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THE HOUSES OF DECEITS: SCIENCE, FORENSIC SCIENCE, AND EVIDENCE

AN INTRODUCTION TO FORENSIC EVIDENCE

Terrence F. Kiely[*]

We have also houses of deceits of the senses, where we represent all manner of feats of juggling, false apparitions, impostures and illusions, and their fallacies. And surely you will easily believe that we, that have so many things truly natural which induce admiration, could in a world of particulars deceive the senses if we would disguise those things, and labor to make them more miraculous. But we do hate all impostures and lies, insomuch as we have severely forbidden it to all our fellows, under pain of ignominy and fines, that they do not show any natural work or thing adorned or swelling, but only pure as it is, and without all affectation of strangeness.

FRANCIS BACON: THE NEW ATLANTIS (1626)

INTRODUCTION

In the 1997 science-fiction film Gattaca, directed by Andrew M. Nicol, a genetically engineered society of the very near future has perfected its use

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of DNA and hair analysis to the point where they serve as common identification methods as we would use a driver's license or social security number today. The plot elements, involving forensic science, mixed identities and murder, are chillingly close to the twenty-first century world of forensic science that we will soon experience. In a recent editorial in the British forensic science journal SCIENCE AND JUSTICE, entitled *Where Will All the Forensic Scientists Go?*[1], Professor Brian Caddy ponders the possibility of police authorities having forensic scientists as part of the initial police response to notice of a crime. He notes the current ability to do an online computer search of a fingerprint from the crime scene and analogous developments in mobile DNA profiling. This advance will be accomplished by the gradual elimination of gel-based systems DNA profiling in favor of the micro-chip as a medium for DNA strand analyses, which will facilitate a major change in crime scene processing:

> From these small beginnings we shall see hand held micro-chip based devices placed in the hands of the crime scene officer which will have the capability of relaying the scene DNA profile to the data bank for comparison purpose. The data bank then becomes a primary function of the forensic science laboratory but as robotization advances this role will be managed by a small number of technicians.[2]

There are similar advances that are already used today and are comparable to digitized collections of fingerprint and footwear impressions. Such advances include the Automated Fingerprint Identification System (AFIS) and the recently created and rapidly expanding CODIS system, linking American state and federal DNA data banks.[3]

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1. 37 SCIENCE & JUSTICE, No. 4, at 223 (1997).

2. *Id.* The routine use of forensic scientists is not the norm in most countries, especially in civil law legal systems. This under-utilization may well be the result of limited resources, but can also be attributed to a lack of sophistication about the advantages of a rigorous forensic science component in routine police crime scene work. *See*, PR De Forest, *Proactive Forensic Science*, 38 SCIENCE & JUSTICE, No. 1, at 1 (1998). For the utilization of forensic sciences in civil law systems, see, generally, Pierre Margot, Editorial, *The role of the forensic scientist in an inquisitorial system of justice*, SCIENCE & JUSTICE, Volume 38, No.2, at 71 (1998). For an examination of the effort to achieve international standards for the gathering, testing and use of crime scene data, *see generally*, Janet Thompson, *International forensic science*, 38 SCIENCE & JUSTICE, No. 3, at 141 (1998). For a detailed study of the developments in international forensic science standards and methodologies, see, Editors, Richard S. Frank and Harold W. Peel, *Proceedings of the 12th INTERPOL Forensic Science Symposium* (The Forensic Sciences Foundation Press, 1998).

3. Professor Caddy further notes that with the advent of microcolumns being etched onto microchips the miniaturization of gas chromatographic and capiary electrophoretic systems seems to be assured as crime scene instruments, especially when new detector systems for drugs, fire accelerants and explosives have been developed. *Id.* Mobile DNA unit manufactures predict working models in the hands of police in three years. *See* Kevin James, *Police Gadgets Aim to Fight Crime With 007-Style Ingenuity*, N.Y. TIMES, March 7, 2000, at A21.

This article has two goals: First, to analyze the contemporary fit of forensic science in the world of twenty-first century criminal prosecutions; and second, to examine cases addressing the general acceptability of forensic science methodology. The material to follow will provide an overview of the influence and contemporary utilization of science in the field of criminal law. Specifically, it will address the application of the various disciplines encompassed in the world of forensic science, as applied to the investigation and trial of criminal cases. It is not the intention of the author to detract from the importance of the past contributions or recent developments in the ongoing claims of experts in forensic science. The article certainly does not equate such with the "impostures or illusions" that concerned Chancellor Bacon. The article does, however, take a close look at the claims made by forensic science, the response of the courts to those claims, and finally, the concerns that continue to be raised by jurists. While this article cannot demonstrate the intricacies of the law's response to the claims of all of the individual forensic sciences used in the criminal justice system, such as DNA, hair, fiber or fingerprint analyses, it is the intention of the author to provide an overview of general principles applicable to all such applications.

It is essential to make a clear distinction between twenty-first century methods for recognizing, storing, and testing potentially important crime scene data and the conceptual apparatus used to interpret it in a court of law. As we enter a new century it is time to take a detailed look back on the development of the relationship between the law and the world of forensic science up to this point. This article will attempt to provide such an analytical retrospective, by discussing the legal context within which the claims and offerings of the forensic sciences are articulated as we depart the century where both forensic science and forensic evidence were born and developed.

The quotation from Francis Bacon that precedes this article may serve as a signpost for the discussion of forensic evidence to follow. Bacon warns of the dangers inherent in exaggerated, misleading or simply absurd claims made about the results of scientific theory and experimentation.[4] Historically, scholars have cautioned against ascribing more weight to statements grounded in probability assessments than they deserve. More often than not, proof of fact statements, particularly in science-based litigation, are couched in terms of probabilities. The economist John Maynard Keynes,

4. *See* FRANCIS BACON, THE NEW ATLANTIS (1626). The desire to develop a paradigm for the validation of scientific discoveries and methodology has been a constant struggle since the very early period of modern scientific thinking in 17th century England. Sir Francis Bacon, Lord Chancellor and one of the fathers of modern scientific thinking wrote a work called the New Atlantis, wherein he created a mythical institution called Saloman's House or the College of the Six Days Work, where the inhabitants were devoted to a serious and widespread search for the identification of scientific discoveries and developing rigorous standards for testing their credibility. *See id.*

among a host of others, alerts us to the continuing problem of society, especially in litigation, of carelessly accepting a certain level of proof of a probability that certain facts are true as proof that they are true: "It has been pointed out already that no knowledge of probabilities, less in degree than certainty, helps us to know what conclusions are true, and that there is no direct relation between the truth of a proposition and its probability. Probability begins and ends with probability."[5] Probability, as will be noted throughout this article, is the central and controlling idea in the utilization of forensic science in the modern criminal trial.[6]

Proof of fact in significant late twentieth century litigation is increasingly focused on inferences flowing from the application of the findings of one or more of the natural sciences. The methodologies have changed, and continue to change, as science progresses. The legal system has survived many such changes and will survive even more as the twenty-first century rushes into our national life. The important aspect of this increasing dependence on scientific method as a basis for determining dispositive facts, as far as the litigants are concerned, is the fact generated, not the method used to generate it. The existence or non-existence of a matter of fact depends in large part on the theory of fact-finding being used by the fact seekers.

Discussions of the use of science in the criminal law predictably revolve around the subject of forensic evidence. Forensic evidence refers to facts or opinions proffered in a criminal case that have been generated or supported by the use of one, typically more than one, of the corpus of forensic sciences routinely used in criminal prosecutions.[7] There is an extensive list of such disciplines, the legal ramifications of which will receive extended attention in this article. The more important among the body of forensic sciences are set out below:

Hair Analysis
Fiber Analysis
Glass Fragments and Paint Chips Analyses
Soil Analysis
Ballistics and Toolmarks
Fingerprints
Footwear
Tire Impressions

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5. JOHN MAYNARD KEYNES, TREATISE ON PROBABILITY, 322 (MacMillan, 1948) (1921).

6. The use of probability theory, along with its cousins inferential statistics and extrapolation theory is also at the heart of causation debates in product liability, toxic tort, and environmental cases.

7. Note that while the greatest number of forensic evidence issues arise from a crime scene, there are many crimes involving forensics where there is no crime scene in a traditional sense. Examples would be the movement of a body, forgery, and other questioned document settings, or those cases where there simply is little or no forensic evidence to be discovered.

Blood Spatter Analysis
DNA Analysis
Forensic Anthropology
Forensic Archeology
Forensic Pathology
Forensic Odontology
Questioned Document Analysis
Forensic Psychiatry and Psychology

The central ingredient in the utilization of the findings of the forensic sciences is the crime scene itself. While a crime scene can consist of the basement of a counterfeiter or the broken door lock of a supermarket, typically the term refers to the scene of a violent crime such as a sexual assault or a homicide. The recognition and collection of materials at a crime scene is not only a familiar focus for the training of forensic scientists, it is also the central source and reference point for analysis of the many legal issues that are involved directly or indirectly in the field of forensic evidence. What types of materials are typically found at a crime scene that may, through close examination by forensic scientists, yield valuable information and lead to an arrest and successful prosecution of the perpetrator or the equally important elimination or exclusion of a putative suspect?[8]

Forensic evidence—information generated by one or more of the forensic sciences—comes to the law in one or both of two forms. The first is referred to as a *class characteristic* statement that speaks generally to some aspect of the crime scene under examination. Testimony that the pubic hairs found on a rape-homicide victim came from a Caucasian male or that shell casings found at the scene came from a certain make and model of firearm are two typical examples of such a type of statement. The second type of potential testimony generated by a forensic science are known as *individual or "matching" statements*. These statements attempt to link

8. The list that follows enumerates the physical or the data source for the forensic science and legal discussions that compromise the bulk of the materials in this article: blood, semen and saliva (DNA profiling, matching and typing; blood spatter analysis); non-human DNA (dog, cat, deer, plants, protected species); drugs (drug identification); explosives (bomb and arson identifications and trace element or marker sources); fibers (fiber typing, source identification and matching); hair (hair typing and matching); fingerprints (fingerprint matching, Automated Fingerprint Identification Systems); bones (Forensic Anthropology: gender and age typing; identification of remains; weapon identification); wound analysis (weapons typing; physical movement patterning); firearms and ammunition (ballistics and toolmark identification; crime scene bullet and unspent ammunition chemical comparisons); gun powder residue (shootings, suicides); glass (glass typing and matching); foot, tire, and fabric impressions) (impression typing and matching); paint (paint typing and matching in automobile collisions, hit and run); plastic bags (typing and matching; garbage bags as suffocation device or transport means); soils and minerals (forensic geology: mineral typing and matching); tool marks (tool identification and matching; homicides, burglary, home invasions, etc.); wood and vegetative matter (plant typing and matching; plant DNA, APD matching; limnology); insects, larvae, maggots (forensic entomology: time of death; location analyses); dentition and bite marks (identification of victim; matching bite marks to defendant); tobacco products and smoking materials; (DNA: saliva, brand identification, fingerprints); documents (printer and handwriting analyses).

some data found at the crime scene to a particular defendant. Testimony which reveals that court ordered pubic hair exemplars obtained from a defendant are consistent in all respects to the hair located on the victim, or that fibers found on the victim's clothing are consistent with fibers from defendant's jacket, will serve as examples.[9]

The very concept of class characteristic statements references the reality that many confident general statements may be made under the auspices of an individual forensic discipline.[10] Several brief examples may be noted:

1) A hair at the crime scene came from a Caucasian, African or Asian male, or came from a dog or cat.
2) A fiber found at the crime scene was silk or rayon or wool, or is of the type typically used in sleeping bag liners, or tee shirts or automobile upholstery or outdoor carpeting etc.
3) A shoeprint was made by a certain type of athletic shoe sized 12 and thus the wearer was a male approximately 5'11-6'0, etc.
4) The leafy material found on the corpse was not native to the area of the crime scene but was of a nearby area, or the soil found on the victim's clothing was not native to the crime scene or the insects on the body of the victim indicate the approximate time of death.
5) There are two sets of fingerprints on the knife or gun used to kill the victim, neither of which matches those of the victim.
6) The shell casings indicate the type of handgun used or not used, etc.
7) The bones found in the grave were those of a female approximately thirty years of age, who had at one time suffered a broken collarbone.
8) The blood spatter locations indicate a non-defensive series of encounters between the victim and the perpetrator.

Whether the importance of the testimony of a particular forensic scientist lies in general or class statements about units of crime scene data, or an opinion linking the defendant to the crime scene through an individual "match" opinion, the scientific foundation or basis for such testimony, as in

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9. This division of the information supplied to the criminal justice system into *class* and *individual* is of the utmost importance for both forensic scientists and the criminal bar and will receive extensive examination in the discussion to follow that address the legal acceptance or rejection of the specific offerings of the forensic sciences.

10. *See generally* WILLIAM J. BODZIAK, FOOTWARE IMPRESSION EVIDENCE (CRC Press, 1995); DIMAIO & DIMAIO, FORENSIC PATHOLOGY (CRC PRESS, 1993); ECKERT, INTRODUCTION TO FORENSIC SCIENCES (CRC Press 2d ed. 1997); FISHER, TECHNIQUES OF CRIME SCENE INVESTIGATION (5th ed. CRC Press 1993); GEBERTH, PRACTICAL HOMICIDE INVESTIGATION (3d ed. CRC PRESS 1996); JANES (ed.) SCIENTIFIC AND LEGAL APPLICATIONS OF BLOODSTAIN PATTERN INTERPRETATION (CRC Press 1999); OGLE & FOX, ATLAS OF HUMAN HAIR: MICROSCOPIC CHARACTERISTICS (CRC Press 1999); PICKERING & SAFERSTEIN, THE USE OF FORENSIC ANTHROPOLOGY (CRC Press 1997); SAFERSTEIN, CRIMINALISTICS: AN INTRODUCTION TO FORENSIC SCIENCE (Prentice Hall 6th ed. 1998).

civil cases, is of the utmost concern to the law. As will be discussed later, the law is primarily concerned with the adequacy of the scientific basis for a scientific opinion.

The term "forensic evidence" encompasses two distinct ideas and processes. First, the forensic aspect refers to the processes utilized by the forensic science at issue through which facts and accompanying opinions are generated. The manner in which DNA is extracted, tested, and subjected to population analyses serves as a major example. The methodologies of hair, fiber, and fingerprint examination are further illustrations. The area of "forensic science" encompasses a fairly discrete number of well-known disciplines; whereas the "science" addressed in products liability and environmental civil cases does not lend itself to such finite boundaries.

While there are repetitive areas of scientific focus in civil cases such as chemistry, pharmaceuticals, or biological, mechanical or electrical engineering, there is much less of an opportunity to discuss the general outlines of acceptable methodology in such cases. This is due to the wide variety of pharmacological, chemical, or engineering products subjected to legal scrutiny in state and federal product liability or environmental litigation. In contrast, the forensic sciences, traditionally associated with the prosecution of repetitive crime patterns, such as sexual assault and homicide, allow for broad and repeated methodological reviews. Accordingly, methodological reviews are required to varying degrees by criminal courts. Nonetheless, the legal concerns are basically the same. That is, the concern that the scientists participating in the study and use of the underlying methodologies of their general discipline agree that the method under challenge is generally accepted or considered reliable in that scientific community.

Initially, it is important to recall the fundamentally different reasons for the introduction of scientifically generated information in the civil and criminal litigation systems. The use of the term "litigation" is significant here since it is in the process of litigation that the issues discussed herein become important. This is quite distinct from other contexts where the nature or acceptability of scientific methodologies or opinions are at the center of the inquiry, such as grant requests, patents, contractual disputes, or publication in a scientific peer-reviewed journal. The legal issues most involved in the science debates of the past decade are questions of the relation between scientific and legal standards to determine causation. As the century closes, similar questions are also being increasingly directed to the information claims of the forensic sciences.

Second, the evidence aspect of the concept of forensic evidence refers to a distinct set of procedures unique to the litigation process, separate and distinct from the processes of any forensic science or sciences that are the basis for the proffer of facts in a civil or criminal case. At this point, a dis-

cussion of the basic components of what may be referred to as the forensic science process, across individual disciplines, is necessary as a means of furthering and understanding the broad judicial support given the evidentiary contributions made to the criminal justice system. This support has been in the form of factual assertions and/or opinions from the forensic community.

In civil as well as criminal cases, the parties seek to prove or disprove a sufficiently strong connection between defendant's act or omission and the death or injury in suit. However, the science at issue usually consists of studies that may only be probative of such connection by way of extrapolation, without the individualizing, case specific expert testimony typically provided by forensic scientists.[11] Forensic evidence deals with scenarios far different from civil law tort cases, where no real science is actually performed, to serve the theoretical need for the litigants to prove or cast doubt on causation. The major debate over the harmful effects of migrating silicone on a woman's connective tissue or auto-immune system may serve as a classic contemporary example. In the criminal case, the use of forensic science means that some form of laboratory work has been actually and contemporaneously performed to resolve factual matters in the case.

