Crime Reconstruction

SECOND EDITION

W. JERRY **CHISUM**
and BRENT E. **TURVEY**

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Foreword

Joseph L. Peterson

The second edition of *Crime Reconstruction* is a very important addition to the forensic science and crime scene investigation literature. Editors Jerry Chisum and Brent Turvey, and their associated chapter authors for this volume, have advanced the crime reconstruction literature in three important areas: (1) they have integrated important themes of the 2009 National Academies report on forensic science into their book chapters, calling for more rigorous scientific standards and reliability in all aspects of forensic and crime scene examinations; (2) they have strengthened all chapters, particularly those addressing ethics, trace evidence, and shooting and fire scene reconstruction; and (3) they have added new chapters on forensic science, crime scene investigation, wound pattern analysis, sexual assault reconstruction, and report writing. All chapters also contain key terms, a chapter summary, an abstract, and several questions that should assist college and training instructors in preparing examinations.

I would like to take a moment to highlight several chapters that particularly impressed me in this second edition. Parts 1 and 2 of the second edition address the forensic examiner and the crime scene. Chapter 1 on forensic science sets an important theme by defining the important role of the crime scene reconstructionist as a person who needs the fundamental training in general forensic science in order to apply the methods and techniques of science to reconstruct crimes and interpret available physical evidence. The reconstructionist's primary role is to *take the side of the evidence* and to maintain that position throughout the investigation. Chapter 3 is extremely important and presents a canon of ethics that demands that the scene is interpreted correctly and that the reconstructionist "gets it right" with a minimum of error. The examiner has the professional and moral duty to "pursue the truth" of the evidence, wherever it may lead. Chapter 4 on observer effects and examiner bias is extremely important to the crime scene reconstructionist, particularly as a growing number of challenges to objectivity are recognized in the forensic science and legal literature. Cooley and Turvey rightly point out that while most forensic scientists will not fall victim to overt forms of fraud and bias, many examiners today are much less aware of more covert forms of bias that are present and the effect "context" has in influencing an investigation.

Part 3 on physical evidence provides eight chapters on a variety of evidence forms that may be encountered by the crime scene reconstructionist. Practice Standards for the reconstruction of crime scenes (Chapter 5) also set some primary rules and measures that the investigator should keep in mind regardless of the type of scene. Another extremely important consideration for the reconstructionist is to recognize those evidence dynamics (Chapter 6) that might alter, relocate, or contaminate the physical crime scene either prior to the arrival of the investigator or as a result of the crime scene investigation itself. Trace evidence (Chapter 10) addresses an area that has been pushed to the background of forensic investigation in the past several years because of the rise in DNA profiling. I believe it is important to give trace evidence its due and to encourage

crime scene reconstructionists to be aware of the multiple types of trace materials that can help determine what happened at the scene and establish the association between offenders and victims and the scene itself. The authors also stress that physical evidence is "not necessarily a certain and precise record of actions and events" and may leave an incomplete picture of the crime. All scientific and investigative personnel must recognize that physical evidence will not always answer every question. Other chapters on reconstructing bloodstain evidence (Chapter 12), investigating shooting incidents (Chapters 13 and 14), and reconstructing fire scenes (Chapter 15) are well crafted and provide insight to the new (and experienced) investigator. Part 4 on the courtroom provides solid instruction and important insight on report writing, presentation, and testimony.

Crime Reconstruction (Second Edition) is a thoroughly researched and well-written text assembled by two noted authors and practitioners in the field of forensic science. Chisum and Turvey are to be commended for their scholarship. It will soon become the standard reference for professionals and students of crime reconstruction.

Preface

THE NATIONAL ACADEMY OF SCIENCE REPORT: A MANDATE FOR SCIENCE IN FORENSIC SCIENCE

Brent E. Turvey and William "Jerry" Chisum[1]

The first edition of *Crime Reconstruction* was written throughout 2005 and early 2006 as a multidisciplinary science text for advanced forensic professionals. It offered a clear rationale for returning to a forensic generalist-oriented model and provided useful tools, guidelines, and even practice standards for physical evidence interpretation. This filled an important gap in the forensic science literature.

