

Chapter 10

Crime Scene Reconstruction

INTRODUCTION

Crime scene reconstruction is the process of determining or eliminating the events and actions that occurred at the crime scene through analysis of the crime scene pattern, the location and position of the physical evidence, and the laboratory examination of the physical evidence. Reconstruction not only involves scientific scene analysis, interpretation of the scene pattern evidence and laboratory examination of physical evidence, but also involves systematic study of related information and the logical formulation of a theory.

IMPORTANCE OF CRIME SCENE RECONSTRUCTION

It is often useful to determine the actual course of a crime by limiting the possibilities that resulted in the crime scene or the physical evidence as encountered. The possible need to reconstruct the crime is one major reason for maintaining the integrity of a crime scene. It should be understood that reconstruction is different from 're-enactment', 're-creation' or 'criminal profiling'. Re-enactment in general refers to having the victim, suspect, witness or other individual re-enact the event that produced the crime scene or the physical evidence based on their knowledge of the crime. Re-creation is to replace the necessary items or actions back at a crime scene through original scene documentation. Criminal profiling is a process based upon the psychological and statistical analysis of the crime scene, which is used to determine the general characteristics of the most likely suspect for the crime. Each of these types of analysis may be helpful for certain aspects of a criminal investigation. However, these types of analysis are rarely useful in the solution of a crime. Reconstruction is based on the ability to make observations at the scene, the scientific ability to examine physical evidence, and the use of logical approaches to theory formulations.

NATURE OF RECONSTRUCTION

Reconstruction is based partly on scientific experimentation and partly on past experiences. However, its steps and stages, as found in forensic science, closely follow basic scientific principles, theory formation, and logical methodology. It involves consideration and incorporation of all investigative information with physical evidence analysis and interpretation molded into a reasonable explanation of the crime and its related events. Logic, careful observation, and considerable experience, both in crime

scene investigation and forensic examination of physical evidence, are necessary for proper interpretation, analysis and, ultimately, crime scene reconstruction.

BASIC PRINCIPLES FOR PHYSICAL EVIDENCE AND RECONSTRUCTION

The foundation of crime scene reconstruction is established by following the basic principles used in the forensic examination of physical evidence. The Locard theory of transfer is the fundamental basis of any forensic analysis. Although the lack of transfer has limited value in forensic laboratory examinations, it still has significant importance in crime scene reconstruction. Figure 10.1 shows the stages commonly involved in the examination of physical evidence at the crime scene and the laboratory.

RECOGNITION

Any type of forensic analysis usually starts from recognition of the potential evidence and separation of this from those items that have no evidential value. As discussed in the previous chapters, once the evidence is located, every effort and precaution should be used to preserve, to document and to collect this evidence. Laboratory analysis and comparisons of physical evidence are used to identify objects, substances, and materials, and to trace its origin. Once an item is identified it is then compared with known reference materials or standards. Depending upon the outcome of the comparison between the questioned sample and the known samples, one can then attempt to individualize the evidence and determine its origin. Once the crime scene appearance has been studied and the examination of physical evidence carried out, the crime or case can then be reconstructed.

Any type of reconstruction generally starts from recognition. Unless the potential evidence can be recognized, no further reconstruction can be carried out. Although the examination of a *macroscopical scene* or a *microscopical scene* is different, however, the general approach remains the same. Once potential physical evidence has been recognized the investigator should always make every possible effort to properly document, collect, and preserve the evidence. If a question arises, the investigator should always contact an expert in the field before any alteration of the evidence is done. This is important because most conditional evidence and pattern evidence can be easily altered or destroyed. It is very important to emphasize that *once such evidence has been altered, the ability to conduct a reconstruction, will be limited.*

IDENTIFICATION

Identification is a comparison process, which utilizes the class characteristics of a standard object or known substance to compare with the evidential item collected from the crime scene – by comparing the physical properties, morphological properties,

chemical properties and biological properties. Table 10.1 is an example of some of the physical and morphological properties to be compared for identification purposes.

Even the identification of persons also starts with the same logical process of physical type of identification that uses properties such as the height, weight, size, race, and hair and eye color, etc. to include or eliminate someone. Then more specific measurements can be carried out to individualize a person. The types of physical measurements are referred to as anthropometry, a system developed by Alphonse Bertillon in the early 1900s. However, if one identifies a friend or relative, one generally uses a combination of class characteristics and the special features (individualizing characteristics) of the person and then compares them to a mental picture of the person. This process of comparison is the same process used to identify a hair, weapon, or clothing.

When an item of physical evidence is identified but cannot be truly individualized, it will always have similar class characteristics; for this reason, statements about how similar these characteristics are can sometimes be made. The degree of similarity of particular evidence or characteristics depends on many factors, and varies from being fairly easily calculated, as in the case of blood groups, to being limited to only broad estimates of similarity. Table 10.2 is a list of the specific areas used in reconstruction through identification of serological evidence class characteristics.

INDIVIDUALIZATION

Individualization is unique to forensic science; it refers to the demonstration that a particular sample is unique, even among members of the same class. It may also refer to the demonstration that a questioned piece of evidence from a crime scene and a similar known sample of evidence have a common origin. Thus, in addition to class characteristics, objects and materials possess individual characteristics that can be used to distinguish members of the same class. The nature of these individual characteristics varies from one type of evidence to another, but forensic scientists try to take advantage of them in efforts to individualize a piece of physical evidence. Some types of evidence can be truly individualized, but with some other types an approach to the goal of individualization is possible. These types of individualizations are referred to as partial, and in some cases they are nothing more than refined identifications, such as genetic marker determination from a bloodstain, DNA typing of semen evidence, or trace elemental analysis of paint chips. The term identification is sometimes used to mean personal identification (the individualization of persons). Fingerprints, for example, can be used to 'identify' an individual. The terminology is unfortunate, since this is really an individualization. Likewise, dental evidence and dental records may be used by a forensic odontologist in making personal individualizations in situations where dead bodies cannot be readily identified otherwise (such as in mass disaster or in cases of fire and explosions).

The identification and individualization analyses of physical evidence and the conclusions drawn from them are important ingredients in a final reconstruction.

RECONSTRUCTION

Reconstruction is based on the results of crime scene examination, laboratory analysis, and other independent sources of information to reconstruct case events. Reconstruction often involves the use of inductive and deductive logic, statistical data, information from the crime scene, pattern analysis, and laboratory analysis results on a variety of physical evidence. Reconstruction can be a very complex task, linking many types of physical evidence, stain pattern information, analytical results, investigative information, and other documentary and testimonial evidence into a complete entity.

The developing fields of artificial intelligence (CODIS and AFIS, for example) and expert systems have opened up a new dimension in reconstruction. These systems allow forensic scientist modeling and representation of laboratory analysis results, reasoning and enacting of a crime scene, logic, comparing and profiling of a suspect, and making logic decisions concerning the case. Advances in hardware and software have added systematic problem solving to the forensic scientist's repertoire. Computer technology allows communication between the user and the expert system – in a sense each is helping the other to solve a specific forensic problem. Reconstructions are often desirable in criminal cases in which eyewitness evidence is absent or unreliable. They are important in many other types of cases, too, such as automobile and airplane accidents, fire and arson investigation, and major disasters.

