THE NEW FORENSICS:
CRIMINAL JUSTICE, FALSE CERTAINTY, AND THE SECOND GENERATION OF SCIENTIFIC EVIDENCE

Erin Murphy

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ABSTRACT

Accounts of powerful new forensic technologies such as DNA typing, biometric scanning, and cell site or RFID tracking fill the daily news. Such techniques have already gained renown for helping to exonerate those wrongly convicted, and for exposing the failings of a criminal justice system that too readily relied upon old forms of faulty forensic evidence like handwriting, ballistics, or even fingerprints. Advocates applaud the introduction of a "new paradigm" for forensic evidence, and promise that these new techniques will revolutionize the future investigation and trial of criminal cases.

To be sure, these new forensic sciences offer an unprecedented degree of certainty and reliability. Yet that alone does not necessarily render them less susceptible to misuse by the criminal justice system. In fact, as this Article argues, the very characteristics most lauded in these new forensic techniques actually exacerbate the conditions that ultimately caused traditional forensic sciences to fall into disrepute.

This Article challenges the new orthodoxy of forensic science. In so doing, it reframes the debate about forensic evidence in the criminal justice system in three respects. First, this Article sets forth a new taxonomy of forensic evidence, and distinguishes between first and second generation sciences by enumerating specific, classifiable characteristics. Second, using that framework, this Article illustrates how the pathologies of the criminal justice system that ultimately tarnished the first generation of forensic evidence are in fact aggravated, rather than relieved, by the particular characteristics of the second generation. Lastly, this Article criticizes current approaches to improving the use of forensic evidence in the criminal justice system for failing to account for the particular characteristics of second generation sciences, and instead advocates for changes tailored to those specific concerns.

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INTRODUCTION

Forensic science has long captured the public's imagination of criminal justice. From Sherlock Holmes' trademark magnifying glass to the shaky handwriting on the ransom note for the Lindbergh baby to the swirling double helix of DNA, images of the mystical power of forensic science pervade popular culture. The most-watched television drama in the country these days is often a show called "CSI: Crime Scene Investigation," and viewers not satisfied with just that offering can also tune in to "CSI: NY," "CSI: Miami," or any number of programs showcasing forensic science technologies.[1] As one scholar presciently observed ten years ago, "[t]o consider the future . . . is largely to talk about the creeping scientization of factual inquiry."[2] Today, that "creep" has fully erupted into a sprint. Legal scholars across a variety of disciplines now wrestle with questions concerning science in the judicial system.

Of course, traditional forensic evidence has long played a role in criminal justice. But currently poised on the horizon is a new generation of forensic sciences capable of investigating and inculpating suspects on an order of power far greater than that afforded by traditional forensic techniques. This array of exciting new methods -- such as DNA typing, data mining,[3] biometric technologies,[4] and forensic MRI imaging,[5] --

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[1] *See, e.g.*, Jennifer Frey, *On Crime-Scene Shows, the Science Is Arresting*, WASH. POST, Sept. 19, 2004, at N01 ("[S]cience is hip. Science is popular. Science grabs ratings.").

[2] MIRJAN R. DAMAŠKA, EVIDENCE LAW ADRIFT 143 (1997).

[3] *See, e.g.*, *United States v. Forest*, 355 F.3d 942 (6th Cir. 2004) (approving cell phone site tracking); *People v. Rickafort*, No. A101531, 2004 Cal. App. Unpub. LEXIS 2500 (Cal. Ct. App. Mar. 18, 2004) (using FasTrak records to document defendant's travel to site of arson on morning of offense); *State v. Guthrie*, 627 N.W.2d 401 (S.D. 2001) (admitting into evidence

represent a marked advance over the rudimentary techniques of old, and will surely stake a central and indispensable role in the future administration of criminal justice.

Yet the experience of traditional forensic sciences in the criminal justice system caution against rushing too quickly to embrace these new techniques. In recent years, the legitimacy of evidentiary stalwarts like handwriting,[6] voice exemplars,[7] hair and fiber,[8] bite and tool marks,[9] and

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the search terms conducted on defendant's work computer, which included "household accidents" and "bathtub accidents" in bathtub murder case, along with evidence that purported suicide note was generated on computer after drowning); David A. Lieb, *States Seeking to Track Cell Phones for Traffic Conditions*¸ ASSOCIATED PRESS, Oct. 8, 2005 (detailing pilot programs to track drivers through their cell phones).

[4] *See, e.g.*, Mark Brunswick, *State Seeks to Get in the Face of ID Theft*, STAR TRIB. (Minneapolis, Minn.), Jan. 6, 2006 (identifying Minnesota as one of thirteen states to use facial recognition software on Minnesota driver's license photos); Arthur Kane, *Facial Scanning Targets ID Theft*, DENVER POST, Jan 2, 2005 (describing use of biometrics, including facial recognition as a means of detecting fraudulent identity card applications); Spencer Hsu, *D.C. Forms Network of Surveillance*, WASH. POST, Feb. 17, 2002, at C1 (describing use of such software during demonstrations, football games, and other large public events); Stephen Thompson, *Facing Security*, TAMPA TRIB., Feb. 9, 2002, at 1 (describing implementation of facial recognition software at Tampa area airport).

[5] *See, e.g.*, *Harrington v. State*, 659 N.W.2d 509 (Iowa 2003) (reversing and remanding for a new trial after evidentiary hearing that included testimony about brain scan that showed no memory of crime, although court declined to consider such evidence); *People v. Smith*, 107 P.3d 229 (Cal. 2005) (noting that PET scan bolstered defendant's claim of brain injury); *Friedrich v. Intel Corp.*, 181 F.3d 1105 (9th Cir. 2005) (crediting evidence of SPECT brain scan in a case involving claims for long term disability); *see also* L.A. Farwell & S.S. Smith, *Using Brain MERMER Testing to Detect Concealed Knowledge Despite Efforts to Conceal*, 46 J. FORENSIC SCI. 1:1-9 (1001); Andre A. Moessens, *Brain Fingerprinting -- Can It Be Used to Detect the Innocence of Persons Charged with a Crime?*, 70 UMKC L. REV. 891 (2002); Malcolm Ritter, *Brain Scans May Be Used as Lie Detectors?*, ASSOCIATED PRESS, Jan. 29, 2006, http://abcnews.go.com/Technology/wireStory?id=1553625.

[6] *See, e.g.*, Michael J. Saks, *Merlin and Solomon: Lessons from the Law's Formative Encounters with Forensic Identification Science*, 49 HASTINGS L.J. 1069, 1097 (1998) ("After standing unquestioned for most of this century, a re-evaluation of handwriting identification expertise has resulted from the Supreme Court's decision in *Daubert*.").

[7] *See, e.g.*, Erica Beecher-Monas, *Blinded By Science: How Judges Avoid the Science in Scientific Evidence*, 71 TEMP. L. REV. 55, 96 (1998) ("Voice identification has also failed the scientifically valid prong of *Daubert*.").

[8] *See, e.g.*, *id.* at 86-87 (describing trial court's rejection of hair evidence for failure to meet standards of validation, despite recognition of "long history of admissibility").

[9] ANNOTATED SCIENTIFIC EVIDENCE REFERENCE MANUAL § 1-3.5.1[2] (Michael J. Saks et al. eds., 2004) [hereinafter ANNOTATED SCIENTIFIC] (identifying "scores of forensic techniques," including bite mark testing, that "might not survive empirical test").

even fingerprints[10] has been seriously called into question. Exoneration studies have demonstrated the shocking degree to which the criminal justice system has historically failed to prevent spurious sciences and faulty or fraudulent evidence from serving to convict innocent defendants. For example, one study found that defective scientific evidence contributed to over one-half of wrongfully obtained convictions.[11]

Of course, the unreliability of traditional techniques, and the failure of the criminal justice system to keep out such invalid evidence, has in large part been exposed through the use of the new, more reliable forensic techniques such as DNA typing. Accordingly, the conventional wisdom tends to assert that the qualities that make new methods so desirable and reliable will likewise render these techniques less susceptible, if not wholly immune, from the problems that plagued traditional sciences. Many critics of traditional sciences have even embraced new methodologies as offering a "new scientific paradigm" for forensic evidence, one in which "untested assumptions and semi-informed guesswork [is] replaced by a sound scientific foundation and justifiable protocols."[12]

But it stands to reason that a system that failed to stem the abuse of obviously faulty forms of forensic evidence might also be wholly ill-equipped to safeguard the use of more robust, complicated forms of such evidence, both in terms of assuring its integrity and of fostering healthy scientific development. In fact, as this Article argues, the very characteristics that make this new generation of forensic evidence so promising serve only to enhance the need for concern about the use of such evidence in the criminal justice system.

This Article sets forth three challenges to the customary way of thinking about forensic evidence in the criminal justice system. First, in contrast to the notion that all forensic sciences are essentially created equal and simply range on a continuum of less to more reliable, this Article defines a clear distinction between first generation and second generation forensic techniques and sets forth a framework for classifying

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[10] *See, e.g.*, Jennifer L. Mnookin, *Fingerprint Evidence in an Age of DNA Profiling*, 67 BROOK. L. REV. 13, 39-43 (2001) (detailing the uncritical acceptance of fingerprint evidence and chronicling subsequent challenges to the underlying validity of the technique).

[11] Michael J. Saks, *Scientific Evidence and the Ethical Obligations of Attorneys*, 49 CLEV. ST. L. REV. 421, 424 (2001) (citing statistics from the Innocence Project indicating that unintentional -- as opposed to fraudulent -- forensic science errors play a factor in 63% of wrongful conviction cases); *see also id.* at 424 (observing that one fourth of the cases involved fraudulent forensic science errors).

[12] *See, e.g.*, Michael J. Saks & Jonathan J. Koehler, *The Coming Paradigm Shift in Forensic Identification Science*¸ SCIENCE, Vol. 309, at 892 (Aug. 5, 2005).

such techniques based upon their relevant characteristics. Second, this Article uses the historical experience of first generation sciences in the criminal justice system to assess the future experience of second generation evidence. Contrary to conventional wisdom, which roundly favors second generation techniques over their now-discredited predecessors, this Article argues that the very characteristics that instill such confidence in the second generation sciences -- such as their technical complexity, reliance on databasing, and breadth of application -- in fact simply aggravate the conditions that ultimately caused widespread failures in the use of first generation evidence.

Third, this Article criticizes the suggestions typically put forward for improving the use of forensic evidence in the criminal justice system -- such as allocating greater funds for defense experts, holding more thorough hearings, or increasing training opportunities for lawyers and judges -- and argues that these suggestions fail to account for the particular demands of second generation sciences. Rather, this Article contends that our current models of criminal justice, even operating at their optimal level, cannot adequately safeguard the widespread use of highly probative and sophisticated evidence. Thus, in this age of powerful and pervasive new forensic technologies, the criminal justice system must reckon anew with how it accommodates scientific evidence. This Article therefore argues for new safeguards specifically responsive to the concerns raised by second generation evidence.

Part I defines the two generations of forensic evidence, and uses DNA technology to illustrate the particular characteristics of second generation sciences. Part II identifies the two "fronts" on which the battle for quality assurance is waged and lost with respect to all forensic evidence: the government laboratory and the courtroom, and demonstrates why the stakes are particularly high and the challenges particularly acute with regard to second generation techniques. Part III acknowledges conventional proposals to improve the judicial system's processing of forensic evidence and criticizes them for failing to address the distinct characteristics of the second generation. That Part then endeavors to sketch solutions specifically tailored to these concerns.

I. A NEW TAXONOMY OF FORENSIC EVIDENCE.

A. Defining The First And Second Generations.

The list of traditional forensic sciences is long and familiar. Such techniques include analysis of bite and tool marks, hair and fiber, ballistics, handwriting, voice exemplars, and fingerprints. These techniques have long appeared in criminal cases, but only in an

occasional and sporadic fashion. For a myriad of reasons, none of these "first generation" methods ever fully occupied the field of criminal adjudication.

First, traditional forensic techniques tended to apply only to particular categories of offenses. Handwriting analysis only aids those cases in which a writing is at issue; ballistics only when a gun had been discharged; blood typing only when there was some human biological residue. No single technique reliably solved a wide range of cases. Second, even within applicable cases, the recovery rate of such evidence was relatively low. Ballistic evidence is not available in every gun-related case, but only those in which a bullet is actually recovered. The delicacy of recovering hair or fiber strands likewise yields a low rate of recovery, since such evidence is readily lost or overlooked. Thus, only a fraction of cases within that limited category produced forensic evidence.

Third, first generation techniques require that the police identify a "suspect" for comparison -- whether in the form of an individual person or inanimate object. That is, ballistics not only applies only if a gun has been discharged and a bullet recovered, but also requires the recovery of a suspected weapon. Likewise, handwriting analysis works only if a suspected author had been identified. As a result, first generation forensic sciences lack a robust investigative capacity to identify a suspect in the first instance, and instead operate mainly to confirm the defendant's connection to a crime after some other evidence had identified him as the perpetrator. Given each of these limitations, these traditional forensic techniques appeared in criminal cases in a piecemeal and sporadic fashion, and usually in a supporting role to other forms of evidence like eyewitness testimony or the defendant's confession.[13]

In addition, when such evidence did appear, it tended not to be terribly conceptually demanding. First generation sciences -- for better or

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[13] It is worth noting that fingerprinting might be viewed, in some respects, as a bridge technology between the first and second generation. Fingerprinting historically has shared the characteristics of the first generation: it was available in a limited number of cases, had little investigative capacity, and was based on very little scientific validation. However, increased attention on validating the methodological underpinnings of fingerprinting techniques have pushed it more into the second generation category. More importantly, fingerprinting formally entered the second generation with the advent of the Automated Fingerprint Identification System (AFIS), which computerized the record-keeping and thus allowed for greater use of printing as an investigative tool. Simon A. Cole, *Fingerprint Identification and the Criminal Justice System*, *in* DNA AND THE CRIMINAL JUSTICE SYSTEM 74 (David Lazer, ed. 2004) (describing AFIS). Because fingerprints are often difficult to recover, and because prints occasionally contain cells that in turn yield DNA profiles, and because AFIS emerged about the same time as did DNA typing databases, fingerprinting techniques are likely to remain a secondary and occasional source of evidence, rather than a high-volume technology. Moreover, fingerprints allow identification only through a direct match to their owner; DNA typing allows identification even through familial association.

for worse -- typically do not depend upon technically sophisticated concepts, nor do they require particularly complex machinery or instrumentation to interpret. For example, handwriting or fiber analysis requires little more than a microscope and basic chemicals, and most of those who analyze such evidence have no advanced degree of any kind. First generation techniques are often even intuitively comprehensible by lay people; most people can quickly grasp the notion of matching fingerprint ridges, handwriting slants, or bullet grooves.[14] Finally, these techniques did not implicate greater questions of personal privacy or protection or proprietary information; to the extent that these techniques revealed information, that information tended to be limited to the facts and circumstances only of the case or suspect at hand.

The defining characteristics of the second generation of forensic evidence stand in stark opposition to the first generation. These second generation sciences include methods related to DNA typing, data mining (such as cell site or RFID tracking), biometric scanning (such as iris or facial recognition), or fMRI imaging. First, second generation techniques are not offense-specific, but rather apply across a broad range of charges and case types. They can apply as well to the most trivial misdemeanor as to the most serious felony. Second, such techniques have a high recovery rate, and thus yield results in a greater percentage of cases within that broad range. For instance, a typeable DNA sample can be recovered from a crime scene at a far greater frequency than can a useable fingerprint,[15] or an fMRI image could answer questions about a defendant's guilt in almost every interrogation. Second generation techniques in some respects can even render first generation methods irrelevant: where there is a fingerprint or hair evidence or even a handwriting sample, there is often sufficient genetic material to conduct DNA typing.

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[14] *See, e.g.*, David L. Faigman, *The Tipping Point in the Law's Use of Science: the Epidemic of Scientific Sophistication that Began with DNA Profiling and Toxic Torts*, 67 BROOK. L. REV. 111, 117 (2001) (noting ballistics and fingerprinting analysis both result in matching characteristics that are visible); Mnookin, *supra* note 10, at 32-33 (identifying the "cultural plausibility" of fingerprinting science as a contributing factor to its uncritical acceptance); *Developments in the Law -- Confronting the New Challenges of Scientific Evidence*, 108 HARV. L. REV. 1481, 1503 (1995) (chiding judges for applying a "show-and-tell" principle of admissibility, whereby a court admits scientific evidence that is intuitively visually comprehensible, such as fingerprint or handwriting, but excludes that which requires interpretation, such as polygraph).

[15] LAWRENCE KOBILINSKY, THOMAS F. LIOTTI & JAMEL OESER-SWEAT, DNA: FORENSIC & LEGAL APPLICATIONS 6 (2005). *Compare also, e.g.*, JOHN M. BUTLER, FORENSIC DNA TYPING 34 (2d ed. 2005) (listing various sources of DNA), *with* Cole, *Fingerprint Identification and the Criminal Justice System*, *in* DNA AND THE CRIMINAL JUSTICE SYSTEM, *supra* note 13, at 73 (outlining limitations of fingerprinting as a forensic technique).

Third, second generation techniques offer stronger -- and sometimes even scientifically certain -- proof of guilt. Rather than simply include the suspect within a class of potential defendants, second generation evidence typically purports to point exactly, and with scientific certainty, to the suspect as the perpetrator. Fourth, second generation techniques have the potential to generate this conclusive proof even in the absence of any other evidence, because second generation technologies tend to rely upon the accumulation and comparative examination of vast amounts of information stored in databases. As such, they have the power to isolate a suspect -- whether from a review of DNA profiles from all the men in the town aged 20-25 that happens to include the perpetrator's brother, or from a review of records indicating cell phone ownership.

Fifth, second generation techniques tend to derive from technically sophisticated and scientifically robust methodologies that require expensive equipment and particular expertise to interpret. For instance, conducting DNA testing or verifying facial recognition software requires both specialized training and access to appropriate, and typically costly, instrumentation. Finally, in part due to the technical sophistication and instrumentation of such methods, execution of second generation techniques also often raises concerns related to privacy or the exposure of proprietary information. Many of these novel methods involve proprietary information that the private companies that developed them seek to protect, or require reference to vast databases that contain information related to those not implicated in the crime at hand.

In order to illustrate the precise characteristics of second generation sciences, and to convey a sense of how such techniques will effect the administration of criminal justice, the next section explores the archetypal second generation science: DNA typing.

B. The Archetypal Second Generation Science: DNA Typing.

DNA typing debuted as a forensic tool in 1985, when Sir Alec Jeffreys first recognized its potential to answer the questions of identity that are often central to the resolution of criminal cases.[16] After its birth in the United Kingdom, the technique quickly jumped the pond, and by 1988 it had appeared in the United States in the first reported appellate

[16] Mnookin, *supra* note 10, at 40. DNA typing has also found application in family court cases, where paternity is at issue, and even in civil matters, *see, e.g.*, *Alabama Tombigbee Rivers Coalition v. Norton*, No. CIV.A.CV-01-S-0194-S, 2002 WL 227032 (N.D. Ala. 2003) (discussing challenge to listing of species on Endangered Species Act that involved DNA testing of contested fish).

case.[17] Since then, the power of DNA science as has dazzled every faction of the criminal justice community, even defense attorneys.[18]

Consider an investigation in the United Kingdom: a brick thrown off an overpass hits a car passing below, killing the driver. Investigators have no leads other than a small quantity of blood found on the brick, which in turn yielded a DNA profile. A search of the nationwide database, which contained over two million profiles, reveals no direct matches. However, a "familial" search of the same database -- looking for profiles that correlate highly to the evidentiary profile -- yields a match. Investigators followed the lead to a relative, and find the suspect, who later confesses and is convicted.[19] Although the perpetrator's profile was not in the database, his relative's profile -- which would approximate his profile at a much higher frequency than would the profile of an unrelated individual -- directed officers to the right person.

As this anecdote illustrates, DNA typing has the potential to transform the manner in which suspects are apprehended, prosecutions are brought, and convictions are secured. As one of the most developed of the second generation sciences, DNA typing provides excellent clues into how second generation sciences will change criminal justice, and what potential concerns such evidence will raise.

1. A High Volume of Cases With A Forensic Evidence Component.

A study of DNA typing reveals the manner in which second generation evidence transforms the nature of proof within the criminal system. Because such techniques are methodologically robust, apply across a wide range offenses, and have a high recovery rate, it is easy to anticipate that cases with this forensic evidence component will soon displace those cases without such evidence, ultimately resulting in a

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[17] *Andrews v. State*, 533 So. 2d 841 (Fla. Dist. Ct. App. 1988).

[18] *See, e.g.*, David Lazer, *Introduction: DNA and the Criminal Justice System*, *in* DNA AND THE CRIMINAL JUSTICE SYSTEM, *supra* note 13, at 3-4 (quoting Bruce Budowle, director of the FBI lab, as commenting that "[o]ne attorney … had the position that thousands of innocent people are in jail because of DNA typing" and "[t]hat same attorney" thinks that "thousands of innocent people are in jail because of no DNA typing"). While Budowle's observations nicely illustrate both sides of the DNA coin, they fail to acknowledge the significant differences between *exculpatory* DNA typing and *inculpatory* DNA typing. The power of DNA evidence to *exclude* a suspect has never been in serious dispute -- by analogy, it is easy to determine that your type AB blood sample did not come from your O+ suspect. But it raises far more contestable issues to conclude that a particular suspect is precise, or even probable, source of the sample.

[19] Matthew Falloon, *DNA Traps Brick Thrower Who Killed Lorry Driver*, THE GUARDIAN (London), Apr. 20, 2004.

criminal docket with a large volume of cases involving scientific evidence.

For instance, although DNA typing techniques were both cumbersome and expensive when first conceived, recent scientific advances now allow rapid processing and turnaround at a rate conducive to the wide-scale use of DNA evidence. Whereas processing used to take weeks, if not months; with robotics and automation, it is expected that analysts will soon be able to process up to 800 samples a day.[20] For instance, in the United States, the average turnaround time for a DNA request today is twenty three weeks in a state laboratory, and thirty weeks in local laboratories.[21] By comparison, the national crime laboratory of the United Kingdom (the Forensic Science Service or FSS), which leads the world in its application of forensic DNA, tolerates only a twenty-four day turnaround time for submission and return of forensic samples.[22] Offender samples -- those drawn in ideal conditions from a single-source, known individual -- typically take the FSS five days.[23] Miniaturization processes will one day enable on-scene analysis of DNA that takes only seconds.[24]

Furthermore, modern techniques allow analysts to take the smallest bit of biological material and duplicate it to create a testable quantity,[25] as well as to examine multiple places, or loci, on the genetic

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[20] Shaila K. Dewan, *As Police Extend Use of DNA, A Smudge Could Catch a Thief,* N.Y. TIMES, May 26, 2004, at A1. DNA testing in the United States is largely conducted in state or local laboratories. Nicholas P. Lovrich, Michael J. Gaffney, Travis C. Pratt & Charles L. Johnson, *National Forensic DNA Study Report*, U.S. Dep't of Justice Grant 2002-LT-BX-K 003), Dec. 12, 2003, at 15, http://www.ncjrs.gov/pdffiles1/nij/grants/203970.pdf [hereinafter *National Report*] (reporting that 80.1% of law enforcement agencies use a state laboratory to process DNA evidence, 11.7% use a local agency laboratory, and only 2.9% use private laboratories). Currently, state laboratories process an average of 1,284 samples a year, whereas the local laboratories process an average of only 771. *Id.* at 28-29. Automation not only reduces the time associated with processing DNA, it also reduces the costs. Although it is difficult to estimate the precise expense of processing DNA results, it is estimated that analyzing a simple, typical rape kit today costs roughly $1,100. *Id.* at 34. This estimate includes the costly chemicals or reagents necessary to do the tests, as well as salaries of analysts, but not overhead or equipment. *Id.*

[21] *National Report*, *supra* note 20, at 28-29.