Asserting that evidence interpretation must be a scientific process, *Crime Reconstruction* reminded the criminal justice community that this task is in the domain of forensic scientists. More specifically, the authors demonstrated collectively that the interpretation of physical evidence should remain the province of forensic scientists trained to apply the scientific method objectively without law enforcement involvement, influence, or oversight. It took a then controversial position that law enforcement investigators should be in charge of the criminal investigation and that forensic scientists should be in charge of the scientific investigation. The view that police employees are capable of acting as wholly objective scientists—while also charged with investigating crime, working with victims, interviewing suspects, and making arrests—was refuted throughout with careful citation of literature, cases, experience, and the applicable principles of cognitive psychology. Until the publication of this first edition, such views were widely held but rarely voiced out of a very real fear among those practicing forensic science—many of whom work for law enforcement agencies.

One purpose in writing *Crime Reconstruction* was to acknowledge the current status of the reconstructionist community—that it tends to be inappropriately composed of law enforcement officers and evidence technicians (a.k.a. crime scene investigators) who have, at best, undertaken a short course training model. Such practitioners, while well meaning, tend to use oversimplified reconstruction techniques with little or no actual scientific background (e.g., education in proper use of the scientific method from scientists in a nonlaw enforcement context).

This second edition of *Crime Reconstruction* has been adapted to serve both students of forensic science and professional forensic scientists charged with the task of evidence interpretation. Our primary goal was and remains the development of tools and practice standards for the forensic generalist based on the scientific method, analytical logic, and critical thinking.

[1] Mr. Chisum served as a peer reviewer for the National Academy of Science report, which also cited the first edition of *Crime Reconstruction* as a learned treatise on numerous issues.

Our second edition is also written in the still foaming wake of the National Academy of Science (NAS) report on forensic science.[2] This national audit of the forensic science community in the United States, commissioned by the U.S. Congress, lays out both criticisms and mandates that echo those found in our first edition. Because not all forensic science students and professionals have read the NAS report as they should and because its findings and recommendations are so vital to the future of forensic science, a review is necessary.

The purpose of this preface is to explain our support of the NAS committee on *Identifying the Needs of the Forensic Science Community* (a.k.a. the NAS report). This includes, specifically, the separation of law enforcement culture and forensic science practice; the development of an independent National Institute of Forensic Science (NIFS); the promulgation of basic scientific education requirements for forensic scientists; and the nurturing of forensic science graduate programs along with related Ph.D.-level research into new forensic methods, fraud, bias, and related error rates. These are issues that the forensic science community has had a half-century to investigate and study, but has instead chosen to ignore. We feel this must change in order that forensic science remains worthy of service to society.

THE NAS REPORT—A COMMUNITY RESPONSE

The impetus for the NAS report, which is a congressionally funded system-wide investigation and review of the forensic sciences, included the following: publication of an ongoing series of critical legal reviews regarding the tremendous bias and lack of science in forensic practice; ongoing occurrence of highly publicized forensic frauds, blunders, and crime lab scandals across the United States; ever-increasing number of DNA exonerations sourced back to flawed or misleading forensic evidence documented by groups such as the Innocence Project[3]; and publication of the first edition of this text. All of these are referenced in the final version of the report. The findings were prepared to inform the U.S. Congress, to help them with related legislative and budgetary decisions, per the role of the NAS.

Judge Harry T. Edwards was the cochair of the NAS committee responsible for investigating the forensic science community and the final NAS report.[4] He testified to the Senate Committee on the Judiciary on March 18, 2009, regarding his role and perspective (Edwards, 2009)[5]:

> I started this project with no preconceived views about the forensic science community.... And I do not watch, CSI programs on television, so I was not affected by Hollywood's exaggerated views of the capacities of forensic disciplines. Rather, I simply assumed, as I suspect many of my judicial colleagues do, that forensic science disciplines typically are grounded in scientific methodology and that crime laboratories and forensic science practitioners generally are bound by solid practices that ensure that forensic evidence offered in court is valid and reliable. I was surprisingly mistaken in what I assumed. The truth is that the manner in which forensic evidence is presented on television—as invariably conclusive and final—does not correspond with reality.

[2] Edwards, H., and Gotsonis, C. (2009). *Strengthening Forensic Science in the United States: A Path Forward.* Washington, DC: National Academies Press; url: http://nationalacademies.org/morenews/20090218.html.

[3] See http://www.innocenceproject.org.

[4] The National Academy of Science committee on *Identifying the Needs of the Forensic Science Community.*

[5] Edwards, H. (2009). Statement before United States Senate, Committee on the Judiciary, March 18.

