process-based evidence. When an accusation stems from a process and not a person, appropriate scrutiny of the process (even in the absence of an in-court witness) should satisfy these doctrines. Finally, and perhaps most importantly, we advance a holistic framework for scrutinizing the reliability of process-based evidence in the courtroom. Rather than equating the reliability of a process with the reliability of some surrogate witness, we argue that the probative value of process-based evidence should instead directly depend on the underlying process's transparency, falsifiability, and objectivity.

A. *Reframing the Subpoena*

Because the star of a witness-based system is in-court testimony, courts have developed powerful tools for ensuring the presence of witnesses.¹⁶² The

161. FISHER, *supra* note 80, at 377–78; Laurence H. Tribe, Comment, *Triangulating Hearsay*, 87 HARV. L. REV. 957, 958 (1974).

162. To be sure, the traditional evidence rules outline exceptions to witness production for certain forms of hearsay, information subject to judicial notice, and demonstrative aids, but undeniably, the primary avenue for receiving information is live, in-court testimony from a witness.

subpoena power and the Compulsory Process Clause, for example, ensure that knowledgeable witnesses take the stand and provide useful information.¹⁶³ Indeed, some foundational aspects of our adjudicatory system, such as jury observation of an opponent's cross-examination, are impossible without live witnesses.¹⁶⁴ Compulsory process is, in many ways, the source from which the rest of evidence law flows.

The irony is that compulsory process—at least as it is traditionally understood—provides little help to someone challenging process-based evidence. All that compulsory process ensures is a witness who will present the photograph, the business record, or the forensic lab result. Further, as discussed in Part III, cross-examining that witness yields little because what an opponent needs to challenge is the process itself, not its witness surrogate.¹⁶⁵ The witness surrogate may have only limited knowledge of the internal workings of the process and can otherwise easily resist further questioning.¹⁶⁶

What process-based evidence requires is a functional analog to being “called to the stand,” a functional analog to the traditional subpoena. For a witness, taking the stand creates transparency: the factfinder and the public can see and scrutinize the witness.¹⁶⁷ Taking the stand also exposes the witness to cross-examination.¹⁶⁸ Process-based evidence is therefore in need of a procedural tool that will achieve those same results—a tool that will render process-based evidence more transparent and vulnerable to scrutiny.

Enhanced discovery is just such a tool. Conventionally, discovery conjures up images of banker's boxes or hard drives full of documents, and in some cases, that will precisely be what the opposing party needs to challenge process-based evidence. Discovery of calibration results, performance reviews, standard operating procedures, company policies, design documents, and the like all enable an opponent to scrutinize the process that created the process-based evidence and challenge its reliability.

But sometimes, “putting the process on the stand” requires more than conventional discovery. After all, not every machine or business procedure

163. See U.S. CONST. amend. VI, cl. 4; FED. R. CIV. P. 45 (governing subpoena power in civil cases); FED. R. CRIM. P. 17 (governing subpoena power in criminal cases); GEORGE FISHER, EVIDENCE 730–31 (3d ed. 2013) (detailing how courts have interpreted the Sixth Amendment to allow defendants to put witnesses on the stand).

164. FISHER, *supra* note 80, at 377–78.

165. See *supra* subpart III(A).

166. Imwinkelried, *supra* note 20, at 97–98 (“Today, a forensic scientist witness often does not appear at trial to describe a manual scientific analysis. Rather, the witness will testify about the results of an automated forensic technique that he or she oversaw.”).

167. Tribe, *supra* note 161, at 958.

168. *Id.*

has been subjected to calibration or performance reviews.¹⁶⁹ Instead, an opponent may want access to the machine or process itself. If a mass spectrometer provides critical evidence in a case, the opponent may wish to test that machine using known samples. If a laboratory used a standard procedure to test for cocaine, then the opponent may wish to send blinded (but known) test samples to challenge the lab's accuracy.

Naturally, courts would need to carefully monitor and limit such access. The machines still belong to the other party, and we might worry about opponents damaging them (either inadvertently or intentionally). Internal procedures may contain trade secrets or have other ramifications for competition.¹⁷⁰ But such court involvement is arguably no different than how courts police access to and interactions with witnesses in the courtroom. Perhaps early on, courts will have to puzzle out how to provide appropriate access to lab equipment or internal processes. But like anything else, standard legal practices will emerge over time. Challenging the calibration of a blood alcohol testing device will become no different than cross-examining an eyewitness.

These concerns about enhanced discovery cohere with recent academic scholarship proposing new frameworks for gaining access to source codes or challenging machine evidence. For example, Professor Edward Imwinkelried has recently recognized that computer source code, such as the code used to determine whether a DNA match exists, has generally been exempted from scrutiny by litigants, even where that source code produces outputs that become evidence in the courtroom.¹⁷¹ Because it is the process, not any one person, that is generating the evidence, we agree with Imwinkelried that the defense should have a limited right of access to examine the source code directly.¹⁷² Professor Andrea Roth has similarly recognized that so-called machine testimony—that is, information provided by processes such as cameras, thermometers, and other mechanical systems—has hereto been mishandled in courtrooms.¹⁷³ For Roth, the patchwork doctrines that have emerged are “intellectually incoherent and fail to fully empower juries to assess machine credibility.”¹⁷⁴ Roth, like Imwinkelried, would engage

169. Just as not every witness has readily available (or admissible) eye exams, psychiatric evaluations, or character witnesses to attack or attest to their character for truthfulness.

170. The problem of trade secrets is a complicated one requiring more development. One should be able to make analogies to witness privileges, however. Just as various privileges protect witnesses from certain lines of inquiry on the stand, trade-secret-privilege law would protect entities from having to disclose certain information in process-based discovery. However, just as witness privileges yield under some circumstances, so would trade-secret privileges.

171. Imwinkelried, *supra* note 20, at 98–101.

172. *Id.* at 97, 101.

