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Establishing Culpability: Forensic Technologies and Justice

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As this article is being written, the United States is convulsed in an intense discussion about the desirability and operationalization of so-called "body cameras," lightweight, miniaturized digital video cameras that can be mounted on the clothing (and cars) of police officers to record their interactions with the public (e.g., Mateescu et al., 2015; Simon and Bueermann, 2015; Stalcup and Hahn, 2016). This discussion has been prompted by a convergence of technological developments, which have rendered such cameras ever smaller and more affordable, with a significant number of high-profile, mostly racially-charged, incidents, some of them fatal, between police and citizens, which were recorded either with body cameras or with increasingly ubiquitous privately held video recording devices, such as those on many mobile telephones. This discussion is very unlikely to be confined to the US; it has begun, or should be expected to soon begin, around the world.

The pace of technological development today is such that I expect the vast majority of readers of this article will know a great deal more than me about the outcome of the societal discussion of body cameras, putting me at somewhat of a disadvantage. (Indeed, it will presumably not be long before my characterization of 2015-vintage body cameras as "miniature" and "lightweight" will seem quaint.) My ignorance of the future notwithstanding, I believe it is possible to say that this discussion will implicate the very questions about the truth-producing capabilities of machines and the handling of those questions by legal institutions that form the topic of this article.

Photographs and Video

Law has long dreamed of the idea of mechanical forms of truth-telling that would be immune to the foibles which were such a familiar part of legal evidence: the lies, the biases, the inaccuracy. Wigmore's (1940: §1367) famous remark about cross-examination being the "greatest legal engine ever invented for the discovery of truth" notwithstanding, law has long been both tempted and repulsed by the idea of more literal "engines" which might prove "greater" still. Without discounting the existence of an earlier history of legal truth-making machines, it is reasonable to date the flourishing to such devices to "the second half of the nineteenth century," which

> saw a new mode of persuasion rising to dominance, driven by a new class of machine-made testimonies that threatened to turn words into an inferior mode of communicating facts. Ever alert and never involved, machines such as microscopes, telescopes, high-speed cameras and x-ray tubes purported to communicate richer, better, and truer evidence often inaccessible otherwise to human beings. The emblem for this new type of mechanical objectivity was visual evidence. "Let nature speak for itself," became the watchword, and nature's language seemed to be that of photographs and mechanically generated curves (Golan, 2004: 183-184).

The notion of “mechanical objectivity,” or what Seltzer (1992: 100) has called “machine culture,” is drawn from Daston and Galison (1992) who discussed numerous late nineteenth century scientific devices for recording observations, such as pen registers, sphygmometers, and so on.

One of the earliest technologies to invoke mechanical objectivity was that ancestor of the body camera, the photograph. Some late nineteenth-century courts concluded that “the photograph was not merely evidence, but the best kind of evidence imaginable: mechanical, automatic, and no subject to those biases and foibles that may cloud human judgment,” one court going so far as to declare, “We cannot conceive of a more impartial and truthful witness than the sun.” Indeed, one commentator presciently “suggested that when photographic techniques were ‘perfected,’ all of the streets and alleys of cities should be swept by surveillance cameras. The author hoped that these cameras would capture images of anyone rioting or disturbing the peace for use in subsequent legal proceedings” (Mnookin, 1998: 18-19). While it is now well understood that the perceived objectivity and impartiality of the photograph is illusory, the photograph has nonetheless continued to generate strong claims of objectivity. “Throughout its history of use in law enforcement and criminal identification practices,” Finn (2009: xii) writes, “the subjectivity of the photograph has been rendered largely invisible against the tremendous literal power of the image to record objects in the live world.” At the same time, however, “the photograph’s offer of verisimilitude was threatening: indeed, in its strongest form, the photograph threatened to make the fact-finding portion of a trial redundant by providing the facts in an incontestable form”

(Mnookin, 1998: 6). Mnookin (1998: 54) suggests that courts partially resolved this tension by allowing photographs as evidence, but only as "demonstrative evidence," that illustrated the testimony of a witness, rather than evidence that could offer a stand-alone claim to truth.