Since its publication in February 2009, the NAS report has received a number of responses from the professional community. The International Association for Identification released a memo advising "that members not assert 100% infallibility (zero error rate) when addressing the reliability of fingerprint comparisons,"[6] despite a century of advocating precisely the opposite; the American Academy of Forensic Sciences (AAFS) acknowledged that "forensic scientists should be assiduously held to Codes of Ethics,"[7] despite the fact that in more than 50 years it has failed to develop one for its membership; and the American Society of Crime Lab Directors responded by endorsing the report's "new paradigm" and supporting the need for "mandating ethics guidelines, ensuring quality through establishing standards for education, training, accreditation, certification, and use of common language."[8] These are important revelations to be sure. From these and other published accounts, the authors get the impression that forensic organizations worldwide not only endorse the report, but even go so far as to suggest that they have long been agents of the reforms it suggests.

However, anyone who has read the NAS report will be confronted by two crucial omissions from this wave of organizational endorsements. First, the NAS report makes clear the need for science in forensic science—at the very least practitioners must achieve an undergraduate degree with a formal scientific foundation. Clear organizational statements in favor of requiring a science-oriented undergraduate degree in order to serve as a practicing forensic scientist are absent, as most forensic organizations cater to a law enforcement-based membership. Many law enforcement-employed forensic practitioners lack the ability to meet any degree requirement, relying instead on an experience waiver. Second, the NAS report makes clear the need for separating law enforcement culture from forensic science. This is an issue that forensic science organizations have entirely ignored or opposed because, again, they would lose a significant portion of their membership if they were to follow this mandate.

While these issues are apparent to any scientist who has read the report, they seem less than apparent to most of the forensic practitioners and attorneys that the authors have discussed the matter with. Subsequently, it has become clear that many practitioners aren't reading the NAS report because they think that they already know what's in it, having read their particular organization's supportive yet narrow responses. They don't know what's in it, why it's important, or even what it means for the community.

SEPARATING SCIENTIFIC AND LAW ENFORCEMENT CULTURES

Chapter 4 of the NAS report is entitled "The Principles of Science and Interpreting Scientific Data." This chapter makes clear what science is, what it involves, and defines it as a culture with its own philosophy, mission, and objectives. It is necessary because so much of the criminal

[6] Garrett, R. (2009). President, *International Association for Identification*, open letter to the membership, February 19.

[7] Bohan, T. (2009). "The American Academy of Forensic Sciences Approves Position Statement in Response to the National Academy of Sciences' "Forensic Needs" Report," Press Release, *AAFS*, September 4.

[8] "ASCLD's Comments on the Release of the NAS Report on Forensic Science," press release, *American Society of Crime Lab Directors*, February 19, 2009; available at www.ascld.org.

justice community is subordinate to the law, and too many forensic practitioners forget that law and science have different missions. As stated in the NAS report (2009, p. 4-11):

> The methods and culture of scientific research enable it to be a self-correcting enterprise. Because researchers are, by definition, creating new understanding, they must be as cautious as possible before asserting a new "truth." Also, because researchers are working at a frontier, few others may have the knowledge to catch and correct any errors they make. Thus, science has had to develop means of revisiting provisional results and revealing errors before they are widely used. The processes of peer review, publication, collegial interactions (e.g., sharing at conferences), and the involvement of graduate students (who are expected to question as they learn) all support this need. Science is characterized also by a culture that encourages and rewards critical questioning of past results and of colleagues. Most technologies benefit from a solid research foundation in academia and ample opportunity for peer-to-peer stimulation and critical assessment, review and critique through conferences, seminars, publishing, and more. These elements provide a rich set of paths through which new ideas and skepticism can travel and opportunities for scientists to step away from their day-to-day work and take a longer-term view. The scientific culture encourages cautious, precise statements and discourages statements that go beyond established facts; it is acceptable for colleagues to challenge one another, even if the challenger is more junior. The forensic science disciplines will profit enormously by full adoption of this scientific culture.

This is a welcome acknowledgment that the mandates of good science need to be written out and explained, as they are so poorly understood both within the forensic science community and among its end users—the courts and law enforcement. The NAS report also makes clear at multiple points that forensic science is often developed and practiced outside of scientific culture and by nonscientists. Subsequently, the forensic science community has yet to fully embrace fundamental scientific mandates for lack of understanding that they actually exist, let alone that science does not result without them.

This echoes warnings expressed in Thornton and Peterson (2002), that forensic scientists are rarely trained in the scientific method, do not understand its implications, and that this ignorance leads to abuse.[9] Similarly concerned, the authors wrote (Chisum and Turvey, 2007, p. 85): "most practicing [forensic examiners] would probably have a great deal of enthusiasm for strict adherence to standards that embrace diminished bias, analytical logic, and the scientific method, if only they understood what these things are."