173. Roth, *supra* note 20, at 2000–22.

174. *Id.* at 1972.

machine testimony on its own terms, focusing credibility and reliability assessments on a machine's internal processes rather than the witness stand.¹⁷⁵

Our proposal favoring enhanced discovery coheres with Imwinkelried and Roth, though our proposal extends to the broader category of process-based evidence. By increasing direct access to the systems generating evidence in particular cases—including machines, business practices, and even publication procedures—reliability assessments quickly become more meaningful, and witness-based obfuscation is eliminated.

B. Recasting Hearsay and Confrontation

Reformation of the subpoena power, standing alone, would provide an incomplete solution; complementary reforms are necessary elsewhere in the evidentiary rules. Compulsory process goes hand-in-hand with the hearsay rule and the Confrontation Clause. The subpoena helps secure witness attendance at trial. If a party fails to provide a witness, then the hearsay rule and the Confrontation Clause will generally exclude the evidence.¹⁷⁶ However, as discussed above, the intense, witness-based focus of the hearsay rule and recent Confrontation jurisprudence leads to wasteful and distortive results when applied to process-based evidence. Therefore, allowing for increased access to the systems underlying process-based evidence would ultimately prove fruitless unless hearsay and confrontation are also adapted to our process-based world.

1. Hearsay.—The conventional hearsay rule improperly manages process-based evidence, whether produced by machines or by people. For machine-generated evidence, the hearsay rule is inapplicable because the rule only covers assertions made by a person.¹⁷⁷ For person-generated process evidence, the hearsay rule is both too strict and too lax. It is too strict in requiring that declarants testify, because the reliability of process-based evidence derives from the underlying process, not the individuals involved. It is also too lax in that the business records exception often offers a workaround,¹⁷⁸ giving business records a free pass. Statements made in the regular course of business are indeed typically more reliable than one-off statements, but what if the processes are fundamentally flawed? What if a business's procedures in a particular context incentivize employees to inflate or distort their numbers? Opposing parties need the ability to meaningfully

175. *Id.* at 2022–23.

176. *See* U.S. CONST. amend. VI, cl. 3; FED. R. EVID. 802.

177. FED. R. EVID. 801(a) (“‘Statement’ means a person’s oral assertion, written assertion, or nonverbal conduct, if the person intended it as an assertion.”).

178. FED. R. EVID. 803(6).

access and scrutinize those business processes, as well as other hearsay-producing processes.

What is therefore necessary is an analog to the hearsay rule for process-based evidence, one that would provide meaningful access and the ability to challenge processes. The reconceptualized process-based hearsay rule would seek to achieve the same ends sought by the traditional, witness-based hearsay rule—namely the opportunity for opponents to test evidentiary assertions in court—but it would do so in full recognition of the significant conceptual differences between the two types of evidence.

A reconceptualized hearsay rule would admit process-based hearsay through two paths. The first path, analogous to live testimony subject to cross-examination, is actually to provide opponents with access and the ability to scrutinize the underlying processes, as discussed in subpart IV(A)'s enhanced discovery proposal above. In allowing litigants to directly scrutinize the system that generated evidence in a particular case, the process-based hearsay rule achieves the same functional goals as the traditional hearsay rule in that opposing parties are offered the opportunity to examine critical junctures of reliability and make weak points visible to the jury.¹⁷⁹ At the same time, however, the process-based hearsay rule ends the unnecessary—and indeed, inaccurate—procedure that suggests that the reliability of process-based evidence hinges primarily on a witness surrogate.

The second path for the admissibility of process-based hearsay would be a new class of enumerated exceptions analogous to Rules 803 and 804 for witness-based evidence. These exceptions to enhanced discovery and access would involve instances in which courts could presume that process-based evidence was sufficiently reliable for jury consideration. The rule-based structure of the exceptions would promote uniformity, efficiency, and predictability.¹⁸⁰ For example, one can imagine an exception for evidence produced by machines certified by government agencies or evidence produced by processes accredited by an independent third party.¹⁸¹ There could be an exception for standard, commercially available processes, such as cameras, phones, and computers (or they could even be handled via judicial notice). Finally, as an analog to Rule 804, an exception might admit

179. Compare this solution to the (near-identical) benefits gained by cross-examining a witness about person-based evidence. See Tribe, *supra* note 173, at 958 (noting cross-examination of a person reveals inaccuracies in the inferential chain between the object of a description and the testimony itself).

180. See Liesa L. Richter, *Goldilocks and the Rule 803 Hearsay Exceptions*, 59 WM. & MARY L. REV. 897, 947 (2018) (advocating for the expansion of Rule 803 hearsay exceptions rather than “upending the entire system” or “implementing unique restrictions applicable only to single exceptions”).

181. Cf. FED. R. EVID. 803(8) (providing a hearsay exception for public records so long as the source and other circumstances do not indicate a lack of trustworthiness).

evidence produced by machines and processes no longer available for testing if certain contextual guarantees of trustworthiness were met.¹⁸²

Undoubtedly, many of the same types of evidence admissible today under the hearsay rule will remain so under the new regime. But the point is that the enhanced discovery rule and its exceptions will be uniquely structured to handle process-based evidence. No longer will we be trying to contort the hearsay rule to do work that it was not designed to do. And the key distinction is not whether a person was involved, as the hearsay rule's current definition implies. The key distinction is whether a person was engaged in an ad hoc judgment, in which case the witness-based hearsay rule should apply, or whether there was a standardized process involved, in which case the new regime should apply.

2. *Confrontation Clause*.—Process-based evidence similarly requires a rethinking of Confrontation doctrine. Recall that *Melendez-Diaz* and its progeny require that the prosecution produce a live witness when presenting forensic evidence.¹⁸³ But as we argued in subpart II(A), this requirement is just an empty shell. A lab analyst who processes countless samples over the course of a day surely does not remember how she analyzed a particular sample. Any testimony she gives will in reality derive from written documents (i.e., hearsay); so the presence of a witness is mere formalism. Besides, the ultimate source of reliability is not the analyst, but rather the system of checks and procedures that characterizes the lab. Demanding that the prosecution introduce the lab analyst as a live witness may make for great theater, but it does little to further the objective of the Confrontation Clause. Far better would be a Confrontation Clause that provided defendants with enhanced discovery of the lab's procedures and equipment.