This was not true of another form of photograph, a photograph of the inside of the body: the x-ray. "[B]y emphasizing the objective aspect of x-ray photographs—presenting them as the deterministic product of the immutable laws of nature," litigants won the admissibility of X-ray evidence just prior to the turn of the twentieth century (Golan, 2004: 192-195). By the 1920s, x-ray images had become an exception to the demonstrative evidence doctrine, admissible "as substantive evidence of the conditions revealed by them" (Golan, 2004: 207).

While x-rays required expert interpretation, in the late 1960s a descendant form of photography, the surveillance camera, was admitted with "no one to speak for them in court. Thus, for the first time, the courts faced machine-made visual evidence that was no longer required to be coupled with a human agency in order to express what it contained" (Golan, 2004: 209). It has been noted that "This approach came to be known as the 'silent witness' doctrine because it recognizes the photograph as one that 'speaks for itself' and not for human patron (Golan, 2004: 210).

Curiously, however, as the technology has improved, the pendulum in the courtroom has swung back. Beginning around the early 1990s, prosecutors with poor-quality images from surveillance cameras began proffering expert witness to interpret these images. Drawn from an eclectic and inconsistent group of disciplines, these intepreters of CCTV images, in some cases purported to be able to support definitive statements that a particular person was the person captured in the video image. There was, and remains, little empirical support for such extreme claims (Edmond et al., 2009). While many courts have disallowed these extreme claims, courts in many countries have generally admitted more modestly formulated imaging evidence (Edmond et al., 2013).

A seminal moment for the video camera was undoubtedly the 1991 beating of Rodney King by Los Angeles police officers, captured on a now quaint home video camera by a bystander. While the unedited footage, given widespread coverage on television, shocked viewers, the case has been interpreted as standing for the proposition that even seemingly incontestable readings of video images are subject to social interpretation. The video did not simply "speak for itself" (Judith Butler quoted in Stalcup and Hahn, 2016). In his famous analysis, Goodwin (1994) showed that at the police officers' trial the defendants softened the impact of the video by slowing it to a frame-by-frame analysis and invoking "professional vision," using the authority of experts to frame the officers' moment-by-moment seemingly brutal actions as reasonable and consistent with their training (see also Ronell, 1992; Cannon, 1999).

Two decades later, the modest dissemination of relatively inexpensive video cameras and the remote possibility that any given police action might fortuitously be subject to citizen counter-surveillance has been replaced by the perceived *ubiquity* of much more inexpensive, lightweight, pocket-sized cameras integrated into a device commonly possessed by many, if not most, citizens, the mobile telephone. This not even to speak of the well documented explosion of surveillance cameras in urban areas around the globe (Doyle et al., 2012). This technological development has transformed expectations so that any police encounter that takes place in front of bystanders may be expected to be filmed by these third parties: the cameras, to some extent, have been turned on the police (Koskela, 2009; Goldsmith, 2010; Wilson and Serisier, 2010; Stuart, 2011). Indeed, at the time of this writing, the popular media is suffused with debate about the “Ferguson effect,” named after a notorious police killing in Ferguson, Missouri. The claim is that police are “holding back” and avoiding encounters with citizens for fear of having their behavior filmed and posted on the internet.

Fingerprinting and Forensics

Another criminal identification technology, fingerprinting, more directly mimicked the mechanical inscription devices described by Daston and Galison. The fingerprint—at least the deliberately captured fingerprint--was widely described as possessing this quality of mechanical objectivity (Cole, 2001: 165-166). Fingerprinting was “a simple mechanical process . . . an actual impression taken mechanically from the hand of the prisoner.” Fingerprints were “an absolute impression taken direct from the body itself; if a print be taken at all it must necessarily be correct” (Troup et al., 1894: 28-29). For example, the Boston Police Department declared that the advantage of fingerprinting was that “as the digits record themselves there are no inaccuracies” (Garner, 1910: 635). Fingerprint identification was seen to echo emerging technologies of duplication, such as the letter press, carbon paper, “the message-recording machine, the machine that sets type and the press that prints thousands of copies to the hour” (De Pue, 1902: 93). As another commentator put it, “The fingerprint system reduced identification to a method of bookkeeping” (Faurot, 1921: 105).