The NAS report further provides for the need to separate the forensic science community from law enforcement culture. This is discussed in many sections, and all throughout Chapter 6, "Improving Methods, Practice, and Performance in Forensic Science," where it is explained (2009, p. 6-1):

> The majority of forensic science laboratories are administered by law enforcement agencies, such as police departments, where the laboratory administrator reports to the head of the agency. This system leads to significant concerns related to the independence of the laboratory and its budget. Ideally, public forensic science laboratories should be independent of or autonomous within law enforcement agencies. In these contexts, the director would have an equal voice with others in the justice system on matters involving the laboratory and other agencies. The laboratory also would be able to set its own priorities with respect to cases, expenditures, and other important issues. Cultural pressures caused by the different missions of scientific laboratories vis-à-vis law enforcement agencies would be largely resolved. Finally, the forensic science laboratories would be able to set their own budget priorities and not have to compete with the parent law enforcement agencies.

[9] The work of Dr. Joseph L. Peterson, criminalist practitioner, researcher, and educator, is referenced multiple times in the NAS report. He also presented before the NAS committee as part of their inquiry.

The NAS committee's recognition of the incompatibility between scientific and law enforcement/prosecutorial goals, and the bias this can create and has created, is perhaps its most significant contribution to the future of the forensic science community. This is consistent with specific recommendations for separation found in Cooley and Turvey (2007; see also Chapter 4 of this work),[10] which cites back to Giannelli (1997),[11] Starrs (1993),[12] and Kirk and Bradford (1965).[13]

Forensic scientists perform objective analysis on evidence in order to educate the triers of fact. As such, their methods and means should not be biased by, aligned with, or subordinate to the law enforcement mission. They must not be measured by arrests assisted or convictions secured. They must also not compete with police budgets, with lab equipment set against patrol car maintenance. They must be under the management of other scientists and be evaluated and promoted by virtue of their scientific competence.

If readers take nothing else from the NAS report, let it be that science cannot survive, and therefore does not belong, in the culture of law enforcement. This means that every government-funded crime lab must be removed from law enforcement oversight or affiliation and made an autonomously run government entity.

THE FORENSIC SCIENCE COMMUNITY CANNOT REFORM ITSELF

As explained in the NAS report, the forensic science community is fragmented and broken; it cannot identify, let alone fix, its own problems, and does not speak with a single voice about what is best for its future. Moreover, it has proven incapable of holding itself accountable for anything that it does—with a history of failing to correct identifiable errors and scientific deficiencies.

Consider the following two examples:

The American Academy of Forensic Sciences: The AAFS is often touted as a forward-thinking, science-minded professional organization, with respect to promoting good practice and educational development in the forensic sciences. In reality, the AAFS is primarily a professional networking organization with many nonscience and law enforcement members, including a jurisprudence section for attorneys and judges and a general section for law enforcement employees unable to join other sections. It does not mandate a science degree for membership or advancement, offers no general knowledge exam or certification, and has no specific ethical guidelines for members save those that protect the interests of AAFS. Also, numerous AAFS members remain in good standing despite having been determined by the courts to have

[10] Cooley, C., and Turvey, B. (2007). Observer effects and examiner bias: Psychological influences on the forensic examiner. In *Crime Reconstruction* (W.J. Chisum and B. Turvey, eds). Boston: Elsevier Science.

[11] Giannelli, P.C. (1997). The abuse of scientific evidence in criminal cases: The need for independent crime laboratories. *Virginia Journal of Social Policy Law*, 4:439–470.

[12] Starrs, J. (1993). The seamy side of forensic science: The mephitic stain of Fred Salem Zain. *Scientific Sleuthing Review*, 17:1–8, Winter.

[13] Kirk, P., and Bradford, L. (1965). *The Crime Laboratory: Organization and Operation*. New York: Charles C. Thomas.

provided false and misleading credentials, testimony, or findings under oath. The value of any professional organization is found in the degree to which it credentials and regulates its membership, and the AAFS fails both of these tests.

American Society of Crime Laboratory Directors/Laboratory Accreditation Board (ASCLD/LAB): ASCLD-LAB is the laboratory accrediting body founded by ASCLD. It is governed by lab directors drawn from the very labs that it accredits. This means that it is run by laboratory stakeholders and is not an independent, impartial credentialing body. They do not see it as useful to revoke the credentials of members. Nor do they see it as beneficial to make audit results public. The FBI lab did not lose their ASCLD/LAB accreditation after the fingerprinting errors revealed in the Brandon Mayfield case nor were they sanctioned; DNA Security Inc. didn't lose their ASCLD/LAB accreditation after its senior (and sole) analyst committed forensic fraud in the Duke–Lacrosse rape case. In fact, no known penalties were levied. These are anathema to good scientific practice.

