7

CRIME SCENE EVIDENCE

In any crime perpetrated by an unknown offender, the primary source of information available to investigators will be the crime scene. Although portrayals of modern-day crime scene investigation focus on the physical evidence related to the commission of a crime, the crime scene is also a source of witnesses, victim information, and other potential investigative leads. Discussion of crime scene evidence in this chapter therefore reflects the view of a crime scene as a comprehensive source of investigative information that includes physical evidence, witness statements, and victim information and statements. To begin to identify relationships between crime scene evidence and characteristics of unknown offenders, this chapter discusses the concept of a crime scene, proposes the pieces of crime scene evidence believed to be important to an understanding of crimes and offenders, and discusses the potential uses of and roles for these pieces of evidence either singly or in combination with other pieces of evidence.

CRIME SCENES

The first step in any criminal investigation, whether it will become the subject of profiling or not, is to identify the crime scene. Turvey's (1999) model, which is currently the only extant profiling model to incorporate a glossary of terms, defines a *crime scene* as "a location where a criminal act has taken place" (p. 436). Turvey elaborated on this definition by discussing three types of crime scenes: primary scenes, secondary scenes, and disposal sites. A *primary scene* is "the location where the offender engaged in the majority of their [*sic*] attack or assault upon their [*sic*] victim or victims" (Turvey, 1999, p. 445). A *secondary scene* is defined as "any location where there may be evidence of criminal activity outside the primary scene" (Turvey, 1999, p. 447). A *disposal site* is described as follows: "This term is used to refer to the place where a body is found. A primary scene may be used as a disposal site, or the offender may move the body to another location" (Turvey, 1999, p. 438). Although these definitions communicate some of the basic ideas involved in understanding the parameters of crime scenes, some additional explanation is needed to tie these concepts together and make them useful for analysis.

First, it appears to be common practice, at least as indicated by the descriptions in Turvey's (1999) model and the other profiling models (Douglas, Ressler, Burgess, & Hartman, 1986; Holmes & Holmes, 1996), to classify crime scenes according to the significance of criminal acts that took place in a particular location. Unfortunately, it is not clear from the existing literature how an investigator should determine a criminal act's significance. The pitfall of defining crime scenes according to the significance or proportion of crime events that took place there is that in situations that include multiple crime scenes, it may not be clear how to measure or prioritize the criminal actions perpetrated at each crime scene. Consider the following example: An offender encounters a victim at a café and spends 2 hours conversing with her for the purpose of gaining her confidence so that he can assault her. She then agrees to walk out of the café with this offender. He takes her down a secluded alley where his car is parked, bludgeons her to death in a matter of minutes, and puts her into the trunk of his car. He then drives her body to a remote location, spends 1 hour committing postmortem acts of mutilation, steals her purse, and sets a fire to cover his activities. Which is the primary crime scene? From a legal perspective, the most serious criminal act was the murder that was committed in the alley, but that act encompassed the shortest amount of time. The largest amount of time was spent at the café, and there might be a number of witnesses there who might be able to identify the offender; however, no crime was committed at this location. The car is also a crime scene because the victim's body was transported in it, and there is likely to be evidence found in the trunk. Finally, the largest number of criminal acts were committed at the scene where the body was left, but these acts were neither the most legally serious nor the most time consuming.

It would seem that the purpose of differentiating between crime scenes is to give investigators a practical sense of where a crime was committed and what secondary or tertiary locations were involved in the perpetration of that crime. In addition, however, from the perspective of building and using a science of profiling, the purpose of understanding where a crime took place is to identify important locations from which to gather evidence and make determinations about the crime events so that they can later be related to characteristics of the offender who perpetrated them. Prioritizing crime scenes according to qualitative judgments about the criminal acts that took place there is problematic not only because of the difficulty in distinguishing between the qualities of different criminal acts but also because evidence may need to be collected before such a determination can be made. Determining the primacy of a crime scene before evidence collection therefore puts the proverbial cart before the horse and may hinder the progress of an investigation by drawing attention to locations where evidence collection may not be fruitful and away from locations that may contain important evidence.

Second, Turvey's (1999) definition of *crime scenes* (particularly *primary crime scenes*) appears to be specific to violent crimes. This is not surprising, given that Turvey indicated that profilers are primarily called to consult on "extremely violent, sexual and or predatory cases" (Turvey, 1999, p. 35). However, there is no reason to believe that profiling can be applied only to violent crimes. Although the types of evidence available will vary between violent (e.g., physical evidence, such as blood, skin, and hair) and nonviolent crimes (e.g., embezzlement might include evidence such as financial documents and computer files), the task remains to search for pathways linking evidence to offender characteristics. Whether this endeavor is fruitful would seem to depend less on the violent or nonviolent nature of a crime and more on the power of the available evidence to predict characteristics of the offender. Therefore, in the rest of this book the term *crime scenes* refers to locations where evidence of any type of crime of interest can be found, regardless of whether that evidence relates to a violent act.