In both civil and criminal cases, the information provided from scientific sources must be relevant to one of the issues in the case. In civil cases, this typically involves the question of whether a commercial application of some scientific formulation "caused" the plaintiff's death or injury.

The value of forensic evidence for police and prosecutors lies in its ability to interpret multiple physiological aspects of a crime scene and, hopefully, to link a particular suspect to the crime scene. In this respect, it is of central importance to recognize that in any criminal case there are actually four crime scenes involved, each with its own set of rules and guiding principles:

> The physical crime scene created and left by the PERPETRATOR.
> The crime scene material collected by the CRIME SCENE PERSONNEL.
> The crime scene MATERIAL CAPABLE OF BEING TESTED BY THE CRIME LAB and the results of any such tests.
> The CRIME SCENE INFORMATION ALLOWED INTO EVIDENCE by the trial court according to the case issues and the rules of evidence.

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11. *See* General Electric v. Joiner, 522 U.S. 136 (1997). *See also* Duran v. Cullinan, 677 N.E.2d 999 (Ill. App. Ct. 1997).

The relative importance and focus of each of these successive crime scenes depends upon a solid understanding of four major factors, which are the basis for all aspects of the utilization of any of the forensic sciences:

> RECOGNITION—the ability to understand what could be present at the scene.
> COLLECTION PROCEDURES—understanding and utilizing the most current thinking on the subject of collection procedures.
> TESTING PROCEDURES—understanding and utilizing the most current thinking on the subject of forensic laboratory testing protocols.
> TRIAL EVIDENCE REQUIREMENTS—witness and exhibit foundation requirements and the applicability of relevancy under the rules of evidence

The value of information generated by the techniques and methods of forensic science, as far as the law is concerned, initially rests upon the police authorities at the scene of a crime recognizing an item as having potential value and properly collecting and storing it prior to lab analysis. If the material is not seen and collected, the forensic evidence analysis is obviously nullified. This reality underscores the need for increased training, especially in smaller communities across America, in the basic and advanced procedures for crime scene analysis.[12] In a post-O.J. Simpson legal environment, the collection process itself has become fair game for defense lawyers eager to stop the forensic evidence process from reaching its evidentiary conclusion.[13]

In many ways, the O.J. Simpson trial was a catalyst for the current renewed focus by trial counsel and judges on the rights and wrongs of crime scene investigation and testing. Hotly debated issues include: The alleged failure to conduct an adequate crime scene investigation; contamination of samples; deficient-testing processes; and a host of other crime scene related matters. Law school and post-graduate legal training has recently begun reemphasizing the importance of forensic evidence instruction as well as the more familiar tools of criminal law such as constitutional criminal procedure, criminal law theory, and the law of evidence. The importance of forensic science to criminal law lies in its potential to supply vital information about how a crime was committed and who committed the crime. This information, which if it survives the screening function of the rules of evi-

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12. *See* ECKERT: *supra* note 9; WILLIAM Eckert, INTERPRETATION OF BLOODSTAIN EVIDENCE AT CRIME SCENES (CRC Press 1989); BARRY FISCHER, TECHNIQUES OF CRIME SCENE INVESTIGATION (CRC Press 5th ed. 1993); GEBERTH, PRACTICAL HOMICIDE INVESTIGATION: TACTICS, PROCEDURES AND FORENSIC TECHNIQUES (CRC Press 4th ed. 1998); SAFERSTEIN *supra* note 9.

13. *See* Testimony of Dr. Henry Lee, California v. O.J. Simpson, 1995 WL 521227; Testimony of Dr. William J. Bodziak, California v. O.J. Simpson, 1995 WL 619212; Testimony of Dr. Robbin Cotton, California v. O.J. Simpson, 1995 WL 289344.

dence, and will be accepted into evidence, could become "fact" in the ensuing trial.

The basic legal antagonism between forensic scientists, lawyers, and the courts can be encapsulated in two basic questions: 1) How far do forensic scientists say they can go in making a definitive statement about a crime scene and/or the linking of a suspect to it because they have a microscope; and 2) How far do we let them go because we have a Constitution? The importance of these questions lies in the recognition of just how far and on what empirical basis any such statements can be made at all. Additionally, it is important to understand the impact that such statements may have on a jury in regard to the truth of the factual predicate of any such opinion. The concern has always been that the testimony of a criminalist that a hair or fiber obtained from a suspect was *consistent in all respects or not dissimilar* will be internalized by jurors as a statement of a definite match. Defense lawyers often refer to this as the "white lab coat and resume" problem. Thus, it is important to realize that, with the possible exception of fingerprint and ballistics testimony, the opinion of most forensic experts are typically only permitted to be couched in such a qualified statement.

In broadest terms, the "matching" process utilized by forensic scientists involves demonstrating the manner in which a physical item from a crime scene, or other data, may be analyzed so as to provide a purported link between the defendant and the crime scene involved in the prosecution. Each of the datum recovered from a crime scene, whether hair, fiber, soil, glass particles, blood products, foot or tire prints, or firearms, may be broken down into a series of sub-components for purposes of analysis and comparison. It is important that prosecutors and defense counsel make a detailed study of these separate disciplines.[14]

It is essential to recall most of the forensic sciences routinely used in criminal cases are basically observational, experience-based disciplines. The disciplines focus on the employment of the latest microscope technology, such as the comparison microscope. In today's judicial climate, as seen in the string of recent United States Supreme Court "science" cases, the designation of forensic science as science has come under pre-trial scrutiny with respect to the relevant methodologies that a forensic scientist routinely relies upon.

There are a series of questions that courts, prosecutors, and defense counsel need to address concerning forensic science based prosecutions:

1) What is the relevant scientific world I need to know?
2) Where can I locate the scientific literature that I must master to

14. *Id.*

effectively use forensic science to generate evidence to prosecute or defend a crime or to counter any such evidence presented?
3) What are the key scientific treatises on the general subjects of criminalistics and discrete forensic sciences?
4) What are the key texts with respect to the theoretical and practical application of each of the forensic disciplines such as forensic anthropology, footwear impression, DNA analysis, bloodstain interpretation and the like?
5) What are the basic outlines of the forensic science involved?
6) What are the leading forensic science journals that will reflect both the tried and true, as well as cutting edge thinking about forensic science theory and applications?
7) Who are the leading experts in each field? [We saw many of today's best experts in the O.J Simpson case, i.e., Dr. Henry Lee, Dr. Michael Baden, Dr. Cyril Wecht, Dr. Robin Cotton and William Bodziak.][15]
8) What are the emerging theories in the world of forensic science? Where are the upcoming conferences to be held, what papers will be presented, and how are they accessible?
9) Who are the emerging scholars/practitioners in the world of forensic science?
10) What are the relevant professional associations for each area of forensic science, in particular, crime lab accreditation? What are their individual accreditation standards and procedures and how do I access them?
11) Where are the leading forensic science degree programs located? How can I identify their curriculum and associated faculty information?[16]

SCIENCE AND THE SUPREME COURT

State and federal courts in both civil and criminal areas are increasingly concerned with cases in need of an encompassing and practice-oriented definition of science and scientific method. Such a definition is necessary as an essential element to the admissibility of opinions of experts based upon such science. Indeed, in the past decade, the whole subject of the propriety and extent of expert testimony in civil and criminal cases has

15. The transcripts of the testimony of these prominent forensic science experts are available for downloading for Westlaw customers. All practitioners in the fields of forensic science and criminal law will benefit from a continuing review of this material. It also serves as excellent and focused classroom study material.

16. A host of additional questions will arise when court and counsel are deep into admissibility arguments concerning the factual offspring of the application of a particular forensic science. Questions of that nature for each discipline covered will be isolated and addressed in the author's forthcoming book, INTRODUCTION TO FORENSIC EVIDENCE: SCIENCE AND THE CRIMINAL LAW, to be published by CRC Press in the fall of 2000.

been attacked from both sides. An ongoing battle exists as to what is a legally acceptable scientific foundation for the proffering of expert opinion in a wide variety of environmental, products liability, and criminal cases. This article will now briefly examine the issues involved and the considerable differences that exist between civil and criminal cases concerning the ongoing use of science-based expert opinion in modern American litigation.

The focus for most of the nineteenth and twentieth centuries has been on the qualifications of the proffered expert witness which, if deemed adequate, usually resulted in an acceptance of the propriety of the scientific method which served as a basis for the expert's opinion. Until recently, most courts have expressed appreciation, rather than skepticism, for the contribution of expert witnesses in assisting them in difficult science-based fact finding processes.[17] The legal process' ultimate goal is not to find absolute truth. Any system that allows a jury to conclude that a defendant is guilty or not guilty in such important matters would appear to have something else in mind. The actual goal of the American litigation system is more modest. It strives to provide the best context, the fairest context, and the optimal context, for a jury to find truth. The goal of providing the best opportunity for a jury to find their version of the truth is especially important to understand before entering into extended discussions of the nation's courts current interest in the question of the bases of forensic science.

It is important to note the term *science* in the discussions to follow has little or no connection to the utilization and understanding of that term as it is uniformly thought of by the international scientific community. John Horgan, in his excellent book *The End of Science: Facing the Limits of Knowledge in the Twilight of the Scientific Age*,[18] sought out the world's leading philosophers of science: Theoretical physicists, evolutionary biologists, mathematicians, astronomers and chaos theorists, to get their perspective as to whether "science" was at a close, with nothing significant left to be discovered. Hogan's book provides an overview of modern scientific thinking across a wide variety of fields. The questions of law and science

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17. For a more cautious perspective *see* French v. Rogers, 9 F. Cas. 790, 797, (Cir. Ct. E.D. Pa. 1851) (involving the Morse telegraph patents):

> [T]here is no place in which the evidence of scientific men, upon topics within their own departments of knowledge, is more to be desired than in this court, when sitting for the trial of patent causes; and the opinions also of such men, when duly supported by reasoning founded on ascertained facts, must of course be valued highly. Bit it is a mistake to suppose that , even on a question of science, opinion can be dignified here or else where with the mantel of authority. . . . [T]hese remarks are not dictated by a spirit of unkind or uncourteous commentary on the depositions before us. We know that when opinion is active, it is not always easy to limit its range. *Id.*

18. JOHN HORGAN, THE END OF SCIENCE: FACING THE LIMITS OF KNOWLEDGE IN THE TWILIGHT OF THE SCIENTIFIC AGE (Addison-Wesley 1996). *See also* JOHN MADDOX, WHAT REMAINS TO BE DISCOVERED: MAPPING THE SECRETS OF THE UNIVERSE THE ORIGINS OF LIFE AND THE FUTURE OF THE HUMAN RACE (Free Press, 1998).

addressed in the discussion to follow are light years away from the type of scientific inquiry posited by the interviewed scholars.

In its simplest and most practical terms, the question of what is or is not "science" typically revolves around the issue of whether an expert witness chosen by one of the sides in litigation may testify at all, or render a particular opinion, assuming he or she is qualified to give *any* opinion. In cases involving a wide variety of commercially produced chemical compounds, pharmaceuticals, medical devices and engineered goods, court resources are being increasingly taxed in pre-trial hearings while counsel seek to determine the scientific validity of the supporting methodologies for opinions of an amazingly disparate number of expert witnesses. The presence of litigation involving questions of science or the nature of the validity of modes of scientific inquiry has been part and parcel of our legal life since the start of our national life, primarily residing in cases brought up in the nation's patent system. The significant modern decisions addressing the "science question" have shifted focus as a result of the growth of biological, chemical, and engineering-based issues arising in modern products liability and criminal prosecutions.[19]

Historically, a central concern in such cases is how the courts fashion a set of observational and linguistic guidelines to gauge the adequacy of a scientific opinion. This debate has come full circle in the search by modern courts for a one-size-fits-all definition of a legally sound scientific methodology. A definition which will serve justice in the increasing and predictably complex product liability and criminal cases of this new century.

An examination of judicial materials from 1798 until the late 1800s reveals that the question of what was or was not "science" or a reputable development in science, was of concern only to those actually engaged in scientific endeavors. There was no pressure or perceived necessity on the part of the legal system to utilize or forge an overarching theory of what is or is not science. The key factor was the solidity of the foundation for the expertise of the witness herself, rather than the reliability of general acceptability of a utilized methodology. In fact, it was not until 1923 in the case of *Frye*

19. Science-based disputes also abound in contract actions and regulatory proceedings, whether the Food and Drug Administration (FDA), the Occupational Safety and Health Administration (OSHA), the Consumer Product Safety Administration (CPSA) or a bevy of other science-based government organizations. Modern case law increasingly references a wide variety of science-based matters, which are becoming challenged in pretrial hearings in ever-greater numbers. What is generally acceptable or reliable methodology in various fields that would justify an opinion, such as the cancer causing potential of certain commercial products? Who determines the answers to these questions? What is the scientific standard to utilize in this inquiry? At what point in the history of a product or a disputed event and its alleged victim are we to focus? Are civil and criminal cases sufficiently different in terms of their goals and processes to require different analyses? Is every opinion that is grounded in some aspect of science subject to pre-trial scrutiny to test the adequacy of the methodology and the opinion used?

v. United States,[20] that the courts formally addressed the question. Even after the *Frye* decision, it was not until seventy years later that the United States Supreme Court returned to the issue with full force.

The focus on the general acceptability or reliability of methodology has been at the center of the *Daubert v. Merrell Dow Pharmaceuticals, General Electric v. Joiner,* and *Kumho Tire Company Ltd. v. Carmichael et al.* cases decided by the United States Supreme Court in the past decade. A very brief discussion of those decisions is necessary as a precursor to the detailed analysis of law and forensic science to follow. The *Frye* and/or *Daubert* acceptability or reliability requirements are the current basis for judging the acceptability of scientific opinion in both civil and criminal cases.

Frye involved the scientific status of a rudimentary lie detector machine. The Court in *Frye* realized that legal doctrine could not supplant the views of the scientists, and therefore took the position that if the relevant scientific community generally accepted the methodology at issue, then the methodology would be acceptable to the law. The general acceptability rule was thus born and continued to be the rule for the next seventy years, until the 1993 decision by the United States Supreme Court in *Daubert v. Merrell Dow Pharmaceuticals.*[21]

It is noteworthy that the period from 1923 to 1993 saw the gradual development of, and eventual explosion of, products liability law in the 1960s and 1970s.[22] The major work of the nation's courts in the products field was the creation and refinement of the mass of principles involved in forming the law of strict liability for products.[23] It was not until 1993 when defendant Merrell Dow Pharmaceuticals challenged the methodology of a plaintiff's expert in determining that the interpretation of a body of epidemiological studies established—according to the plaintiffs' expert's unique methodology—that the ingestion of the drug Bendectin was the cause of fetal malformations.

In *Daubert v. Merrell Dow Pharmaceuticals,* Justice Blackmun noted that in the seventy years since its formulation in the *Frye* case, the general acceptance test had been the dominant standard for determining the admissibility of novel scientific evidence at trial. While the general acceptance test has been under increasing criticism, it has nonetheless continued to be followed by a majority of courts.[24] Justice Blackmun observed that the

20. 293 F. 1013 (D.C. Cir. 1923).

21. 509 U.S. 579 (1993).

22. *See generally* J. WADE ET AL., PROSSER, WADE & SCHWARTZ, CASES AND MATERIALS ON TORTS (9th ed. 1994).

23. *Id.*

24. *Daubert*, 509 U.S. 579, 585 (1993). For a comprehensive listing of the many cases on either side of this controversy, *see* P. GIANNELLI & E. IMWINKELRIED, SCIENTIFIC EVIDENCE ,Vol. I §§' 1-10-1-10(H), (2d. ed. 1998 Supp.).

merits of the *Frye* test had been much debated, and the scholarship on its proper scope had continued to grow at an ever-increasing pace.[25] Here, the Court agreed with Merrell Dow that the proper focus of such discussions should henceforth be the provisions of the Federal Rules of Evidence, not the seventy-year-old *Frye* decision. The Court noted that they were required to interpret the legislatively enacted Federal Rules of Evidence as they would any statute, and that Rule 401 and 402 provided the baseline theory.[26] These two rules of relevancy were to be utilized in future cases, in conjunction with Rule 702, setting forth the basic principles regarding the admissibility of expert testimony.[27] The Court observed that nothing in the language of the Rules, or specifically Rule 702, mandated general acceptance as an absolute prerequisite to admissibility and, indeed, would be at odds with the liberal thrust of the Federal Rules of Evidence.

However, the conclusion that the *Frye* test was replaced by the Rules of Evidence did not mean there were no checks on the admissibility of purportedly scientific evidence, nor was a trial judge disabled from screening such evidence. Under the Federal Rules of Evidence, the trial judge was required to warrant that any and all scientific testimony or evidence admitted was not only relevant, but also reliable.[28] The primary authority for this obligation was Federal Rule of Evidence 702. When presented with an offer of expert scientific testimony, a trial judge must determine at the outset whether the expert proposes to testify to scientific knowledge that would assist the trier of fact to understand or determine a fact in issue. If so, then a preliminary assessment is required to determine whether the reasoning or methodology underlying the testimony was scientifically valid and whether that reasoning or methodology properly could be applied to the facts at issue.[29]

Several observations are in order concerning the ruling in *Daubert*. Initially, it will be convenient to set out a summary of the requirements for the admissibility of scientific expert witness opinion under states continuing to follow *Frye* or the more recent *Daubert* decision. Under either decision, and regardless of what facts or factors are applied in a particular case, there

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25. *Daubert*, 509 U.S. at 586. Justice Blackmun cited several examples in footnote four. *Id.* at 586 n. 4.