The contours of the Confrontation Clause are of course a matter of constitutional interpretation, not mere evidentiary policy. So how then can we recast Confrontation Clause jurisprudence to account for our new understanding of process-based evidence? As it turns out, acknowledging process-based evidence requires only a subtle reframing. When it comes to process-based evidence, the functional accuser—the “witness[] against [the defendant]”¹⁸⁴—is the underlying process, not the various people who may have contributed to the process. And thus the right of Confrontation involves

182. Cf. FED. R. EVID. 804 (unavailability exceptions); FED. R. EVID. 807 (residual hearsay exception allowing hearsay to be admissible when necessary and reliable).

183. *Melendez-Diaz v. Massachusetts*, 557 U.S. 305, 324–25 (2009). The *Melendez-Diaz* line of cases leaves exactly who needs to be called somewhat murky. At minimum, we know that: (a) an affidavit with no live witness is insufficient, *id.*; (b) the person cannot be an unrelated co-worker, *Bullcoming v. New Mexico*, 564 U.S. 647, 652 (2011); and (c) that the person may be an expert relying on the results of another, *Williams v. Illinois*, 567 U.S. 50, 58 (2012).

184. U.S. CONST. amend. VI, cl. 3.

the defendant's ability to challenge the process, not a talking head on the witness stand.

This reframing, however, requires some careful parsing. For example, it surely cannot be the case that if a forensic hair analyst performs a microscopic hair comparison¹⁸⁵ and writes a report "matching" hair found at the crime scene to the defendant, then that qualifies as process-based evidence and the analyst need not testify. In that scenario, it intuitively seems that the defendant should have a right to cross-examine the specific analyst—after all, the analyst is making a direct accusation against the defendant. Further consideration, however, suggests that this example does not involve process-based evidence at all. The analyst made a subjective comparison of the crime-scene evidence and the defendant's hair. Referring back to the distinctions made in Part II, that kind of evidence is witness-based, plain and simple. The reliability depends on the analyst as an individual, and indeed, from a Confrontation Clause perspective, that analyst *knows* whom he is accusing. The conventional Confrontation Clause requirements of in-court testimony and cross-examination should apply.

What kind of forensic analysis would qualify as process-based and warrant different treatment? Suppose the forensic hair analyst performed mitochondrial DNA (mtDNA) testing instead, a process that involves some manual (human) procedures and some automated (machine) procedures.¹⁸⁶ Further suppose that the analyst is only involved in sequencing; the analyst does not match the sample mtDNA profile with the defendant and does not even know who the suspect is. Instead, the lab's computer system, using pre-specified cutoffs, makes the "match" determination. This sequence results in process-based evidence. The accusation arises from the process, not the analyst personally. The analyst's role in the process is to execute tasks according to the predetermined procedure, and it is the *process* that cries out for scrutiny, not the analyst individually.

One can find room in the Supreme Court's existing Confrontation jurisprudence to accommodate this distinction between witness-based and process-based evidence. *Melendez-Diaz* and *Bullcoming* involved witness-based forensic results because the analysts in both cases knew what the

185. Microscopic hair comparison has been widely discredited as being extremely error-prone and has been linked to a number of wrongful conviction cases. See generally Edward K. Cheng, *Mitochondrial DNA: Emerging Legal Issues*, 13 J.L. & POL'Y 99 (2005) (noting the high error rates involved in microscopic hair analysis and identifying studies linking such analysis to "wrongful capital convictions"); see also Brandon L. Garrett & Peter J. Neufeld, *Invalid Forensic Science Testimony and Wrongful Convictions*, 95 VA. L. REV. 1, 48–51 (2009) (noting that forensic hair analysis has a high rate of error and has been known to implicate defendants who were later exonerated by DNA evidence).

186. See Cheng, *supra* note 185, at 103–05 (noting mtDNA analysis uses the same machinery as normal DNA analysis, and mtDNA analysts follow the same principles as other DNA analysts).

desired outcome should be. In *Melendez-Diaz*, the analyst's task was to determine if a substance was cocaine;¹⁸⁷ in *Bullcoming*, the analyst was assessing blood-alcohol content outside a medical setting.¹⁸⁸ Introducing those forensic reports without the analyst's live testimony therefore violated the Confrontation Clause.

*Williams v. Illinois*¹⁸⁹ presents a very different context.¹⁹⁰ In *Williams*, an outside laboratory performed the DNA sequencing of the crime scene sample, which was later "matched" to the defendant by a testifying expert.¹⁹¹ The Supreme Court held that this arrangement did not violate Confrontation, even though the analysts from the outside laboratory did not testify.¹⁹² To be sure, the primary rationale underlying *Williams* was that the testifying expert merely used the outside lab results as a *basis* for his opinion under Rule 703, and so it was only the testifying expert who was the accuser. But a cleaner, alternative theory of the case is that the outside laboratory's DNA profile in *Williams* was process-based evidence, unlike in *Melendez-Diaz* or *Bullcoming*. The *Williams* holding is therefore perfectly consistent with the theory that process-based evidence should be admissible without a live witness.¹⁹³

Finally, as with witness-based evidence, not every piece of process-based evidence needs to trigger Confrontation Clause protection. Processes that operate without the intent of producing information for future prosecution might not be subject to Confrontation's strictures at all.¹⁹⁴ Phone records, for example, are process-based but are not produced with an eye toward future prosecution. They might be subject to hearsay-type restrictions but not Confrontation requirements. But forensic analyses by definition would almost always trigger Confrontation Clause concerns and rightfully so.¹⁹⁵

187. 557 U.S. at 308.

188. 564 U.S. at 651.

189. 567 U.S. 50 (2012).

190. *Id.* at 58.

191. *Id.* at 56.

192. *Id.* at 58.

