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Understanding Criminal Justice Innovations

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Burgeoning science and technology have provided the criminal justice system with the opportunity to address some of its shortcomings. And the criminal justice system has significant shortcomings. Among other issues, we have a mass incarceration problem; clearance rates are surprisingly low; there are serious concerns about wrongful convictions; and the system is layered with racial, religious, and other biases. Innovations that are widely used across industries, as well as those directed specifically at the criminal justice system, have the potential to improve upon such problems. But it is important to recognize that these innovations also have downsides, and criminal justice actors must proceed with caution and understand not only the potential of these interventions but also their limitations. Relevant to this calculation of caution is whether the innovation is broadly used across industry sectors or, rather, whether it has been specifically developed for use within the criminal justice system. These latter innovations have a record of not being sufficiently vetted for accuracy and reliability. Accordingly,

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criminal justice actors must be sufficiently well versed in basic science and technology so that they have the ability and the confidence to critically assess the usefulness of the various criminal justice innovations in light of their limitations. Considering lawyers' general lack of competency in these areas, scientific and technological training is necessary to mold them into modern competent criminal justice actors. This training must be more than superficial subject-specific training, though; it must dig deeper, delving into critical thinking skills that include evaluating the accuracy and reliability of the innovation at issue, as well as assessing broader concerns such as the need for development transparency, the possible intrusions on individual privacy, and the incentives to curtail individual liberties given the innovation at hand. Lawyers trained to competently assess science and technology can then propel our system forward.

INTRODUCTION

Burgeoning science and technology have provided the criminal justice system with the opportunity to address some of its shortcomings. And the criminal justice system has significant shortcomings. Among other issues, we have a mass incarceration problem; clearance rates are surprisingly low; there are serious concerns about wrongful convictions; and the system is layered with racial, religious, and other biases. Innovations that are widely used across industries, as well as those directed specifically at the criminal justice system, have the potential to improve upon such problems. But it is important to recognize that these innovations also have downsides, and criminal justice actors must proceed with caution and understand not only the potential of these interventions but also their limitations. Relevant to this calculation of caution is whether the innovation is broadly used across industry sectors or, rather, whether it has been specifically developed for use within the criminal justice system. These latter innovations have a record of not being sufficiently

vetted for accuracy and reliability. Accordingly, criminal justice actors must be sufficiently well versed in basic science and technology so that they have the ability and the confidence to critically assess the usefulness of the various criminal justice innovations in light of their limitations. Considering lawyers' general lack of competency in these areas, scientific and technological training is necessary to mold them into modern competent criminal justice actors. This training must be more than superficial subject-specific training, though; it must dig deeper, delving into critical thinking skills that include evaluating the accuracy and reliability of the innovation at issue, as well as assessing broader concerns such as the need for development transparency, the possible intrusions on individual privacy, and the incentives to curtail individual liberties given the innovation at hand.

This Article examines the usefulness of criminal justice innovations, their potential pitfalls, and the importance of preparing criminal justice actors for the fair deployment of these innovations within the system. Part I outlines some significant problems plaguing the criminal justice system. Part II highlights a number of innovations that have been directed at solving, or at least mitigating, some of these concerns. Part III notes that criminal justice innovations have a dark side, though. For example, some innovations disadvantage individuals without sufficient technological savvy, and others surreptitiously discriminate against particular racial groups. Further, there even may be real questions about the accuracy of the results these innovations produce—especially where innovations targeted specifically at the criminal justice system are in play. Part IV explains that, in order to improve the fair and accurate deployment of these innovations, legal actors should be competent in critically evaluating these innovations' usefulness and accuracy. Training may very well be necessary to facilitate this. Criminal justice innovations should not be just blindly and uncritically accepted as clear and safe improvements in our system. They must instead be carefully evaluated by clear-eyed and open-minded individuals working within our system. This Article concludes by explaining that legal actors armed with critical thinking skills where science and technology are concerned have the power to propel our system forward.

I. SIGNIFICANT PROBLEMS WITHIN THE CRIMINAL JUSTICE SYSTEM

Problems within the criminal justice system are overwhelming. For example, we have an enormous mass incarceration problem, with nearly two million people, or about 0.6% of the population, behind bars.[1] No other

[1] Wendy Sawyer & Peter Wagner, *Mass Incarceration: The Whole Pie*, PRISON POL'Y INITIATIVE (2022), https://www.prisonpolicy.org/reports/pie2022.html

country in the world incarcerates such a significant proportion of its population.[2] At the same time, we have the problem of relatively low clearance rates.[3] At the federal level, in 2018, just 62% of murders and manslaughters, 33.4% of rapes, 30% of robberies, and 14% of burglaries were cleared via arrest or other "exceptional means," including the death of the offender or the victim's refusal to cooperate after the offender had been identified.[4] Additionally, there is an overwhelming number of wrongful convictions in the United States. It is difficult to know the true number of wrongful convictions in this country because many convicted individuals claiming innocence are never exonerated, the U.S. criminal justice system often makes it very difficult to overturn convictions, and experts began systematically tracking exonerations only in 1989.[5] But, since they have been systematically tracked, there have been more than 3,000 exonerations in this country.[6] It is almost certain that this number does not include all wrongful

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[https://perma.cc/6ZSZ-45PG].

[2] *See id.* ("The United States has the dubious distinction of having the highest incarceration rate in the world."); Derick Moore, *U.S. Population Estimated at 332,403,650 on Jan. 1, 2022*, U.S. CENSUS BUREAU: AMERICA COUNTS (Dec. 30, 2021) (estimating the U.S. population to be 332,403,650 as of Jan. 1, 2022), https://www.census.gov/library/stories/2021/12/happy-new-year-2022.html [https://perma.cc/7TQ9-ZUB2].

[3] *See* Matt Clarke, *U.S. Murder Clearance Rates Among Lowest in the World*, HUMAN RIGHTS DEFENSE CENTER: CRIM. L. NEWS (Feb. 16, 2018), https://www.criminallegalnews.org/news/2018/feb/16/us-murder-clearance-rates-among-lowest-world/ [https://perma.cc/5SLA-PFEG] ("Statistically, U.S. law enforcement agencies are the worst crime solvers in the Western world."); Weihua Li & Jamiles Lartey, *As Murders Spiked, Police Solved About Half in 2020*, MARSHALL PROJ. (Jan. 12, 2022), https://www.themarshallproject.org/2022/01/12/as-murders-spiked-police-solved-about-half-in-2020 [https://perma.cc/3G7K-53E5] ("The lower clearance rate in 2020 was an extension of a long, steady drop since the early 1980s, when police cleared about 70% of all homicides, and a decline that experts say was exacerbated by the pandemic.").

[4] FED. BUREAU INVESTIGATION, CRIME IN THE UNITED STATES, 2018, at 1–3 (2019), https://ucr.fbi.gov/crime-in-the-u.s/2018/crime-in-the-u.s.-2018/topic-pages/clearances.pdf [https://perma.cc/2CTH-J5Y5]. Clearance rates may not be the best way to measure police effectiveness, however. *See* Shima Baradaran Baughman, *How Effective Are Police? The Problem of Clearance Rates and Criminal Accountability*, 72 ALA. L. REV. 47, 65 (2020) ("In sum, clearance rates provide an imperfect measure of police effectiveness, as they are difficult to measure accurately[,] . . . may be exaggerated[,] . . . . [and] may lead to police incentives to arrest individuals rather than deal with crimes in alternative ways.").

[5] *See* Meghan J. Ryan, *Compensation for Wrongful Conviction and Incarceration in the United States*, *in* COMPENSATION FOR WRONGFUL CONVICTIONS IN COMPARATIVE PERSPECTIVE (Wojciech Jasiński & Karolina Kremens eds., forthcoming 2023), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4002746 [https://perma.cc/8UF9-XKVQ] (discussing the challenge of measuring wrongful convictions).

