Physical Evidence

Key Terms

class characteristics

comparison

identification

individual characteristics

product rule

reconstruction

Learning Objectives

After studying this chapter you should be able to:

- Review the common types of physical evidence encountered at crime scenes
- Explain the difference between the identification and comparison of physical evidence
- Define and contrast individual and class characteristics of physical evidence
- Appreciate the value of class evidence as it relates to a criminal investigation
- List and explain the function of national databases available to forensic scientists
- Explain the purpose physical evidence plays in reconstructing the events surrounding the commission of a crime

The Green River Killer

This case takes its name from the Green River, which flows through Washington State and

empties into Puget Sound in Seattle. In 1982, within six months the bodies of five females were discovered in or near the river. The majority of the victims were known prostitutes who were strangled and apparently raped. As police focused their attention on an area known as Sea-Tac Strip, a haven for prostitutes, girls mysteriously disappeared with increasing frequency. By the end of 1986, the body count in the Seattle region rose to forty, all of whom were believed to have been murdered by the Green River Killer. As the investigation pressed on into 1987, the police renewed their interest in one suspect, Gary Ridgway, a local truck painter. Ridgway had been known to frequent the Sea-Tac Strip. Interestingly, in 1984 Ridgway had actually passed a lie detector test. Now with a search warrant in hand, police searched the Ridgway residence and also obtained hair and saliva samples from Ridgway. Again, insufficient evidence caused Ridgway to be released from custody. With the exception of one killing in 1998, the murder spree stopped in 1990, and the case remained dormant for nearly ten years. But the advent of DNA testing brought renewed vigor to the investigation. In 2001, semen samples collected from three early victims of the Green River Killer were compared to Ridgway's saliva that had been collected in 1987. The DNA profiles matched and the police had their man. An added forensic link to Ridgway was made by the location of minute amounts of spray paint on the clothing of six victims that compared to paints collected from Ridgway's workplace. Ridgway avoided the death penalty by confessing to the murders of forty-eight women.

It would be impossible to list all the objects that could conceivably be of importance to a crime; every crime scene obviously has to be treated on an individual basis, having its own peculiar history, circumstances, and problems. It is practical, however, to list items whose scientific examination is likely to yield significant results in ascertaining the nature and cir-

cumstances of a crime. The investigator who is thoroughly familiar with the recognition, collection, and analysis of these items, as well as with laboratory procedures and capabilities, can make logical decisions when the uncommon and unexpected are encountered at the crime scene. Just as important, a qualified evidence collector cannot rely on collection procedures memorized from a pamphlet but must be able to make innovative, on-the-spot decisions at the crime scene.

COMMON TYPES OF PHYSICAL EVIDENCE

1. ***Blood, semen, and saliva.*** All suspected blood, semen, or saliva—liquid or dried, animal or human—present in a form to suggest a relation to the offense or people involved in a crime. This category includes blood or semen dried onto fabrics or other objects, as well as cigarette butts that may contain saliva residues. These substances are subjected to serological and biochemical analysis to determine identity and possible origin.

2. ***Documents.*** Any handwriting and typewriting submitted so that authenticity or source can be determined. Related items include paper, ink, indented writings, obliterations, and burned or charred documents.

3. ***Drugs.*** Any substance seized in violation of laws regulating the sale, manufacture, distribution, and use of drugs.

4. ***Explosives.*** Any device containing an explosive charge, as well as all objects removed from the scene of an explosion that are suspected to contain the residues of an explosive.

5. ***Fibers.*** Any natural or synthetic fiber whose transfer may be useful in establishing a relationship between objects and/or people.

6. ***Fingerprints.*** All prints of this nature, latent and visible.
7. ***Firearms and ammunition.*** Any firearm, as well as discharged or intact ammunition, suspected of being involved in a criminal offense.
8. ***Glass.*** Any glass particle or fragment that may have been transferred to a person or object involved in a crime. Windowpanes containing holes made by a bullet or other projectile are included in this category.
9. ***Hair.*** Any animal or human hair present that could link a person with a crime.
10. ***Impressions.*** Tire markings, shoe prints, depressions in soft soils, and all other forms of tracks. Glove and other fabric impressions, as well as bite marks in skin or foodstuffs, are also included.
11. ***Organs and physiological fluids.*** Body organs and fluids are submitted for toxicology to detect possible existence of drugs and poisons. This category includes blood to be analyzed for the presence of alcohol and other drugs.
12. ***Paint.*** Any paint, liquid or dried, that may have been transferred from the surface of one object to another during the commission of a crime. A common example is the transfer of paint from one vehicle to another during an automobile collision.
13. ***Petroleum products.*** Any petroleum product removed from a suspect or recovered from a crime scene. The most common examples are gasoline residues removed from the scene of an arson, or grease and oil stains whose presence may suggest involvement in a crime.
14. ***Plastic bags.*** A disposable polyethylene bag such as a garbage bag may be evidential in a homicide or drug case. Examinations are conducted to associate a bag with a similar bag in

the possession of a suspect.

15. ***Plastic, rubber, and other polymers.*** Remnants of these manufactured materials recovered at crime scenes may be linked to objects recovered in the possession of a suspect perpetrator.

16. ***Powder residues.*** Any item suspected of containing firearm discharge residues.

17. ***Serial numbers.*** This category includes all stolen property submitted to the laboratory for the restoration of erased identification numbers.

18. ***Soil and minerals.*** All items containing soil or minerals that could link a person or object to a particular location. Common examples are soil imbedded in shoes and safe insulation found on garments.

19. ***Tool marks.*** This category includes any object suspected of containing the impression of another object that served as a tool in a crime. For example, a screwdriver or crowbar could produce tool marks by being impressed into or scraped along a surface of a wall.

20. ***Vehicle lights.*** Examination of vehicle headlights and taillights is normally conducted to determine whether a light was on or off at the time of impact.

21. ***Wood and other vegetative matter.*** Any fragments of wood, sawdust, shavings, or vegetative matter discovered on clothing, shoes, or tools that could link a person or object to a crime location.

THE SIGNIFICANCE OF PHYSICAL EVIDENCE

The examination of physical evidence by a forensic scientist is usually undertaken for identification or comparison.

Identification

Identification has as its purpose the determination of the physical or chemical identity of a substance with as near absolute certainty as existing analytical techniques will permit. For example, the crime laboratory is frequently asked to identify the chemical composition of an illicit-drug preparation that may contain heroin, cocaine, barbiturates, and so on. It may be asked to identify gasoline in residues recovered from the debris of a fire, or it may have to identify the nature of explosive residues—for example, dynamite or TNT. Also, the identification of blood, semen, hair, or wood would, as a matter of routine, include a determination for species origin. For example, did an evidential bloodstain originate from a human as opposed to a dog or cat? Each of these requests requires the analysis and ultimate identification of a specific physical or chemical substance to the exclusion of all other possible substances.

The process of identification first requires the adoption of testing procedures that give characteristic results for specific standard materials. Once these test results have been established, they may be permanently recorded and used repeatedly to prove the identity of suspect materials. For example, to ascertain that a particular suspect powder is heroin, the test results on the powder must be identical to those that have been previously obtained from a known heroin sample. Second, identification requires that the number and type of tests needed to identify a substance be sufficient to exclude all other substances. This means that the examiner must devise a specific analytical scheme that will eliminate all but one substance from consideration. Hence, if the examiner concludes that a white powder contains heroin, the test results must have been comprehensive enough to have excluded all other drugs—or, for that matter, all other substances—from consideration.

Simple rules cannot be devised for defining what constitutes a thorough and foolproof analytical scheme. Each type of evidence obviously requires different tests, and each test has a different degree of specificity. Thus, one substance could conceivably be identified by one test, whereas another may require a combination of five or six different tests to arrive at an identification. In a science in which the practitioner has little or no control over the quality and quantity of the specimens received, a standard series of tests cannot encompass all possible problems and pitfalls. So the forensic scientist must determine at what point the analysis can be concluded and the criteria for positive identification satisfied; for this, he or she must rely on knowledge gained through education and experience. Ultimately, the conclusion will have to be substantiated beyond any reasonable doubt in a court of law.