193. To be sure, we have argued here that the Confrontation Clause gives defendants *other* rights against process-based evidence, but the fact remains that our proposal does not conflict with the holdings in *Melendez-Diaz*, *Bullcoming*, and *Williams*.

194. See *Michigan v. Bryant*, 562 U.S. 344, 358 (2011) ("When . . . the primary purpose of an interrogation is to respond to an 'ongoing emergency,' its purpose is not to create a record for trial and thus is not within the scope of the [Confrontation] Clause."); *Davis v. Washington*, 547 U.S. 813, 822 (2006) ("[Statements] are testimonial when the circumstances objectively indicate that there is no such ongoing emergency, and that the primary purpose of the interrogation is to establish or prove past events potentially relevant to later criminal prosecution.").

195. Note that for process-based evidence, the hearsay rule and the Confrontation Clause remain doctrinally separate, just as it is now for witness-based evidence under *Crawford*. The hearsay exceptions discussed above for unavailability or for well-known, reliable processes might

C. *Credibility as Reliability*

To assess witness-based evidence, factfinders often rely heavily on witness credibility.¹⁹⁶ If one *believes* the witness, then the testimony is reliable; if not, then it is not. And generally speaking, factfinders are comfortable making credibility determinations, whether based on demeanor, cross-examination, or the witness's character for truthfulness.¹⁹⁷ To be sure, social science over the last several decades has questioned the accuracy of such assessments, but most factfinders are at least comfortable and familiar with making witness credibility determinations.¹⁹⁸

Assessments of process-based evidence may seem a different matter. We frequently determine the credibility of a salesperson's pitch, a colleague's movie or restaurant recommendation, or a friend's excuse for declining a dinner invitation. We less often assess a process's reliability. In fact, we normally defer to process-based evidence, giving it a strong presumption of accuracy. We rarely question whether our electrical bill is correct, whether the bank correctly deposited our check, or whether a medical test result is accurate. Much of this deference is rational and efficient. The advantage of processes is in their uniformity and accuracy. Problems, should they occur, usually occur in systemic, widespread fashion and will be discovered by regulators or parties with greater stakes.¹⁹⁹ It is not worth our own personal time to investigate process reliability. We lack the expertise and access, and we can simply freeride on the efforts of others.

But the courtroom is one context in which we cannot simply presume accuracy, and factfinders may be bewildered as to how to assess the reliability of a process. How can we increase jury competence with process-based evidence? One step is to teach process-assessment principles to attorneys in law school or through continuing education. Just as nascent trial attorneys

therefore not extend to Confrontation. After all, if *Crawford* is to be taken seriously, Confrontation is a procedural right, not just an exercise in ensuring reliable evidence. *See Crawford v. Washington*, 541 U.S. 36, 61 (2004) ("To be sure, the Clause's ultimate goal is to ensure reliability of evidence, but it is a procedural rather than a substantive guarantee.").

196. *See* Roth, *supra* note 20, at 1985 (identifying tools and doctrines designed to provide factfinders with sufficient information in order to determine a witness's credibility).

197. Jeremy A. Blumenthal, *A Wipe of the Hands, a Lick of the Lips: The Validity of Demeanor Evidence in Assessing Witness Credibility*, 72 NEB. L. REV. 1157, 1162–63 (1993); *see also* Max Minzner, *Detecting Lies Using Demeanor, Bias, and Context*, 29 CARDOZO L. REV. 2557, 2578 (2008) (explaining that though juries are not good at analyzing a witness's demeanor, they may be able to do a better job in some situations).

198. Improving how factfinders handle witness credibility determinations is well beyond the scope of this Article. We can always hope, however, that improvements in how to handle process-based reliability determinations will ultimately come around and promote improvements in how to handle witness-based reliability determinations.

199. *E.g.*, Matt Hamilton, *Did DWP Overcharge You? Customers to Receive Info on Billing Settlement Starting This Week*, L.A. TIMES (Mar. 28, 2017), [http://www.latimes.com/local/lanow/la-me-ln-dwp-settlement-info-packet-20170327-story.html# \[https://perma.cc/HZU6-JFZG\]](http://www.latimes.com/local/lanow/la-me-ln-dwp-settlement-info-packet-20170327-story.html# [https://perma.cc/HZU6-JFZG]).

learn to master the art of cross-examination, attorneys need to understand the weaknesses of process-based evidence, know how to use the enhanced discovery tools to probe those weaknesses, and be proficient at educating jurors about them at trial.

Second, jurors can receive further help through jury instructions explaining some simple ways for assessing process-based evidence. We sketch three basic principles or factors below. The careful observer will recognize that these factors share a deep kinship with factors used in assessing scientific reliability under *Daubert v. Merrell Dow Pharmaceuticals*.²⁰⁰ This kinship should be entirely unsurprising. The power of science derives from its process-based nature, and so how the legal system determines reliable scientific experts should mirror how it determines reliable, process-based evidence.²⁰¹ *Daubert* of course is an evidentiary rule, applied by judges to screen or “gatekeep” scientific evidence from the jury, but the principles are not exclusively useful for gatekeeping. They can also inform factfinding and the weighing of process-based evidence.²⁰²

1. Testing.—A reliable process is not only capable of being tested but in fact has been tested and has known error rates.²⁰³ Process-based evidence’s reliability comes from the fact that the underlying process is standardized and thus produces predictable results not dependent on the subjective perception or caprice of a person. Since it produces reproducible results, testers can give it known samples and assess its performance. Indeed, if a process is not capable of being tested, it is arguably not process-based evidence at all. And notably, testing not only ensures reliability, but the resulting data on error rates also help the factfinder assess the probative value of the process-based evidence.²⁰⁴

200. *Daubert v. Merrell Dow Pharm. Inc.*, 509 U.S. 579, 592–95 (1993).

201. One could conceive of a *Daubert*-like regime for screening process-based evidence. *Id.* at 592–95.

202. Although we do not propose one here, one could conceive of a “gatekeeping” scheme for handling process-based evidence. Courts could justify the more paternalistic scheme using arguments similar to those for expert evidence: Lay jurors are unfamiliar with assessing processes, whereas judges could develop greater expertise through repeated exposure. On the other hand, given the prevalence of process-based evidence, a gatekeeping scheme would significantly alter the power balance between judge and jury.