[6] NAT'L REGISTRY OF EXONERATIONS, https://www.law.umich.edu/special/exoneration/Pages/about.aspx [https://perma.cc/ZP3D-DDUV] (last visited Mar. 2, 2022).

convictions since 1989, and scholars have surmised that, in reality, anywhere from 0.02% to 15% of convictions are wrongful.[7] Beyond mass incarceration, low clearance rates, and wrongful convictions, there is a layer of bias and discrimination that has seeped into numerous aspects of the criminal justice system.[8] Economically disadvantaged defendants often have a very different experience within the system than economically advantaged defendants.[9] And the same is true with minority defendants.[10] As The Sentencing Project explained in its 2018 report on racial disparities in the U.S. criminal justice system, "[t]he United States in effect operates two distinct criminal justice systems: one for wealthy people and another for poor people and people of color."[11] For example, "27% of all individuals arrested in the United States" in 2016 were Black—"double their share of the total population."[12] Blacks were also held in jail prior to trial at 3.5 times the rate of non-Hispanic whites.[13] And Blacks are imprisoned about five times as frequently as

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[7] *See* Meghan J. Ryan & John Adams, *Cultivating Judgment on the Tools of Wrongful Conviction*, 68 SMU L. REV. 1073, 1075–76 (2015) (summarizing commentators' estimates on the number of wrongful convictions). One might view the lower end of this estimate—0.02%—as reflecting an acceptably small rate of error that is unavoidable in a system where omniscience is impossible. While 100% accuracy is indeed impossible where convictions are at issue, it may be helpful to think of such small error rates in other contexts. One legal commentator has explained:

> It may help to consider the analogy of plane crashes. Roughly 18,000 flights arrive or depart Atlanta's Hartsfield-Jackson airport each week. If five of those planes crashed—roughly .027% of flights—operations at the airport would cease immediately. So, too, would 125 people wrongfully imprisoned annually (.027% of all state court felony convictions) represent a disturbing number of wrongful convictions.

Robert J. Smith, *Recalibrating Constitutional Innocence Protection*, 87 WASH. L. REV. 139, 143–44 (2012) (citations omitted). Even small rates of error are significant when the consequences of such errors are so severe.

[8] *See* Ryan & Adams, *supra* note 6**Error! Bookmark not defined.**, at 1100–02 (explaining how biases are "pernicious . . . throughout the criminal justice system"); Report of the Sentencing Project to the United Nations Special Rapporteur on Contemporary Forms of Racism, Racial Discrimination, Xenophobia, and Related Intolerance, SENT'G PROJECT 1 (2018) [hereinafter Sentencing Project Report] (pointing out that "racial disparity [] pervades the U.S. criminal justice system, and for African Americans in particular."), https://www.sentencingproject.org/wp-content/uploads/2018/04/UN-Report-on-Racial-Disparities.pdf [https://perma.cc/EXC7-9HU4].

[9] *See* Sentencing Project Report, *supra* note 8, at 1 ("[T]he experiences of poor and minority defendants within the criminal justice system often differ substantially from that model due to a number of factors, each of which contributes to the overrepresentation of such individuals in the system.").

[10] *Id.*

[11] *Id.*

[12] *Id.* at 2.

[13] *Id.* at 6. ("African Americans were incarcerated in local jails at a rate 3.5 times that of non-Hispanic whites in 2016.").

whites.[14] Differing rates of offense commission do not account for these differences.[15] Data from Harvard's Project Implicit, which tracks various types of bias in the population, suggest that almost all Americans—regardless of race, sex, class, and age—possess at least some biases.[16] Thus, biases—whether explicit or implicit—often surface where individuals have discretion to make decisions. The criminal justice system is rife with discretion—such as police officers' discretion to investigate and arrest, prosecutors' discretion to charge and offer plea deals, judges' discretion to dismiss charges and to sentence, and jurors' discretion to convict. This means there is an overwhelming number of crevices into which biases can seep and infect criminal justice outcomes. These are just some of the difficulties facing the criminal justice system today.

II. INNOVATIONS DIRECTED AT THESE CONCERNS

The progress of science and technology since the birth of the American criminal justice system (or its network of systems) has been remarkable. And, to some extent, actors within the criminal justice system have harnessed these innovations in an attempt to improve the system. These criminal justice innovations are of various types. Some rely on widely accepted science and technology while others are niche innovations directed primarily at the criminal justice community.

One type of criminal justice innovation that is ordinarily based on widespread technology is administrative innovations. These innovations are often aimed at achieving the same criminal justice goals in a more efficient manner—often through electronic means. A typical example is using electronic forms rather than paper ones. Another, more specific, example that

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[14] *See* ASHLEY NELLIS, SENT'G PROJECT, THE COLOR OF JUSTICE: RACIAL AND ETHNIC DISPARITY IN STATE PRISONS 6 (2021) ("Black Americans are incarcerated in state prisons at nearly 5 times the rate of white Americans").

[15] *See id.* at 10–11, 14 ("The totality of the research literature on race and ethnic differentials in imprisonment leads to a similar conclusion: a sizable proportion of disparity in prison cannot be explained by patterns in criminal offending."); Sentencing Project Report, *supra* note 8, at 1–3 (discussing racial disparities in various stages of the criminal justice process).

[16] *See* PROJECT IMPLICIT, https://www.projectimplicit.net/ [https://perma.cc/NMX8-Z53E] (last visited Mar. 4, 2022) (describing implicit bias as an automatic reaction that can lead to unintentional discrimination); Kristin A. Lane, Jerry Kang & Mahzarin R. Banaji, *Implicit Social Cognition and Law*, 3 ANN. REV. L. & SOC. SCI. 427, 433–35 (2007) (describing how people show "ingroup preference"); Annie Murphy Paul, *Where Bias Begins: The Truth About Stereotypes*, PSYCHOL. TODAY (May 1, 1998) ("Psychologists once believed that only bigoted people used stereotypes. Now the study of unconscious bias is revealing the unsettling truth: We all use stereotypes, all the time, without knowing it. We have met the enemy of equality, and the enemy is us.").

some jurisdictions have embraced is text messaging—capitalizing on its efficiency and effectiveness in reminding criminal defendants of their court dates.[17] Not only do missed court appearances cost the court time and money, but they could also cost criminal defendants their freedom.[18] A New York pilot study showed that text messaging criminal defendants decreased their failure-to-appear rates by up to 26% and reduced resulting open arrest warrants for these individuals by 32%.[19] This demonstrates that text messaging defendants about their court dates is an incredibly effective way to improve the criminal justice system, and the cost of doing so is very little.[20] Yet another example of an administrative innovation that some jurisdictions have adopted is making discovery available to defense attorneys on a digital platform, such as TechShare,[21] which makes discovery available "with the click of a button."[22] Employing innovations such as this—similar to what has already long been used in the civil justice system—can improve efficiency and facilitate prosecutors' "timely and effective compliance with discovery

[17] *See* Associated Press, *Text Message Reminders Help People Remember their Court Dates*, L.A. TIMES (May 4, 2019), https://www.latimes.com/nation/la-na-court-case-text-reminders-defendants-20190504-story.html [https://perma.cc/VU6Z-UZYM] ("Courts around the country are embracing text messages as a way to nudge people into showing up for their hearings.").

[18] *See id.* ("No-shows cost the courts time and money, and can cost defendants their freedom."); Brice Cooke, Binta Zahra Diop, Alissa Fishbane, Jonathan Hayes, Aurelie Ouss & Anuj Shah, UNIV. CHICAGO CRIME LAB, USING BEHAVIORAL SCIENCE TO IMPROVE CRIMINAL JUSTICE OUTCOMES: PREVENTING FAILURES TO APPEAR IN COURT 6 (2018) [hereinafter BEHAVIORAL SCIENCE] ("In many jurisdictions, failing to appear can result in an arrest warrant; in NYC this is the default response in accordance with state law.").

[19] *See* BEHAVIORAL SCIENCE, *supra* note 18, at 16 (finding "that receiving any pre-court message reduces [failure to appear] on the court date by 21%"; that "[t]he combination messages, using elements of both the consequences and plan-making sets, were the most effective, reducing [failure to appear] by 26%"; and that "receiv[ing] a combination message set and a post-[failure to appear] message" reduced open warrants for the recipients by 32%); Alissa Fishbane, Aurelie Ouss & Anuj K. Shah, *Behavioral Nudges Reduce Failure to Appear for Court*, 370 SCIENCE 682, 685 (2020) [hereinafter *Behavioral Nudges*] ("[R]eceiving any text message reduced failures to appear by 8 percentage points, which represents a 21% relative reduction . . . [and] [t]he consequences and combination messages were most effective, reducing failures to appear by 8.9 and 9.9 percentage points . . . (23.5 and 26.1% relative reductions), respectively.").

[20] *See Behavioral Nudges*, *supra* note 19, at 689 (discussing the high cost of failures to appear and the effectiveness of the described interventions, which they describe as "cheap" and "incredibly cost-effective").

[21] *See generally* TECHSHARE, https://techsharetx.gov/ [https://perma.cc/2AWM-8PQY] (last visited Jan. 13, 2022).