Moreover, ASCLD/LAB requires that accredited labs set laboratory procedures in stone. Deviations from established procedures are not allowed—reducing any scientist to a technician's role. This sounds good unless the procedure is dated or uninformed, as may be the case. It also goes against the spirit of the scientific method (developing, testing, and eliminating all possibilities). Forensic scientists are not free to try new methods published in scientific journals and analyze evidence within the constraints of a particular case under the ASCLD/LAB "must be in the lab manual" model. That is, unless they have the time develop new standards and protocols, which most labs do not with their caseloads and backlogs. Subsequently, they are compelled to stick with old methodologies and are generally unable to innovate.

These examples, taken from many, show how self-interested and unscientific the forensic science community can be when governing itself. However, the most compelling argument that the forensic science community cannot reform itself is that after more than 50 years it hasn't. The NAS report is clear on this issue, and its findings have the virtue of being both informed and impartial.

THE ADVERSARIAL PROCESS CANNOT REFORM THE FORENSIC SCIENCE COMMUNITY

Contrary to arguments made by those advocating against forensic reform, judges and lawyers have not held the forensic science community accountable for identifiable errors and scientific deficiencies. As explained in the NAS report (2009, p. S-19):

> The adversarial process relating to the admission and exclusion of scientific evidence is not suited to the task of finding "scientific truth." The judicial system is encumbered by, among other things, judges and lawyers who generally lack the scientific expertise necessary to comprehend and evaluate forensic evidence in an informed manner, trial judges (sitting alone) who must decide evidentiary issues without the benefit of judicial colleagues and often with little time for extensive research and reflection, and the highly deferential nature of the appellate review afforded trial courts' *Daubert* rulings. Given these realities, there is a tremendous need for the forensic science community to improve. Judicial review, by itself, will not cure the infirmities of the forensic science community.

The point, which cannot be stressed enough, is reiterated later in the NAS report with less diplomacy (2009, p. 1-14):

> The bottom line is simple: In a number of forensic science disciplines, forensic science professionals have yet to establish either the validity of their approach or the accuracy of their conclusions, and the courts have been utterly ineffective in addressing this problem. For a variety of reasons—including the rules governing the admissibility of forensic evidence, the applicable standards governing appellate review of trial court decisions, the limitations of the adversary process, and the common lack of scientific expertise among judges and lawyers who must try to comprehend and evaluate forensic evidence—the legal system is ill-equipped to correct the problems of the forensic science community. In short, judicial review, by itself, is not the answer.

We agree that judicial review is not and never has been the answer to quality forensic science for the following reasons—beyond the lack of scientific expertise among jurists.

Scientific fact and legal truth are not the same, despite their confusion by some. *Scientific fact* refers to information and events that have been established based on a broad factual record to a reasonable degree of scientific certainty by scientists using the scientific method. *Legal truth* refers to information and events that have been established by a court ruling based on a narrow factual record—at the discretion of either a judge or a jury. Scientific fact is the result of objective and analytical deliberation; legal truth is the result of something else entirely, as explained in Thornton and Peterson (2002, p. 149)[14]:

> Scientific "truths" are established when the validity of a proposition is proven to the satisfaction of a prudent and rational mind. Legal "truths" are not established by the exercise of the scientific method, but by the processes of the adversary system.
>
> The role of physical evidence in the administration of justice may reasonably be described as follows: Science offers a window through which the law may view the technological advances of our age. Science spreads out a smorgasbord of (hopefully) valid facts and, having proudly displayed its wares, stands back. The law now picks out those morsels that appear most attractive to it, applying selection criteria that may or may not have anything to do with science. These selection criteria may appear sensible, even obligatory to the law, but may appear illogical or even whimsical to science.

Scientific fact and legal truth are therefore very different propositions. Not only are they established by entirely different means, they are also sought for what can be incompatible ends. Science seeks to find out what happened and why; the law seeks just resolution of legal conflict.