STAGES IN RECONSTRUCTION

Reconstruction is considered a *scientific fact-gathering process* (see Figure 10.2). Reconstruction generally involves a group of actions that will set the stage for crime reconstruction. The following are the five separate stages commonly used in the process of reconstruction:

- 1 -*Data collection*: all information or documentation information obtained at the crime scene, from the victim, or witnesses. Data including condition of the evidence, obvious patterns and impressions, condition of the victim, etc., are reviewed, organized, and studied.
- 2 -*Conjecture*: before any detailed analysis of the evidence is obtained, a possible explanation or conjecture of the events involved in a criminal act may be done, but it must not become the only explanation being considered at this stage. It is only a possibility. There may be several more possible explanations, too.
- 3 -*Hypothesis formulation*: further accumulation of data is based on the examination of the physical evidence and the continuing investigation. Scene examination and inspection of the physical evidence must be done. Scene and evidence examination includes interpretation of bloodstain and impression patterns, gunshot patterns, fingerprint evidence, and analysis of trace evidence. This process leads to the formulation of an educated guess as to the probable course of events, a hypothesis.
- 4 -*Testing*: once a hypothesis is formulated, further testing must be done to confirm or disprove the overall interpretation or specific aspects of the hypothesis. This stage includes comparisons of samples collected at the scene with known standards and alibi

samples, chemical, microscopical and other analyses and testing. Controlled testing or experimentation of possible physical activity must be done to collaborate the reconstruction hypothesis.

5 -*Theory formation*: additional information may be acquired during the investigation about the condition of the victim or suspect, the activities of the individuals involved, accuracy of witness accounts, and other information about the circumstances surrounding the events. All the verifiable investigative information, physical evidence analysis and interpretation, and experimental results must be considered in testing and attempting to verify the hypothesis. When it has been thoroughly tested and verified by analysis, it can be considered a plausible theory. Figure 10.2, is a model for theory building during crime scene reconstruction.

TYPES OF RECONSTRUCTION

There are many types of reconstruction depending on the nature of the crime, the questions needing to be answered, the types of events that have taken place, and a reconstruction that is based on the degree of involvement of the reconstructionist. As shown in the outline below, there are five common ways to classify the types of reconstruction services that may occur.

CLASSIFICATIONS OF RECONSTRUCTION TYPES

- A Specific type of incident reconstruction:
 - 1 Accident reconstruction:
 - (a) Traffic accident reconstruction: automobiles, trucks, motorcycles, etc.
 - (b) -Other transportation accident reconstruction: trains, airplanes, boat accidents, etc.
 - (c) -Industrial or construction accident reconstruction: ‘on the job’ or employee accidents, building collapses, machinery, etc.
 - 2 Specific crime reconstruction:
 - (a) Homicide reconstruction
 - (b) Arson scene reconstruction
 - (c) Rape case reconstruction
 - (d) White-collar crime reconstruction
 - (e) Other specific crime scene reconstruction
- B Specific events reconstruction
 - 1 Sequence determination
 - 2 Directional determination
 - 3 Position determination
 - 4 Relational determination
 - 5 Conditional determination
 - 6 Identity determination

- C. Degree of involvement reconstruction
 - 1 Total case reconstruction
 - 2 Partial case reconstruction
 - 3 Limited event reconstruction
 - 4 Specific pattern reconstruction
- D Specific type of physical evidence reconstruction:
 - 1 Pattern evidence
 - 2 Shooting investigation evidence
 - 3 Serological evidence
- E Special areas or determinations in reconstruction:
 - 1 -Criminal profiling – including MO, motive, and psychological determinations, or organized or disorganized crime scene determination.
 - 2 Scene profiling – Primary scene or secondary scene determination, etc.

For the purposes of this text, the reconstruction of an event, the criminal act, will be discussed using the classification based on the specific type of physical evidence created by the event and found at the crime scene. This reconstruction process will follow the ‘information gathering process’ as shown above that leads to the reconstruction theory. The theory incorporates all the previously discussed processing of the crime scene with its physical evidence and the investigator’s knowledge of the value and use of forensic testing methods. The physical evidence resulting from the crime and found at the crime scene to be discussed with regards to reconstruction will be pattern evidence, shooting investigation evidence, and serological evidence.

PATTERN EVIDENCE IN RECONSTRUCTION

Pattern evidence is one type of physical evidence encountered at a majority of crime scenes. Often, forensic scientists do not take this type of evidence seriously enough, and think of it as ‘not being very scientific’. Pattern evidence at crime scenes is, however, extremely valuable in the reconstruction of crimes and the activity that has taken place at the crime scene (see Photo 10.1a–c). It can be used to prove or disprove a suspect’s alibi or a witness’s version of what took place at the crime scene, to associate or dissociate the involvement of persons or objects in particular events, or to provide the investigators with new leads or information for further investigation.

Pattern evidence is generally created by the contact of two surfaces (persons, vehicles, or objects) that results in the formation of impressions, imprints or markings. These impressions may be from static or stationary contact or dynamic or moving contact and may be two-dimensional or three-dimensional. In some cases, the contact may be a transfer of material from one surface to another resulting in pattern evidence in the form of a stain or deposit. Pattern evidence also results from the fracture, breaking or cutting of an object. The following is a list of pattern evidence commonly found at different crime scenes:

- 1 Bloodstain patterns
- 2 Glass fracture patterns
- 3 Fire burn patterns
- 4 Furniture position patterns
- 5 Track-trail patterns
- 6 Tire or skid mark patterns
- 7 Clothing article damage or position patterns
- 8 Modus operandi and crime scene profile patterns
- 9 Projectile trajectory and powder residue patterns
- 10 Injury or wound patterns

Pattern evidence found at crime scenes should be carefully documented, processed, enhanced, or collected using all the techniques discussed earlier chapters of this text. The techniques used for pattern evidence reconstruction are the same as those examinations of other types of physical evidence: Recognition › Identification › Individualization › Interpretation › Reconstruction. Figure 10.3 is a flow chart showing these basic stages of reconstruction of pattern evidence.

BLOODSTAIN PATTERN ANALYSIS FOR RECONSTRUCTION

Reconstruction from bloodstain patterns has long been a neglected area, but it has received more attention recently from the law enforcement and legal communities. Bloodstain pattern analysis has been defined in several ways. Bloodstain pattern analysis seeks to define the facts surrounding an investigation by the use of the physical nature of bloodstains. It is the evaluation of the static aftermath of bloodshed in an attempt to determine the actions that created the bloodstains found at the crime scene. Oftentimes, the bloodstain patterns provide a window to the past. The totality of these definitions is that the size, shape, and distribution patterns of the bloodstains found at a crime scene where bloodshed has occurred can be used to reconstruct the bloodshed event(s). The bloodstain pattern analysis is in some cases more useful and significant than the serological or DNA information obtained from the blood. The bloodstain patterns reveal not ‘who’ but ‘what’ with regard to the circumstances of bloodshed. The ‘what’ of bloodshed is the result of careful examination and study of the bloodstains’ appearance at the crime scene. The following are some examples of how reconstruction can be made by the study of the bloodstain evidence:

- Direction of travel of the blood droplets.
- Distance of blood source to target surface.
- Angle of impact of blood droplet.
- Type of blood droplets.
- Determination of blood trails, their direction, and the relative speed of motion.
- Nature of the force used to create the bloodshed.
- -Nature of the object used to cause bloodshed, the number of blows involved, and relative location of persons/objects near bloodshed.
- Sequencing of multiple events associated with the bloodshed.