[22] *Id.* at 28-29.

[23] Christopher H. Asplen, *The Application of DNA Technology in England and Wales*, U.S. Dep't of Justice, Dec. 12, 2003, at 15, http://www.ncjrs.gov/pdffiles1/nij/grants/203971.pdf [hereinafter *DNA in England*]. FSS processes roughly 30,000 offender samples a month. *Id.*

[24] Alec J. Jeffreys, *Genetic Fingerprinting*, Commentary, NATURE MED. Vol. 11, No. 10 (Oct. 2005), at 1039.

[25] The technique of Polymerase Chain Reaction (PCR) allows scientists to amplify genetic material to produce a more readily measurable amount.

strand at the same time.[26] Whereas in the past a forensic scientist often required a significant amount of material, scientists now are able to generate profiles from as few as six cells -- a quantity not even visible to the naked eye.[27] Advances in collection techniques allow easier and less intrusive gathering of samples. Nuclear DNA is obtained from the nucleus of cells; it thus is found not only in blood, but also in saliva containing skin cells, or a hair follicle, or skin scrapings. Buccal swab kits, which demand no more than a painless scrape of the inside of a suspect's cheek, are increasingly sensitive and render clear, typeable results. Moreover, if nuclear DNA testing cannot be performed because a forensic sample contains degraded or dead cells, mitochondrial DNA typing can often recover genetic information stored in the cell long after the nuclear DNA has decomposed. And sophisticated processing techniques also enable analysts in certain situations to "pull-apart" forensic samples containing mixtures of more than one person's DNA, which can be useful in cases involving genetic information from persons of different sexes.[28]

Given the ease with which biological evidence is recovered, and the advances in cost-effective and efficient processing of large quantities of evidentiary samples, it is not hard to envision a future in which biological evidence plays a central role in criminal investigation and adjudication. Today, the public imagination of DNA holds that it is most commonly applicable in the prosecution of serious offenses such as rape and murder. However, perhaps counter-intuitively, it may be that DNA evidence holds the *least* amount of promise as regards these types of offenses: rape and homicide cases tend to be amenable to defenses (such as self-defense or consent) that render the DNA evidence irrelevant, or less probative.[29] Instead, DNA evidence may have the greatest promise

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[26] Multiplexing systems now allow DNA analysts to express the genetic information stored at several loci in one simultaneous process, rather than run separate tests for each locus.

[27] In a pilot program conducted in the United Kingdom in 2000-2001, experienced LCN technicians responded to all stolen vehicle scenes and swabbed for biological evidence. *DNA in England*, *supra* note 23, at 26. The study showed that experienced technicians were able to recover LCN samples from 51% of the scenes they attended. *Id.* at 27. At present, however, LCN is not typically considered generally accepted for inclusion purposes, because it raises a number of serious sensitivity concerns, although it still has value as a method of exclusion. KOBILINSKY, LIOTTI & OESER-SWEAT, *supra* note 15, at 112-13.

[28] The technique is known as Y-STR typing, and capitalizes upon the chromosomal differences between men and women to amplify only the male fragment of the forensic sample. Such a technique aids investigators in rape cases, who often confront mixed samples that contain a female victim and a male perpetrator. *See* KOBILINSKY, LIOTTI & OESER-SWEAT, *supra* note 15, at 113-17.

[29] Although, one exception may be with respect to child sexual abuses cases. Because there are no consent-based defenses to child sexual abuse, the presence of a defendant's genetic

with regard to its use to solve low-level crime like property or possession offenses

For instance, property offenses presently constitute an enormous volume of criminal complaints, but carry a very low rate of arrest or "clearance." Although many people complain of burglaries and thefts, very few of those complaints are answered with an arrest. Yet property offenses cost billions of dollars annually.[30] According to the Department of Justice's Uniform Crime Reporting statistics, there were roughly 10.4 million reports of burglary, theft, and automobile theft in 2003.[31] Of the estimated 1.2 million motor vehicle thefts, only 13.1% of motor vehicle crimes were cleared;[32] of the roughly 7 million larcenies or thefts, only 18.1% were cleared;[33] and of the 2.2 million burglaries, only 13.1% of burglaries were cleared.[34] By means of contrast, a much higher percentage of violent offenses are cleared by arrest; in 2003, there were only 1.38 million reported violent crimes -- offenses such as murder, rape, robbery, and aggravated assault[35] -- and 46.5% of them were cleared.[36] Although property offenses exact a costly penalty on communities, they are rarely closed by arrest or conviction.

However, early data suggest that the availability of DNA evidence can radically transform these numbers. In a typical month, the United Kingdom's Forensic Science Service, or FSS, makes an association or "hit" between a forensic and known samples in their databases in roughly 15 murder cases and 31 rape cases -- and in a whopping 770 motor vehicle offenses.[37] As one study observed, "[f]rom April 1995 to the end of January 2002, the majority of matches were not made in rape, other sexual offenses, or murder. Instead, the largest numbers of matched crimes were commercial and residential burglaries."[38] Local experience bears this out: in Virginia, of the first

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material in the body cavity of a child can more or less conclusively prove a case, even without subjecting a child the trauma of testifying in court.

[30] In 2001, the United States lost 16.6 billion dollars from non-arson related property crimes.

[31] Bureau of Justice Statistics, *Sourcebook of Criminal Justice Statistics, 2003*, Washington, D.C.: U.S. Dep't of Justice, Bureau of Justice Statistics, 2004, at 130.

[32] *Id.* at 57.

[33] *Id.* at 49, 53.

[34] *Id.* at 45, 47.

[35] *Id*. at 11.

[36] *Id.* at 13.

[37] *DNA in England*, *supra* note 23, at 12.

[38] *Id.*

2000 hits in no-suspect cases, only 12% were for murder or rape, whereas 59% helped solve property crimes such as burglary or robbery.[39] Moreover, data suggest that there is a higher than expected correlation between those who commit property offenses and those who commit violent offenses. This fact is likely only to increase attention toward the wisdom of allocating resources to apprehend property offenders.[40]

Similarly, DNA evidence can have a significant impact with regard to narcotics- or weapons-based possession offenses -- whether simple possession or with an intent. Such cases constitute a major volume of crime charged in the United States. For example, a Department of Justice study from 2000 reports that 40% of state-charged felonies across large urban counties were weapon or drug possession related offenses.[41] The viability of such prosecutions, however, often turns on whether the suspect is apprehended in immediate or visible possession of the contraband; the suspect not in actual possession of the contraband often eludes effective prosecution. DNA typing, however, can conclusively link a suspect to an item of contraband. There is even strong indication that suspects possess no "reasonable expectation of privacy" in shed DNA cells,[42] and thus law enforcement can easily gather such probative without worrying about the individual's constitutional rights.

Given the power of this type of tool, it is evident that as the cost of forensic DNA typing goes down, and law enforcement officers' and prosecutors' interest and confidence in such technology goes up, greater and greater numbers of such cases will enter into the criminal justice

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[39] *Virginia Lab Records its 2,000th DNA Cold Hit*, PARK NEWS, June 11, 2004 [hereinafter *Virginia Lab*].

[40] The state of Virginia reports that 37% of the violent crimes linked through the first 1000 "cold hits" were linked to offenders who had only previous convictions for property offenses. Paul B. Ferrara, *An Analysis of the First 1000 Hits and Implementation of Point of Arrest Collection*, Virginia Division of Forensic Science.

[41] U.S. DEP'T OF JUSTICE, BUREAU OF JUSTICE STATISTICS, *Felony Defendants in Large Urban Counties*, 2000, at iii.

[42] *See, e.g.*, *People v. Padilla*, No. B153331, 2002 WL 31518865 (Cal. Ct. App. 2002) (unreported decision finding no violation of defendant's Fourth Amendment rights because defendant had no legitimate expectation of privacy in ejaculated semen provided by girlfriend); Molly McDonough, *Cops Played Lawyer to Get DNA*, ABA J. & Rep., Jan. 27, 2006 (describing court proceedings in *State v. Athan*, No. 75312-1, in which trial court upheld ruse by police, posing as lawyers in fictitious firm, to get defendant's DNA by mailing him a false letter inviting him to join a class action, and then testing the saliva on the envelope upon its return); Richard Willing, *Police Dupe Suspects into Giving up DNA*, USA TODAY, Sept. 10, 2003 (describing a range of trickery to obtain DNA samples including posing as "a phony dating service … a public health worker … a rape counselor … a Taco Bell worker … and a diner").

system.[43] If sending an evidentiary sample to be analyzed for DNA evidence is as easy as it already is to send a sample to be analyzed for narcotics, then law enforcement officers might be expected to regularly conduct such tests, even in cases involving low-level offenses. Indeed, the state of New York has plans to open a state of the art DNA testing laboratory intended only for processing of property and other low-level crimes.[44] In the United Kingdom, roughly 50% of DNA evidence sample submissions in 2001-2002 were for property or theft crimes,[45] and roughly 17% of the submissions of samples for DNA testing were for drug offenses.[46]

Of course, more cases may simply mean that: more cases. But given the scarcity of resources in the criminal justice system, it more likely that DNA-based cases will displace non-DNA based cases than it is that the raw number of cases will simply dramatically increase. Given that prosecutors inevitably must choose only a fraction of cases to pursue from the greater number of cases presented to them for prosecution, it is easy to imagine a bias toward DNA-based evidence in allocating resources.[47] Cases founded on scientific evidence are typically

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[43] One study revealed that a major factor in the under-utilization of DNA typing and databasing technology is simple lack of education and awareness. When surveyed about reasons for failing to submit evidentiary samples, 31.4% of laboratories reported that they did not conduct testing because a suspect had not yet been identified. *National Report*, *supra* note 20, at 22. Yet, in the words of the study, "[c]learly these 'no suspect' cases are exactly the types of crime scene evidence that need to be submitted in order for the DNA database to be effective." *Id.* at 18. In the written comments portion of the survey, laboratory remarks demonstrated a lamentable lack of awareness of available resources, with multiple observations that "National DNA database needed." *Id.* at 19. In short, the survey revealed that -- far more than concerns about funding or backlogs -- the major impediment to the investigatory use of databases was simple lack of information about their availability. *Id.* at 22.

[44] Shaila K. Dewan, *As Police Extend Use of DNA, A Smudge Could Catch a Thief*, N.Y. TIMES, May 26, 2004, at A1. *See, e.g.*, Nat'l Institute of Justice, Office of Justice Programs, U.S. Dep't of Justice, *DNA in 'Minor' Crimes Yield Major Benefits in Public Safety*, Nov. 2004 (reporting that, "[i]n New York, biological evidence from 201 burglaries yielded 86 CODIS-acceptable DNA profiles" and noting success in retrieving evidence from "the sweatband inside a cap, from the inside of a mask, on a cigarette butt, in chewing gum, on a drinking glass, or from a half-eaten sandwich").

[45] Virginia likewise reports that, as more officers use and appreciate DNA services, the "amount of evidence submitted by law enforcement for DNA analysis grows by 30 percent every year." *National Report*, *supra* note 20, at 22.

[46] *DNA in England*, *supra* note 23, at 18.

[47] Thus, for example, whereas in the past the government might not charge a passenger found in a car with a gun in the trunk, because of lack of evidence linking the two, the government would charge that passenger if the gun had the passenger's DNA on it. To make room for that case, the government might not charge the driver found with a gun under his seat -- even

accordingly easier to prove, more certain, and more reliable. Some have complained that such evidence is even demanded by the population at large, and lamented a so-called "CSI effect" in jurors exposed to unrealistic crime scene television shows.[48] Thus, prosecutors faced with limited resources will logically prefer those cases in which proof of scientific certainty is readily available to those that rely only on civilian witnesses or law enforcement officers on overtime pay.[49] If so, then the typical prosecutor's case docket would likely contain a percentage of DNA-based cases disproportionate to, and greater than, the percentage of such cases in the pool at large.[50] The first lesson about second generation sciences then, is that their particular characteristics render them likely to appear in a high volume, and across a wide spectrum (ranging from minor to major offenses) number of cases.

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though in the past that would be the kind of case upon which it would proceed -- due to concern that the lack of DNA evidence renders the case less likely to be successful.

[48] *See, e.g.*, Richard Willing, *"CSI Effect" Has Juries Wanting More Evidence*, U.S.A. TODAY, Aug. 5, 2004.

[49] It may also be that "[o]ne consequence of mathematical proof . . . may be to shift the focus away from such elements as volition, knowledge, and intent, and toward such elements as identity and occurrence . . . ." Laurence H. Tribe, *Trial By Mathematics*: *Precision and Ritual in the Legal Process*, 84 HARV. L. REV. 1329, 1366 (1979). Thus, for example, in the case of widespread availability of DNA evidence, the government might elect to bring cases in which the sole question is one of identity -- readily established by the DNA evidence -- and dispense more readily with those cases where questions of intent are concerned. Imagine a prosecutor can only bring thirty cases due to resource constraints. One hundred cases come in, only forty of which have DNA evidence. The prosecutor may choose to bring a handful of non-DNA cases because of pressing concerns raised by the offense or the victim, but the vast majority of the "thirty" slots are likely to be allocated to the DNA-based cases, even though DNA cases were a minority of the total possible cases brought. The percentage of cases brought with a DNA element (say, 80%) therefore will not mirror the objective percentage of cases with DNA evidence in the world at large (40%).

[50] Of course, it is arguable that the availability of DNA evidence will eventually cause criminals to "wise up" and either take measures to hide their identity or else shift to types of crimes in which DNA evidence is less readily obtained. However, while possible, such a result seems implausible, at least on a broad scale. First, many crimes are committed by those with little education and little foresight, and often while their thought is clouded from illegal drug use. Consider, for instance, the ease with which a robber can hide his identity by putting on a mask, yet not every robber is masked. Second, unlike fingerprints or facial features, it is hard to avoid leaving a DNA trail, even when steps are taken to do just that. BUTLER, *supra* note 15, at 1-2 (describing rape case in which defendant had victim shower to eliminate evidence, but in which investigators recovered saliva cells from a beer can and an amount of semen undetectable to naked eye from bed). Finally, because DNA technology applies across a wide-variety of cases, it may be less susceptible to subtle shifts caused by deterrence, because it would require abstaining from criminality altogether, rather than from a particular crime.

2. An Entirely New Kind Of Case: That In Which The Only Evidence Is Forensic Evidence.

Second generation sciences do not just encourage the substitution of cases with a forensic evidence component for those without such a component. They also have the capacity to identify perpetrators even in the absence of any other evidence. Thus, second generation sciences introduce into the criminal justice system an entirely new kind of case: one in which the only evidence is the scientific evidence.

In the case of DNA typing, law enforcement increasingly has at its disposal a large database of genetic information. Specifically, as law enforcement collects and processes DNA samples, the "profiles," or genetic results of the testing, are loaded into computer databases. These databases typically contain two types of files: "forensic" samples, or samples from crime scenes that contain genetic information of unknown or suspected individuals, and "offender" or "known" samples, single-source profiles that contain the genetic signature of an offender or known person who submitted biological material voluntarily[51] or pursuant to one of many offender-collection statues.[52]

In the United States, the universal DNA database is called CODIS, or the "Combined DNA Index System," and it exists at three

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[51] In fact, recent concerns have arisen as a result of law enforcement's increasing use of DNA "sweeps" to collect genetic information. In a "sweep," law enforcement officers investigating an offense descend on a community and request voluntary submission of DNA samples from the entire eligible population. *See, e.g.*, Pam Belluck, *To Try to Net A Killer, Police Ask a Small Town's Men for DNA*, N.Y. TIMES, Jan. 10, 2005. Voluntary contributors to such efforts have later balked at the government's continued retention of the genetic sample after the case is closed. Tim Potter & Stan Finger, *Motion Asks: What Happens to DNA?,* WICHITA EAGLE, Mar. 9, 2005 (describing motion to return DNA sample filed by man who submitted DNA in a "dragnet" related to search for BTK killer); Richard Willing, *Privacy Issues is the Catch for Police DNA Dragnets*, USA TODAY, Sept. 16, 1998; Keith O'Brien, *Men Seek Return of DNA From Serial Killer Search: Some Claim Police Bullied Them for Swabs*, TIMES-PICAYUNE, Dec. 28, 2003.

[52] For a comprehensive listing of such statutes, *see* David Lazer & Michelle N. Meyer, *DNA and the Criminal Justice System: Consensus and Debate*, *in* DNA AND THE CRIMINAL JUSTICE SYSTEM, *supra* note 13, at 372-73. Unfortunately, the constitutional and statutory limitations on the collection of genetic material, and the proper use of such material, exceeds the scope of this article, although scholars and courts have struggled with this very question. *See, e.g.*, *United States v. Kincade*, 379 F.3d 813 (9th Cir. 2004) (en banc) (upholding statute requiring convicted felons to submit material to DNA database); *Nicholas v. Goord*, 430 F.3d 652 (2d Cir. 2005) (same); D.H. Kaye & Michael E. Smith, *DNA Identification Databases: Legality, Legitimacy, and the Case for Population Wide Coverage*, 2003 WISC. L. REV. 413, 415 (advocating for population-wide database as most effective means of preserving privacy and social justice interests). Suffice it to say that many interesting questions -- ranging from privacy concerns to the scope of the Fourth Amendment and beyond -- are raised by the collection, storage and search of a citizen's genetic information.

levels: local (LDIS), state (SDIS), and national (NDIS).[53] While NDIS is governed by statutes and regulations that strictly circumscribe the information that may be uploaded, and requires that laboratories who load profiles meet certain proficiency standards,[54] the local and state counterparts can often include material obtained under less stringent standards.[55] As of December of 2005, the national database, which is maintained by the Federal Bureau of Investigation (FBI) and to which every state but Mississippi contributes, contained over 2.9 million profiles.[56] Of these, 125,315 were forensic samples, and 2.8 million were known or offender profiles.[57] The states are not far behind: Virginia, which is widely recognized as among the most advanced jurisdiction in dealing with DNA issues,[58] has loaded over 236,000 offender samples and 5000 forensic samples.[59] California has loaded 316,307 known profiles, and keeps 8,801 forensic samples.

The availability of DNA databases has generated an entirely new set of cases: the "cold hit" case, or the case in which the major or only evidence is biological material linking the defendant to the offense. In these cases, the government has no investigatory leads, but manages to develop a genetic profile based upon some material left at the crime scene. The government then runs that forensic profile in a database, and uncovers a "match" -- a stored sample associated with a known person or offender. From that, the government either develops further facts to

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[53] *See* 42 U.S.C. §§ 14131 *et seq.*

[54] For instance, laboratories cannot load partial profiles into NDIS, and strict rules govern what constitutes an appropriate "crime scene" or "forensic unknown" sample. Laboratories must also comply with quality assurance standards issued by a technical working group affiliated with the FBI.

[55] Individual states also maintain offender databases that include profiles extracted in laboratories unqualified to submit material nationally, as well as profiles insufficiently complete to qualify for inclusion in the national database.

[56] NDIS statistics, FBI, CODIS clickable map, *available at* http://www.fbi.gov/hq/lab/codis/clickmap.htm (last visited Jan. 5, 2006). In the United Kingdom, the FSS claims it has effectively loaded the profiles of the entire "criminally active population."

[57] *Id.*

[58] Virginia started its database in 1989, but only loaded known samples from certain sex offenders. In 1990, the state expanded its mandatory submission laws to include select felons, and later added all felons, juveniles adjudicated delinquent, and arrestees.

[59] Virginia Department of Criminal Justice Services, DNA Databank Statistics, *available at* http://www.dcjs.virginia.gov/forensic/information/dna.cfm (last visited Jan. 5, 2005). Notably, these numbers do not include databases kept at the state level, which are often more expansive because they need not comply with federal laws in processing or reporting information.

implicate the suspect, or else brings the case on the basis of this evidence alone. In some cases, the offense occurred long before genetic typing was availability -- including as far back as twenty or thirty years.[60]

As of November 2004, federal investigators had used the national database to make roughly 19,500 "cold hits" -- the shorthand for an association made between two samples that otherwise had not been linked by any evidence.[61] And, as the databases grow, the match capacity has skyrocketed: whereas it took nearly eight years, from 1993-2001, for Virginia to reach its first 1000 "cold hits," the state reached its second 1000 in a matter of eighteen months.[62] Since 2001, the laboratory has averaged at least one "cold hit" a day, and as of July 2002, that figure had already doubled to two and one half hits a day.[63]

To be sure, in the majority of cases, the government will endeavor to collect additional evidence beyond the forensic proof. For instance, in one case, the government established a "cold hit" and, having identified a suspect, then found two witnesses who claimed to recall the suspect having a cut on his finger the day of the murder a year earlier that corresponded to a wound inflicted by the victim.[64] But, in many cases, the government may proceed on the sole basis of genetic evidence, or on marginally probative additional evidence such as the fact that the suspect lived within a reasonable distance of the offense.[65] Some jurisdictions

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[60] *See, e.g.*, David Snyder, *DNA Links Ga. Man to Md. Rapes*, WASH. POST, Apr. 27, 2005, at B5 (describing how a profile entered into the national database by a New York lab turned up "matches" to a string of rapes in the late-1980s in Maryland, as well as two rapes in the New York area in the earlier 1970s).

[61] NDIS statistics, FBI, Measuring Success, *available at* http://www.fbi.gov/hq/lab/codis/success.htm (last visited Jan. 5, 2005). "Cold hits" can be either an offender-to-scene match, meaning a known offender fits an unknown profile recovered at a crime scene, or a scene-to-scene match, meaning that the profile derived from an unknown sample from one crime scene matches that found at another crime scene.

[62] *Virginia Lab*, *supra* note 39; Karin Brulliard, *Va. Gets U.S. Funds for DNA Backlog*, WASH. POST, Sept. 22, 2004, at B01 (reporting that as of July 31, law enforcement in Virginia had found suspects in over 2,000 cases in which there was no evidence -- including 1,200 burglaries and robberies -- through their DNA database).

[63] *Id.*; *see also* Amitai Etzioni, *DNA Tests and Databases in Criminal Justice*, *in* DNA AND CRIMINAL JUSTICE, *supra* note 13, at 200. California likewise reports one cold hit a day. Bureau of Forensic Service, California Dep't of Attorney Gen'l, *available at* http://caag.state.ca.us/bfs/ (last visited Jan. 5, 2005).

[64] New York State Division of Criminal Justice Services, DNA Case Highlights, *available at* http://criminaljustice.state.ny.us/forensic/dnacasehighlights.htm (describing case of Bryan R. Hawkins in Monroe County).

[65] Courts have not reached consensus on the question whether genetic evidence, without more, suffices to support a verdict of conviction. *See, e.g.*, *Roberson v. State*, 16 S.W.3d 156, 170 (Tex. Crim. App. 2000) (observing that "the perils of eyewitness identification testimony far exceed those presented by DNA expert testimony" and affirming that verdict can be based on

have even responded to the influx of cold hit cases by authorizing "John Doe" warrants intended to evade statute of limitations restrictions.[66] Thus, investigators can seek an arrest warrant based on a certain genetic profile, which remains viable should the individual ever enter the system. In Wisconsin, the legislature simply dispensed entirely with statute of limitations.