[22] Jenia I. Turner, Michael Braun & Ronald F. Wright, *Defense Use of Digital Discovery in Criminal Cases* 7 (Jan. 2022) (unpublished manuscript) (on file with the University of Pennsylvania Journal of Law and Public Affairs).

rules."[23] Because digitization facilitates tracking, such platforms also allow (at least for now) researchers to study the extent to which defense attorneys make use of this digitally available information.[24]

Other innovations within the criminal justice system that similarly make use of widespread technology are surveillant in nature. New science and technology have allowed extensive surveillance of individuals, which has been helpful to law enforcement and prosecution. Digital cameras, Stingray devices, extensive internet use, smart phones, and the general "Internet of Things" have created digital trails following each of us wherever we go. Not only is surveillance information useful for investigations and as evidence in criminal cases, but such information is useful in implementing punishment as well. Electronic monitoring is available as an alternative to incarceration in every jurisdiction—an alternative that allows jurisdictions to address problems such as prison overcrowding while simultaneously reducing costs.[25]

Even where individuals escape direct physical surveillance, they may leave physical evidence such as DNA, fingerprints, or other forensic clues behind. Advances in science and technology have led to uncovering some of these clues and employing them in criminal cases. DNA, fingerprint, bitemark, and other forensic evidence are all used to convict—and sometimes to exonerate—individuals in the criminal justice system. Modern DNA analysis is generally based upon scientific research growing out of universities and broadly employed in the biotechnology sectors of industry.[26] Other forensic techniques such as fingerprint, ballistics, and bitemark analyses fall into the niche category of innovations that are primarily

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[23] *Id.* at 8.

[24] *See id.* ("Although this is not their intended purpose, these digital platforms also make it possible to monitor some aspects of attorney behavior during discovery."). Importantly, this resource could perhaps be used as evidence in criminal defendants' claims of ineffective assistance of counsel. *See id.* at 44 (suggesting that information obtained from these platforms could help form the basis for an ineffective assistance claim).

[25] *See* Avlana K. Eisenberg, *Mass Monitoring*, 90 S. CALIF. L. REV. 123, 125, 150–51 (2017). Professor Eisenberg explains, however, that sometimes jurisdictions employ electronic monitoring as an additional condition of punishment, which is problematic. *See id.* at 129–58

[26] *See* Meghan J. Ryan, *Secret Conviction Programs*, 77 WASH. & LEE L. REV. 269, 299 (2020) [hereinafter Ryan, *Secret Conviction Programs*] ("The study of DNA grew out of the biology, chemistry and biochemistry departments of universities."); Meghan J. Ryan, *Escaping the Fingerprint Crisis: A Blueprint for Essential Research*, 2020 U. ILL. L. REV. 763, 772 (2020) [hereinafter Ryan, *Escaping the Fingerprint Crisis*] (explaining that DNA analysis was developed in "research laboratories of universities"); Meghan J. Ryan, Miranda*'s Truth: The Importance of Adversarial Testing and Dignity in Confession Law*, 43 N. KY. L. REV. 413, 428 & n.122 (2016) [hereinafter Ryan, Miranda*'s Truth*] (discussing the reliability that comes from development in research universities).

employed within the criminal justice system.[27]

There are also predictive innovations, which, like most of the forensic sciences, are niche innovations. These are mainly algorithms created by for-profit entities that are used to assess risk within the criminal justice system. For example, companies such as PredPol, Inc. and ShotSpotter, Inc.[28] offer police departments across the country programs that can help better predict where and when crimes will occur.[29] Based on prior crime data, these programs allow the police to better marshal their limited resources to arguably better patrol and deter crime.[30] Additionally, entities such as Northpointe[31] and the Arnold Foundation have developed programs to predict the likelihood that individuals will recidivate, and programs like these have been used to guide decisionmaking on issues such as bail, sentencing, and parole.[32] Reliance on such programs is not surprising considering that a wide variety of disciplines make use of algorithmic decisionmaking, which regularly outperforms human decisionmaking.[33] Making important decisions that affect individuals' liberties and futures should indeed be rooted in as much data as possible, and algorithms can further this goal.

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[27] *But see* Ryan, *Escaping the Fingerprint Crisis*, *supra* note 26, at 772 (noting that these disciplines are sometimes used, in some form, more broadly but that the stakes of false positives and false negatives may be very different outside the criminal justice context).

[28] ShotSpotter Inc. acquired HunchLab in 2018. Press Release, SHOTSPOTTER, ShotSpotter Announces Acquisition of HunchLab to Springboard into AI-Driven Analysis and Predictive Policing (Oct. 3, 2018), https://www.shotspotter.com/press-releases/shotspotter-announces-acquisition-of-hunchlab-to-springboard-into-ai-driven-analysis-and-predictive-policing/ [https://perma.cc/FJ8G-UQJF].

[29] *See* Ryan, *Secret Conviction Programs*, *supra* note 26, at 280 n.50 (describing police departments' uses of technological tools to better predict where and when crime will occur); PREDPOL, https://www.predpol.com/ [https://perma.cc/MH84-994Y] (last visited Jan. 13, 2022); SHOTSPOTTER, https://www.shotspotter.com/ [https://perma.cc/F9Z4-XP2E] (last visited Jan. 13, 2022).

[30] *See* Ryan, *Secret Conviction Programs*, *supra* note 26, at 280 n. 50 ("[T]echnological advances have allowed these departments to more firmly put the power of statistics behind them to improve their predictions.").

[31] Northpointe is now Equivant. *See* Equivant, https://www.equivant.com/northpointe-risk-need-assessments/ [https://perma.cc/SS3L-XMKL] (last visited Nov. 23, 2022).

[32] *See* Ryan, *Secret Conviction Programs*, *supra* note 26, at 279–80 ("[S]everal jurisdictions now employ computer-based risk-assessment tools . . . ."). The Arnold Foundation has now been rolled into Arnold Ventures. *See* Public Letter from Kelli Rhee, President and CEO, LAURA AND JOHN ARNOLD FOUNDATION (Jan. 28, 2019), https://www.arnoldventures.org/newsroom/a-letter-from-our-president [https://perma.cc/RL3Q-DXH2] (announcing the formation of Arnold Ventures).

[33] *See* Ric Simmons, *Big Data, Machine Judges, and the Legitimacy of the Criminal Justice System*, 52 U.C. DAVIS L. REV. 1067, 1072 (2018) ("Across disciplines, predictive algorithms consistently outperform human judgments.").

III. THE DARK SIDES OF CRIMINAL JUSTICE INNOVATIONS

Embracing scientific and technological innovations and employing them to improve the criminal justice system is laudable, but, if not employed with proper caution, there may very well be downsides to employing these innovations. The level of caution necessary is related to whether widespread or niche innovations are at issue. When innovations are widespread outside the criminal justice system, it is more likely that they have been properly vetted and provide sufficient accuracy. In contrast, the niche innovations used primarily within the criminal justice system raise serious questions of accuracy and reliability. Regardless of the innovation, though, it is important to understand that it likely has some drawbacks.

Administrative innovations can be used to improve efficiency of the criminal justice system, as we see with digital discovery, and even to benefit criminal defendants, which is clear with the text messaging services employed throughout the country.[34] It is important to ensure that the use of technology in this category does not exclude participants, though. Preliminary findings based on interviews of attorneys using TechShare suggest that some attorneys believe they lack the technical skills to effectively use the digital database, which may be causing them to ineffectively review and evaluate evidence in their clients' criminal cases.[35] This could have devastating effects on criminal defendants, rendering them victim to less than effective legal representation in their cases. In the same way, criminal defendants cannot benefit from text messages reminding them about their court dates if they lack access to the technology necessary to receive these notices. In our existing world of the haves and the have-nots, and a world somewhat divided by technological savvy as well, it is important not to further stratify these groups in terms of their treatment within the criminal justice system. Improving criminal justice efficiency is great, but we should not leave behind those who are unable to benefit from these administrative innovations.

There are also complications with embracing surveillant innovations without sufficient caution. Some surveillance devices are incredibly intrusive.[36] Technology has the ability to discern where you have driven,

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[34] *See supra* text accompanying notes 17–24 (providing an overview of administrative innovations).

[35] *See* Turner, *supra* note 22 at 10 ("[T]he lack of technological skills by some attorneys prevents them from using the software adequately.").