- Interpretation of contact or transfer patterns.
- Estimation of elapsed time and volume of bloodshed.

Basic bloodstain patterns

Bloodstain patterns found at crime scenes will fall into three broad categories: dropping bloodstain patterns, impacted bloodstain spatters, and special bloodstain configuration patterns. Each category of pattern will be briefly discussed so as to provide basic information of bloodstain patterns for reconstruction. Additional reading, careful study, control experiments, and practice must be undertaken for proper bloodstain pattern analysis.

Dropping blood patterns

The patterns produced by dropping blood found at the crime scene are based on the biochemical and physical properties of liquid blood. The surface tension of the liquid blood causes the blood drops produced from a blood source to be spherically shaped. The blood drops have a viscosity four times that of water. An average volume of a drop of blood is approximately 0.05–0.06 ml (roughly 20 drops in one milliliter) under normal conditions. The blood drop when released from the blood source will oscillate slightly during free fall. It possesses an adhesive quality that provides for a small amount of blood to adhere to most surfaces.

Additionally, a drop of free-fall blood has terminal velocity ranging from 20–25 ft/sec. Many factors will influence the size and shape of the bloodstain once it reaches a target surface. A free-falling drop of blood when impacting a surface will generally produce circular shaped patterns. If the distance a drop of blood falls is increased it produces a circular pattern showing an increase in the stain's diameter until the terminal velocity of drop is reached (see Photo 10.2). At this height and above, the diameter of the resulting circular stain will remain constant. It is for this reason that an interpretation of a drop of blood's *distance fallen* can be done by examination of a bloodstain's diameter.

The target *surface texture* for dropping blood can also affect the size and shape of the bloodstain pattern. Hard, non-porous surfaces will produce circular stain patterns that have smooth edges, whereas softer, porous surfaces will produce spatter stains that are scalloped or have rough edges. Photos 10.3a–c demonstrate the relationship of the surface texture vs. the diameter of stains.

The shape of the resulting bloodstain is changed when the angle at which a blood drop impacts a surface is changed. As the angle of impact is made smaller or more acute, the bloodstain pattern will become more elongated, elliptical, or oval in shape (as shown in Photo 10.4a–c). The impact direction of a drop of blood can also be determined. The 'tail' of the bloodstain generally points to the direction of travel of the blood drop. In turn the blood origin of a drop can be determined. This direction of travel along with the angle of impact is referred to as the *directionality* of a bloodstain pattern.

The *angle of impact* can be determined from measurements of the length and the width of bloodstain. The trigonometric relationship between the ratio of the long axis (length) v. the short axis (width) of a bloodstain can be measured. Its angle of impact can be calculated with a simple trigonometric formula:

Sine of θ = short axis/long axis

Figure 10.5 shows an example of calculation of impact angle of a blood drop. Blood dropping trails are frequently found at crime scenes. Careful examination and analysis of the trail pattern will provide information about direction of travel and the relative traveling speed. The individual bloodstains will possess the directionality characteristics of elongation and the distance between the individual bloodstains will be significant. That is, as the speed of traveling of the bleeding source in a horizontal motion is increased, the more elongated shape of the stain pattern will be the result and the distance between bloodstains will be increased.

A couple's bodies were discovered in the basement of their residence. Both of them were beaten to death. Photos 10.5 a and b show two views of the crime scene. Blood dripping pattern, contact smear pattern, medium velocity impact spatters and large pooling stains were observed on the floor. Through study of the bloodstain pattern, the sequence of events was able to be reconstructed. Their adopted son breaks into the house and kills his father first by hitting him with a sledgehammer. He then drags his father's body to a distant corner and covers him with a bedsheet. He then waits in ambush for his mother to enter the basement. He kills her with a hammer and carries her outside the basement. The mother's blood drips on top of the bloody drag-mark from his father. Subsequent serological analysis identified the mother's and father's blood types and was helpful in the reconstruction of events.

Impacted bloodstain spatters pattern

Bloodstains that have been produced with more energy (force) than gravity is referred to as impacted blood. The force added to the drop of blood causes the drop to break into smaller-sized spatters of blood. These smaller drops of blood are broken into smaller sizes of spatters relative to the amount of force or energy involved. This force (energy) generally comes from two sources: internal or external. Internal force results from the body's internal blood circulation system. Blood travels at a constant speed in arteries, veins, and capillary vessels. As a consequence, the resulting bloodstain patterns will be different. The external force (energy) results from the force that created the bleeding or the force exerted on the blood source. Photo 10.6 shows medium velocity impact spatter found at a homicide scene. The drop's directionality property remains unchanged, however. It is for this reason that blood that has been impacted can be analyzed or examined and a determination of the origin of impact force or the origin of blood source can be determined.

The *point of origin* of impact or bloodshed is determined by a two-step process:

- 1 Determination point of convergence (2-D); and
- 2 Determination of point of origin (3-D).

The *point of convergence* is the process of determining the two-dimensional point of origin of impacted blood spatter. As shown in Figure 10.6, a line or axis is obtained through the center of a representative sample of each impact blood spatter. Once the axis from all the selected blood spatters have been obtained then a line (direction of impact) can be established by projecting back to its origin. When all the lines converge in a small area, this area is the two-dimensional convergence of the impacted blood or bloodshed source. The second step in the point of origin of impacted blood or bloodshed source requires that each of the stains in the convergence be measured and their angle of impact determined. Once the angle of impact has been calculated then the axis line will need to be set by the use of a protractor. Stringing of lines or graphic tape can be used for this process.

Figure 10.6a shows the step I of 2-D point of convergence determination and Figure 10.6b demonstrates the step II 3-D point of origin determination. The 2-D point of convergence and corresponding impact angles are used to determine location of impact. An experienced bloodstain analyst can assist in the determination of which individual spatters to use for this reconstruction step. It is good practice to use more individual spatters than fewer spatters. The point of origin of bloodshed or point of impact determinations will allow the reconstruction of the nature of the force used, the sequence of events, and the relative position of persons or objects near the impacted source. Impacted bloodstain patterns are frequently grouped or classified by the relative amount of force used to create the bloodstain pattern. These classifications can also assist in the interpretation as to the type of weapon used to cause bloodshed. *Low velocity impact spatter* produces bloodstain patterns where the majority of drops of blood are not broken into smaller droplets. The majority of spatter produced is large with diameters of 4 mm or more. *Medium velocity impact spatter* is produced when the majority of larger drops of blood are broken into smaller spatter with diameters of 2–4 mm. The force associated with this type of impact spatter is greater than 25 ft/sec. Impact spatter that measures 2 mm or less is generally the result of *high velocity impact spatter*. The force necessary to produce spatter of this size is in excess of 100 ft/sec and is associated with higher energy sources, such as explosions, gunshot wounds, and high-speed collisions. Photo 10.7 shows the high velocity impact spatter found on the wall behind the victim's head, who dies as a result of gunshot wounds. The overall appearance of this high velocity blood spatter is a mist-like distribution pattern. Aspirated blood from a bloody mouth or nose can sometimes be confused with high velocity impact spatter. Upon close examination the bloodstain pattern analyst should be able to distinguish these two types of patterns.