26. FED. R. EVID 402. The rule provides: "All relevant evidence is admissible, except as otherwise provided by the Constitution of the United States, by Act of Congress, by these rules, or by other rules prescribed by the Supreme Court pursuant to statutory authority. Evidence, which is not relevant, is not admissible." Relevant evidence is defined as that which has "any tendency to make the existence of any fact that is of consequence to the determination of the action more probable or less probable than it would be without the evidence." FED. R. EVID. 401.

27. FED. R. EVID. 702. The rule provides: "If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise." *Id.*

28. *Daubert*, 509 U.S. at 589.

29. *Id.* at 593.

are only a limited number of questions that the courts or scientists themselves could examine in trying to make a sufficiency determination:

1) Are there any published peer reviewed books or articles on the questioned methodology?
2) Is this methodology taught in universities or discussed in professional scientific meetings or colloquia?
3) Can this methodology be tested for accuracy? Does it have a known error rate?
4) Is this methodology generally accepted in the relevant scientific community where similar concepts are studied and used?

These would appear to be the only significant questions asked under either the *Frye* or *Daubert* standards. In *Daubert*, the Court rejected the *Frye* rule and essentially wrapped the above balancing criterion in a Federal Rules of Evidence package, with a stated preference to treat general acceptability as only one, but not the essential, factor to receive attention. Hence, the relevant and reliable standard of *Daubert* as opposed to general acceptability rule of *Frye*, is functionally the same as far as its implementation is concerned. The *Daubert* "relevancy" standard simply means that the scientific information a party seeks to introduce into evidence has the ability to make some fact that is of consequence to the action more probable or less probable than it would be without it.[30]

The *Daubert* decision has yet to be formally accepted by the majority of state courts, which retain their adherence to the *Frye* standard. However, a great number of those states have accepted *Daubert's* more liberal, open analysis approach, making the real differences between the two models increasingly vague and difficult to see. The *Daubert* case prompted another four years of decisions applying what was perceived as its requirements in an extensive variety of scientific methodologies.[31] The important question of, to what extent the *Daubert* gatekeeper could make a pre-trial judgement regarding the actual opinion of an expert if arguably based on relevant and reliable methods, was not addressed in *Daubert*. This important point was resolved in the affirmative in the 1997 decision by the United States Supreme Court in *General Electric v. Joiner*.[32] *Joiner* involved the question of whether long-term exposure to PCB's could cause cancer. The case also provided an extended discussion of the *Daubert* criterion, especially as it related to the importance of the presence or absence of peer reviewed scientific articles on the questioned methodology.

30. FED. R. EVID. 401.
31. For an excellent discussion of *Daubert* and its considerable progeny, *see* Michael H. Graham, *The Daubert Dilemma : At Last A Viable Solution*, 179 F.R.D.1 (1998).
32. General Electric v. Joiner, 522 U.S. 136 (1997).

The final two cases in the *Frye/Daubert* series are *Joiner*[33] and *Kumho Tire*.[34] *Joiner* held that the trial court "gatekeeper" had the authority to rule on the reliability of a proffered expert opinion, even if the methodology used to generate it satisfied the *Daubert* criteria. The decision, written by Justice Breyer, stressed the importance of peer-reviewed literature on the issue of the reliability of the expert opinion involved. Finally, the *Kumho Tire* case, decided in 1999, held that *Daubert's* "gatekeeping obligation," which requires an inquiry into both the relevance and reliability of proffered expert opinion, applied not only to "scientific" testimony, but to all types of expert testimony.

Questions such as, "did this drug or pollution cause the plaintiff's cancer; or do the hair, fiber or fingerprints at a crime scene belong to the defendant?" are crucial to the just resolution of a contested case and typically are only analyzed once. Thus, the legal system's concern over fact generation is essential to justice. Authors Steven Shaplin and Simon Schaffer, in their book *Leviathan and the Air Pump, An Examination of 17th Century Debates about Proof of Fact*, state:

> A discarded theory remains a theory. There are good theories and bad theories-theories currently regarded as true by everyone and theories that no one any longer believes to be true. However, when we reject a matter of fact, we take away its entitlement to the description: it never was a matter of fact at all.[35]

SCIENCE AND THE CRIMINAL LAW

The legal protections against the so-called "coerced" confessions and illegally seized evidence by way of Fourth and Fifth Amendment case law sanctions[36] have gradually increased the simple need to prove a crime by way of circumstantial evidence. This typically is achieved by inference "packaging:" physical data retrieved from a crime scene, analyzed in a forensic lab and presented to a court and jury to meet one or more of the essential facts required by criminal law theory. While the development of federal criminal procedural rights has indeed thrown prosecutorial units back onto the more traditional proof processes, it has always been the case, throughout the history of common law trials, to center proof in inferences generated from a wide variety of circumstantial evidence. Increasingly, in the late twentieth century criminal trial, this circumstantial proof often comes in the form of forensic evidence.

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33. *Id.*
34. 526 U.S. 137 (1999).
35. STEVEN SHAPLIN & SIMON SCHAFFER: LEVIATHAN AND THE AIR PUMP 23 (1985).
36 *See generally* JOHN F. DECKER, REVOLUTION TO THE RIGHT: CRIMINAL PROCEDURE JURISPRUDENCE DURING THE BURGER-REHNQUIST COURT ERA (1992), for an overview of the history of retrenchment in this area.

While this article concentrates on the subject of contemporary forensic evidence, it is important to note that the long history of proof of crime has always depended more on the experience of juror's lives than any startling analysis developed in a laboratory. Logic and common sense have always had, and will continue to have as great, if not greater force, than probabilistically based forensic facts. The famous French mathematician Pierre Laplace observed in 1820 that, "[t]he theory of probabilities is at bottom nothing but common sense reduced to calculus."[37]

Common sense and shared experience have always had more to do with proof of fact than science. The marshaling of facts that comport with the life experience of triers of fact remains the bedrock of any criminal justice system. Indeed, a history of forensic proof might as well be referred to as a history of close observation, of investigators simply slowing down and paying attention.

The history of the forensic sciences is a fascinating study,[38] which in the past was primarily centered on the work of individual scientific pioneers. This can be contrasted with the present day approach of systematized, publicly funded entities designed and intended to aid government prosecutors.[39] The aspect of the forensic sciences that is of interest to practitioners in the criminal justice system is its potential for the production of forensic evidence. For example, facts, which when typically combined with probability assessments geared towards a defendant's participation in a

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37. PIERRE SIMON DE LAPLACE, THEORIE ANALYTIQUE DES PROBABILITIES, (1820).

38. *See* COLIN WILSON, CLUES!: A HISTORY OF FORENSIC DETECTION (Warner Books 1989); JURGEN THORVALD, CENTURY OF THE DETECTIVE (Harcourt, Brace, and World 1965); JURGEN THORVALD, CRIME AND SCIENCE (Harcourt, Brace, and World 1966).

39. *See generally* SAFERSTEIN, *supra* note 10, at 3-7. This is considered the standard text in the field of forensic science. According to Safterstein, Mathieu Orfila (1787-1853) is often referred to as the father of forensic toxicology. *Id.* The Spaniard became a famous professor of medicine and wrote the first major work on the detection of poisons and their effect on animals. *Id.* Alphonse Bertillon (1853-1914) developed a system of measuring the facial features of criminals in an effort to identify criminals on the basis of witnesses' statements. *Id.* Francis Galton (1822-1911) conducted the first serious study of the possibility of a fingerprint identification theory and system. His seminal work, FINGERPRINTS, was published in 1892. The statistical study therein serves as the basis for today's system. *Id.* Leon Lattes (1887-1956) and Dr. Karl Landsteiner developed blood typing [A, B, AB, O]. Lattes also developed a system for determining the typing of a dried bloodstain. *Id.* Calvin Goddard (1891-1955) pioneered ballistics identifications through his work with the comparison microscope (which is still the basic laboratory tool of the contemporary firearm examiner.) *Id.* Albert Osborn (1858-1946) authored the standard text, QUESTIONED DOCUMENTS, which established the discipline of examining questioned documents. *Id.* Hans Gross (1847-1915) was the author of CRIMINAL INVESTIGATION, the first book to systematically analyze the many applications of the natural sciences to criminal investigation. Considered the "bible" in the area of criminal investigation for many years, the book is still quoted (although most recently by feminist legal scholars because of his dubious references to women as morally unsuitable witnesses.) *Id.* Edmond Locard (1877-1966) is famous for his theories and experiments regarding what today is referred to as "trace evidence" e.g., (fiber, glass shards, soil, metal traces on clothes and tools.) He is also renowned for the famous "Locard Principle." According to that principle, a predictable result of close contact between two people is that something is always left and something is always taken away. *Id.* Finally, August Vollmer and Paul Leland Kirk were the architects of the first major, professional crime labs in California. *Id.*

crime, aid in establishing one or more essential elements of the crime, such as intent.

How does forensic evidence differ from other evidence? Forensic science involves the application of scientific theory accompanied by laboratory techniques involving a wide variety of the natural sciences—many of which are centered in the use of the comparison microscope and other developments in the field of microscopy—to the investigation and prosecution of crime. The sciences referred to here are often designated the "*hard sciences*" as opposed to the so-called "*soft sciences*," that are centered in psychiatry or psychology and involve such techniques as criminal profiling or credibility assessments. It is important to remember that the reason for using forensic science is to generate *forensic* evidence. Its whole purpose is generate *evidence*, that is to say, the facts that can be entered into the trial court record. This careful gathering of information is to accomplish the goal of establishing a material fact or facts at or before trial, not to demonstrate the latest technological advance or the most recent forensic science methodology.[40]

Police and prosecutors can use all sorts of information as investigative tools, including experience, hunches, and informers. However the credibility of their later use of physical data recovered from a crime scene is determined by the "evidentiary" care shown towards the entire crime scene investigation process. The most important aspect of that process is the recognition, collection, and protection shown to the physical evidence before and after laboratory analysis. If the authorities do not recognize it at all, or do not collect, store and transfer it properly, it may very well be useless information.

Forensic evidence, like other evidence, is used to reconstruct the historical event that encompasses the crime being prosecuted. Given speedy trial rules and other constitutional protections, as well as the rules of evidence, such recreations are often a formidable task for prosecutors and defense counsel. Historian Carl Becker's observation on writing history applies with equal force to the investigation and prosecution of a crime:

> I ought first of all to explain what I mean when I use the term history. I mean knowledge of history. No doubt throughout all past time there actually occurred a series of events which, whether we know what it was or not, constitutes history in some ultimate sense. Nevertheless, much the greater part of these events we can know nothing about, not even that they occurred; many of them we can

40. Though individuals generate forensically based facts, primarily for use at trials, these facts are also routinely used in developing investigative leads and to provide support for search warrants and charging instruments.

> know only imperfectly; and even the few events that we think we know for sure we can never be absolutely certain of, since we can never revive them, never observe or test them directly. The event itself once occurred, but as an actual event it has disappeared; so that in dealing with it the only objective reality we can observe or test is some material trace which the event has left.[41]

Any trial, from the simplest area of law to the most complex, is essentially an exercise in establishing a version of history. If a case has proceeded to trial, one or more material facts are at issue and must be determined by the trier of fact. Once the jury has determined the basic facts, the court can instruct them as to the applicable law to apply to any facts found by them to have occurred. The history of Anglo-American common law trials is testimony to the great and ongoing difficulty in determining the factual basis of a case. The O. J. Simpson and JonBenet Ramsey murder cases may serve as recent modern examples of this inherent difficulty in the fact-finding function of the American justice system. Both sides to the investigation of a case have their respective versions of "what happened that day." The rules of evidence that channel the information flow in a trial, are primarily *exclusionary* rules, which determine what historical facts—or on occasion, opinions—the jury will be able to hear. In its simplest terms, evidence is legally approved information.

The search for past facts by a court or jury is a form of historical research, but with significant differences. Initially, the facts presented are presented by interested parties in an adversarial encounter, unaccompanied by the objective search allegedly utilized by academic historians. Secondly, the rules of evidence do not open the inquiry to any facts that may appear logically related to the search, but rather, hedge the presentation of facts in a context ruled by numerous areas of policy that would be of less concern to historians.

Historians do not have as strong a prejudice against hearsay, nor require the rigorous foundational requirements for admission required in common law trials. Historians have few time constraints as to when their task is completed, whereas civil and, especially criminal litigants, are under a number of time constraints such as statutes of limitations, multiple speedy trial rules, discovery deadlines, and the disfavor that long trials receive by today's judiciary. Finally, while historians have set high standards to determine the validity of historical conclusions[42] they are not formally operat-

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41. Carl Becker, *Everyman His Own Historian*, American Historical Review, (1932), reprinted in THE HISTORIAN AS DETECTIVE: ESSAYS ON EVIDENCE at 6 (Robin W. Winks ed., Harper Torchbooks 1968). *See also*, DAVID HACKETT FISCHER, HISTORIANS' FALLACIES: TOWARD A LOGIC OF HISTORICAL FAULT (Harper Torchbooks 1970).

42. *See generally*, FISCHER, *supra* note 41; EDWARD HALLETT CARR, WHAT IS HISTORY (Vintage 1961); BECKER, *supra* note 41.

ing under a *beyond a reasonable doubt* or *preponderance of the evidence* standard as are lawyers in criminal and civil cases. The historian's standard is necessarily more fluid.[43]

Nonetheless, the history seeking function of common law trials suffers from the same infirmity as efforts by historians to reproduce the past event. Let us admit then that there are two histories: the actual series of events that once occurred; and the ideal series that we affirm and hold in memory. The first is absolute and unchanged-it was what it was whatever we do or say about it; the second is relative, always changing in response to the increase or refinement of knowledge. The two series correspond more or less; it is our aim to make the correspondence as exact as possible; but the actual series of events exists for us only in terms of the ideal series which we affirm and hold in memory. This is why I am forced to identify history with knowledge of history. For all practical purposes history is, for us and for the time being, what we know it to be.[44]

Arguments for either side of a version of history have always been at the center of legal disputes. The basic inference-based argument set out by the Roman orator Cicero still remains the primary method of convincing a jury to reach one version of history rather than another. This reality is of considerable importance in the discussion of contemporary concerns over the propriety of an expert witness's opinion and its foundation, and the utilization of a wide variety of forensic sciences in the criminal justice system.

Professor Becker's observation could equally apply to any factual search in litigation, not the least of which are efforts to establish scientific facts that will be determinative of the central issues in contemporary environmental, products liability, medical malpractice, and criminal prosecutions. The subject of inference, probabilistics, statistics and extrapolation-based testimony, will be discussed later in this article. Suffice it to say here, in the extensive areas of causation theory, forensic science and forensic evidence, the history question continues to be a major component in any analysis of proof of scientific fact.[45]

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43. *Id.*

44. As noted by historian Robin Winks:

> Evidence means different things to different people, of course. The historian tends to think mainly in terms of documents. A lawyer will mean something rather different by the word, as will a sociologist, or a physicist, or a geologist, or a police officer at the moment of making an arrest. For certain problems evidence must be "hard," while for others it may be "soft." Even if no acceptable or agreed-upon definitions of evidence may be given, most of us recognize intuitively what we mean when we use the word. ROBIN W. WINKS, *supra* note 41 at XV.

45. BECKER, *supra* note 41, at XXVII.

Questions Regarding Forensic Evidence

The delineation of rhetorical questions revolving around our core inquiry as to the nature and value of forensic science may help to clarify the discussion to follow:

> What facts, assumptions or surmises may be obtained from the examination of one or more physical items gathered at a crime scene? What could serve as the basis for any such assumptions or projection, or—simply guesses? What value should be assigned to any such factual estimation in a criminal justice system where life, liberty and essential justice to a victim are all in play? What does it mean to say that one or more physical items, such as hair or fiber are, or are not, *consistent* or not *dissimilar or substantially similar* with another physical specimen? What would be the basis for any such statements and what value should be allocated to them if one set of exemplars was taken from a crime scene and the others from a suspected perpetrator? What does it mean in terms of long held requirements that the elements of a crime must be proved beyond a reasonable doubt? How does circumstantial evidence fit in prosecutorial efforts designed to meet such a high bar of proof in cases partially supported by physical, forensically generated evidence?

How much does physical evidence depend for its force upon the other, more traditional observation by eyewitnesses? How much of this crime scene data comparison testimony is actually based upon scientific theory or recognized scientific methodology? What science, if any, has been traditionally associated with the analysis of crime scene data and how has that changed as we approach the edge of the twenty-first century? Is forensic analysis sound science because of the known theoretical underpinnings of its various disciplines, or because of its use of microscopy and other processes that aid its essentially observational nature? Should it make any difference if forensic crime scene testimony is simply a combination of experience and modern microscopy? What else, from a forensic scientist's standpoint is there to say about physical matter and its examination and the factual assumptions that follow?