Third, despite Turvey's (1999) organization, it is not clear that there are actually three categories of crime scenes. Given the criticisms previously listed, it would be more useful to define a crime scene as any location where evidence or information relevant to a crime is likely to be found. The Technical Working Group on Crime Scene Investigation at the National Institute of Justice (NIJ) discussed in its research report (NIJ, 2000a) the issue of multiple scenes, as opposed to the prioritization of crime scenes that Turvey suggested. The working group defined *multiple scenes* as "two or more physical locations of evidence associated with a crime" (NIJ, 2000a, p. 43). This concept can be applied to profiling, such that all crime scenes would be significant for the collection of evidence, and the evidence itself would be used to determine which acts (violent or not) correspond to which crime scenes. For investigators, multiple crime scenes could then be described by the acts that took place there and/or by the chronology of events indicated by the evidence. For example, in the scenario described earlier, a classification scheme of crime scenes might be the following:

- Crime Scene 1: encounter location (café);
- Crime Scene 2: homicide location (alley);
- Crime Scene 3: transport location (offender's vehicle); and
- Crime Scene 4: postmortem acts location, theft, arson, and body disposal site (remote location).

This scheme treats each location as a crime scene of importance. In addition to indicating locations from which to collect evidence, it provides information about the order in which the various locations were visited by victim and offender and about the criminal acts and other acts important to the crimes that were committed in those locations. This type of framework not only has a conceptual advantage over attempting to identify the primary and lesser scenes, as suggested by Turvey (1999) and others, but also creates a basic organizational scheme for considering the crime scene evidence itself. As discussed in the section titled "Crime Reconstruction," one element of a criminal investigation is the construction of a crime narrative and timeline. To this end, the framework of multiple crime scenes suggested earlier allows for the organization of crime scene evidence according to its location and order in the scheme of crime events.

CRIME SCENE EVIDENCE

Crime scene evidence constitutes the data with which professionals in the profiling field have to work when attempting to predict characteristics of an unknown offender. This evidence can take the form of physical evidence, such as blood, fibers, and weapons, or nonphysical evidence, such as witness descriptions about the crime events and offender and victim information, including his or her relationship to the offender, daily routine, and any other information that could lead to inferences about the perpetrator. In any crime, an investigator would ideally strive to collect as much of the relevant physical and nonphysical evidence as possible. The type of evidence that is likely to be available to an investigator for collection will vary according to the type of crime being investigated. Therefore, the type of evidence that an investigator should aim to identify and collect will depend on the type of crime at issue. For example, suppose a victim is found murdered in his home, with no sign of forced entry. During the autopsy, skin scrapings are found under his fingernails, indicating that he may have attempted to defend himself against his attacker. In this scenario, it might be important to collect DNA samples from the victim's friends and family members, or anyone to whom the victim might have opened his door voluntarily. Collecting this evidence might then indicate whether the skin found under the victim's nails came from one of these individuals, implicating that person in (at the very least) an incident of physical contact with the victim. In contrast, suppose that an individual is the victim of fraud rather than murder. In this case, even if it is believed that the fraud was perpetrated by an individual trusted by the victim, it would not seem as relevant to collect DNA samples from the victim's friends and family members.

It is clear, therefore, that the consideration of pieces of evidence that are important to a science of profiling requires a certain amount of discretion. It certainly is best to be comprehensive about evidence collection, first identifying all relevant crime scenes and then collecting whatever pieces of evidence might be informative. Unfortunately, the volume of evidence that could potentially be collected at any given crime scene could easily become prohibitive, in terms of both the time required to collect it and the time and cost of performing forensic analyses. It is therefore necessary to collect evidence that can reasonably be expected to inform an investigation of the crime at issue, as illustrated by the DNA scenario just described.

To aid in criminal investigations, the NIJ has provided guidelines for crime scene investigation in general (NIJ, 2000a) and for death investigations (NIJ, 1999), fire and arson investigations (NIJ, 2000b), explosion and bombing investigations (NIJ, 2000c), and electronic crime scene investigations (NIJ, 2001) in particular. Although these reports provide information about several aspects of crime scene investigation, including safety considerations, maintaining the evidence chain of custody, and observing professional courtesies, these guidelines vary in the degree to which they specify pieces of evidence to be collected. At one end of the spectrum, the guidelines for death investigations indicate in a very general manner that an investigator is to collect trace evidence before transporting the body. Although the likely presence of blood, hairs, and a few other types of evidence is discussed, the guidelines do not specify what individual pieces of evidence an investigator should be looking for and collecting, what that evidence looks like, why it should be collected, and what information is likely to be gleaned from it.

In contrast, the guidelines for electronic crime scene investigations are very specific. This guide details individual pieces of evidence that should be collected, describes the possible uses for each piece of evidence, and discusses what potential information might be contained in each piece of evidence. The guidelines even include pictures of each piece of evidence, to assist the investigator in correctly identifying it at the scene. For example, one piece of evidence recommended for collection in this guide is a credit card skimmer. Photos are provided of this piece of equipment in various contexts. A definition is also provided: "Credit card skimmers are used to read information contained on the magnetic stripe on plastic cards" (NIJ, 2001, p. 21). The section on potential evidence reads, "Cardholder information contained on the tracks of the magnetic stripe includes: card expiration date, credit card numbers, user's address, user's name" (NIJ, 2001, p. 21).