203. Testing recalls *Daubert*’s falsifiability and error rate factors. *Daubert*, 509 U.S. at 593–94; Munia Jabbar, Note, *Overcoming Daubert’s Shortcomings in Criminal Trials: Making the Error Rate the Primary Factor in Daubert’s Validity Inquiry*, 85 N.Y.U. L. REV. 2034, 2037 (2010) (“[T]he error rate should be the primary factor in the validity inquiry under *Daubert*.”).

204. Cf. Jabbar, *supra* note 203, at 2054 (“Prioritizing the error rate also maximizes the probative value of evidence.” Jabbar analogizes, “The lower the error rate of a scientific methodology, the more likely the methodology is accurate, and thus the more likely that it provides probative evidence. The error rate is therefore a concrete and objective way to measure the probative value of evidence.”).

For example, suppose at issue is whether Fragrance *A* is the same as Fragrance *B*. One process that would provide useful evidence on fragrance similarity might be gas chromatography–mass spectrometry.²⁰⁵ A machine analyzes the chemical composition between Fragrances *A* and *B* and reaches a conclusion based on predetermined thresholds. To assess the reliability of the process, we observe that the accuracy of the machine is capable of being tested and (in nearly every case) has been calibrated on known test samples before being used on Fragrances *A* and *B*. One could even have the spectrometer “compare” two *A* samples and then two *B* samples as an additional check, and we might expect an opposing party using enhanced discovery rights to do exactly that.

The principles work for a human-involved process as well. Suppose rather than a mass spectrometer, a party offers the results of a professional perfume tester instead.²⁰⁶ The perfume tester receives samples blinded by a third party and then uses his nose to make the determination. Despite being a black box, this procedure remains a testable process and potentially a reliable one if the perfume tester was previously tested using known samples. Whether the known samples are sufficiently related to the unknown samples will be a matter for debate, but those are issues for the factfinder to decide. If the perfume tester simply smelled both *A* and *B* and made a determination without any standards or testing, that would fail the testing factor. That kind of subjective observation is more appropriately dealt with as witness-based evidence.

The testing factor works best with diagnostic-type processes, but it also works with other forms of process-based evidence. Business records, for example, arise from nondiagnostic processes, yet they are capable of being tested and having their accuracy rates determined. Bank tellers and clerks can receive blinded “dummy” transactions, and a third party can then check their accuracy. More difficult are things like scientific treatises because accuracy is less straightforwardly defined. In the case of a treatise though, its weakness on the testing factor is made up for in the second factor, transparency.

2. *Transparency.*—Reliability often comes from transparency.²⁰⁷ A process whose internal workings and outcomes are publicly observed and subject to criticism will generally be more robust and accurate than one closely guarded. This preference for transparency extends well beyond the enhanced discovery rules proposed earlier. Enhanced discovery—access and

205. Charles Cronin, *Lost and Found: Intellectual Property of the Fragrance Industry; From Trade Secret to Trade Dress*, 5 N.Y.U. J. INTELL. PROP. & ENT. L. 256, 270 (2015).

206. Bernstein, *supra* note 82, at 483–84 (discussing a perfume sniffer as an example of “connoisseur testimony”).

207. After all, “[s]unlight is . . . the best of disinfectants.” *Buckley v. Valeo*, 424 U.S. 1, 67 (1976) (per curiam) (quoting LOUIS D. BRANDEIS, *OTHER PEOPLE’S MONEY AND HOW THE BANKERS USE IT* 62 (1933)).

disclosure by the opposing party within the narrow confines of litigation—is the bare minimum demanded to ensure the workings of the adversarial system. Yet enhanced discovery alone is far from ideal for ensuring reliability. By contrast, a process in the public domain is subject to perpetual access and testing by any interested party, making its weaknesses far more likely to be known.

To return to the fragrance comparison example: Suppose the mass spectrometer uses widely accepted techniques and is regularly certified by an internationally recognized standards organization. Its results are likely to be more reliable (or at least, less likely to have hidden flaws) than an instrument internally designed and tested by a private firm. Might the proprietary system be better? Sure. But trust and reliability come from transparency.

The peer-review factor in the *Daubert* context is akin to this transparency factor.²⁰⁸ Courts and commentators sometimes treat peer-review publication itself as a kind of touchstone of reliability, but that is an oversimplification.²⁰⁹ Instead, it is the entire process that matters. Top journals have rigorous peer review in part to protect their reputation and in part due to the stiff competition for publication slots. That peer review creates transparency, and as referees ask hard questions, weaknesses come to light. After publication, because top journals have wide readership, other experts will both read the article and respond with criticisms and potential concerns. It is the whole process that creates transparency and ensures quality.

3. *Objective Standards.*—The third factor, the presence of objective standards, is a key enabler of testing and transparency. Indeed, one might even argue that the presence of at least some objective standard is necessary for there to be a process at all. A “process” that produces subjective and vague determinations lacks objective standards and is both nontransparent and almost impossible to test. Take, for example, a fragrance tester who merely reports smelling apples with hints of raspberry. That tester provides witness-based, not process-based, evidence.

Objectivity is of course a matter of degree. It will vary from process to process and will affect the probative force of the process-based evidence as measured on a continuum. Mass spectrometry involves objective standards throughout. The blinded fragrance expert faces some objective testing standards but otherwise is a black box.

* * *

208. See *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 593 (1993).

209. See *id.* (“[S]ubmission to the scrutiny of the scientific community is a component of ‘good science,’ in part because it increases the likelihood that substantive flaws in methodology will be detected.”).

On a final note, none of these factors—testing, transparency, objectivity—are absolutely required for a process to be sufficiently reliable for consideration. But this multifaceted inquiry is no different than in the case of assessing witness credibility. A witness’s consistency, lack of defensiveness, and reputation for truthfulness may all contribute to a jury’s decision to believe his testimony, but no one factor is always dispositive. The key point is that tools exist for evaluating the relative strength of process-based evidence, and factfinders can use them.