For several reasons, including the lack of central recordkeeping, it is difficult to determine the present frequency with which the government brings cases in which the only evidence is genetic material.[67] First, although laboratories increasingly record their "cold hit" match occurrences, most fail to follow-up on the number of cases that actually proceed to prosecution and disposition. Second, of those jurisdictions that have tracked the prosecution rates, none appear likewise to track whether or not additional evidence was subsequently adduced in the case. Third, the "cold hit" is still a relatively recent phenomenon, and thus the cases may not have yet wended their way through the courts.[68] Finally, it seems likely that in a great number of cases, the existence of the genetic evidence results in a guilty plea, which increases the likelihood that no judicial trail is left because there is no appellate challenge. In Virginia, for example, an inmate arrested apparently on the basis only of a cold hit pleaded guilty and accepted the death penalty.[69]

DNA alone); *People v. Rush*, 672 N.Y.S.2d 362, 363 (App. Div. 1998) (upholding conviction based only on DNA evidence, even given that complainant misidentified defendant at trial, and rejecting argument that DNA is not "infallible" and thus cannot stand alone because "[v]irtually no evidence is absolutely conclusive"). In the United Kingdom, the Court of Appeal quashed the conviction of a man found guilty by a jury solely on the basis of genetic evidence indicating that the random match probability of his genetic profile to the evidentiary sample was about one in four million; based on those statistics, the court concluded that he was one in seven to ten males in the United Kingdom with such a profile. Mike Redmayne, *Rationality, Naturalism, and Evidence Law*, 2003 MICH. ST. L. REV. 849, 879-80 (2003) (citing *R v. Lashley*, an unreported case discussed in Mike Redmayne, *Appeals to Reason*, 65 MOD. L. REV. 19 (2002)). Professor Redmayne noted that the accused also had no connection to the area. *Id.*

[66] *See, e.g.* Edward J. Imwinkelreid, *The Relative Priority that Should Be Assigned to Trial Stage DNA Issues*, in DNA AND THE CRIMINAL JUSTICE SYSTEM, *supra* note 13, at 94-95 (listing states where legislators have proposed John Doe legislation, along with those in which prosecutors have sought such warrants even without express legislative authorization).

[67] *See* Lazer & Meyer, *supra* note 52, at 379.

[68] In Virginia, for example, a survey conducted in 2003 of the outcome of the first 1000 cold hits revealed that 100 resulted in convictions through plea or trial, 7 yielded not guilty verdicts, and fifty-three were never prosecuted; 752 were pending at the time of the survey. Ferrara, *supra* note 40.

[69] Bill Baskervill, *DNA Match Leads to Death Row*, DETROIT NEWS, Mar. 11, 2002.

From anecdotal reports, however, it is clear that some such cases are going forward.[70] The first apparent case occurred in the United Kingdom, and was a rape case in which no other evidence was introduced save the genetic information and the fact that the defendant had access to the area of the offense.[71] In Louisiana, Derrick Lee Todd was arrested as result of a DNA dragnet conducted in May of 2003.[72] In August and October of 2004, he was convicted of two separate murders and sentenced to death.[73] In Virginia, a murder that occurred in 1992 remained unsolved for years, and investigators had no leads. Four years later, offender Mack Reaves was required to submit a DNA sample, but backlogs prevented it from being processed until 2001. Once analyzed, the sample was matched to the 1992 case, and Mr. Reaves pleaded guilty in 2001 to avoid the death penalty.[74] Clearly, the "cold hit" case has staked a place in the criminal justice system that will likely only expand as courts and prosecutors grow increasingly reliant upon, and comfortable with, DNA databases.[75]

Yet at present, the legal framework for thinking about forensic evidence hews to a notion of forensic evidence better suited to the characteristics of the first, rather than the second, generation. The Supreme Court last addressed the constitutional requirements for expert assistance to indigents in an insanity case in 1985, *Ake v. Oklahoma*, which in turn recognized only the barest of entitlements to expert advice where the defense hinged on the question of the defendant's sanity.[76] Similarly, the Court's latest articulation on the

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[70] *See, e.g.*, *People v. Harrison*, 2005 WL 2429974 (NY Oct. 4, 2005); *see also* Lazer & Meyer, *supra* note 52, at 379 (reporting that a 2001 study of New York's first 102 cold hits found that four had resulted in convictions, and that charges were pending in 14 others, but there was no data about the remaining cases).

[71] *Regina v. Adams*, [1998] 1 Crim. App. 377 (Eng. C.A. 1997).

[72] Melinda DeSlatte, *Jury Hears Testimony of DNA Evidence in Derrick Lee Todd Case*, THE SUN HERALD (So. Miss.), Oct. 5, 2004.

[73] *Id.*

[74] Tom Jackman, *VA Man Receives Life Sentence for '92 Slaying: VA DNA Database Led Police to Suspect Eight Years After Shopkeeper's Death*, WASH. POST, at B02. In another Virginia case, a man was arrested and charged for a rape that occurred 22 years earlier. David Stegon, *DNA Cold Hit Leads to Rape Charge*, MANASSAS JOURNAL MESSENGER, Jan. 11, 2005.

[75] Notably, there are presently over 500,000 backlogged evidentiary samples believed amenable to testing, in homicide, rape, and property crime offenses. *National Report*, *supra* note 20, at 14.

[76] *Ake v. Oklahoma*, 470 U.S. 68 (1985); *see also Caldwell v. Mississippi*, 472 U.S. 320 (1985).

importance of preservation of physical evidence in a criminal case came almost twenty years ago in *Arizona v. Youngblood*,[77] in which the Supreme Court held that the Due Process Clause was not violated by the government's destruction of physical evidence, so long as it was not done in bad faith.[78] In short, contemporary approaches to scientific evidence assume what is now a quaint conception of the role of forensic science in criminal adjudication: the view that forensic evidence is auxiliary, occasional, and non-determinative. But as the preceding section demonstrated, the emerging reality is that forensic science is central, pervasive, and determinative in criminal adjudication.

II. THE SINS OF THE FATHER: TWO FRONTS, TWO FAILURES.

If the criminal justice system of the future will contain a high volume of cases involving forensic science-based proof -- and indeed, some of which involve *only* such proof -- then it remains to be asked whether our conventional models of criminal process are up to the task of managing such evidence. There are two essential questions that must be answered with regard to forensic evidence: is the technique used to interpret the evidence reliable as a method, and was that technique executed reliably in the particular case.[79] In the landmark case of

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[77] 488 U.S. 51 (1988).

[78] In many jurisdictions, a defendant had no right to obtain physical evidence in control of the state for purposes of independent testing. In specific response to the availability of DNA testing, many legislatures have granted to defendants a legal entitlement to testing both pre-trial and post-conviction. *See, e.g.*, D.C. Code § 22-4133; Helen Dewar & Dan Morgan, *Senate Approves Bill On Victims' Rights*: *Both Chambers Tackle Busy Agendas*, WASH. POST, Oct. 10, 2004, at A05 (reporting on passage of federal law appropriating funds for defense DNA testing). However, this right to test tends only to apply to DNA, and is second to the government's right -- if the government elects to test, and such testing consumes the sample, the defendant cannot claim a violation.

[79] Laurens Walker & John Monahan, *Social Facts: Scientific Methodology as Legal Precedent*, 76 CAL. L. REV. 877, 886-87 (1998) [hereinafter Walker & Monahan, *Social Facts*]. *Daubert* subscribes to the same basic structure, finding "conclusions and methodology" to implicate distinct interests. *Daubert*, 509 U.S. at 595 (placing "the focus, of course, . . . solely on principles and methodology, not on the conclusions that they generate"); *but see Joiner*, 522 U.S. at 146 (breaking down distinction and observing that "conclusions and methodology are not entirely distinct from one another"). Professor Michael Saks, examining the criminal law, finds maintenance of the distinction between conclusions and methodology beneficial, and subdivides the inquiry one degree further:

> At the highest level of abstraction are scientific theories, the basic concepts underlying and explaining a field's empirical knowledge. One step down are general applications of the theory, that is, broad applications to the real world of procedures, techniques, relationships, or measures that follow from the theory. At the most concrete level are specific applications of the field's knowledge, tools, and procedures to the case at bar.

Daubert v. Merrill Dow Pharmaceuticals[80] the Supreme Court, in elaborating its regime for assessing such evidence, expressed confidence in "the capabilities of the jury and of the adversary system generally," including "[v]igorous cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof," to safeguard against the introduction of faulty or fraudulent scientific evidence.[81]

Yet the use of scientific evidence in criminal cases has long been fraught with error, and it is not insignificant that the Supreme Court expressed its confidence in a civil, rather than criminal, case.[82] In the wake of the Supreme Court's opinion in *Daubert* -- which applied an identical legal standard in both the civil and criminal context -- almost all of the first generation forensic standard bearers came under intense suspicion. Serious doubts were raised about the validity of almost every

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Michael J. Saks, *The Aftermath of Daubert: An Evolving Jurisprudence of Expert Evidence*, 40 JURIMETRICS J. 229, 233-347 (2000); *see also* David L. Faigman, Elise Porter & Michael J. Saks, *Check Your Crystal Ball at the Courthouse Door, Please: Exploring the Past, Understanding the Present, and Worrying About the Future of Scientific Evidence*, 15 CARDOZO L. REV. 1799, 1822, 1827 (1994). By illustration, with regard to DNA typing: the "scientific theory" underlying DNA is something like the cells of human beings contain genetic material that is unique to each individual and capable of evaluation. The "general application" of the theory is that, for example, polymerase chain reaction or capillary electrophoreses effectively express the results of genetic typing. Finally, the "specific application" refers to the effectiveness of the execution of the technique in a specific case.

[80] *Daubert v. Merrill Dow Pharmaceuticals, Inc*., 509 U.S. 579, 596 (1993).

[81] *Daubert*, 509 U.S. at 596. *Daubert* replaced the longstanding standard of admissibility in federal courts enunciated in *Frye v. United States*, 293 F. 1013 (D.C. Cir. 1923). *Daubert*, 509 U.S. at 585-89. In the wake of *Daubert*, which applied only to federal courts, many states -- some of which have evidentiary rules modeled on the federal rules of evidence, adopted its standards. *See* David E. Bernstein & Jeffrey D. Jackson, *The Daubert Trilogy in the States*, 44 JURIMETRICS J. 351, 355-56 (2004) (observing that by mid-2003, roughly twenty-seven states had adopted a test consistent with *Daubert*); *cf. Minor v. State*, 914 So.2d 372, 400 (Ala. Crim. App. 2004) (noting state's continued adherence to *Frye* doctrine, except as regards DNA evidence, which state law requires to be evaluated pursuant to *Daubert*).

[82] In fact, the Court had previously denied certiorari in a criminal case that would have raised the same issue. Paul C. Giannelli, *"Junk Science": The Criminal Cases*, 84 J. CRIM. L. & CRIMINOLOGY 105, 110 & n.33 (1993) (observing that the Supreme Court denied certiorari in a criminal case in which DNA evidence was admitted, *United States v. Jakobetz*, 955 F.2d 786 (2d Cir.), *cert. denied*, 506 U.S. 834 (1992)). Indeed, in the remand of *Daubert*, Judge Kozinski ruefully observed that the Court's newly-announced criteria would pose unconsidered problems for forensic evidence. *Daubert*, 43 F.3d at 1317 n.5; Giannelli, *supra*, at 110 ("Despite highly visible efforts to reform the rules governing experts in the civil arena, the 'junk science' debate has all but ignored criminal prosecutions."). Perhaps wary of this prediction, a bill circulated unsuccessfully in Congress that exempted criminal evidence from the proposed codification of the *Daubert* test. H.R. 988, 104th Cong., 1st Sess. (1995).

one of the traditional forensic sciences that had enjoyed decades of "general acceptance" under the old test of *Frye v. United States*.[83]

Moreover, it is not simply the methodologies of these first generation forensic sciences that have garnered criticism. Rather, the routinely shoddy practices around the execution of forensic techniques have also come increasingly to light. The list of forensic analysts and laboratories caught up in scandals of one variety or another is long and ignominious, and include allegations of fabrication and improper handling of evidence, falsification of results and reports, and corrupt or misleading testimony.[84]

Unfortunately, the pall of the historical failure of the criminal courts to effectively scrutinize first generation forensic sciences has already been cast over the luminous, sophisticated second generation techniques. For instance, even the short history of DNA evidence is specked with examples of both questionable methodological assertions and erroneous applications of techniques. In the early 1990s, one expert testified that "in the experience of the entire forensic laboratory community, he did not know of a single instance 'where different individuals that are unrelated have been shown to have matching DNA profiles for three or four probes.'"[85] Today, such a statement is patently absurd: indeed, in 2004, the founder and pioneer of forensic DNA testing, Sir Alec Jeffreys, declared that a ten loci probe was "no longer

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[83] *Frye v. United States*, 293 F. 1013 (D.C. Cir. 1923); *see also* Saks, *Merlin and Solomon*, *supra* note 6, at 1097-1127 (cataloguing a "series of encounters"). Indeed, in the wake of *Daubert*, many of the forensic sciences attempted to reposition themselves as non-sciences -- after years of insisting upon their scientific legitimacy -- in order to avoid the strictures of *Daubert*. *See, e.g.*, Saks & Koehler, *supra* note 12, at 892; Saks, *Aftermath*, *supra* note 79, at 237 (describing how members of forensic science's "weakest fields, with the most tenuous commitment to real science, offered to recategorize themselves as nonsciences"). That strategy was defeated with the Supreme Court's decision in *Kumho Tire Co. v. Carmichael*, in which the Supreme Court extended the *Daubert* test to all expert testimony, including "technical or other specialized" knowledge. 526 U.S. 137, 147 (1999).

[84] *See, e.g.*, Paul C. Giannelli, *The Abuse of Scientific Evidence in Criminal Cases*: *The Need for Independent Crime Laboratories*, 4 VA. J. SOC. POL'Y & L. 439, 442-468 (1997) (cataloging a range of "sciences" and associated scandals).

[85] *Commonwalth v. Crews*, 536 A.2d 508, 522 (Pa. 1994); *see also* Paul C. Giannelli, *Ake v. Oklahoma: The Right to Expert Assistance in a Post-Daubert, Post-DNA World*, 89 CORNELL L. REV. 1305, 1387 (2004) (describing testimony of analyst in the first DNA execution case, *Spencer v. Commonwealth*, who claimed -- without contradiction -- that there was "no disagreement in the scientific community about the reliability of DNA print testing" even though two National Academy of Science reports indicated several large areas of disagreement).

foolproof," and recommended that fifteen or sixteen markers be used to safeguard against false inclusions.[86]

Similarly, scandals have revealed systemic problems in a number of "flagship" DNA laboratories and related horrific tales of reports of false-positive DNA matches.[87] In Texas, a scandal rages regarding the Houston crime laboratory. News accounts revealed the laboratory's deplorable physical condition and shoddy practices, which in part resulted in the misplacement of 280 boxes of evidence covering 8000 odd criminal cases.[88] In fact, the Houston laboratory falsely inculpated a man by wrongly claiming that DNA evidence found at the crime scene matched his genetic profile.[89] In other laboratories, improper handling of evidence has turned up "matches" that appear to result from contamination, rather than actual guilt.[90] Problems have emerged in laboratories across the country,[91] including the elite Federal Bureau of

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[86] Alok Jha, *DNA Fingerprinting 'No Longer Foolproof': Pioneer of Process Calls for Upgrade*, THE GUARDIAN (London), Sept. 9, 2004, at 5.

[87] *See also* Mnookin, *supra* note 10, at 49-50 (describing case of Raymond Easton, who was arrested and charged after officers linked him through a "cold hit" that matched his DNA at six loci, but released based on testing of additional loci conducted after it was revealed that illness prevented him from having committed the crime); *see also* Maryann Spoto, *Murder, rape charges dropped due to botched DNA evidence*, Star-Ledger (New Jersey), Feb. 7, 2006 (reporting that cold hit case must be dropped because the analyst who made the match had examined evidence from the old case, along with a new case involving the defendant, on the same day, raising the possibility of cross-contamination); Annie Sweeney & Frank Main, *Botched DNA Report Falsely Implicates Woman; Case Compels State to Change How It Reports Lab Findings*, CHI. SUN-TIMES, Nov. 8, 2004 (noting that laboratory indication that forensic profile "matched" woman, based on what ultimately turned out to be only partial match, was revealed erroneous when woman, after arrest on warrant, shown to be incarcerated at time of offense).

[88] Ralph Blumenthal, *In Texas, Oversight for Crime Labs is Urged*, N.Y. TIMES, Jan. 5, 2005.

[89] *See, e.g.*, Steve McVicker, *More DPS Labs Flawed: DNA Testing Woes Across State Threaten Thousands of Cases*, HOUSTON CHRON., Mar. 27, 2004 (describing audits revealing widespread failures at forensic laboratories across Texas, initiated after DNA retesting of biological evidence revealed that an analyst at the Houston laboratory falsely inculpated a convicted man); Adam Liptak, *You Think DNA Evidence is Foolproof? Try Again*, N.Y. TIMES, Mar. 16, 2003 (discussing exoneration of Josiah Sutton, wrongfully inculpated by a DNA analyst at the Houston crime lab).

[90] Steven Hepker, *DNA Test Results Still a Mystery*, THE JACKSON CITIZEN PATRIOT, Jan. 19, 2005 (describing 22-year old murder case in which DNA testing revealed profile of apparent culprit, as well as an utterly unrelated, then four-year-old boy); *see also infra* note 97 (describing the famous Leskie case in Australia, in which genetic testing matched a profile on a murdered child's bib to a clearly unrelated rape victim whose sample had been tested by the same analyst in the preceding weeks).

[91] Vic Ryckaert, *Judge Asked to Halt DNA Retests: Crime Lab Less Than Candid About Cases Under Review, Attorney Says*, THE INDIANAPOLIS STAR, Aug. 13, 2003 (describing fall-out from publication of prosecutor's request that crime lab retest DNA evidence in 64 cases believed compromised by analyst); Keith Matheny, *Supervisor Accused of Passing Off DNA*

Investigation DNA lab,[92] and around the world.[93] An error as small and unintentional as an analyst accidentally squeezing a pipette into the wrong tube or forgetting to change gloves after an extraction can compromise critical evidence in a case.[94] Most alarmingly, these problems are rarely uncovered through the traditional operation of adversarial process.[95]

Given this history, it is perhaps not surprising that scholars have roundly criticized the use of scientific evidence by criminal courts, and pointed out the myriad ways in which adversarial process fails to safeguard the integrity of forensic evidence. For example, a thorough analysis of scientific evidence often requires particular expertise, which counsel often lacks. Much scientific evidence therefore demands outside assistance, in the form of an expert. Yet courts jealously guard limited

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Test, TRAVERSE CITY RECORD-EAGLE, Dec. 19, 2004 (detailing internal investigation of supervisor in Michigan State Police Crime Lab DNA unit that had a subordinate take a proficiency test for him); Glenn Puit, *Police Forensics: DNA Mix-up Prompts Audit at Lab*, LAS VEGAS REVIEW-J., April 19, 2002, at 1B (Las Vegas lab). Even the private laboratories have not proven exempt from such corruption. *See, e.g.*, Rick Orlov, *Lab Used by LAPD Falsified DNA Data*, L.A. DAILY NEWS, Nov. 18, 2004 (describing dismissal of Sarah Blair from Orchid Cellmark, after allegations that she manipulated DNA data); Jeff Coen & Carlos Sadovi, *Crime lab botched DNA tests, state says*, CHI. TRIB., Aug. 19, 2005 (noting that Illinois state police found numerous errors in results reported from Bode Technology, and independent lab based in Virginia).

[92] Richard Willing, *Mueller Defends Crime Lab After Questionable DNA Tests*, USA TODAY, May 1, 2003, at A03 (noting that purported quality control guidelines did not catch technician's failure to run negative controls in 100 DNA cases, caught only when coworker blew whistle). Questions have also arisen about work done by the Virginia state crime lab -- one of the leading laboratories in the country in the DNA field. *See, e.g.*, Maurice Possley, Steve Mills & Flynn McRoberts, *Scandal Touches Elite Labs: Flawed Work, Resistance to Scrutiny Seen Across U.S.*, CHICAGO TRIB., Oct. 21, 2004.

[93] *Leskie Bib Puts Science in the Dock*, THE AGE, Nov. 22, 2004, *available at* http://www.theage.com.au/articles/2003/11/21/1069027328463.html?from=storyrhs.

[94] Paula McMahon, *Crime Lab Botches Murder Inquiry: Prosecutors Must Drop Charges after DNA Evidence is Contaminated*, SUN-SENTINEL (Ft. Lauderdale, FL), June 24, 2003 (announcing dropping of murder and robbery charges due to "someone squeezing the eye-dropper into the wrong vial" and noting disagreement regarding whether government or defense attorney caught error); Keith Paul, *Audit Calls for Changes in Police DNA Lab*, LAS VEGAS SUN, May, 23, 2002, at 1 (reporting results of audit conducted after independently hired defense expert caught forensic lab in mistakenly labeling DNA typing results with name of innocent man).

[95] Many errors were uncovered due to factual impossibility (for example, a DNA "match" made to an individual incarcerated at the time of the offense), while others were exposed by a whistle-blower. *See, e.g.*, Sweeney & Main, *supra* note 87. In only a select few instances does it seem to be that the defense exposes the problem at the trial stage through independent testing or legal or factual challenges.

budgets,[96] and most jurisdictions require counsel to demonstrate that their request is "reasonable"[97] and that the issue is "likely to be a significant factor in his defense."[98] Moreover, scholars observe, jurors may have trouble comprehending the arguments and assessing the reliability of the evidence,[99] and judges may be ill-prepared to rule on questions involving scientific principles.[100] When confronted by forensic science, judges may simply conclude, as did one Indiana court, that all evidence derived from "precise, physical measurements and chemical testing" is presumptively accurate and reliable unless demonstrated otherwise.[101]

Accordingly, the literature is full of proposals to tweak certain aspects of judicial process to improve the quality of evidence it receives. Scholars have argued to: require more extensive pre-trial hearings into reliability of evidence,[102] increase the number of court-appointed independent experts,[103] create a "complexity exception" to the right to

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[96] Giannelli, *supra* note 85, at 1312 (citing numerous studies demonstrating that "[j]udges routinely deny lawyers' requests for expert/investigative fees" in capital cases (internal quotation omitted)).

[97] 472 U.S. at 323 n.1.

[98] Many states, along with the federal government, implement the constitutional right to expert assistance statutorily. For example, the Criminal Justice Act provides for expert assistance to indigent federal defendants when "necessary for an adequate representation." *See, e.g.*, 18 U.S.C. § 3006A(e)(1) (2000). As many commentators have noted, expert assistance is frequently difficult for an indigent to obtain. *See, e.g.*, John F. Decker, *Expert Services in the Defense of Criminal Cases: the Constitutional and Statutory Rights of Indigents*, 51 U. CIN. L. REV. 574 (1982); Giannelli, *supra* note 85, at 1365.

[99] Of course, debates rage concerning whether such evidence exceeds fair expectations of jurors' abilities, or whether juries are up to the task of resolving scientific disputes often unresolved among the experts in the field. *Compare, e.g.*, Joseph Sanders, *Scientifically Complex Cases, Trial By Jury, and the Erosion of Adversarial Process*, 48 DEPAUL L. REV. 355, 360, 363 (1998) and Graham C. Lilly, *The Decline of the American Jury*, 72 U. COLO. L. REV. 53, 68 (2001) (arguing that "long-term trends in the nature of litigation" poses "serious questions about the potential of American juries to adequately perform their traditional roles"), *with* David W. Shuman, *et al.*, *Assessing the Believability of Expert Witnesses: Science in the Jurybox*, 37 JURIMETRICS J. 23 (1999); Erwin J. Imwinkelried, *The Standard for Admitting Scientific Evidence: A Critique from the Perspective of Juror Psychology*, 28 VILL. L. REV. 554, 570-71 (1982-83).