Comparison

A comparison analysis subjects a suspect specimen and a standard/ reference specimen to the same tests and examinations for the ultimate purpose of determining whether they have a common origin. For example, the forensic scientist may place a suspect at a particular location by noting the similarities of a hair found at the crime scene to hairs removed from a suspect's head. Or a paint chip found on a hit-and-run victim's garment may be compared with paint removed from a vehicle suspected of being involved in the incident. The forensic comparison is actually a two-step procedure. First, combinations of select properties are chosen from the suspect and the standard/reference specimen for comparison. The question of which and how many properties are selected obviously depends on the type of materials being examined. (This subject will receive a good deal of discussion in forthcoming chapters.) The overriding consideration must be the ultimate evidential value of the conclusion. This brings us to the second objective. Once the examination has been completed, the forensic scientist must draw a conclusion about the origins of the specimens. Do they or do they not come from the same source? Certainly if one or more of the properties selected for comparison do not agree, the analyst will not hesitate to conclude that the specimens are not the same and hence could not have originated from the same source. Suppose, on the other hand, that all the properties do compare and the specimens, as far as the examiner can determine, are indistinguishable. Does it logically follow that they come from the same source? Not necessarily so.

To comprehend the evidential value of a comparison, one must appreciate the role that probability has in ascertaining the origins of two or more specimens. Simply defined, *probability* is the frequency of occurrence of an event. If a coin is flipped one hundred times, in theory we can expect heads to come up fifty times. Hence, the probability of the event (heads) occurring is 50 in 100. In other words, probability defines the odds at which a certain event will occur.

Individual Characteristics. Evidence that can be associated with a common source with an extremely high degree of probability is said to possess **individual characteristics**. Examples of this are the ridge characteristics of fingerprints, random striation markings on bullets or tool marks, irregular and random wear patterns in tire or footwear impressions, handwriting characteristics, irregular edges of broken objects that can be fitted together like a jigsaw puzzle (see Figure 3–1), or sequentially made plastic bags that can be matched by striation marks running across the bags (see Figure 3–2). In all of these cases, it is not possible to state with mathematical exactness the probability that specimens are of common origin; it can only be concluded that this probability is so high as to defy mathematical calculations or human comprehension. Furthermore, the conclusion of common origin must be substantiated by the practical experience of the examiner. For example, the French scientist Victor Balthazard has mathematically determined that the probability of two individuals having the same fingerprints is one out of 1×10^{60}, or 1 followed by sixty zeros. This probability is so small as to exclude the possibility of any two individuals having the same fingerprints. This contention is also supported by the experience of fingerprint examiners who, after classifying millions of prints over the past hundred years, have never found any two to be exactly alike.

Class Characteristics. One disappointment awaiting the investigator unfamiliar with the limitations of forensic science is the frequent inability of the laboratory to relate physical evidence to a common origin with a high degree of certainty. Evidence is said to possess **class characteristics** when it can be associated only with a group and never with a single source. Here again, probability is a determining factor. For example, if we compare two one-layer automobile paint chips of a similar color, their chance of originating from the same car is not nearly as great as when we compare two paint chips having seven similar layers of paint, not all of which were part of the car's original color. The former will have class characteristics and could only be associated at best with one car model (which may number in the thousands), whereas the latter may be judged to have individual characteristics and to have a high probability of originating from one specific car.

Blood offers another good example of evidence that can have class characteristics. For example, suppose that two blood specimens are compared and both are found to be of human origin, type A. The frequency of occurrence in the population of type A blood is 26 percent—hardly offering a basis for establishing the common origin of the stains. However, if other blood factors are also determined and are found to compare, the probability that the two blood samples originated from a common source increases. Thus, if one uses a series of blood factors that occur independently of each other, one can apply the **product rule** to calculate the overall frequency of occurrence of the blood in a population.

For example, in the O. J. Simpson case, a bloodstain located at the crime scene was found to contain a number of factors that compared to O.J.'s blood:

Blood Factors	Frequency
A	26%
EsD	85%
PGM 2+2–	2%

The product of all the frequencies shown in the table determines the probability that any one individual possesses such a combination of blood factors. In this instance, applying the product rule, 0.25 × 0.85 × 0.02 equals 0.0044. or 0.44 percent, or 1 in 200 people who would be expected to have this particular combination of blood factors. These bloodstain factors did not match either of the two victims, Nicole Brown Simpson or Ronald Goldman, thus eliminating them as possible sources of the blood. Although the forensic scientist has still not individualized the bloodstains to one person—in this case, O. J. Simpson—data have been provided that will permit investigators and the courts to better assess the evidential value of the crime-scene stain. As we will learn in Chapter 13, the product rule is used to determine the frequency of occurrence of DNA profiles typically determined from blood and other biological materials. Importantly, modern DNA technology provides enough factors to allow an analyst to individualize blood, semen, and other biological materials to a single person.

One of the current weaknesses of forensic science is the inability of the examiner to assign exact or even approximate probability values to the comparison of most class physical evidence. For example, what is the probability that a nylon fiber originated from a particular sweater, or that a hair came from a particular person’s head, or that a paint chip came from a car suspected to have been involved in a hit-and-run accident? Very few statistical data are available from which to derive this information, and in a society that is increasingly dependent on massproduced products, the gathering of such data is becoming an increasingly elusive goal. One of the primary endeavors of forensic scientists must be to create and update statistical databases for evaluating the significance of class physical evidence. Of course, when such information—for example, the population frequency of blood factors—is available, it is used; but for the most part, the forensic scientist must rely on personal experience when called on to interpret the significance of class physical evidence.

People who are unfamiliar with the realities of modern criminalistics are often disappointed to learn that most items of physical evidence retrieved at crime scenes cannot be linked definitively to a single person or object. Although investigators always try to uncover physical evidence with individual characteristics—such as fingerprints, tool marks, and bullets—the chances of finding class physical evidence are far greater. To deny or belittle the value of such evidence is to reject the potential role that criminalistics can play in a criminal investigation. In practice, criminal cases are fashioned for the courtroom around a collection of diverse elements, each pointing to the guilt or involvement of a party in a criminal act. Often, most of the evidence gathered is subjective in nature, prone to human error and bias. The believability of eyewitness accounts, confessions, and informant testimony can all be disputed, maligned, and subjected to severe attack and skepticism in the courtroom. Under these circumstances, errors in human judgment are often magnified to detract from the credibility of the witness.

The value of class physical evidence lies in its ability to corroborate events with data in a manner that is, as nearly as possible, free of human error and bias. It is the thread that binds together other investigative findings that are more dependent on human judgments and, therefore, more prone to human failings. The fact that scientists have not yet learned to individualize many kinds of physical evidence means that criminal investigators should not abdicate or falter in their pursuit of all investigative leads. However, the ability of scientists to achieve a high degree of success in evaluating class physical evidence means that criminal investigators can pursue their work with a much greater chance of success.

Admittedly, in most situations, trying to define the significance of an item of class evidence in exact mathematical terms is a difficult if not impossible goal. While class evidence is by its very nature not unique, our common experience tells us that meaningful items of physical evidence, such as those listed on pages 70–71, are extremely diverse in our environment. Select, for example, a colored fiber from an article of clothing and try to locate the exact same color on the clothing of random individuals you meet, or select a car color and try to match it to other automobiles you see on local streets. Furthermore, keep in mind that a forensic comparison actually goes beyond a mere color comparison and involves examining and comparing a variety of chemical and/or physical properties. The point is that the chances are low of encountering two indistinguishable items of physical evidence at a crime scene that actually originated from different sources. Obviously, given these circumstances, only those objects that exhibit a significant amount of diversity in our environment are deemed appropriate for classification as physical evidence.