Moreover, judicial players have their own agendas and cultures to satisfy. None of this is a secret, but it will not be heard from beneficiaries of the current law enforcement-dominated forensic science community. In plain language, too many prosecutors are focused on obtaining convictions, not justice or fact finding; too many defense attorneys lack sufficient motive, education, or resources to really question law enforcement employed or affiliated forensic personnel; too many attorneys on both sides are content to hire "experts" who are either ignorant of science or ignore it in their interpretation of evidence; and too often judges are former prosecutors with the agenda of protecting law enforcement-employed or -affiliated forensic personnel from scrutiny—serving as back-up prosecutors rather than neutral interpreters of the law.

[14] Thornton, J., and Peterson, J. (2002). The general assumptions and rationale of forensic identification. In *Modern Scientific Evidence: The Law and Science of Expert Testimony* (D.L. Faigman, D.H. Kaye, M.J. Saks, and J. Sanders, eds.). St. Paul, MN: West Group.

Because there is a need to separate forensic science from law enforcement culture, because the forensic science community cannot reform itself, and because the adversarial process is not suited to the task developing and regulating scientific practice, we wholly support the NAS report's recommendation for the development of a National Institute of Forensic Science (NIFS). This would be an "independent federal agency" that is not "in any way committed to the existing system" and not "part of a law enforcement agency," with "a culture that is strongly rooted in science" and must be wholly endorsed (2009, p. S-13). It must be created separate from DOJ, separate from any law enforcement oversight, and separate from any law enforcement budget priorities.

The authors hope that the NIFS would not be composed of members drawn from ASCLD or ASCLD/LAB, the FBI, or those strongly affiliated with the AAFS, as this would perpetuate the very problems it should seek to alleviate. Instead, the NIFS should be run by a strong leader from the forensic science community with no political loyalties or employment ties to its end users (e.g., law enforcement and prosecutorial agencies). It should be governed by a body composed of scientists from various applied and research backgrounds who are also not compromised by an employment or funding relationship with end users. It would be best composed of scientists, and for scientists, to serve the justice system most effectively.

FORENSIC SCIENTISTS MUST MEET BASIC EDUCATIONAL REQUIREMENTS: THEY MUST BE EDUCATED AS SCIENTISTS

The imposition of basic educational standards is one of the greatest challenges confronting the forensic science community. A major contributing factor to the problem is, again, the alignment of forensic science with law enforcement. Many forensic examiners work for or within law enforcement agencies that have very low educational requirements—where a vocational criminal justice degree is viewed as an acceptable substitute for a scientific education. This is not something that the law enforcement community prefers to acknowledge or be reminded of. To retain membership of the nonscientific forensic examiners employed by law enforcement, most forensic organizations either do not impose degree requirements or provide exceptions for law enforcement experience. This has created one of the most serious problems identified by the NAS report: an overall lack of scientific education and training, let alone a culture of science, in the forensic sciences.

The NAS report makes clear in its discussion of education reform that an undergraduate degree in the forensic sciences, or some other related science, is necessary and that a graduate degree is preferable. It also provides that on the job training is an inadequate substitute (2009, p. 8-1):

> Forensic examiners must understand the principles, practices, and contexts of science, including the scientific method. Training should move away from reliance on the apprentice-like transmittal of practices to education at the college level and beyond that is based on scientifically valid principles, as discussed in Chapter 4. For example, in addition to learning a particular methodology through a lengthy apprenticeship or workshop during which a trainee discerns and learns to copy the skills of an experienced examiner, the junior person should learn what to measure, the associated population statistics (if appropriate), biases and errors to avoid, other threats to the validity of the evidence, how to calculate the probability that a conclusion is valid, and how to document and report the analysis. Among many skills, forensic science education and training must provide the tools needed to understand the probabilities and the limits of decision making under conditions of uncertainty.

> To correct some of the existing deficiencies, the starting place must be better undergraduate and graduate programs, as well as increased opportunities for continuing education. Legitimating practices in the forensic science disciplines must be based on established scientific knowledge, principles, and practices, which are best learned through formal education and training and the proper conduct of research.

This runs contrary to the views of many law enforcement forensic examiners who argue that experience trumps education and that science can be learned on the job. It also helps with the task of preventing law enforcement examiners and prosecutors from suggesting that one must be in law enforcement, or work for law enforcement, in order to be a scientist. In fact, precisely the opposite is true.