Special bloodstain patterns

Numerous other types of bloodstain patterns are found at crime scenes that can be used for reconstruction purposes. These patterns involve analysis of individual stains, overall patterns of stains, and a combination of individual stains within overall patterns of stains. *Dispersion effects* of forward spatter and back spatter are found with both medium and high velocity impact bloodstain patterns. Photos 10.8a and b show the experimentation of such blood spatter patterns. If the dispersion patterns are absent, then the investigator must be able to reconstruct the crime scene so as to explain their absence. In bloodstain pattern analysis, the absence of bloodstain patterns is equally as important as the presence of bloodstain patterns. Oftentimes the absence of spatter is in the form of an outline of the

intermediate target or object that received the blood spatter. Therefore, this intermediate target can be identified.

A quantity of blood impacting a surface with a certain amount of force is known as *projected blood*. This type of special bloodstain pattern is commonly associated with major injuries with open wounds with a large amount of blood projected on vertical surfaces, such as arterial gushes. Photo 10.9 shows one example of arterial gushing pattern. This pattern has sharp, spineous edges and frequently shows movement or motion. The larger quantity of blood is deposited on vertical surfaces and then flows downward as it is acted upon by gravity and produces a *flow pattern* of the blood. Larger quantities of blood deposited on a horizontal surface then flowing downward because of the topography of the surface also produce a flow pattern of blood, as shown in Photos 10.10a and b.

Blood dripping into a pool of blood can produce a special feature bloodstain pattern. The appearance of this type of bloodstain pattern is different from the projected bloodstain pattern. The edges of these types of blood spots are not as spineous and sometimes referred to a rebound spatter patterns. The *repetitive dripping pattern* shows no motion that is commonly found with the projected bloodstain pattern, as depicted in Photo 10.11. When an object or body part is used to inflict injury or contact a sufficient amount of liquid blood, blood will transfer to the object or body part. The arc motion of the bloody object will produce a *cast-off bloodstain pattern*. The linear nature of the pattern and the repeating shape changes of the resulting individual blood drops deposited on a target surface distinguish this pattern, as shown in Photo 10.12. The blood drop shape changes due to the changes in the impact angle. The cast-off pattern also allows for a determination of the number of blows inflicted on the blood source. Any bloody object that is given a flinging motion including moving hands, arms, and legs can produce cast-off patterns at a crime scene, as shown in Photo 10.12. Ceilings, walls, furniture, and the clothes of the person inflicting the trauma are usual targets for depositing of cast-off bloodstain patterns.

Once bloodshed has occurred, it is common to find pools of blood. The *pooling of blood* provides information about the amount of blood deposited and the type of injury the person received. The pools of blood can be transferred to other surfaces by contact. *Contact-transfer bloodstain patterns* are the result of blood adhering on an object or body through direct contact and then transferred onto a new location, as shown in Photo 10.13. This new location can be at distances both large and small. The contact-transfer pattern is in the shape of the object due to a stationary or static transfer, and then the object's shape can be determined. For example, a bloody knife blade that is placed on a bed sheet will leave a contact-transfer pattern in the shape of the knife blade.

If the contact-transfer patterns are due to folding of the receiving surface, then two similar bloody imprints may result from the same object, or one image from the other bloody image, hence a 'butterfly' or mirror image of the original stain is created.

The contact-transfer pattern can show the presence of an interrupted or discontinuous pattern. This type of interruption of the pattern is generally produced due to motion of a repetitive nature or folding of the receiving surface materials. The direction and the

sequence of the motion can be determined from examination of these types of bloodstain patterns.

Contact-transfer patterns can often be created through dynamic motions. This type of transfer pattern is commonly referred to as a blood smear or blood smudge. When an unstained object moves through a blood surface the resulting pattern is called a *wipe pattern*. The smear pattern can exhibit 'skeletonization' and show directionality of motion of the original unstained object. A swipe pattern is also produced when a bloody object contacts an unstained surface. Motion and direction can also be identified with these patterns, as shown in Photo 10.14.

Documentation of bloodstain patterns

Bloodstain patterns found at a crime scene or on items of physical evidence that are to be used for reconstruction *are evidence*. Therefore, they should be subjected to the same documentation protocols as discussed in earlier chapters. However, by their nature there are some documentation techniques that are especially useful for bloodstain patterns. As with general crime scene documentation purposes, any documentation is useful for any subsequent examinations, reconstructions, or as a tool to prepare for trial.

Photography of bloodstain patterns

Photography of bloodstain patterns follows the same basic process as with general crime scene photography – general, overall views followed by specific, close-up views. Because measurement and exact sizing of bloodstain patterns is important, the bloodstain pattern photographs must have scales placed in the photograph. The scales are important even in the overall views so as to give perspective and dimension to the documentation. Labels, arrows, and other markers as previously described are especially important in bloodstain pattern photography. Photos 10.15a–c show the photographic documentation of bloodstains.

Because photographs may have to be printed to actual size, scales should be placed at right angles along the edges of the pattern. For larger areas or overall views a process of 'road-mapping' by the placing of tape measures along entire walls or surfaces is useful, as shown in Photos 10.16 and 10.17.

Close-up or laboratory examination quality photographs of bloodstain imprint patterns or individual spatters (as depicted in Photo 10.17) follow the lighting and tripod placements previously discussed. Flashes should be diffused or bounced to prevent burn-out of the bloodstain images.

Frequently, borderline quality bloodstain imprint patterns must be enhanced prior to documentation or reconstruction can be attempted. The field enhancement reagents, like luminol, tetramethylbenzidine, amido black, leucomalachite green, or fluorescence, can be used to spray on to large areas to enhance bloodstain imprint patterns. The investigator should follow the procedures and precautions discussed in Chapter 8 of this book.

Sketching of bloodstain patterns

The final step of documentation of bloodstain patterns is the use of sketches. Sketches of bloodstain patterns can be stand-alone or incorporated into the general crime scene sketch. The local district attorney or state attorney should be consulted before any bloodstain patterns and reconstruction are used for trial purposes.

Acetate overlays with the bloodstain patterns can be used on the general sketches without altering or changing the sketch. Many commercially available computer programs for bloodstain pattern documentation and reconstruction have gained in popularity for use by law enforcement agencies. One advantage of the computer sketch programs is that they allow for three-dimensional sketches that are useful for reconstruction purposes and it is easier to plot the bloodstain evidence in scale.