[36] *See* Meghan J. Ryan, *Criminal Justice Secrets*, 59 AM. CRIM. L. REV. 1541, 1584 ("Considering the broad growth of secrecy in surveillance . . . the accumulation of intrusive government surveillance on individual citizens creates matters of real constitutional concern.").

what you have read, which Internet sites you have visited, who you have talked to on the telephone, and even what you have said. Although helpful to law enforcement and useful for other reasons, many of these innovations can invade individual privacy. Of course, the Fourth Amendment addresses the extent to which individual uses of these innovations go beyond the bounds of reasonableness (or trespass) for Fourth Amendment purposes.[37] But the Court has not as a whole addressed the sweeping invasion of privacy and chilling of action and speech created by the broad fabric of surveillant innovations. Some courts and at least four Supreme Court Justices have expressed serious concern, though, about the aggregation of individual acts of surveillance and the impact they have on individuals' and society's reasonable expectations of privacy.[38]

There are also concerns about surveillance techniques such as the electronic monitoring of criminal defendants awaiting trial or of already sentenced criminal offenders. While electronic monitoring as an alternative to incarceration is almost certainly less burdensome for both the government and the individual, criminal defendants often are the ones to foot the bill for electronic monitoring,[39] meaning that this alternative is more available to economically advantaged defendants. This of course raises equality concerns. Additionally, by being less burdensome to the state, there is the worry that the government will not have the same budgetary pressures to address mass

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[37] *See, e.g.*, U.S. v. Jones, 565 U.S. 400, 413 (2012) (finding that a GPS tracking device constituted a search); Kyllo v. United States, 533 U.S. 27, 40 (2001) (finding that a thermal imaging device directed at a home constituted an unlawful search).

[38] *See* Orin Kerr, *The Mosaic Theory of the Fourth Amendment*, 111 MICH. L. REV. 311, 313 (2012); Ryan, *supra* note 36, at 1595 (discussing some Justices' acceptance of the mosaic theory); *see also* United States v. Maynard, 615 F.3d 544, 562–63 (D.C. Cir. 2010) (seemingly adopting the mosaic theory); Commonwealth v. McCarthy, 142 N.E.3d 1090, 1106 (Mass. 2020) ("The limited number of cameras and their specific placements, however, also are relevant in determining whether they reveal a mosaic of location information that is sufficiently detailed to invade a reasonable expectation of privacy."); United States v. Diggs, 385 F. Supp. 3d 648, 652 (N.D. Ill. 2019) ("The GPS data at issue here fits squarely within the scope of the reasonable expectation of privacy identified by the Jones concurrences and reaffirmed in Carpenter.").

[39] *See* April Glaser, *Incarcerated at Home: The Rise of Ankle Monitors and House Arrest During the Pandemic*, NBC NEWS (July 5, 2021), https://www.nbcnews.com/tech/tech-news/incarcerated-home-rise-ankle-monitors-house-arrest-during-pandemic-n1273008 [https://perma.cc/4CBT-QTX2] ("Though electronic monitoring is cheaper for municipalities and states than jail, the cost of the surveillance device is often passed on to the people wearing them."); Ava Kofman, *Digital Jail: How Electronic Monitoring Drives Defendants Into Debt*, PROPUBLICA (July 3, 2019), https://www.propublica.org/article/digital-jail-how-electronic-monitoring-drives-defendants-into-debt [https://perma.cc/CQP6-AD6Q] ("A 2014 study by NPR and the Brennan Center found that, with the exception of Hawaii, every state required people to pay at least part of the costs associated with GPS monitoring.").

incarceration and the related issues of overcriminalization and long sentences. Finally, sometimes the condition of electronic monitoring is added to an existing sentence despite its often punitive nature, raising proportionality and Ex Post Facto Clause concerns.[40]

Even more issues arise when dealing with surveillant innovations related to nondigital evidence because these are often niche criminal justice innovations.[41] "Unlike DNA analysis, which developed in the research laboratories of universities" and is widely used in industry, other areas of forensic examination "sprouted from the forensic needs of police departments" and are not regularly relied on outside of the criminal justice system.[42] As a result, there often has been less rigorous review of the usefulness, accuracy, and reliability of these other methods.[43] Indeed, there are serious concerns about the accuracy and reliability of most forensic science evidence used in courts. In 2009, the National Academy of Sciences released a report criticizing nearly every forensic science discipline other than DNA analysis.[44] The President's Council of Advisors on Science and Technology chimed in seven years later with similar concerns.[45] In particular, many forensic science disciplines have not been shown to be based on scientific evidence, and analyses in these disciplines seem to be riddled with subjectivity and inconsistencies among the practitioners.[46] Fingerprint analysis, for example, is based on assumptions rather than scientific

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[40] *See* Eisenberg, *supra* note 25, at 158, 166 ("When eventually faced with an Ex Post Facto challenge to a retroactive EM law, the Supreme Court should find . . . that these laws are punitive in effect . . . .").

[41] One might argue that, for example, fingerprint analysis is not a niche innovation because fingerprints are commonly used for identification outside of the criminal justice system such as to gain access to one's iPhone. The risks of false positives and false negatives are very different in these two contexts, though, and the approaches to fingerprint analysis are quite different.

[42] Ryan, *Escaping the Fingerprint Crisis*, *supra* note 26, at 772. One might note, however, that some of these disciplines are used in some form outside the criminal justice system. A form of fingerprint matching, for example, is often used to access secure locations such as iPhones. This algorithmic approach to the forensic science likely has different thresholds for matching considering the different risks involved with false positives and false negatives in the two different contexts.

[43] *Id.*

[44] *See generally* NAT'L RSCH. COUNCIL, STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD 127–82 (2009) (describing various forensic science disciplines and assessing their reliability and usefulness).

[45] *See* PRESIDENT'S COUNCIL OF ADVISORS ON SCI. & TECH., FORENSIC SCIENCE IN CRIMINAL COURTS: ENSURING SCIENTIFIC VALIDITY OF FEATURE-COMPARISON METHODS 95–96 (2016) (indicating that jurors should be advised of the relatively high rate of false positives in fingerprint matching).

[46] *See* NAT'L RSCH. COUNCIL, *supra* note 44, at 8, 128 (explaining that many forensic science disciplines are rooted in heuristics rather than scientific theory).

research.[47] First, there is the unproven assumption that every fingerprint is unique.[48] Second, there is the assumption that human examiners can discern one fingerprint from the next even when those prints are deformed by the mechanics of touch, differing skin conditions, the nature of the surface touched, the type of residue involved, the capture and development techniques of the images, the size of the print available for comparison, and any other relevant factors.[49] Despite the lack of sufficient research, there are some studies suggesting that fingerprint examiners reach inconsistent conclusions.[50] One study found that examiners reached match determinations different from their previous determinations on the same prints about 8.3% of the time.[51] That unreliability increased to 16.6% when the researchers presented the subjects with biased contextual information—a condition often present during real-world fingerprint examinations.[52] Other studies have shown examiners' error rates, of, for example, 4.2% for false positives and 8.7% for false negatives.[53] All of this raises questions about the accuracy and reliability of fingerprint evidence.

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[47] *See* Ryan, *Escaping the Fingerprint Crisis*, *supra* note 26, at 772 (noting that many have criticized fingerprint matching for a lack of scientific foundation).

[48] *Id.* at 796 ("Central to the enterprise of fingerprint matching is the assumption that each individual possesses unique fingerprints that can be distinguished from other fingerprints such that a latent print can be matched to an exemplar print and thus lead to the positive identification of an individual.").

[49] *See* NAT'L RSCH. COUNCIL, *supra* note 44, at 137–38 (describing the many factors that affect the details in fingerprint impressions); Ryan, *Escaping the Fingerprint Crisis*, *supra* note 26, at 800–01 ("An important aspect of fingerprint matching that has proven challenging is the changeability of prints based on the conditions under which they are made.").

[50] *See* Ryan, *Escaping the Fingerprint Crisis*, *supra* note 26, at 785 ("Generally, these studies suggest that examiners' decisions are unreliable and, moreover, they might reach erroneous identification conclusions at a concerning rate . . . .").

[51] *See* Itiel E. Dror & David Charlton, *Why Experts Make Errors*, 56 FORENSIC IDENTIFICATION 600, 611 (2006) (finding that inconsistent decisions were made in 2 out of 24 cases in a control group); Ryan, *Escaping the Fingerprint Crisis, supra* note 26, at 786 (discussing the Dror & Charlton study). Note, however, that this study assessed only six fingerprint examiners. *See* Dror & Charlton, *supra*, at 606 ("Six fingerprint experts . . . participated.").