[100] *See, e.g.*, Mnookin, *supra* note 10, at 34 (discussing absence of base rates with regard to early uncritical acceptance of fingerprinting evidence).

[101] *See, e.g.*, Jay A. Zollinger, Comment, *Defense Access to State-Funded DNA Experts: Considerations of Due Process*, 85 CAL. L. REV. 1803, 1813-14 (1997).

[102] Christopher G. Shank, Note, *DNA Evidence in Criminal Trials: Modifying the Law's Approach to Protect the Accused from Prejudicial Genetic Evidence*, 34 ARIZ. L. REV. 829, 870 (1992).

[103] Sanders, *supra* note 99, at 377; Paul S. Milich, *Controversial Science in the Courtroom: Daubert and the Law's Hubris*, 43 EMORY L.J. 913, 925 (1994).

trial by jury,[104] apply the tests of *Daubert* and *Frye* more rigorously,[105] increase funding for defense experts and attorney training,[106] authorize the enlistment of specialized courts or specially-trained judges and juries,[107] or overhaul the laboratory system.[108]

Each of these recommendations has its own merits, and if implemented could dramatically improve the quality of scientific evidence.[109] Yet none of them address, much less rectify, the particular economy of the criminal justice system, which perpetuates the introduction of faulty forensic science evidence. And, more importantly as regards the second generation of forensic science, none acknowledge the many ways in which the unique characteristics of second generation techniques threaten only to magnify the shortcomings already manifest in the criminal justice system.

This Part examines the two primary sites for evaluating and safeguarding the integrity of forensic evidence: the scientific process and the judicial process or, in shorthand, the laboratory and the courtroom. As to each site, this Part first considers the structural problems that arose with regard to the first generation sciences, and then argues that the characteristics peculiar to the second generation only aggravate and augment, rather than relieve or diminish, these concerns. Along the way, this Part criticizes the conventional approaches to improving the quality of forensic evidence for failing to take into account the distinctive needs and concerns of second generation sciences.

A. *The Laboratory.*

The established method for good distinguishing good from bad science is to consider its resilience when subjected broadly to challenge. Indeed, three of the four suggested criteria of the *Daubert* court's test for identifying reliable scientific methodologies depended upon just that: whether the science was testable, whether it had withstood peer review,

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[104] Sanders, *supra* note 99, at 387 (citing *In re Japanese Elec. Prods.*, 631 F.2d 1069 (3d Cir. 1980)); Lilly, *supra* note 99, at 81-82 (same).

[105] Milich, *supra* note 103, at 925;

[106] Giannelli, *supra* note 84, at 475-76.

[107] Lilly, *supra* note 99, at 85.

[108] Giannelli, *supra* note 84, at 476-477.

[109] Of course, some of these recommendations -- specifically designed for a civil justice system -- cannot reasonably be implemented on a broad scale in the criminal justice system. For instance, some suggestions impinge upon other rights: qualifying specialized juries or removing certain questions from jury determination could impermissibly prejudice the defendant's Sixth Amendment right to a jury of his peers.

and whether it had gained general acceptance in the relevant community.[110] Underlying the Court's injunction lies the premise that good science thrives, and evolves, in an open environment.[111] Open debate both spurs the development of good science and thwarts the propagation of the bad.[112] Competition inspires scientists to challenge orthodoxy and engage in experimentation. Diversity further subjects theories to rigorous peer review and testing, which in turn ensures that they bear out under close scrutiny and in various conditions. But while all of this may be true, it has unfortunately never described the field of forensic science.

1. A diagnosis of the first generation.

Forensic science has never been ordinary science. The techniques of forensic science rarely find analogues in an industrial or academic setting. As commentators have observed, "[t]here is virtually no other 'market' for identification tests,"[113] and there "are no industrial uses of what forensic identification scientists do."[114] Thus, forensic science is created by the government, developed almost exclusively for government use, and executed almost entirely by government personnel.[115] Unlike scientific techniques that emerge from collaborative or competitive environments spanning a variety of interests and orientations, almost all forensic science, and almost all forensic scientists, claim common ancestry in the government. "Peer review" in forensic science varies only slightly from self-congratulation,[116] and the scientists who "validate" a

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[110] *Daubert*, 509 U.S. at 593.

[111] *Daubert*, 509 U.S. at 593 ("[S]ubmission to the scrutiny of the scientific community is a component of 'good science,' in part because it increases the likelihood that substantive flaws in methodology will be detected."). Indeed, the *Daubert* Court specifically defined good science as that which is subject to "falsifiability, or refutability, or testability." *Id.* at 593 (quoting K. POPPER, CONJECTURES AND REFUTATIONS: THE GROWTH OF SCIENTIFIC KNOWLEDGE 37 (5th ed. 1989)).

[112] *Daubert*, 509 U.S. at 596.

[113] Beecher-Monas, *supra* note 7, at 73; *see also* Saks, *Merlin and Solomon*, *supra* note 6, at 1131 (commenting on "the lack of other institutions (such as academia or industry) where competition or critical evaluation might create incentives for improved knowledge as well as improved technique").

[114] Saks, *Merlin and Solomon*, *supra* note 6, at 1093.

[115] Giannelli, *supra* note 84, at 470 & n.182 (reporting that 79% of crime laboratories are governed by law enforcement).

[116] ANNOTATED SCIENTIFIC, *supra* note 9, § 1-3.5.1[2] (observing that the conceptions of "peer review" and "publication" as centerpieces of scientific validity, as expressed in *Daubert*, are not very rigorous in the forensic disciplines); *cf.* John Monahan & Laurens Walker, *Social*

particularly theory or methodology are those who often stand to gain a benefit from its approval.[117]

Thus, rather than finding motivation in a robust external community of peers, the forensic scientist is instead beholden almost exclusively to the demands of government police investigators and attorneys.[118] So long as this client remains satisfied, the laboratories need not engage in any development. And, in fact, crime laboratories primarily engage in applied science, limiting their responsibilities to the mechanical processing of government evidence.[119] Indeed, many police crime laboratories are staffed with technicians holding no more than an undergraduate degree, and who are ill-trained to do any independent research or analysis even if encouraged by adequate resources or incentives. As a result, it has long been observed that "forensic sciences that grow up in the criminal law don't grow."[120]

The lack of meaningful external peer review not only stunts the methodological growth of forensic science, but it also enables forensic laboratories to evade the stringent quality control standards typically imposed on scientific environments. Many forensic laboratories fail to adhere to even basic standards of monitoring. In the oft-quoted words of one renowned scientist, "clinical laboratories must meet higher standards to be allowed to diagnose strep throat than forensic labs must meet to put a defendant on death row."[121] Many labs do not engage in validation studies or routine exercises of blind proficiency testing,[122] and those that do such testing tend to shroud the result in secrecy rather than publish them publicly as in other scientific disciplines.[123] Thus, forensic

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Authority: Obtaining, Evaluating, and Establishing Social Science in Law, 134 U. PA. L. REV. 477, 500 (1986) (characterizing scientific findings made in-house and unpublished as "highly suspect").

[117] Faigman, Porter & Saks, *supra* note 79, at 1829.

[118] Saks & Koehler, *supra* note 12, at 833 (observing the "cultural difference between normal science and forensic science" and cautioning that "[w]hen individuals who are not steeped in the culture of science work in an adversarial, crime-fighting culture, there is a substantial risk that different set of norms will prevail"); *see also* Saks, *Merlin and Solomon*, *supra* note 6, at 1093 & n.109.

[119] *Id.* at 1093. Of course, lack of resources also contribute to this phenomena.

[120] Saks, *Merlin and Solomon*, *supra* note 6, at 1090-2; *see* Mnookin, *supra* note 10, at 40-43. For example, many commentators have observed that forensic sciences such as fingerprinting readily lend themselves to both validity and proficiency testing, and yet the discipline has wholly failed to conduct full-scale studies in either respect.

[121] Eric Lander, *DNA Fingerprinting on Trial*, 339 NATURE 501, 505 (1989).

[122] Saks & Koehler, *supra* not 12, at 894 ("[B]lind tests are practically nonexistent.")

[123] Saks, *Merlin and Solomon*, *supra* note 6, at 1094; *see also* Beecher-Monas, *supra* note 7, at 84.

laboratories catch their own errors at unacceptably low rates, and few external incentives -- such as rigorous accreditation or monitoring standards -- exist to impose a higher burden upon them.

Finally, within the forensic science field, structural barriers impede the development of robust "defense-oriented" forensic research or practices. Of course, defense testing does and can occur, but there is generally not a centralized market that drives the development of institutional "defense-side" forensic testing or research facilities. And, to the extent that scientists attempt to undertake such projects, their inquiries or requests for raw data are often met with the adversary's -- rather than the scientist's -- response.[124] In the words of one commentator, "[w]here science advances by open discussion and debate, forensic science has been infected by the litigator's preference for secrecy."[125] Forensic scientists often feel the pressure of their central and even sole client: the government.[126] Thus, defense research is almost non-existent, and defense testing piecemeal and sporadic.

2. The pathologies of the second: databases, privacy, and proprietary secrets.

At first blush, it might seem that the second generation of forensic sciences would exhibit fewer, not more, symptoms of the pathologies outlined above. After all, many of the second generation techniques derive from technologies relevant to the world outside of the police precinct, and scientists with expertise in these areas populate both research institutions and private industry. Indeed, advances in DNA research fill the news every day, and many commentators have specifically applauded the rigor with which DNA typing techniques were developed as compared to first generation of disreputable forensic techniques. But closer examination reveals that, in fact, the particular characteristics of second generation techniques only worsen, rather than relieve, the problems of regulating forensic sciences in several different respects. Namely, such techniques: lack commercial or research applications despite the illusion of market robustness; rely on databases kept in the control of the government that make independent research all

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[124] Giannelli, *supra* note 84, at 470, 473.

[125] Saks, *Merlin and Solomon*, *supra* note 6, at 1092-93; *see* Giannelli, *supra* note 82, at 117-18.

[126] Saks & Koehler, *supra* note 12, at 893 ("All [forensic science] experts are tempted, many times in their careers, to report positive results when their inquiries come up inconclusive, or indeed to report a negative report as positive." (quoting A.A. Moenssens, 84 J. Crim. L & Crimol. 1, 17 (1993).

the more difficult; derive from methods that raise legitimate concerns about safeguarding privacy and proprietary information; and require a level of technical expertise, financial investment, and mechanical sophistication that inhibits the development of informal and independent advisors.

First, despite the specter of commercialism that looms around second generation techniques, the specific methods tend to be particular to the government even where a technique has some non-forensic applications. For instance, although facial recognition technologies might be readily developed by industry as a means of security control, their use for investigative purposes in crowds or group situations is likely most pertinent for law enforcement. Similarly, it is likely that it would be only government entities that would amass large databanks of "faces." Or take, for example, the field of DNA typing. Obviously, there is great interest in genomics-based work among research scientists, pharmaceutical companies, and others. However, to suggest that this general research interest in genomics in turn validates DNA typing for forensic purposes is like suggesting that the widespread market for electricity somehow ensures the proper functioning of an electric chair. In fact, the methods typically used by research-oriented entities, and the questions they seek to answer, have little resonance in the context of forensic identification science.

Indeed, the geneticist's objective is typically very different than that of the forensic scientist. Whereas a geneticist is typically looking for areas of the genetic strand that regulate human attributes, diseases, or characteristics, the forensic scientist most commonly studies only those places -- typically, the thirteen established loci -- at which the genetic material has already been shown to have no demonstrable function or purpose.[127] Thus, the research scientist tends to focus on areas of the genome that differ from the areas studied by the forensic scientist. To state it in the crudest terms, genetic researchers specifically focus their attention on understanding the parts of the human genome that *do* something, whereas forensic scientists are specifically focusing only on those parts that do not.

Furthermore, the particular techniques used by the geneticist often differ from that of the forensic scientist: for instance, a geneticist may study the sequences of particular genes in order to determine their function or importance, whereas a forensic scientist often looks not at

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[127] KOBILINSKY, LIOTTI, & OESER-SWEAT, *supra* note 15, at 104. *But see* Barry Steinhardt, *Privacy and Forensic DNA Data Banks*, in DNA AND THE CRIMINAL JUSTICE SYSTEM, *supra* note 13, at 173 (rejecting the term "junk DNA" because it may turn out that these loci in fact do code for some useful purpose).

sequences but rather at repeat patterns that occur at a particular place of the genetic strand; or a geneticist may use cloning in order to reproduce genetic material at a high rate of accuracy in order to study it, whereas a forensic scientist relies upon a different process altogether.[128] In short, the academic or industry research scientist may have little interest in pursuing the questions of forensic science, because the answers are less interesting or lucrative than those posed for academic or commercial purposes.

Second, the effect of the monopsony in forensic science is in fact more dramatic with regard to second generation techniques, because these techniques tend to rely upon databases held by or opened exclusively to the government. For instance, effective DNA typing requires the compilation, storage, and search of vast amounts of data -- the "databasing" aspect of the second generation. These databases are critical in many respects, including to help determine the likelihood of a profile appearing in the population at large, or to make "matches" between evidentiary samples. Yet they are kept entirely within government control.

Thus, even if non-governmental scientists wanted to access this treasure trove of genetic data,[129] they are rarely able to do so. Even with regard to a particular case, the government's source materials and raw data are heavily protected by statutory protections and rules of discovery,[130] and judges rarely require disclosure of anything beyond the

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[128] Genetic typing of nuclear DNA is typically performed through a process known as polymerase chain reaction, or PCR. Molecular biologists, however, typically amplify genes of interest through a more reliable process known as cloning. KOBILINSKY, LIOTTI, & OESER-SWEAT, *supra* note 15, at 19-20.

[129] For instance, population geneticists might very well have great interest in research using such data. Conversation of author with Dr. Montgomery Slatkin, Professor of Integrative Biology, University of California, Berkeley, 3/3/06.

[130] The rules of discovery often limit the scope of mandatory disclosure to that which is used in the particular case. For example, Federal Criminal Procedure Rule 16 requires the government to provide only a description of "the witness's opinions, the bases and reasons for those opinions, and the witness's qualifications." FED. R. CRIM. P. 16(a)(1)(D). Thus, counsel's requests can fall on deaf ears. *See* Beecher-Monas, *supra* note 7, at 78; Paul C. Giannelli, *Criminal Discovery, Scientific Evidence, and DNA*, 44 VAND. L. REV. 793, 815 (1991) (discussing need for greater discovery of "predicate materials" underlying DNA evidence and concluding that "the rules do not require adequate discovery"); Pat Smith, *Hearings Begin in DNA Discovery Spat*, THE RECORDER (SAN FRANCISCO), Feb. 2, 2005 (describing hearing in which public defenders sought jurisdiction-wide order allowing broader than case-only discovery). Indeed, the defendant in one case received "greater discovery under the FOIA [Freedom of Information Act] after his trial than he could have received under Rule 16 prior to trial." Giannelli, *supra*, at 816 (citing *United States v. Stifel*, 594 F. Supp. 1525, 1528, 1531-38 (N.D. Ohio 1984)).

materials relevant in the instant dispute.[131] Rather, it is only the government scientist that has both cause and capacity to search the database. This inevitably inhibits, or outright prevents, any challenges -- whether from a defense attorney or an independent researcher -- to the validity of a methodological conclusion. The same holds true for other forms of second generation science, although in some cases it might be a private party rather than the government that holds the relevant information. For instance, facial recognition or iris scan techniques depend on databases of recorded biometric information, and radio frequency tracking like cell site information or vehicle movements in turn relies on data collected and stored from particular towers or stations. But getting a hold of such data, and examining it for unusual patterns, inaccurate records, or error in data processing, is all but impossible for an independent researcher.

Of course, the courts and government have good reason to be reluctant in throwing open such materials to any researcher or attorney who makes a request, which leads to the third concern with regard to second generation forensic sciences: protection of privacy. The second generation of forensic sciences draws upon databases as a means of making sense of a piece of evidence, and such databases often incorporate information that extends well beyond that pertaining to either an individual suspect or an individual case. For example, in the case of DNA typing, databases can reveal "familial" connections, exposing information concerning persons not even included within the immediate pool of collected information. And raw DNA samples have the power to reveal the very essence of personhood: for instance, a person's phenotypic characteristics, gender, health, and genealogy. Thus, even apart from any statutory laws that limit access,[132] the government is

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[131] *See, e.g.*, William C. Thompson & Simon Ford, *DNA Typing: Acceptance and Weight of the New Genetic Identification Tests*, 75 VA. L. REV. 45, 105 (1989) (citing *People v. Wesley*, 140 Misc.2d 306, 239-30 (Albany County Ct. 1988), and describing defense challenge countered by government's introduction of previously unpublished and undisclosed studies); *see also* Saks, *Merlin and Solomon*, *supra* note 6, at 1093 (noting that the defendant has little access to those few studies generated by government scientists).

[132] Many states have inadequately defined privacy laws, that seem to leave the door open for some measure of use or study by third parties, or for non law-enforcement related purposes. *See* Steinhardt, *supra* note 127, at 175-80. Yet the breadth of most of these statutes is that they allow law enforcement, or other public officials, to use the database for non law-enforcement purposes or, to the extent that they authorize non law-enforcement usages, it tends to be limited to "humanitarian purposes" or missing persons identification. Most states lack an organized regime through which defense-oriented research entities -- non-law enforcement and non public-officials, can gain access to government databases. The wide range of vague and confusing statutory requirements itself leaves unclear the parameters for a private researcher. *See* Seth Axelrad, *Survey of DNA Database Statutes*, American Society of

understandably reluctant to simply open up databanks -- which increasingly include the genetic information of arrestees, who have not even been adjudicated guilty -- to any researcher who comes along. If most people shudder to think that one's social security number might be known to the world, imagine broadcasting a 13-loci genetic profile.

Relatedly, second generation techniques also tend to depend upon proprietary technologies or materials developed by private, for-profit entities, who in turn either expressly collaborate or tacitly cooperate solely with the government. Private cell phone companies and e-mail providers, and search engines might be reluctant to reveal how data is collected and stored, thereby allowing competitors access to proprietary information. Think of the recent controversy regarding Google's refusal to disclose the search terms entered into its search engine during one week: the company's primary claim was not privacy, but rather the need to protect proprietary information.[133] Although in that case even the government was met with resistance in disclosing such information, it is notable that the government managed to obtain the same data from three other private search engines without any opposition; yet one can imagine that, if obtaining such information is occasionally difficult for the government, then it will be all but impossible for defense counsel to convince a court that such access must be granted in every criminal case.

To give a concrete example from a second generation dispute that has already played itself out, forensic DNA typing is typically performed using "kits" developed by a private company, and processed on machines sold by another private entity.[134] The methods and validation studies underlying these technologies are in turn often tightly guarded as the intellectual property of the companies that develop them.[135] Thus, quite apart from reasons of individual privacy, the government -- along with

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Law, Society & Ethics, *available at* http://www.aslme.org/dna_04/grid/statute_grid.html (last visited Feb. 27, 2006).

[133] Katie Hafter & Matt Richtel, *Google Refuses to Hand Over Search Data to US*, INT'L HERALD TRIB., (Jan. 20, 2006).

[134] *See, e.g.*, BUTLER, *supra* note 15, at 97 (describing "[t]wo primary vendors for STR kits used by the forensic community" as "Promega Corporation … and Applied Biosystem"); *id.* at 359-63 (describing various instruments used to perform capillary electrophoreses and their manufacturers, along with software used to interpret data).

[135] *See* BUTLER, *supra* note 15, at 100-01 (comparing Promega corporation, which published its primer sequences, with Applied Biosystems, which "has repeatedly refused to release the primer sequences … claiming that this information is proprietary"). Applied Biosystems claimed that "they would lose revenue if generic brand products were produced by other entities using the revealed primer information." *Id.* Jennifer N. Mellon, Notes, *Manufacturing Convictions: Why Defendants are Entitled to the Data Underlying Forensic DNA Kits*, 51 DUKE L.J. 1097, 1099 (2001) (reviewing the resistance to discovery exhibited by private DNA kit manufacturing companies and arguing for greater disclosure).

the individual companies -- often successfully resist disclosure of the scientific theories that underpin its techniques.[136] This total government monopoly on both the methods of testing and the storage and generation of data, however, inevitably obstructs critical research or inquiry.

Finally, the more technically complex the technique, the more difficult it is to cultivate independent analysts to check the government's work. Whereas the fingerprint or ballistics analyst at the local sheriff's office might retire and start taking defense-side consulting referrals at home, the local DNA analyst cannot readily do the same. Simply buying the software necessary to examine the data generated by a DNA lab -- even without conducting independent tests of the raw biological sample -- requires a substantial capital investment, and some companies refuse even to sell such equipment to independent experts.[137] And actually conducting independent research projects or experiments requires access to data, and funding, far in excess of what is typically available in an individual case to indigent defendants.[138]

As a result of all of these factors, independent research is all but non-existent. And even independent tests of evidence in individual cases are not terribly common.[139] Indeed, such tests are not typically performed

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[136] *See, e.g.*, *Minnesota v. Traylor*, 656 N.W.2d 885, 900 (Minn. 2003) ("[W]e hold that disclosure of the primer sequences and unlimited access to Perkin-Elmer's validation studies are not necessary for the scientific community to validate the Profiler Plus and Cofiler kits and, therefore, that Traylor's due process right to a fair trial has not been violated.").

[137] One independent scientist described how, despite purchasing DNA typing analysis software from a private company, the company refused to provide technical support -- or even a user's manual -- because he was not government affiliated. Lecture by Dr. Simon Ford, Lexigen Science and Law Consultants, at the Public Defender Service for the District of Columbia, 2002.

[138] One expert reported that he was able to conduct useful, albeit informal, studies regarding DNA transfer only because the wealthy defendant for whom the study might prove beneficial subsidized his work. *See* Report of Dr. Marc Taylor, Technical Associates, Inc., Re: *Commonwealth v. Dirk K. Greineder*, TA Case 1458, *available at* http://www.bioforensics.com/conference04/Transfer/Taylor&Johnson%20Study.pdf (last visited Jan. 5, 2005) (reporting results of informal experiments to determine rate at which DNA transfers to a third party).

[139] In fact, in many jurisdictions, a defendant had no right to obtain physical evidence in control of the state for purposes of independent testing. In specific response to the availability of DNA testing, many legislatures have granted to defendants a legal entitlement to testing both pre-trial and post-conviction. *See, e.g.*, D.C. Code § 22-4133; Helen Dewar & Dan Morgan, *Senate Approves Bill On Victims' Rights*: *Both Chambers Tackle Busy Agendas*, WASH. POST, Oct. 10, 2004, at A05 (reporting on passage of federal law appropriating funds for defense DNA testing). However, this right to test is second to the government's right -- if the government elects to test, and such testing consumes the sample, the defendant cannot claim violation of that right. Nevertheless, some courts grant the defendant's request to have a defense expert present during testing that is likely to consume the entire sample.

by defense-oriented laboratories,[140] but rather are done by larger private laboratories hostile to defense interests, whose primarily interest is in maintaining large government contracts and for whom defense testing constitutes a small fraction of the work.[141] Accordingly, just as the government's monopoly on the forensic sciences of old so often thwarted scientific progress and concealed shoddy work, that continued monopoly -- only strengthened and enhanced by the particular characteristics of the second generation -- threatens to do precisely the same, and ultimately expose second generation sciences to the very attacks that long plagued the first generation.