When speaking of law and scientific matters, it is important to always recall that there are two quite distinct areas of legal practice involved. On the civil side, "science" related issues are involved primarily in the area of products liability and its sub-set of chemical based injuries often referred to as "toxic torts." There are, of course, a whole range of business-related legal issues that may involve scientific matters, from contract issues, patent-infringements, antitrust and the like. In criminal law, the science-based issues cover considerable ground, ranging from proof offerings in the areas of hair and fiber analyses, soil, glass and paint identification, and a host of

facts related to forensic pathology, toxicology, blood products, and the whole field of ballistics and tool marks. In these kinds of criminal cases, some degree of science is actually being accomplished for purposes of generating material facts, such as DNA identifications or bullet or shell casing matching. This is quite distinct from civil product liability cases centered on issues of causation, where science is not used for the immediate case, and published scientific articles, usually not precisely descriptive of the science at issue are used by way of extrapolation analyses.[46]

Forensic scientists "in white lab coats" are routinely involved in forensic evidence focused criminal prosecutions. Their work is utilized to shed light on the physical dynamics that created the crime scene and hopefully, to add significant linking information as to the identity of the perpetrator. They are rarely involved in answering the dispositive "scientific" causation issues at the center of modern products liability litigation, such as whether migrating silicone from a ruptured breast implant causes auto-immune system damage?[47]

Forensic evidence involves the efficacy of information that has been scientifically generated for a particular case, the validity of which is grounded in past experiences in similar cases as evidenced in the forensic literature. Tort cases, on the other hand, present a radically different situation. True "science" questions are rarely central issues even in the most complex of tort products liability cases. In fact, outside of a clear cause-in-fact or causal relation problem—seldom the central issue in these cases—the questions revolve primarily if not exclusively around the issue of "science as business." The bulk of products liability cases do not deal with "science," understood in the sense discussed in the world of international science, at least in any sense of how that term is understood by research scientists. More often, they focus on one of the ways a manufacturing corporation has utilized complex but practical science to develop and market products and actually designs the product or publishes materials concerning the risks involved in utilizing such products by their customers.[48]

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46. *See* KIELY, *supra* note 16, § 1, for a contemporary example.

47. *See generally* MARCIA ANGELL, M. D., SCIENCE ON TRIAL: THE CLASH OF MEDICAL EVIDENCE AND THE LAW IN THE BREAST IMPLANT CASE (1996), for discussion regarding peer review and the difficulty of determining causal relation.

48. John Horgan notes Nobel Prize-winning chemist Professor Stanley Miller's criticism of scientific papers culled from other published works where there was no hard won finding resulting from extensive laboratory work. JOHN HORGAN, THE END OF SCIENCE: FACING THE LIMITS OF KNOWLEDGE IN THE TWILIGHT OF THE SCIENTIFIC AGE 139 (Broadway Books 1997.) Professor Miller referred to such works as "paper chemistry." *Id.* In hard-fought, science-based civil cases like the breast implant and pcb cancer actions, we may borrow the idea and refer to the use of previously published articles to claim or deny causation as "paper science," though such a charge may not necessarily be made about forensic science-based testimony in criminal actions.

The historical hallmark of crime scene investigation has always been close observation and application of common sense and logic to solve the crime being observed. This was true well before the current preoccupation of the courts and legal scholars as to the precise relationship of law and science, especially in areas of tort causation in the civil law and the forensic sciences in the criminal law. In fact, the law has never been able to develop acceptable scientific methodologies, theories, and opinions. What the law has done, especially at the very end of this century, is to craft legal doctrine designed to ensure that proffered scientific explanations and opinions comport with the most credible scientific thinking about methods and conclusions offered in a civil or criminal case.

Modern post-*Daubert* criminal courts are experiencing an increasing need to comply with defense demands to delve into the scientific bases of the whole body of forensic sciences, not the least of which are the trace evidence staples of hair, fiber, soil, finger, and footwear impressions. What is being seen in these recent challenges are basic observational disciplines aided by modern microscopy, without the existence of the minimal type of comparative statistical databases available in more science-based disciplines such as DNA typing and population predictability. In a legal milieu that has praised itself for its constitutionally responsible attitude regarding the imposition of scientific incursions into the factual foundation of legal theory, the observational base of a significant amount of forensic science's contribution to the criminal law may seem alarming. However, this has always been the case. This reality does not detract from the increasingly modern scientific environment in which so much forensic work is done and its factual offerings input into modern criminal trials.[49]

FORENSIC SCIENCE AND CIRCUMSTANTIAL EVIDENCE

The next discussion will revolve around the central topic of circumstantial evidence, specifically, traditional modes of observation and examining forensic practices and probability analyses. These subjects are separate, but intimately related aspects of historical and contemporary attempts at truth seeking and truth finding in the criminal trial process. Contemporary forensic evidence conferences and forensic literature exhibit considerable enthusiasm for the power and potential of twenty-first century scientific advances, such as DNA research and developments in laser-based technology, for the investigation and solution of crimes. It is often overlooked, however, that the greater number of the traditionally employed forensic sciences are centered in close observation, aided by modern microscopy, and do not employ any additional statistics-based projections as to the po-

49. *See generally,* W. PAGE KEETON ET AL., PRODUCT LIABILITY (1999); DAVID G. OWEN ET AL., PRODUCT'S LIABILITY AND SAFETY: CASES AND MATERIALS (3rd ed. 1998); JERRY J. PHILLIPS, PRODUCT LIABILITY IN A NUTSHELL (5th ed. 1998).

tential accuracy of any laboratory "match."[50] It must be remembered that the term forensic is a very old term. It has always been cast in terms of the presentation of arguments in public forums. In fact, in the face of ongoing criticism that forensic or rhetorical arguments merely taught methods for hiding or embellishing the truth, the rejoinder, from Plato's day, has been that forensic argument is designed to "make the truth sound like the truth."[51]

An examination of American criminal cases from the earliest days disclose several interesting observations of expert assistance in establishing material facts in a criminal prosecution. Initially, it is of value to note just how few cases there are that address the issue in any significant way. Additionally, it is clear—as demonstrated by the number of science-based patent cases—that courts were generally willing to listen, even gratefully, to qualified experts. However, given the basic observational and logical base for forensic-based testimony, courts were generally more skeptical and at times, more demanding in the criminal arena.

Given the centrality and importance of the observational core of much of modern forensic science, it will be of value to examine a small selection of criminal cases from the nineteenth century that mark the traditional judicial approach to pre-microscopic offers of forensic assistance. The practical application of the principles of modern microscopy utilized in well-funded, professionally staffed and equipped public laboratories, is a creature of the second half of the twentieth century. The beginnings of the legal response to forensic claims based on studied observation, logic and common sense, are to be found in both the late eighteenth and second half of the nineteenth century. The real history of forensics in the law does not begin with impressive applications of science until the 1920s and 1930s. If the assumption that forensic science is basically and historically centered in observation and extrapolation is accurate, its history runs much deeper than currently considered.[52]

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50. *See* SAFERSTEIN, *supra* note 10 at 1-26. This observation would arguably apply to the analysis of: hair; fiber; soil; footprints; fingerprints; tire impressions; forensic anthropology; forensic archeology; entomology; limnology; and bite-mark identification techniques.

51. Specifically, "forensic" is defined as "1. Pertaining to or used in courts of law or in public debate. 2. Adapted or suited to argumentation." RANDOM HOUSE WEBSTER'S COLLEGIATE DICTIONARY (1995). It was applied in ancient times to law arguments in the Athenian democracy and was a mainstay in the English public school curriculum until the late nineteenth century. It has always been used in tandem or interchangeably with the idea of classic rhetoric. The term "forensics" is still used today in referencing secondary school programs of instruction in competition in speech, dramatic oratory, and legislative argument.

52. *See* Carol G. Thomas and Edward Kent Webb, *From Orality to Rhetoric: An Intellectual Transformation* in PERSUASION: GREEK RHETORIC IN ACTION (Ian Worthington ed., Routledge 1994).

Early Case Analyses[53]

On a day of heavy rain on June 10, 1792, in Philadelphia, Jane M'Glaughlin lost her life as the result of being pushed down a set of stairs at the entrance to her home by Margaret Biron, her landlord. According to Biron, she had refused M'Glaughlin admittance due to her intoxication and obstreperous behavior. Witnesses testified that the two had argued in the past without any blows being struck. Margaret Biron was indicted for murder and put to trial. At her hearing, Doctor Hutchinson, a medical doctor, testified that he had examined the deceased's body and found "considerable" injury to the bone on one side of the head, but that the wound was not necessarily mortal. He also testified that the deceased appeared to be intoxicated at the time of her contact with the wall. Based on his testimony and that of neighbors who recalled no previous encounters between the two other than verbal blows, the court failed to find the mental state for murder and reduced the charge to "atrocious manslaughter."[54]

This brief report of the contribution of a medical doctor's simple observations and its obvious effect upon the court's determination concerning the legal element of intent, is a very early example of the importance of the use of scientific observation as an aid to supplying material facts. Several cases selected from the late nineteenth century will be discussed next, due to their comprehensive and perceptive analysis of circumstantial evidence arising in forensic science settings.

In *People v. Smith*, decided in Ohio in 1853, the prosecuting witness, Holcomb, was shot at about 10:30p.m., while standing in the parlor of a saloon near a common glass window.[55] Since the window sash was down, in order to see an object on the outside, it was imperative to look through the glass. The shooter stood on the outside, not over a few feet from the window. To prove the shooter's identity, the only testimony was that of the victim, Holcomb. Holcomb testified that while leaning over to pick up his books from a table, he happened to look out the window and saw a man whom he identified as the defendant, within one or two feet of the window. The man he observed had his arm extended, a pistol in his hand pointing toward Holcomb, and discharged it in his direction. Holcomb claimed that due to the flash of the discharge, he distinctly saw and recognized the defendant, and that he "saw his eyes, nose, and white teeth, and that he was as certain of that as he was of anything under heaven." He further testified to being in fear of the defendant for some time.

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53. A detailed history of forensic and criminal law has yet to be written. *See* SAFERSTEIN, *supra* note 10; WILSON, A HISTORY OF FORENSIC DETECTION (1989).

54. Commonwealth v. Biron, 4 Dall. 125, 1 L.Ed. 769 (Sp. Ct. Penn. 1792).

55. People v. Smith, 2 Ohio St. 511 (1853).

The State presented several witnesses, who were not present at the shooting, to show the results of experiments and observations subsequently made at the tavern. The tests were alleged to be conducted under identical circumstances as to light, position, firing with a pistol, similar to the circumstances that existed when Holcomb was shot. This was done "for the purpose of proving by inferences, from such experiments and observations, of the light within, the darkness without, the firing of a pistol, etc., that Holcomb might or could have seen and known the defendant under these circumstances and in the manner related by him."[56]

The defendant offered to prove that the state's witnesses had attempted experiments as near as possible to those stated above at another place rather than where the crime was committed. Those tests were conducted under the same circumstances of light, distance, etc., yet the party standing inside was unable to identify the outside shooter. The state objected and argued that the witness, as an expert, was only permitted to state whether he was acquainted with the laws of light and vision, and, if so acquainted, to state his opinion as to the effect of a sudden light, like that made by the firing of a gun or pistol on one's vision. Further, the expert was asked whether sudden light would or would not aid one looking at a person or object, in darkness, in distinguishing or seeing more clearly that person or object.

The court was unanimously of the opinion that the trial court erred in rejecting the defendant's offered testimony. The court noted that the victim, Holcomb, had sworn that he distinctly recognized the prisoner by the flash made by the discharge of the pistol:

> This was a most material statement. Without it, there was no pretense of sufficient evidence to convict. Now, it was certainly lawful to disprove this statement, by showing the impossibility, or natural improbability, of its being true. This is not denied, but it is said that it could not be done by proof of experiments. If not, how could the proof be made? No one but Holcomb was looking through the window when the crime was committed. No one but he saw the pistol fired, or the person who fired it. Direct contradiction, by eyewitnesses of the transaction, was therefore impossible and would perhaps be equally impossible in a large majority of like cases. Unless, then, proof of experiments is receivable, a man is very much at the mercy of another, who swears against him, and perjury or mistake, however great, instead of incurring punishment, or being rectified, may answer to produce conviction. But it is said that the proper rebutting proof would be the opinions of 'experts,' to use the language of the bill of exceptions. Now, I apprehend, that the firing

56. *Id.* at 515-16.

> of a pistol in a man's face, at the distance of a few feet, is not quite so common an occurrence as to have raised up a class of 'experts,' whose acquaintance 'with the laws of light and vision' makes their opinion, in a case like the present, the only competent testimony, or gives to such opinions any preference over the proof of facts. It requires no scientific witness to tell a jury whether he saw the eyes, and nose, and white of the teeth, of a man who shot at him, by the flash of the pistol that he fired.[57]

The value of common sense observations by ordinary citizens was deemed the equal, if not, more profitable basis for proof of identity here:

> And proof that a number of men, of ordinary powers of vision, have tried the experiment, and found themselves unable thus to distinguish countenances—found that their vision was not thereby aided at all—is evidence entitled to as much, if not more, weight, than the opinions of scientific men can be; for the question whether a face can be thus told, is merely one of fact, and not one of science; and any man, whether learned or unlearned, after hearing the proofs, can decide with reasonable certainty upon its probability. If a man were to swear that he distinguished the color of another's eyes, at the distance of a hundred yards, could his statement be disproved only by the opinion of some one skilled in the 'laws of vision?' Or, if he should testify that, with a lever of a given length, he moved a certain weight, would it be necessary, in order to contradict him, to call a witness able to talk learnedly of the *vis inertiae* of matter and the laws of mechanical forces? Might not experiments made by unlearned men, with such an instrument, be quite satisfactory?[58]

The state had argued that the defendant's experiments were not made by looking through the same window that Holcomb had looked through. The court equally rejected that contention:

> [B]ut does that deprive them of all value? Is there such a difference, in common window-glass, that the judgment could not, in any degree, be aided by an experiment made with another pane? Suppose that scientific men had been called to give their opinions, as the court ruled was proper, would all of them have been set aside who had not experimented at that identical window? Or, suppose that particular pane had been wholly destroyed by the shot, would it follow that no experiments could be made at all?[59]

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57. *Id.* at 517.
58. *Id.* at 517-18.
59. *Id.* at 518.