In the same way, when one is dealing with more than one type of class evidence, their collective presence may lead to an extremely high certainty that they originated from the same source. As the number of different objects linking an individual to a crime increases, the probability of involvement increases dramatically. A classic example of this situation can be found in the evidence presented at the trial of Wayne Williams (see the case reading at the end of this chapter). Wayne Williams was charged with the murders of two individuals in the Atlanta, Georgia, metropolitan area; he was also linked to the murders of ten other boys or young men. An essential element of the state's case involved the association of Williams with the victims through a variety of fiber evidence. Actually, twenty-eight different types of fibers linked Williams to the murder victims, evidence that the forensic examiner characterized as "overwhelming."

In further evaluating the contribution of physical evidence, one cannot overlook one important reality in the courtroom: The weight or significance accorded physical evidence is a determination left entirely to the trier of fact, usually a jury of laypeople. Given the high esteem in which scientists are generally held by society and the infallible image created for forensic science by books and television, it is not hard to understand why scientifically evaluated evidence often takes on an aura of special reliability and trustworthiness in the courtroom. Often physical evidence, whether individual or class, is accorded great weight during jury deliberations and becomes a primary factor in reinforcing or overcoming lingering doubts about guilt or innocence. In fact, a number of jurists have already cautioned against giving carte blanche approval to admitting scientific testimony without first giving due consideration to its relevancy in a case. Given the potential weight of scientific evidence, failure to take proper safeguards may unfairly prejudice a case against the accused.

Physical evidence may also exclude or exonerate a person from suspicion. For instance, if type A blood is linked to the suspect, all individuals who have type B, AB, or O blood can be eliminated from consideration. Because it is not possible to assess at the crime scene what value, if any, the scientist will find in the evidence collected, or what significance such findings will ultimately have to a jury, it is imperative that a thorough collection and scientific evaluation of physical evidence become a routine part of all criminal investigations.

Just when an item of physical evidence crosses the line that distinguishes class from individual is a difficult question to answer and is often the source of heated debate and honest disagreement among forensic scientists. How many striations are necessary to individualize a mark to a single tool and no other? How many color layers individualize a paint chip to a single car? How many ridge characteristics individualize a fingerprint, and how many handwriting characteristics tie a person to a signature? These questions defy simple answers. The task of the forensic scientist is to find as many characteristics as possible to compare one substance with another. The significance attached to the findings is decided by the quality and composition of the evidence, the case history, and the examiner's experience. Ultimately, the conclusion can range from mere speculation to near certainty.

There are practical limits to the properties and characteristics the forensic scientist can select for comparison. Carried to the extreme, no two things in this world are alike in every detail. Modern analytical techniques have become so sophisticated and sensitive that the criminalist must be careful to define the limits of natural variation among materials when interpreting the data gathered from a comparative analysis. For example, we will learn in the next chapter that two properties, density and refractive index, are best suited for comparing two pieces of glass. But the latest techniques that have been developed to measure these properties are so sensitive that they can even distinguish glass originating from a single pane of glass. Certainly this goes beyond the desires of a criminalist trying to determine only whether two glass particles originated from the same window. Similarly, if the surface of a paint chip is magnified 1,600 times with a powerful scanning electron microscope, it is apparent that the fine details that are revealed could not be duplicated in any other paint chip. Under these circumstances, no two paint chips, even those coming from the same surface, could ever compare in the true sense of the word. Therefore, practicality dictates that such examinations be conducted at a less revealing, but more meaningful, magnification (see Figure 3–3).

Distinguishing evidential variations from natural variations is not always an easy task. Learning how to use the microscope and all the other modern instruments in a crime laboratory properly is one thing; gaining the proficiency needed to interpret the observations and data is another. As new crime laboratories are created and others expand to meet the requirements of the law enforcement community, many individuals are starting new careers in forensic science. They must be cautioned that merely reading relevant textbooks and journals is no substitute for experience in this most practical of sciences.

FORENSIC DATABASES

In a criminal investigation, the ultimate contribution a criminalist can make is to link a suspect to a crime through comparative analyses. This comparison defines the unique role of the criminalist in a criminal investigation. Of course, a one-on-one comparison requires a suspect. Little or nothing of evidential value can be accomplished if crime-scene investigators acquire fingerprints, hairs, fibers, paint, blood, and semen without the ability to link these items to a suspect. In this respect, computer technology has dramatically altered the role of the crime laboratory in the investigative process. No longer is the crime laboratory a passive bystander waiting for investigators to uncover clues about who may have committed a crime. Today, the crime laboratory is on the forefront of the investigation seeking to identify perpetrators. This dramatic reversal of the role of forensic science in criminal investigation has come about through the creation of computerized databases that not only link all fifty states, but tie together police agencies throughout the world.

The premier model of all forensic database systems is the *Integrated Automated Fingerprint Identification System* (IAFIS), a national fingerprint and criminal history system maintained by the FBI. IAFIS first became operational in 1999. IAFIS contains fingerprints and access to corresponding criminal history information for nearly 50 million subjects (or 500 million fingerprint images), which are submitted voluntarily to the FBI by state, local, and federal law enforcement agencies. In the United States each state has its own *Automated Fingerprint Identification System* (AFIS), which is linked to the FBI's IAFIS. A crime-scene fingerprint or latent fingerprint is a dramatic find for the criminal investigator. Once the quality of the print has been deemed suitable for the IAFIS search, the latent-print examiner creates a digital image of the print with either a digital camera or a scanner. Next, the examiner, with the aid of a coder, marks points on the print to guide the computerized search. The print is then electronically submitted to IAFIS and within minutes the search is completed against all fingerprint images in IAFIS and the examiner may receive a list of potential candidates and their corresponding fingerprints for comparison and verification (see Figure 3–4).

Many countries throughout the world have created *National Automated Fingerprint Identification Systems* that are comparable to the FBI's model. For example, a computerized fingerprint database containing nearly nine million ten-print records connects the Home Office and forty-three police forces throughout England and Wales.

Forensic Brief

In 1975, police found Gerald Wallace's body on his living room couch. He had been savagely beaten, his hands bound with an electric cord. Detectives searched his ransacked house, cataloging every piece of evidence they could find. None of it led to the murderer. They had no witnesses. Sixteen years after the fact, a lone fingerprint, lifted from a cigarette pack found in Wallace's house and kept for sixteen years in the police files, was entered into the Pennsylvania

State Police AFIS database. Within minutes, it hit a match. That print, police say, gave investigators the identity of a man who had been at the house the night of the murder. Police talked to him. He led them to other witnesses, who led them to the man police ultimately charged with the murder of Gerald Wallace.

In 1998, the FBI's *Combined DNA Index System* (CODIS) became fully operational. CODIS enables federal, state, and local crime laboratories to electronically exchange and compare DNA profiles, thereby linking crimes to each other and to convicted offenders. All fifty states have enacted legislation to establish a data bank containing DNA profiles of individuals convicted of felony sexual offenses (and other crimes, depending on each state's statute). CODIS creates investigative leads from two indexes: the *forensic* and *offender* indexes. The forensic index currently contains about 110,000 DNA profiles from unsolved crime-scene evidence. Based on a match, police in multiple jurisdictions can identify serial crimes, allowing coordination of investigations and sharing of leads developed independently. The offender index contains the profiles of nearly three million convicted or arrested individuals. (Unfortunately, hundreds of thousands of samples are backlogged, still awaiting DNA analysis and entry into the offender index.) Law enforcement agencies search this index against DNA profiles recovered from biological evidence found at unsolved crime scenes. This approach has proven to be tremendously successful in identifying perpetrators because most crimes involving biological evidence are committed by repeat offenders.

Several countries throughout the world have initiated national DNA data banks. The United Kingdom's *National DNA Database,* established in 1995, was the world's first national database. Currently it holds about three million profiles, and DNA can be taken for entry into the database from anyone arrested for an offense likely to involve a prison term. In a typical month, matches are found linking suspects to 26 murders; 57 rapes and other sexual offenses; and 3,000 motor vehicle, property, and drug crimes.