GLASS FRACTURE PATTERNS

Broken glass at crime scenes can sometimes aid in reconstruction, providing information about the events which took place, and assisting in proving or disproving an alibi or witness's story. Glass fracture patterns are most often associated with burglary, criminal mischief, shooting incidents, and fire scenes. The most common types of information that can be obtained by studying glass fracture patterns are:

- Direction of impact force applied (from inside out or outside in).
- Approximate force of impact.
- Approximate angle of impact of force.
- Determination of the type of glass fracture.
- -Determination of the sequence of firing, direction of firing, and the type of firearm for the projectile holes present.
- -Estimation of the fire temperatures, direction of fire travel, and the intensity of heat from the melted glass.

The use of glass fracture patterns in crime scene reconstruction relies on careful recognition, documentation, and study of radial and concentric glass fracture markings. Other information for reconstruction is obtained by analysis of rib marks, spatial relationships, crack marks, and the condition of any melted glass.

To conduct even a basic reconstruction based on glass fracture evidence, investigators should be familiar with the different categories of glass and generally how each type of glass fractures. Glass is an amorphous, super-cooled liquid, composed primarily of silicon dioxide (sand). There are three general classes of glass: plate, tempered, and safety. Each type of class has certain characteristics, and will fracture differently.

Plate glass is a common variety of glass used to make windows and mirrors. When plate glass is exposed to a force significant enough to rupture the surface tension and break the glass, characteristic pie-shaped glass shards are formed. If broken glass remains in the frame the observed fracture pattern will consist of a center point, where the force contacted the windowpane, with radiating (radial) fracture lines going out from the center point. In addition, there will be fracture lines running perpendicular to the radial lines,

concentric fracture lines. Photo 10.18 shows the radial and concentric glass fractures. By carefully examining a broken edge of a piece of glass along a radial line, you can determine the direction of force. This analysis is helpful in determining from which side of the glass the window was broken. Investigators can use this information to confirm a false burglary report by showing that the window was broken from the inside out rather than outside in as reported by the homeowner.

Safety glass is found in automobile windshields. Basically, safety glass is two separate panes of plate glass adhered together with a clear laminated layer. While this glass fractures in a similar way to plate glass it remains intact after breaking due to the laminate layer. Safety glass was designed to reduce injuries to passengers should they be propelled into the windshield as the result of a traffic accident. Caution must be exercised when interpreting safety glass fracture patterns in that there are two separate panes of glass, which will have independent radial and concentric fractures.

Since safety glass remains intact it can provide valuable information in shooting incidents. The direction of each gunshot can be determined by locating the crater, which is located on the side of glass facing the impacting force. Also, if more than one bullet penetrates the windshield it is possible to sequence the shots if the bullet holes are close enough together that their separate radial fracture lines converge. The subsequent bullet hole can be determined because radial lines from that bullet hole terminate where they meet the existing radial line from the prior fracture. Figure 10.7 explains the formation of fracture marks and the direction. Photo 10.19 shows the radial fracture and the concentric fracture on the windshield of a vehicle.

Tempered glass is a single pane glass that is durable and difficult to fracture due to its significant surface tension. When enough force is applied to break this surface tension the entire pane of glass fractures into thousands of small pieces, commonly referred to as dicing. Tempered glass is used in side windows of automobiles. In most cases a vast majority of the diced glass falls from the window frame, into the car and on the ground. Many investigators fail to realize the potential value of this evidence, and therefore fail to collect all of the glass fragments. While it is a daunting task to reassemble the thousands of diced glass fragments this precise exercise can yield valuable information. Photos 10.20a–d show reconstruction of a bullet hole location from diced window fragments. It is possible to reassemble the diced window and determine the location at which the projectile struck the window, the direction of the projectile flight, an approximate angle of incident, and in some cases whether more than one projectile struck that window. This type of reconstruction is very helpful in shooting reconstruction cases where one or more side windows have been broken by bullets.

FIRE BURN PATTERNS

Fire burn patterns often provide information on the various factors which led to or caused a fire. Detailed study of the burn patterns generally helps in determining the point of fire origin, the direction of fire travel, and the degree of damage of a fire, which may contain clues for arson investigations. The following is a partial list of common patterns found at fire scenes:

- Inverted cone or 'V' pattern
- Multiple points of origin burn patterns
- Low burn pattern configurations
- Depth of charring patterns or alligator patterns
- Trailer patterns
- Smoke stain pattern Melted material patterns
- Concrete spalling patterns

Every fire forms a pattern that is determined chiefly by the configuration of the environment, the availability of combustible material, and the type and intensity of the fire. From a study of the fire patterns, and a determination of any deviations from normal or expected patterns, an experienced fire investigator can reconstruct a fire scene.

FURNITURE POSITION PATTERNS

At an indoor crime scene, the position and condition of furniture often yields information about the events that caused the pattern, their sequence, and possible actions of perpetrators and victims. Displaced or broken furniture can indicate that a struggle took place. Patterns of disarray in ordinary or expected furniture placement or condition may further reveal actions taken by suspects or witnesses.

TRACK-TRAIL PATTERNS

Occasionally, track-trail patterns are encountered at crime scenes. Proper interpretation of them can yield information about how many persons were present at a scene, whether they were moving about, the nature of the movement (walking, running) and the direction of travel, and whether heavy objects were being carried or dragged. Some of these types of patterns can give class characteristic information or data about the individual responsible for producing the patterns, such as shoe size, stride length, sex, weight, or any abnormalities in movement or gait.

TIRE AND SKID MARK PATTERNS

Tire or skid mark patterns are often seen at outdoor crime scenes, and can provide important reconstruction information for the crime scene investigator. The value of skid mark patterns in traffic accident reconstructions is well known and documented. However, the use of these patterns in crime scene investigation and reconstruction is often neglected. These markings can yield information about the number and types of vehicles involved, the possible speed of travel, direction of travel, whether or not brakes were applied, and whether turns were made. Photos 10.21a–d show some of the skid marks and yaw marks found at an accident scene.

CLOTHING OR ARTICLE PATTERNS

This type of pattern evidence can be subtle or, at times, very obvious! Detailed observation, measurement, documentation, and correct interpretation of these patterns can be valuable and essential in crime scene reconstruction. Some examples of the types of information that can be obtained from these patterns are whether a suspect ransacked a scene, proof or disproof of an alibi, direction and route taken by a suspect, physical contact between persons, persons and vehicles, or between vehicles, disturbances of expected patterns at the crime scene, and possible information about the sequence of events. Photo 10.22 shows a bloody fabric pattern left behind at the scene.

MODUS OPERANDI AND SCENE PROFILE PATTERNS

These patterns are more subtle, and require careful observation, as well as extensive knowledge of criminals and details of their previous crimes. Modus operandi (MO) patterns can link apparently unrelated crimes together at the investigative stage. These patterns include information such as methods used to gain entry to a premises, types of weapons preferred, types of force used, types of language used, the sequence of actions followed by the suspect, types of property taken, and the types of any materials left behind at the scene.

Scene profiles often reveal information with regards to identification of primary v. secondary scenes; active scenes v. passive scenes; organized scenes v. disorganized scenes. A detailed discussion of the different types of crime scenes can be found in Chapter 1 of this text.