Although the NIJ guidelines are informative to varying degrees, it is unfortunate that they are not uniform in terms of their exhaustiveness in recommendations for evidence collection. There is no single list of evidence in the field that generalizes across crime scenes, and investigators will therefore have to rely on these and other practice guidelines to determine how to collect evidence for the types of crimes they are investigating. The degree of clarity with which investigators proceed with collecting crime scene evidence will therefore depend on the clarity and specificity of the guidelines they follow.

In terms of building a model of profiling that will relate crime scene evidence to offender characteristics, it may not be possible to rely on practice guidelines and other literature to create an exhaustive list of every possible piece of evidence that can and should be collected for every type of crime. However, it is still possible to look to this literature to ascertain the types of crime scene evidence that are likely to be collected and available for use both in investigations and for the purposes of attempting to generate predictions about offenders.

The following sections are compiled from Saferstein's (2001) chapter on physical evidence, the *FBI Handbook of Forensic Services* (Wade, 2003), and the NIJ guidelines previously discussed (NIJ, 1999, 2000a, 2000b, 2000c, 2001). They contain a descriptive list of types of evidence commonly collected and analyzed by forensic scientists and (in many cases) an explanation for why this evidence might be of interest. Although this list is not exhaustive, it represents the pieces of data that are likely to be available for use in making predictions about offender characteristics.

Abrasives

Samples from a crime scene can be analyzed to determine what kinds of abrasive materials were used to sabotage engines or other machinery.

Adhesives, Caulks, and Other Sealants

Samples of these materials can be analyzed for color and composition.

Anthropological Examination

Suspected bone fragments can be analyzed for composition, origin, and damage (e.g., bullet holes).

Audio Recordings

Recordings containing voices and signals (e.g., gunshots and telephone touchtones) can be examined, transcribed, and compared with other samples.

Bank Security Dyes

Banks have packs containing visible red or pink dyes to stain money and clothing, as well as tear gas to disable an offender. Money, clothing, and other items can be analyzed for the presence of dye and tear gas.

Blood, Semen, and Saliva

This category includes both the fluids themselves and the materials that might contain them (e.g., cigarette butts, chewing gum, and envelopes and stamps). This evidence can be collected in liquid form, through dried stains, and from materials that have been saturated with the fluids. Analysis of this evidence is conducted to determine identity and possible sources.

Building Materials

Forensic analyses can be conducted on materials such as brick, mortar, plaster, stucco, cement, and concrete to determine composition and comparison to other samples.

Codes and Ciphers

Codes are of particular interest in cases of racketeering, terrorism, foreign intelligence, violent criminals, and street and prison gangs. Materials that may contain these types of codes include drug records, gambling records, loan sharking records, money laundering records, and prostitution records.

Computers

Examinations can determine the type of data files contained in a computer, compare those files with known documents or files, determine the time when and sequence in which files were created, extract files from computers and storage media (e.g., disks, CDs), recover deleted files, convert file formats, search data files by keywords, recover passwords, and analyze and compare source codes.

Documents

Paper; ink; indented writing; obliterations; and handwritten, typewritten, burned, or charred documents can be examined. Other examples of documents include anonymous letters, extortion letters, bank robbery notes, and fraudulent checks. Photocopies can sometimes be identified with the machine that produced them. Torn edges of papers can sometimes be matched; information on burned or charred documents can sometimes be deciphered. Age of documents can sometimes be determined. Embossed or sealed impressions can sometimes be identified with the instrument that produced them.

Drugs

Substances seized in violation of drug laws can be examined in liquid, powder, pill, and solid form. They can be examined as bulk or as residue. (Although Saferstein's [2001] text does not discuss legal substances in this category, it would seem important to collect drugs that, although not illegal, might be material to an investigation. For example, if a suicide is suspected, it might be possible to look for and collect any psychotropic medications and determine whether the victim was compliant with the prescription.)

Electronic Devices

Owner- or user-entered data can be extracted from personal digital assistants, cellular telephones, pagers, and global positioning system units. Data can also be extracted from facsimile machines, stun guns, and bomb detonators.

Explosives

Devices containing explosive charges, as well as objects expected to contain residue of an explosive, can be examined. Analyses can identify the components used to construct the devices (e.g., switches, batteries, detonators, wires), identify the main charge, determine the construction characteristics, determine the manner in which the device functioned or was intended to function, and determine the specific assembly techniques used by the builder of the device.

Feathers

Analyses can determine bird species and compare crime scene feathers with other feathers.

Fibers

Both natural and synthetic fibers, including rope, twine, and cordage, can be examined. Analysis can identify the type of fiber (e.g., animal, vegetable, mineral, and synthetic), and crime scene fibers can be compared with other samples.

Fingerprints

Comparisons can be made with partial and full fingerprints and latent and visible fingerprints. Hands and fingers may also be submitted for comparison.

