

**FUTURE ISSUES IN FORENSIC SCIENCE**

Michael Buerger  
Bernard H. Levin  
Richard Myers

**Futures Working Group White Paper Series**

August 2018



## Acknowledgements

The authors and the Futures Working Group (FWG) express their deep appreciation to the Federal Bureau of Investigation, the FBI Academy, and the Behavioral Science Unit for their intellectual and material support of the Futures Working Group during its first decade. We are indebted to the Society of Police Futurists International (PFI) for its sponsorship of the Futures Working Group. The opinions expressed in this document are those of the authors and contributors alone and do not purport to represent either the Federal Bureau of Investigation, the U.S. Department of Justice, or the Society of Police Futurists International.

This paper offers a specific perspective of the future of forensic science as developed from a meeting at the FBI Academy with members of the Laboratory Division. The authors thank the members of the Laboratory Division, the Futures Working Group, and other colleagues who provided direct and indirect input, contributions, and intellectual catalyst in the development of this project. Special thanks go to J. Amber Scherer for her assistance in the preparation and editing of this white paper.

Dr. John Jarvis was chairman of the FWG from 2006 until 2016. Most FWG activities, including this white paper, occurred under his leadership. Dr. Jarvis was instrumental in bringing this document to the fore; he bears no responsibility for any errors or omissions.

### Suggested Citation:

Buerger, M., Levin, B., & Myers, R. (2018). *Future issues in forensic science*. Futures Working Group, Society of Police Futurists International.

Release date: August 2018.

The opinions and statements expressed throughout this volume are those of the individual authors and contributors and should not be considered an endorsement or a reflection of the official position of the Futures Working Group, the Society of Police Futurists International, the Federal Bureau of Investigation, or any other institution, or organization for any policy, program, or service.

## **A Word from the President**

This white paper represents another offering in a continuing series of white papers authored by members and affiliates of PFI's Futures Working Group (FWG). At the time this work was first authored, the FWG was co-sponsored by PFI and the Federal Bureau of Investigation. Although this work is not being co-published by the FBI, PFI gratefully acknowledges the FBI's support in this and many other work products written during more than a decade of strong collaboration.

These white papers are intended to spark ideas and incite creativity in responding to the future challenges and opportunities that policing and the criminal justice community must confront. As with most white papers, this is a working document. It is not intended to be the final word or definitive perspective concerning the topics discussed. Rather, these papers are designed to foster further discussion and consideration of possible, probable, and preferable future directions for policing. In this vein, the current paper offers a perspective on the future role forensic science might play in policing, the justice system, and society as a whole. We hope you find this, as well as past and subsequent FWG white papers, to be useful.

Jane Hall  
Royal Canadian Mounted Police (Ret.)  
President of PFI  
2018-2019

## FUTURE ISSUES IN FORENSIC SCIENCE

The 2009 National Academy of Sciences report *Strengthening Forensic Science in the United States: A Path Forward* placed a new emphasis on the scientific integrity of forensic examination of criminal case evidence. This document was released in the aftermath of several high-profile scandals involving a variety of crime laboratories, emerging concerns about the rigor and the scientific basis of certain techniques, and the scientific consistency and validity of some laboratory practices. This constellation of events brought forensic sciences to the attention of the Congress and the nation.

As part of the April 2012 *Future Threats and Drivers* conference, members of the Futures Working Group met with representatives of several investigative agencies and the FBI Crime Lab to discuss the current state of forensic evidence collection and examination. Some elements of that discussion are omitted here for reasons of security, and others because they involve exploratory scientific investigations that are still in development. Common to all topics of discussion were four themes:

- (1) Media-based fictional depictions of forensic science that create what we here refer to as “an expectation of ‘miracle science’ in forensic examination” (aka the “CSI effect”).
- (2) The rapid expansion of technologies with applications for crime and forensics.
- (3) The comparable shrinkage of financial resources available to law enforcement in general and forensic science laboratories in particular.
- (4) Issues at law, such as determining the admissibility of expert witness testimony based upon scientific methods of examination in the wake of *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, or upon “‘technical’ and other ‘specialized knowledge’” in the wake of *Kumho Tire Co. LTD. Et al. v. Carmichael et al.*<sup>1</sup>

Shadowing all four themes is the still-unresolved public debate over the proper role and limit of government in the provision of services. Privatization of correctional facilities is already an established reality and the growth of private police and security forces is an emerging fact in the current economic climate. Private laboratories have been called into service for forensic examination of evidence, as states and the federal government have pushed to reduce the critical backlog of evidence awaiting forensic examination in sexual assaults and others cases (see, e.g., Ritter, 2012). Each theme is discussed in greater length in the following pages.