D. Examples

This Part has proposed some significant reforms to the rules of evidence to accommodate the rise of process-based evidence. Instead of witness appearance and cross-examination, we have proposed enhanced discovery. Relatedly, we have refocused the hearsay rule and Confrontation Clause away from witness appearance and toward more meaningful mechanisms for ensuring reliability and confrontation. Finally, we reframed credibility so that factfinders probe the accuracy, transparency, and objectivity of the underlying process, rather than focusing on the credibility of witness surrogates.

It bears re-emphasizing that the strength of our process-based evidence regime is in its conceptual shift. Under our proposal, process-based evidence comes out from under the shadow of witnesses. Process-based evidence is no longer hindered by rules primarily concerned about witness reliability and instead is scrutinized on its own terms. Consider the following four examples in which distinguishing processes from witnesses will rationalize evidence law.

1. Forensic Results.—Perhaps the most dramatic impact of a process view will be on forensics. Currently, the Confrontation Clause requires the appearance of an analyst in court to present forensic evidence—no matter how reliable or unreliable the underlying process. This requirement is highly inefficient.²¹⁰ Defendants receive minimal benefits, as the analyst is unlikely to remember any specific sample. At the same time, the costs to the system are substantial. With labs already struggling to meet even a fraction of demand,²¹¹ asking analysts to spend their days in court to provide meaningless testimony makes little sense.²¹²

210. *Melendez-Diaz v. Massachusetts*, 557 U.S. 305, 341 (2009) (Kennedy, J., dissenting) (noting that *Melendez-Diaz* “imposes enormous costs on the administration of justice”).

211. James M. Anderson et al., *The Unrealized Promise of Forensic Science: An Empirical Study of its Production and Use 2* (RAND Corp., Working Paper No. 1242, 2018) https://www.rand.org/pubs/working_papers/WR1242.html [<https://perma.cc/U9VQ-5B7F>].

212. Some recent scholarship has suggested that courts and forensic labs have adjusted to make

Under a process-based regime, these awkward practices are eliminated in favor of more appropriate safeguards. The right to enhanced discovery gives defendants direct access and the opportunity to challenge the process that led to inculpatory evidence. No longer will defendants engage in fruitless cross-examinations of individual technicians; instead, defendants can challenge just how accurate the machines and processes really are.

The process-based regime also incentivizes good forensic lab practices and encourages compliance with the well-known recommendations of the National Research Council (NRC).²¹³ The NRC's report on forensic reform in 2008 emphasized the need for blinding samples;²¹⁴ performing proficiency testing; standardizing accreditation; "assessing the development and introduction of new technologies in forensic investigations";²¹⁵ "standard[izing] terminology";²¹⁶ funding research to address issues of "accuracy, reliability, and validity";²¹⁷ and furthering research on "human observer bias and sources of human error in forensic examinations."²¹⁸

These attributes are precisely the ones that the process-based evidence regime promotes. If a lab has all of these attributes, enhanced discovery is practically simple. The standardized procedures, objective standards, and testing results are already transparent and publicly available. And because the forensic analyses are in fact the result of a process, there is no need for individual analysts to appear in court—a far more efficient state of affairs.

At the same time, the proposed regime penalizes bad forensic practices. The NRC reserved its harshest criticism for analyses that neglected blinding, lacked objective standards, and were dependent on subjective determinations

in-person testimony feasible so that early admonitions of a system collapse have not come true. See Edward K. Cheng, *Catherine Bonventre, The Impact of Melendez-Diaz v. Massachusetts*, EXCITED UTTERANCE: THE EVIDENCE & PROOF PODCAST (Mar. 19, 2018), <https://www.excitedutterancepodcast.com/listen/2018/3/19/48-catherine-bonventre> [https://perma.cc/CS6H-LY55] (noting strategies that laboratories have developed in response to *Melendez-Diaz*'s in-person testimony requirement). Even so, technician time could be far better spent, and as we argue, there are better ways to assure reliable forensic evidence.

213. Although the NRC report was released with great fanfare in 2008 and is widely regarded as having made sound recommendations for reform, most observers have acknowledged that it has had little practical effect thus far. George C. Thomas III, *Blinded by the Light: A Review of Mark Godsey's Blind Injustice*, 15 OHIO ST. J. CRIM. L. 597, 608 (2018); see also *State v. Davidson*, 509 S.W.3d 156, 211–12 (Tenn. 2016) (collecting cases and expressly rejecting the NRC report's findings as it relates to fingerprint evidence in Tennessee courts), *cert. denied*, 138 S. Ct. 105 (2017).

214. COMM. ON IDENTIFYING THE NEEDS OF THE FORENSIC SCI. CMTY. ET AL., NAT'L RESEARCH COUNCIL OF THE NAT'L ACADS., *STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD* 124 (2009), <https://www.ncjrs.gov/pdffiles1/nij/grants/228091.pdf> [https://perma.cc/X9JS-QKPJ].

215. *Id.* at 19–20.

216. *Id.* at 189.

217. *Id.* at 190.

218. *Id.* at 191.

by analysts.²¹⁹ This kind of forensic analysis is emphatically not process-based; it is witness-based. It therefore should not benefit from the streamlined treatment proposed above and instead should face the current Confrontation Clause strictures requiring the analyst to appear and testify.

Ultimately for forensics, the true power of the process-based regime may again come from the shift in perspective. If the process-based procedure becomes the standard by which (good) forensics are admitted in criminal cases, then subjective forensic analyses admitted under witness-based rules will become the aberration. And as an aberration, perhaps judges will treat bad forensics more skeptically, perhaps excluding the worst cases under *Daubert*.