Firearms and Ammunition

Any firearm, bullet, cartridge, or cartridge cases can be examined. Firearms examination can assess the general condition of a weapon and whether it is functional or in a condition that could lead to an unintentional discharge. Trigger-pull examinations can demonstrate the amount of pressure necessary to release the hammer or firing pin. Analyses can determine whether a firearm has been altered to be fully automatic. Firearms can also be test-fired to obtain specimens for comparison to crime scene evidence. Fired bullets can be examined to identify general rifling characteristics such as caliber, physical features of the rifling impressions, and bullet manufacturers. Cartridge casings can be examined to determine the caliber, manufacturer, and marks of value for comparison. Unfired cartridges can be examined to determine whether the ammunition was loaded or extracted from a particular firearm. Gun parts can be examined to determine the caliber and model of gun from which they originated. Bullet jackets can be analyzed when a bullet has fragmented, preventing the comparison of individual pieces to test-fired ammunition. Bullet-lead analyses can be conducted if no firearm is recovered or bullet marks cannot be sufficiently analyzed.

General Unknowns

Powders, liquids, and stains that cannot be readily identified can be examined by forensic scientists. Even though a full identification might not be possible, it is often possible to ascertain the general classification of a substance or compare it with a known comparison sample.

Glass

Glass particles and fractures, including panes that might have holes made by a bullet or other projectile, can be examined. Analyses can determine whether particles of glass originated from a broken source. Examinations of glass fractures can determine the direction and type of the breaking force and the sequencing of shots.

Gunshot Residue

Patterns of gunshot residue can be duplicated with the firearm of interest and ammunition. By firing into test materials at known distances, patterns can be established to serve as a basis for estimating muzzle-to-target distances. Chemical analyses can also be conducted to determine the presence of gunshot residue.

Hair

Animal and human hairs can be analyzed. For human hairs, race, body area, method of removal, damage, and alteration (e.g., coloring) can be determined.

Images

Film, negatives, digital images, prints, and video recordings can be analyzed. Dimensions of individuals and objects can be derived; location, time, and date can be determined; authenticity or image manipulation can be detected; the source and age of photographic products can be determined; cameras can be examined to determine whether they produced a particular image; and automobile makes and models can be determined from surveillance images.

Impressions

Tire markings, shoe prints, depressions in soil, and other forms of tracks can be examined. Glove or fabric impressions and bite marks can also be evaluated. Casts, which are then analyzed by forensic scientists, can be made of some types of impressions. In some cases, such as shoe prints on hard surfaces, photographs are taken and dust impressions are made.

Ink

Ink can be analyzed to determine its composition and relationship to type of writing instrument. Date of ink manufacture can also be assessed.

Lubricants

Petroleum products, automotive fluids, cosmetics, and polishes can be examined to inform cases of sexual assault, vehicular homicide, and heavy equipment sabotage cases.

Metals

Metals can be examined for comparison and composition. Method of manufacturing can be determined (e.g., casting, forging, and grinding). Response of a metal to an applied force or load can be determined, and chemical composition can be examined. These analyses would be used to determine the causes of failure of or damage to metal; the temperature to which a metal was exposed; the methods used to cut or sever metal; the formation of metal fragments and nature of fragment sources; and conditions of watches, clocks, and timers (e.g., whether an appliance was on or off when an explosion occurred). Analyses can also determine whether a lamp bulb was lit when its glass envelope was broken or when it was subjected to an impact force (e.g., car accident).

Organs and Physiological Materials

Body organs and fluids (e.g., urine) can be analyzed for drugs, alcohol, and poisons. Tissues, bones, and teeth can also be examined for DNA purposes or for comparison to other materials (e.g., dental impressions).

Paint

Liquid and dried paint that might demonstrate a transfer related to a crime can be analyzed. The layer structure of a paint sample can be compared with known sources. Color, manufacturer, model, and model year of an automobile can be determined from a paint chip.

Pepper Spray and Foam

Items can be analyzed for pepper resin, dye, or tear gas.

Plastic, Rubber, and Other Polymers

Assorted manmade objects, such as plastic bags, can be examined and compared with known sources.

Serial Numbers

Stolen property can be submitted for the restoration of erased identification numbers.

Soil and Minerals

All items containing soil or minerals, such as soil embedded in shoes, or insulation found on clothing, can be submitted for examination. Color, texture, and composition can be determined and compared with known samples.

Tape

Adhesive tape pieces and suspected roll of origin can be compared. Composition, construction, and color can also be examined and compared with known sources.

Tool Marks

Examinations can be made of objects suspected of containing the impression of another object that served as a tool in the crime, such as a crowbar that produced marks when wedged against a windowsill. Lock-and-key examinations can be included.

Victim Data

Demographic information about the victim, as well as habits, lifestyle information, and history, can be compiled.

Weapons of Mass Destruction

Weapons associated with nuclear or radiological, biological, or chemical agents can be evaluated. Explosives may also be included.

Witness Statements

Interviews with witnesses can provide information about crime events that can later be compared with the physical evidence.

Wood and Other Vegetative Matter

Wood, sawdust, shavings, or other vegetation can be examined to match sides, ends, and fractures; determine wood species; and compare crime scene wood with other samples.