---

<sup>1</sup> *Daubert v. Merrell Dow Pharmaceuticals Inc.* 509 U.S. 579 (1993). *Kumho Tire Co., LTD., et al. v. Carmichael et al.* 526 U.S. 137 (1999)

## 1. Unrealistic Expectations

“The CSI Effect” is a common lament among police and prosecutors alike. Popular television shows like CSI and NCIS feature dramatic presentations of forensic analysis as an embedded, coordinated part of criminal investigations. Such a distortion of the structure, capacity, and speed of actual justice system practices creates an unrealistic expectation on the part of citizens generally, and jurors in particular.<sup>2</sup> The CSI Effect imputes to the investigative process an impossible scientific basis (“miracle science”) that cannot be matched in an unscripted world. The result is a mystical inversion of logic that transforms the absence of evidence into “Evidence!” Miracle science has become a baseline expectation in juries, and that expectation becomes a tool of manipulation for defense attorneys. All fiction requires the willing suspension of disbelief; by contrast, “miracle science” rests upon an uncritical *assumption of belief*.

Fictional forensics are predicated on several *dei ex machina* written in to the scripts:

- 1 – physical evidence is always suitable, available, and highlighted;
- 2 – the collection of evidence is conducted by the lead investigator or a member of his or her highly integrated team;
- 3 – analysis of the evidence is done immediately; if other duties impinge on the analyst, they are magically shunted away in order to analyze the evidence of the moment; no other case is important;
- 4 – the analyst is an informed member of the team who can make intuitive statements about the relationship of the evidence to the overall case investigation.

Real-world forensics are much different, of course. Evidence may be collected by the first officer who responds to the scene, by responding investigators, by a team of evidence technicians (who may be sworn officers or trained civilians), or in rare cases by a special team with advanced training for unusual situations. Some evidence is not suitable for analysis due to outside factors (weather, additional distortions, the lapse of time, etc.). Probative artifacts may be surrounded by a multitude of useless items collected “just in case.” Lab technicians who are insulated from the specifics of the case analyze the collected physical evidence: they analyze an item, not an investigation. Reports of the scientific analysis are returned to the investigating team in due course,

---

<sup>2</sup> “The CSI Effect” is primarily noted in juries at this time, and jury trials represent a very small proportion of the criminal justice field’s business, albeit a very high-profile proportion. The degree to which this may expand the demand for jury trials, and the degree to which it now and in the future affects plea negotiations, is still uncharted territory.

depending upon the workload of the crime lab: lengthy delays are the norm, fast turnaround the exception.<sup>3</sup>

Nevertheless, the CSI Effect endures. Police officers continue to report citizen expectations of intact fingerprints or useable DNA samples at every burglary scene, and the like. Every introduction of a new technique carries the possibility of raising even greater expectations, even if that technique is not acceptable to the courts under the *Daubert* test.

## 2. Emerging Technologies

Considerable interest in new techniques of forensic analysis usually dominates the discussion of emerging technology. These are the techniques that hold the promise of advancing the pursuit of justice, both bringing the guilty to the bar and exonerating the wrongly accused. However, the future of forensics must also take into account new advances in science and technology that make the task of the forensic laboratory even more complex, more expensive, and more difficult to explain to courts.

The field of forensics does not appear to be prepared for the burgeoning of nanotechnology and molecular assembly, popularly referred to as 3-D printing. Among the immediate possibilities and challenges that will inevitable be scaling up are:

- anonymous 3-D printed firearms;
  - with no clear baseline against which to measure ballistics marking, etc., 3-D printed firearms effectively circumvent most of the existing NIBIN database.<sup>4</sup> The black market potential for untraceable firearms is considerable, both domestically and abroad;

---

<sup>3</sup> In at least one case familiar to the American public, the CSI Effect appears not to have had an impact. Part of the prosecution's evidence against Casey Anthony was a technique known as LIBS (laser-induced breakdown spectroscopy) on air found in the trunk of her car, where the body of her daughter allegedly had been hidden for some period of time. Other forms of evidence, including computer-generated images and an erroneous count of the number of times a computer had searched the internet for "chloroform," were rejected by the jury as it returned a verdict of "Not Guilty" to murder charges. Wikipedia contains short summaries of the issues.