[52] *See* Dror & Charlton, *supra* note 51, at 610 ("From the 24 experimental trials that included the contextual manipulation, the fingerprint experts changed four of their past decisions . . . ."); Ryan, *Escaping the Fingerprint Crisis*, supra note 26, at 786 (discussing the Dror & Charlton study).

[53] *See* Igor Pacheco, Brian Cerchiai & Stephanie Stoiloff, MIAMI-DADE POLICE DEP'T, MIAMI-DADE RESEARCH STUDY FOR THE RELIABILITY OF THE ACE-V PROCESS: ACCURACY & PRECISION IN LATENT FINGERPRINT EXAMINATIONS 53 (2014), https://www.ojp.gov/ncjrs/virtual-library/abstracts/miami-dade-research-study-reliability-ace-v-process-accuracy [https://perma.cc/7XKE-W556]; PRESIDENT'S COUNCIL OF ADVISORS ON SCI. & TECH., *supra* note 45, at 98.

Fingerprint analysis is certainly not the only forensic science not sufficiently supported by research. The same—or worse—can be said about bitemark analysis, arson science, ballistic analysis, and almost every other forensic science discipline used in courts today.[54] Despite the inaccuracy, or at least uncertainty about the accuracy, of most forensic science disciplines, they are endowed with the aura of science and tend to hold significant sway over judges and juries.[55] Forensic science evidence is often damning for a criminal defendant and a harbinger of conviction.[56]

Predictive innovations also have a dark side, and they, too, are often niche criminal justice innovations warranting careful examination. Although predictive algorithms have the potential to usher greater accuracy, fairness, consistency, and efficiency into decisions such as bail, sentencing, and parole,[57] critics charge that these innovations instead create a false sense of accuracy and actually introduce biases into decisionmaking.[58] The program COMPAS, for example, uses social science research to predict recidivism in criminal offenders, but at least one study suggests that "the algorithm [is only] somewhat more accurate than a coin flip."[59] The problem with accuracy

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[54] *See generally* NAT'L RSCH. COUNCIL, *supra* note 44 (criticizing nearly every forensic science discipline).

[55] *See* Ryan, *Secret Conviction Programs*, *supra* note 26, at 293 (indicating that scientific and technological evidence is "regularly present[ed] . . . as having the imprimatur of science").

[56] *See* Joel D. Lieberman, Courtney A. Carrell, Terance D. Miethe & Daniel A. Krauss, *Gold Versus Platinum: Do Jurors Recognize the Superiority and Limitations of DNA Evidence Compared to Other Types of Forensic Evidence?*, 14 PSYCHOL., PUB. POL'Y, & L., 27, 32, 52–53 (2008) (finding that DNA is the greatest determinant of guilt); Ryan, *Escaping the Fingerprint Crisis*, *supra* note 26, at 775 ("[J]udges and juries generally consider fingerprint evidence very persuasive."); Ryan, *Secret Conviction Programs*, *supra* note 26, at 293 (indicating that scientific and technological evidence is often "evidence of guilt"); *cf.* NAT'L REGISTRY OF EXONERATIONS, *supra* note 6**Error! Bookmark not defined.** (showing that 709 out of 2,997—or about 24%—of wrongful convictions result from false or misleading forensic evidence).

[57] *See* Ryan, *Secret Conviction Programs*, *supra* note 26, at 281–87 ("Proponents of these predictive criminal justice programs explain that such a methodical, evidence-based approach to difficult criminal justice questions will usher in a system with greater fairness, consistency, and accuracy.").

[58] *See id.* at 287–92 ("Although adopting a data-driven approach to criminal justice is alluring, some commentators have criticized the use of computer programs in all of these areas—in setting bail, sentencing, and making parole decisions—for embedding and exacerbating biases in the criminal justice system.").

[59] Julia Angwin, Jeff Larson, Surya Mattu & Lauren Kirchner, *Machine Bias*, PROPUBLICA (May 23, 2016), https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing [https://perma.cc/ZEJ5-8DE2] (last visited Oct. 5, 2019); *see also* Ryan, *Secret Conviction Programs*, *supra* note 26, at 289–90 ("Beyond these race- and individualization-based criticisms, some commentators have argued that these criminal justice programs are not as accurate as they might seem . . . .").

is exacerbated by the proprietary nature of these programs.[60] The private companies seeking to make a profit off their programs understandably do not want to divulge the programs' details.[61] Moreover, courts have found that the details of criminal justice programs developed by private companies are undiscoverable trade secrets.[62] Third parties' inability to obtain the details of such programs stymies outside efforts to assess the accuracy of these programs.[63] Instead, we often have just the profit-motivated companies' evaluations that their products produce accurate results.[64]

Beyond accuracy, bias is also a concern. Even if the programs were to produce accurate results, there is the question of whether they should be used for criminal justice decisionmaking if questionable factors—such as race or even proxies for race—are used in their algorithms. For example, if a predictive program uses one's level of education as a factor in determining the risk of recidivism, and if Black persons on average have a lower level of education than white persons,[65] is it fair to use level of education as a factor

[60] *See* Ryan, *Secret Conviction Programs*, *supra* note 26, at 308 (explaining that, because of developers' IP interests, courts have generally denied litigants' requests to gain access to the algorithms and source codes underlying the programs that power, for example, breathalyzer devices).

[61] *See* Meghan J. Ryan, *Secret Algorithms, IP Rights, and the Public Interest*, 21 NEV. L.J. 61, 90 (2020) [hereinafter Ryan, *Secret Algorithms*] ("[The developers] understandably want to maintain their monopoly over the programs to amass the greatest returns on their investments."); Ryan, *Secret Conviction Programs*, *supra* note 26, at 324 ("One of the reasons that these algorithms and source codes are kept secret is that outside companies have created them and rely on this secrecy to make profits; the algorithms and source codes are proprietary in nature.").

[62] *See* Ryan, *Secret Algorithms*, *supra* note 60, at 88–89 ("When defendants have requested access to the underlying source codes and algorithms powering these programs and producing their outputs, judges have ordinarily denied their requests."); Ryan, *Secret Conviction Programs*, *supra* note 26, at 307–08, 320–21 (offering examples of defense attorneys' unsuccessful attempts to obtain discovery access to the underlying source code and algorithms of particular technologies).

[63] *See* Ryan, *Secret Algorithms*, *supra* note 61, at 88–89 ("The true accuracy of these tools often remains unknown."); Ryan, *Secret Conviction Programs*, *supra* note 26, at 307–08, 320–21(offering examples where there are reliability questions about particular technologies in part because third parties have not been granted access to the underlying source codes and algorithms of the technologies and thus have been unable to independently validate them).

[64] *See* Ryan, *Secret Algorithms*, *supra* note 61, at 91 ("[T]here often has been no thorough, independent review of the instruments producing outputs that could affect the fates of criminal defendants."); Ryan, *Secret Conviction Programs*, *supra* note 26, at 330 (questioning whether researchers can independently validate these products without access to their underlying source codes and algorithms).

[65] *See* Melanie Hanson, *Education Attainment Statistics*, EDUC. DATA INITIATIVE (Nov. 22, 2021), https://educationdata.org/education-attainment-statistics [https://perma.cc/SQ7V-R648] ("For Black and Latino/Hispanic students, there are fewer and fewer students at the higher levels of education – their population size shrinks by 27% at each educational tier.").

in making decisions about an individual's bail, sentence, or parole? This gets at the fact that these predictive programs generate individual decisions based on generalizations torn from limited data.[66] As with other issues within the criminal justice system, consistency across cases comes at the price of individualization within cases.[67]

IV. BETTER UNDERSTANDING AND IMPLEMENTING CRIMINAL JUSTICE INNOVATIONS

Embracing scientific and technological innovations within the criminal justice system is important, but better understanding these innovations is necessary to avoid or mitigate the troubling aspects of implementing these innovations. Greater refinement of particular innovations could of course improve their uses within the criminal justice system, but education—of judges and lawyers, as well as of the researchers and developers behind these innovations—is key to improving implementation of these innovations to better the criminal justice system.

Lawyer lore is that people attending law school are unskilled in science and math.[68] And students rarely learn about science, math, and related burgeoning technology in law school.[69] This translates into lawyers acting within the criminal justice system—as either advocates or judges—who may have insufficient critical thinking skills when it comes to innovations relevant to the law and its applications. Indeed, there have been some indications that lawyers across the country are less than comfortable with science and math,

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[66] *See* Ryan, *Secret Conviction Programs*, *supra* note 26, at 289 (explaining that algorithmic "predictions of future dangerousness, or anything else, are only risk assessments[—that] [t]hey are generalizations based on the limited data available").