USING CRIME SCENE EVIDENCE

Once the types of crime scene evidence just described are collected, the physical evidence will likely be sent to a crime laboratory, where various forensic analyses will be conducted. The results of these analyses will then be available to investigators. In some situations, as suggested by the preceding sections, crime scene evidence can provide a direct link to an offender, whereas in other situations additional inferences have to be made to go from pieces of crime scene evidence to predictions about an offender. In the former case, crime scene evidence is used for identification and comparison purposes; in the latter case, additional inferences are incorporated through the process of crime reconstruction. Nonphysical evidence, such as victim information and witness statements, will not be analyzed in the same manner as physical evidence, but similar principles apply to its use. Investigators can compare nonphysical evidence with analyses of the physical evidence to determine whether the information is consistent. Likewise, investigators may be able to make direct inferences about the crime events and the unidentified perpetrator on the basis of nonphysical evidence (e.g., witness' physical description of offender, offender's car, and license plate).

Identification and Comparison of Crime Scene Evidence

In his text on criminalistics, Saferstein (2001) indicated that physical evidence is typically examined for two purposes: identification and comparison. According to Saferstein (2001), *identification* is "the process of determining a substance's physical or chemical identity" (p. 62). For example, if evidence of blood is found at a crime scene, it would be important to ascertain whether the blood came from a human or an animal. Likewise, if a white powder is found at the scene of a drug arrest, the crime laboratory should be able to determine whether it is a drug and identify the chemical composition of that drug. To accomplish this, criminalists use tests that compare the evidence of interest with standard materials. For example, if in the drug example it was suspected that the white powder was cocaine, then criminalists would compare a sample of the white powder with a known sample of cocaine. Conversely, the criminalist must also conduct additional tests to exclude other substances from consideration. So, for example, in addition to running a chemical comparison to determine that the white powder is cocaine, the criminalist would run a set of tests to determine that the white powder is not heroin, powdered sugar, or some other substance. Unfortunately, there are no definitive standards for determining when an identification is conclusive. According to Saferstein (2001), "it is left to the forensic scientist to 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" (p. 63).

A *comparison analysis* is "the process of ascertaining whether two or more objects have a common origin" (Saferstein, 2001, p. 63). For example, a criminalist might be able to note similarities between a carpet fiber found on a victim's body and a carpet fiber taken from the carpet of a suspect's residence. Determining whether two samples are similar involves judgment on the part of the forensic scientist. If the forensic scientist determines that the properties of the two carpet fibers, for example, do not match, then he or she would conclude that they did not come from the same source. However, if the forensic scientist determines that the two fibers are similar, this does not necessarily indicate that they did come from the same source. When conducting a comparison analysis, there are certain types of evidence that will possess individual characteristics that will increase the likelihood of determining a common source. According to Saferstein (2001), these individual characteristics are "properties of evidence that can be attributed to a common source with an extremely high degree of certainty" (p. 65). Examples of this type of evidence include fingerprint ridges, striation marks found on bullets, pieces of tape torn sequentially from the same roll, and handwriting comparisons. Another type of evidence is that which contains *class characteristics*, defined as "properties of evidence that can only be associated with a group and never with a single source" (Saferstein, 2001, p. 65). For example, given the mass production of carpets, a forensic scientist might be able to determine that both carpet fibers in a particular scenario came from a certain class of carpets, but it would not be possible to ascertain that they came from the carpet in the suspect's residence. According to Saferstein (2001), "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 evidence" (p. 66). A certain degree of judgment is involved in comparing pieces of evidence, and even when similarities are noted it is not always possible to indicate the probability that these pieces have the same origin. Although these comparisons can therefore be inconclusive, it is nonetheless important to note that there would be a low probability of discovering carpet fibers, for example, that came from the same crime, and were indistinguishable from each other, but originated from different sources. Thus, this type of evidence, particularly if there is a collective body of evidence with class characteristics, might still have utility in corroborating other pieces of evidence and supporting an investigative hypothesis of events.

The practice of identifying the properties of evidence and comparing pieces of evidence to each other or to a source of origin is what forensic scientists use to provide direct links between evidence and offenders. For example, the comparison of fingerprint ridges is often used to identify the person who left those fingerprints at a given location. Likewise, the advent of DNA typing has allowed scientists to match samples of blood, semen, and other materials to individual offenders. Use of these techniques makes it possible to demonstrate links such as those placing an individual offender at a crime scene, determining injurious contact between a victim and a specific offender, and determining the source of a handwritten note. These determinations require no additional inferences but can be demonstrated solely on the presence of identifying evidence and the comparison of that evidence to the offender.