B. *The Courtroom.*

Of course, even assuming that forensic evidence lives primarily in the gated community of government science, this lack of scrutiny from the scientific community need not imply a lack of scrutiny by the legal community. Indeed, *Daubert* expressly outlines a legal regime that purports to altogether exclude evidence founded on unreliable techniques, and lay bare the faults of evidence executed in a flawed manner.[142]

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[140] There do exist a handful of individual academics or scientists willing to entertain defense-side consulting work and review government reports with an objective eye, but of course they are still restricted to the data disclosed by the government. Perhaps the most successful such entity is one established in 2002, which consists of an automated analysis service, available at a reasonable price to the defense, that provides an independent review of the CD-ROM of the government's raw data. *See* http://bioforensics.com. This service provides defense counsel with a thorough report of all of the genetic information recorded during testing -- rather than just the government's gloss on the "relevant" information -- and highlights possible problem areas. Because this service reviews cases from a wide variety of labs, and a broad array of cases within a lab, it also has produced a data set from which research conclusions may be analyzed, and has a limited potential -- if used consistently -- to spot recurrent or systemic errors, at least as regards the raw data.

[141] *See, e.g.*, *People v. Boykin*, No. 168461, slip op. at 15 (Cal. Super. Ct. May 5, 1999) (holding DNA inadmissible because laboratory analyst's bias in favor of prosecution went "beyond advocacy" to indicate outright hostility to defense function); Giannelli, *supra* note 85, at 1396 (describing, in the context of DNA analysis, that "[w]hen faced with an ambiguous situation, where the call could go either way, crime lab analysts frequently slant their interpretations in ways that support prosecution theories"); *see also* Janet C. Hoeffel, Note, *The Dark Side of DNA Profiling: Unreliable Scientific Evidence Meets the Criminal Defendant*, 42 STAN. L. REV. 465, 499-500 (1990) (describing how "[a]nalyzing biological evidence and testifying about it in court has become an extremely lucrative business" in which the chief aim is to "sell . . . to crime laboratories in the U.S.").

[142] *Daubert*, 509 U.S. at 593 ("[S]ubmission to the scrutiny of the scientific community is a component of 'good science,' in part because it increases the likelihood that substantive flaws in methodology will be detected."). Indeed, the *Daubert* Court specifically defined good science as that which is subject to "falsifiability, or refutability, or testability." *Daubert*, 509 U.S. at 593 (quoting K. POPPER, CONJECTURES AND REFUTATIONS: THE GROWTH OF SCIENTIFIC KNOWLEDGE 37 (5th ed. 1989)).

Yet while *Daubert* addressed the admissibility of scientific techniques, it did not specify how a court should treat requests to admit the same kind of scientific evidence when tendered numerous times or in multiple cases, especially if by the same party.[143] Must each courtroom entertain and fully air challenges to the admissibility of a technique each time it is used, or may a judge properly rely on such findings made in another case, or another courtroom, or county, or nation? When should an admitted technique be considered "scientific law,"[144] and what should happen when new developments suggest that a previously-accepted technique is subject to renewed scrutiny or challenge? Who bears the burden of putting forth evidence that calls into question the continued reliability of an established methodology?

In the civil law context, scholars have long sought legal rules that grant the flexibility necessary to treat each case individually, while also promoting a measure of consistency and efficiency in the deployment of scientific evidence in a wide variety of courtrooms and contexts. Accordingly, Professors John Monahan and Laurens Walker have long championed an approach to judicial treatment of scientific evidence that recognizes both the need for stability and for fluidity.[145] Based upon a functional and textual analysis,[146] they argue that methodological questions are more "law-like,"[147] whereas questions involving the

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[143] Indeed, the *Daubert* Court seemed expressly to duck the question, noting that "[a]lthough the *Frye* decision itself focused exclusively on 'novel' scientific techniques, we do not read the [Federal Rules of Evidence] requirements to apply specially or exclusively to unconventional evidence." *Daubert*, 509 U.S. at 594 n.11. The Court went on to assume that "well-established propositions are less likely to be challenged than those that are novel, and they are more handily defended," and observed that "theories that are so firmly established as to have attained the status of scientific law . . . properly are subject to judicial notice." *Id.*

[144] *Daubert*, 509 U.S. at 594 n.11.

[145] *See, e.g.*, Laurens Walker & John Monahan, *Scientific Authority: The Breast Implant Litigation and Beyond*, 86 VA. L. REV. 801, 802 (2000) [hereinafter Walker & Monahan, *Breast Implant Litigation*]; Walker & Monahan, *Social Facts*, *supra* note 79, at 877; Laurens Walker & John Monahan, *Social Frameworks: A New Use of Social Science in Law*, 73 VA. L. REV. 559, 559-60 (1987); Monahan & Walker, *supra* note 120, at 479. Professors Monahan and Walker initially limited their proposals to the use of social scientific evidence in the civil arena, although they briefly nodded to the use of empirical evidence to establish, for example, community standards of decency in criminal obscenity trials. Walker & Monahan, *Social Facts*, *supra* note 79, at 880-81. Recently, however, they have advocated the extension of their argument to the hard sciences, as well. Walker & Monahan, *Breast Implant Litigation*, *supra*, at 802 (proposing to "extend our earlier work" by applying their scientific authority model, "which was limited to social science research," to hard science questions resolved by science panels).

[146] Walker & Monahan, *Breast Implant Litigation*, *supra* note 145, at 819; Walker & Monahan, *Social Facts*, supra note 79, at 890.

[147] Walker & Monahan, *Breast Implant Litigation*, *supra* note 145, at 821 (concluding that "it is plausible on occasion to treat general science as law-like," specifically "when an efficient

application of methodologies are more "fact-like."[148] Accordingly, a judge considering a methodological question might rely solely upon written submissions rather than oral hearings, and may look to extrinsic materials as support for a decision. A factfinder assessing a technique's proper application, on the other hand, is confined to the challenges raised in court, typically through cross-examination of live witnesses, as regards the evidence in the particular case.[149]

This rubric carries great logical appeal. Permitting a trial court to adopt previous findings can save on costly and repetitious hearings, and also minimize the possibility that one court will rule a technique inadmissible and unreliable while another, across the hall, rules the same technique -- possibly based on the same evidence -- reliable. Moreover, just as much robust debate in the scientific community occurs on paper -- in journals or papers -- so too could that debate be fairly represented to a court without the testimony of live witnesses. Allowing a court to determine an admissibility question by looking outside of a factual record adduced by the parties, as a judge might look outside the record to sources of legal authority, diminishes the likelihood that a technique roundly criticized as illegitimate will somehow sneak into a courtroom due to (even strategic) lack of vigorous opposition. After all, it hardly behooves the justice system if, for example, astrology is ruled a reliable and admissible science simply because the trial judge was bound by the record and no party presented the court with evidence to the contrary.

Conversely, it seems fitting that questions regarding the proper application of an established technique should be treated in a fact-like manner, and left to adversarial challenge and fact-finder determination. After all, error is an inevitable part of scientific testing, and a particular error need not undermine the legitimacy of the evidence as a whole. The execution of a particular scientific test is arguably well determined by looking only within a record, and only to the evidence judged relevant to

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process will be enabled to produce a just result"); *id.* (defining an "efficient process" as one that "yields valid scientific conclusions without wasteful redundancy"). They observe that, [l]ike law, methodology applies generally and produces results beyond particular instances. . . . Thus, methodology transcends the particulars of any individual project." Walker & Monahan, *Social Facts*, *supra* note 79, at 886-88.

[148] Application of a methodology is particular to a certain case, and thus more close resembles fact. Walker & Monahan, *Social Facts*, *supra* note 79, at 888. Monahan and Walker thus argue that "legal force should be given only to the essential components of relevant social science methodologies, and not to the details of how those methodologies were applied in particular cases." *Id.* at 879.

[149] Although *Daubert* did not expressly endorse this model, it does in many respects honor this idea in reposing sole responsibility for the admission of scientific evidence on the judge, as gatekeeper.

the question at hand. Moreover, assigning weight to the evidence in a particular case -- considering all its flaws, contradictions, or weaknesses -- is the fact-finder's very purpose.

This model -- revolutionary for civil law -- has in fact long been the actual, if not explicitly enunciated, practice in the criminal law.[150] Trial courts routinely accord forensic methodologies "law-like" status, relying in part upon legal memoranda, scientific documents, and precedent -- rather than factual hearings with live witnesses -- to determine their admissibility.[151] Indeed, trial courts routinely find scientific methodologies reliable *solely* on the basis of judicial notice,[152] and appellate courts have endorsed a particular methodology or technique based solely upon recognition of the technique's approval in another jurisdiction, or its own appraisal of the literature of the field.[153]

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[150] *See, e.g.*, Saks, *Aftermath*, *supra* note 79, at 232 (recounting the "long practice, especially among state supreme courts, which have had considerable experience with expert evidence over the past century, of treating decisions about the admissibility of scientific evidence as a matter of law"); ANNOTATED SCIENTIFIC, *supra* note 9, § 1-3.8 (same).

[151] *See, e.g.*, *Hayes v. State*, 660 So.2d 257, 262, 264 (Fla. 1995) (vacating death sentence founded on unreliable DNA evidence after taking "judicial notice" of the National Resource Council's 1992 forensic science report and citing cases in other jurisdictions); *Commonwealth v. Crews*, 640 A.2d 395, 519 (Pa. 1994) (rejecting defendant's complaint regarding trial court's "reliance on judicial decision from other jurisdictions to establish the scientific community's general acceptance of DNA testing"); *United States v. Porter*, 618 A.2d 629, 635 (D.C. 1992) (conducting appellate review of admission of DNA evidence and noting that "[i]n doing so, we may consider not only expert evidence of record, but also judicial opinions in other jurisdictions, as well as pertinent legal and scientific commentaries"). Professor Saks likewise observes that law-like treatment of forensic evidence includes applying de novo review to admissibility decisions, judicial approval of opinions based upon on extrinsic sources, and categorical deference to precedent finding a particular methodology admissible. Saks, *Aftermath*, *supra* note 79, at 232.

[152] *See, e.g.*, *United States v. Havvard*, 117 F. Supp. 2d 848, 854 (S.D. Ind. 2000) (accepting fingerprint evidence despite lack of scientific testing because they "have been tested for roughly 100 years" by "adversarial proceedings"); *People v. Palmer*, 145 Cal. Rptr. 466, 472 (Cal. 1978) (approving gunshot residue evidence based upon a scan of literature in field).

[153] *See, e.g.*, *Porter*, 618 A.2d at 635 (D.C. 1992); *United States v. Iron Cloud*, 171 F.3d 587, 591, 593 (8th Cir. 1999) (reversing and remanding for evidentiary hearing on admissibility of scientific methodology, based upon appellate judicial notice of studies calling the methodology into question); *United States v. Beasley*, 102 F.3d 1440, 1448 (8th Cir.1996) ("We believe that the reliability of the PCR method of DNA analysis is sufficiently well established to permit the courts of this circuit to take judicial notice of it in future cases"); *People v. Chandler* ("Courts of this state may continue to take judicial notice of the admissibility of the RFLP method of DNA testing, including the statistical analysis"); *see also People v. Richie*, No. B158254, *available at* 2005 WL 1340382 (Ct. App. Cal. 2005) (granting appellant's request to take judicial notice on appeal of four more recent scientific studies in support of position, because "we can consider scientific literature outside the record to determine whether a scientific technique is generally accepted").

At the same time, trial courts have typically refused to look at evidence of a laboratory's reliability -- or lack thereof -- in executing a technique to resolve questions of admissibility or methodological soundness.[154] Rather, such attacks are treated in a fact-like manner, and considered through a case-specific lens as relevant only to the fact-finder's "weighting" of the evidence. Indeed, some courts refuse even to allow counsel any access to, or argument about, a laboratory's or analyst's errors in cases other than the one at bar, finding such evidence irrelevant to the question whether the technique was executed reliably as regards the particular case.[155]

But if the historical experience of forensic science suggests anything, it is that somehow this law/fact model falters in the criminal justice context. Rather than streamline the introduction of forensic evidence, the criminal justice process seems instead to effectively railroad it. This subpart identifies the ways in which the distinctive characteristics of criminal process undermine the proper functioning of this model in the criminal justice system, first as regards to forensic science generally, and then as regards to second generation sciences such as DNA typing. Specifically, with regard to methodological integrity, the first section argues that this model overlooks the structural asymmetry of the parties to a criminal case, which in turn magnifies the impact of early admissibility determinations, which are often unreliable. With regard to the application of the technique, this section concludes that this model relies too heavily on adversarial processes to uncover errors, when in fact

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[154] *See, e.g.*, *United States v. Morrow*, 374 F. Supp.2d 51, 67 (D.D.C. 2005) ("A laboratory's error rate is a measure of its past proficiency and is of little value in determining whether a test has methodological flaws.... What the defendant has sought to do here is challenge the proficiency of the tester rather than the reliability of the test. Such challenges go to the weight of the evidence, not its admissibility." (internal quotation omitted)); *State v. Adams*, 817 N.E.2d 29, 48 (Ohio 2004) (noting "reliability inquiry relates to the validity of the underlying scientific principles, not the correctness of the expert's conclusions"). The Court in *Morrow* identified three possible types of error: "(1) a laboratory's past error rate; (2) the error rate that results if an analyst follows the … protocol and uses properly calibrated instruments in the specific case at hand; and (3) the possibilities of human error in the specific case at hand." *Id.* at 66-67. Regarding the first type of error -- what might be considered the "generally sloppy lab" argument -- the Court noted that the past error rate might not be admissible at all, and if admissible, would be relevant only to the weight of the evidence at hand. The last type of error, the "lab was sloppy in this case" error, would be admissible only as to weight, unless the sloppiness in the case was so grave that it undermined the reliability of the methodology altogether. *Id.* at 68.

[155] *See, e.g.*, *People v. Funston*, No. CO32472, *available at* 2002 WL 313198 (Ct. App. Cal. 2002) (unpublished opinion) (finding no error in trial court's exclusion on prejudicial/probative grounds the exclusion of evidence that lab had twice in 277 case reviews made reports that turned out to be "false positives," where trial court reasoned that "the question is one of relevance" and "the fact [that the lab] made errors in the past is not probative" of the issue whether it erred in the instant case).

the criminal justice system -- with its scarce resources, weak discovery practices, and high rate of plea bargaining -- tends to resemble more of an administrative process than an adversarial process one.[156] The second section then explains how these shortcomings, while generally problematic with regard to first generation techniques, are in fact especially acute when considered in light of the characteristics particular to the second generation.

1. A diagnosis of the first generation.

In every jurisdiction, the prosecution function is consolidated in a central figurehead. With regard to the federal criminal courts, the office of the Attorney General ultimately coordinates the actions of all prosecutors throughout the nation. In cities and states, offices are likewise coordinated on a local or statewide level. Nationwide, then, a forensic technique's proponent in a particular jurisdiction is essentially a single litigant: the prosecutor.[157] Indeed, given the nature of the field of forensic science, even the government's chief proponents of the technology -- the scientific witnesses -- can become institutional figures.[158] As a proponent of evidence, the prosecutor, and even the government scientist, is an institutional player in the system, handling a wide variety of cases in which the issue may arise.[159]

This centralized, institutional role well positions the government at the inception of a new technology to ensure that the methodology is thoroughly and adequately presented to -- and therefore accepted by -- the courts. The prosecutor can consolidate resources to present the strongest case possible for admission. She can assign specialized or multiple counsel, work collaboratively with scientists to develop arguments and theories in support of the technique's admission, or decide not to seek admission until conditions are optimal. The prosecutor can actively "forum shop" a new forensic technique by choosing those cases and those

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[156] *See, e.g.*, Gerald Lynch, *Our Administrative System of Criminal Justice*, 66 Fordham L. Rev. 2117 (1998).

[157] *Daubert*, 509 U.S. at 592 n.10 (citing *Bourjaily v. United States*, 483 U.S. 171, 175-76 (1987)). The rules do not specifically place the burden upon the proponent, but that is who it falls to naturally.

[158] By example to the contrary, in civil cases the perceived problem is the opposite: there is an abundance of experts able and willing to testify to "any" opinion. *See, e.g.*, Gross, *supra* note 3, at 1129-30 ("[E]xpert witnesses are too readily available"); *id.* at 1130 ("Experience has shown that opposite opinions of persons professing to be experts may be obtained to any amount." (quoting *Winans v. New York & Erie R..R.*, 62 U.S. (21 How.) 88, 101 (1858))).

[159] *Cf.* Marc Galanter, *Why the 'Haves' Come Out Ahead: Speculations of the Limits of Social Change*, 9 LAW & SOC'Y REV. 95 (1974).

courtrooms -- indeed, those judges -- most likely to be receptive to the proposed technology. A prosecutor eager to see a technology accepted might even choose test cases with reference to which defense lawyers seem the least likely to pose a formidable adversary.[160]

At the same time, the very structural dynamics that well equip the prosecutor to argue in support of novel scientific evidence in turn undermine the defense's ability to fight meaningfully against it. Unlike the prosecutorial function, the defense function is typically diffused among paid private practitioners, or localized central offices. In many jurisdictions, defense attorneys are not even repeat players within the criminal justice system, but rather take criminal cases only when required by the courts.[161] This decentralization of the defense function impedes any concerted and comprehensive defense response to new forensic techniques at the critical moment when a new technique gains momentum. Coordination of the initial defense response to a new government technique therefore occurs, if at all, with much less frequency.[162]

This may be particularly true in the early stages of a technique, when the government has its tightest grip and the only literature about the development or validation of the method is that generated by the

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[160] Indeed, one need not even subscribe to a dark view of prosecutors to think such choices might be made; the prosecutor who believes in the integrity of the scientific technique, as such a proponent should, would logically choose a less formidable adversary or atmosphere if for no other reason than to save on the unnecessary expenditure of time and effort.

[161] *See* Steven K. Smith & Carol J. DeFrances, *Indigent Defense*, at 2, Bureau of Justice Statistics, Feb. 1996 (describing "ad hoc" appointment system)*; see also* Carol J. DeFrances, *State-Funded Indigent Defense Services, 1999*, at 2-3, Bureau of Justice Statistics (Sept. 2001) (commenting that "[t]he decentralized and diverse ways of delivering indigent defense services make collecting information nationwide difficult," and identifying the three primary mechanisms as public defender systems, assigned counsel, and contract appointments); Caroline Wolf Harlow, *Defense Counsel in Criminal Cases*, Bureau of Justice Statistics, November 2000 (reporting that even in the 75 largest counties,

[162] Indeed, at least preliminary data bears this out. In his study of federal and state court challenges to expert evidence, Professor Risinger observed that "[t]he most striking contrast between the state and federal numbers is the prosecution's higher loss rate in state courts." D. Michael Risinger, *Navigating Expert Reliability: Are Criminal Standards of Certainty Being Left on the Dock?*, 64 ALB. L. REV. 99, 112 (2000) (citing the expert win rates of the government in criminal cases as 90% of the time in the federal system, and 75% of the time in state courts). Professor Risinger attributes this difference in part to the difference in the types of challenges raised in state versus federal court. *Id.* However, the disparity perhaps also can be explained by the greater resources and geographic dispersion of federal prosecutors versus state prosecutors. With more resources and options at their disposal when putting forth scientific evidence, federal prosecutors naturally succeed at a higher rate. To the contrary, at a local or state level, prosecutors have fewer resources and options. Similarly, the defense response is perhaps strongest and best coordinated at the local level.

government.[163] Thus not only may the defense attorney's own perspective on a methodology's legitimacy be distorted, but even the skeptical attorney may encounter a dearth of critical analyses.[164] Unarmed with legitimate contrary voices, and often confronted with the popular misperception by judges that forensic laboratories, and those they employ, are neutral "scientists" rather than partisan advocates, the advocate is ill-positioned to mount an effective challenge.[165]

In addition, even where coordination is possible or desirable, the nature of the defense role may preclude it. The defense attorney, unlike the prosecutor, meets forensic evidence reactively: she cannot pick or choose the perfect case or the perfect forum in which to mount an opposition. And confidentiality and access limitations thwart effective pooling of data. For instance, an attorney would be hard-pressed to advocate a third party's retention and storage of the ballistic evidence in a client's case for the purpose of conducting systematic studies. Nor could an attorney use the findings made in one case to either support or attack the findings in another, without risking a conflict of interest.

Moreover, ethical rules bind defense attorneys to the zealous representation of each individual client, which further affects the defense attorney's determination to challenge admissibility. Consider a defense attorney presented with a novel scientific technique in a homicide case. That attorney, knowing that ultimately the trial will turn on self-defense rather than identity, might choose to mount a lackluster or even no challenge when the government tenders the evidence. In such a case, both practically and ethically speaking, the defense attorney with limited resources would be remiss if she wasted precious time and effort carefully opposing the admission of the scientific evidence, even if she knows that failing to mount such a challenge will make it harder in a future case to convince the same judge that the very same kind of evidence admitted earlier should now be considered inadmissible.[166]

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[163] *See supra* Part II.A.

[164] Giannelli, *supra* note 85, at 1386 ("There is a special need for outside experts when novel scientific evidence is introduced. Paradoxically, there is often a lack of defense experts in these cases precisely because the procedure is new.").

[165] Judges further view the lack of controversy in the field as proof that the principle is sound and well-accepted, rather than possible evidence of "an impoverished research tradition, lack of resources, or stagnation." Saks, *Merlin and Solomon*, *supra* note 6, at 1135 ("In many of the cases we have reviewed, the courts were presented with only one-sided questions regarding the adequacy of a given kind of asserted scientific evidence. Prosecutors typically offered the novel forensic science and defendants typically offered no reply of substance. The courts in these cases often said they were impressed at the 'uncontradicted' expert testimony.").; *see* Beecher-Monas, *supra* note 7, at 97 n.311.

[166] The defense cannot subvert the zealous pursuit of a single client's defense even to the greater good of all defendants generally.

Relatedly, an attorney might accede to fifty cases in which the defendant agrees under oath during a plea colloquy that certain forensic evidence corresponded to him before attempting to come into court and argue in the one case going to trial that in fact that very forensic method is entirely unreliable.

The efforts expended by the government at the early stages of a technique's acceptance in turn reap prolonged reward, because the decisions rendered in these initial hearings my conclusively establish the widespread acceptance of the technique. Once a technique take root, both practical and legal obstacles preclude its easy extirpation. As one scholar has observed, "most evidence law is only conditionally applicable: it comes to life only if the litigants invokes its rules."[167] But the law-like treatment of scientific methodologies transforms the active posture of *Daubert* into a passive one: rather than ask whether a proponent of scientific evidence has proven the technique's reliability by a preponderance of the evidence, criminal courts presume a technique admissible unless a party demonstrates by some unascertainable standard that other courts erred in admitting it, or that the science has undergone a significant change that warrants revisiting a prior court's findings.[168] The ultimate result, however, is that a technique need only gain enough approval, even without any significant opposition or at an infant or premature moment in its development, before the law's impulse toward efficiency and consistency take hold and a science admissible in enough jurisdictions turns presumptively admissible in all others.[169]

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[167] DAMAŠKA, *supra* note 2, at 87.

[168] *See, e.g.*, ANNOTATED SCIENTIFIC, *supra* note 9, § 1-3.8 (agreeing that revisiting admissibility determinations makes no sense "unless there is a change in the state of scientific knowledge"). *Cf. United States v. Leon*, 468 U.S. 897, 927 (1984) (Blackmun, J., concurring) (agreeing with majority's view of social science evidence introduced in support of outcome, but describing the court's decision as "a provisional one" subject to reconsideration should experience call into question the empirical assumptions upon which the decision rested). Of course, where evidence is *excluded*, incentives remain high to improve upon the science and try again. *See, e.g.*, Walker & Monahan, *Breast Implant Litigation*, *supra* note 145, at 823 (relating trial court's rejection of plaintiff's scientific evidence, in which court discouraged blind "precedential effect" but rather encouraged revisiting the question "in the event that new and conclusive studies emerge"). Finally, it should be noted that some forensic science admissibility questions are decided by statute, thus obviating this concern altogether. *See, e.g.*, Paul C. Giannelli, *Admissibility of Forensic Science Evidence*, 28 OKLA. CITY U. L. REV. 1, 5 (2003) (describing various forensic techniques, including hypnosis, battered-wife syndrome, DNA, and polygraph evidence that received legislative validation).