<sup>4</sup> In the summer of 2018 the federal government quietly settled a legal dispute with Cody Wilson who seeks to create the largest and most comprehensive repository of 3D blueprints to allow the production of firearms of all calibers and sizes. The federal government's actions effectively opened the floodgates for the proliferation of all forms of 3D blueprints. The trajectory of this ruling remains unclear at present, but would

- designer drugs;
- designer poisons;
- other criminal tools (for forced entry, etc.) that defeat existing security and defensive techniques.

The rise of personal manufacture by molecular assembly will give rise to an updated version of the *Anarchist's Cookbook*, a library of downloadable programs like script kiddies' viruses. The contemporary version of 'script kiddies' is The Dark Web, devised as an anarchic work-around of corporate control but equally useful for the criminal element (and perhaps more so). While modern law enforcement has made inroads into the Dark Web, it likely will remain an expanding *terra incognita* for years to come and constitute a continuing challenge in digital forensics.

Robotics has been notable in its absence, perhaps because of a presumption of either standard industrial manufacture (hence comparability to tool marks) or their being amenable to composition analysis. Several factors are worth consideration:

- robotics is the most accessible technology for DIY (Do It Yourself) assembly, including improvised and mix-and-matched components;
- a wide range of household, hobbyist, and handyman technologies lend themselves to robotics, making it difficult and labor-intensive to track parts alone; while this could be offset by a comprehensive database, there are generations of pre-existing and idiosyncratic parts that date back more than a century;
- mechanical robotics is a small portion of the robot universe; all of the cyber- and cyberwarfare issues can be vested here as well. On the positive side, that increases the opportunities for the development of leads; on the negative, it expands considerably the quantum of resources that must be brought to bear on the articles of evidence, as well as the scope of what might constitute evidence.

Eyewitness testimony has come under considerable challenge in the past several years. There is mounting scientifically-based evidence of the tenuous credibility of eyewitness testimony: limited retention of detail, creating the potential for distortion of testimony, or the substitution of creatively "recalled" descriptions of individuals and events rather than accurate recounting of observations. This creates a new avenue for impeaching witnesses or undermining their credibility. Preparing witnesses for testimony and for cross-examination has been challenging in the past; it now has a potentially new dimension, having to overcome the science-based challenges of the defense.

---

seem to auger ill for the criminal justice system and public safety concerns, albeit a win for libertarian and free speech advocates.

### 3. The Impact of Diminished Budgets

With the multiple and rapid emergence of forensic examination techniques (and equipment) there is a daunting amount of information and material of which to be knowledgeable. For a variety of reasons, investigations training at all levels must be transformed so that rookie cops and seasoned veterans alike are aware in near real time of new developments, including new evidence possibilities, collection needs, hazards, and limitations. A sweeping directive to “find me something in those 100 garbage bags of items seized” places burdens on laboratory capacity. This is especially true when there has been no on-scene screening to identify items with likely evidential value, nor any realistic attempt at proper preservation or avoidance of cross-contamination. At the federal level of investigations, evidence response teams (ERTs) and expert teams are the norm. For most of America, however, a rookie cop with less than six month’s experience has to know enough (a) to not jeopardize the scene, (b) to identify evidence that is potentially probative, and (c) to understand when and why to bring in additional resources or a specialist. The authors recognize that inculcating this much knowledge by traditional methods in a few months of experience verges on the impossible. Narrowing the gap between present and future practicalities may well depend on a radical restructuring of some training and education approaches.

It is essential that all field agents (including state and local first responders) are aware of all the possibilities for evidence. While safety of the officers and citizens at a crime scene is the first priority always, the preservation of evidence remains a top priority of initial response. Training is often one of the first parts of an agency budget sacrificed in hard economic times. State and local jurisdictions are less and less able to avail themselves of the specialized training needed to keep current. Traditional operations commitments and capabilities are preserved at the expense of training, research, and development resources. Under such conditions, the issues above have had the effect of narrowing the range of “preferred” evidence-gathering techniques, particularly DNA. Lab priorities have shifted in response, and older, less media-sexy techniques that continue to have probative value, such as tool impressions and shoe- and tire marks, have effectively been abandoned in some jurisdictions.