[67] *See id.* ("Attempts to achieve uniformity among cases often translates into not being able to individualize the sentence or other criminal justice outcome in the particular case at bar. In some sense, then, fairness across cases comes at the price of fairness within an individual case.").

[68] *See* Jackson v. Pollion, 733 F.3d 786, 788 (7th Cir. 2013) ("Innumerable are the lawyers who explain that they picked law over a technical field because they have a 'math block'—'law students as a group, seem peculiarly averse to math and science.'") (internal citations omitted); DAVID L. FAIGMAN, MICHAEL J. SAKS, JOSEPH SANDERS & EDWARD K. CHENG, MODERN SCIENTIFIC EVIDENCE: STANDARDS, STATISTICS, AND RESEARCH METHODS, at v (2008) ("Judges and lawyers, in general, are not known for expertise in science and mathematics. Nor is science a subject given significant attention in American law schools.").

[69] *See* GEO. MASON UNIV. SCH. L., THE VALUE OF JUDICIAL TRAINING IN QUANTITATIVE & SCI. METHODS (Apr. 8, 2013) ("Courses on statistics, economics, and finance are almost entirely absent in legal education programs even though judicial analysis of these matters affects untold resources throughout the world on a daily basis.").

and with the technology that grows out of these disciplines.[70] For example, in oral arguments for the 2010 U.S. Supreme Court case of *City of Ontario v. Quon*,[71] Chief Justice Roberts and Justice Kennedy demonstrated their ignorance of pager and e-mail technologies when they asked somewhat humorous questions. First, Chief Justice Roberts asked: "Maybe – maybe everybody else knows this, but what is the difference between a pager and e-mail?"[72] Later, Justice Kennedy inquired: "And he's talking with a girlfriend, and he has a voice mail saying that your call is very important to us; we'll get back to you?"[73] Laughter ensued.[74] To be fair, pager technology was not as common in 2010 as, say, texting technology is today.[75] But the exchange—even if perhaps in jest—raises concern about judges' competency in rendering decisions involving new science and technology.[76] Age can

[70] *Cf.* Meghan J. Ryan, *Science and the Eighth Amendment*, *in* THE EIGHTH AMENDMENT AND ITS FUTURE IN A NEW AGE OF PUNISHMENT 314 (Meghan J. Ryan & William W. Berry III eds., 2020) ("A significant hurdle to the Court's reliable and accurate use of science and data in its Eighth Amendment cases is the Justices' general lack of fluency with these materials.").

[71] 560 U.S. 746 (2010).

[72] Transcript of Oral Argument at 29, City of Ontario v. Quon, 560 U.S. 746 (2010).

[73] *Id.* at 44.

[74] *Id.*

[75] *Compare* Mary Bellis, *History of Pagers and Beepers*, THOUGHTCO. (Jan. 30, 2021), https://www.thoughtco.com/history-of-pagers-and-beepers-1992315 [https://perma.cc/Q2MD-YGSU] (explaining that, by the mid-1990s, pagers were at the height of their popularity with more than 61 million in use), *and* Alex Perry, *Hey Gen Z, This Is a Pager, and in the '90s They Were Everywhere*, MASHABLE (Aug. 31, 2019), https://mashable.com/article/pagers-explained-90s-week#:~:text=While%20the%20technology%20dates%20back,preferred%20tool%20of%20drug%20dealers [https://perma.cc/F8XW-Z8MA] ("While the technology dates back to the late 1940s, pagers hit their peak in the Clinton years. By 1994, there were 61 million pagers in use around the world . . . ."), *with* Mobile Subscriptions (chart), *in Ericsson Mobility Visualizer,* ERICSSON, https://www.ericsson.com/en/reports-and-papers/mobility-report/mobility-visualizer?f=1&ft=3&r=2,3,4,5,6,7,8,9&t=1,2,3,4,5,6,7&s=1&u=1&y=2016,2027&c=3 [https://perma.cc/WCK5-TVV7] (last visited Nov. 28, 2022) (showing more than six billion smartphone users worldwide today), *and Worldwide Texting Statistics*, https://shso.vermont.gov/sites/ghsp/files/documents/Worldwide%20Texting%20Statistics.pdf [https://perma.cc/2AMA-42R8] (Apr. 7, 2022) ("Text messaging is the most used data service in the world.").

[76] *Cf.* Ryan, *supra* note 70, at 314 ("These somewhat humorous questions take on a very serious tenor if a lack of understanding about science or technology can affect life-and-death decisions as is often the case in the Eighth Amendment context.").

correspond with such a lack of competency,[77] and judges tend to be older,[78] making them perhaps a more vulnerable population in this regard.[79] Indeed, in reaction to the exchanges in *Quon*, a writer for the *Economist* quipped: "Yes, the [J]ustices are old."[80] Other lawyers—young and old—may also lack sufficient competency with science and technology, though. This is consistent with some lawyers' suggestions that they lack adequate savvy to properly use innovations such as TechShare to benefit their clients.[81] The stereotype that lawyers are not good at or try to steer clear of science and math is probably not as accurate now as it was before the technology boom of the late 1990s and early 2000s when intellectual property practices exploded.[82] There does, however, seem to be some aversion to math and science among even newly minted lawyers.

In tension with many lawyers' aversion to math and science is the increasing reliance by the criminal justice system and its actors on technologies growing out of these foundational disciplines. Because the criminal justice system increasingly employs innovations based on these subjects,[83] having sufficient knowledge about science, math, and technology

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[77] *See* Meghan J. Ryan, *Juries and the Criminal Constitution*, 65 ALA. L. REV. 849, 885–86 (2014) ("Judges' struggles with technology may, in part, be due to one facet of their underrepresentativeness of society: they are, on average, much older than the average American."); PEW RESEARCH CTR., MILLENNIALS: A PORTRAIT OF GENERATION NEXT 6 (2010), https://www.pewresearch.org/wp-content/uploads/sites/3/2010/10/millennials-confident-connected-open-to-change.pdf [https://perma.cc/4TF7-B22Z] ("Millennials' technological exceptionalism is chronicled throughout the survey. It's not just their gadgets—it's the way they've fused their social lives into them.").

[78] *See* Ryan, *supra* note 77, at 875 ("[W]here the average age of federal judges was fifty-three in 2010, the average age of Americans in that year was approximately thirty-seven.").

[79] Indeed, studies show that older individuals often have a more difficult time staying on top of technological innovations than younger individuals. *See* Ryan, *supra* note 77, at 886 ("Studies show that younger individuals stay on top of technological trends more frequently and easily than older Americans."); PEW RESEARCH CTR., *supra* note 77 (explaining that Millennials lead the way in their uses of technology); KATHRYN ZICKUHR, GENERATIONS AND THEIR GADGETS, PEW INTERNET & AMERICAN LIFE PROJECT, PEW RESEARCH CTR. (Feb 3. 2011), https://www.pewresearch.org/internet/2011/02/03/generations-and-their-gadgets/ [https://perma.cc/V6PE-XHN9] (examining different generations' uses of gadgets).

[80] B.G., *Yes, the Justices Are Old*, THE ECONOMIST (Apr. 23, 2010), https://www.economist.com/babbage/2010/04/23/yes-the-justices-are-old [https://perma.cc/W4UU-3XKE].

[81] *See supra* text accompanying note 35

[82] *See* Kevin G. Rivette, Henry R. Nothhaft & David Kline, *Discovering New Value in Intellectual Property*, HARVARD BUS. REV. (Jan.–Feb. 2000), https://hbr.org/2000/01/discovering-new-value-in-intellectual-property [https://perma.cc/6QTV-V655] (describing Richard Thoman, the Xerox CEO at the time, as "not your typical chief executive officer" because his focus was on intellectual property).

[83] *See* Jackson v. Pollion, 733 F.3d 786, 788 (7th Cir. 2013) ("The discomfort of the legal profession . . . with science and technology . . . [is] increasingly concerning, because

is essential to making good decisions involving them. For example, judges act as "gatekeepers," deciding whether certain scientific or technological evidence can get before the jury.[84] Consider the case of fingerprint evidence. Not only does the judge determine whether an examiner's match determination should be heard by the jury, but she also decides whether an opposing expert, who will testify about the unreliability of fingerprint matching, may be heard.[85] If a judge cannot competently assess whether fingerprint evidence is reliable or understand the basis for the opposing expert's testimony in light of, for example, the long history of relying on fingerprint evidence in criminal cases,[86] it makes it very difficult for the judge to make good admissibility decisions in this instance. Similarly, without sufficient grounding in science and technology, judges might have a difficult time determining when a defendant should be granted access to the source codes and algorithms underlying instruments like breathalyzers and probabilistic genotyping systems. These judicial decisions can be game-changers in cases, and, ideally, these decisions would be based on knowledge about the reliability of the evidence and the relative risks associated with making more information available to the parties and perhaps the jury.