Forensic Brief

Fort Collins, Colorado, and Philadelphia, Pennsylvania, are separated by nearly 1,800 miles, but in 2001 they were tragically linked though DNA. Troy Graves left the Philadelphia area in 1999, joined the Air Force, and settled down with his wife in Colorado. A frenzied string of eight sexual assaults around the Colorado University campus set off a manhunt that ultimately resulted in the arrest of Graves. However, his DNA profile inextricably identified him as Philadelphia's notorious "Center City rapist." This assailant attacked four women in 1997 and brutally murdered Shannon Schieber, a Wharton School graduate student, in 1998. His last known attack in Philadelphia was the rape of an 18-year-old student in August 1999, shortly before he left the city. In 2002 Graves was returned to Philadelphia, where he was sentenced to life in prison without parole.

The *National Integrated Ballistics Information Network* (NIBIN), maintained by the Bureau of Alcohol, Tobacco, Firearms and Explosives, allows firearms analysts to acquire, digitize, and compare markings made by a firearm on bullets and cartridge casings recovered from crime scenes. The NIBIN program currently has 236 sites that are electronically joined to sixteen multistate regions. The heart of NIBIN is the *Integrated Ballistic Identification System* (IBIS), comprising a microscope and a computer unit that can capture an image of a bullet or cartridge casing. The images are then forwarded to a regional server, where they are stored and correlated against other images in the regional database. IBIS does not positively match bullets or casings fired from the same weapon; this must be done by a firearms examiner. IBIS does, however, facilitate the work of the firearms examiner by producing a short list of candidates for the examiner to manually compare. Nearly 900,000 pieces of crime scene evidence have been entered in NIBIN and more than 10,000 “hits” have been recorded, many of them yielding investigative information not obtainable by other means.

Forensic Brief

After a series of armed robberies in which suspects fired shots, the sheriff’s office of Broward County, Florida, entered the cartridge casings from the crime scenes into NIBIN. Through NIBIN, four of the armed robberies were linked to the same 40-caliber handgun. A short time later, sheriff’s deputies noticed suspicious activity around a local business. When they attempted to interview the suspects, the suspects fled in a vehicle. During the chase, the suspects attempted to dispose of a handgun; deputies recovered the gun after making the arrests. The gun was test-fired and the resulting evidence entered into NIBIN, which indicated a possible link between this handgun and the four previous armed robberies. Firearms examiners confirmed the link through examination of the original evidence. The suspects were arrested and charged with four prior armed robbery offenses.

The *International Forensic Automotive Paint Data Query* (PDQ) database contains chemical and color information pertaining to original automotive paints. This database, developed and maintained by the Forensic Laboratory Services of the Royal Canadian Mounted Police (RCMP), contains information about make, model, year, and assembly plant on more than 13,000 vehicles with a library of more than 50,000 layers of paint. Contributors to the PDQ include the RCMP and forensic laboratories in Ontario and Quebec, as well as forty U.S. forensic laboratories and police agencies in twenty-one other countries. Accredited users of PDQ are required to submit sixty new automotive paint samples per year for addition to the database. The PDQ database has found it's greatest utility in the investigation of hit-and-runs by providing police with possible make, model, and year information to aid in the search for the unknown vehicle.

The previously described databases are maintained and controlled by government agencies. There is one exception: a commercially available computer retrieval system for comparing and identifying crime-scene shoe prints known as *SICAR* (shoeprint image capture and retrieval).[1] SICAR's pattern-coding system enables an analyst to create a simple description of a shoe print by assigning codes to individual pattern features (see Figure 3–5). Shoe print images can be entered into SICAR by either a scanner or a digital camera. This product has a comprehensive shoe sole database that includes more than three hundred manufacturers of shoes with more than eight thousand different sole patterns, providing investigators with a means for linking a crime-scene footwear impression to a particular shoe manufacturer.

CRIME SCENE RECONSTRUCTION

Previous discussions of identification and comparison have stressed laboratory work routinely performed by forensic scientists. However, there is another dimension to the role of forensic scientists in a criminal investigation: working as a team to reconstruct events before, during, and after the commission of a crime. Reconstructing the circumstances of a crime scene entails a collaborative effort that includes experienced law enforcement personnel, medical examiners, and criminalists. All of the professionals contribute a unique perspective to develop the crime-scene **reconstruction**. Was more than one person involved? How was the victim killed? Were actions taken to cover up what actually took place? To answer these questions, everyone involved with the investigation must pay careful attention and apply logical thinking.

The physical evidence left behind at a crime scene plays a crucial role in reconstructing the events that took place surrounding the crime. Although the evidence alone does not describe everything that happened, it can support or contradict accounts given by witnesses and/or suspects. Information obtained from physical evidence can also generate leads and confirm the reconstruction of a crime to a jury. The collection and documentation of physical evidence is the foundation of a reconstruction. **Reconstruction supports a likely sequence of events by observing and evaluating physical evidence and statements made by witnesses and those involved with the incident.**

Law enforcement personnel must take the proper actions to enhance all aspects of the crime-scene search so as to optimize the crime-scene reconstruction. First, and most important, is securing and protecting the crime scene. Protecting the scene is a continuous endeavor from the beginning to the end of the search. Evidence that can be invaluable to reconstructing the crime can be unknowingly altered or destroyed by people trampling through the scene, rendering the evidence useless. The issue of possible contamination of evidence will certainly be attacked during the litigation process and could make the difference between a guilty and not-guilty verdict.

Before processing the crime scene for physical evidence, the investigator should make a preliminary examination of the scene as it was left by the perpetrator. Each crime scene presents its own set of circumstances. The investigator’s experience and the presence or absence of physical evidence become critical factors in reconstructing a crime. The investigator captures the nature of the scene as a whole by performing an initial walk-through of the crime scene and contemplating the events that took place. Using the physical evidence available to the naked eye, he or she can hypothesize about what occurred, where it occurred, and when it occurred. During the walk-through, the investigator's task is to document observations and formulate how the scene should ultimately be processed. As the collection of physical evidence begins, any and all observations should be recorded through photographs, sketches, and notes. By carefully collecting physical evidence and thoroughly documenting the crime scene, the investigator can begin to unravel the sequence of events that took place during the commission of the crime.

Often reconstruction requires the involvement of a medical examiner or a criminalist. The positioning of the victim in a crime scene can often reveal pertinent information for the investigation. Trained medical examiners can examine the victim at a crime scene and determine whether the body has been moved after death by evaluating the livor distribution within the body (see p. 21). For example, if livor has developed in areas other than those closest to the ground, the medical examiner can reason that the victim was probably moved after death. Likewise, the examiner can determine whether the victim was clothed subsequent to death, because livor will not develop in areas of the body that are restricted by clothing. A criminalist or trained crime-scene investigator can also bring special skills to the reconstruction of events that occurred during the commission of a crime. For example, a criminalist using a laser beam to plot the approximate bullet path in trajectory analysis can help determine the probable position of the shooter relative to that of the victim (see Figure 3–6). Other skills that a criminalist may employ during a crime-scene reconstruction analysis include blood spatter analysis (see pp. 359–364), determining the direction of impact of projectiles penetrating glass objects (see pp. 116–118), locating gunshot residues deposited on the victim's clothing for the purpose of estimating the distance of a shooter from a target (see pp. 471–474), and searching for primer residues deposited on the hands of a suspect shooter (see pp. 475–478).

Reconstruction is a team effort that involves putting together many different pieces of a puzzle (see Figure 3–7). The right connections must be made among all the parts involved so as to portray the relationship among the victim, the suspect, and the crime scene. If successful, reconstruction can play a vital role in helping a jury arrive at an appropriate verdict.

Chapter Summary

The examination of physical evidence by a forensic scientist is usually undertaken for identification or comparison purposes. The object of identification is to determine the physical or chemical identity with as near absolute certainty as existing analytical techniques will permit. Identification first requires the adoption of testing procedures that give characteristic results for specific standard materials. Once this is done, the examiner uses an appropriate number of tests to identify a substance and exclude all other substances from consideration. The identification process is normally used in crime laboratories to identify drugs, explosives, and petroleum products. Also, the identification of evidence such as blood, semen, or hair is routinely undertaken in a crime laboratory. Normally, these identifications would include a determination for species origin (such as human blood or rabbit hair).