FORENSIC SCIENCE GRADUATE PROGRAMS AND SCHOLARLY RESEARCH MUST BE FEDERALLY SUPPORTED

Currently, many forensic science programs operate out of schools of criminal justice aligned with or taught by current and former law enforcement. The model is vocational rather than scholarly. In other words, these programs are designed to produce police officers, correctional officers, crime scene technicians, or bench criminalists for government crime labs. This is reflected by the types of instructors employed—too many are criminal justice practitioners, not objective scientists or academic scholars. In this environment, research is not supported, funded, or viewed as necessary within forensic science. The NAS report offers that (2009, p. 8-11):

> Many forensic degree programs are found at small colleges or universities with few graduate programs in science and where research resources are limited. The lack of research funding has discouraged universities in the United States from developing research-based forensic degree programs, which leads to limited opportunities to attract graduate students into such programs. Only a few universities offer Ph.D.-level education and research opportunities in forensic science, and these are chemistry or biology programs with a forensic science focus.
>
> Most graduate programs in forensic science are master's programs, where financial support for graduate study is limited. In addition, the lack of research funds means that universities are unlikely to develop research programs in forensic science. This lack of funding discourages top scientists from exploring the many scientific issues in the forensic science disciplines. This has become a vicious cycle during which the lack of funding keeps top scientists away and their unavailability discourages funding agencies from investing in forensic science research. Traditional funding agencies have never had a mission to support forensic science research.[15]

This passage explains the need for establishing Ph.D. forensic science programs that would generate research in the forensic sciences. It is something that just about every other scientific discipline benefits from. Such programs need to be initiated, developed, and funded. Two areas where Ph.D.-level research is desperately needed by the forensic sciences are error rates and examiner bias, as discussed repeatedly throughout the NAS report.

[15] The Stanford Research Institute formed a forensic science program from 1969 to 1973. Due to lack of funding, the program died. One of the authors (Chisum) was employed in this program. Some of the proposals for research were revived by the NIJ years later.

Error Rates

Too many in the forensic science community have falsely believed and testified that the error rates of their methods and examinations are essentially zero or are too complex for measurement. As such, it is argued, they need not be studied at all. This misconception about error rates and whether they may be reliably gauged, or relevant, often starts at the top. The seed of arrogance and ignorance from senior examiners is planted in the forensic community—in soil of loyalty or fear. It is gathered and spread as junior examiners are trained to parrot responses that they cannot question and do not understand. Once this happens enough times on the record, they become vested and intellectually immovable.

Consider, for example, the continued testimony of Dr. Bruce Budowle, the FBI's top forensic scientist.[16] As provided in *U.S. v. Llera Plaza et al.* (2002, p. 510)[17]:

> Dr. Budowle's testimony with respect to methodology error was as follows:
>
> Q: Tell us how it [error rate] applies to scientific methods, methodology.
>
> A: Well, this transcends all kinds of forensic, it transcends all disciplines in that, but in the forensic area particularly, this has been an issue discussed repeatedly in lots of disciplines, whether it is DNA chemistry and latent fingerprints.
>
> We have to understand that error rate is a difficult thing to calculate. I mean, people are trying to do this, it shouldn't be done, it can't be done. . . .
>
> An error rate is a wispy thing like smoke, it changes over time because the real issue is, did you make a mistake, did you make a mistake in this case? If you made a mistake in the past, certainly that's valid information that someone can cross-examine or define or describe whatever that was, but to say there's an error rate that's definable would be a misrepresentation.
>
> So we have to be careful not to go down the wrong path without understanding what it is we are trying to quantify.
>
> Now, error rate deals with people, you should have a method that is defined and stays within its limits, so it doesn't have error at all. So the method is one thing, people making mistakes is another issue.

The NAS report makes clear that any testimony suggesting near or complete infallibility regarding a method or an examiner is unscientific and, worse still, false. Furthermore, there was great concern by the NAS committee regarding the number of practitioners in the forensic science community who were unwilling to concede that they had an error rate of "more than zero."[18] As described in the NAS report (2009, pp. 1-9–1-10):

> In testimony before the committee, it was clear that some members of the forensic science community will not concede that there could be less than perfect accuracy either in given laboratories or in specific disciplines, and experts testified to the committee that disagreement remains regarding even what constitutes an error. . . . Failure to acknowledge uncertainty in findings is common: Many examiners claim in testimony that others in their field would come to the exact same conclusions about the evidence they have analyzed.

[16] Dr. Bruce Budowle is referenced multiple times in the NAS report and also presented before the NAS committee as part of their inquiry.

[17] *U.S. v. Carlos Ivan Llera Plaza, Wilfredo Martinez Acosta, and Victor Rodriguez*, Case Nos. CR. 98-362-10, CR. 98-362-11, 98-362-12, United States District Court, E.D. Pennsylvania, January 7, 2002.