Although these types of forensic procedures are commonly believed to be ironclad, and are relied on in court to demonstrate the veracity of crime hypotheses in which physical evidence is used, there are significant limitations that should be kept in mind when considering conclusions that are made about physical evidence using these techniques. First, as Saferstein (2001) pointed out, many police forces have not adopted the approach of using crime scene technicians with specialized training in evidence collection and preservation. Instead, "often a patrol officer or detective is charged with the responsibility of collecting the evidence" (Saferstein, 2001, p. 16). Depending on the training of these officers, the integrity of the evidence from the initial collection may be limited. Second, the identification and comparison of crime scene evidence involves a degree of judgment on the part of the forensic scientist. Different forensic scientists might therefore have different opinions about the identity or similarity of pieces of evidence. Third, in comparing individual and class characteristics of evidence, there are no standards for determining just when class characteristics become individual characteristics. For example, there are no guidelines that instruct a forensic scientist as to how many fingerprint ridges have to match to determine that there is a high enough probability to match a fingerprint to a particular individual. Finally, every identification and comparison is actually expressed as a probability rather than a conclusive match. Whether a paint chip matches a particular vehicle is expressed as a probability. Whether two fingerprints came from the same person is expressed as a probability. Even situations involving DNA matches are actually expressed as probabilities. Determining whether a probability is strong enough to draw conclusions about a crime is up to the forensic scientist; the investigator; and, ultimately, the court. Although these procedures are fallible, they represent the current state of the art in the use of forensic science in criminal investigations.

Crime Reconstruction

In some situations, it is not possible to go directly from pieces of crime scene evidence to characteristics of the offender. Although there are limitations to the practice of identifying and comparing pieces of evidence to draw conclusions about the offender, often the route from evidence to offender characteristics is still fairly direct and does not require more than the scientific analysis of evidence and a professional decision about whether that evidence indicates a particular offender. Unfortunately, some types of evidence (e.g., blood) might not be available at a crime scene for analysis or may not be relevant for particular types of crimes. In other cases, this evidence might be available for use once a suspect is apprehended but is insufficient for generating leads to identify potential suspects. Finally, there are types of nonphysical evidence that may be useful for predicting offender characteristics but will not be subjected to forensic scientific analysis. In these types of situations, additional inferences must be made to relate evidence to offender characteristics.

If the evidence in and of itself does not provide sufficient links to the offender, it is necessary to use a different approach for considering the available evidence and predicting offender characteristics. *Crime reconstruction* is a process already used within traditional criminal investigation (Chisum & Rynearson, 1997; Saferstein, 2001) that approaches the evidence by relating it to behavioral information about the crime, in the form of a narrative and timeline. This behavioral information can then be used to advance predictions about offender characteristics that cannot be made on the basis of the evidence itself. Crime reconstruction is not a process that bypasses physical evidence; instead, it incorporates findings regarding the physical evidence (when available) into a larger context that includes a consideration of offender behavior. For example, a victim might be found in her home, with her wrists bound by a piece of rope. It certainly is important to collect the rope as evidence and identify its properties so that class comparisons can be made in the event that a suspect is arrested and is found to be in possession of a similar product. It may even be the case that if the rope is a rare type, determinations can be made about where it was purchased or what types of individuals might have had access to it, thereby reducing the search parameters for suspects and increasing the probability of linking the rope to an offender. However, in terms of making predictions about offender characteristics, it is unlikely that the rope itself will be predictive of any particular offender characteristics. What is more likely to predict offender characteristics is the role the rope played in the context of crime events. Did the rope come from the victim's home, or was it brought to the scene? The first case might indicate an impulsive offender who committed an unplanned offense, whereas the second scenario hints at premeditation. Was the rope tied tightly enough to control the victim's movements, or was it more loosely tied, perhaps indicating some other purpose, such as the fulfillment of a sexual fantasy? Was the rope tied in an elaborate knot that would indicate a certain type of expertise on the part of the offender? To build a science that predicts offender characteristics from crime scene evidence, in cases in which the forensic analysis of that evidence is insufficient for making those predictions, one must first make inferences that relate a piece of evidence to a behavior or choice on the part of the offender, so that investigators can attempt to make predictions about the offender based on that behavior or choice. This is the essence of crime reconstruction.

An example of how crime reconstruction is used is in the area of automobile accident reconstruction. In any automobile collision, the evidence that is likely to be available would include broken glass, dents and other body damage to the automobiles involved, paint transfer from one automobile to another or to a third object, skid marks on the road, tire characteristics, witness statements, and injuries to the drivers and passengers. Taken individually, these pieces of evidence might indicate that an accident took place, but they do not necessarily provide insight into how the accident occurred and whether one or both parties is responsible. However, by combining principles of physics and other forensic sciences with logic, investigators can make determinations about the likely sequence of events involved in a given automobile accident. This process must be conducted so that the timeline and narrative both explain and are supported by the crime scene evidence.

Consider the following illustration. A woman reports a late-night hit-and-run accident in which she states that a blue truck swerved into her car, just as she had parked it and was preparing to exit the vehicle. According to this individual, the truck then drove away from the scene. The woman stated that the driver of the truck was maneuvering erratically and did not even slow down before colliding with her parked car. She is certain that the driver must have seen her because she still had her headlights on. Various pieces of evidence are collected and analyzed, including the woman's statement; broken glass; photographs of the damage to the front and side of the parked car; the parked car's headlights; and photographs and measurements of the accident scene, including tire marks and paint scrapings from the parked car. From the analysis of this evidence, investigators are able to determine the following timeline and narrative: On the basis of the time of the woman's 911 phone call, the collision occurred between 12:45 and 1:00 a.m. On the basis of the force required to produce the damage to the parked car, it is determined that the truck was traveling between 30 and 35 miles per hour at the time of impact. A paint transfer found on the parked vehicle confirms that it came into contact with a blue truck. Analysis of scrapings from the paint transfer reveal that the paint corresponds to a particular make and model of blue truck. Clear glass fragments found near the parked car are also consistent with glass used in the same make and model of truck. Contrary to the woman's description, skid marks found on the road indicate that the driver of the truck did attempt to stop before colliding with her car. Also, contrary to her statement, analyses of the woman's headlights indicate that they were not lit at the time of impact. Swerving tire marks were noted both approaching the parked car and leading away from it.