In *People v. Deacons*, decided by the New York Court of Appeals in 1888, the defendant, an itinerant tramp, was accused of the murder of a Mrs. Stone.[60] The finding of her dead body conclusively proved the corpus delecti with the unambiguous evidence of a murder having been committed. The defendant confessed in a rambling and contradictory nature, claiming that he struck her in anger and panicked, trying to hide the comatose body in the victim's basement.[61]

The court moved to the single error it felt was worth discussing, a blood spot identification introduced to support the deliberate nature of defendant's actions. Witnesses Raines and Atwood had identified certain spots which they had observed and characterized as blood at the top and bottom of the entrance to the victim's cellar. Raines testified that within three days of the killing he discovered a spot of blood on the surface of the trap door of the deceased's home. He proceeded to cut it out, gave it to Mr. Atwood, and that Mr. Atwood then examined the spots on the cellar bottom. Mr. Atwood opined that these spots were indeed blood. He testified that he inspected them under a microscope, and after comparing the spots with blood from his own finger, concluded that their appearances were similar. The defendant objected to the testimony as being a non-scientific offer, and accordingly inadmissible. The court dismissed that contention, ruling that there was an important distinction between testimony that what was observed was blood as opposed to human blood:

> He thus stated simply facts, giving no opinion, and expressly admitted that he could not determine whether the spots were human blood. Mr. Atwood described himself as engaged in the business of fire insurance, but as having done a little in chemistry, and something more in microscopy. He examined the splinter under the microscope, and swears that he ascertained the stain upon it to be blood. He swears to this not as an opinion, but a fact directly founded upon his own observation. In each instance the evidence was objected to as incompetent, and the objection is defended here upon the ground that the witnesses were not experts. It was not needed that they should be. That a spot or stain is blood may be proved by any person who has observed it, and is able from such observation to state the fact. . . . If the effort had been to distinguish between human blood and that of some animal the question would have been one of science, and have required the application of very great skill and knowledge. No such effort was made.[62]

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60. People v. Deacons, 16 N.E. 676 (1888).
61. *Id.* at 678.
62. *Id.* at 379, 382. *See also* Greenfield v. People, 85 N.Y. 82; People v. Gonzalez, 35 N.Y. 61. The *Gonzalez* court stated:

In *People v. Justus*, the defendant was accused of murdering his father, by shooting him at close range while the father sat on the family's front porch. The defendant testified that the gun's discharge was accidental, occurring as a result of his having tripped in the process of putting the gun away.[63] The defendant stated that he was about six feet from the door when the gun went off, which he felt was about the same distance to where his father was sitting in the chair when the gun discharged. At the coroner's jury, the defendant testified that he took the gun at the suggestion of his father and went out and shot a squirrel the dogs had treed.[64]

The defendant objected to the testimony of State witnesses that was based on simulated experiments with cardboard cutouts. Those witnesses concluded that the father was shot at a closer range than testified to by the defendant, indicating a purposeful shooting. James Birdseye, at the request of the corner and in the presence of the coroner's jury, performed several "experiments" with the defendant's gun, by firing it at targets made out of pasteboard at different distances. During the testimony of the coroner, the state showed him the three pasteboard targets, which he identified. The coroner then testified that he saw the defendant's gun tested at different distances and that the distances were marked respectively on the targets. He also testified that he saw the gun loaded when the experiments were made, that the loads of powder were a charger full, and that the charger was the one on the pouch used by the defendant. Witness James Birdseye testified that he had loaded the gun and used the powder-flask which the defendant said he used to load the gun. He stated that he filled the charger full each time and that the distances on the targets were all accurate.[65]

The court recognized that the purpose of the tests were to rebut the defense of accidental killing by showing that the statements of the defendant, upon which this defense was based, were inconsistent with the inferences

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> Stains of blood, found upon the person or clothing of the party accused, have always been recognized among the ordinary indicia of homicide. The practice of identifying them by circumstantial evidence, and by the inspection of witnesses and jurors, has the sanction of immemorial usage in all criminal tribunals. Proof of the character and appearance of the stains by those who saw them has always been regarded by the courts as primary and legitimate evidence. It is in its nature original proof, and in no sense secondary in its character. The degree of force to which it is entitled may depend upon a variety of circumstances, to be considered and weighed by the jury in each particular case; but its competency is too well settled to be questioned in a court of law. Science has added new sources of primary evidence, but it has not displaced those that have previously existed. The testimony of chemist who has analyzed blood, and that of the observer who has merely recognized it, belong to the same legal grade of evidence; and though the one may be entitled to much greater weight that the other with the jury, the exclusion of either would be illegal. *Id.*

63. People v. Justus, 8 P. 337 (1883).
64. *Id.* at 339.
65. *Id.*

resulting from the target experiments which would prove to be the true circumstances of the case:

> As no one was present except the prisoner when the deceased was killed, the ruled, and that his statements were inconsistent with the theory of a "near" gunshot wound, which the prosecution claimed was the cause of the death, the object of the experiments made on the pasteboard targets which were offered in evidence was to prove by inference that the deceased came to his death by a near gunshot wound at the hands of the defendant.[66]

The court noted that the witnesses who made the experiments were not experts, and thus incapable of expressing an opinion as to whether the pattern indicated by near gunshot wounds upon the human body sufficiently corresponded in appearance with the observations resulting from their experiments to connect such results to the fact at issue. The State had argued that it was offered to show only the effect engendered by near gunshots on the pasteboard targets, stressing that the jury was undoubtedly qualified and permitted to infer that similar results would be effected by near gunshot wounds on the human body. Such inferences should be adequate to demonstrate that the gunshot wound from which the victim died was the result of a near gunshot wound, thereby establishing a murderous intent.[67]

The court challenged this assertion, expressing concern over the apparent lack of expertise in medical matters on the part of the witnesses:

> Is the evidence of such experiments admissible for the purposes claimed? Gunshot wounds belong to a branch of medical science, and often gave rise to many questions of a difficult nature, although, generally, a gunshot wound is easily distinguished. And among the questions frequently rising is, was the ball fired near the deceased or from a distance? Observation and study, however, in this department of science have noted and described with much exactness the appearance and character of gunshot wounds. In "near" wounds, as they are termed, when the muzzle is placed near the surface of the body of the deceased when fired, the characteristics of the wound is thus described: (1) A superficial bluish color of the skin from the contusion caused by the explosion. (2) Particles of charcoal and ignited powder imbedded in the skin. (3) Slight burning. (4) Coagulation of blood mixed with powder on the lips of the wound. If the muzzle is placed in direct contact when exploded, the wound is large and circular, the skin denuded, blackened, and

66. *Id.*

67. *Id.* at 339. Forensics serves to establish the necessary *mens rea*, or mental states, along with all other essential elements of the crime being prosecuted.

> burned, and the point at which the ball entered is livid and depressed.[68]

Continuing, the court observed:

> Now, it must be manifest that there are here noted so many marked characteristics of near gunshot wounds which could by no possibility be reproduced, or represented by experiments upon pasteboard, yet upon which the fact of a near wound is made to depend, and often to be determined, that it would be utterly unsafe to apply the inferences sought to be deduced from such experiments to the fact in dispute, unless there can be found in such experiments, and the subject-matter which it is their object to explain or illustrate, some point of similitude or ground of common resemblance, always present, as a result induced by a similarity of conditions or circumstances. It may be suggested that some identity of resemblance may be traced in the powder burns exhibited by the experiments as the result of near shots, and in the wounds of the deceased, which the medical authorities indicate are usually if not always present in "near" wounds. But when, as here, the case is not susceptible of direct proof, and the fact in issue—whether the ball was fired near or from a distance—depends of necessity for a correct determination upon the appearance of the wound, the fact, and its experienced consequences, does not belong to the ordinary information of men, but lies within the limits of a particular branch of medical science, and requires to be proved by persons skilled in it, the better to enable the jury to reach a safe conclusion.[69]

"It would seem questionable," the court continued, "to allow non-professional witnesses to prove, through the instrumentality of experiments, matters not within the scope of their personal observation and experience."[70] In addition, considering the extent to which other aspects of near wounds aided in determining the facts surrounding the near wounds, such as wadding characteristics or the body of the victim, the courts should pause to admit such experiments unless supported by solid reasoning or sanctioned by prior cases. Hence, the results of the pasteboard experiments here were not admitted and the judgment was reversed and a new trial ordered.[71]

FORENSIC SCIENCE AND FORENSIC EVIDENCE.

One cannot separate, for trial purposes, forensic evidence from the testimony of forensic experts. Based upon this reality, many legal issues fol-

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68. *Id.*
69. *Id.* at 339.
70. *Id.*
71. *Id.* at 340.

low, not the least of which is a minimal understanding of the rules of criminal discovery and the overarching rules of evidence themselves. Those rules control the entirety of the information flow in any trial, not just one for the prosecution of a criminal act.

Many important and dispositive issues arise from the indispensable presence of forensic experts in criminal trials: What is science? Who qualifies as an expert? Who must pay for the experts? How does criminal discovery provide for the exchange of scientific information between the prosecution and defense? The first big subject involves the question of what are the appropriate standards of "forensic" science which can support a proffer of fact that can be used to establish a material fact in a case. It cannot be overlooked that the term *forensic science* implies the use of a scientific theory or methodology to generate facts in the investigation and prosecution of a crime. The *Daubert* question is a preliminary question as to whether it is a reliable and fair way to generate a material fact, let alone a particular fact that may be used in any particular prosecution.

FORENSIC SCIENCE, PROBABILITY, AND THE LAW

The foregoing review of several selected cases from the nineteenth century are instructive as we begin the twenty-first century, especially considering the effect that inference and probability may have in our near and distant future. These two venerable concepts are the kernel and *raison d'etre* of circumstantial evidence, the engine of forensic evidence and the criminal prosecutorial process itself.

Robert Hooke, the early seventeenth century inventor of the microscope and an associate of the great experimentalist Sir Robert Boyle, along with Francis Bacon, recognized the difficulty of finding adequate systems for the testing of scientific claims and productions, especially in cases of attempts to fashion one uniform set of constructs for any such task:

> [T]he limits to which our thoughts are confined, are small in respect of the vast extent of Nature itself; some parts of it are too large to be comprehended, and some too little to be perceived, and from thence it must follow that not having a full sensation of the object, we must be very lame and imperfect in our conceptions about it, and in all the propositions which we build upon it; hence we often take the shadow of things for the substance, small appearances for good similitudes, similitudes for definitions; and even many of those, which we think to be the most solid definitions are rather expres-

sions of our misguided apprehension then of the true nature of the things themselves. . . .[72]

The danger of seeing more than there is to see in the results of experimental processes continues to be a focus of attention in countless criminal appeals involving forensic evidence. It is a concern that has been with us from the birth of modern scientific method.

Professors Steven Shaplin and Simon Schaffer in their book *Leviathan and the Air Pump* provide a fascinating study of the struggle between theorists and those who considered themselves experimentalist pioneers in the study of nature. They observe:

> The English experimentalists of the mid-seventeenth century and afterwards increasingly took the view that all that could be expected of physical knowledge was 'probability,' thus breaking down the radical distinction between 'knowledge,' and 'opinion.' Physical hypotheses were provisional and revisable; assent to them was not obligatory, as it was to mathematical demonstrations: and physical science was, to varying degrees, removed from the realm of the demonstrative. The probabilistic conception of physical knowledge was not regarded by its proponents as a regrettable retreat from more ambitious goals; it was celebrated as a wise rejection of a failed project. By the adoption of a probabilistic view of knowledge, one could attain to an approximate certainty and aim to secure legitimate assent to knowledge-claims. The quest for necessary and universal assent to physical propositions was seen as inappropriate and illegitimate. It belonged to a 'dogmatic' enterprise, and dogmatism was seen not only as a failure but as dangerous to genuine knowledge.[73]

This perceptive observation applies with equal force to contemporary discussions of the place of probability in the forensic sciences and the use of their contributions to the investigation and trial of criminal cases.

Beginning with the famous decision by the California Supreme Court in *People v. Collins* in 1968, there has been a steady stream of law review articles and symposia, arguing for or against the development of a mathematically centered system for the weighing of evidence in criminal cases.[74] These commentators also propose devising a juror-oriented Bayesian-centered system for both weighing and compounding such values into a verdict. The rapid disintegration of all such proposals into mathematical

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72. ROBERT HOOKE: MICROGRAPHIA, OR SOME PHYSIOLOGICAL DESCRIPTIONS OF MINUTE BODIES MADE BY MAGNIFYING GLASSES WITH OBSERVATIONS AND INQUIRIES THEREON at Preface, 2 (1667).

73. SHAPLIN & SHAFFER, *supra* note 35, at 24.

74. People v. Collins, 438 P.2d 33 (Cal. 1968).

symbols that would befuddle the most conscientious judge and jury has considerably diminished the attractiveness of the ideas for the practicing forensic scientists and trial lawyers. Nonetheless, there is still considerable respectable academic interest in and support for such systems of evidence evaluation.[75]

In a recent article in the Jurimetrics Journal entitled *Forerunners of Bayesianism in Early Forensic Science*, authors F. Taroni, C. Champod and P. Margot observe that in many areas of forensic science, such as those involving hair, fiber, fingerprints, tool marks, shoe prints, paint, and document examination, the Bayesian approach remains ignored or untrusted.[76] The article argues that it is time for Bayesian methods of evaluating evidence to be generalized to all transfer traces including shoeprints and fingerprints. Such a broad use of the Bayesian perspective, the authors contend, not only follows from the recent achievements of statistical argument in forensic science, but also from the history of its earlier and productive use, at the turn of the century, in a number of disparate of trace evidence cases and contexts.[77] As noted by Taroni et al:

> Scientific evidence, though used in court for centuries, did not achieve real prominence until the end of the 19th century, when new scientific techniques (such as anthropometry and fingerprinting) became increasingly common in police inquiries. Alphonse Bertillon provided solutions to the problem of identification of habitual offenders. His most famous innovation was the application of anthropometry in the context of criminal law, following the techniques employed at the time by Quetelet, Topinard, or Broca. Bertillon proposed to use somatic measurements (nine, and later twelve, measures taken with utmost precision at particularly invari-

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75. *See generally* Richard Lempert, *Some Caveats Concerning DNA As Criminal Identification Evidence: With Thanks to the Reverend Bayes*, 13 CARDOZO L. REV. 303 (1991); Ordway Hilton, *The Relationship of Mathematical Probability to the Handwriting Identification Problem*, 1 INT. J. FORENSIC DOCUMENT EXAMINERS 224 (1995); James McGivney and Robert Barsley, *A Method For Mathematically Documenting Bitemarks*, 44 J. FOR. SCI., NO.1, 45 (1999); F. Taroni and Aitken, *Probabilistic Reasoning in the Law: Assessment of Probabilities and Explanation of the Value of Trace Evidence Other Than DNA Evidence*, 38 SCI & JUST, NO.3, AT 179 (1998); JM Curran, CM Triggs, JS Buckelton, KAJ Walsh and T Hicks, *Assessing Transfer Probabilities in a Bayesian Interpretation of Forensic Glass Evidence*, 38 SCI & JUST, NO. 1 (1998); Frederick Schauer and Richard Zeckhauser, *On The Degree Of Confidence For Adverse Decisions*, 25 J. LEGAL STUD. 27 (1996) ; Richard Lempert, *The New Evidence Scholarship: Analyzing the Process of Proof*, 66 B.U. L. REV. 439 (1986); Symposium, *Decision and Inference in Litigation*, 13 CARDOZO L. REV. 253 (1991); Frederick Mosteller & Cleo Youtz, *Quantifying Probabilistic Assessments*, 5 STATISTICAL SCI. 2 (1990).;Edward J. Imwinkelried, *The Use of Evidence of an Accused's Uncharged Misconduct to Prove Mens Rea: The Doctrines Which Threaten to Engulf the Character Evidence Prohibition*, 51 OHIO ST. L.J. 575, 586-93 (1990); IAN HACKING, THE EMERGENCE OF PROBABILITY (Cambridge University Press 1975).

76. 38 JURIMETRICS J. 183 (1998). This is an excellent review of the earliest Bayesian applications of probabilities in the investigation of crime. It should be examined by anyone interested in this central problem in criminal justice and legal studies.

77. *Id.* at 188-89.

able adult body locations) as discriminating characteristics for the identification of habitual offenders.[78]

Edmond Locard was perhaps the most famous forensic scientist of the nineteenth century, renowned for his "Locard Principle," i.e., all close physical contacts result in an exchange of trace amounts of matter, typically hairs, fibers, soils, and other trace evidence of physical specimens. He taught that the physical certainty provided by scientific evidence rested upon evidential values of different orders, which were measurable and could be expressed numerically:

> Hence the expert knows and argues that he knows the truth, but only within the limits of the risks of error inherent to the technique. The expert should explicitly indicate this numbering of adverse probabilities. The expert is not the judge: he should not be influenced by facts of a moral sort. His duty is to ignore the trial. It is the judge's duty to evaluate whether or not a single negative evidence, against a sextillion of probabilities, can prevent him from acting. And finally it is the duty of the judge to decide if the evidence is in that case, proof of guilt. . . . These guidelines remain pertinent to scientists or lawyers even today, eighty years later.[79]

Taroni, Champod, and Margot indicate in their footnote materials a somewhat blase' acceptance of the reality that to date, there are no statistics available for the greatest number of forensic sciences, such as hair, fiber, soil, footprints and tire impressions etc:

> Currently, probabilities of error are not provided with most scientific evidence. While DNA evidence is necessarily accompanied by some statistics, other forensic fields, such as those involving fingerprints, shoe prints, tool marks, or document examinations, do not appear to lend themselves to a statistical approach . . . . Moreover, even if probabilities are common in biological evidence, a large span of error estimations (in laboratory errors, for example) is systematically ignored.[80]

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78. The classification of the anthropometric forms (one per individual) was based on a division of measurements into three classes (small, medium, and large). The classes were defined arbitrarily by such fixed intervals as would apportion an average set of measurements into three approximately equal divisions. In practice, data is classified according to the following procedure. When an arrested individual refused to provide his identity after an inquiry, his anthropometric measurements were taken. If a match with previously collected data could be found, taking into account the table of tolerance values established by Bertillon, the identification was completed by the examination of accompanying file photographs and physical marks—such as tattoos, scars, etc. Faced with this evidence, the suspect generally admitted his identity. Id. at 184-85.

79. *Id.* at 187.

