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Evolving Trends in Forensic Science

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KEYNOTE ADDRESS

EVOLVING TRENDS IN FORENSIC SCIENCE

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This address will focus on the 2009 report ("the Report")[2] of the National Academy of Science Research Council ("NRC"), which was commissioned by Congress to look at evolving trends in forensic science. Understanding what is happening in the forensic sciences is very complicated because of the wide variations that exist in different jurisdictions. There are federal laboratories, state or regional laboratories, county laboratories, and municipal laboratories. Almost all public crime laboratories examine controlled substances, and many examine firearms and tool marks. A majority of laboratories also screen biological samples, usually in preparation for DNA analysis, and examine forms of trace evidence. Many forensic examiners do not work in a traditional laboratory, however. They work within law enforcement offices and primarily conduct crime scene investigations, especially fingerprint examinations and bloodstain pattern analyses, and sometimes perform other forensic functions.

The fragmented nature of the forensic enterprise has made it difficult to study and to improve its principal product: evidence on which courts can confidently rely so

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[2] COMMITTEE ON INDENTIFYING THE NEEDS OF THE FORENSIC SCIENCES COMMUNITY, NATIONAL RESEARCH COUNCIL, STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD (2009). All references not otherwise identified are to this report. Any direct quotations have been cited.

that the guilty are identified and the innocent are not erroneously convicted. The Report found many problems. Among the disturbing findings was that much forensic evidence introduced in criminal trials has not undergone any meaningful scientific validation and that many forensic professionals are not adequately trained or funded. The result is that faulty forensic evidence may, at times, lead to erroneous convictions of innocent persons, leaving the real perpetrators free to commit additional crimes. Furthermore, improvements in forensic science would undoubtedly assist homeland security in carrying out its missions.

I. Lack of Scientific Validation

Two important questions must be considered in deciding whether the conclusions of a particular forensic technique should be admitted in a courtroom: (1) Is the technique scientific, and (2) do practitioners of the technique avoid interpretations that become tainted by error, bias, or the lack of proper procedures?

Let us see what these questions mean. A large number of the techniques used in forensic laboratories are not informed by the culture of science. As the Report concluded, "Many of the processes used in the forensic science disciplines are largely empirical applications of science—that is, they are not based on a body of knowledge that recognizes the underlying limitations of the scientific principles and methodologies used for problem solving and discovery."[3]

Let me give you an example. Years ago, before 9/11, I was on a committee that was supposed to investigate whether one could add anything to black or smokeless gun powder so that if it was used to make a pipe bomb, it would

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[3] *Id.* at 38.

be easier to trace where the pipe bomb was manufactured. Initially, I thought that gunpowder was a product of the Industrial Revolution and that it was made according to a formula. But, apparently, making gunpowder is like making wine. It has a cellulose base, which varies depending on the vegetable material that is used. Then different ingredients are added to this base so that every batch of black and smokeless powder is somewhat different. A technician who worked for the Bureau of Alcohol, Tobacco, and Firearms, a government agency that investigates pipe bomb incidents, had the idea of collecting samples from facilities that make black and smokeless powder. After a pipe bomb incident, one could compare the powder in the pipe bomb with the collected samples and derive useful information about the vicinity in which the bomb was likely made.

A "scientific" approach would proceed in a different manner. It would consider how large a sample one needed to collect, whether the sample needed certain characteristics, and what kind of training and accreditation are necessary for the persons engaged in collecting and comparing the samples.

The Report examined a number of the major forensic sciences in detail, and the NRC was disturbed to find that many are based on "observation, experience, and reasoning without an underlying scientific theory. . . ."[4] Let us look at some of the fields the Report examined.

A. DNA Evidence

The profound effect of DNA[5] evidence on our criminal justice system is a remarkably recent development. In Great Britain, a seventeen-year-old mentally challenged

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[4] *Id.* at 128.