SHOOTING SCENES – INVESTIGATION AND RECONSTRUCTION

Reconstruction of shooting scenes is often necessary to determine several factors critical to the investigation. Determining the manner of death – homicide, suicide, or accidental – may be difficult without a reconstruction. In addition to providing investigative information and assisting in accurate conclusions, shooting scene reconstructions can be used to help a grieving family cope with the harsh reality that a loved one took their own life. A reconstruction can also provide information as to the relative location(s) of the shooter(s) and victim throughout the incident. Moreover, a reconstruction can help determine the muzzle-to-target distance, which can be a pivotal factor in distinguishing between a homicide and suicide. Also, trajectory reconstructions can be performed to provide valuable information that can in many cases prove or disprove suspect, victim, or witness accounts of shooting scenarios. While reconstruction in the investigation of shooting cases should be a routine procedure for crime scene investigators, it has historically not been utilized to its maximum ability.

The components of a successful shooting investigation include investigative information, crime scene processing, autopsy and medical records, laboratory examination of physical and pattern evidence, and related reconstruction experiments. As with most investigations the ability to conduct a meaningful reconstruction in shooting cases is highly dependent upon the quality of crime scene documentation, searching, and the collection and preservation of all relevant evidence. In shooting cases evidence such as gunshot residue is prone to destruction or loss if efforts are not made to expeditiously locate and preserve such evidence. Also, in all too many cases not all of the relevant evidence is located before the crime scene is released or lost.

PRELIMINARY STEPS FOR SHOOTING INCIDENT INVESTIGATIONS

Investigative information, including statements from all involved parties, is valuable not only to the overall investigation, but also to crime scene personnel. While crime scene investigators must remain open-minded and objective, investigative information can assist them in their duties. For example, if witness statements or the scenario indicate that the ability to see movements was hindered by poor lighting it would be critical for crime scene personnel to take available light photographs. It would be beneficial to know the scope of the incident and how many potential parties were involved with or witnesses to the incident. Documentation should be taken to corroborate or refute stated observations or perceptions.

Gunshot residue analysis can be of great value in helping determine who may have been involved in the shooting and approximate muzzle-to-target distances. However, gunshot residue can be easily lost if not properly collected and protected. In most cases it is advisable to swab the hands of the victim and any potential shooter for the presence of gunshot residue as soon as possible. Gunshot residue can be collected by swabbing with 5% nitric acid solution and/or collected on SEM collection disks. Collection should be done as soon as possible as gunshot residue will dissipate over a relatively short period of time. A gunshot victim's clothing should be preserved as a gunshot residue distribution pattern can assist in distance determinations. The clothing must be carefully removed, not folded, and allowed to dry.

Clothing from both victim and potential shooters should be seized as it may contain gunshot residue, blood spatter, glass fragments, other forms of trace or transfer evidence, or tears, damage or soil patterns that may be useful for reconstruction purposes. The presence of trace evidence or damage to the clothing may be used to corroborate a statement regarding movement or events during and after the shooting incident.

In cases where multiple shots were fired by one or more shooters it is imperative to account for and locate all associated firearms evidence. This can be best accomplished by conducting a thorough inventory of the total number of bullets each firearm could store and how many are 'missing', number of recovered shell casings, number of bullet holes (entry v. exit if possible), any bullet strikes or deflections, number and type of wound, and to a lesser extent witnesses' accounts of the number of shots fired. Once this accounting has been completed investigators should attempt to reconcile the data and ensure that they have accounted for all possible shots, and recovered all firearms

evidence. The shooting scene should not be released until all evidence is accounted for. At times it is necessary to x-ray the victim or conduct an autopsy to get a clear understanding as to how many bullets or fragments struck the victim, and how many are located within the victim.

ROLE OF MARKINGS ON PROJECTILES

Projectiles found at crime scenes can be examined by forensic laboratories and provide valuable information that can be used in the reconstruction process. Firearms examination by the forensic laboratory can provide information about the type of firearms used in the investigation, such as the caliber of the firearm, type of ammunition used, and rifling characteristics that may provide a list of possible manufacturers and models. Microscopic examination of the projectile may also provide information about the types of surfaces contacted by the projectile after firing.

Weapon-specific markings on projectiles

Markings found on fired projectiles are either class characteristics, individualizing characteristics, or markings received after leaving the muzzle. Class characteristics are markings that are common to a type of firearm, its manufacturer or the particular model of the firearm. Common class characteristics are the number of lands and grooves, their direction of twist, the degree of pitch, and the widths of the lands and grooves. Individualizing characteristics found on fired projectiles are markings that are usually the result of use or wear from the firing of the firearm or were created during the manufacturing process. These markings include striations received by the projectile as it passes down the barrel of the firearm, skid marks, shavings, and uneven wear markings.

Post-muzzle markings and trace evidence

Additional markings that can be used for reconstruction of trajectory are the markings placed on a projectile after it leaves a muzzle. These markings used for reconstruction can be attributed to silencers, intermediate target impacts, and the final impact surface or terminal trajectory marking. Silencers may place additional striations on the projectiles specific to the silencer. Every time the fired projectile impacts with an intermediate target it will maintain the Locard Exchange Principle and receive trace material from the intermediate target. This trace evidence can be identified and individualized to a target on the crime scene. If the projectile passes through the intermediate target, then a pathway of direction will be made and useful for reconstruction. Some additional useful types of trace evidence from intermediate targets for reconstruction are gunshot residues on hands and clothing and patterns of cylinder and muzzle flash. The size and shape of the terminal trajectory surface marking can be useful for reconstruction, as discussed below. The markings on the projectile from the terminal surface will confirm terminal trajectory and as such, are useful in reconstruction. Photos 10.23a and b show the red fiber found on the bullet which provided a crucial link between the bullet and the victim.

MUZZLE-TO-TARGET DISTANCE DETERMINATIONS

Muzzle-to-target distance determinations have been successfully used by firearm examiners for over 75 years. Over the years modern refinements of instrumentation and detection levels have improved the destructive and non-destructive methodologies used. Generally, distance determinations involve a comparison of gunshot residue distribution found on the item collected at the crime scene to laboratory-prepared gunshot residue patterns acquired at various distances. Each step in the preparation, detection, and comparison of the gunshot residue should be carefully documented. Some of the basic steps in the process are:

- Proper at-scene documentation and handling of evidence.
- Visual examination of the target surface – macroscopically and stereo-microscopically.
- Infrared photography (as shown in Photos 10.24a and b).
- -Enhancement and mapping of distribution of GSR particles by chemical reaction for nitrites or lead. See Gunshot Residue Enhancement in Chapter 9.
- Identification and measurement of shotgun pellet patterns if a shotgun was used.
- -Control tests – particle loss/redistribution control, environmental or condition controls, test target material selection, angle effects, etc.
- Preparation of test targets – proper ammunition use.
- Objective comparison and evaluation of targets.
- Determination of range of firing.

Care must be employed in the interpretation of gunshot residue patterns or the lack thereof. There are several relevant factors that may affect the anticipated pattern. The composition of the target surface will impact the ability of that surface to hold and retain the gunshot residue. Also, if the target surface is blood-soaked or wet from rain or environmental factors the ability to recover gunshot residue or locate a GSR pattern will likely be diminished. An acute angle of incident may also reduce the amount of GSR deposited on the target surface. A trajectory reconstruction can help determine the angle of incident.