Within the police and investigative community, the age-in-service compression that affects supervision and other areas of police work has a dramatic impact in this arena. The loss of 20-year detectives is not just a loss of accumulated expertise and institutional memory, but a loss of craft transmittal as well. While the new model of swift turnover may bring in new investigators with better knowledge of the newest scientific investigation techniques, it inhibits the integration of that knowledge into the broader stream of time-honored refined (and perhaps validated) techniques.

There are additional research agendas vested in the emerging currents. We do not yet know the impact of ‘magic science’ upon serendipity in investigations, nor whether incorporation of serendipity will be encouraged or discouraged. Our general



understanding of the investigative process is largely derived from higher-profile investigation successes, leavened by some spectacular failures. The actual “baseline” of practice is not tracked.

### Consequences for Training

As future forensic science support becomes more refined it will become easier to identify issues such as contaminants on fingerprints prior to lifting, trace elements on metal fragments, and the like. The training needs to adequately inform first-responding officers of the potential for scene contamination, and supervisors of the need to enforce discipline in initial crime-scene investigations. Not only must initial academy training be more robust, but annual in-service training must expand to match the level of sophistication of in-service legal updating.

The need for demonstrated skill should reside in the state’s certification power. The nature of in-service training can, and probably should, shift from the present basis of a legislature-mandated number of hours to a “topics needed” basis, replacing seat-time off the road with as much tele-learning as can be mounted. Mere attendance (which assumes but cannot verify that learning occurs as a result of environmental exposure, and that retention is both precise and long-lasting) should be replaced with “demonstration of understanding” within the certification process. This should be governed at the State level: the need for skill should reside in the State’s certification power, not the local conditions of employment.

### The Privatization Movement

The current rise of privatized forensics labs has two looming negative impacts: disproportional resources and the possibility of reduced guardianship. Moreover, the cost savings represented by privatization at one point in time are not guaranteed to be permanent. While contracts can be renegotiated or awarded to competitors, the issues related to confidence in accuracy can be as costly as the financial burdens. Any change in a contract raises a wedge issue for the defense in still-active cases, suggesting dissatisfaction with the previous contract holder’s reliability, as well as price. Further, the huge start-up costs and risks will create barriers to entry for potential competitors. Most private laboratories are likely to become segments of large-scale multinational corporations rather than remain innovative start-ups.

Private laboratories draw upon more varied sources of funding than do state laboratories funded by the tax base. As such, they have more flexibility and greater latitude in offering salary and benefits. If the salary differentials lure experienced forensic analysts away from law enforcement employment, the reliability of state-funded crime labs may be diminished further over time.

The State monopoly over evidence analysis is broken when physical analysis is outsourced. The legacy of past scandals suggests that there might be value to such a transformation, severing the inherent, if subtle, bias of state employees analyzing evidence in which the State has a direct interest. However, the human factor is no less problematic in the private sector. The issues that played out at the Hinton State Laboratory Institute in Massachusetts in the Dookhan case are just as likely in a private setting, and potentially more so if bonuses are tied to high-volume production (see, e.g., Associated Press 2012a; Associated Press 2012b; Associated Press, 2012c; Arsenault, 2012; for a full review, Cunha, 2014)

Privatization creates new demands for evidence preservation and transmittal (what does “chain of custody” mean when evidence must be turned over to the opposing side?). It may also create the need for an entirely new level of scientific validation for evidence twice-tested, first by the private lab contracted by the State, then by the defense’s chosen lab. What (if any) distortions occur, with what type of physical evidence, to what mathematical proportions, and what are the judicial implications? That level of uncertainty – if it occurs – would create an entirely new level of educational outreach to prosecutors and the judiciary.

Corruption of forensic insiders is just as pernicious as the corruption of public employees. Forensic examiners in particular localities, either public or private, could receive supplemental income from competing private labs to subtly skew the results of examinations, or reveal results prematurely. This might not be done on a detectable case-level basis, but subtly across the lifetime performance of the lab’s equipment. The intent could be to undermine cases, but the more profitable avenue might be to create distrust in a competitor’s product, thus gaining a market advantage in both the public and private realms.

Judicial distrust in a laboratory’s competence – akin to the lead composition or Mayfield fingerprint cases – could also disadvantage the State across the board, not just in a particular technology.