[169] Unfortunately, "reducing the variability and dynamism across cases severely limits the opportunities for adversarial testing of diverse scientific evidence." David S. Caudill & Richard E. Redding, *Junk Philosophy of Science? The Paradox of Expertise and Interdisciplinarity in Federal Courts*, 57 WASH. & LEE L. REV. 685, 750 (2000).

That is, for precisely the reasons cited by Monahan and Walker,[170] trial courts typically choose not to undertake lengthy or complicated admissibility hearings -- often involving at least nominally the same litigants and witnesses heard by another court -- but instead simply adopt the findings of earlier courts and rule the technique admissible. Moreover, a court confronting an admissibility question previously decided understandably feels less compelled to require the prosecutor -- perhaps the exact same prosecutor that previously held a complex hearing in another courtroom or even that same courtroom, to re-enact the earlier hearings. This practice arguably even pays heed to the principles of equal treatment under the law: a technique judged admissible in one court is likewise deemed admissible in another, thereby treating like litigants alike and inuring the courts from the embarrassing specter of disparate results.[171]

But for obvious reasons, prosecutors have little reason to undertake a challenge to the prevailing wisdom. Able to rely on the findings in other proceedings, and act responsively only upon challenge, it is in the government's interest to do nothing to disrupt the status quo. In fact, the law-like treatment of scientific methodologies subverts the inclination toward innovation and experimentation that typically characterizes scientific development.[172] After all, the law tends to view

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[170] *See* Walker & Monahan, *Social Frameworks*, *supra* note 145, at 583-84 (noting that factual treatment of social science evidence, requiring "[t]he same testimony about the same research studies . . . in case after case" is "an inefficient use of court time"); *see also* Saks, *Aftermath*, *supra* note 79, at 233 (criticizing the Supreme Court's decision in *Joiner* in part because "it is inefficient to allow parties to relitigate the same general question over and over"); *cf.* ANNOTATED SCIENTIFIC, *supra* note 9, § 1-3.8 ("Once a higher court determines, on the scientific merits, that a . . . forensic identification technique can do what it purports to do (unless there is a change in the state of scientific knowledge), there is not much sense in allowing the same question to be revisited by the trial courts in case after case.").

[171] In contrast, the Supreme Court in *General Elec. Co. v. Joiner*, 522 U.S. 136 (1997), announced that the abuse of discretion standard governed appellate review of trial courts' admissibility decisions. *Id.* at 146. In applying this standard, the Court bestowed upon lower courts the deference traditionally reserved for partly factual determinations, even while recognizing the potential for them to reach different decisions with regard to the same evidentiary admissibility issues. *Id.* at 142.; *see, e.g.*, Beecher-Monas, *supra* note 7, at 78 & n.153; Saks, *Aftermath*, *supra* note 79, at 233. In this regard, Professor Saks has observed that the abuse of discretion standard of review announced in *Joiner* technically permits one court to uphold the legitimacy of a majority-endorsed technique, while another court finds the minority-endorsed technique legitimate, thereby leaving the public baffled. Saks, *Aftermath*, *supra* note 79, at 234; *see also* Janet C. Hoeffel, *The Sixth Amendment's Lost Clause: Unearthing Compulsory Process*, 2002 WIS. L. REV. 1275, 1324 ("The second effect of the *Daubert* trilogy is that lower courts are deciding the same issues differently. A particular expertise or scientific method may be admitted in one court and denied in another.").

[172] Of course, there are some situations in which the government may desire progress or change. For instance, the government might advance scientific knowledge in response to a persuasive attack made by defense lawyers on the basis of a technique's shortcoming, or a

uncertainty as evidence of falsehood, and the promulgation of new theories only calls into question the legitimacy of those previously accepted and proven. Questioning an established theory serves only to provide opposing counsel, or the courts, with the ammunition necessary to defeat the continued admissibility of the technique.[173] Thus, the law-like treatment of forensic methodologies actually discourages government scientists from engaging in further research and development of forensic technique. As every grandmother knows, "if it ain't broke, don't fix it."

On the defense side, strong incentives discourage the lawyer from raising challenges to scientific evidence, not only with respect to challenges to a technique's legitimacy as a methodology, but also with respect to the reliability of the evidence in a particular case.[174] The very "scientific" nature of forensic evidence bestows an air of reliability that defense attorneys may be loathe to tackle.[175] And, just as it has been observed that elaborate legal regimes may tilt a defense attorney in favor of constitutional arguments and against factual arguments,[176] so too must it be recognized that, as regards scientific evidence, defense attorneys

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court's adverse ruling on admissibility, or the prospect of increasing a technique's forensic capacity.

[173] *See* Saks, *Merlin and Solomon*, *supra* note 6, at 1131-32 ("Fundamental new discoveries risk raising judicial doubts about all that had gone before, and what the future may reveal about the present. No advances means raising fewer doubts. We have seen examples of forensic identification sciences . . . that have been largely frozen in time, with little if any fundamental progress since their foundational appearances in court.").

[174] Again, the history of scientific evidence in the criminal justice system -- even of the low-tech variety, suggests that the vast majority of counsel do just that. Giannelli, *supra* note 82, at 114-15 (cataloguing litany of "junk science" testimony, and observing that some experts testified up to 127 times without meeting meaningful opposition); Saks, *supra* note 11, at 431 (citing study indicating that "out of 90 state court opinions in which handwriting identification evidence was proffered," there was not a single challenge to the admissibility of the forensic handwriting examiners); *see also* Saks, *Merlin and Solomon*, *supra* note 6, at 1132-33 & n.347 (describing freedom with which forensic scientists usually testify, even to baseless propositions, because there is no academic or commercial community to hold them accountable and lawyers fail to attack). Indeed, studies have shown that the defense calls an expert in only a small percentage of cases. In a survey of appellate court cases decided after *Daubert* over a span of six years, one scholar found only 213 state court challenges to the prosecution's scientific evidence, and eighty such challenges in federal court. Risinger, *supra* note 142, at 125; *see also* William J. Stuntz, *The Uneasy Relationship Between Criminal Procedure and Criminal Justice*, 107 Yale L.J. 1, 42 (1997) (citing study of appointed counsel in New York City, which revealed that the defense used experts in only 17% of homicide cases, and in only 2% of felony cases).

[175] ANNOTATED SCIENTIFIC, *supra* note 9, § 1-3.5.1[2] ("It appears that historically [defense] lawyers brought few challenges to the basic validity of a wide range of techniques routinely relied on by prosecutors. . . . [T]he lawyers mainly assumed that these experts could do what they claimed they did.").

[176] Stuntz, *supra* note 174, at 15, 21.

have the freedom to cope with the results of scientific testing in ways other than to scrutinize it carefully. Instead of undertaking a challenge to the evidence, an "overworked, underpaid," court-appointed counsel -- who may also lack the time, knowledge, or energy to even screen the case for the reliability of its scientific conclusions[177] -- may simply try to incorporate the findings into the theory of the case or,[178] more likely, negotiate a plea bargain.[179] Even counsel willing to critically examine a scientific orthodoxy may be discouraged in the face of the seemingly insurmountable burden of adducing sufficient arguments that the forensic technique, and the cases endorsing it, are in fact illegitimate.

In this respect, although the "sequence of procedural ideas inherent in the adversary model" conceives the system as "a dispute between two sides in a position of theoretical equality before a court which must decide on the outcome of the contest,"[180] the reality flatly contradicts this ideal. The adversary in the criminal justice system tends to perform simply a screening function -- winnowing out those few cases that will actually make it before a factfinder for resolution. This administrative -- rather than adversarial -- character renders the *Daubert* Court's primary safeguard -- the advocate and the adversarial process[181] -- truly vigilant in only a small fraction of cases.

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[177] One scholar remarks that under-litigation in the criminal field "could be the result of a number of factors," including that "criminal defense lawyers have seen little profit" from such challenges, due to the lack of judicial receptivity. David L. Faigman, *The Law's Scientific Revolution: Reflections and Ruminations on the Law's Use of Experts in Year Seven of the Revolution*, 57 WASH. & LEE L. REV. 661, 661 n.2 (2000). Moreover, "most criminal defense work is conducted by over-worked, underpaid, and under-resourced public defenders," whereas "challenging forensic science expert testimony is a time-intensive and expensive proposition." *Id.* Thus, "[p]ublic defenders simply might not have the time and money to do it effectively." *Id*.

[178] For instance, rather than challenge the DNA recovered in a rape case, counsel might point to the location of recovery -- for instance, a stain on the bed versus on the floor or in the living room, as evidence that the sex was consensual. In the highly publicized O.J. Simpson trial, the defense argued that certain aspects of a blood stain on the socks of the defendant suggested police tampering, rather than exclusively relying upon an argument questioning the DNA typing results. *See* Richard Lempert, *After the DNA Wars: Skirmishing with NRC II*, 37 JURIMETRICS J. 439, 444-46 (1997).

[179] *See, e.g.*, Lynch, *supra* note 156, at 2121 n.2 (noting that "[m]eaningful statistics are elusive" with regard to the rate of plea bargaining, but that "there is no real dispute that …the vast majority of cases are disposed of without a formal trial").

[180] Mirjan Damaška, *Evidentiary Barriers to Conviction and Two Models of Criminal Procedure: A Comparative Study*, 121 U. PA. L. REV. 506, 563 (1973).

[181] *Daubert*, 509 U.S. at 596.

2. The pathologies of the second: high volume, low stakes, and technical complexity.

It might be argued that second generation scientific techniques alleviate many of the concerns raised in the preceding section. Indeed, many of the very characteristics that define the second generation -- the technical complexity, scientific certainty, recurrent presence in a wide range of cases, and database-based comparisons -- might instill confidence in its wide-scale use in the criminal justice system. Advocates of DNA typing, for instance, have argued that it is in fact the new model for judging all forensic science. They propose that the rigor of DNA science will spare it from the embarrassments that plagued traditional forensic sciences, and even advocate the "DNA paradigm" as a tool for reassessing even first generation techniques.[182]

But of course, as already attested to by its young lifetime, DNA typing has suffered its equal share of scientific scandal and hyperbolic assertion.[183] And closer examination of the historical experience of forensic science, coupled with the consideration of the characteristics peculiar to the sciences of the second generation, reveals that this kind of evidence is at greater, not lesser, risk for error in the current regime. Specifically, when it comes to a complicated second generation technology, courts are too willing to look "law-like" across cases, and even jurisdictions, to approve a technique -- even when narrower scrutiny is merited. Conversely, with regard to errors in the execution of a second generation technique, courts are too willing to limit the "fact-like" inquiry to the materials generated in the case before them, even when the kinds of errors to which the second generation is susceptible are visible only upon broader review. In short, when it comes to second generation technologies, the "law-like" treatment of methodological questions and the "fact-like" treatment of application errors risks creating a criminal justice system in which a high volume of cases that contain seemingly conclusive evidence end up proving guilt without meaningful scrutiny of any kind.

Indeed, the technical complexity, scientific certainty, and methodological rigor of second generation technologies renders it all the more likely that all parties involved will demur from assuming an active role in safeguarding the validity and integrity of scientific evidence. With respect to judges, resource constraints and even intellectual timidity may

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[182] Saks & Koehler, *supra* note 12, at 893.

[183] *See* introduction to Part II.

encourage the "amateur scientists"[184] of the bench to lean upon the "law-like" status of other court's rulings rather than spend precious time confronting a technically complex and seemingly highly probative technique, whether to make an independent determination of the technique's admissibility or to rule intelligently on legal objections. Indeed, the scientific complexity of second generation techniques puts them at the greatest risk of simply "assume[ing] a posture of mystic infallibility."[185] Yet relying upon the earlier findings may be especially problematic with regard to second generation technologies. The more a technology is scientifically complex, financially costly, and dependent on databases in the unique possession of a single entity, the less likely it is that it has been subject to scrutiny outside of the government's forensic community, especially early in its inception.

Moreover, even well meaning judges may struggle themselves with understanding complicated scientific or mathematical principles,[186] especially when such technologies tend to carry a veneer of reliability

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[184] *Daubert*, 509 U.S. at 601 (Rehnquist, J., concurring). Justice Rehnquist, of course, coined this phrase as an expression of skepticism at the propriety of having federal court judges resolve complicated scientific disputes, many of which remain unresolved by experts in the field. That debate -- regarding the capacity of judges to render decisions with regard to highly technical evidence, continues to rage. *Cf., e.g.*, Faigman, *supra* note 177, at 684 (looking with optimism into future, in which "lawyers and judges will become increasingly sophisticated consumers of science").

[185] *United States v. Addison*, 498 F.2d 741, 744 (D.C. Cir. 1974). In the words of one scholar, "disputing the technology is like disputing the law of gravity." Hoeffel, *supra* note 141, at 465. As stated by a defense lawyer confronting DNA typing evidence, "[w]hen an expert comes in an says there's a one in 700 million chance that your man is not the one . . . it just kills you." *Id.* at 466 & n.10. Thus, in the aftermath of the trial of the first man in New York state to be convicted in part based upon DNA typing evidence, one juror observed, "The DNA was kind of a sealer on the thing. You can't really argue with science." *Id.* at 515 & n.297.

[186] For example, early DNA cases allowed testimony regarding the testing and sampling, as well as testimony that the two samples "matched," but refused to admit statistical evidence due to lack of general consensus in the community. *See, e.g., Crews*, 640 A.2d at 401-02; *State v. Bible*, 858 P.2d 1152, 1185 (Ariz. 1993). The reasoning in such cases often mirrors that expressed by the *Crews* majority, which likened "match" testimony to testimony saying "I saw a blue Chevrolet run over this dog." *Id.* at 402-03. According to the *Crews* court, even though the testimony cannot establish that it was the defendant's blue car, it remains "useful, admissible testimony." *Id.* The difference, of course, is that jurors sitting in the dog homicide trial can rely upon their intuitive or experiential knowledge about the frequency of blue Chevrolets in the area to assign weight to the evidence; for instance, jurors in Detroit might assign different probative value to such evidence than jurors in San Francisco. To the contrary, a juror who first hears testimony that every person's DNA is unique, and then hears evidence from a DNA analyst who reports that the DNA in the suspect's sample "matched" the forensic sample, can infer only that in fact the forensic sample came from the defendant. In this sense, such testimony may in fact be more damaging than a random match probability calculation. Absent personal knowledge concerning the frequency of certain genetic profiles in the population, the juror simply has no other independent or experiential knowledge upon which to rely in determining the significance of the "match" statement.

because they exist in the world outside the courtroom even if, on closer inspection, that existence takes an entirely different form. Furthermore, the high volume of such cases only confirms this instinct: for instance, the more a judge sees cases with DNA evidence in which the defendant admits guilt and the evidences goes unexamined, the more it affirms the belief that this kind of evidence is typically trustworthy and reliable. Rather than slow their dockets by undertaking what seems like unnecessarily cumulative and repetitive hearings, the court can instead cite to the findings of another jurisdiction and revert to a default rule of admissibility, demanding some special showing of possible error in that case before assigning an expert or permitting a challenge.[187] After all, delving deeply into highly technical or complicated scientific knowledge, only to arrive at a conclusion contrary to that held by those in similar office, risks humiliation in basing a conclusion on a misunderstanding of technical material found in a discipline outside the familiar terrain of the law.[188]

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[187] Of course, such a showing may be difficult either because the science is too complicated to even interpret without an expert assistance, *see supra* text and accompany notes at 118-19, or because the data, at least superficially, appears sound even if flawed, *see supra* text and accompanying notes at 176-77.

[188] Consider, for instance, the enormous backlash that attended the trial court's decision in *United States v. Plaza*, which held aspects of fingerprinting evidence insufficiently reliable after application of the *Daubert* test. 188 F. Supp.2d 492 (E.D. Pa. 2002), *withdrawn from bound volume but available at* 2002 WL 27305, at *19 (noting that the government may introduce evidence attesting to uniqueness of fingerprints and to similarities between the latent print and that of the suspect, but precluding "testimony expressing an opinion of an expert witness that a particular latent print matches, or does not match, the rolled print of a particular person and hence is, or is not, the fingerprint of that person"). Ostracized as obtuse and unsophisticated, and lambasted for breaking with one hundred years of precedent, the trial court eventually determined to save face and reverse course despite the wealth of scholarship supporting the court's initial conclusion. *United States v. Plaza*, 179 F. Supp.2d 549, 576 (E.D. Pa. 2002) (vacating earlier opinion). As an aside, the second *Plaza* opinion illustrates nicely the import placed by the government upon admissibility rulings in a regime that accords them law-like precedence, and the pressures that prosecutorial watchfulness in turn imposes upon courts. In its motion for reconsideration in *Plaza*, the government argued not only with regard to its "prosecutorial effectiveness" in the case at bar, but also pleaded that "other cases in which fingerprint identification could be expected to play a significant role . . . would be seriously compromised by the preclusion of [the requested] opinion testimony." *Id.* at 552-53. Thus, in effect, the government premised its argument for admission not only on the facts of the case at bar, but on its fear of the widespread repercussions of an opinion precluding the introduction of such testimony. Incidentally, the *Plaza* opinion also illustrates well the difficulty in fixing with specificity the preferred form of proof-taking in admissibility decisions. In its reconsideration opinion, the trial court claimed benefit from materials outside the record; however, the judge felt constrained to earmark them as such. *Id.* at 554 (interposing a "[*Historical Note* (*not drawn from testimony*)"). Moreover, the court highlighted the particular importance of live testimony as one of the decisive factors in its decision to reconsider. *Id.* at 575 (observing that one of the witnesses at the reconsideration hearing, FBI print unit chief "Stephen Meagher, heretofore a name in a transcript, became a

For the very same reasons, even a competent defense attorney may simply conclude that it requires too great of an effort, and reaps too little of a reward, to scrutinize the evidence for a flawed methodological approach or erroneous result.[189] The rigor of second generation techniques might even lead an attorney to simply trust the integrity of the evidence, thus making the case seem less sympathetic, otherwise insurmountable, and essentially "open-and-shut."[190] Or, again, the more technically complex an evidentiary form appears, the more that even a well-meaning attorney may simply not be capable of comprehending the science, regardless of the effort they expend.[191] After all, how many lay

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real person, and through his live testimony I was able to get a substantially more rounded picture of the procedure").

[189] Anecdotal evidence suggests that just this is happening. The methodologies underlying DNA testing techniques have been robustly challenged in only a handful of cases; in the first appellate criminal case challenging the admissibility of DNA evidence, the defense called no experts. *State v. Andrews*, 533 So.2d 841 (Fla. 1988); *see also* Hoeffel, *supra* note 141, at 499 & n.193 (1990) (describing how, after the introduction of DNA evidence in 1987, no case mounted a meaningful challenge until the landmark hearing in *People v. Castro*, No. 1508/87 (N.Y. Sup. Ct. 1989)). Challenges to the application of these technologies may receive even less scrutiny. *see also* Risinger, *supra* note 142, at 125 (noting in addition that only two of federal court cases studied posed direct, rather than derivative, challenges to the DNA evidence, and in only 44% of the state court cases and 18% of the federal court cases were there any challenges to DNA evidence at all). Although data regarding the challenges mounted by defense attorneys to the execution of the testing -- which would be reflected in cross-examination rather than by an admissibility hearing -- are harder to come by.

[190] Of course, that would violate the ethical rules. *See, e.g.*, William H. Simon, *The Ethics of Criminal Defense*, 91 MICH. L. REV. 1703, 1703 (1993) (recognizing ethical obligation of defense counsel zealously to pursue defense even of guilty client, while doubting ethical propriety of "aggressive defense" tactics); David Luban, *Are Criminal Defenders Different?*, 91 MICH. L. REV. 1729, 1729 (1993) (citing obligation to "zealous advocacy" while arguing that institutional considerations differentiate criminal defense lawyers). *But see* Darryl K. Brown, *Rationing Criminal Defense Entitlements: An Argument from Institutional Design*, 104 COLUM. L. REV. 801, 809 (2004) (arguing that scarce defense resources should be allocated upon express, rather than covert, bases such as "factual innocence").

[191] In the words of one court, "DNA printing is a highly complex process which only a trained expert fully understands. Without this understanding, defense counsel cannot properly prepare for trial, or understand appropriate avenues to question results or cross-examine experts testifying for the prosecution. Without special training, the defense would be at the mercy of the prosecutor's expert, unable to discern weaknesses in the procedures used or in the interpretation of results." Zollinger, *supra* note 101, at 1811 (quoting *Tennessee v. Edwards*, 868 S.W.2d 682, 698-98 (Tenn. Crim. App. 1993)) (internal quotation marks omitted). It is worth noting that the lack of outside assistance is often not readily compensated for by the availability of government experts, because many government scientists refuse to accommodate defense requests for assistance. One study revealed that of 300 crime laboratories, "fifty-seven percent . . . would only examine evidence submitted by law enforcement officials." Giannelli, *supra* note 85, at 1331 (quoting Joseph L. Peterson *et al.*, *The Capabilities, Uses, and Effects of the Nation's Criminalistics Laboratories*, 30 J. FORENSIC SCI. 10, 13 (1985)).

people can work one long weekend and master the techniques of forensic MRI imaging or DNA amplification and testing?

Of course, an attorney may always request expert assistance to help interpret scientific evidence. But such assistance is likely to be less, not more, availing with regard to second generation evidence. That is because these techniques are likely to appear in a much higher volume and across a range of cases, including low-level offenses. A defense attorney handling one hundred cases -- especially if they are all misdemeanors -- simply cannot feasibly conduct the kind of scrutiny necessary to petition meaningfully for assistance in the forty cases that contain scientific evidence of some kind. And, absent expert eyes, the complicated technologies of the second generation may prevent counsel from even articulating to a court why assistance is necessary;[192] just as in one DNA case, an untrained request was denied as "no more than a plea that DNA evidence is simply too 'complicated.'"[193]

Even if counsel were able to demonstrate such a need in all those cases, it is simply unreasonable to expect that courts can appoint independent experts in all, or even most, of the cases in light of the high volume of second generation techniques. Not only would such appointments be inefficient, but they would also be extraordinarily costly. Experts are likely to be more expensive as regard second generation sciences: counsel requires a greater time commitment from experts in technical fields, because it takes longer both to educate the defense attorney and to interpret the materials. And the same highly technical nature that generates demand with regard to highly technical expertise in turn works to decrease supply. Simply reading raw data in a DNA case requires software that can cost thousands to tens of thousands of dollars, and the rapid evolution of the technology can render a large capital investment obsolete within a short number of years. Similarly, the costs associated with MRI imaging or facial recognition technologies all but preclude the development of plentiful independent expert shops. The parsimony with which judges grant requests in turn also affects the depth of the expert pool, because defense lawyers have few resources to draw upon when developing their cases.[194] Thus, such experts are more scarce,

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[192] *See, e.g.*, *Little v. Armontrout*, 835 F.2d 1240, 1244 (8th Cir. 1987); *see also* Thompson & Ford, *supra* note 131, at 52 (describing DNA evidence as "unusually complex, requiring a complicated series of procedures, drawn from molecular biology" which may require "lawyers . . . to consul experts in a variety of fields, including population genetics, chemistry, and microbiology").