A comparative analysis has the important role of determining whether a suspect specimen and a standard/reference specimen have a common origin. Both the standard/reference and the suspect specimen are subject to the same tests. Evidence that can be associated with a common source with an extremely high degree of probability is said to possess individual characteristics. Evidence associated only with a group is said to have class characteristics. Nevertheless, the high diversity of class evidence in our environment makes their comparison significant in the context of a criminal investigation. As the number of different objects linking an individual to a crime scene increases, so does the likelihood of that individual's involvement with the crime.

Importantly, a person may be exonerated or excluded from suspicion if physical evidence collected at a crime scene is found to be different from standard/reference samples collected from that subject.

A dramatic enhancement of the role of forensic science in criminal investigation has come about through the creation of computerized databases. The Integrated Automated Fingerprint Identification System (IAFIS), a national fingerprint and criminal history system, is maintained by the FBI. The FBI's Combined DNA Index System (CODIS) enables federal, state, and local crime laboratories to electronically exchange and compare DNA profiles, thereby linking crimes to each other and to convicted offenders. The National Integrated Ballistics Information Network (NIBIN), maintained by the Bureau of Alcohol, Tobacco, Firearms and Explosives, allows firearms analysts to acquire, digitize, and compare markings made by a firearm on bullets and cartridge casings recovered from crime scenes. The International Forensic Automotive Paint Data Query (PDQ) database contains chemical and color information pertaining to original automotive paints. SICAR (shoeprint image capture and retrieval) has a comprehensive shoe sole database.

Physical evidence left behind at a crime scene, properly handled and preserved, plays a crucial role in reconstructing the events that took place surrounding the crime. Crime-scene reconstruction relies on the combined efforts of medical examiners, criminalists, and law enforcement personnel to recover physical evidence and to sort out the events surrounding the occurrence of a crime.

Review Questions

1. The process of ___________ determines a substance's physical or chemical identity with as

near absolute certainty as existing analytical techniques will permit.

2. The number and type of tests needed to identify a substance must be sufficient to ___________ all other substances from consideration.

3. A(n) ___________ analysis subjects a suspect and a standard/reference specimen to the same tests and examination for the ultimate purpose of determining whether they have a common origin.

4. ___________ is the frequency of occurrence of an event.

5. Evidence that can be traced to a common source with an extremely high degree of probability is said to possess ___________ characteristics.

6. Evidence associated with a group and not to a single source is said to possess ___________ characteristics.

7. True or False: One of the major deficiencies of forensic science is the inability of the examiner to assign exact or approximate probability values to the comparison of most class physical evidence. ___________

8. The value of class physical evidence lies in its ability to ___________ events with data in a manner that is, as nearly as possible, free of human error and bias.

9. The ___________ accorded physical evidence during a trial is left entirely to the trier of fact.

10. True or False: Physical evidence cannot be used to exclude or exonerate a person from suspicion of committing a crime. ___________

11. True or False: The distinction between individual and class evidence is always easy to make. ___________

12. Modern analytical techniques have become so sensitive that the forensic examiner must be aware of the ___________ among materials when interpreting the significance of comparative data.

13. True or False: A fingerprint can be positively identified through the IAFIS database. ___________

14. True or False: A database applicable to DNA profiling is ___________.

15. True or False: A crime can accurately be reconstructed solely on the presence or absence of physical evidence. ___________

Further References

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Case Study

Fiber Evidence and the Wayne Williams Trial

On February 26, 1982, a Fulton County, Ga., Superior Court jury returned a verdict of "guilty as charged" on two counts of murder brought against Wayne Bertram Williams by a Fulton County grand jury in July 1981. Williams had been on trial since December 28, 1981, for the asphyxial murders of Nathaniel Cater and Jimmy Payne in April and May of 1981. During the 8-week trial, evidence linking Williams to those murders and to the murders of 10 other boys or young men was introduced.

An essential part of this case, presented by the Fulton County District Attorney's Office, involved the association of fibrous debris removed from the bodies of 12 murder victims with objects from the everyday environment of Williams.

Fiber evidence has often been an important part of criminal cases, but the Williams trial differed from other cases in several respects. Fiber evidence has not played a significant role in any case involving a large number of murder victims. The victims whose deaths were charged to Williams were 2 of 30 black children and black young men who were reported missing or who had died under suspicious circumstances in the Atlanta area over a 22-month period beginning in July 1979. During the trial, fiber evidence was used to associate Williams with 12 of those victims.

Fiber evidence is often used to corroborate other evidence in a case—it is used to support other testimony presented at a trial. This was not the situation in the Williams trial. Other evidence and other aspects of the trial were important but were used to support and complement the fiber evidence, not the usual order of things. The "hair and fiber matches" between Williams's environment and 11 of the 12 murder victims discussed at the trial were so significant that, in the author's opinion, these victims were positively linked to both the residence and automobiles that were a major part of the world of Wayne Williams.

Another difference between this case and most other cases was the extremely large amount of publicity surrounding both the investigation of the missing and murdered children and the arrest and subsequent trial of Williams. Few other murder trials have received the attention that the Williams case received.…

It is often difficult to get an accurate picture from press reports of the physical evidence introduced at a trial and the significance of that evidence. This article will also set forth in some detail the fiber evidence that linked Williams to the murder victims.

By discussing only the fiber evidence introduced at the trial, many other aspects of the case against Williams are being neglected. Additional evidence dealing with Williams's motivations—his character and behavior, his association with several of the victims by eyewitness accounts, and his link to a victim recovered from a river in Atlanta—[were] also essential to the case.…

Development of Williams as a Murder Suspect

Before Wayne Williams became a suspect in the Nathaniel Cater murder case, the Georgia State Crime Laboratory located a number of yellowish-green nylon fibers and some violet acetate fibers on the bodies and clothing of the murder victims whose bodies had been recovered during the period of July 1979 to May 1981. The names of those victims were included on the list of missing and murdered children that was compiled by the Atlanta Task Force (a large group of investigators from law enforcement agencies in the Atlanta area). The yellowish-green nylon fibers were generally similar to each other in appearance and properties and were considered to have originated from a single source. This was also true of the violet acetate fibers. Although there were many other similarities that would link these murders together, the fiber linkage was notable since the possibility existed that a source of these fibers might be located in the future.

Initially, the major concern with these yellowish-green nylon fibers was determining what type of object could have been their source. This information could provide avenues of investigative activity. The fibers were very coarse and had a lobed cross-sectional appearance, tending to indicate that they originated from a carpet or a rug. The lobed cross-sectional shape of these fibers, however, was unique, and initially, the manufacturer of these fibers could not be determined. Photomicrographs of the fibers were prepared for display to contacts within the textile industry. On one occasion, these photomicrographs were distributed among several chemists attending a meeting at the research facilities of a large fiber producer. The chemists concurred that the yellowish-green nylon fiber was very unusual in cross-sectional shape and was consistent with being a carpet fiber, but again, the manufacturer of this fiber could not be determined. Contacts with other textile producers and textile chemists likewise did not result in an identification of the manufacturer.

In February 1981, an Atlanta newspaper article publicized that several different fiber types had been found on two murder victims. Following the publication of this article, bodies recovered from rivers in the Atlanta metropolitan area were either nude or clothed only in undershorts. It appeared possible that the victims were being disposed of in this undressed state and in rivers in order to eliminate fibers from being found on their bodies.[2]

On May 22, 1981, a four-man surveillance team of personnel from the Atlanta Police Department and the Atlanta Office of the FBI was situated under and at both ends of the James Jackson Parkway Bridge over the Chattahoochee River in northwest Atlanta. Around 2 a.m., a loud splash alerted the surveillance team to the presence of an automobile being driven slowly off the bridge. The driver was stopped and identified as Wayne Bertram Williams.