[5] deoxyribonucleic acid

hospital kitchen porter confessed to a rape-homicide. DNA testing showed that the same person had committed two rape-murders. The kitchen porter could not have perpetrated the second crime because he was in custody at the time it was committed. DNA testing eventually identified the person who had committed both of the crimes. From the very beginning, DNA evidence was used not only to convict but also to acquit. As of this writing, the Innocence Project, which investigates allegations of wrongful convictions, has identified 250 cases in which DNA evidence shows that the inmate did not commit the crime for which he or she was incarcerated.[6]

DNA testing differs from other forensic techniques in a number of ways. Unlike the other forensic sciences, which are products of law enforcement efforts and play no role outside the legal system, forensic DNA testing is a byproduct of cutting-edge science. From the beginning, the scientific community has been involved in validating the use of DNA for forensic science. By 1996, only ten years after DNA's courtroom debut, the National Academy of Sciences had already convened two committees to issue recommendations on using DNA within the forensic enterprise. Eminent scientists served on these committees and testified at judicial hearings on the admissibility of DNA evidence in court. The other forensic sciences had to wait until the NRC Report was issued in 2009 before persons in the scientific community weighed in on their claims.

It is not only the scrutiny to which DNA testing has been subjected that has led to its becoming the "gold standard" for forensic evidence. It is also the nature of DNA itself. DNA has enormous variability. Before the forensic use of DNA, the scientific community had agreed

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[6] *See* The Innocence Project, http://www.innocenceproject.org (last visited May 2, 2010).

that no individuals other than identical twins have identical DNA profiles. Therefore, it has been possible to develop statistical models of the likelihood that a person would have the particular genetic pattern found at the crime scene. That does not mean, however, that DNA evidence is infallible. Its reliability will depend on how it is collected and analyzed. Problems have been reported at a number of laboratories over the handling and interpretation of DNA and with "drylabbing"[7]—the falsification of scientific results. In addition, there may be statistical issues, for instance, in dealing with mixed samples when a number of persons jointly committed a rape. Still, unlike other forensic techniques, DNA evidence is a child of science as compared to some of the other forensic disciplines examined in the Report.

B. Friction Ridge Analysis

One of the most controversial aspects of the Report is its treatment of fingerprints, palm prints, and sole prints, the analysis of which is collectively known as friction ridge analysis. In the United States for over a century, examiners have claimed that when they compare prints left by a suspect (the latent print) with prints taken from that suspect, they can accurately conclude that a match exists and that only the suspect could be the source of the latent print. Indeed, fingerprint evidence is undoubtedly thought by many to be the bedrock of forensic science. Examiners work in laboratories or are part of police identification units that go directly to crime scenes.

There are, of course, large databases of fingerprints. Most of you in this audience have probably had fingerprints taken. However, it is not true that if your latent print is

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[7] STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD, *supra* note 2, at 193.

found, a computer will compare the latent crime scene print with a print taken from you and unerringly determine whether there is a match. Actually, friction ridge analysis depends a great deal on subjective interpretations.

Since 1959, the technique used in friction ridge analysis has been described by the acronym ACE-V: "Analysis, Comparison, Evaluation, and Verification."[8] Nowadays, computers are often part of this process because they can be used to generate candidates for comparison. The process begins with the examiner taking a detailed look at the latent print, which is often in the form of a digital image, and then making a visual comparison of the latent print with the known prints. Source determination is made when the examiner concludes based on his or her experience that a sufficient quality and quantity of friction ridge detail agrees between the latent and known print. Verification occurs when a second examiner, who may be aware of the first examiner's conclusion, agrees.

The ACE-V method does not specify a standard test protocol for which features of the prints must be compared. Unlike the case with DNA analyses, population statistics for fingerprints have not been developed, and there seem to be endless permutations of loops, whorls, arches, and deltas.

The friction ridge community continues to assert that the ability to see and assess the details in a latent print is an acquired skill, which depends on lengthy experience and training, such as working at the FBI laboratory. Some in the community argue that the ACE-V method leads to a zero error rate, though the claim that any human process has a zero error rate is absurd. Consequently, when testifying in court, examiners usually speak in terms of absolute certainty and refuse to express their conclusions in probabilistic terms.

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[8] *Id.* at 137.

A number of recent events have undermined this claim of absolute certainty. One is the Brandon Mayfield case.[9] After terrorist attacks on commuter trains in Madrid, Spain, the Spanish authorities sent the Federal Bureau of Investigation ("FBI") digital images of partial latent prints found on plastic bags that contained detonator caps. The FBI determined that an Oregon attorney, Brandon Mayfield, who was known to be sympathetic to radical causes, made the prints. Mayfield was arrested and jailed. After Spanish authorities alerted the FBI to additional information, the FBI sent two examiners to Spain, and it was eventually concluded that Mayfield had been misidentified. He received two million dollars in compensation.