[193] Zollinger, *supra* note 101, at 1812-13 (citing *Cade v. Florida*, 658 So.2d 550, 555 (Fla. Dist. Ct. App. 1995); *North Carolina v. Mills*, 420 S.E.2d 114, 118 (N.C. 1992); *Taylor v. Texas*, 939 S.W.2d 148, 151 (Tex. Crim. App. 1996)).

[194] Saks, *Merlin and Solomon*, *supra* note 6, at 1092 & n.112.

which means that even when available, experts in second generation sciences are likely to be stretched thin and quite costly. Thus, it is instead quite plausible that in the vast majority of cases, the highly technical, seemingly conclusive evidence of guilt will never be examined by any adversarial eye.

Moreover, even assuming that courts could in fact appoint an expert in every case, it is nevertheless unlikely that those experts would be able to undertake the kind of examination necessary to truly safeguard the integrity of the evidence. Second generation technologies make sense only in reference to large volumes of data, none of which is feasibly disclosed or, even if disclosed, feasibly reviewed in every case. For instance, verifying that a cell-site report accurately identified the location of a phone at a particular time requires likewise verifying all of precursor data -- such as the accuracy of the record of tower location, clarity and lack of interference with signal reception, and correspondence to actual physical terrain -- which is likely difficult to scrutinize closely in every case.[195]

Similarly, the scale of error that occurs in second generation science is an order of magnitude larger than that which occurs in first generation techniques: whereas a faulty hair comparison may wrongly inculpate someone in one case, a wrongly calibrated machine can churn out large volumes of erroneous information. Or take some of the common types of error that occur in DNA typing: a manufacturer may contaminate a kit,[196] an analyst may contaminate a sample,[197] or a technician may erroneously input data into the database.[198] These kinds

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[195] *See, e.g.*, David A. Lieb, *States Seeking to Track Cell Phones for Traffic Conditions*, Associated Press (Oct. 8, 2005) (detailing pilot programs to track drivers through their cell phones) (explaining tracking technology).

[196] Contamination at the manufacturing level has occurred in the United Kingdom, and another incident recently arose in the United States. *See, e.g.*, Becky Pallack & Kim Smith, *Contaminated DNA strikes 3 cases*, AZ DAILY STAR, December 13, 2005 (describing how same unknown sample turned up in testing at Tucson crime lab and then in two Florida crime labs, causing officials to conclude that the tubes used for testing where contaminated at a factory). Interestingly, prosecutors in the Tucson case moved the court to preclude the defense from even mentioning the contamination to the jurors, arguing that it unduly prejudiced the jury with regard to the reliability of testing in that case; their request was denied. *Id.*

[197] Sample contamination occurs so frequently that most labs require their analysts to keep their own DNA profiles on file, so that they can be compared against findings. *See, e.g.* KOBILINSKY, LIOTTI, & OESER-SWEAT, *supra* note 15, at 99 (advocating this practice).

[198] For example, a Las Vegas lab inadvertently switched two DNA profiles as it entered them into the database; as a result, an innocent man spent a year in jail awaiting prosecution for sexual assault. Glenn Puit, *Police Forensics: DNA Mix-up Prompts Audit at Lab*, LAS VEGAS REVIEW-J., April 19, 2002, at 1B.

of errors, or even the likelihood that a particular analyst or lab commits these kinds of errors -- whether deliberate or accidental -- simply cannot be captured in a single-case review, even if glaringly apparent upon a comparative or wider lens inspection.[199]

Consider, for example, the FBI scandal concerning analyst Jacqueline Blake, who pled guilty to falsifying reports of "negative controls" -- the data used to demonstrate that no contamination has taken place during testing.[200] Her actions came to light when a coworker who was working late noticed a problem with the files on Blake's computer.[201] Similarly, an analyst fired from a private laboratory for substituting clean control files for problematic samples was discovered only when a reviewer noticed that her negative blank files were strangely identical in every case.[202] In such cases, an independent review of the documents related to a single case in which the negative control was falsified would not reveal any cause for alarm, even though a more comprehensive inspection could have caught the suspicious data.

Alternatively, consider a case that recently arose in Michigan. There, the DNA of a grown man turned up in the testing of evidence related to a thirty-six-year-old murder case. On its face, the evidence would have appeared reasonable and reliable. But because the man, who was four at the time of the murder, lived one hundred miles away from the scene, and would have somehow had to drop blood on the deceased victim for the profile to appear, it raised suspicions. And, in fact a broader review of the laboratory records revealed that the man's DNA was being tested by the very same laboratory around the same time as the

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[199] *See, e.g.*, Phoebe Zerwick, *DNA mislabeled in murder case*, JOURNAL REPORTER (GREENVILLE), Aug. 28, 2005 (describing case of woman implicated in sister's death when sample tubes were erroneously mislabeled); Tom Jackman, *Paternity Suit Raises Doubts About DNA Tests*, WASH. POST, Aug. 21, 2005, at C1 (cataloging a list of faulty DNA tests).

[200] *See* Department of Justice Press Release, *Former FBI Biologist Pleads Guilty to Filing False DNA Laboratory Reports*, May 18, 2004. Specifically, negative controls are blank injections designed to safeguard against and expose any contamination that might have occurred in the testing process. If a blank comes back with stray material, then the analyst knows that the results of a test -- especially of an "unknown" may be the result of contamination. Rather than run blank injections, however, Ms. Blake apparently substituted a completed file in 103 cases, and misrepresented that copied file as a blank run in the case. *See* Maurice Possley, Steve Mills & Flynn McRoberts, *Scandal Touches Even Elite Labs*, CHI. TRIB., Oct. 21, 2004; Richard Willing, *Mueller defense crime lab after questionable DNA tests*, USA TODAY, May 1, 2003, at 3A.

[201] U.S. Dep't of Justice, Office of the Inspector General, The FBI DNA Laboratory: Review of Protocol and Practice Vulnerabilities, at ii (May 2004), *available at* http://www.usdoj.gov/oig/special/0405/final.pdf.

[202] *See* Aff. of Dr. Robin W. Cotton, PhD, *Maryland v. Kenneth Ernest Abend*, Nos. K-02-506 and K-0401903 (Nov. 2, 2004), at 3 & attachment B (on file with author).

evidence was processed in the old case.[203] But imagine if the man had fit the population of plausible suspects; in such a case, it is highly likely that no review of the findings would have taken place, and even if it did, that no judge would have authorized counsel to conduct a "fishing expedition" to determine whether contamination might have occurred. In both instances cited above, in order to catch the error, the review of evidence would have to look outside the scope of the information presented in the individual case.

Of course, for this level of scrutiny to occur, an expert would have to be appointed in every case, and would have to be given access to a much larger volume of materials than standard discovery authorizes.[204] Yet such appointments, and such routinely broad access, is all but impracticable. Not only would requiring such sweeping document disclosure in every case effectively destroy the bank accounts of a jurisdiction,[205] but it would also demand disclosure of an unsustainably, and perhaps even impossibly, large quantity of paperwork.[206] Every case

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[203] Although the analysts insist that no contamination occurred, and the age of the man at the time of the offense precluded any argument that he murdered the woman, it is easy to imagine a different outcome had the evidence been from a contemporaneous crime. *See e.g.*, Teresa Mask, *How Jurors See DNA Evidence may decide unsolved killing: 1969 slaying trial continues today*, DETROIT FREE PRESS, July 19, 2005.

[204] At a minimum, a skilled reviewer must have broad access to the laboratory's contamination logs and corrective action files, laboratory protocols, maintenance logs, proficiency testing results, caseworker files, and so on. *See, e.g.*, Giannelli, *supra* note 130, at 815-16 & n.152 (explaining need for more extensive discovery in DNA cases).

[205] John Devlin, Comment, *Genetics and Justice: An Indigent Defendant's Right to DNA Expert Assistance*, 1998 U. CHI. LEGAL F. 395, 396 n.111 (citing the typical cost of a DNA expert as ranging from $1000 to $10,000); Giannelli, *supra* note 85, at 1398 (reporting expert costs as high as $28,000); *see also id.* at 1363 ("If the standard [for appointing an expert] is too demanding, the right is gutted. If the standard is too lax, the costs skyrocket."). Nevertheless, the first National Academy of Sciences recommended just that: they suggested that defense DNA experts be appointed in all cases involving DNA, because few attorneys can deal with this type of science. NATIONAL RESEARCH COUNCIL COMMITTEE ON DNA TECHNOLOGY IN FORENSIC SCIENCE, DNA TECHNOLOGY IN FORENSIC SCIENCE 147-49 (1992) [hereinafter NRC I]. The subsequent report recommended appointment of experts, either to the court or to the parties, and noted that the complexity of DNA evidence might require the appointment of multiple experts. COMMITTEE ON DNA FORENSIC SCIENCE, NATIONAL RESEARCH COUNCIL, THE EVALUATION OF FORENSIC DNA EVIDENCE 169-70 (1996) [hereinafter NRC II].

[206] Early challenges to the sufficiency of discovery in DNA cases reveal courts' struggles to strike the right balance between the defense's interest in obtaining comprehensive material to challenge the validity of the government's assertions, and the government's interest in controlling the burden of amassing documents. *See, e.g.*, *United States v. Yee*, 129 F.R.D. 629, 630 (N.D. Ohio 1990) (commenting with regard to broad discovery request that "the defendants appeared to accept . . . the government's contention that the materials that they are seeking are not encompassed within Fed. R. Crim. P. 16"). In *Yee*, the magistrate judge ultimately granted the defendants' request, mainly because the case posed one of the initial challenges to the admissibility of DNA evidence. Moreover, he specifically cited as support

involving DNA evidence, or cell site tracking information, or biometric identification technologies, or e-mail or search engine data, simply cannot also carry with it the obligation to disclose the entire contents of databanks, cell tower locations or global positioning verification studies, internet service provider storage and retrieval systems, and so on. For this reason, the courts' demonstrated reluctance to approve the means necessary to conduct effective scrutiny in the case of second generation evidence is not in the end pathological; in fact, it may be quite reasonable. It is simply that it is also dangerous: the very qualities of second generation sciences that make them so desirable in turn also make it all the more likely that they will never be subjected to adversarial scrutiny of any kind. And while this lack of scrutiny is troubling on its face, it becomes all the more troubling when considered in light of the very real possibility that, given the investigative power of these technologies, it may be the only actual evidence of the defendant's guilt.

III. WHERE DO WE GO FROM HERE?

When it comes to second generation evidence, the effective lack of scrutiny may, statistically speaking, actually be okay; as noted above, in the vast majority of cases, it is likely that no error took place, and second generation sciences are at base far more credible sources of evidence than the traditional forensic sciences.[207] But criminal justice has never been satisfied to settle for being a random game of chance; as the familiar edict goes: "[b]etter that ten guilty persons escape than that one innocent suffer."[208]

And with regard to sophisticated scientific evidence, the stakes may often be even higher. As noted above, second generation technologies allow criminal cases to be built on little more than scientific proof: for instance, charges are routinely brought based upon only a "cold hit" DNA match. In some instances, the crime might even have occurred five, ten, or twenty years earlier -- making an effective defense

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the lack of "extensive independent scientific assessment and replication of the reliability of the procedures that have been developed by the F.B.I.," as well as the "fact that the defendants have developed bona fide questions about each of the categories in which they are seeking discovery." *Id.* at 631.

[207] *But see* Giannelli, *supra* note 85, at 1397 ("A British study (albeit small) found that '38 per cent of defence lawyers who had obtained an independent analysis' of DNA evidence received reports that 'differed from those of the prosecutions' expert.'").

[208] 4 WILLIAM BLACKSTONE, COMMENTARIES 358; *In re Winship*, 397 U.S. 358, 372 (1970) (Harlan, J., concurring) ("[I]t is far worse to convict an innocent man than to let a guilty man go free.").

all the more difficult to muster.[209] And, of course, it is reasonable to expect that, as the use of scientific evidence increases, so too might the error rate. If the only evidence in a thousand theft cases across the country is going to be the testimony of a forensic analyst that the defendant matched the evidence when the likelihood of random match was one in 240 billion, then surely the structural edifice of the criminal justice system should support the conclusion that we can trust that analysis each and every time.

However, the existing recommendations for improving the quality of forensic science in the criminal justice system all stay within the conventional framework, asking only to shore it up by: granting more money for experts; training lawyers better; holding more elaborate hearings; selecting more competent juries; or allowing for greater independent testing. Thus, these conventional "fixes" continue to rely upon inaccurate views of adversarial process: the notion that an attorney is willing and able (or even obligated) to engage in extensive pre-trial investigation and maneuvering to winnow contestable cases from uncontestable cases; that judges will conduct an adversarial proceeding of some kind (whether a motions hearing or trial) in those contestable cases; and that it is efficient, much less possible, to assign experts to review the outcomes of all scientific testing. Moreover, the conventional fixes rely upon an outdated view of the nature of forensic evidence: that case-specific review is a sufficient, or even preferable, level of scrutiny to ensure the quality of evidence entering the system.

Thus, none of the conventional approaches actually confront the problems presented by the second generation of forensic evidence. To be sure, some measure of increased access to experts, or broader discovery, or greater leeway on cross-examination might aid defense lawyers in fulfilling their checking function. But in a high complexity, high volume, database-based world of forensic evidence, simply bestowing each defense lawyer with an expert or requiring a hearing in every case is not only impracticable, it is also not effective. Resource constraints make such approaches all but impossible to implement with regard to high volume second generation techniques, and the scientific robustness of such techniques means that such expenditures would, in the vast majority of cases, be unnecessary and wasteful. In most cases, after all, the science will be sound. Thus, simply ramping up the appointment of experts or the number or scope of pre-trial hearings would largely be wasteful.

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[209] What innocent person could recall their activities on a random day many years earlier, or even locate the witnesses to verify their assertions?

Moreover, even if resource constraints entirely disappeared, the monitoring of second generation sciences require a scope of inquiry broader than that accorded to each defendant in a criminal case. As explained above, even if experts could be assigned in every case, simply closely examining the particular case file will not typically reveal whether any problems or errors in the scientific testing, or whether the methodological approach used by the government was sound. Fortunately, however, such errors are readily captured when viewed from a wholesale perspective, and therefore are easily amenable to quality control of a different kind. Although hardly exhaustive, this Part attempts to set forth some recommendations below, again using the specific template of DNA typing, addressed to these particular concerns. Although perhaps none of these recommendations alone offer a complete safeguard, if implemented together they have great potential to improve dramatically the introduction of forensic evidence in the criminal justice system.

A. Loosening The Government's Grip On The Technology.

As argued above, forensic sciences generally, and second generation technologies in particular, often require a greater depth and breadth of review in order to uncover flaws in either the underlying methodological theories or the execution of that theory in a particular case. A ballistics finding might be based on nothing more than the comparison of a recovered bullet to a bullet fired from a suspected gun; by comparison, the reliability of conclusions drawn in DNA typing may in turn depend upon the reliability of match probabilities derived from databases of genetic material, or comparison of the work done in one case with that done in other cases performed by the same analyst. Thus, effective monitoring of second generation evidence necessarily demands access to materials beyond those generated for an individual case. But given the other characteristics of such technologies -- their appearance in a high volume of cases and the privacy and proprietary concerns that broad disclosure may raise -- how might such reviews take place?

Perhaps the single most important change has long been advocated by scholars and members of the defense community: wide-scale reform of the forensic laboratory system, to ensure better quality control and to adjust the atmosphere so that it more closely resembles a neutral scientific lab than a charged advocate for the government.[210] And,

[210] Scholars have recommended the creation of independent laboratories with higher quality technicians, Giannelli, *supra* note 84, at 441; the strengthening of accreditation, protocol, and proficiency review of labs, *id.* at 474 & n.201-02; Beecher-Monas, *supra* note 7, at 100; encouraging ongoing validation studies, Saks, *Aftermath*, *supra* note 79, at 289 n.41, 239; and

of course, truly independent forensic laboratories are essential in part because they form the first line of defense against shoddy forensic science. Such a system might readily be lodged in public universities, or created as non-profit organizations.

But even the creation of an independent laboratory system cannot alone adequately guarantee the kind of openness and debate necessary to ensure the continued growth of forensic sciences. Development and monitoring of complex second generation techniques requires that no single institution be the sole custodian of the tools necessary to develop and challenge scientific orthodoxies. Yet, as is explained above, this is often the case with regard to forensic science. Indeed, in the case of DNA typing, this kind of information is currently held closely by the government and the private companies that generate the materials used by forensic laboratories, and rarely accessible to the public at large.

Accordingly, as the primary investors in forensic sciences, and the guardians of the underlying methodological data, the government should establish an entity -- such as a bipartisan board -- responsible for granting access to private or proprietary information on a circumscribed basis. Such an entity would set up procedures for researchers to gain access, field requests as appropriate, and even award grants for study.[211] Confidentiality agreements could place appropriate limits on the experts' ability to disclose discrete pieces of sensitive data, while nevertheless allowing a researcher to engage in the kind of open debate essential to healthy scientific development. For instance, in DNA typing, such an entity would grant access to researchers wishing to examine the databases or primer sequences. Alternatively, public defender organizations --

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the institution of a legal entitlement to independent or corroborative testing of scientific evidence. Beecher-Monas, *supra* note 7, at 90 n.250. The right to independent testing, however, cannot alone ensure the integrity of all forensic evidence. First, in many cases, the DNA sample is exhausted by government testing, and no evidence remains for independent submission. Second, a costly and time-consuming procedure such as duplicative testing cannot serve as the ordinary means of verifying the integrity of the government's results. Third, there are many strategic reasons why defense counsel might elect not to conduct routine independent testing. For instance, to the extent that a jurisdiction bestows a right to retest evidence, however, that right loses meaning unless it also includes a proscription on the government's comment on the exercise, or failure to exercise, such a right. Until courts resolve the questions of confidentiality and evidentiary use surrounding independent testing, defense lawyers would be reluctant to submit all evidentiary items -- particularly those already shown to "match" the defendant -- to confirmatory testing.

[211] The FBI currently solicits a limited amount of such research, but this limited opportunity is clearly inadequate. First, because it is the government that is soliciting the work, it is the government that defines what projects are interesting or worthy of being undertaken, rather than allowing a vibrant research community to make such determinations. Second, because the government selects the recipients of such grants, it is able to skew the awards toward sympathetic researchers.

whether individual offices in a particular jurisdiction or professional associations such as the National Association of Criminal Defense Lawyers or even non-profits erected precisely to conduct these types of reviews, might retain experts for the purpose of conducting particular independent studies.[212]

By means of illustration, consider the following concrete example from a controversy currently unfolding in the DNA community. The DNA typing technique most commonly used in the United States today examines genetic information at thirteen different places, or loci, on the genetic strand. Regardless of the number of loci developed, DNA analysts typically calculate the significance of a "match" between the forensic and known samples using a method known as the "product rule."[213] The product rule, in turn, relies upon data developed by FBI scientists to determine the frequency of particular alleles, or numerical expressions of genetic information, in the population.[214] The validity of this method depends upon two critical assumptions: first, that the sample upon which the frequency tables are based are sufficiently large and sufficiently random to draw general conclusions.[215] Second, that there is no link or correlation between each piece of information.[216] At present courts across the nation have accepted the results of DNA typing into

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[212] Data generated by a researcher commissioned by either a specific defense office or professional organization would necessarily be protected by attorney-client privilege, such that access to the information contained in such a study or report could not be disclosed broadly.

[213] BUTLER, *supra* note 15, at 501; *see* KOBILINSKY, LIOTTI & OESER-SWEAT, *supra* note 15, at 167-69; Frederick Bieber, *Science and Technology of Forensic DNA Profiling*, in DNA AND THE CRIMINAL JUSTICE SYSTEM, *supra* note 13, at 35. For an excellent primer on principles and techniques of forensic DNA, *see* KOBILINSKY, LIOTTI & OESER-SWEAT, *supra* note 15, at 1-196.

[214] By imprecise analogy, if the perpetrator was described as a white man with brown hair, crossed eyes, and large feet, and the suspect matched that description, the analyst would use a table showing the frequency with which each of those traits occurs in the relevant ethnic population, and then multiply them to determine the likelihood that all three traits would be found together by chance.

[215] Following the analogy used above, if the frequency tables were conducted by sampling two hundred people at a large-sized shoe store, then naturally the purported frequency of large-footedness would fail to reflect the actual frequency of large-sized feet in the population. Or if, for some reason, it should turn out that all people with crossed-eyes also have large feet, then the assumption that each variable was independent proves incorrect.

[216] *See, e.g.*, BUTLER, *supra* note 15, at 501 (describing product rule); *see also* KOBILINSKY, LIOTTI & OSSER SWEAT, *supra* note 15, at 135, 341 (defining "linkage" and assumption of "linkage equilibrium"). For example, when analysts look at only the male fraction of DNA, the product rule cannot be used, because the various pieces of genetic information are known to be linked. *Id.* at 116.

evidence and ruled the product rule -- and the frequency tables underlying it -- an acceptable way of representing the significance of a match.

Yet, recent evidence suggests that the data upon which the frequency tables are based may not be sufficiently large, or sufficiently nonrandom, to rely conclusively upon the statistical frequencies advanced by the government.[217] How that evidence was uncovered, and what has happened since the discovery, however, illustrate the specific problems raised by second generation sciences. Notably, the data was uncovered when an alert analyst happened to observe, and then to pursue out of sheer intellectual curiosity, the fact that two unrelated individuals (one Caucasian, one Black) matched at nine loci, even though under current statistical models a person picked at random would match that nine loci profile at a rate approximating 1 in 754 million in Caucasians, 1 in 561 billion in African Americans, and 1 in 113 trillion in Southwest Hispanics.[218] Then, simply because she was "curious," that analyst then checked the rest of the 60,000 person database for such matches, and uncovered 90 pairs of individuals who matched at nine loci, and several pairs at 10 and even 11 loci.[219] But although such matches raised serious questions about the accuracy of the populations statistics used in criminal cases, the analyst could take no further action, because she had "no time or the funding to look into it anymore."[220] Hence, the research stalled.

However, upon learning of such findings, a defense attorney representing a man charged with a "cold hit" crime, on the basis of a nine

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[217] Emerging independent research also indicates that the second assumption -- that of independence at the various loci -- may not hold true for all populations. After three years of battling government refusal to disclose the data upon which it based its frequency tables, defense experts obtained a fraction of the data and conducted independent analysis. As a result, these experts uncovered that in certain Native American populations, it appeared that correlations were evident between several of the loci that had been glossed over by government researchers. Dan E. Krane, Travis E. Doom, Laurence Mueller, Michael L. Raymer, William M. Shields, & William C. Thompson, Commentary, J. FORENSIC SCI., Vol. 49, No. 6 (Nov. 2004) (noting that "examination of data reported . . . for two Native American populations . . . shows significant departures from HWE [Hardy-Weinberg Equilibrium] at three loci for each population" and arguing that "these loci should not be used when the product rule is employed to compute the frequency of multi-locus genotypes in these populations").

[218] *See In the Matter of the Application of the State of California for An Order*, MISC-001 (Oct. 17, 2005), Tr. at 21-22 (on file with author); *see also* Poster Presentation at Promega 12th International Symposium, 2001, Kathryn Tryoer, Theresa Gilboy, and Brian Koeneman,"A Nine STR Locus Match Between Two Apparently Unrelated Individuals," Arizona DPS Crime Laboratory, Phoenix, AZ.

[219] Tr. at 23, 26-30.