#### **4. Developments in the Legal Sphere**

The 1993 Supreme Court decision in the *Daubert* case established that the Federal Rules of Evidence superseded the *Frye* doctrine of “‘generally accepted’ as reliable in the relevant scientific community.” The Court established a four-part standard to guide the “gate-keeping function” of the courts: scientific “testing, peer review, error rates [associated with the technique], and general ‘acceptability’ in the relevant scientific community” (*Kumho Tire*, 1999). The introduction and acceptance of new forensics techniques continues to be contested under those general rules.

The post-*Daubert* age has seen the rise of a new genre of pseudo-scientific journals, intended to give what is termed “junk sciences” the legitimacy of publication in order to claim “peer review” validation. These journals hide in plain sight amid a plethora of journals of varying stature, creating a smokescreen of legitimacy. This creates a new possibility for future contests of evidence.

The *faux* science journals are exposed in high-profile trials, and themselves become irrelevant, but the industry shifts again into online avatars (e.g. *Policing Quarterly* mimetically spoofs *Police Quarterly*; PLoOS, the *Public Library of Over-the-Horizon Science* competes against PLoS for the public’s short attention span, etc.) or sponsored by new corporate or think-tank titles that mimic the names of more legitimate entities (Brooking Institute for The Brookings Institution, the Academy of Criminalistics Justice Sciences for the Academy of Criminal Justice Sciences, etc.). In all cases, the *faux* science entities veil themselves in the halo of legitimacy of the real institutions, coasting on borrowed legitimacy created by the vague uncritical recollection of an un- or semi-informed public and/or judiciary.

A similar phenomenon resides within the higher education industry, where online for-profit institutions have created their own “certifying” bodies, representing to the public that for-profits are “accredited” at the same level of rigor that traditional brick-and-mortar institutions are. In addition, we will see even more conflicts of interest such as are now roiling medical journals.

### A Potential Wild Card

The future could bring about a “perfect storm” condition in the legal arena that could dramatically alter criminal investigative forensics as we know them:

- culmination of the existing dissatisfaction with the “dueling experts” model for courtroom presentations of evidence and interpretations thereof;
- culmination of frustration with cases, or a high-profile case, involving serious *Brady* misconduct by police and/or prosecutors (*Brady v. Maryland* 373 U.S. 63 [1963]);
- failure to resolve issues related to *Daubert*-valid elements or from some other source;
- irreconcilable competing claims from private labs against each other’s products or the products of public labs.

The following is one possible solution to these problems: it nudges the existing system a bit toward the European model of investigative judges, but leaves intact the primary responsibilities for prosecution, defense, and decision. The major improvement – with the usual caveats about the integrity of the new process and its employees, which is no more guaranteed than any other element of the system – is the shift toward

the bromide that “everyone is entitled to their own opinion, but no one is entitled to their own facts.”

The Court or courts place the forensics field into receivership, under Court direction (comparable to the 1974 *Morgan v. Hennigan* school desegregation decision in Boston, which also brought executive branch operations under the domain of the judiciary). The legal rubric is that the Court’s interest in finding the truth has been impaired by the effective perversion of the adversary system, which presumes that both sides have equal access and capacity.

All evidence collected, interpreted, and analyzed is submitted to the supervision of the Courts, although the existing police, federal, and private laboratories continue to be administered (and paid for) by the previous arrangements. Special masters would oversee the process and verify results prior to dissemination to both sides. The prosecution would receive forensic analysis results at the same time that the Masters do, perhaps prior, in order to make a preliminary determination about the viability of the case. Weak cases would be eliminated from consideration, or perhaps charged downward to facilitate plea negotiations. Where the preliminary evidence suggests a new theory of the crime’s cause, there would be no need to burden the Court’s review.

Another group of Special Masters would vet and approve court-certified experts across various topics, and would maintain a database of all credentials, pre-trial depositions, and testimony given in court. That database would be available to both prosecution and defense to: determine consistency of the science provided over time and new developments; facilitate legitimate challenge based on inconsistency; eliminate junk science from the courtroom; and, assure as much as possible the integrity of the roles of expert testimony.

### Possible Consequences

There are several best-base outcomes and several “unintended consequences” that might arise from such a dramatic shift.

#### *Best Case*

1. Streamlining of the system for handling science-based evidence;
2. Elimination of large amounts of quackery and prevention of junk science from muddying the adversarial process;
3. The combined effect of 1 and 2 is the simplification of the trial process;
4. Increasing transparency in the evidentiary process;
5. Minimizing the use of the courts as a battleground for market share between and among private providers;

6. Minimizing the possibility of *Brady* violations, to the benefit of both the defense and The State (including reduction of *Brady*-related appeals and the corresponding burden on the courts);
7. Standardizing the level of admissibility of evidence, at least at the federal appellate level.