[18] For an excellent discussion of this issue, see Cole, S.A. (2005). More than zero: Accounting for error in latent fingerprint identification. *Journal of Criminal Law and Criminology*, 95.

> The insistence by some forensic practitioners that their disciplines employ methodologies that have perfect accuracy and produce no errors has hampered efforts to evaluate the usefulness of the forensic science disciplines. And, although DNA analysis is considered the most reliable forensic tool available today, laboratories nonetheless can make errors working with either nuclear DNA or mtDNA—errors such as mislabeling samples, losing samples, or misinterpreting the data.

The NAS report puts these issues to rest, clearly identifying a need for humility and future research when it explains that based on its inquiry (2009, p. 1-6):

> The fact is that many forensic tests—such as those used to infer the source of toolmarks or bite marks—have never been exposed to stringent scientific scrutiny. Most of these techniques were developed in crime laboratories to aid in the investigation of evidence from a particular crime scene, and researching their limitations and foundations was never a top priority. There is some logic behind the application of these techniques; practitioners worked hard to improve their methods, and results from other evidence have combined with these tests to give forensic scientists a degree of confidence in their probative value. Before the first offering of the use of DNA in forensic science in 1986, no concerted effort had been made to determine the reliability of these tests, and some in the forensic science and law enforcement communities believed that scientists' ability to withstand cross-examination in court when giving testimony related to these tests was sufficient to demonstrate the tests' reliability. However, although the precise error rates of these forensic tests are still unknown, comparison of their results with DNA testing in the same cases has revealed that some of these analyses, as currently performed, produce erroneous results.

The NAS report goes on to define the type of errors that can occur in forensic casework, explains that they can indeed be measured when clearly distinguished, and warns "[t]he assessment of the accuracy of the conclusions from forensic analyses and the estimation of relevant error rates are key components of the mission of forensic science" (p. 4-9).

Examiner Bias

The NAS report discusses the issue of examiner bias and subconscious observer effects at length. It explains (2009, p. 4-9):

> Human judgment is subject to many different types of bias, because we unconsciously pick up cues from our environment and factor them in an unstated way into our mental analyses. Those mental analyses might also be affected by unwarranted assumptions and a degree of overconfidence that we do not even recognize in ourselves. Such cognitive biases are not the result of character flaws; instead, they are common features of decision making, and they cannot be willed away.[9]
>
> A familiar example is how the common desire to please others (or avoid conflict) can skew one's judgment if coworkers or supervisors suggest that they are hoping for, or have reached, a particular outcome. Science takes great pains to avoid biases by using strict protocols to minimize their effects.
>
> Fn9: See, e.g., M.J. Saks, D.M. Risinger, R. Rosenthal, and W.C. Thompson. 2003. Context effects in forensic science: A review and application of the science of science to crime laboratory practice in the United States. *Science and Justice* 43(2):77-90.

This is an important discussion to have on record, as many in the forensic community believe and argue one or more of the following regarding examiner bias and observer effects: They don't exist, they can be willed away, they are dealt with by peer review and publication, and/or they have never heard of them. Of course, none of these is true—save the last.

In failing with these arguments, the next line of attack from vested forensic practitioners and their law enforcement employers has been to suggest that if these concerns were real, it wouldn't just be the defense bar discussing them in law review articles, which is why a chapter on this subject was included in Chisum and Turvey's *Crime Reconstruction* (in this edition, see Chapter 4: Observer Effects and Examiner Bias: Psychological Influences on the Forensic Examiner).

Given our previously published findings, and their agreement with the NAS report, we concur with its assessment that (2009, p. 4-11): "Research has been sparse on the important topic of cognitive bias in forensic science—both regarding their effects and methods for minimizing them." Further, we agree with the inference that more study of these subjects is necessary—not less.

Because of the politics involved, error rates and examiner bias are best studied by disinterested students of criminology and forensic science at the graduate level. Within a university environment, scholarship and the mandates of good science can be supported and encouraged. Such researchers are also freer to make objective findings, and to publish them, than those who are politically bound to the interpretive policies of an agency or organization.

CONCLUSION

Despite the remarks of some and the fears of others, we do not view the NAS report as an attack on the forensic science community. On the contrary, we view it as a call to salvage its scientific credibility. Currently the forensic science community lacks both scientific research and real or even impartial leadership—and it needs one to encourage the other. Although it is imperfect in many ways, the NAS report is an excellent set of starter blueprints for the continued scientific development of forensic science, and much needed forensic reform. Consequently, it is cited throughout this book.