By reconstructing events from the available evidence, as just illustrated, the investigator now has a set of information that includes physical evidence (glass fragments), behaviors (swerving and skidding), and a sequence of events (driving erratically, skidding, hitting a parked car, and leaving the scene). Although the presence of any individual piece of evidence (e.g., pieces of glass) might not be predictive of the characteristics of the hit-and-run driver, it might be possible to predict relationships between the types of behaviors (leaving the scene) and choices (selection of a blue truck as the vehicle) made by the driver and other characteristics that may help to identify him.

Roles of Physical Evidence in Crime Reconstruction

To relate crime scene evidence to behavioral information for the purposes of a crime reconstruction, one must understand the various ways that evidence can inform a timeline or narrative of the crime. To some extent, the process of going from evidence to a crime reconstruction is simply the logical formation of conclusions based on information at the scene or from the analyses of forensic scientists. For example, in the hit-and-run scenario, if skid marks occur only when a driver applies the brakes, and if skid marks are found on the road before the parked car, in a trajectory consistent with the path of the moving car, one could logically conclude that the driver of the moving car applied the brakes before hitting the parked car. The evidence thus provides an indicator of the order of events (braking before collision). There are several additional roles that evidence can play in forming a crime reconstruction. One model for considering these roles is articulated next.

Chisum and Rynearson (1997) proposed a model for the adaptation of crime scene evidence to crime reconstruction, focusing on the roles that evidence can play in informing a timeline and narrative. According to this model, evidence can be sequential, be directional, describe action, define location, define ownership, and limit the crime scene. Each role is described subsequently and includes an example from the hit-and-run automobile scenario just discussed. It is important to note that evidence can serve more than one role. For example, a trail of blood drops could serve as directional evidence, by indicating a direction of travel through a crime scene, and it could serve as ownership evidence if it were analyzed for DNA and matched to a suspect with a high degree of probability.

Sequential evidence establishes the sequence of events surrounding a criminal act. In the hit-and-run scenario, the location of the skid marks would indicate that the driver applied the brakes, collided with the parked car, and then drove away, in that order. The woman's report also provides sequential evidence (albeit conflicting), indicating that the driver of the truck hit the parked car without slowing down and then drove away.

Directional evidence shows where something was going and where it was coming from. Tire tracks at the scene of the hit-and-run accident indicate the pathway of the truck as it collided with the parked car and as it left the scene.

Action evidence establishes the motion or actions of individuals at the scene. For example, the size, shape, and depth of the dent in the parked car indicates that it was hit by another vehicle, being driven by an individual who, as indicated by tire tracks, drove away after impact.

Location evidence establishes the position of individuals at a crime scene as well as the orientation of people and objects at the scene. The location of the parked car establishes where the contact occurred and the orientation of the moving truck as it struck the car. The woman's description also establishes her presence at the scene and, to the extent that her statement is reliable, the presence of an individual driving a blue truck.

Ownership evidence determines the source or identity of the evidence. Analysis of the blue paint scrapings taken from the parked car leads to the identification of a particular make and model of truck. In the case of the hit-and-run scenario, there is no physical evidence that would link the crime to a particular offender. An example of how one might be able to determine the source or identity of the evidence conclusively would be if the driver had been injured and left blood at the scene of the accident before driving away. If this individual were later apprehended (preferably while driving a blue truck with paint transfer from the parked car and a broken headlight), his or her blood could be compared with the blood at the scene to determine whether they came from the same individual.

Limiting evidence defines the parameters of the crime. In the hit-and-run scenario, the woman's description of the blue truck, combined with the matching of the paint scrapings to a make and model of blue truck, limits the search parameters for the vehicle that hit the parked car. *Limiting evidence* can also refer to physical barriers. For example, if an accident had taken place in a parking garage, and both drivers had remained at the scene, the parameters of the crime scene would be confined to that parking garage.

In addition to the roles of evidence previously described, Chisum and Rynearson (1997) discussed three other uses for evidence.

1. *Relational evidence* establishes the relationship of pieces of evidence by virtue of their location with respect to the location

of the other item. For example, yellow broken glass found on the ground near the smashed turn signal light of the parked car indicates that the glass came from the parked car.

2. *Functional evidence* describes how things work, as well as the operational condition of an item. For example, if skid marks would be expected to appear only when a driver applied sudden pressure to the brakes, then the presence of skid marks at the hit-and-run scene would be functional evidence leading to the conclusion that the driver of the truck had applied the brakes around the time he or she left the skid marks on the road.
3. *Missing or inferred information* refers to evidence that has been removed from the scene. The information has to be inferred by the investigator on the basis of the space left where that evidence would be expected to be found. For example, if the turn signal light of the parked car had been smashed by the impact of the truck during the hit-and-run accident, then investigators would expect to find pieces of yellow glass at the accident scene. If this glass were not present, investigators might conclude that either someone removed the glass or that the turn signal light had been broken at another location and was not affected by the impact of this hit-and-run accident.