The mechanical associations surrounding the recording of fingerprint impressions gradually migrated to the process of interpretation of those impressions by human experts. As one examiner put it

> The finger print expert has only facts to consider ; he simply reports what he finds . . . If two prints are identical in every particular, they were made by the same person. If they are different, they were not made by the same person. No matter how many finger print experts may be engaged in the labor of comparing two prints, their verdict must be the same (Gribben, 1919).

Another examiner invoked the silent witness doctrine for the fingerprint: "identity is proven when the evidence can 'speak for itself;' in other words when the evidence becomes *self-evident*" (Burtis Bridges, quoted in T.D. Cooke, introduction to Mairs, 1955: 3).

Of course, we now know that human fingerprint examiners and other interpreters of scientific evidence were not machines; traces inferred to derive from a common source are not "identical in every particular," but rather *similar enough* that such an inference is made (e.g., Cole, 2009); the inference is probabilistic, not categorical (e.g., Champod and Evett, 2001); and human examiners often reach different verdicts from the same data (e.g., Ulery et al., 2011; Haber and Haber, 2014; Dror and Charlton, 2006). Nonetheless, it has become quite common for forensic experts of all sorts to adopt this mantle of mechanical objectivity, to claim that even largely unregulated acts of human interpretation are mechanical, with all the connotations of objectivity and accuracy that term implies.

Recently, this reliance on human observation has made forensic science an object of criticism for its susceptibility to "confirmation bias," a concern that comes under the heading of "human factors." It is claimed that the forensic sciences have fallen behind mainstream science and medicine in paying heed to the potential for scientific observations to be biased by human observers. These problems were addressed long ago in fields ranging from astronomy (with its "personal equations") to medicine with its double blind clinical trials (Schaffer, 1988; Risinger et al., 2002). Resistance to these criticisms leads to invidious comparisons between the pattern recognition disciplines, like fingerprints and firearms and toolmarks, and disciplines, like DNA and drug analysis, which rely at least in part on machine observations. Paradoxically, while historically many forensic scientists claimed to behave like machines, this controversy might be expected to encourage the greater use of actual machines into the interpretation of forensic traces.

Polygraphs, Lie Detectors, and Breathalyzers

While the treatment of forensic analyses as "truth machines" is metaphorical, there are also, of course, more literal "truth machines." Lie detector devices were envisioned early in the 20th century by Hugo Munsterberg, and the idea disseminated broadly. "From 1900 to 1920, a series of 'soul machines,' 'truth-compelling machines,' and 'machines to cure liars' were described" in the popular American press, "with great enthusiasm" (Bunn, 2012: 180). These devices were literal embodiments of mechanical objectivity, making use of the same sorts of inscription devices (like sphygmomanometers, galvanometers, pneumographs, and kymographs) as those described by Daston and Galison (Bunn, 2012: 127). From the 1930s through the 1950s both science and science fiction explored the topic of "mechanical mind reading" whose "simplified, mechanized vision helped to shape perceptions of and expectations for what would become the sciences of brain imaging" (Littlefield, 2011: 68).