2. *Scientific Articles*.—As discussed in subpart III(B), the learned treatise exception is structurally odd. The exception focuses on the witness, the conduit for the treatise, rather than the treatise itself. Treatises are hearsay but qualify for the exception if “relied on by [an] expert” and the expert “establishe[s] [the treatise] as a reliable authority.”²²⁰ And the treatise must “be read into evidence, . . . not received as an exhibit.”²²¹ Better would be a framework that focused on the treatise and dispensed with the witness conduits.

The proposed regime handles treatises far more cleanly as process-based evidence. Our confidence in the reliability of a journal article or treatise comes not only from the reputation of the author but also from the publication process, which involves peer review and public disclosure. Since information on the publication process is readily obtainable (and in some cases, judicially noticeable), scientific articles and treatises are easily admissible. A jury can then assess the evidentiary weight of a treatise by considering the reliability of the publication process. Note that under a process-based evidence regime, no experts are needed to introduce treatises in evidence. The reliability of treatises comes from their origins, not some expert witness who vouches for it.²²² Parties should be able to contest the reliability of the publication process and the treatise itself on the basis of documents alone.

219. *Id.* at 8.

220. FED. R. EVID. 803(18).

221. *Id.*

222. Note that the vouching expert does not need to be the author under the learned treatise exception and indeed will be someone hired by the party. Bernstein, *supra* note 82, at 454–55 (“The problem of conscious bias arises when ‘hired guns’ adapt their opinions to the needs of the attorney who hires them.”). At least on direct examination, the expert merely has to rely on the proposition cited and vouch for the treatise’s acceptance in the field. One gets the impression that the witness-based rules are more concerned with providing a witness than ensuring that the goal—reliable evidence—is met.

This simplified method for introducing scientific information promotes efficiency and lowers economic barriers for indigent parties by reducing the need for expert witnesses. For example, Jennifer Mnookin has proposed expanding the use of “modular expert evidence,” in which groups of experts develop standardized, premade modules to educate jurors on topics like the reliability of eyewitness identification, how to interpret DNA evidence, and the like.²²³ Under our current evidentiary system, a significant obstacle to modular expert evidence is the hearsay rule (and the requirements of the learned treatise exception). The process-based regime, by contrast, allows modules to go straight to the factfinder, presuming that they were developed using sufficiently reliable processes.

3. *Photographs.*—The proposed regime coheres with the current two-path system for admitting photographs, except that it appropriately flips the script. Recall that, at present, the legal system prefers treating photographs as demonstrative evidence, since the evidence comes from the in-court witness, and the photograph is merely an accompanying demonstrative aid.²²⁴ Admission along this path is relatively simple, but using photographs as demonstrative evidence is pure fiction. The power of the photograph is not in illustrating the witness’s testimony but rather in its more objective, process-based perspective.²²⁵ By contrast, a current regime skeptically treats the silent witness theory almost as a second-best.²²⁶ Our proposed regime does not. It handles recorded images on their own terms, which is indeed as a silent (process-based) “witness.”

Under a process-based regime, special rules can simplify the admission process for standard photographs or videos, such as those from cameras, video recorders, and phones. Those rules obviate the need for enhanced discovery, except when specific circumstances suggest untrustworthiness.²²⁷ For other types of video evidence, the process-based framework would handle images more carefully than the existing demonstrative regime. For example, a computer-generated accident reconstruction would require

223. Jennifer L. Mnookin, *Repeat Play Evidence: Jack Weinstein, “Pedagogical Devices,” Technology, and Evidence*, 64 DEPAUL L. REV. 571, 589–95 (2015).

224. FED. R. EVID. 1002; Mnookin, *supra* note 7, at 67.

225. See Jordan S. Gruber et al., *Video Technology*, 58 AM. JUR. TRIALS 481, 502 (1996) (“In addition to being *pervasive*, video technology and television is extremely *persuasive*.” (emphasis in original)).

226. *E.g.*, *United States v. Rembert*, 863 F.2d 1023, 1026 (D.C. Cir. 1988) (recognizing the “silent witness” model, under which the admissibility of a photograph is based on the reliability of the process by which it is made” is applicable only “where obviously no witness has viewed the scene portrayed”).

227. *Cf.* FED. R. EVID. 803(8).

enhanced discovery of the software and procedures used for constructing the animation.²²⁸ (Some form of Rule 403 might apply as well.)

Concededly, because process- and witness-based rules would operate concurrently, nothing formally prevents parties from continuing to introduce photographs as demonstrative evidence. But over time, we expect a cultural shift. Visual evidence with high evidentiary value will tend to be process-based and admitted through streamlined process-based evidentiary exceptions. The demonstrative evidence mechanism would slowly become the exception, and courts will treat it with greater skepticism.²²⁹

4. *Business Records*.—As discussed in subpart III(D), Rule 803(6), the business records exception, is one of the few areas in which traditional evidence law properly acknowledges the reliability of process-based evidence. The current evidentiary regime, however, still gets a few things wrong: First, Rule 803(6) is a hearsay exception, so the burden is on the proponent to prove its elements.²³⁰ Second, until recently in federal courts and still in some jurisdictions, Rule 803(6) requires an in-court custodian, another example of the traditional regime relying on witness surrogates.²³¹ Third, the exception arguably goes too far. True, business records should not be barred by the hearsay rule, but they should not receive a free pass.²³² An opponent may want a meaningful opportunity to challenge the reliability of the process that created the record.

The proposed process-based framework handles business records appropriately. As process-based evidence, they are not excludable as conventional hearsay nor do they require an exception like Rule 803(6). At the same time, business records are not given a free pass. Proponents must provide enhanced discovery of the business record process to their opponents, with exceptions made only for special circumstances and under certain conditions.

228. Thus tying in our proposal above. *See supra* subpart IV(A).

229. NEAL FEIGENSON, *EXPERIENCING OTHER MINDS IN THE COURTROOM 2–3* (2016) (discussing concerns about visual evidence that does nothing but advocate for the party's subjective narrative).