GEOMETRIC PROJECTION METHODS FOR TRAJECTORY DETERMINATIONS

The crime scene investigator can use two geometric methods for trajectory determinations. One method of trajectory reconstruction is based on physical methods (probes, rods and strings) and the other method is based on optical projection methods (visual sightings and the use of low-power lasers). Whichever method is chosen careful documentation of the entire reconstruction process should be accomplished.

Physical projection methods

- 1 -*Entry hole geometry*: The shape of projectile entry and exit holes in target surfaces can be measured and an estimated angle of entry can be calculated. Most projectile holes are elliptical shaped and by the use of trigonometry (cosine of the ratio of the width to the length of the hole) the angle of impact can be determined.
- 2 -*Probes and rods*: Probes are useful for establishing projectile trajectories if the projectile holes are close together and there is no access to the blind side of one of the projectile holes. Be careful to avoid altering or damaging projectile holes when inserting the probe. Wooden rods, solid metal rods, or hollow metal tubes are useful for this reconstruction method. Use a rod in width close to the approximate diameter of the hole; however, do not use a rod so thick that you have to force the rod into the hole.
- 3 -*Strings*: Longer distances between projectile holes can be aligned using probes with attached strings. Care should be taken not to allow the strings to sag or be deflected by the sides of the holes; this would produce significant error.

Optical projection methods

- 1 -*Optical sighting*: One of the simplest means of assessing the alignment of projectile holes in reconstruction is to align them visually by looking through them. The alignment achieved is only preliminary and lacks precise direction. Photographing the trajectory reconstruction alignment through one projectile hole to the other hole should be attempted.
- 2 -*Low power lasers*: The laser is useful for aligning projectile holes over simple optical sighting because it is capable of defining a straight line over a longer distance. Care should be used with long distances because projectile trajectories are influenced by gravity, which can curve the projectile path. This is especially true with lower velocity projectiles.
- 3 -*Alignment of laser path with projectile holes in walls*: When trajectories end within walls, observational access to the termination point must be attained without disturbing the projectile entry hole. Cutting into the wall close to the projectile hole will allow access. Another technique for gaining access to a blind projectile hole is to use a probe with the laser. The probe (hollow probes work very well) is inserted in the projectile hole (carefully avoiding damaging the hole) and the laser is aligned with the probe to effectively 'extend' the probe.
- 4 -*Documentation of laser beam*: Documentation (video and photographic) should be continuous, but at least done when the laser beam is aligned with two or more projectile holes. Visualization of the laser beam path is enhanced by the addition of smoke or dust. It is difficult to use visualizing smoke outdoors or in any area with air circulation.
- 5 -*Positioning stages*: Commercially manufactured positioning platforms for lasers are available to facilitate the positioning of the laser. The laser head is mounted on a multi-axis stage with appropriate scales for calculations and documentation purposes.

6 -*Angle information from the aligned laser beam:* Protractors and tape measures can be used to establish the orientation and document the location of the projectile holes in relation to fixed points at the crime scene. Plumb bobs, inclinometers, and levels are useful for further insuring correct measurements of angles. After a projectile trajectory has been obtained and documented, a second determination of trajectory should be done.

7 -*Placement of intermediate targets in the laser beam:* Using a laser beam allows for easy interposing of objects or people in the laser so as to check reconstruction scenarios. In the case of soft intermediate targets (mattresses, pillows, cushions, etc.), a hollow probe is very useful. Be careful to prevent possible errors by preventing deflections.

8 -*Dual-opposed co-axial lasers:* As shown above for soft objects a hollow probe is useful for reconstruction alignment of projectile holes. Using a substitute object of the same shape, size, weight, etc. can duplicate scenarios without damaging actual evidence. If projectile holes exist in objects like bodies, two lasers must be used to establish trajectory alignments. The first laser's alignment is established and the second laser is mounted in the beam of the first laser. This placement of the second laser allows for moveable placement of subject 'bodies' in the laser beams.

9 -*Auxiliary alignment targets and lighting issues:* It is difficult to utilize lasers for trajectory reconstruction at outdoor scenes. Night-time experimentation of reconstruction scenarios can work well for these types of scenes. Temporary or auxiliary targets, white index cards or reflective strips can be used to facilitate experimentation in the daylight. Placement of the cards or strips at various locations in the laser beam can allow for successful reconstruction of outdoor scenes in the daytime.

Precautions and sources of error

Post-impact trajectories of projectiles can present errors in reconstruction. Predictions are difficult if the projectile has grazed, ricocheted, or hit a target with a large angle of impact.

For all trajectory reconstructions with intermediate targets, the possibility of *deflection* must be taken into account. In other words, when a projectile passes through an object, there will be some degree of deflection. The degree is established by the nature of the object, its shape, and the way in which the projectile interacted with it. See Table 10.3 for possible sources of error due to deflection factors.

Although two points can be used to establish a projectile trajectory, this is insufficient if deflections have possibly taken place. It is for this reason that the least amount of points is three or more for relatively accurate trajectory reconstructions. In addition, an assessment of the likelihood and possible degree of deflection is necessary for a reconstruction that is scientific in nature. Well-designed controlled experimentation may be indicated. The experimentation should include a range of deflection scenarios and test firings of the weapon to determine its variability.

SHELL CASING EJECTION PATTERNS

Shell casings located at a crime scene can provide valuable information. These casings can be used for subsequent comparisons to suspect guns, to determine if they fired that particular cartridge. If no weapon is found, the cartridge case can be entered into a firearms database, such as Drugfire, IBIS, or NIBIN and compared to a database of cartridge cases. The location of the shell casings may be useful in determining the approximate location of the shooter in reference to the ejected shell casing. Photos 10.28a and b show the casing ejection pattern experiments. While a majority of semi-automatic or automatic firearms eject to the right, experimentation must be conducted with the actual weapon used, or a similar make and model, to determine the ejection pattern of that particular gun. When test firing a weapon to determine the ejection pattern for that gun, several factors must be considered as they may influence the ejection pattern. These factors include: type of ammunition, shooter's hand-hold and body position, whether the shooter was stationary or in motion during the ejection, the ground surface that the ejected casings land on, and environmental factors such as rain and wind. In addition to considering these factors, caution must be exercised in reaching conclusions regarding shell casing ejection patterns in that the observed location of one or more of the casings may not be the true ejection location – the casing may have been kicked or moved by vehicular traffic after being ejected.

OTHER CONSIDERATIONS

Glass fracture distribution patterns

When bullets strike or penetrate glass the subsequent fracture lines can reveal information as to the location of the projectile hole, direction and approximate angle of incidence, and number of sequence of projectiles fired through the glass. Refer to the glass fracture pattern section earlier in this chapter. In addition to the information obtained by examination of the fracture patterns, the distribution of glass debris can be helpful in shooting reconstructions. The starting and ending points, as well as the length of the glass debris field, may provide information as to where the window(s) were initially broken, and the movement of the vehicle after the window(s) were broken.