Two days after Williams's presence on the bridge, the nude body of Nathaniel Cater was pulled from the Chattahoochee River, approximately 1 mile downstream from the James Jackson Parkway Bridge. A yellowish-green nylon carpet-type fiber, similar to the nylon fibers discussed above, was recovered from the head hair of Nathaniel Cater. When details of Williams's reason for being on the bridge at 2 a.m. could not be confirmed, search warrants for Williams's home and automobile were obtained and were served on the afternoon of June 3, 1981. During the late evening hours of the same day, the initial associations of fibers from Cater and other murder victims were made with a green carpet in the home of Williams. Associations with a bedspread from Williams's bed and with [Williams's] family dog were also made at that time.

An apparent source of the yellowish-green nylon fibers had been found. It now became important to completely characterize these fibers in order to verify the associations and determine the strength of the associations resulting from the fiber matches. Because of the unusual cross-sectional appearance of the nylon fiber and the difficulty in determining the manufacturer, it was believed that this was a relatively rare fiber type, and therefore, would not be present in large amounts (or in a large number of carpets).

[Williams's] Carpet

Shortly after Williams was developed as a suspect, it was determined the yellowish-green nylon fibers were manufactured by the Wellman Corporation. The next step was to ascertain, if possible, how much carpet like Williams's bedroom carpet had been sold in the Atlanta area—carpet composed of the Wellman fiber and dyed with the same dye formulation as [Williams's] carpet. Names of Wellman Corporation customers who had purchased this fiber type, technical information about the fiber, and data concerning when and how much of this fiber type had been manufactured were obtained.

It was confirmed that the Wellman Corporation had, in fact, manufactured the fiber in Williams's carpet and that no other fiber manufacturer was known to have made a fiber with a similar cross section. It was also determined that fibers having this cross-sectional shape were manufactured and sold during the years 1967 through 1974. Prior to 1967, this company manufactured only a round cross section; after 1974, the unusual trilobal cross section seen in Williams's carpet was modified to a more regular trilobal cross-sectional shape. A list of sales of that fiber type during the period 1967 through 1974 was compiled.…

Through numerous contacts with yarn spinners and carpet manufacturers, it was determined that the West Point Pepperell Corporation of Dalton, Ga., had manufactured a line of carpet called "Luxaire," which was constructed in the same manner as [Williams's] carpet. One of the colors offered in the "Luxaire" line was called "English Olive," and this color was the same as that of [Williams's] carpet (both visually and by the use of discriminating chemical and instrumental tests).

It was learned that the West Point Pepperell Corporation had manufactured the "Luxaire" line for a five-year period from December 1970 through 1975; however, it had only purchased Wellman 181B fiber for this line during 1970 and 1971. In December 1971, the West Point Pepperell Corporation changed the fiber composition of the "Luxaire" line to a different nylon fiber, one that was dissimilar to the Wellman 181B fiber in appearance. Accordingly, "Luxaire" carpet, like [Williams's] carpet, was only manufactured for a 1-year period. This change of carpet fiber after only 1 year in production was yet another factor that made [Williams's] carpet unusual.

It is interesting to speculate on the course the investigation would have taken if the James Jackson Parkway Bridge had not been covered by the surveillance team. The identification of the manufacturer of the nylon fibers showing up on the bodies could still have occurred and the same list of purchasers of the Wellman fiber could have been obtained. The same contacts with the yarn and carpet manufacturers could have been made; however, there would not have been an actual carpet sample to display. It is believed that eventually the carpet manufacturer could have been determined. With a sample of carpet supplied by West Point Pepperell—which they had retained in their files for over 10 years—it would have been possible to conduct a house-by-house search of the Atlanta area in an attempt to find a similar carpet. Whether this very difficult task would have been attempted, of course, will never be known. A search of that type, however, would have accurately answered an important question that was discussed at the trial—the question of how many other homes in the Atlanta area had a carpet like [Williams's] carpet. An estimation, to be discussed later, based on sales records provided by the West Point Pepperell Corporation indicated that there was a very low chance (1/7792) of finding a carpet like Williams's carpet by randomly selecting occupied residences in the Atlanta area.

Only the West Point Pepperell Corporation was found to have manufactured a carpet exactly like [Williams's] carpet. Even though several manufacturers had gone out of business and could not be located, it was believed that, considering the many variables that exist in the manufacture of carpet and the probable uniqueness of each carpet manufacturer's dye formulations, it would be extremely unlikely for two unrelated companies to construct a carpet or dye the carpet fibers in exactly the same way. A large number of other green fibers, visually similar in color to Williams's carpet, were examined. None was found to be consistent with fibers from [Williams's] carpet.

Probability Determinations

To convey the unusual nature of [Williams's] residential carpet, an attempt was made to develop a numerical probability—something never before done in connection with textile materials used as evidence in a criminal trial.[3] The following information was gathered from the West Point Pepperell Corporation:

1. West Point Pepperell reported purchases of Wellman 181B fiber for the “Luxaire” line during a 1-year period. The Wellman 181B fiber was used to manufacture “Luxaire” carpet from December 1970 until December 1971, at which time a new fiber type replaced that Wellman fiber.

2. In 1971, West Point Pepperell sold 5,710 square yards of English Olive “Luxaire” and “Dreamer” carpet to Region C (10 southeastern states which include Georgia). “Dreamer” was a line of carpet similar to “Luxaire” but contained a less dense pile. In order to account for the carpet manufactured during 1971, but sold after that time, all of the “Luxaire” English Olive carpet sold during 1972 to Region C (10,687 square yards) was added to the 1971 sales. Therefore, it was estimated that a total of 16,397 square yards of carpet containing the Wellman 181B fiber and dyed English Olive in color was sold by the West Point Pepperell Corporation to retailers in 10 southeastern states during 1971 and 1972. (In 1979, existing residential carpeted floor space in the United States was estimated at 6.7 billion square yards.)[4]

3. By assuming that this carpet was installed in one room, averaging 12 feet by 15 feet in size, per house, and also assuming that the total sales of carpet were divided equally among the 10 southeastern states, then approximately 82 rooms with this carpet could be found in the state of Georgia.

4. Information from the Atlanta Regional Commission showed that there were 638,995 occupied housing units in the Atlanta metropolitan area in November 1981.[5] Using this figure, the chance of randomly selecting an occupied housing unit in metropolitan Atlanta and finding a house with a room having carpet like Williams’s carpet was determined to be 1 chance in 7,792—a very low chance.

To the degree that the assumptions used in calculating the above probability number are reasonable, we can be confident in arriving at a valid probability number.…

The probability figures illustrate clearly that [Williams's] carpet is, in fact, very uncommon. To enhance the figures even further, it is important to emphasize that these figures are based on the assumption that none of the carpet of concern had been discarded during the past 11 years. In fact, carpet of this type, often used in commercial settings, such as apartment houses, would probably have had a normal life span of only 4 or 5 years.…[6]

The Williams Trial

To any experienced forensic fiber examiner, the fiber evidence linking Williams to the murder victims was overwhelming. But regardless of the apparent validity of the fiber findings, it was during the trial that its true weight would be determined. Unless it could be conveyed meaningfully to a jury, its effect would be lost. Because of this, considerable time was spent determining what should be done to convey the full significance of the fiber evidence. Juries are not usually composed of individuals with a scientific background, and therefore, it was necessary to "educate" the jury in what procedures were followed and the significance of the fiber results. In the Williams case, over 40 charts with over 350 photographs were prepared to illustrate exactly what the crime laboratory examiners had observed.…

Representatives of the textile fiber industry, including technical representatives from the Wellman and West Point Pepperell Corporations, were involved in educating the jury regarding textile fibers in general and helped lay the foundation for the conclusions of the forensic fiber examiners. The jury also was told about fiber analysis in the crime laboratory.