80. *Id.* at 187, n. 13. *See also* Taroni, et al., *Statistics: A Future in Tool Marks Comparisons?*, 28 J. ASS'N FIREARMS & TOOLMARKS EXAMINERS 222 (1996); Jonathan J. Koehler et al., *The Random Match*

An editorial in SCIENCE AND JUSTICE, the leading British forensic journal, entitled, "*Does Justice Require Less Precision Than Chemistry?*,"[81] takes issue with the latest, and perhaps most successful brief for a Bayesian approach to the evaluation of criminal evidence, INTERPRETING EVIDENCE,[82] by Robertson and Vignaux. The editorial cites recent DNA rulings in England holding that the use of statistics based on Bayes theory by a jury trespassed on an area particularly within the province of the jury's traditional prerogatives. The English Appeals Court has held that the use of defense sponsored mathematical formulas for the weighing of evidence was inappropriate and might be impractical should different jurors apply different values to particular items of evidence, commenting that jurors evaluate evidence by the joint application of their individual common sense and knowledge of the world to the material before them.[83] The editorial writer, Alistair R. Brownie concludes:

> This appears to signal a fairly comprehensive rejection of the use of probability calculations in English criminal law and a dashing of the hope expressed by Robertson and Vignaux that logic, probability and inference would provide the language of which lawyers and scientists would communicate with each other . . . . Justice in the United Kingdom does not require or welcome the precision of the chemist. Or at least at present it does not encourage the amateur to dabble.[84]

The combination of logic, experience, and common sense remain the tools of judges, prosecutors, defense lawyers, and jurors, as it has since the earliest days of English and American criminal jurisprudence. The use of probability analysis in non-forensic criminal settings illustrates its ongoing validity, if not necessity, in a criminal justice system centered in the balance of conflicting bodies of circumstantial evidence. Indeed, given the historical necessity for the gathering and arguing of inferences from circumstantial evidence and the concomitant use of formal or informal probability analyses, we must always remind ourselves that our system of criminal justice resides in a world of probability. Indeed, the use of inferences is at the center of many, if not most of our fact-finding experience. As observed by the historian Robin Winks:

Probability in DNA Evidence: Irrelevant and Prejudicial?, 35 JURIMETRICS J. 201 (1995); Frederick Schauer and Richard Zeckhauser, *On The Degree Of Confidence For Adverse Decisions*, 25 J. LEGAL STUD. 27 (1996).

81. 37 SCIENCE & JUSTICE, No.2, at 73-4 (1997).

82. BERNARD ROBERTSON AND G.A. VIGNAUX, INTERPRETING EVIDENCE: EVALUATING FORENSIC EVIDENCE IN THE COURTROOM (John Wiley & Sons 1995).

83. *See* Denis Adams [1996] 2 Cr. App. R. 467.

84. 37 SCIENCE & JUSTICE, NO. 2, at 73-4 (1997).

> We all make inferences daily, and we all collect, sift, evaluate, and then act upon evidence. Our alarm clocks, the toothpaste tube without a cap, warm milk on the breakfast table, and the bus that is ten minutes late provide us with evidence from which we infer certain unforeseen actions. The historian must reconstruct events often hundreds of years in the past, on the basis of equally homely although presumably more significant data, when the full evidence will never be recoverable and, for that portion of it recovered, when it may have meanings other than we would attach to similar evidence today. Thus the historian has evolved his standards of inquiry, of thoroughness, and of judgment to provide him with a modus operandi.[85]

Given the fragility of the litigation's version of reconstructing an historical event due to the consistent absence of direct proof on central issues, how do we accept and shape our uses of probability and what does its centrality say about our theoretical insistence on proof beyond a reasonable doubt?

In the 1998 case of *Wynn v. State*, the defendant was charged with housebreaking and theft when authorities found him in possession of stolen items.[86] The State sought to introduce evidence of the defendant's prior charges for similar activity. The United States Court of Appeals for the Second Circuit held that evidence that the defendant committed housebreaking and theft other than that for which he was on trial was not admissible under the "absence of mistake" exception to the *other crimes* rule.[87] Justice Raker, dissenting, agreed with both the trial court and the Court of Special Appeals that the admission of the evidence in question was appropriate under the "absence of mistake or accident" exception to the general rule of exclusion of other crimes evidence set out in Maryland Rule 5-404(b). Wynn's possession of the goods stolen from the Quigley home, explained throughout his trial defense as the result of an innocent and unknowing purchase at a flea market, might otherwise be characterized as "unintentional," "mistaken" or even "accidental." It was for the purpose of dispelling Wynn's express claim, and its various possible characterizations, that the trial court rightfully permitted the prosecution to present evidence of Wynn's possession of goods stolen from other residences. Justice Raker analyzed the problem from the standpoint of probability analyses under the aegis of the *doctrine of chances*:

> The theory of relevance underlying the admission of the other crimes evidence in this case is perhaps better, and more intuitively,

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85. WINKS, *supra* note 41, at xvi.
86. Wynn v. State, 718 A.2d 588 (Md. 1998).
87. *Id.* at 601. *See* FED. R. EVID. 404(b).

explained by the doctrine of chances, also known as the 'doctrine of objective improbability,' a doctrine first articulated by Professor Wigmore, and now recognized generally by courts and commentators. In actuality, the trial judge recognized the doctrine, although not articulated as such. . . . The doctrine of chances is based on probabilities, and is premised on the proposition that mere coincidence is less probable as the recurrence of similar events increases.[88] Professor Wigmore articulates this doctrine as follows: The argument here is purely from the point of view of the doctrine of chances—the instinctive recognition of that logical process which eliminates the element of innocent intent by multiplying instances of the same result until it is perceived that this element cannot explain them all. Without formulating any accurate test, and without attempting by numerous instances to secure absolute certainty of inference, the mind applies this rough and instinctive process of reasoning, namely, that an unusual and abnormal element might perhaps be present in one instance, but that the oftener similar instances occur with similar results, the less likely is the abnormal element likely to be the true explanation of them.[89]

Professor Edward Imwinkelried has commented that the fortuitous coincidence becomes too abnormal, bizarre, implausible, unusual, or objectively improbable to be believed. The coincidence becomes telling evidence of *mens rea*.[90] In short, similar results do not usually occur through abnor-

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88. *Wynn* 718 A.2d at 606 (Raker, J., dissenting) citing United States v. Danzey, 594 F.2d 905, 912 (2nd Cir.1979); Gore v. United States, 441 U.S. 951 (1979); State v. Crawford, 582 N.W.2d 785, 793-95 (Mich. 1998); State v. Lough, 853 P.2d 920, 930-31 (Wash. Ct. App. 1993), *aff'd*, 847, 889 P.2d 487 (Wash. 1995); Westfield Ins. Co. v. Harris, 134 F.3d 608, 615 (4th Cir.1998)

89. Wynn 718 A.2d at 606 (Raker, J., dissenting) quoting 2 JOHN HENRY WIGMORE, EVIDENCE IN TRIALS AT COMMON LAW § 302, at 241 (Chadbourn rev. ed.1979). Professor Wigmore's famous example is worthy of repeating here:

> [I]f A while hunting with B hears the bullet from B's gun whistling past his head, he is willing to accept B's bad aim . . . as a conceivable explanation; but if shortly afterwards the same thing happens again, and if on the third occasion A receives B's bullet in his body, the immediate inference (i.e., as a probability, perhaps not as a certainty) is that B shot at A deliberately; because the chances of an inadvertent shooting on three successive similar occasions are extremely small; or (to put it another way) because inadvertence or accident is only an abnormal or occasional explanation for the discharge of a gun at a given object, and therefore the recurrence of a similar result (i.e., discharge towards the same object, A) excludes the fair possibility of such an abnormal cause and points out the cause as probably a more natural and usual one, i.e., a deliberate discharge at A. In short, similar results do not usually occur through abnormal causes; and the recurrence of a similar result . . . tends (increasingly with each instance) to negative . . . inadvertence . . . or good faith or other innocent mental state, and tends to establish (provisionally, at least, though not certainly) the presence of the normal, i.e., criminal, intent accompanying such an act; and the force of each additional instance will vary in each kind of offense according to the probability that the act could be repeated, within a limited time and under given circumstances, with an innocent intent. *Id.*

90. EDWARD J. IMWINKELRIED, UNCHARGED MISCONDUCT EVIDENCE 5:06, at 16 (1999). Professor Imwinkelried has also observed that the doctrine of chances may be used to prove the *actus reus* of a

mal causes.[91] The United States Court of Appeals for the Seventh Circuit recently characterized the basis of the doctrine in noting that *the man who wins the lottery once is envied; the one who wins it twice is investigated.*[92] In *Wynn*, as the dissent noted, the probative value of the legally permissible inference can be drawn independently of the prohibited inference. It is the objective implausibility of the occurrence, sans nefarious activity, which rebuts the claim of an innocent occurrence.[93]

The dissent in *Wynn* further observed that the doctrine of chances rests on the trial court's assessment of the improbability that someone would be innocently involved in similar activity. In determining whether "other crimes" evidence is sufficiently probative, one act alone may be sufficient. The proper focus was not necessarily quantitative; instead, the proper focus was the qualitative value of the evidence within the particular context of an individual case. Similarly, the question of how many similar events are enough depends on the complexity and relative frequency of the event rather than on the total number of occurrences. The unlikely coincidence that Wynn purchased the items at a flea market triggered the court's appropriate, albeit unspecified, application of the doctrine of chances.[94]

The standing of probability analyses in our criminal justice system is still of great concern. This is especially true in the area of forensic science and its outgrowth in the form of forensic evidence. Not the least of the probability analyses difficulties is the absence of a statistical base in most of the forensic sciences, with which to determine the chances of any proffered "match" occurring in the general population.[95]

FORENSIC SCIENCE, FORENSIC EVIDENCE AND THE MODERN CRIME SCENE

The basic methodologies of the vast majority of the forensic sciences

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crime. Edward J. Imwinkelried, *The Use of Evidence of an Accused's Uncharged Misconduct to Prove Mens Rea: The Doctrines Which Threaten to Engulf the Character Evidence Prohibition*, 51 OHIO ST. L.J. 575, 586-93 (1990). *See also* Eric D. Lansverk, Comment, *Admission of Evidence of Other Misconduct in Washington to Prove Intent or Absence of Mistake or Accident: The Logical Inconsistencies of Evidence Rule 404(b)*, 61 WASH. L. REV. 1213, 1225-26 (1986) "When the evidence reaches such a point, the recurrence of a similar unlawful act tends to negate accident, inadvertence, good faith, or other innocent mental states, and tends to establish by negative inference the presence of criminal intent." *Id.*

91. WIGMORE, *supra* note 89, at 241.

92. United States v. York, 933 F.2d 1343, 1350 (7th Cir. 1991).

93. Wynn v. State, 718 A.2d 588, 613 (Md. 1998). For other cases applying or discussing the doctrine of chances, *see* United States v. Queen, 132 F.3d 991, 996 (4th Cir.1997); United States v. Robbins, 340 F.2d 684, 688 (2nd Cir.1965); Lee v. Hodge, 882 P.2d 408, 412 (Az. 1994); People v. Erving, 73 Cal.Rptr.2d 815, 821-22 (Cal. 1998); State v. Kahey, 436 So.2d 475, 488 (La.1983); People v. VanderVliet, 508 N.W.2d 114, 128 n. 35 (Mich. 1993); State v. Sadowski, 805 P.2d 537, 542-43 (Mont. 1991); In re Estate of Brandon, 433 N.E.2d 501, 504 (N.Y. 1982); State v. Johns, 725 P.2d 312, 322-23 (Or. 1986); Morgan v. State, 692 S.W.2d 877, 881 (Tex.Crim.App.1985).

94. *Wynn*, 718 A.2d at 606 (Raker. J., dissenting).

95. *See* Frederick Schauer and Richard Zeckhauser, *On the Degree of Confidence For Adverse Decisions*, 25 J. LEGAL STUD. 27 (1996), for an interesting article quantifying levels of proof in non-criminal processes used for allocating guilt.

have received guarded acceptance in most state courts. However, many have never really been subjected to a close *Frye* or *Daubert* preliminary scrutiny. Until recently, forensic sciences such as hair and fiber analysis have simply been routinely accepted without objection.

A recent example is the Indiana Supreme Court's opinion in *McGrew v. State*, a rape case involving testimony "matching" a pubic hair found in the car where the victim was allegedly attacked and a pubic hair exemplar from the defendant.[96] Prior to releasing the state's expert hair analyst, the court directed a telling series of questions to him:

> COURT: [I]n regard to the examination. It is simply a physical, visual examination of the hair?
> ANALYST: Yes sir.
> COURT: You simply say that one hair looks like another one or it doesn't look like another one?
> ANALYST: I say it's sufficiently similar to have come from that person or it is dissimilar.
> COURT: And if you say that it . . . [is] similar to come from that person . . . that doesn't mean that it comes from that person.
> ANALYST: It just simply means that it could have come from that person.
> COURT: And you do not know the statistical percentages of how many people would have similar hair?
> ANALYST: There are no statistics. It's hard to say.[97]

Modern case reports are increasingly filled with lengthy discussions of forensic expertise.[98] Whether arising under claims of incompetence of counsel or the trial court's failure to supply indigents with adequate funding with which to hire their own experts, courts are increasingly engaging in wide ranging forensic science discussions. A striking fact about such recent cases is that in most states, before the post-*Daubert* era, the bulk of the contemporary claims of scientific inadequacy were either not raised or given short shrift by the courts. Today, prosecutors, citing years-long use by police of these sciences, now argue for their unchallenged acceptance. Defense counsel are increasingly seeking to challenge the bases for forensic science, especially in the trace evidence area. However, a present-day examination of cases seems to indicate that a serious post-*Daubert* challenge to the scientific validity of the corpus of forensic sciences may be a day late and a dollar short. A very recent discussion of this type is found in cases analyzing the *Frye* standard's general scientific acceptability or the *Dau-*

96. McGrew v. State, 682 N.E.2d 1289 (Ind. 1997).
97. *Id.* at 1291.
98. *See* Mealey's Daubert Reports available on Westlaw, Lexis and in most law school libraries. *See also* GIANELLI AND IMWINKELRIED: SCIENTIFIC EVIDENCE (2d ed. Michie 1993).

bert's relevant and reliable standards on the subject of Luminol or phenolphthalein testing as presumptive tests for the presence of blood at a crime scene.

Luminol and phenolphthalein are used as presumptive tests in the field to identify potential blood stains. However, the two tests can generate false positive reactions.[99] The tests can react to metal surfaces, cleansers containing iron-based substances, horseradish, and rust. Neither test can distinguish between animal blood and human blood, nor can they determine how long the substance has been at the scene. When a positive reaction occurs, a criminalist must do a confirmatory test in order to conclusively determine that the test sample is human blood. For these reasons, courts have been very wary of accepting the scientific validity of presumptive tests to demonstrate blood findings. However, it is important to realize that Luminol and phenolphthalein have been and continue to be routinely used by police as investigative tools and as a basis for obtaining a search warrant. There is a noticeable movement towards acceptance of these chemical tests as presumptive proof of the presence of human blood at a crime scene. Luminol analyses are often used in conjunction with blood splatter pattern analysis, central to many crime scene reconstruction efforts.[100]

This issue has been recently revisited in a 1998 Arkansas murder case. In *Ayers v. State*, a defendant was convicted of capital murder and theft of property in excess of two thousand five hundred dollars.[101] Sometime between midnight February 24, 1995, and 1:00 a.m. February 25, 1995, in the parking lot of the Whisperwood Apartments on Baseline Road in Little Rock, appellant Antonio Ayers and William Hall were involved in an argument. As the argument intensified, Ayers drew a gun and shot Hall once in the chest and once in the back as Hall tried to run away. Hall continued running from Ayers, but Ayers caught up with Hall and began kicking him and beating him, leaving Hall lying on the parking lot. Ayers then left, but returned in Hall's vehicle and drove over Hall's body. Ayers then fled the scene in Hall's vehicle, leaving Hall for dead.[102]

At trial, the State presented evidence revealing that after the appellant shot the victim he got into Hall's vehicle and drove over him. During the State's direct examination of Annette Tracy, a Little Rock Police Department crime-scene specialist, Tracy described an exhibit as a photograph of the underside of Hall's vehicle with what appeared to her to be possible

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99. *See generally* Dale L. Laux, *Effects of Luminol on the Subsequent Analysis of Bloodstains*, 36 J. FORENSIC SCI. 1512 (1991); Fred E. Gimeno, *Fill Flash Color Photography to Photograph Luminol Bloodstain Patterns*, 39 J. FORENSIC IDENTIFICATION 305 (1989).

100. *See* BEVEL & GARDNER: BLOODSTAIN PATTERN ANALYSIS (CRC PRESS, 1997); SCIENTIFIC AND LEGAL APPLICATIONS OF BLOODSTAIN PATTERN INTERPRETATION (James ed., CRC PRESS 1999).

101. Ayers v. State, 975 S.W.2d 88 (Ark. 1998).

102. *Id.* at 90.

blood on the oil pan. The State then moved to admit the photograph. The defendant objected to the admission of the exhibit, claiming that it was not relevant and was unduly prejudicial because Tracy described only "possible blood." The State responded that subsequent evidence would establish that samples collected from the underside of the car were identified as human blood of the victim's blood type. On that basis, the trial court admitted the photograph.