Prosecutors and defense attorneys also need to be scientifically and technologically competent. For example, if a prosecutor does not understand the basis of a DNA expert's calculations and the assumptions involved, a prosecutor may wrongly pursue a prosecution or unwittingly misrepresent the facts. Indeed, the aptly named "prosecutor's fallacy" refers to a conclusion that the probability of innocence given the evidence is equal to the probability of the evidence given the defendant's innocence.[87] In other words, a

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of the extraordinary rate of scientific and other technological advances that figure increasingly in litigation."); Ryan, *supra* note 77, at 884 ("Many of today's criminal constitutional moral questions involve not only matters of evolving values but also matters of evolving technology.").

[84] *See* Kumho Tire Co. v. Carmichael, 526 U.S. 137, 141 (1999) ("*Daubert*'s general holding . . . set[s] forth the trial judge's general 'gatekeeping' obligation . . . ."); Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 597 (1993) (noting a judge's "gatekeeping role").

[85] *See, e.g.*, People v. Caradine, No. A121968, 2012 Cal. App. Unpub. LEXIS 1346, at *53–54 (Cal. Ct. App. Feb. 23, 2012) ("The court's conclusion that Cole, a historian and sociologist who had read and written on the subject of fingerprint analysis but had never himself studied fingerprints, did not qualify as an expert on the reliability of fingerprint analysis as it related to this case was not an abuse of discretion."); *cf., e.g.*, Commonwealth v. Ashley, 694 N.E.2d 862, 866 (Mass. 1998) ("In a series of cases in recent years, we have reaffirmed the principle that the admissibility of expert testimony regarding the capacity of eyewitnesses to make identifications is within the trial judge's discretion.").

[86] *See, e.g.*, United States v. Crisp, 324 F.3d 261, 268 (4th Cir. 2003) ("[Defendant] today advocates the wholesale exclusion of a long-accepted form of expert evidence. Such a drastic step is not required of us under *Daubert*, however, and we decline to take it.").

[87] *See* MICHAEL O. FINKELSTEIN, BASIC CONCEPTS OF PROBABILITY AND STATISTICS IN THE LAW 5 (2009) (explaining that the prosecutor's fallacy "arises from inverting the

prosecutor could mistakenly determine and present to the court or jury that there is only a one-in-a-million chance that the defendant is innocent because there was only a one-in-a-million chance that a random person's DNA profile would match the DNA evidence in question as the defendant's did. But such an "assessment [would be] misguided because it purports to determine the defendant's probability of guilt based solely on the associative evidence, ignoring the strength of other evidence in the case."[88] It ignores the a priori likelihood that the defendant is guilty.[89] Obviously, other evidence—such as alibi evidence, eyewitness testimony, and information about motive—is also relevant to a determination of guilt.[90] There is, of course, also the possibility that a laboratory error led to a mistake in the DNA analysis.[91] The upshot of this is that DNA evidence must be viewed in context, and lawyers need to understand this to make good prosecutorial and defense decisions where DNA evidence is involved. Similarly, a defense attorney may not be aware that it is worth challenging the DNA results produced by a probabilistic genotyping system if the lawyer is not sufficiently well versed in science and technology. These systems have been challenged as being insufficiently accurate,[92] but, if a defense lawyer is unable to wade into the nuances of the program, she might simply accept its results. Lawyers who are not confident in their ability to examine the science and technology underlying today's criminal justice innovations will be handicapped in pressing the system to produce just results.

Providing lawyers with greater resources such as training to make more educated decisions about criminal justice innovations is paramount. Because

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conditional"); Kathy Taylor, *The Prosecutor's Fallacy*, CTR. FOR EVIDENCE-BASED MED. (July 16, 2018), https://www.cebm.ox.ac.uk/news/views/the-prosecutors-fallacy [https://perma.cc/UEM5-6H2D] ("The Prosecutor's Fallacy is . . . when the probability of innocence given the evidence is wrongly assumed to equal an infinitesimally small probability that that evidence would occur if the defendant was innocent."); William C. Thompson & Edward L. Schumann, *Interpretation of Statistical Evidence in Criminal Trials: The Prosecutor's Fallacy and the Defense Attorney's Fallacy*, 11 L. & HUMAN BEHAV. 167, 170–71 (1987) (describing the prosecutor's fallacy and providing examples).

[88] Thompson & Schumann, *supra* note 87, at 170.

[89] *See id* ("[W]e must consider not just the percentage of people who would match but also the a priori likelihood that the defendant in question is guilty.").

[90] *See* Jonathan J. Koehler, *Forensic Fallacies and a Famous Judge*, 54 JURIMETRICS 211, 215 n.29 (2014) ("[F]actors other than matching incidence rate, including eyewitness testimony, alibis, motives, and so forth are obviously relevant to a guilt determination.").

[91] *See* Meghan J. Ryan, *The Privacy, Probability, and Political Pitfalls of Universal DNA Collection*, 20 SMU SCI. & TECH. L. REV. 3, 18 (2017) ("DNA may be the gold standard for identification, but it still poses the risk of mistakes. For example, the use of degraded samples can lead to faulty 'matches,' samples can be contaminated, and there is the risk of human error—such as a lab technician's mix-up of sampl—or even fraud.".).

[92] *See* Ryan, *Secret Conviction Programs*, *supra* note 26, at 315–23 (discussing concerns about the accuracy of probabilistic genotyping systems such as TrueAllele and STRmix).

science and technology are always advancing, though, the training must be more than superficial. It should instill essential critical thinking skills where science and technology are concerned. One risk when faced with new science and technology is to fall into the trap of creating false dichotomies—seeing only the good or only the bad in an innovation.[93] But training should be aimed at preparing lawyers for understanding the nuances—recognizing the benefits of an innovation but also understanding its limitations. These critical thinking skills include questioning the usefulness, accuracy, and reliability of an innovation. Such inquiries frequently require digging deeper into the innovation to assess how the innovation was developed. This is especially true when the innovation is a niche innovation used primarily within the criminal justice system.[94] Digging deeper often requires some level of transparency on the part of the developer. And examining the usefulness of the innovation also requires assessing the long-term consequences and risks of adopting it, such as the potential to exacerbate biases or curtail individual liberty. Not only will honing these necessary critical thinking skills improve the adoption and implementation of certain innovations within the system, but it should also improve lawyers' abilities to communicate—with each other, clients, and experts—and enhance their confidence in dealing with scientific and technological issues. These advancements should, in turn, improve the quality of legal arguments and decisionmaking in these areas.

In recent years there have been some laudable efforts to shore up the scientific and technological training of lawyers. Certain continuing legal education (CLE) programs offer discussions of scientific and technological issues, and various organizations have erected more intensive training programs for lawyers.[95] Some organizations offer the more intensive training to only the select few, though, and most such programs are directed at particular discrete fields, such as neuroscience or DNA analysis.[96] All

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[93] *See* Kevin Escandón, Angela L. Rasmussen, Isaac I. Bogoch, Eleanor J. Murray, Karina Escandón, Saskia V. Popescu & Jason Kindrachuk, *COVID-19 False Dichotomies and a Comprehensive Review of the Evidence Regarding Public Health, COVID-19 Symptomatology, SARS-CoV-2 Transmission, Mask Wearing, and Reinfection*, 21 BMC INFECTIOUS DISEASES 710 (2021) (discussing the problem of false dichotomies in the COVID-19 context).

[94] *See supra* Part II.

[95] *See, e.g.*, *About NCSI's Programs*, NAT'L CTS. & SCIS. INST., https://www.courtsandsciences.org/programs [https://perma.cc/EU99-5H66] (last visited Mar. 4, 2022) (offering a variety of science and technology training programs for judges).