The trial, as it developed, can be divided into two parts. Initially, testimony was given concerning the murders of Nathaniel Cater and Jimmy Ray Payne, the two victims included in the indictment drawn against Williams in July 1981. Testimony was then given concerning Williams's association with 10 other murder victims.

The fiber matches made between fibers in Williams's environment and fibers from victims Payne and Cater were discussed. The items from Williams's environment that were linked to either or both of the victims are shown in the center of the chart. (See Figure 1.) Not only is Payne linked to Williams's environment by seven items and Cater linked by six items, but both of the victims are linked strongly to each other based on the fiber matches and circumstances surrounding their deaths.

In discussing the significance or strength of an association based on textile fibers, it was emphasized that the more uncommon the fibers, the stronger the association. None of the fiber types from the items in Williams's environment shown in the center of Figure 1 is by definition a "common" fiber type. Several of the fiber types would be termed "uncommon."

One of the fibers linking the body of Jimmy Ray Payne to the carpet in the 1970 station wagon driven by Williams was a small rayon fiber fragment recovered from Payne's shorts. Data were obtained from the station wagon's manufacturer concerning which automobile models produced prior to 1973 contained carpet made of this fiber type. These data were coupled with additional information from Georgia concerning the number of these models registered in the Atlanta metropolitan area during 1981. This allowed a calculation to be made relating to the probability of randomly selecting an automobile having carpet like that in the 1970 Chevrolet station wagon from the 2,373,512 cars registered in the Atlanta metropolitan area. This probability is 1 chance in 3,828, a very low probability representing a significant association.

Another factor to consider when assessing the significance of fiber evidence is the increased strength of the association when multiple fiber matches become the basis of the association. This is true if different fiber types from more than one object are found and each fiber type either links two people together or links an individual with a particular environment. As the number of different objects increases, the strength of an association increases dramatically. That is, the chance of randomly finding several particular fiber types in a certain location is much smaller than the chance of finding one particular fiber type.

The following example can be used to illustrate the significance of multiple fiber matches linking two items together. If one were to throw a single die one time, the chance or probability of throwing a particular number would be one chance in six. The probability of throwing a second die and getting that same number also would be one chance in six. However, the probability of getting 2 of the same numbers on 2 dice thrown simultaneously is only 1 in every 36 double throws—a much smaller chance than with either of the single throws. This number is a result of the product rule of probability theory. That is, the probability of the joint occurrence of a number of mutually independent events equals the product of the individual probabilities of each of the events (in this example—$1/6 \times 1/6 = 1/36$). Since numerous fiber types are in existence, the chance of finding one particular fiber type, other than a common type, in a specific randomly selected location is small. The chance then of finding several fiber types together in a specific location is the product of several small probabilities, resulting in an extremely small chance. . . .

However, no attempt was made to use the product rule and multiply the individual probability numbers together to get an approximation of the probability of finding carpets like Williams's residential carpet and Williams's automobile carpet in the same household. The probability numbers were used only to show that the individual fiber types involved in these associations were very uncommon.…[7]

In addition to the two probability numbers already discussed (bedroom and station wagon carpets), each of the other fiber types linking Williams to both Cater and Payne has a probability of being found in a particular location. The chance of finding all of the fiber types indicated on the chart [Figure 1] in one location (seven types on Payne's body and six types on Cater's body) would be extremely small. Although an actual probability number for those findings could not be determined, it is believed that the multiple fiber associations shown on this chart are proof that Williams is linked to the bodies of these two victims, even though each fiber match by itself does not show a positive association with Williams's environment.

Studies have been conducted in England that show that transferred fibers are usually lost rapidly as people go about their daily routine.[8] Therefore, the foreign fibers present on a person are most often from recent surroundings. The fibrous debris found on a murder victim reflects the body's more recent surroundings, especially important if the body was moved after the killing. Accordingly, the victims' bodies in this particular case are not only associated with Williams but are apparently associated with Williams shortly before or after their deaths. It was also pointed out during the trial that the locations of the fibers—on Payne's shorts and in Cater's head hairs and pubic hairs—were not those where one would expect to find fibrous debris transferred from an automobile or a house to victims who had been fully clothed.

Although from these findings it would appear that the victims were in the residence of Williams, there was one other location that contained many of the same fibers as those in the composition of various objects in his residence—Williams's station wagon. The environment of a family automobile might be expected to reflect, to some extent, fibers from objects located within the residence. This was true of the 1970 station wagon. With one exception, all of the fiber types removed from Payne and Cater, consistent with originating from items shown in the center of Figure 1, were present in debris removed by vacuuming the station wagon. The automobile would be the most logical source of the foreign fibers found on both Payne and Cater if they were associated with Williams shortly before or after their deaths. It should also be pointed out that two objects, the bedspread and the blanket, were portable and could have at one time been present inside the station wagon.

Both Payne and Cater were recovered from the Chattahoochee River. Their bodies had been in the water for several days. Some of the fibers found on these victims were like fibers in the compositions of the bedroom carpet and bedspread except for color intensity. They appeared to have been bleached. By subjecting various known fibers to small amounts of Chattahoochee River water for different periods of time, it was found that bleaching did occur. This was especially true with the carpet and bedspread fibers from Williams's bedroom.

Two crime laboratory examiners testified during the closing stages of the first part of the trial about Williams's association with Payne and Cater. They concluded that it was highly unlikely that any environment other than that present in Wayne Williams's house and car could have resulted in the combination of fibers and hairs found on the victims and that it would be virtually impossible to have matched so many fibers found on Cater and Payne to items in Williams's house and car unless the victims were in contact with or in some way associated with the environment of Wayne Williams.

After testimony was presented concerning the Payne and Cater cases, the Fulton County District Attorney's Office asked the court to be allowed to introduce evidence in the cases of 10 other victims whose murders were similar in many respects. Georgia law allows evidence of another crime to be introduced "… if some logical connection can be shown between the two from which it can be said that proof of the one tends to establish the other as relevant to some fact other than general bad character."[9] There need be no conviction for the other crime in order for details about that crime to be admissible.

It was ruled that evidence concerning other murders could be introduced in an attempt to prove a "pattern or scheme" of killing that included the two murders with which Williams was charged. The additional evidence in these cases was to be used to help the jury "… decide whether Williams had committed the two murders with which he is charged."[10]

There were similarities between these additional victims and Payne and Cater. (See Figure 2.) Although some differences can also be seen on this chart, the prosecution considered these differences to fit within the "pattern of killing" of which Payne and Cater were a part. The most important similarities between these additional victims were the fiber matches that linked 9 of the 10 victims to Williams's environment. The fiber findings discussed during the trial and used to associate Williams to the 12 victims were illustrated during the trial. (See Figure 3.)

The 12 victims were listed in chronological order based on the dates their bodies were recovered. The time period covered by this chart, approximately 22 months, is from July 1979 until May 1981. During that time period, the Williams family had access to a large number of automobiles, including a number of rental cars. Three of these automobiles are listed at the top of Figure 3. If one or more of the cars was in the possession of the Williams family at the time a victim was found to be missing, the space under that car(s) and after the particular victim's name is shaded.

Four objects (including the dog) from Williams's residence are listed horizontally across the top of Figure 3, along with objects from three of his automobiles. An "X" on the chart indicates an apparent transfer of textile fibers from the listed object to a victim. Other objects from Williams's environment which were linked to various victims by an apparent fiber transfer are listed on the right side of the chart. Fiber types from objects (never actually located) that were matched to fiber types from one or more victims are also listed either at the top or on the right side of the chart. Fourteen specific objects and five fiber types (probably from five other objects) listed on this chart are linked to one or more of the victims. More than 28 different fiber types, along with the dog hairs, were used to link up to 19 objects from Williams's environment to 1 or more of the victims. Of the more than 28 fiber types from Williams's environment, 14 of these originated from a rug or carpet.