[220] Id. at 25.

loci match,[221] attempted to gain access to the data to conduct further investigation. Consistent with expectations, however, the government vehemently opposed the request citing exactly the arguments elaborated above: privacy concerns,[222] the burden that it would place on the government "to require the State to do a search to satisfy a single Defendant,"[223] and the fact that such research was outside the scope of the analyst's duties.[224] Ultimately, the Court ordered the government to disclose only the barest of information -- a summary of the report of the analyst's findings.[225]

Thus, although strong evidence exists current assumptions about the significance of a match may not in fact hold, there is exists little to no mechanism for neutral, open research into this question even though this data buttresses the claims of early dissenters from the current methods of statistical calculations.[226] The government, which controls the data, lacks

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[221] As a means of saving time and money, some states routinely do only the "Profiler Plus" test, which looks to nine loci, rather than also do the "Cofiler" test to reach the full thirteen.

[222] Tr. at 70.

[223] Tr. at 6. Ironically, the analyst testified that one requested search would take a less than an hour, and the other only a couple of months. Tr. at 57-58, 71.

[224] Tr. at 58, 70.

[225] *See* Minute Entry, In the Matter of the Application of the State of California for an Order Requiring Custodian of Records as DPS Product Documents/DNA Database Unit, Arizona v. Lopez, No. CR-20051252, (Super. Ct. Az. Oct. 26, 2005) (ordering Arizona lab to conduct a specific search of state database, and report results to defense attorney) (on file with the author).

[226] Those dissenters argued that the population samples used to draw conclusions were insufficiently large and not demonstrably randomized -- the government researcher who published the study upon which the frequency tables are based looked at sample group sizes in the low hundreds. *See e.g.*, NRC I, *supra* note 205, at 91 (1992); P.J. Bickel, *Discussion of The Evaluation of Forensic Evidence*, Proc. Nat'l Acad. Sci. Vol. 94, P. 5497 (May 1997) (observing that "many scientists would not agree that he modeling assumptions" that assume that the data is drawn from a "random sample[]" of the relevant population and that no linkage is present). For instance, many charge that such a small sample size is insufficiently random, and thus inferences about the composition of the population at large are inappropriate -- the frequency table for genetic characteristics in the African American population was developed from only 210 profiles; for Caucasians it was 203, and Hispanics 209. *See* Bruce Budowle, et al., *Population Data on the Thirteen CODIS Core Short Tandem Repeat Loci in African Americans, U.S. Caucasians, Hispanics, Bahamians, Jamaicans, and Trinidadians*, J. FORENSIC SCI. 1999 Nov. 44(6):1277-86, at 1278. A subsequent study attempted to address these concerns, and drew upon data from roughly 1749 African-Americans, 1511 U.S. Caucasians, and 1421 Hispanics; that study concluded that these populations were in Hardy-Weinberg Equilibrium. *See* Bruce Budowle, B. Shea, S. Niezgoda & R. Chakraborty, *CODIS STR Loci Data from 41 Sample Populations*, J. Forensic Sci. 46(3), 453-89 (2001). That conclusion was later criticized, *see supra* note 163, at 1. At present, laboratories use a "theta correction" to account for the possibility of substructure among certain populations. KOBILINSKY, LIOTTI & OESER-SWEAT, *supra* note 15, at 156.

the money, time, expertise or, perhaps most critically, the interest, to conduct the necessary inquiries. And the court demonstrates a clear reluctance to saddle the government with a burdensome research project simply for the benefit of a single defendant in a single case, or to disregard the privacy interests involved and simply throw open the databases. As a consequence, however, critically important scientific inquiry is effectively thwarted. If, however, a neutral entity were charged with granting limited, extra-judicial access to these databases, then surely an independent researcher or a commissioned expert would be able to demonstrate the existence of a legitimate project.

Second, within the bounds of an individual case or investigation, defense attorneys should be permitted to petition the court for equal access to the databases of stored genetic profiles. States should follow the lead of jurisdictions like Illinois, one of the few in the nation in to provide a statutory framework for defense access to databases in individual cases.[227] Such access entitles the defendant, upon a particular showing, to search the database just as can the government. That way, again using DNA typing as an example, the defense would have as much capacity to investigate as presently does the government, in case an evidentiary item suggests a genetic profile other than the defendant's, or a mixture of profiles points to a different possible perpetrator. Such searches are clearly contemplated by the defendant's right to due process anad the assistance of counsel, and essential to the equitable administration of justice.[228] One lawyer in Missouri reported that she represented a man with no prior violent convictions, who was "matched" through a "cold hit" in a database to a case in which the government intended to seek the death penalty. Noticing that the government had failed to check the database with regard to an intimate sample taken from the victim, the attorney persuaded the laboratory -- over the objections of the prosecutor -- to run the second profile through the database. When the second profile turned up a match to a convicted sex offender, the case against her client was dismissed.[229]

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[227] The Illinois statute permits the defendant in any case where DNA may be relevant to the defense investigation or at trial to move the court for an order requiring the state police to conduct certain genetic tests, or to make certain comparisons or searches within the database. 725 ILL. COMP. STAT. § 5/116-5; *see also* O.C.G.A. § 24-4-63 (2005) (providing similar right to Georgia defendants upon a showing that "access to the DNA data bank is material to the investigation, preparation, or presentation of a defense at trial or in a motion for a new trial").

[228] By comparison, just as the government cannot instruct a witness not to talk to the defense, so too should the government not be allowed to "sequester" biological "witnesses," particularly potentially exculpatory ones.

[229] Email from Cynthia Dryden, public defender in St. Louis, MO, on file with author.

Third, the government should be required to allow periodic audits of forensic laboratory facilities. The same entity responsible for granting access to database could also regulate requests to conduct such inspections. Requests might be commissioned on an annual or biannual basis, and submitted by the same collective entities noted above -- such as consortia of independent attorneys' offices, interest groups, or national associations. Such audits would include open-file, big-picture review of a laboratories' materials, including comparison across cases, and confidentiality restrictions could ensure that no information was inappropriately disclosed.

Finally, laboratories should be required in every case to demonstrate that certain key documents -- such as protocols, analysts' resumes, and contamination and error logs -- were disclosed or available at all times. With the advent of the internet, such items are easily posted on a website to which access might be granted as DNA evidence arises in a particular case. Alternatively, a laboratory could simply hold "visiting hours" during which such items are available for inspection.

In order to ensure the proper functioning of these entitlements, and to provide an incentive to the government to set up appropriate institutions, the courts should routinely exclude forensic evidence not amenable to this kind of reasonable adversarial access on the grounds that it has not been exposed to true peer review. After all, *Daubert* itself specifically instructs that "submission to the scrutiny of the scientific community is a component of 'good science,' in part because it increases the likelihood that substantive flaws in methodology will be detected."[230] It further acknowledge that the "scientific project is advanced by broad and wide-ranging consideration of a multitude of hypotheses."[231] Precisely to enable such wide-ranging consideration, open access -- perhaps not to every individual litigant, but certainly to a qualified and limited community of researchers -- must be required.

B. Loosening The Courtroom's Grip On The Law.

Change is also necessary with regard to the legal structures that encourage the parties to approach methodological question reactively rather than proactively, that pigeonhole questions regarding the execution of a particular technique into too narrow of a box, and that rely unduly on an adversarial model when criminal justice is instead largely administrative. With regard to DNA, given the anticipated volume of

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[230] *Daubert*, 509 U.S. at 593.

[231] *Id.* at 597.

cases, it is inevitable that human error -- whether from deliberate malfeasance, reckless disregard, or pure accident -- will infect some results. Moreover, as the scientific techniques evolve, inevitably so too will our understanding of what constitutes legitimate scientific practice. Yet the current legal structure fails to embrace, much less address, either of these realities. Several small shifts in legal obligations could reap significant reward.

First, the law should impose upon the government an affirmative duty to disclose any departures from protocol undertaken by the government analysts in reaching the results at issue in the case.[232] Such an affirmative duty, like the duty of the government to disclose exculpatory evidence to the defense,[233] places upon the party best positioned to observe and report any deviations from standard practice the obligation to bring them to the attention of the court. In many cases, such departures from protocol may be explained by sound scientific practice or evolving standards, but they nevertheless should be identified and reported by the government, rather than leaving to the defense -- who is often least well-positioned to notice -- the responsibility of uncovering them. Once disclosed, the defense may elect to challenge the legitimacy of the technique in light of the modification, or it may elect to argue to the jury that the modification was ill-advised or invalidated the results, or it may forego use of the information altogether.

Such an obligation is appropriately in keeping with the law-like deference accorded the findings of validity of a particular methodology. Presumably, the court initially approved the introduction of the results of a particular technique on the premise that the approved technique was executed in a particular case in conformance with general standards. If, however, some "tweaking" or modification was required, then the government owes to the court the duty to disclose the deviation -- much as an advocate of one position owes to the court the obligation to disclose binding contrary authority, or as the government owes the obligation to disclose information in its possession that contradicts the statements of its witnesses. In short, it should be the government, rather than the defense's

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[232] For example, in a DNA case, it may be that a protocol requires that the analyst disregard as spurious any peaks lower than a certain cut-off level, or in particular position to another peak, or at a particular height-ratio to another peak. Yet, in a particular case, the government may attempt to incorporate those peaks because some other information justifies -- in the government's eyes -- the peak's inclusion. In the present legal framework, the government is under no obligation to disclose to the defense its decision to override standard practices; in the proposed regime, the government would be required to bring that discretionary decision to light.

[233] *Brady v. Maryland*, 373 U.S. 667 (1963).

careful review or good luck, that calls to attention any deviations from the protocols that garnered acceptance of the method in the first place.

Second, the question whether the laboratory generally operates at a sufficient level of competence should be considered as both a legal and a factual question to be determined in every case.[234] As a threshold matter, evidence processed at laboratories that fall below a reasonable standard of operational efficiency should not be admitted. A restaurant that had served up roaches in its spaghetti on five earlier occasions is not, after all, a place you would go to eat, no matter how much assurance it gives that your meal was prepared in a sanitary manner. In the same vein, when a person's freedom, and not just good digestion, is on the line, a similar standard should apply. A facility that has a demonstrated history of improper storage or handling of evidence, or inexcusable rate of failure on proficiency tests, simply cannot generate results reliable enough to discount the risk of error, regardless of how meticulously the tests appear to have been performed in an individual case. Moreover, staking admissibility of evidence on a laboratory's general reliability not only creates incentives on the part of the government laboratory to comply with published standards of operation -- so as not to seem to fall below general levels of competence, but it also gives the prosecution a vested interest in the competent management of the laboratory, thereby encouraging an oversight role in place of unquestioned allegiance.

Because such a question is a quintessentially legal one -- does this laboratory generally operate at a threshold level of reliability? -- courts would have to set appropriate standards of operational legitimacy. And while a degree of deference to earlier decisions is warranted, an approved lab can always be proven unreliable, or a tainted laboratory can redeem itself by demonstrating that procedures have been put in place to remedy a systemic error. Regardless, even with regard to laboratories that meet the appropriate threshold standard, any evidence of error should always be admitted -- particularly in "cold hit" cases -- as factual

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[234] At present, this question is often treated as irrelevant -- and thus excluded for evidentiary purposes -- when the defense can make no showing of expected malfeasance affecting the results in the case at bar. The second National Research Council report refused to even recommend consideration of laboratory error, whether as a qualifier on the statistical calculations or as independent evidence regarding reliability, at all in trial. NRC II, *supra* note 205, at 185; *but see* Jonathan J. Koehler, *Why DNA Likelihood Ratios Should Account for Error (Even When a National Research Council Report Says They Should Not)*, 37 JURIMETRICS J. 425, 428 (1997) (arguing that error rates should be calculated into probability determinations). Alternatively, some commentators and courts have suggested that there exists some level at which the general practices of a laboratory fall so far below the acceptable standards that they cease to be "reliable," and thus should be excluded. *See, e.g.*, *People v. Castro*, 144 Misc.2d 956, 545 N.Y.S.2d 985, 986 (N.Y.Sup.Ct.1989) (holding that admissibility should turn in part on whether the technique was properly executed).

evidence for the jury to weight as it deems appropriate. Of course, the government, in turn, could introduce evidence that any problems or errors in the laboratory are routinely dealt with in a professional and efficient manner, or that the laboratory's cited errors did not affect the particular case.

Third, to encourage scientific progress, and to ensure that it is honored in the courts, the law should place upon the government affirmative obligations consistent with the obligations of good science. Although the law's interest in finality, certainty, and consistency tends to value precedent over innovation, these principles ill-serve the enterprise of science, which thrives instead on novelty and experimentation. Rather than entrench methodologies and penalize the government for experimentation, the law should create incentives for the government to engage in research and development, and to bring forward new evidence in support of its techniques.

Thus, the government should carry a burden of placing before the court continued evidence of a technique's legitimacy. Rather than render admission of a methodology a one-time question that, once answered, is rarely asked again, the law should affirmatively require the government to provide evidence affirming the technique's continued viability. This is not to say that the government should be expected to reinvent the wheel -- or conduct full-scale admissibility hearings -- in every case. Instead, rather than start from an assumption that "no news is good news," such an approach would regularly ask "what have you done for me lately?" While the disclosure of new validation studies might not be considered essential to the continued admission of the methodology, the failure to supply a court with evidence of continued development within the field would, after a substantial amount of time, cause such evidence to be viewed with increasing skepticism. Likewise, the absence of evidence demonstrating the methodology's continued validity could alone constitute evidence of its obsolescence, and justify exclusion. In short, whereas an ancient legal principle is venerated for having stood the test of time, a scientific technique should be greeted skeptically absent evidence of ongoing examination.

Fourth, not all legitimate scientific methodologies should be treated alike. Law imposes upon science a degree of certainty that is unrealistic, and then entrenches one result over another without due regard for the existence of legitimate conflict.[235] The rules for

[235] Law, like science, must remain receptive to new information, allowing it to adapt over time. Walker & Monahan, *Breast Implant Litigation*, *supra* note 145, at 822 (arguing for the contingent "law-like" treatment of certain scientific results, while noting that "[i]nevitably, science changes over time just as law changes over time"); *id.* at 822 n.119 (quoting Heidi Li Feldman, *Science and Uncertainty in Mass Exposure Litigation*, 74 TEX. L. REV. 1, 16 (1995)

admissibility settle for the "general acceptance" of one method when in fact authentic conflict exists, and more than one method may have attained a threshold of reliability. That is, in science, it is not unusual that two opposing positions may equally be supported by legitimate argument and proof. In such cases, law-like deference to one position at the expense of the other thwarts and distorts the actual state of the science. In this respect, conflicting, but equally legitimate, methodological approaches merit equal play before a jury. Drawing on Professors Monahan and Walker's model, for instance, whereas law-like treatment of scientific methodologies might entitle a judge to instruct a jury that a particular technique was sound, such an instruction might instead be that several separate and competing approaches or techniques were sound. The parties can argue in favor of a particular approach, and the fact-finder can decide which of those three it finds most persuasive.[236]

However, it should not be left to the defense to identify the areas of conflict, or to seek out and retain experts in support of that position. Consistent with its duty to see that "justice be done" rather than simply win every case,[237] and rather than simply selecting and advocating for the theory that suits it best, the government should bear a burden of presenting evidence and disclosing the results that stem from competing legitimate theories. Such a burden properly acknowledges both the government's near-monopoly on forensic science, and the impossibility of bestowing expert assistance upon every defendant in every case. It is simply sensible to impose an affirmative duty on the government to disclose the different outcomes generated by any legitimate technique -- whether considered the minority or majority view, or whether favorable or not to the government's position. Failure to produce such evidence -- like failure to disclose exculpatory information in its possession -- could constitute grounds for precluding the evidence altogether.

By means of illustration, take a question regarding the proper means of calculating the random match probability in a "trawl" case, where the government matched the defendant after making a "cold hit" in a database. At present, there exists reasonable debate regarding the

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("As scientists acquire new data and change their collective judgments about which background assumptions to hold constant, they revise and replace even well-established scientific theory. Science does not achieve absolute finality.") (footnote omitted)).

[236] Of course, some commentators find appalling that juries should be allowed to resolve methodological disputes that even expert scientists cannot resolve. However, if presented with the equal legitimacy of both positions, then jurors are in many respects in the best position to adopt whichever approach best fits the circumstances of the case. For instance, jurors might be more conservative in a "cold hit" case than in a case with corroborating evidence, and for good cause.

[237] *Berger v. United States*, 295 U.S. 78, 88 (1935).

preferred method for calculating the match probability in such cases. As the DNA Advisory Board has explained:

> There are alternate methods for assessing the probative value of DNA evidence. Rarely is there only one statistical approach to interpret and explain the evidence. The choice of approach is affected by the philosophy and experience of the user, the legal system, the practicality of the approach, the question[s] posed, available data, and/or assumptions.[238]

For example, some argue a likelihood ratio that takes into account the size of the database should be used.[239] Some suggest that the results of a "trawl" are more reliable than in a simple confirmation case, because the analyst has compared the genetic profile to a database and excluded a large number of persons.[240] Some think that a simple "counting method" is most appropriate,[241] and some contend that the likelihood of a "false positive" increases as the analyst looks in a database for a match, and thus the statistical probability should be accordingly discounted by this risk.[242]

In the current procedural environment, government lawyers could pick which of these methods it preferred, demonstrate its reliability, and effectively ignore any contrary voices unless specifically raised by an opposing party. In a select few cases, the defense might be knowledgeable or well-resourced enough to itself offer a more favorable method, but in the vast majority of cases, defense counsel will not undertake to argue or even know to argue any opposing view. Yet allowing the government to pick its preferred methodology from among legitimate competitors, and leaving to the defense the obligation to uncover alternative theories, saddles the party with the least resources and least access with the burden of introducing an equally valid approach. While such a burden might rightly operate as regards other forms of evidence, history suggests that, in the lopsided world of forensic science, it is rarely borne well. Rather, bestowing on the government a legal obligation to present all statistical calculations that have any legitimate basis -- not just to the fact-finder but also directly to defense counsel in handing over discovery in the case -- diminishes the risk that institutional

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[238] BUTLER, *supra* note 15, at 614.

[239] *See, e.g.*, NRC II, *supra* note 205, at 40.

[240] *See, e.g.*, BUTLER, *supra* note 15, at 618 (citing Evett, Foreman & Weir, BIOMETRICS 56(4), at 247-76 (2000)); Peter Donnelly & Richard D. Friedman, *DNA Database Searches and the Legal Consumption of Scientific Evidence*, 97 MICH. L. REV. 931, 933 (1999).

[241] NRC I, *supra* note 205; BUTLER, *supra* note 15, at 515.

[242] *See, e.g.*, William C. Thompson, Franco Taroni, & Colin G. Aitken, *How the probability of a false positive affects the value of DNA evidence*, J. FORENSIC SCI., Vol. 48, No. 1 (Jan. 2003); Koehler, *supra* note 237, at 428.

inequities or the administrative nature of criminal process will result in the presentation of misleading scientific evidence.

C. Harnessing National Expertise.

In extending their social authority model to the hard sciences, Professors Monahan and Walker explore the use of the "National Science Panel" in resolving questions pertaining causation in breast implant litigation.[243] Such panels are convocations of experts, charged with resolving contested questions regarding recurring issues. In Walker and Monahan's model, the findings of such panels could in turn be given law-like deference -- capable of being "overturned," but presumptively correct. In the civil arena, the primary purpose of such panels is to produce a coherent response to the scientific questions that occur throughout the nation so that litigations is conducted more efficiently and consistently. But in the criminal arena, such panels have the potential to serve more than just the aim of efficiency -- they might also function as a counterweight to the government monopoly on forensic science.

Indeed, since the early days of DNA, a modified version of the expert panel model has proved useful in guiding the use of DNA science in the courts. In 1992, the Federal Bureau of Investigation, along with a consortium of government agencies, issued a report that it had commissioned from a committee charged with summarizing and analyzing the state of scientific knowledge in the field of DNA evidence.[244] After controversy erupted, another report issued in 1996.[245] Scholarly discussion regarding the merits of the panels, and of the conclusions that each reached, abound.[246] What is clear, however, is that the reports of the panels served to inform and educate judges and litigators about the legitimate areas of dispute in the field, and provided a useful summary and reference for best practices.[247] In this regard, the beneficial educative role played by neutral expert panels -- particularly

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[243] Walker & Monahan, *Social Facts*, *supra* note 79, at 823-24 (describing operation of national science panels). Professors Walker and Monahan also discuss the potential sources of authority for convening such panels, as well as for the treatment of the panel's results by both district and appellate courts. *Id.* at 825-830.

[244] NRC I, *supra* note 205.

[245] NRC II, *supra* note 205.

[246] *See, e.g.*, Lempert, *supra* note 178.

[247] *See, e.g.*, *United States v. Ewell*, 252 F. Supp. 2d 104, 109 n.8 (D. N.J. 2003) (referring to standards set by NRC); *People v. Watson*, 789 N.E. 2d 375 (Ct. App. Ill. 2003) (same); *United States v. Trala*, 162 F. Supp. 2d 336 (D. Del. 2001).

with respect to resolving DNA-related disputes, can be illustrative and instructive.[248]

A regularly convened panel of neutral, national experts could survey the field for legitimate instances of peer review, and identify areas in which continued study is desirable.[249] Such panels should be encouraged to embrace -- rather than attempt to resolve -- conflicts in the scientific community with regard to the desirability of various methods or techniques. If questions regarding the best method of reaching some determination have yet to be resolved, but varying legitimate theories exist, the panel could highlight the conflict and summarize the arguments in favor and against each position. Such a document would undoubtedly prove a useful guide for prosecutors, defense lawyers, and judges alike.

CONCLUSION

Although this Article used DNA typing both to illustrate the problems presented by second generation technologies and to recommend possible means of mitigating them, it is intended to begin a conversation generally about how the criminal justice system will accommodate the evidence from this next generation of forensic science. Whether the evidence in question is that a cell phone was used at a particular time and place or that a brain scan reveals that the defendant has a memory of being at the crime scene, these techniques raise similar concerns about the capacity of the judicial process to safeguard the integrity of such evidence.

The distinct characteristics of second generation forensic sciences -- including the complexity and sophistication of the methodological techniques, the breadth of application, the scientific certainty of the conclusions, the implication of privacy and proprietary interests, and the

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[248] Neither of the prior two committees was convened by a neutral party, and so while it may be without question that the members of each committee strived to complete a fair and balanced report -- and may have achieved that goal -- it cannot be said that their origins were neutral. Of course, the conclusions of such panels would garner additional legitimacy if they are deliberately composed by a neutral and disinterested body. Compare, for example, the "two-step process" used by the judge in the civil case studied by Professors Walker and Monahan. *See* Walker & Monahan, *Breast Implant Litigation*, *supra* note 145, at 808-809. In that case, the judge first designated a "Selection Panel" to provide "names of neutral, impartial persons who have indicated expertise" and would be able to communicate well and serve, and then chose the four-person panel from that list of names. *Id.* Ideally, to preserve both the appearance and actuality of fairness, such panels would be appointed and monitored by a neutral party, such as a member of the judicial or even legislative branch.

[249] *Cf.* Saks, *Merlin and Solomon*, *supra* note 6, at 1132-33 (questioning whether "admissibility decisions of courts are instruments too blunt to guide the development of scientific fields"); Thompson & Ford, *supra* note 135, at 100-07 (identifying problems in reliance upon databases and suggesting areas of necessary development and study).

reliance on databases -- raise a host of concerns that must be considered as such evidence continues to infiltrate criminal cases. Moreover, the fact that these technologies have the power to provide strong evidence of an individual's guilt even in the absence of any other evidence makes the task of monitoring the accuracy of such evidence all the more important.

While the recommendations posited above relate particularly to DNA, it is easy to extrapolate from the concerns addressed therein to the evaluation of any second generation technology. Each attempts to strike an efficient balance among the various competing concerns. In setting forth adjustments to the legal regime intended to accommodate this second generation of forensic evidence, this Article essentially aims to fashion a justice system worthy of the innovative forms of evidence that enter into it.