At trial, Scott Sherill, a forensic serologist with the State Crime Lab, testified that the substance shown in State's Exhibit 25 was indeed human blood but that he was unable to determine the blood type. The defendant relied on *Brenk v. State,* a 1993 Arkansas opinion, where the court confronted the issue of whether Luminol testing evidence should be allowed in light of the fact that Luminol does not distinguish between certain metals, vegetable matter, human blood, or animal blood.[103] The *Brenk* court held that evidence concerning the use of Luminol would not be admissible unless additional tests showed that the substance tested was human blood related to the alleged crime. *Brenk* clearly did not apply to the facts of the instant case because Luminol was not used and because serological testing showed that the substance found underneath Hall's car was, in fact, human blood.[104]

In the instant case, the State having presented unchallenged evidence that appellant drove over Hall in Hall's vehicle after shooting him, the court found that the State proved that Hall had, in fact, been underneath the car where the blood was found at a time when he was bleeding profusely from newly inflicted gunshot wounds. This, the court found, presented very convincing circumstantial evidence connecting the blood found underneath the victim's vehicle with this crime.[105]

In *State v. Canaan,* involving presumptive tests for the presence of blood, the defendant was convicted of premeditated murder, aggravated robbery, and aggravated burglary.[106] Sometime in the morning hours of October 20, 1994, Michael Kirkpatrick was murdered. The evening before, he was observed at a bar with Canaan. During the investigation, a neighbor of the deceased, Jerry Staley, informed police that the defendant had been at the victim's house the evening before and had been driving a maroon Oldsmobile. Because the victim had been with Canaan, police went to the defendant's home to ask what he knew of the homicide. The officers observed a maroon Oldsmobile at Canaan's home.

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103. Brenk v. State, 847 S.W.2d 1 (Ark. 1993).
104. *Ayers,* 975 S.W.2d at 92.
105. *Id.*
106. Canaan v. State, 964 P.2d 681 (Kan. 1998).

The Defendant was soon after injured in a crash following a high speed car crash while attempting to evade arrest. During the investigation, the police requested John Wilson of the Regional Crime Lab to conduct Luminol tests. Wilson tested Canaan's Oldsmobile and house. During the course of the investigation, John Wilson also performed a Luminol test on the Oldsmobile that Canaan was driving the night of the murder, which indicated the possible presence of blood on the left corner of the driver's seat and door panel. An additional Luminol test of Canaan's home showed the presence of bloody footprints on the front porch and step and down the main hallway into the master bedroom. The footprints turned at the edge of the bed as if someone turned and sat down on the bed. The Luminol also reacted when it was placed on a watch found in a bedroom. Further presumptive tests validated the reaction to blood on the Oldsmobile seat.[107]

Canaan then filed a motion asserting that the Luminol testing failed to meet the general acceptability requirement of *Frye*. However, the trial court found that Luminol testing had achieved widespread acceptance, was not really novel or new, and, once the State laid its foundation for use in the instant case, no *Frye* hearing was warranted.

At trial, Canaan renewed his objection to the introduction of Luminol evidence, asserting Luminol is only a presumptive test for blood. In other words, it may indicate the presence of blood, but it also reacts similarly with other materials, including common household cleansers. The district court ruled that the fact the Luminol test was a presumptive test goes only to the weight, rather than the admissibility, of the evidence. On appeal, Canaan argued the district judge should have conducted a *Frye* hearing because Kansas had never determined the reliability of Luminol evidence.[108] Additionally, Canaan argued there was no evidence that state expert, John Wilson was qualified to testify as an expert in the field of Luminol testing techniques or as to the validity and reliability of the exact techniques he used in this case.

At trial, John Wilson testified that he had been the chief chemist at the Regional Crime Lab in Kansas City since 1978, where he supervised other chemists, analyzed various categories of trace evidence—such as blood—and went to crime scenes when requested. He also taught two crime scene classes a year for local law enforcement in Kansas and Missouri to train people how to conduct a proper crime scene investigation. He had also earned a degree in biology and chemistry and had worked at the Johnson County Crime Lab two years prior to becoming the chief chemist for the

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107. *Id.* at 686.

108. It is important to realize that Canaan's observation is true for most jurisdictions and could apply equally to post-*Daubert* continuing acceptance of hair, fiber, footprint and a host of other "widely accepted" forensic sciences.

Regional Crime Lab. Additionally, he attended a number of seminars on blood analysis presented by the FBI, American Association of Forensic Science and others. His total forensic chemistry career spanned twenty-three years.[109]

Wilson started as a forensic chemist at the Kansas City, Missouri police lab in 1973. Wilson attended a number of classes and various seminars with the American Academy of Forensic Science (an association of forensic scientists). He also attended a number of seminars at the FBI academy in Quantico, Virginia, and classes on blood analysis at the University of California. Wilson further testified that he received training in Luminol testing. He completed a number of classes at the FBI academy, including a crime scene investigation course, and attended various seminars with the American Academy of Forensic Scientists and the Midwest Association of Forensic Scientists.[110] The court accepted expert Wilson's careful description of the process of presumptive blood testing using Luminol:

Wilson testified that forensic scientists have used Luminol testing for about sixty years. It has been available for approximately eighty years and scientific papers on Luminol were published in the 1920's. He testified that he had conducted Luminol testing hundreds of times and has testified as an expert witness in other criminal cases over the years regarding the results of Luminol testing. . . . Wilson explained how Luminol testing works: Luminol is a chemical that reacts with blood and undergoes a chemical reaction that gives off light (chemiluminescence). When blood and Luminol come into contact, it essentially causes a very faint blue glow that one can see in the dark. Luminol testing works by placing a Luminol reagent in very small concentrations in a sodium hydroxide water solution and then placing it in a spray mister, which creates a very fine mist. The forensic chemist makes the area as dark as possible because the actual spraying needs to occur in total darkness. The forensic chemist then begins spraying the very fine mist in the area to be searched for blood stains. If blood is present, a chemical reaction causes a blue glow. The chemiluminescence of the blood and Luminol mixture occurs if it is dark enough and there is enough blood present. Luminol testing is extremely sensitive, depending on what one is looking for and what surface is being sprayed. It is sensitive to 1:1,000,000 to 1:10,000,000 parts per million.[111]

Responding to defendant's claims concerning the reaction of Luminol to a number of common non-blood substances, Wilson testified that Luminol is actually fairly specific for blood and that there are few things other than blood that cause it to react. Forensic scientists, he continued, use it on

109. *Canaan*, 964 P.2d at 693.
110. *Id.*
111. *Id.*

a regular basis as an investigative tool to locate crime scenes that have been cleaned and are able, on occasion, to reconstruct what occurred at the crime scene. This may result in determining the sequence of events, where the blood was, perhaps how it was cleaned up, and maybe even tracks made by footprints that have blood on them. Luminol may also reveal tire tracks, shoe prints, and handprints that were made in blood. The duration of the luminescent results of a positive test before fading would vary from a few seconds to several minutes, and ideally, it would last long enough to photograph.[112]

The amount of time a test remains luminescent, the expert opined, depends upon the material the blood is on and how the spray that is being used affects it. In his years of experience, Wilson has had occasion to have positive Luminol results for footprints twenty to fifty times. There was one occasion where he was able to follow a person outdoors across a public park for over a quarter of a mile. Wilson stated that the Luminol test is generally accepted as a presumptive test for blood in the scientific community of forensic science and is recognized as reliable within the scientific community of forensic scientists.

The court in *Canaan* ruled that only when there was a doubt as to the scientific reliability of evidence must the State prove its reliability and acceptance of the science, and held that Luminol testing was universally accepted. The trial court did require the State to lay a foundation as to Wilson's qualifications to administer the test, and a review of Wilson's testimony showed he was clearly qualified to administer the Luminol tests and that the underlying science was reliable and accepted.[113]

The use of Luminol also withstood challenge in the recent case of *State v. Maynard*, where the defendant was convicted of second-degree murder and armed criminal action.[114] The Court of Appeals held that a testifying police detective was qualified as an expert witness in Luminol testing.

Wendell Maynard lived with his girlfriend, Rewa Walker, in Kansas City, Missouri. Ms. Walker spent the evening of March 10, 1993, with Lashawn Hollingshed, Mr. Maynard's cousin. According to Ms. Hollingshed, Ms. Walker called Mr. Maynard from a pay phone between 10:00 and 11:00 p.m. to tell him that she was on her way home and that she loved him. Ms. Walker's body was found over a year later. She had been murdered. Mr. Maynard was charged with first degree murder and armed criminal action.

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112. *Id.*
113. *Id.*
114. State v. Maynard, 954 S.W.2d 624 (Mo. Ct. App. 1997).

Detective Owings found blood droplets on a livingroom mirror and similar specimen scrapings on the fish tank in the living room. The detective noticed visible blood splatters on the living room walls, ceiling and door molding and noticed a large bloodstain on a carpet remnant. Detective Owings also found a steamer carpet cleaner on defendant's porch which had blood in its internal chamber; a checkered comforter with blood on it in the dining room; a table in the kitchen with blood on it; and two pieces of a gold-colored chain, a gold-colored lion pendant, and a broken gold-colored ring in the bedroom, all with blood on them.[115]

Police performed Luminol tests on the stairs leading up to the front door of defendant's apartment, the dining room carpet and the trunk of the deceased's automobile. The tests displayed a blue glowing color, which is a positive indication of blood. Frank Booth, a forensic chemist with the Regional Crime Lab, also testified that the positive tests indicated the presence of blood. Mr. Booth agreed, however, that the presence of rust, dust particles, or some cleaning agents could also cause a positive response.[116]

The police determined that the twenty-four inch blood stain on the carpet remnant was consistent with having resulted from a gunshot wound to the head. While the blood splatters found throughout the house were not consistent with gunshot wounds, they could have been caused by two persons fighting or by moving a bloody object around. The bloodstains on the stairway leading up to Mr. Maynard's apartment were likely caused by someone dragging a bloody object up or down the stairs. A large bloody object being placed in the trunk likely caused the bloodstains in the trunk of Ms. Walker's Saab. The examination of the coveralls showed that they contained blood stains on the left hip area, across the lap area, the back left shoulder and the right sleeve.[117]

The court ruled that Detective Owings was sufficiently qualified to testify as an expert about Luminol testing, since he received training at the

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115. *Id.* at 629.

116. "The police performed DNA tests on the bloodstains in the carpet, the overalls and the carpet cleaner. Utilizing a genetic profile from blood samples obtained from Ms. Walker's parents, it was determined that only 64 out of 100 million couples could have produced the kind of genetic profile found in the blood stains. Additionally, the genetic profile found in the bloodstains would occur only twice in a population of 100 million." *Id.* at 628.

117. *See Maynard*, 954 S.W.2d at 628. Ms. Walker's skeletal remains were found over one year after her disappearance. Ms. Walker's skull was covered with a pair of shorts and a striped Unitog rental work shirt bearing the name "Wendell" and the numbers "8223760004." The shirt and shorts that covered Ms. Walker's skull were wrapped with duct tape. Four projectiles were within the duct tape. Information obtained from Unitog established that Mr. Maynard had rented the shirt. Mr. Maynard admitted the shirt was his but stated that he had two to three weeks' worth of these shirts and did not realize one was missing. An examination of the skull showed multiple fractures of the left temporal and parietal areas and a gunshot wound in the left temporal region. Michael Edward Berkland, Deputy Medical Examiner from the Jackson County Medical Examiner's office, testified that Ms. Walker died from multiple gunshot wounds to the head. Mr. Berkland testified that the half liter of blood found in the apartment's carpet remnant was consistent with multiple gunshot wounds to the head. *Id.*

Regional Crime Lab from the chief chemist, John Wilson, regarding Luminol tests at crime scenes and had conducted Luminol tests on multiple occasions.[118]

The extensive amount of recoverable physical *datumuin* at modern crime scenes and the concomitant complexity of ensuing investigation and prosecution becomes apparent each year. Defense counsel continue to raise an increased number and variety of challenges to the claims of modern forensic science. Recent cases in a wide range of crimes, but especially in homicide and sexual assault charges, may serve as indicators of the complexity of modern crime scenes and the extensive knowledge of forensic matters with which lawyers are charged with knowing.[119] A single crime scene can involve multiple aspects of forensic science and concomitant legal issues.

FORENSIC SCIENCE AND THE CRIMINAL LAW: A CASE STUDY

This article will conclude with a case study arising out of the rape-murder of a ten year-old child in a rural Illinois community. The purpose of this exercise is to demonstrate the complexity from a forensic science and forensic evidence standpoint of the modern crime scene. This is especially the case in instances of sexual assault and homicide.

In *People v. Sutherland*, the defendant was convicted of aggravated kidnapping, aggravated criminal sexual assault, and murder.[120] An oil field worker discovered the nude body of ten year-old Amy Schultz. Her clothes—shirt, shorts, underpants, shoes, and socks—were found strewn

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118. *Id.* at 633. *See also* State v. Stenson, 940 P.2d 1239, 1264 (Wash. 1997), where defendant was convicted of the first-degree premeditated murder of his wife and his business partner. The pants the Defendant was wearing at the time of the murders were an important piece of evidence. There were stains on the right leg and smaller stains on the left leg of the pants. The forensic scientist whose specialty was crime scene reconstruction and the interpretation of bloodstain patterns visually identified the stains as blood. The stains all reacted positively upon application of phenolphthalein (phenol), which is a catalytic color test that is a presumptive test for blood. The court accepted the reliability of Luminol as a presumptive test for the presence of human blood. The appeals court ruled that the trial court correctly admitted the results of the phenol testing, which were supported by the forensic scientist's testimony that the stains on the pants looked like blood by visual inspection and under a microscope. So long as a jury is clearly told that the phenol test is only a presumptive test and may indicate a substance other than human blood, it is admissible. *But see* State v. Fukusaku, 946 P.2d 32 (Hawi'i 1997), where the trial court excluded expert testimony on the Luminol and phenolphthalein test results, ruling that, because of the limitations of the tests, the presumption of the presence of blood was relevant only to the extent that it could be supported by confirmatory tests. Moreover, the trial court ruled that, without confirmatory tests, the prejudicial effect of the evidence was not outweighed by its probative value. Inasmuch as confirmatory tests were not conducted, the trial court excluded the evidence.

119. Ballistics experts are now asserting that supportable comparisons may be made between lead in a bullet taken from a shooting victim and the lead contained in unspent bullets found in the defendant's possession.

120. People v. Sutherland, 610 N.E.2d 1 (Ill. 1993). The defendant in this case is currently on death row awaiting the results of further appeals in this case. In February of 2000, Governor Ryan of Illinois imposed a moratorium on all executions, based in part, upon the recent release of eleven death row inmates due to post-trial DNA results.

along the oil lease road. Due to the lack of any eyewitnesses, the trial was centered in the presentation of forensic evidence in the areas of forensic pathology, hair and fiber analysis, and tire tread casting impression comparisons. The *Sutherland* case study will serve as a clear example of the ongoing inter-relationship between the world of forensic science and the investigation and proof of crime.

Significant questions about justice are at the heart of this and all other similar prosecutions. Let's return to some critical questions set forth earlier in this article. What facts or assumptions or surmises may be obtained from the examination of one or more hairs or fibers gathered at a crime scene? What could serve as the basis for any such assumptions or projections, or—simply guesses? What value should be assigned to any such factual estimations in our criminal justice system where life and liberty and justice to a victim are all in play? What does it mean to say that one or more hairs or fibers or tire tracks are or are not *consistent or not dissimilar or substantially similar* with another? What would be the basis for any such statements and what value should be allocated to them if one set of exemplars was taken from a crime scene and the others from a suspected perpetrator?

What does it mean in terms of long held requirements that the elements of a crime must be proven beyond a reasonable doubt? How does forensically generated circumstantial fact fit in prosecutorial efforts designed to meet such a high bar of proof in cases partially supported by hair or fiber evidence? How much does hair, fiber, or tire tread evidence depend for its force upon other more traditional observation by eyewitnesses? How much of all of this in the area of hair or fiber analysis and comparison testimony has to do with scientific theory or recognized scientific methodology? What science, if any, has been traditionally associated with hair, fiber or tire tread analyses and how has that changed as we approach the edge of the twenty-first century? Is hair, fiber or tire tread comparisons *scientific* as respects the theoretical underpinnings of those who are devoted to its functioning in a criminal investigation and trial or because of its use of microscopy, business or other processes that aid its essentially observational nature? Should it make any difference if they are simply a combination of experience and modern microscopy? What else, from a forensic scientist's standpoint is there to say about hair, fiber or tire tread analyses and the factual assumptions that follow. Is there more there to give hair, fiber, or tire tread analysis as great or greater claim to belief than fingerprint, impression, ballistics, tool marks, or DNA?[121]

In the "trace areas" of hair, fiber, soil, paint and glass, the predictive capabilities will vary widely, with something less, or much less, than indi-

121. *See supra* note 10.

vidual identification of a sample exemplar with crime scene data. So, for each separate discipline discussed henceforth, we need to ask what this science *can say* and what it *cannot say*. What are the basic methodologies used in this field in its practitioner's efforts to bring forth "identifying" evidence? How many accepted modes are there to compare hair, fiber, tire casts, soil samples, DNA, bullets and shell casings etc.? How have the courts responded to these various techniques and their exclusionary or inclusionary claims? It is also very important to note the definitive *exclusionary* capability of these "trace" sciences. The trick here is trying to figure out how strong is the *inclusion*.

What can be determined with a fairly high confidence level regarding hair analysis? Hair is class evidence and thus it is not possible, except in rare instances, to determine that a questioned hair sample came from a particular individual to the exclusion of others. However, as long as a match is not claimed, and there is good class comparisons made, particular transactional facts can pretty much cinch it in the eyes of a jury. The science makes very strong claims in the area of *class characteristic* statements such as that the examined exemplar is hair, and is human versus animal hair, male versus female hair, infant versus mature adult hair, Caucasian, Negroid or Asiatic hair, whether the hair was forcibly removed, the body area as source, and an increasing number of other general conclusions.