### *Negative Outcomes*

1. Withdrawal of a significant number of the private laboratories, unwilling to submit their work product to such a level of scrutiny or concerned about the exposure or erosion of proprietary techniques and other interests;
2. Increased workload inputs to State labs, without corresponding resource increases, requiring drastic triage of caseloads. This is a less likely outcome, but the withdrawal of private providers could stimulate greater resources for state crime labs, comparable perhaps to the Sexual Assault Kit (SAK) backlog initiative of the National Institute of Justice;
3. Quackery cannot be eliminated entirely. Each new development of scientific knowledge or refinement of technique will introduce a period of contested science, before being resolved in the scientific arena and thereafter in the legal one;
4. Gaming the system will continue, a calculated risk based on the relative probability/probabilities of whether or not the other side will challenge the decisions.

## **5. Other Concerns**

### Security

Much of the new layer of scientific investigation is at the Big Machine in a Lab level, but a constant underlying theme – inherent in Moore’s Law and its other-tech equivalents – has been the eventual reduction of the size and delicacy from the large prototype to a hand-held (or at least vehicle-transportable) device that can be field-deployed. Most of these machines are computers at their core, and thus vulnerable to all the hacking and distortion effects found elsewhere in cyberspace. Field security – against eradication or tampering by distortion – will be a critical issue as the technology evolves.

### Digital Evidence

Though we tend to treat digital evidence as a category separate from physical evidence, digital images from cell-phone cameras, home and business security cameras, and police body-worn cameras play an increasingly prominent role in evaluating situations and identifying participants. In some instances, videos uploaded to social

media platforms on the internet may initiate new criminal investigations, or complicate ongoing ones, such as the 2007 “Swirly Face” pedophilia investigations that began in Thailand and spread to Canada (see, e.g., Canadian Press, 2012). The issue of “photoshopping,” electronically altering original images so that they depict something else, or someone else, is expected to blossom as an issue in forensic investigations and require specialized expertise (Metz & Collins, 2018).

### Biometrics

The expansions of DNA technology and facial recognition software have added new tools to the investigative skill set. To the extent they rely on comparisons to databases (as do fingerprints now, at least in the initial stages), they are vulnerable to unintended and unrecognized biases in the compilation of reference databases. The existing NGI, AFIS, and CODIS databases allow for certitude in comparison under current practices. Issues arise when new capacities expand upon verified ones, such as DNA phenotyping: the use of an unknown DNA sample (no match in existing databases) to construct a visual image of the suspect’s face. Criticisms of this technique include concerns that it predicts “average faces based on sex and ancestry, rather than specific faces of individuals [and thus creates potentially overbroad intrusion into the lives of many innocent citizens]” (Curtis & Hereward, 2018).

Biometric tracking is also a privacy issue: the recent apprehension of the Golden State Killer by submitting a fictionalized profile of his DNA to a public genealogy site is about to test the heretofore secure boundaries between public and private. Legal limits are set on government uses of the technology (Del Greco, 2017), but illicit individual use by stalkers and other predators is a wide-open field at the moment. The adoption of state-issued biometric identify cards like Australia’s proposed “The Capability” (Curtis & Hereward, 2018) or India’s emerging Aadhaar system (Goel, 2018) undoubtedly will test those boundaries even further in the near future. Some assert that the Big Brother surveillance capacity forecast in the novel *1984* and updated in the movie *Minority Report* is already being assembled in parts of the globe (Denyer, 2018).

Additional concerns have emerged recently about the accuracy of visual biometrics: a recent test of facial recognition software packages noted large gaps in identifying even so basic a feature as gender: 99 percent accuracy for white males, but error rates between 21 and 35 percent for dark-skinned females (Lohr, 2018). Part of the discrepancies lay in the algorithms used, which tend to be proprietary, and thus concealed from independent evaluation. Another source of error is the data set used to test and refine the software, which can skew results without any inherent prejudice in the creation of the algorithm (Lohr, 2018).