During the 1920s, the modern lie detector was developed through the complementary, and often competing, efforts of William Marston, John Larson, and Leonarde Keeler (Bunn, 2012; Alder, 2007). The claim, of course, was that lie detectors were *machines* that detected deception scientifically, in contrast to the old-fashioned way in which humans (endeavored to) detect lies during ordinary social interaction. The "assumption" was "that the body provides us with objective data that do not require interpretation; or put another way, the body appears to be self-reporting" (Littlefield, 2011: 5). The lie detector, like the modern literary detective which emerged around the same time, was concerned with "solving the mystery of the body by converting it into a truth-telling machine" (Thomas, 1999: 39). Larson's lie detector's "great advantage was that the automated device minimized the examiner's judgment in taking the readings, thereby fulfilling one criterion of the scientific method, which was to 'eliminate all personal factors wherever possible'" (Alder, 2007: 5). Proponents of the lie detector intentionally touted its mechanical appearance as an intimidating "black box" (Bunn, 2012: 142).

Claims about the "automatic" nature of the lie detector have always been half-hearted, though, in that proponents have simultaneously insisted that the machine needs to be properly manipulated by its human operator. Indeed, many have gone so far as to claim that the reliability of the machine depends on the skill of the operator. The machine could supposedly detect lies automatically, and yet it required an expert to operate it and interpret the results (Bunn, 2012: 143). “The paradox,” as Littlefield (2011: 5) notes, “is that even as the body speaks, what it is saying required interpretation, often by scientific experts.” As early as the 1920s, Marston made “the shocking discovery that subjects’ reactions depended on the qualities of the examiner” (Alder, 2007: 53), and Marston always insisted that the lie detector was a test, not a machine (Bunn, 2012: 126). Keeler’s version of the polygraph was likewise premised on the notion that the reliability of the interrogation lay, not in the machine at all but in Keeler’s “personal know-how” (Alder, 2007: 80). This “made Keeler himself a lie detector, and it constituted his true innovation” (Alder, 2007: 81). Nonetheless, polygraph proponents continued to perpetuate “the charade that it is the polygraph machine and not the examiner which assesses the subject’s veracity” (Alder, 2007: 106). Indeed, it would appear that polygraph operators to this day do not desire complete mechanical objectivity:

> In the 1990s new computer algorithms were developed that could analyze the subject’s physiological responses with mechanical neutrality. But because the algorithms might preclude operators from accusing subjects of lying (whatever the machine said), the nation’s top examiners at the Department of Defense Polygraph Institute report that most operators usually turn the computer off (Alder, 2007: 129).

The lie detector was famously ruled inadmissible by the United States Court of Appeal for the District of Columbia in *Frye v. United States* (1923), and it has generally remained inadmissible with some exceptions. Many have argued that “the courts rejected the lie detector not for its failings but for its power" (Alder, 2007: 147). By purporting to determine whether an individual is telling the truth, lie detection devices can sometimes directly resolve the "ultimate issue" rather than, like all other evidence, providing incremental evidence toward or against it, thus "invading the province of the jury," in the legal phrase. Thus, the lie detector is existentially threatening to the law. The lie detector "represented the dreams of a criminology in support of the law, but it promised to replace the due process of law altogether" (Bunn, 2012: 192). Early press reports about the proto-lie detector devices declared: "It Will Make Expert Testimony Unnecessary and May Eliminate Juries in Trials" (Bunn, 2012: 106; Golan, 2004: 250). Golan (2004: 250) suggests "experimental psychology was threatening to reintroduce similar procedures" to the medieval ordeal "into the courtroom, with machines playing the part previously allocated to deity. . . . It was not the human expert who threatened the jury's province. It was the machine—and it did not threaten merely to invade the province of the jury; it threatened to obliterate it." Shniderman (2011-12: 469-470, original emphasis), however, posits a different, more mundane, explanation: "The admissibility decision appear to be based more on which party is proffering the evidence than any scientific or legal factors. Among the technologies of similar scientific validity, lie detection is the *only* technique offered almost exclusively by defense counsel."