However, in respect to linking a hair from a crime scene to a hair exemplar obtained from a suspect, the terms allowed by courts to support the "identification" of a crime scene hair with a sample taken from a defendant are much more verbally circumspect. The typical terminology encompasses such conclusory terms as *compatible with*, *consistent with*, *not dissimilar*, *substantially similar*, and *consistent in all respects*.

What can a simple fiber tell us from a class characteristic standpoint? To what degree should police and defense counsel be concerned with weather, temperature, terrain, wildlife and other non-fiber elements and influences invariably present in many crime scene scenarios? What are possible fiber sources in each crime scene? What are the class characteristics of fiber datum? What are the comparison points in attempts to connect fibers found at the crime scene to fibers associated with the defendant in the case at hand? What is there to compare in fiber analyses?[122] Initially, it is important to identify the broadest categories of fibers and then work down to the fiber characteristics actually used in making fiber comparisons and accompanying pronouncements by forensic specialists.

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122. An initial determination has to be made that the crime scene datum is indeed fiber as opposed to hair or other substances. *See supra* note 10. *See also* Harold Deadman, *Fiber Evidence and the Wayne Williams Case*, FBI LAW ENFORCEMENT BULLETIN, (March, May 1984).

Fibers fall into two categories, natural and manmade. Both types are used in the manufacture of commercial products of a wide variety, ranging from all types of apparel, automobile seat covers and home, office, toys and automobile coverings. All commercial offerings typically provide an immense variety of styles and colors to choose from. To a significant degree, all of such fiber and the commercial processes used to produce the fiber itself and its applications, are patented and collected in massive proprietary databases maintained by manufacturers. While not generally available to police authorities or the public at large, these database collections are typically available to forensic experts on a cooperative, case by case basis by the international fiber industry.

Fibers come in three basic packages, animal, vegetable, and mineral. Natural fibers thus include animal fibers such as wool, silk and furs; vegetable fibers include cotton, linen, jute, hemp, and sisal. Mineral fibers include asbestos, glass, and fiber wool. The number of synthetic fibers is legion, including acetates, acrylics, nylons, polyester, spandex and a host of others. These are the type of fibers that can be located at a crime scene and subsequently identified as to type and commercial application, if needed.[123]

Tire treads are also quite varied in design and easily traced to a manufacturer, dependant, however on the quality of the casting and photographic technique used to preserve the tread impression at the crime scene. The comparison of tread impressions is a commonly used tool in crime scene investigations.[124]

Given this brief background on the types of forensic issues involved in the *Sutherland* case, we will now proceed to a close examination of the case study.

The Facts

At 9 a.m. on July 2, 1987, an oil field worker discovered the nude body of 10-year-old Amy Schultz of Kell, Illinois. The body was found approximately one hundred feet from an oil lease access road in rural Jefferson County, face down and covered with dirt. There were shoeprints on her back and several hairs were found stuck in her rectal area. In addition, a large open wound on the right side of Amy's neck exposed her spinal cord area. A pool of blood around Amy's head indicated that the murderer had killed her where she lay.[125]

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123. *Id.*

124. *See* SAFERSTEIN *supra* note 10, at ch. 15.

125. *Sutherland*, 610 N.E.2d at 5. Amy had last been seen alive at approximately 9:10 in the evening of July 1, 1987, walking alone on Jefferson Street near 4th Street in the town of Kell, Illinois, in Marion County. Tina Sutherland, the defendant's sister-in-law, testified that on the evening of July 1, 1987, the

Amy Schultz's shirt, shorts, underpants, shoes and socks were found scattered along the oil lease road. Seventeen feet from the body, automobile tire impressions were found and near the tire impressions, a shoeprint impression similar in design to that on the body was found. The police took casts of the tire and shoeprint impressions.[126]

Dr. Steven Neurenberger performed an autopsy on July 3, 1987, wherein he observed a fourteen point five centimeter wound running from the middle of Amy's throat to behind her right ear lobe. The incision cut through the neck muscles, severing the carotid artery and jugular vein, and cut into the cartilage between the neck and vertebrae. Amy's right eye was hemorrhaged and there was a small abrasion near her left eyebrow; her ear was torn off; the skin at the base of the ear and both her lips were lacerated from being compressed against the underlying teeth; there were also linear abrasions to the outer lips of the vagina which demonstrated that force had been applied to the back, forcing the vagina against the ground.

The pathologist's search for internal injuries found three hemorrhages inside the skull, a fractured rib, a torn liver, and tearing of the rectal mucosa. Amy's vocal cords were hemorrhaged and her esophagus was bruised. Dr. Neurenberger deduced from these injuries that the killer had *strangled Amy to unconsciousness or death, anally penetrated her, slit her throat, and stepped on her body to force exsanguination.* Dr. Neurenberger placed the time of death between 9:30 and 11 p.m. on July 1, 1987, based on the contents of her stomach.[127]

The Prosecution's Forensic Evidence: Hairs and Fibers

Several months after the discovery of Amy's body, the police at Glacier National Park in Montana notified Illinois authorities about Sutherland's abandoned car, a 1977 Plymouth Fury. At the time of the murder, Sutherland had been living in Dix, Illinois, in Jefferson County, on the county line between Dix and Kell. Illinois police authorities ascertained that defendant's car had a Cooper "Falls Persuader" tire on the right front wheel. Deputies and David Brundage, a criminalist, then traveled to Mon-

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defendant was visiting his brother and her at their home in Texico, Illinois, in Jefferson County. She further testified that he often visited since he was living with his mother in Dix, Illinois, a short five minutes away. On the night of Amy's murder, she testified that the defendant left her home at approximately 8 to 8:30. She also testified that the ride from her house to Kell took six to seven minutes. A Deputy Sheriff testified that the distance from Kell to the crime scene was 12.1 miles and took 14 minutes to drive. *Id.*

126. *Id.* at 3. At the time of defendant's indictment in connection with Amy Schulz's death, he was serving a 15-year sentence in a federal prison after pleading guilty to shooting at employees of the National Park Service at Glacier National Park, in Montana. Prior to the trial, the defense filed a motion-in-limine to exclude from evidence knives found in his possession at the time of his arrest in Glacier National Park. The trial court denied the motion, ruling that the knives had "some slight probative value" and would not substantially prejudice the defendant by their introduction. *Id.* at 9.

127. *Id.* at 3-4.

tana where they made an ink impression of the right front wheel of Sutherland's car. Illinois State Police forensic scientist David Brundage evaluated the plaster casts of the tire print impressions made at the scene of the crime and testified that the tire impressions left at the scene were *consistent in all class characteristics* with only two models of tires manufactured in North America: the Cooper "Falls Persuader" and the Cooper "Dean Polaris."[128] After comparing the plaster casts of the tire impression at the scene with the inked impression of the tire from Sutherland's car, Brundage concluded that *the tire impression at the scene corresponded with Sutherland's tire and could have been made by that tire.* Brundage, however, was unable to exclude all other tires as having made the impressions due to the lack of comparative individual characteristics, such as nicks, cuts, or gouges.[129]

Mark Thomas, the manager of mold operations at the Cooper Tire Company, determined "mal" wear similarity, and hence Sutherland's tire *could have made the impression found at the crime scene.* Thomas also compared blueprints of Cooper tires with the plaster casts of the tire impressions and determined that the *"probability"* was *"pretty great"* that a size P2175/B15 tire—the same size as Sutherland's "Falls Persuader" tire—had made the impression preserved in the casts. He admitted that there were a great number of such tires on the roads of America.[130]

Criminalist Kenneth Knight compared the two pubic hairs recovered from Amy Schulz's rectal area with Sutherland's pubic hair. He also made comparisons with pubic hairs from members of Amy's family as well as pubic hairs from twenty-four prior offenders concluding that the pubic hairs found on Amy did not originate from her family or the twenty-four suspects, but *"could have originated"* from Sutherland.

Knight also examined thirty-four dog hairs found on Amy's clothing and concluded that the dog hairs *were consistent with and could have originated from* Sutherland's black Labrador, Babe. Knight also testified that the dog hairs on Amy's clothes were *dissimilar* from her family's three dogs, her grandparents' dog, and the dogs of three neighbor families. Tina Sutherland, Sutherland's sister-in-law, testified that Sutherland usually carried Babe in his car, making it virtually impossible to be in the car without getting covered with dog hair. Multiple dog hairs found in Sutherland's car were found to be consistent with the hairs from Babe.[131]

Knight further examined Amy's clothing for foreign fibers, finding a total of twenty-nine gold fibers in her socks, shoes, underwear, shorts, and

128. *Id.*
129. *Id.*
130. *Id.* at 4.
131. *Id.* at 4-5.

shirt. Knight testified that all but one of the gold fibers found on Amy's clothes *"could have originated"* from defendant's auto carpet, but could not exclude all other auto carpets as possible sources. He also testified that that the one remaining gold fiber found on Amy's clothes *could have originated* from defendant's car upholstery.

Knight also examined and compared twelve cotton and four polyester fibers found on the front passenger side floor of Sutherland's automobile with cotton and polyester fibers from Amy's shirt, concluding that the fibers from the car displayed the same size, shape, and color of the fibers from the shirt and thus *could have originated from the shirt.* He also compared three polyester fibers found on the front passenger seat and floor with fibers from Amy's shorts and found theme consistent in diameter, color, shape, and optical properties and opined that the fibers from the car *could have originated from the shorts.*[132]

The forensic defense expert Richard Bibbing, agreed with the State's expert's conclusions on all the comparison evidence except as to the cotton fibers found in defendant's car. He did not agree that the cotton fibers were consistent, due to what he determined were differences in size and color.[133]

The Court's Analysis: The Hairs and Fibers

Sutherland argued that the prosecution's circumstantial hair, fiber, and tire print comparison evidence was insufficient to prove guilt beyond a reasonable doubt, contending that the probative value of the State's forensic evidence lay merely in establishing that the defendant could not be excluded as the possible offender, not that he must be found by a jury to actually be the offender.[134] The court ruled that the evidence, when viewed in the light most favorable to the prosecution, established that the defendant was proved guilty beyond a reasonable doubt. The *overwhelming and overlapping nature of the circumstantial evidence* supported the jury finding that Sutherland kidnapped, sexually assaulted, and murdered ten year-old Amy Schulz.[135]

The court also rejected the defendant's claim that the prosecutor had overstepped the bounds in arguing that the forensic testimony here had established a series of fiber "matches" when the actual testimony was couched in terms of consistency. The State argued in its closing that:

> [I]n every single case the fibers found on Amy's socks, shoes, and underpants, shorts, and shirt were consistent with the fibers from

132. *Id.* at 5.
133. *Id.*
134. *Id.* at 8.
135. *Id.*

> the defendant's car carpeting and dissimilar to all the carpets in her home environment and in her grandparents' house and the vehicles that they drive and in the business where her father works, so there can be no doubt that she got them from there. They came from one place. Those fibers on her clothing came from the defendant's car.
>
> [T]he red shorts are a very big part of this case... Mr. Bibbing [defense expert witness] didn't examine the shorts at all, and we know from Ken Knight's testimony that fibers from the shorts were found in the passenger side of the car.
>
> [T]his evidence doesn't stand alone. It can be considered together with the carpet fibers on her clothing, the seat fabric fiber on her shirt, the dog hair all over her clothes, the foam rubber on her clothing, the defendant's tire impressions being the same as that found near Amy, and the clothing fibers from Amy's shirt and shorts which were deposited in the front passenger side area of the car. . . .
>
> [Y]ou know, with regard to the evidence in the car that Amy was in there, you know what's uncontradicted in this case? The evidence that the red polyester fibers from her shorts were found in the passenger side area of the defendant's car. That is fibers just like them,—uncontradicted because the defense expert didn't look at them[136].

Sutherland argued that these alleged misstatements constituted reversible error, citing the important case of *People v. Linscott,* decided in 1991.[137] In *Linscott*, the State's evidence established that hairs found in the victim's apartment were *consistent with* the defendant's hairs. Comparable to *Sutherland*, the State's expert in *Linscott* could not conclusively identify the hairs as originating from the defendant. Despite the expert witness's testimony to such effect, the prosecutor argued to the jury that the rug in the area where Karen was laying was ripped out sometime later, rolled up and shipped to the laboratory. And that another group of hairs were obtained, the head hairs of Steven Linscott.[138] The *Linscott* court found such overreaching to be reversible error.

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136. *Id.* at 10-11.

137. People v. Linscott, 566 N.E.2d 1355 (Ill. 1991). *See also* People v. Giangrand, 428 N.E.2d 503 (Ill. 1981).

138. *Linscott,*566 N.E.2d at 1359. The prosecutor also distorted the mathematical probability regarding the hair-comparison evidence. Despite the lack of a solid foundation, the prosecutor argued that the odds of another individual having hair with the same characteristics as defendant's hair were about 1 in 3 million. *Id.*

In the *Sutherland* case the court was also of the opinion that the prosecutor's overstatement of the fiber-comparison evidence was improper. Prosecutorial misconduct in closing argument, the court ruled, warranted reversal and a new trial, however, only if the improper remarks resulted in substantial prejudice to the defendant. In other words, the comments must have constituted a material factor in the conviction, circumstances the court found absent in Sutherland's case:

> We do not find that the remarks in this case substantially prejudiced the defendant. Unlike *Linscott* the evidence in this case was not closely balanced. The State presented an overwhelming volume of circumstantial evidence: the tire print found by the crime scene was consistent with defendant's car's tire; the dog hair on the victim's clothing was consistent in all respects to the defendant's dog's hair and the dog hair found in his car; the foreign fibers found on the victim's clothing were consistent with the carpeting and upholstery in defendant's car; the clothing fibers found in the defendant's car were consistent with the fibers in the victim's clothing; finally, the pubic hair found on the victim were consistent with the pubic hair standards obtained from the defendant. Given the amount of evidence, it is implausible to think that the prosecutor's remarks could have been a material factor in the conviction. In this case, the jury would not have reached a different result, even if the prosecutor had not made the remarks.(citations omitted)[sic] Accordingly, defendant was not denied a fair trial and we will not disturb the conviction.[139]

In a spirited dissent, Justice Clark took aim at the whole question of the weight to be given the large number of *consistent with* forensic testimony in the trial, in light of the requirement of a finding of guilt beyond a reasonable doubt:

> In my opinion, the sum total of all of this circumstantial evidence leads one to the less than convincing belief that it "could have been" the defendant who committed this brutal crime. Nearly half of the proffered circumstantial evidence has holes in it. With regard to the tire impression evidence, Mark Thomas did not state that the "probability" was "pretty great" that it was defendant's right front tire that made the impression near the crime scene but, rather, that the "probability" was "pretty great" that the same size tire as the defendant's made the impression. This is a distinction with a great deal of difference. Equally important is Thomas' concession that there were a significant number of such tires on the road. . . . In

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139. *Sutherland*, 610 N.E.2d at 12.

terms of the twelve cotton fibers found in the defendant's car which the State's expert, Kenneth Knight, stated could have originated from the victim's shirt, the defense expert Richard Brisbing noticed differences in the size and color of these cotton fibers. Thus, like the tire impression evidence, this evidence is not as convincing as the majority finds. . . Consequently, because the circumstantial evidence suggesting that the defendant committed this crime was far from overwhelming, and because two prejudicial errors occurred which denied the defendant a fair trial, I would reverse defendant's convictions and remand for a new trial.[140]

CONCLUSION

The *Sutherland* case study set out above serves as an example of all of the points discussed in this article, which has attempted to provide an overview of the field of forensic evidence. A great deal remains to be said about the court's response to forensic testimony admitted in a host of discrete areas such as blood splatter analysis, DNA, forensic anthropology, odontology, entomology and fingerprint analysis. The new century will bring rapid and amazing new developments in this vital area of criminal law and science. It is more important than ever before for lawyers and courts to increase efforts to both understand and responsibly use the awesome potential of the world of forensic science in our criminal justice system. It is not the absolute truth of the theory being utilized that is the essential goal of the use of forensic science in the trial of crimes, but rather the basic rightness and common sense nature of the case facts generated with any such theory. Theories come and go. The criminal justice system's need to fairly and responsibly search for facts continues into the twenty-first century. As noted by author John Horgan, in his insightful study of end of the century science:

> Science's success stems in large part from its conservatism, its insistence on high standards of effectiveness. Quatum mechanics and general relativity were as new, as surprising, as anyone could ask for. But they were believed ultimately not because they imparted an intellectual thrill, but because they were effective: they accurately predicted the outcome of experiments. Old theories are old for a good reason. They are robust, flexible. They have an uncanny correspondence to reality. They may even be true.[141]

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140. *Id.*

141. JOHN HORGAN, THE END OF SCIENCE: FAILING THE LIMITS OF KNOWLEDGE IN THE TWILIGHT OF THE SCIENTIFIC AGE 136 (1997).