## Ethics

Inevitably, with change comes a set of ethical questions. Some of the more obvious ethical issues are:

1. The Forensic science community is primarily *reactive*.
  - How do we anticipate the next threats? And what forensic skills will be needed?
2. Determining top *priorities* is often challenging.
  - a. Funding
  - b. Research
  - c. Operations
3. *Examiners* always have a preference. This could involve holding on to old, outdated methods, risk-aversion, etc. There are other potential biases that emerge if examiners are too familiar with related information about the case, extraneous to the examination of the evidence article or articles (Dror, 2018).
4. With regards to forensic science *research*, just because you can do something, should you? (e.g., DNA repair research, creating a genetic profile).
5. A difficult challenge is faced when assessing the state of *maturity* for new capabilities (e.g., The Casey Anthony case).

This brief white paper has provided a once-over-lightly scan of looming issues, threats, and opportunities. We leave to the reader the expansion or rejection of the suggestions we offer.

## **REFERENCES**

Arsenault, Mark (2012). Police chiefs, justice system brace for fallout from drug lab scandal. The Boston Globe, 17 September. Accessed 9/17/12 from <http://www.boston.com/news/local/massachusetts/2012/09/16/police-chiefs-justice-system-brace-for-fallout-from-drug-lab-scandal/bSUs8EKZ5V6VPrBK6v8hWM/story.html>

Associated Press (2012a). Shutdown of Mass. Lab Could Jeopardize Drug Cases. 31 August. Accessed 9/26/12 from <https://www.forensicmag.com/news/2012/08/shutdown-mass-lab-could-jeopardize-drug-cases>

----- (2012b). Chemist's Inflated Resume Gives Lawyers New Doubts. 26 September. Accessed 09/26/12 from <http://www.nytimes.com/aponline/2012/09/26/us/ap-us-state-police-lab-shutdown.html?ref=us>

Associated Press (2012c). Mass. Chemist in Drug Test Flap Is Arrested. 27 September. Accessed 09/28/12 from <http://www.nytimes.com/aponline/2012/09/28/us/ap-us-state-police-lab-shutdown.html?ref=us>

Bilton, Nick (2012). Disruptions: With a 3-D Printer, Building a Gun With the Push of a Button. *The New York Times*. 7 October. Accessed 10/7/12 from <http://bits.blogs.nytimes.com/2012/10/07/with-a-3-d-printer-building-a-gun-at-home/?ref=business>

Canadian Press, The (2012). Convicted 'swirly face' pedophile Christopher Neil released from jail. *The Vancouver Sun*, October 3. Accessed 05/10/18, from: <http://www.vancouversun.com/news/metro/convicted+swirly+face+pedophile+christopher+neil+agrees/7337372/story.html>

Cuhna, Glenn A. (2014, May). *Investigation of the Drug Laboratory at the William S. Hinton State Laboratory institute, 2002-2014*. Office of the Inspector General, Commonwealth of Massachusetts.

Curtis, Caitlin, and James Hereward (2018). How Accurately Can Scientists Reconstruct A Person's Face From DNA? *Smithsonian Magazine*. May 4. Accessed 05/10/18 from: <https://www.smithsonianmag.com/innovation/how-accurately-can-scientists-reconstruct-persons-face-from-dna-180968951/>

Del Greco, Kimberly J. (2017). Law Enforcement's Use of Facial Recognition Technology. Statement Before the House Committee on Oversight and Government Reform. March 22. <https://www.fbi.gov/news/testimony/law-enforcements-use-of-facial-recognition-technology>

Denyer, Simon (2018). In China, facial recognition is sharp end of a drive for total surveillance. *The Washington Post*. January 7. Accessed 01/08/18 from: <https://www.washingtonpost.com/news/world/wp/2018/01/07/feature/in-china-facial-recognition-is-sharp-end-of-a-drive-for-total-surveillance>

Dror, Itiel E. (2018). Biases in forensic experts. Editorial. *Science*. April 19.

Lohr, Steve (2018). Facial Recognition is Accurate, If You're a White Guy. *the New York Times*. 02/09/18. Accessed 02/09/18 from: <https://www.nytimes.com/2018/02/09/technology/facial-recognition-race-artificial-intelligence.html>



Metz, Cade, and Keith Collins (2018). How an A.I. 'Cat-and-Mouse Game' Generates Believable Fake Photos. The New York Times. 01/02/18. Accessed 01/03/18 from: <https://www.nytimes.com/interactive/2018/01/02/technology/ai-generated-photos.html>

National Research Council of the National Academy of Sciences (2009). *Strengthening Forensic Science in the United States: A Path Forward*. Washington DC: The National Academies Press.