The combination of more than 28 different fiber types would not be considered so significant if they were primarily common fiber types. In fact, there is only 1 light green cotton fiber of the 28 that might be considered common. This cotton fiber was blended with acetate fibers in Williams's bedspread. Light green cotton fibers removed from many victims were not considered or compared unless they were physically intermingled with violet acetate fibers which were consistent with originating from the bedspread. It should be noted that a combination of cotton and acetate fibers blended together in a single textile material, as in the bedspread, is in itself uncommon.…

The previous discussion concerning the significance of multiple fiber matches can be applied to the associations made in the cases of all the victims except Bell, but especially to the association of Patrick Baltazar to Williams's environment. Fibers and animal hairs consistent with having originated from 10 sources were removed from Baltazar's body. These 10 sources include the uncommon bedroom carpet and station wagon carpet. In addition to the fiber (and animal hair) linkage, two head hairs of Negroid origin were removed from Baltazar's body that were consistent with originating from the scalp area of Williams. Head hair matches were also very significant in linking Williams to Baltazar's body. In the opinion of the author, the association based upon the hair and fiber analyses is a positive association.

Another important aspect of the fiber linkage between Williams and these victims is the correspondence between the fiber findings and the time periods during which Williams had access to the three automobiles listed on the chart. Nine victims are linked to automobiles used by the Williams family. When Williams did not have access to a particular car, no fibers were recovered that were consistent with having originated from that automobile. Trunk liner fibers of the type used in the trunks of many late-model Ford Motor Company automobiles were also recovered from the bodies of two victims.

One final point should be made concerning Williams's bedroom and station wagon carpets where probability numbers had been determined. Fibers consistent with having originated from both of these "unusual" carpets were recovered from Payne's body. Of the 9 victims who were killed during the time period when Williams had access to the 1970 station wagon, fibers consistent with having originated from both the station wagon carpet and the bedroom carpet were recovered from 6 of these victims.

The apparent bleaching of several fibers removed from the bodies of Payne and Cater was consistent with having been caused by river water. Several fibers similar to those from Payne and Cater were removed from many of the victims whose bodies were recovered on land. Consistent with the bleaching argument, none of the fibers from the victims found on land showed any apparent bleaching. The finding of many of the same fiber types on the remaining victims, who were recovered from many different locations, refutes the possibility that Payne's and Cater's bodies picked up foreign fibers from the river.

The fact that many of the victims were involved with so many of the same fiber types, all of which linked the victims to Williams's environment, is the basis for arguing conclusively against these fibers originating from a source other than Williams's environment.

It is hoped that this article has provided valuable insight concerning the use of fiber evidence in a criminal trial, has provided answers to questions from those in the law enforcement community about textile fiber evidence in general, and has presented convincing arguments to establish Wayne Williams's association with the bodies of the murder victims.

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Identification

The process of determining a substance's physical or chemical identity. Drug analysis, species determination, and explosive residue analysis are typical examples of this undertaking in a forensic setting.

Comparison

The process of ascertaining whether two or more objects have a common origin.

Individual Characteristics

Properties of evidence that can be attributed to a common source with an extremely high degree of certainty.

Class Characteristics

Properties of evidence that can be associated only with a group and never with a single source.

Product Rule

Multiplying together the frequencies of independently occurring genetic markers to obtain an overall frequency of occurrence for a genetic profile.

Reconstruction

The method used to support a likely sequence of events by observing and evaluating physical evidence and statements made by those involved with the incident.

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Federal Bureau of Investigation, Washington, D.C.

Wayne Williams is shown talking to police outside his home. *Courtesy Corbis Bettmann*

Figure 3–1 The body of a woman was found with evidence of beating about the head and a stablike wound in the neck. Her husband was charged with the murder. The pathologist found a knife blade tip in the wound in the neck. The knife blade tip was compared with the broken blade of a penknife found in the trousers pocket of the accused. Note that in addition to the fit of the indentations on the edges, the scratch marks running across the blade tip correspond in detail to those on the broken blade. *Courtesy Centre of Forensic Sciences, Toronto, Canada*

Figure 3–2 The bound body of a young woman was recovered from a river. Her head was covered with a black polyethylene trash bag (shown on the right). Among the items recovered from one of several suspects was a black polyethylene trash bag (shown on the left). A side-by-side comparison of the two bags' extrusion marks and pigment bands showed them to be consecutively manufactured. This information allowed investigators to focus their at-

tention on one suspect, who ultimately was convicted of the homicide. *Courtesy George W. Neighbor, New Jersey State Police*

Figure 3–3 (a) Two-layer paint chip magnified 244 times with a scanning electron microscope. (b) The same paint chip viewed at a magnification of 1,600 times. *Courtesy Jeff Albright*

Figure 3–4 The computerized search of a fingerprint database first requires that selected ridge characteristics be designated by a coder. The positions of these ridge characteristics serve as a basis for comparing the latent print against file fingerprints. *Courtesy Sirchie Finger Print Laboratories, Inc., Youngsville, N.C., www.sirchie.com*

Latent Print File Print

Figure 3–5 The crime-scene footwear print on the right is being searched against eight thousand sole patterns to determine its make and model. *Courtesy Foster & Freeman Limited, Worcestershire, U.K., www.fosterfreeman.co.uk*

Figure 3–6 A laser beam is used to determine the search area for the position of a shooter who has fired a bullet through a window and wounded a victim. The bullet path is determined by lining up the victim's bullet wound with the bullet hole present in the glass pane.

Figure 3–7 Crime-scene reconstruction relies on the combined efforts of medical examiners, criminalists, and law enforcement personnel to recover physical evidence and to sort out the events surrounding the occurrence of a crime.

Figure 1 Items from residence and station wagon of Wayne Williams that were found on Jimmy Ray Payne and Nathaniel Cater.

Figure 2 Chart used during the trial to show similarities between Payne and Cater and 10 other murder victims.

Figure 3 Fiber findings discussed during the trial and used to associate Williams with the 12 victims.

[1] Foster & Freeman Limited, *http://www.fosterfreeman.co.uk*.

[2] Prior to the publication of the February 11, 1981, newspaper article, one victim from the task force list, who was fully clothed, had been recovered from a river in the Atlanta area. In the 2 1⁄2-month period after publication, the nude or nearly nude bodies of 7 of the 9 victims added to the task force list were recovered from rivers in the Atlanta area.

[3] J. Mitchell and D. Holland, “An Unusual Case of Identification of Transferred Fibers,” *Journal of the Forensic Science Society*, vol. 19, 1979, p. 23. This article describes a case in which carpet fibers transferred to a murder victim’s body in England were traced back to the carpet manufacturer and finally to an automobile owned by the person who eventually confessed to the murder.

[4] This information was taken from a study by E. I. du Pont de Nemours & Co. concerned with the existing residential floor space with carpet in the United States. This study was reported in a marketing survey conducted by the Marketing Corporation of America, Westport, Conn.

[5] Information regarding the number of housing units in the Atlanta metropolitan area was obtained from a report provided by the Atlanta Regional Commission. The report, dated November 11, 1981, contained population and housing counts for counties, super districts, and census tracts in the Atlanta metropolitan area.

[6] Information about carpet similar to Williams’s carpet was developed through contacts with carpet manufacturers and carpet salesmen in Georgia. It was determined that this type carpet was

often installed in commercial settings, such as apartments, and in those settings, had an average life span of 4 to 5 years.

[7] Joseph L. Peterson, ed., *Forensic Science* (New York: AMS Press, 1975), pp. 181–225. This collection of articles, dealing with various aspects of forensic science, contains five papers concerned with using statistics to interpret the meaning of physical evidence. It is a good discussion of probability theory and reviews cases where probability theory has been used in trial situations.

[8] C. A. Pounds and K. W. Smalldon, "The Transfer of Fibers between Clothing Materials During Simulated Contacts and Their Persistence During Wear," *Journal of the Forensic Science Society*, vol. 15, 1975, pp. 29–37.

[9] *Encyclopedia of Georgia Law*, vol. 11A (The Harrison Company, 1979), p. 70.

[10] *The Atlanta Constitution*, "Williams Jury Told of Other Slayings," Sec. 1-A, 1/26/82, p. 25.