Evaluation of Crime Reconstruction

It is vital to clearly appraise the strengths and weaknesses of crime reconstruction because in many cases the inferences gleaned from reconstruction are the behavioral variables that will be used to attempt to generate predictions about offenders. There currently is a paucity of research in the areas of forensic crime scene evidence analysis and crime reconstruction. First, as mentioned previously, the process of identifying and comparing crime scene evidence involves the use of individual judgment, and the degree of similarity between two pieces of evidence cannot be precisely quantified. This introduces a significant potential for error in even the most direct links between crime scene evidence and offender characteristics, such as the matching of fingerprint ridges to the fingers of a suspect. Research is needed to determine the reliability and validity of the identification and comparison procedures used by forensic scientists. Second, the extent to which crime reconstruction will be a reliable and valid process will be limited from the outset by the evidence available and the accuracy of the forensic scientific conclusions that are drawn from that evidence. Research on the accuracy rates of forensic science analyses is therefore also relevant to crime reconstruction. Third, even if determinations made by forensic scientists can be demonstrated through research to be highly accurate, there is no information about the reliability and validity of drawing logical inferences from those determinations. The reconstruction process itself must therefore also be subjected to rigorous empirical study. Until such time as sufficient research exists to assess the techniques of forensic science evidence identification–comparison and crime reconstruction, predictions generated from the use of these techniques must be made cautiously and with a clear understanding of the limitations.

In its current state, there is one other issue to be addressed regarding crime reconstruction. It is apparent, particularly as discussed by Chisum and Rynearson (1997), that crime reconstruction is intended to be used by individuals with some criminal investigative knowledge or experience. This is reflected by the fact that in cases in which the logic forming the connections between the evidence and the crime reconstruction is not obvious, there is a presumption that the individual reconstructing the crime will have the requisite knowledge or experience to understand how a particular piece of evidence supports a particular inference in a timeline or narrative. For example, if an investigator observes photographs of red glass near the rear of a dented car with a broken taillight and reads a laboratory report concluding that the composition of the red glass is consistent with the glass used in the make and model of car in the photograph, it would not require any special expertise to draw the logical conclusion that the glass probably came from the car's taillight when it was hit by something or someone. However, an individual would need to have some basic familiarity with firearm use, for example, to determine that the absence of shell casings at the site of a machine gun shooting would indicate that someone had removed them from the scene.

Building a science of forensic crime scene evidence analysis and crime reconstruction, and determining sufficient levels of proficiency or expertise for conducting these types of analyses, is beyond the scope of this book, but some guidelines can be offered. Building such a science would involve collecting data on the types of inferences that forensic scientists make in identifying or comparing pieces of evidence and attempting to approximate the probabilities involved in asserting matches or identifications as well as attempting to determine the accuracy of these inferences by comparing them to known standards or situations. For example, research could examine the process by which forensic scientists attribute fingerprints to an individual. Data could be collected on the types of characteristics that are compared (e.g., ridges, patterns), the number or percentage of characteristics that must correspond between an evidentiary fingerprint and a suspect's print before a match is declared, and the process by which this correspondence is determined. In addition, research could approximate the accuracy rate of fingerprint matching by comparing the results of the previously described process with fingerprints from known sources. These types of study would illuminate the process and success rate of the forensic science procedures that are currently in use.

With regard to crime reconstruction, a similar research process could be used to test the veracity of the kinds of inferences that are currently made by law enforcement agents when they attempt to reconstruct the timeline and narrative of a crime. Bearing in mind that the accuracy of any crime reconstruction will vary according to the strength of the available evidence, and the analysis of that evidence by forensic scientists, studies could examine the statements made in a crime reconstruction, determine the logical bases for those statements, and compare the statements and the reconstruction as a whole with known crime outcomes. For example, investigators could be provided with the same set of materials that was available to law enforcement at the time of investigation of a solved crime. Each inference made in an investigator's crime reconstruction could be evaluated and compared with the actual case outcome. Thus, an investigator might construe that the offender in a home-invasion case entered through a bedroom window and left through the back door. The investigator might then describe the basis of this inference as being the pattern and direction of a set of muddy footprints determined by the forensics laboratory to be inconsistent with the feet and shoes of every member of the household. This inference could then be compared with the narrative of the solved case to determine its accuracy, as well as whether it was properly derived from the evidence cited as the basis for the inference.

The body of research that could be generated from the types of study just described will certainly influence the task of profiling to the degree that profiling relies on forensic evidence analyses and crime reconstructions. Until this body of research is established, any crime reconstruction should simply be treated as a working hypothesis. Inferences should be checked against the results of forensic analyses and the pieces of evidence themselves and, to the extent to which findings converge, confidence in the resulting timelines and narratives can be increased. Ultimately, however, these working hypotheses will need to be compared with proven facts to confirm their validity and the validity of the process.