[96] *See, e.g.*, *id.* (focusing on fairly specific topics and offering the program only to judges). Some of these programs are somewhat questionable—where corporations and foundations with interests in the outcome of litigation pay for judges to attend educational seminars in resort locations. *See* Abner Mikva, *The Wooing of Our Judges*, N.Y. TIMES (Aug. 28, 2000), https://www.nytimes.com/2000/08/28/opinion/the-wooing-of-our-judges.html (arguing that all the measures taken "to help foster the notion of judicial integrity . . . . all

lawyers who might be dealing with these innovations ought to have thorough training on these matters. But, in addition to courses about neuroscience and DNA analysis, lawyers need training on how to think critically about science and technology, and also assess the reliability of scientific studies. For example, if a judge is dealing with fingerprint evidence in a case, instead of just grandfathering it in because of its long history of use in the United States,[97] a judge should look at the evidence critically, applying the *Daubert*[98] or *Frye*[99] test to determine whether the evidence truly is reliable. Fingerprint examiners' records of contradicting even their own match determinations[100] should at least be considered in this analysis. Similarly, when determining the weight to give a predictive program—such as those sometimes used to aid bail, sentencing, and parole decisions—a judge might need to think about the data, algorithms, and source codes on which the program is based. Understanding that assessing the scientific or technological tool is important will be the first step to realizing that additional testing and transparency are also often necessary. Taking such factors into account, judges, and other lawyers, will be able to better harness the power and understand the limits of scientific and technological innovations.

Although enhanced training cannot ordinarily remedy the shortcomings of criminal justice innovations, it can likely lessen some of the negative effects that might flow from them—such as wrongful convictions and the perpetuation of unjust biases. Through CLE requirements, states have long relied on training to keep lawyers up to date on the state of the law.[101] And lawyers, generally having obtained bachelor's degrees and juris doctors, are ordinarily successful in fairly traditional learning environments. Thus, it seems, there is a probability that training lawyers on these topics can make significant headway in their scientific and technological competency. Indeed,

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becomes meaningless . . . when private interests are allowed to wine and dine judges at fancy resorts under the pretext of ''educating' them").

[97] *See* Ryan, *Escaping the Fingerprinting Crisis*, *supra* note 26, at 776 ("Despite the significant concerns about the accuracy and reliability of fingerprint analysis, courts continue to routinely admit expert testimony from fingerprint examiners . . . .").

[98] Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 597 (1993) (explaining that, under the Federal Rules of Evidence, the trial judge is tasked with "ensuring that an expert's testimony both rests on a reliable foundation and is relevant to the task at hand," and explaining that "[p]ertinent evidence based on scientifically valid principles will satisfy those demands").

[99] Frye v. United States, 293 F. 1013, 1014 (D.C. Cir. 1923) (setting the "general acceptance" standard for the admissibility of expert testimony).

[100] *See supra* text accompanying notes 50–53 (detailing studies that raise questions about the accuracy and reliability of fingerprint analysis).

[101] *See PLI's Credit Information: CLE Requirements*, PRAC. L. INST., https://www.pli.edu/credit/CLE [https://perma.cc/VC2X-N43N] (last visited Mar. 4, 2022) (summarizing CLE requirements in various jurisdictions).

when some state supreme courts feared that their lawyers were falling behind in technological skills that would allow them to effectively represent their clients, they imposed CLE technology requirements.[102] Florida, for example, now requires lawyers to earn three technology credits every three years.[103] Perhaps the same should be done with scientific and technological training beyond the most basic technology issues. Training is a cornerstone in building expertise. Even with thorny topics such as implicit bias, where there is the potential that training could actually heighten rather than reduce biases, if training is done correctly, it can be effective.[104] This training should be multifaceted, though, and educate students about their shortcomings and how to overcome them.[105] Establishing a foundation of scientific and technological literacy and critical thinking skills, and then bringing scientific and technological issues to life using, for example, simulations, could really enhance lawyers' competency in these areas.

Building scientific and technological competency is essential to improving legal decisionmaking, but it could also help in spurring additional research that can improve the data upon which legal decisions are based. Many of the criticisms surrounding the forensic sciences, for example, are

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[102] *See, e.g.*, RULES REGULA. FLA. BAR § 6-10.3, https://www-media.floridabar.org/uploads/2022/08/Ch-6-2022_02-AUG-RRTFB-8-1-2022.pdf [https://perma.cc/3R33-T3JN] (imposing a three-credit technology requirement every three years); 27 N.C. Admin. Code § .1518, https://www.ncbar.gov/for-lawyers/governing-rules-of-the-state-bar/1518-continuing-legal-education-program/ [https://perma.cc/4RHW-JTMG] (imposing a one-credit technology requirement per year).

[103] *See* Mark D. Killian, *Court Approves CLE Tech Component*, FLA. BAR NEWS (Oct. 15, 2016), https://www.floridabar.org/the-florida-bar-news/court-approves-cle-tech-component/ [https://perma.cc/4HSA-US8F] ("The change increases the mandatory CLE hours for each Florida lawyer from 30 to 33 in a three-year reporting cycle with the three additional hours devoted to technology training.").

[104] *See* Katerina Bezrukova, Chester S. Spell, Jamie L. Perry & Karen A. Jehn, *A Meta-Analytical Integration of Over 40 Years of Research on Diversity Training Evaluation*, 142 PSYCH. BULL. 1227, 1227 (2016) ("[D]iversity training has the potential to make a huge positive impact because diversity training strives to address prejudice, stereotyping and other biases."); Patricia G. Devine, Patrick S. Forscher, Anthony J. Austin & William T.L. Cox, *Long-Term Reduction in Implicit Race Bias: A Prejudice Habit-Breaking Intervention*, 48 J. EXPERIMENTAL SOC. PSYCH. 1267, 1276 (2012) ("Overall, our results provide compelling and encouraging evidence for the effectiveness of our multifaceted intervention in promoting enduring reductions in implicit bias."); Joelle Emerson, *Don't Give Up on Unconscious Bias Training—Make It Better*, HARVARD BUS. REV. (2017) ("Unconscious bias training can be a useful component of diversity and inclusion efforts, but only if it's thoughtfully designed with research in mind and its limitations are well understood.").

[105] *See* Bezrukova et al., *supra* note 104, at 1244–45 ("Most effective types of diversity training programs were primarily designed to increase both diversity awareness and skills."); Devine et al., *supra* note 104, at 1276 ("Overall, our results provide compelling and encouraging evidence for the effectiveness of our multifaceted intervention in promoting enduring reductions in implicit bias.").

rooted in insufficient research.[106] Take the case of fingerprint examination. It is not necessarily true that the practice cannot be a useful tool, but the problem is that there is insufficient research establishing its reliability or even the potential for reliability when incorporating suggested reforms. Experts who could potentially shore up the practice—such as biomedical engineers—are often unaware of the need for more research in this area, though.[107] If lawyers could better understand their scientific and technological needs, they could perhaps better communicate these needs to the experts who could provide the necessary foundational research. They could also communicate more effectively with the relevant funding sources. Cultivating sufficient understanding and communication skills among lawyers is essential to pushing the criminal justice system and the tools on which it relies forward.

CONCLUSION

Cutting-edge science and technology provide the opportunity to address some of the pressing problems within the criminal justice system, such as mass incarceration, low clearance rates, wrongful convictions, and pervasive biases. Some interventions are more trustworthy than others, though. Innovations used throughout society tend to be better vetted for accuracy and reliability than those developed primarily for use within the criminal justice system. But regardless of the innovation, legal actors need to be aware of its possible limitations. For example, the innovation could potentially exacerbate biases, mislead judges and jurors, limit individuals' liberty, or be insufficiently accurate in light of the goal of proving guilt or innocence. Unfortunately, many lawyers currently lack an adequate skill set to successfully engage in deep examinations of the usefulness, accuracy, and reliability of criminal justice innovations. But training can help improve their competency. Further, increased scientific and technological competency on the part of lawyers can actually work to improve the innovations used within the system. By having the skills to communicate their needs with experts who can develop new innovations or tweak existing ones, lawyers can help propel the criminal justice system forward.

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[106] *See* NAT'L RSCH. COUNCIL, *supra* note 44, at 8 (explaining that "[a] body of research is required to establish the limits and measures of performance and to address the impact of sources of variability and potential bias" in the forensic sciences but that such research "seems to be lacking in most of the forensic disciplines that rely on subjective assessments of matching characteristics"); *supra* text accompanying notes 46–47.

[107] *See* Ryan, *Escaping the Fingerprint Crisis*, *supra* note 26, at 783 ("Perhaps because they are novices in the forensic science discipline and it thus may not seem obvious what research is necessary to shore up the practice, scientists who have the requisite expertise to fill this void generally seem unaware of it.").