A second development has been increasing research on contextual bias. After the Mayfield debacle, psychologist Itiel Dror, affiliated with a university in Great Britain, obtained copies of latent and known prints that fingerprint examiners had compared and found to match. Dror sent the prints back to the examiners and told them that they were from the Mayfield case. Most of the examiners then changed their minds and said that the prints did not match. The only thing that had changed was the context in which the prints were compared. These developments led a Maryland state court judge to refuse to allow fingerprint evidence in a death penalty case on the ground that the ACE-V methodology was "a subjective, untested, unverifiable identification procedure that purports to be infallible."[10]

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[9] *See* Mayfield v. Gonzales, No. Civ. 04-14-1427-AA, 2005 WL 1801679 (D. Or. July 28, 2005).

[10] *State v. Rose*, No. K06-0545 (Md., Baltimore Co. Cir. Oct. 19, 2007).

C. Other Pattern/Impression Evidence: Shoeprints and Tire Tracks

The hypothesis on which examiners in the fields of pattern and impression rely is that shoes and tires pick up wear characteristics that individualize them. Over time, further changes take place so that elapsed time after the crime may affect an examiner's conclusions and certainty. Although it may be possible to identify class characteristics, there is no consensus about the number of individual characteristics needed in order to attribute a shoe or tire to a specific source. Examiners who seek to testify in terms of individualization are making experience-based conclusions unsupported by research data. At this time, examiners in these fields have not addressed what research needs to be done and by whom. Much more research is needed in this field.

D. Bite Marks

We can see the difference between a discipline that is rooted in science and one that is not if we look at a discipline such as forensic odontology, which is concerned with analyzing the bite marks that are at times found on victims of homicide, sexual assault, and child abuse. In these often sensational cases, there is a good deal of pressure on prosecutors to identify the perpetrator. Evidence of bite-mark comparisons is often introduced in these cases with the claim that the comparison shows a conclusive and unique match. But are bite-mark comparisons a valid forensic technique?

The Report pointed to a large number of problems. In the first place, the uniqueness of bite marks has never been established. No large study of large populations has ever been conducted to establish the uniqueness of bite

marks, and there is no central database. Furthermore, human skin may not accurately register bite marks, and the marks can be distorted by the elasticity of the skin. A final conclusion that the bite mark allows the unconditional identification of the perpetrator is not warranted.

Under some circumstances, bite-mark comparisons may be useful in excluding a suspect. For instance, suppose that a small child is covered with bites as unfortunately sometimes happens. If evidence is available that a very limited number of persons have access to the child, it may be possible, by examining this small group's bite marks, to exclude those whose bites could not have made the marks on the child. However, this is a much more limited use than claims that a bite-mark comparison allows the identification of the one person in the world who is responsible for the crime. This is clearly a field in which additional research is badly needed.

E. Analysis of Hair Evidence

Prosecutors have, for over one hundred years, sought to introduce hairs found at the crime scene to identify the defendant. DNA analysis does not work unless the root of the hair is present. Forensic hair examiners traditionally resorted to microscopic hair analysis. They would collect samples of hair from the suspect and then compare these hairs microscopically with the hair found at the crime scene. There are no studies that establish the frequency with which hair patterns are distributed among populations. Nevertheless, we know from transcripts of trials that hair examiners, at times, claim that in the thousands of examinations they have conducted, they have never seen as close a match as with the pubic hair found in this case. This testimony can be extremely prejudicial when it is the only evidence that seemingly ties the defendant to the crime scene.

It is possible to subject hairs to a mitochondrial DNA ("mtDNA") examination, but this type of examination is of limited use because all persons with a female ancestor in common share the same mtDNA profile. Microscopic hair evidence may be of some use in excluding suspects and assisting in criminal investigations, but using it to identify a particular defendant is highly questionable. Testimony regarding microscopic hair analysis had been introduced in many of the cases in which convictions were set aside based on nuclear DNA evidence.

F. Controlled Substances

The analysis of drugs rests on a strong scientific basis. Examiners use methods of classical analytical chemistry and best practices that have been adopted in the United States and worldwide. Problems in this field stem not from the science that is employed but from the reporting of results. Often, too little information is furnished to enable a lawyer for the accused to understand and ask questions about what was done. Developments in the law may resolve some of these problems.