One way around judicial exclusion was the fact that, even if courts would not accept polygraph tests as evidence, they would accept confessions extracted during polygraph examinations, which, at least in Keeler's version, were the true goal of the examination (Alder, 2007: 126). Thus, the polygraph was in some sense an empty box: "Given the nature of the ruse, the interior workings of the machinery are almost beside the point" (Alder, 2007: 128). Indeed, Keeler sought to turn the judicial opposition to the polygraph on its head, by extending the machine metaphor to the trial itself:

> As jurors were also incapable of evaluating sophisticated psychological tests, he agreed that they ought not to hear polygraph evidence either. Instead, he advocated trying criminal cases before expert criminologists wielding a polygraph, with a judge to rule on legal technicalities. Keeler looked forward to a justice system run with the efficiency, precision, and impersonality of a machine (Alder, 2007: 147)

Today, a number of more sophisticated neuroimaging technologies are being promoted as replacements for the old-fashioned polygraph, such as a technique that uses Functional Magnetic Resonance Imaging (fMRI) known as Brain Electrical Oscillation Signature (BEOS) testing (or, absurdly, "Brain Fingerprinting"). These techniques have not been well received in U.S. courts, but BEOS was quickly admitted, on a rather thin scientific basis, in India. Some scholars have attributed this to weak judicial regulation of expert evidence in Indian law (Gaudet, 2011). Other explanations for India's embrace of the neuroimaging include a desire for "modernization at all costs" and a desire to do away with "third degree" police torture, although it is noted "that even when there is a distinct desire to do away with physical torture, there appears to be an inability to challenge all the conditions responsible for its persistence" (Lokaneeta, 2014: 18).

Some of these new technologies rely on different "software" (questioning protocols) as well as different hardware: the guilty knowledge test (GKT), as opposed to the Control Question Tests (CQT) and Directed Lie Tests (DLT) that dominated applications of the polygraph (Iacono and Lykken, 2008: 621-623). The GKT replaces the trial process, not merely by purporting to resolve the ultimate issue, as all "lie detector" technologies do, but in another way as well. For the GKT protocol "a full investigation and subjective examination must be carried out *before* a test is ever ordered. To say nothing of scientific process, Brain Fingerprinting's reliance on a legitimate/illegitimate knowledge paradigm defies *due process*, by assuming a verdict of guilt or innocence long before the mechanical exam is ever undertaken" (Littlefield, 2011: 137, original emphasis).

Alcohol breath testing devices, most popularly known as "breathalyzers," constitute of another class of technologies that quite literally purport to "establish culpability" (e.g., Barone and Vosk, 2015). As is the case for fingerprints and other pattern recognition disciplines, there are also human interpretive routines for detecting intoxication that seek to invoke the mantle of mechanical objectivity, even without the physical trappings of mechanisms. The horizontal gaze nystagmus (HGN) test is based on the purported ability of a police officer to detect alcohol intoxication. One California court, in finding the test admissible, noted "The nystagmus effect can be observed without mechanical, electronic, or chemical equipment of any kind." Thus, the police officer himself is a sort of cyborg detection technology (Jasanoff, 1995: 60).

It is not coincidental that the above case occurred in California, which adheres to a curious variant of the "*Frye* standard" for admissibility used in many U.S. states. The federal *Frye* standard, copied in many states, demands "general acceptance in the relevant field to which" the scientific or technological claim "belongs." Some California courts have seemed to restrict the application of California's version of the *Frye* standard, the "*Kelly* standard," to forms of expert evidence based on the products of machines (e.g., Crooke and Depew, 2012: 28; Epstein, 2004: 32). But this restriction of *Kelly* to machine-based evidence has also been criticized as a misinterpretation of *Kelly* (e.g., Hedger, 2004: 200).

DNA profiling

In the late 20th century, "the truth machine" reappeared yet again, this time in the form of a powerful new forensic identification technology, DNA profiling. This technique in some sense replaced serological blood testing—it operated on the same forensic traces: bodily fluids. The technology, however, derived from cutting edge molecular biology: the forensic applications were only one practical application of techniques that were also widely used in basic biological research. Finally, the technique was also a bit like fingerprinting—and it even briefly adopted that name ("DNA fingerprinting")—in that it purported to offer individualized identification.