230. FED. R. EVID. 803 Notes of Advisory Committee on 2014 Amendments.

231. *Compare* FED. R. EVID. 803(6) (allowing a certification that “complies with Rule 902(11) or (12)” in the alternative to a live witness’s testimony), *and* FED. R. EVID. 902 Notes of Advisory Committee on 2017 Amendments (clarifying why the amendment allows for authentication of “certain electronic evidence” without a foundation witness: “As with the provisions on business records in Rules 902(11) and (12), the Committee has found that the expense and inconvenience of producing a witness to authenticate an item of electronic evidence is often unnecessary”), *with* CAL. EVID. CODE § 1271 (West 2015) (business records exception not requiring a custodian), *and* N.D. CENT. CODE ANN. § 31-08-01 (LexisNexis 2010) (same).

232. Arguably, the one exception to this “free pass” is the limitation in *Palmer v. Hoffman*, 318 U.S. 109, 111–12 (1943), which eliminates the business records exception for records produced in anticipation of litigation or under abnormal circumstances.

V. Conclusion: A Process-Based Revolution?

Although the evidentiary reforms we propose in this Article may seem somewhat radical at first, we believe that they are largely evolutionary. The witness-based paradigm developed and became entrenched in a world in which evidence came from people. With the rise of processes and process-based evidence, the time has come for evidence law to evolve to meet the new context. The legal system ought not fetishize the witness. It should demand witnesses only when they are the actual source of evidence, and it should recognize processes as the independent evidence-generating sources they are.

Our proposed reforms do nothing more than this. They distinguish witness-based from process-based evidence. They eliminate the awkward legal constructs that result when the law demands witnesses for everything: photographs as demonstrative evidence, the learned treatise exception, custodians for business records, forensic evidence tagged to a specific analyst, among others. Instead, our reforms scrutinize process-based evidence on its own terms, giving opponents access to the underlying processes and examining the processes' accuracy, transparency, and objectivity.

Though we propose significant changes for process-based evidence, the world of witnesses remains intact. The parties remain free to introduce witnesses, cross-examine them, and challenge their character for truthfulness. All we have proposed is that process-based evidence not be treated like witness-based evidence and that the legal system not exhibit a preference for the latter.

But we would be remiss if we did not acknowledge the potentially revolutionary implications of our proposal. Heretofore, process-based evidence has been effectively suppressed by the existing witness-based framework, giving it no room to expand in influence. Our proposal lets the genie out of the bottle. If fully implemented, process-based evidence will compete with witness-based evidence on an even playing field, and in a fair fight, the legal system may start shifting dramatically in the process-based direction. After all, the rest of the world has shifted from people to processes. Why shouldn't the legal system?

We can take this argument one step further. Suppose we were tasked with designing an evidentiary system from scratch, without the shackles of tradition. On one hand, there is process-based evidence, which emphasizes objectivity, testability, and documentation. On the other hand, there is witness-based evidence, which social science has repeatedly demonstrated to be fallible in ways not readily detected by factfinders.²³³ Why should the legal

233. Blumenthal, *supra* note 197, at 1160–63; Minzner, *supra* note 197, at 2565–71.

system treat both equally? Should not the evidentiary preference indeed be the opposite of what it is now? Rather than preferring witnesses, the legal system should prefer processes, and only where process-based evidence is unavailable should courts settle for in-person testimony.²³⁴ If a photograph or video captures a crime in progress, the legal system should prefer that process-based evidence over a witness.²³⁵ Unless a witness can attest to some factor not captured by the photograph or video, any overlapping testimony by the witness should be excluded. The reliability of the video should trump the subjectivity and fallibility of the witness. To be sure, such a radical departure from current practice has its dangers, but the discussion is worth having.

Whether process-based evidence is an equal partner or becomes a preferred medium, the resulting cultural shift may have profound implications for the legal system. For example, will broader acceptance of process-based evidence shift us away from a system based on oral testimony and toward a documentary system favored in civil law countries? After all, processes and process-based evidence are creatures of documents. How will a shift toward documents and away from oral testimony impact the narrative nature of American trials? Will it lead jurors to view evidence more atomistically and more in line with Bayesian models of proof, instead of today's holistic, story-based models?²³⁶ What effect will that shift have on the moral force of judicial pronouncements?

Consider another philosophical implication. Processes in many ways represent the triumph of systems over individuals. They embody a belief that careful algorithmic reasoning produces better and more reliable results than the intuitive judgments of individual artisans. And once one proves a system reliable, there is no need to revisit that question—unlike in the case of a witness or expert, who changes on a case-by-case basis. Will broader acceptance of process-based evidence lead the legal system to de-emphasize individualized justice in favor of system-wide efficiency and accuracy? Will it spawn broader issue-preclusion doctrines and precedent? What do we as a society gain and lose from such a shift?

Perhaps both changes—toward a documentary system and a systems approach—have practically occurred already. The prevalence of settlement

234. For a discussion of the emergence of the witness preference, see Fisher, *supra* note 1, at 602–24.

235. Such an occurrence would reverse the phenomena discussed by Professor Mnookin. Mnookin, *supra* note 7, at 54.

236. See Michael S. Pardo & Ronald J. Allen, *Juridical Proof and the Best Explanation*, 27 *LAW & PHIL.* 223, 228–32 (2008) (explaining the “inference to the best explanation” model); Nancy Pennington & Reid Hastie, *Explaining the Evidence: Tests of the Story Model for Juror Decision Making*, 62 *J. PERSONALITY & SOC. PSYCHOL.* 189, 189–90 (1992) (explaining the “Story Model”); Boaz Sangero & Mordechai Halpert, *Why a Conviction Should Not Be Based on a Single Piece of Evidence: A Proposal for Reform*, 48 *JURIMETRICS* 43, 44, 48–51 (2007) (taking, in part, a Bayesian approach to forensic evidence).

and motions practice (and the death of trials) in modern litigation suggest that the modern legal system is already comfortable dispensing with individualized justice and oral testimony. The only remaining relic is the trial, which still champions the person over the process.

In any event, it is time for the evidentiary rules to make the leap into the process-based world of the twenty-first century. Let us recognize and handle process-based evidence for what it is, and let the chips fall where they will.