G. Questioned Document Examination

Questioned document examiners, who are also referred to as forensic document examiners or handwriting experts, compare a questioned item, such as a ransom request, a bomb threat, or a codicil to a will, with an item that was written by the suspect. The NRC Committee agreed that there may be a scientific basis for handwriting comparison, at least when there was no intention to forge or obfuscate, but that more research needs to be done.

H. Explosives Evidence and Fire Debris Analysis

Most of the analysis of explosions is based on well-established chemistry. Arson investigations are more troublesome. Though there clearly was a fire in which persons may have been killed, leading to a prosecution for murder and the possibility of a death penalty, the critical question may be whether an accelerant was used to start the fire or whether the fire started accidentally. The NRC Committee heard testimony about the paucity of research to date on reliably establishing that a particular fire was deliberately set.

I. Summary

This brief summary of the NRC Committee's conclusions about the scientific validity of some of the most commonly used forensic techniques indicates that there is a dearth of good scientific research establishing the scientific bases and validity of many traditionally accepted forensic disciplines.

II. Accreditation, Certification, and Codes of Ethics

The Report also found another pervasive problem with the forensic sciences—inconsistencies and deficiencies in accreditation, certification, and standards.

A. Accreditation

An accredited laboratory has a management system in place that sets out acceptable practices for its various activities. It is primarily concerned with the management system, technical methods, and quality of the work a laboratory produces. It cannot be self-assessing. Oversight

must come from outside the participating laboratory to ensure that standards are rigorous and not self-serving. Only a few jurisdictions require that their laboratories be accredited. Identification units, those forensic entities outside crime laboratories, do not participate in accreditation systems. This means that a forensic discipline such as fingerprinting, which is largely conducted outside laboratories by identification units, is for the most part not subject to accreditation requirements.

Proficiency testing is often a part of accreditation. Proficiency tests can be blind, meaning that the test subject in the lab is unaware that the sample he or she is given for analysis is a test sample and not a real case, or the tests can be open or declared. Blind tests require a great deal of work and expense to prepare. Instead of working on pending cases, the examiner's time is spent preparing a test. Furthermore, it is hard to keep the test blind. Crime lab personnel often have relationships with law enforcement personnel, so it is easy to find out whether there is an actual case that corresponds to the materials the examinee is being asked to analyze. Another problem with proficiency tests is that they achieve very little if they are too easy, and a number of courts have recently complained that proficiency testing in some disciplines is not sufficiently rigorous.

B. Certification

In some fields of science, professionals, such as doctors and nurses, must be certified before they can practice. A certification requirement could mandate that all forensic scientists who practice and testify must be certified. Certification boards consisting of respected professionals could develop standards for education, training, and experience that would have to be met before a forensic scientist could become certified in a particular discipline. Passing some kind of written or oral

examination would also be part of the certification process. Certification, like accreditation, is voluntary in most states.

C. Codes of Ethics

There is no single code of ethics to which all members of the forensic science community subscribe. Some forensic society organizations do have codes, but they can be enforced only against someone who is a member of that organization. A national code and better enforcement mechanisms are needed.

III. The NRC Committee's Central Recommendation: Congress should establish an independent federal entity: The National Institute of Forensic Science ("NIFS")

The preceding material discusses some of the many weaknesses of our present forensic science enterprise. The malfunctions discussed—the lack of science in much forensic science and the imperfections in our laboratories—can have profound effects on lives in our country. The wrong people may go to prison or even to death row, and others who should be prosecuted will evade punishment. The NRC Committee found that courts could not correct this system and the dangers it poses by operating on a case-by-case basis. Instead, the Committee recommended that Congress establish a new independent federal entity. This entity cannot be part of the law enforcement community because forensic science must serve law enforcement officers, prosecutors, and defendants.

The National Institute of Forensic Science ("NIFS") would be charged with implementing the ideas and changes previously discussed. For instance, NIFS would competitively fund research demonstrating the validity of forensic methods and studies measuring the accuracy of

forensic analyses. It would develop mandatory best practices and standards for laboratories and for accreditation and certification.

Of course, this Report appeared just as the United States entered a severe budgetary crisis. Whether NIFS ever will be funded remains to be seen. However, its analyses and recommendations may have an effect on how forensic science is practiced even if NIFS is not created.