DNA profiling developed rapidly in the decades following its introduction in mid-1980s. The technology became more discriminating; able to work with ever smaller traces by "amplifying" them; faster; cheaper; and more mobile. It purported to be almost as discriminating as fingerprint identification, and yet, it was in some ways superior: as the technology developed, it was able to derive information from small amounts of any type of body cell—thus becoming useful in cases in which legible fingerprints were not present. In addition, it has certain claims to scientific credibility, by having derived from mainstream molecular biology, that fingerprinting lacked. Perhaps most importantly, it was able to exploit the unusual data structure of genetic information to make relatively transparent and defensible calculations of the rarity of the genetic features found consistent between the "crime scene stain" and the known genotype of the suspect.

The visual technologies for imaging genetic profiles were in some sense also "truth machines." The earliest visual representation of DNA evidence, "[t]he autoradiograph[,] entered the practice of criminal identification as a genetic 'fingerprint': it was a coherent, unified evidentiary statement that was understood to guarantee identification" (Finn, 2009: 66). With this image, "The expert witness and the examining lawyer collaborate to instruct, cajole, and rhetorically retrain the fact-finder's eyesight, with greater or lesser success, to 'see' DNA and so, by a metonymic transfer of meaning, to perceive the truth whole" (Jasanoff, 1998: 720). DNA typing was "a whole technology of certainty, predicated on the index" that "manifests itself in a methodology of detached observation that will lay claim to objectivity at the same time that it produces its observing subject" (Hutchings, 2001: 135-136). In court, this threatened to swamp other legal considerations: "The charisma of genetic science is such that DNA has power beyond other forms of evidence, that its presence in courts is almost always decisive" (Gerlach, 2004: 192).

Several scholars, however, have pointed out that claims about the "automatic" nature of DNA profiling have been overstated. Early cases clearly showed that interpretation was necessary to make sense of DNA evidence and that DNA scientists often transgressed their own rules for calling DNA profiles consistent (Jasanoff, 1998: 728; Lander, 1992; Mnookin, 2006). And so, "The autoradiograph was deconstructed, revealing the fragmented and specialized processes behind its construction. The image was shown to be the product of complex and diverse scientific practices, and its interpretation was shown to be bound to the equally complex subject of population genetics" (Finn, 2009: 66). The credibility of DNA is far from automatic; it relies upon the technology surviving challenges to laboratory practices, statistical interpretation, implications of contamination, challenges to the chain of custody and so on. "The 'genetic witness' speaks for itself only when presented in the form of expert *testimony,* and, as we have seen, interrogation of that 'voice' points to an extended, indefinitely complicated, series of fallible practices through which evidence is collected, transported, analyzed, and quantified" (Lynch et al., 2008: 336, citation omitted, original emphasis) In addition, DNA results only acquire their truth value in the context of larger narrative explanations of the crime (Lynch et al., 2008).

Such arguments were not stable because, in contrast to many of the technologies discussed above, the automation of DNA profiling was, and is, not fixed but progressing rapidly. Autoradiographs, which were once eyeballed by scientists, could later be machine read. The autoradiographs themselves were soon phased out when gel electrophoresis was replaced by "capillary electrophoresis," which was always machine read, and yielded what became known as "graphical outputs" (Figure 32.1). These developments enhanced the appearance of mechanical objectivity in DNA analysis and interpretation: "Arguments about the relative alignment of bands across lanes, the use of arbitrary correction factors for band-shifting, and suspicions about 'subjective' visual inspection no longer seem salient when judgments are programmed, and molecular weights of STR sequences are read automatically and visualized as discrete, color-coded, graphic peaks" (Lynch et al., 2008: 234). But, "In part the 'digital' properties of STR profiles are due to what [forensic scientist Christophe] Champod calls the 'preprocessing' of graphic data before they are quantified and presented publicly. What Champod seems to suggest is that the ‘subjective’ or judgmental aspects of STR analysis become hidden, because they are ‘black-boxed’ by delegating visual inspection and analysis to machines” (Lynch et al., 2008: 298).

Over the last several decades, DNA profiling was quickly and widely adopted by law enforcement agencies around the world (Hindmarsh and Prainsack, 2010). Though it was used primarily to build cases against suspects, attorneys sometimes used it to reinvestigate cases in which the convict claimed innocence. By testing preserved evidence, which had not been DNA tested at the time of the original investigation, these attorneys were sometimes able to expose wrongful convictions. These cases became celebrated, and, in addition to exposing serious problems in criminal justice systems, also enhanced DNA’s mythic status. Indeed, it was in this context that one of these “innocence” attorneys, Peter Neufeld, called DNA profiling a “truth machine” (Lynch et al., 2008: 263).

This belief in the “mechanical objectivity” of DNA evidence extends to convicts themselves (Machado and Prainsack, 2012: 77). They believe “that DNA technologies enable the automatic identification of ‘offenders.’” Interestingly, however, some convicts feel “more protected by the automation provided by technology,” because they feel disempowered. “Hence automation transposes the power of decision and its political character to technology, perceived as neutral and effective, in a form of ‘mechanical objectivity’ which ‘*serves as an alternative to personal trust*’” (Machado et al., 2011: 142, quoting Porter). These beliefs also extent to crime victims. For example, in Mulla’s

(2014: 37) ethnographic account of forensic nursing, one of her informants described DNA as "the hand of God."

More sophisticated technology brought the interpretation of high-quality, single-source samples much closer to "automatic" status, but many issues remain in DNA interpretation, especially in cases involving what are called "mixtures," samples with more than one contributor. Indeed, in some of these cases, it is not possible to determine from the evidence alone precisely how many contributors there are (Lynch et al., 2008: 284-290).

One such issue is bias, as discussed above, by which analysts may be influenced by "contextual" information that suggests what the interpretation of the DNA profile "should be." Anecdotal cases (Thompson, 2009: 261-262) and controlled studies (Dror and Hampikian, 2011) have suggested that analysts interpretations can change depending on context. More generally, it is clear that the interpretation of DNA mixtures is not at all straightforward, and this has become an area of extensive scholarly debate.

Into this debate has entered yet another generation of "truth machines"—"automated" computer systems for DNA mixture interpretation that supposedly adopt an "objective," pre-determined set of rules for mixture interpretations that are immune from the difficulties of bias and backward reasoning that are a source of concern for human interpretation. These systems may be thought of as a reconstruction of the claim that DNA interpretation can be mechanized. The best known of these algorithms is TrueAllele, which has been aggressively marketed as "an objective and scientifically valid method for assessing the statistical value of DNA evidence," especially in complex mixture cases (Thompson et al., 2012: 18). However, it has been noted that "The fact that an automated system can produce answers to the questions one puts to it is no assurance that the answers are correct. While automated systems appear promising, their ability to handle 'hard cases' like" complex mixtures "remains to be fully evaluated" (Thompson et al., 2012: 19). Murphy (2015: 102) cautions that automated systems "may favor models that rely less on input from an actual person," and this may "come at the expense of ignoring the qualitative value that a well-trained analyst may provide." At least one alternative, open-source system, LRmix, is much less automated, allowing for "'strong interaction' between the analyst and software" (Murphy, 2015: 103).

Another issue raised by TrueAllele, however, is that, as a for-profit corporation, it has insisted that its source code remain proprietary, and it has refused to turn the source code over for defense inspection when it is used to inculpate defendants in criminal trials (Murphy, 2015: 100-103). The battle over source codes in criminal trials has a long history involving breathalyzer devices (Short, 2009), as well as early DNA kits (Mellon, 2001). TrueAllele has always been found admissible in the U.S., and almost always worldwide, despite challenges to both admissibility and transparency (Moss, 2015).

Future Truth Machines

Law's ambivalent desire for a "truth machine" seems to be a perpetual enough one that we should continue to expect to entertain such claims for the foreseeable future. We already discussed in the introduction the increasing dissemination of surveillance cameras, and the coming advent of police body cameras. Moving from the investigative phase of the criminal justice process to the punishment phase, computer programs that automatically implement sentencing guidelines are already in place in several jurisdictions. As Aas (2005: 76) comments, “The guidelines’ self-referential and machine-like nature has distanced them, not only from the communities in which they are applied, but furthermore, from the individuals who are supposed to give meaning to their content—the judges.”

Where else should we expect to see truth machines? Proponents of “intelligence-led policing” argue that entire crime scenes can be reduced to information that can than be mined for connections and links with other sources of “intelligence,” resulting in conclusions about past and future crimes alike. For example, Roux *et al.* (2012: 17) describe the crime scene investigation as a “hypothetico-deductive mechanism.” In some sense, this is nothing new, in that crime scene investigation has been invoking mechanical objectivity since the late nineteenth century (Burney and Pemberton, 2013: 18). “The perfect detective,” some of the popular press argued in the 1860s, “was not so much a scientist as a machine” (Summerscale, 2008: 199). And, Keeler promoted an “Illinois State Police Mobile Crime Detection Laboratory and Emergency Unit,” which was described as “almost a complete crime detection laboratory on wheels,” in the 1940s (Bunn, 2012: 167-168).

Will machines sweep through entire crime scenes gathering up and interpreting “truth”? Perhaps. But, as is so often the case, the science fiction of Philip K. Dick helps explore the tricky epistemological issues that such a technological future raises. In *The Penultimate Truth* (1964), robots provide security and assist human detectives in investigating crime scenes. But a German-made assassination machine, “the standard model 2004 Eisenwerke Gestalt-macher” (138), is capable not only of penetrating a wellguarded home and carrying out an assassination, but also of depositing traces in order to "frame" a designated individual for the crime. For the assassination described in the novel, seven traces lead back to the faux perpetrator, including fingerprints, hair, fibers, voice, inferred body weight from bending of a window sill, blood drops, and brain waves. Once again it would seem that machines have usurped the law: "It would appear beyond a reasonable doubt that Stanton Brose, the man who had hired Foote to look into this felony, was the killer" (143). Does this mean forensics cannot be trusted because evidence can be manufactured?

It isn't clear. As the detectives investigating the murder reason, Brose would have been implicated as the murderer, had the detectives not figured out that the murder was carried out by a Gestalt-macher. Having reached this conclusion, their suspicions would fall on anyone but Brose since the machine was programmed to frame Brose. However, another possibility is that Brose programmed the machine to implicate himself in order to throw suspicion off himself (167). Characteristic of Dick's conundrums, it's impossible to tell which scenario obtains. Perhaps, then, establishing culpability still requires context, no matter how many machines are involved in its manufacture.

Conclusion

The attraction that machines and mechanical objectivity hold for law and for criminal justice systems more generally is understandable. The unreliability, biases, and foibles of human judgment are familiar enough to explain the yearning for the mechanical. And yet, as this review has shown, mechanical solutions have historically failed to fully deliver on the hopes that have been invested in them. The problems have been fairly consistent. Machines themselves are never perfectly reliable, and they are usually not as reliable as their promoters claim. The very erasure of human judgment that is considered the benefit of machines is also their drawback: there are times when human discretion is considered desirable. Machines are not necessarily free of bias either; the biases are simply those written (by human designers) into their programming or calibration. And, the supposed "objectivity" of machines will always be somewhat illusory. Mechanical recordings and outputs will also lack some form of context and nuance. For all these reasons, machines will almost surely continue to exert both attraction and repulsion upon custodians of justice systems.

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