Blood spatter patterns

Blood spatter analysis is also an important component of shooting incident reconstructions. High velocity impact spatter is associated with high-energy injuries, such as inflicted by gunshots. Refer to the previous section on blood spatter pattern analysis for additional details. Locating a high velocity impact spatter pattern can help determine the relative location of the victim, and corroborate that a shooting occurred in the particular location. When a bullet strikes a blood source both forward and back spatter occurs. This fact can be useful in reconstructions. The presence of high velocity spatter on the back of a suicide victim's hand helps establish the manner of death as suicide, as shown in Photos 10.29a and b.

Accident reconstruction – vehicle dynamics

When a vehicle is involved in a shooting incident the vehicle dynamics and motion must be accounted for during the reconstruction process. It may be beneficial to utilize an accident reconstruction expert to examine skid marks and vehicle damage to approximate the speed and direction of travel before, during, and after the shooting incident. While accident reconstruction alone will rarely answer all of the relevant issues, it is one of the many available methods or examinations that may be used to conduct a comprehensive shooting scene reconstruction.

SPECIAL ISSUES ASSOCIATED WITH POLICE OFFICER-INVOLVED SHOOTINGS

While the basic issues and needs for proper crime scene documentation and processing are the same whether or not the shooting incident involves a police officer, there are special issues associated with police shootings. If police-involved shootings are not investigated and handled correctly and thoroughly the involved police agency, individual officer(s), and entire criminal justice system will likely face severe criticism, loss of public trust and confidence, and exposure to large civil liability. Police chiefs, District Attorneys, and government leaders need to prepare for the high level of scrutiny the incident and their subsequent actions will undergo. Also, they must formulate their plans in a manner to guarantee as much independent objectivity into the investigation as possible. Further, they must recognize difficulties that often complicate police-involved shootings such as lack of witnesses.

Police shootings will certainly attract significant media attention and public interest. Often public impressions are established in the early hours of the investigation, and with minimal or no input from the police department. It is imperative to expeditiously and accurately report relevant information to the media through an organized public information system. Failure to respond to basic media inquiries or questions will likely be viewed as a defensive posture. However, caution must be exercised not to be premature in conclusions or comments. As the investigation proceeds and concludes it is often beneficial to meet with civic leaders and groups as well as with media representatives, in addition to family members and legal counsel for both the involved police officers and the shooting victim's family.

Perceptions are a reality that police chiefs and leaders must be aware of and account for in their actions. Where possible, the entire investigation should be conducted by an external agency. The District Attorney will have the ultimate responsibility of determining whether the shooting was lawful and justified. However, police or laboratory personnel will likely conduct the crime scene processing and investigation. If there are insufficient local resources for an outside agency to provide the crime scene and investigative functions then supervisors need to ensure that all personnel involved in the investigation are not closely associated with any of the involved officers. Further, since this case is likely to be highly scrutinized, and litigated in some forum – likely civil court – every available resource and expert should be utilized. If the forensic laboratory or crime scene

unit has expertise in shooting reconstruction or related disciplines it would be advantageous to involve them as soon as possible, most likely at the initial crime scene. There are some common characteristics in police shootings that can create investigative challenges. In many cases, there is a lack of witnesses, at least available witnesses within the early portion of the investigation. The individual wounded during the encounter may be dead or incapacitated to the point where they are unavailable to interview. The officers involved in the shooting are more frequently exercising their constitutionally protected rights and availing themselves for questioning at a later date in the presence of legal counsel. As a result it is possible that the crime scene processing unit will need to perform their functions with little or no background information.

REQUIREMENTS FOR RECONSTRUCTIONS AFTER CRIME SCENE RELEASED

All crime scene photographs, autopsy reports and photographs, videotapes of scene, measurements, notes, crime scene reports, and laboratory reports of physical evidence testing that are available must be thoroughly studied. Whenever possible, visiting the crime scene at the time of the incident and direct observation of the scene and patterns is most desirable. Complete and accurate documentation of a scene is also important. Direct examination of the physical evidence to observe any type of damage, stains and conditions will provide the best opportunity for later reconstruction analysis. It should be noted that complete reconstructions are often not possible. However, partial reconstructions – reconstructing certain facts or aspects of the events without necessarily being able to reconstruct all of them – can be extremely valuable for the case investigation. Information developed through reconstruction can often lead to the successful solution of a case. Investigators and laboratory personnel (as well as medical examiner personnel in death cases) must cooperate and work together to document every important aspect of a scene, carry out analysis of the physical evidence, and conduct a thorough and unbiased investigation of a case and share all the necessary information for reconstruction. A team approach concept should always apply to crime scene investigation and reconstruction.

WRITING A RECONSTRUCTION REPORT

GENERAL RECOMMENDATIONS

- 1 Two examiners should review and sign the report.
- 2 State what materials were reviewed and used as a basis for the report.
- 3 -Be accurate and in complete agreement with notes taken during the review and reconstruction process.
- 4 Use labeled photographs to aid in articulating your observations and comments.
- 5 Do not interject or rely on unsubstantiated information.
- 6 Clearly state any relevant facts or circumstances not known to you.

- 7 If your interpretations are limited due to a lack of data state this.
- 8 Do not over-commit or too narrowly limit your opinions and observations:
 - (a) -Use words like: consistent with, similar to, most probable, inconsistent with available data or facts, inconclusive, cannot be determined with the available information, etc.
 - (b) Keep an open, objective mind.
- 9 -Restrict stating opinions until the summary or conclusion; keep facts, observations, and data separate.
- 10 -Be prepared to objectively evaluate a hypothetical with the stated facts, arriving at a different conclusion or opinion.
- 11 -Be general; many of the underlying details should be reserved for oral testimony – remember, anything written will be carefully reviewed by other experts.
- 12 Stay objective and true to the facts.

Any reconstruction can only be as good as the information provided. Information may come from the crime scene, physical evidence, records, statements, witness accounts, and known data. The process of information gathering and its use in reconstruction show the scientific nature of crime scene reconstruction and will allow for its successful use by investigators.

Figure captions

Figure 10.1 Stages of physical evidence examination

Figure 10.2 Fact-gathering process.

Figure 10.3 Flow chart depicting the basic stages in crime scene reconstruction.

Figure 10.4 Diagram of impact angle.

Figure 10.5 Trigonometric calculation of impact angle.

Figure 10.6a Two-dimensional point of convergence of impact splatter.

Figure 10.6b Impact splatter's three-dimensional point of origin determination.

Figure 10.7 Rib and hackle marks on side of broken glass.

Photo captions

Photo 10.1a-c

A Connecticut State Police Lieutenant was struck and killed by a tractor trailer unit as he was assisting a disable motorist on the hard shoulder of an interstate highway.

(a) Overall view of the right side of the truck matching the description of the evading suspect truck. Note the swipe mark in the dirt below the trailer number, 160.

(b) View of the Lieutenant's shirt, depicting the Connecticut State Police shoulder patch.

(c) Close-up view of the mark on the trailer after the image was enhanced and photographed. The state Police shoulder patch is clearly visible.

Photo 10.2 The diameter of the blood-stain increases as the distance falling is increased until the distance reached is 48 inches or greater. At this distance the diameter remains constant.

Photo 10.3a-c Effect of target surface on shape of blood droplet.

Photo 10.4a-c Effect of impact angle on shape of blood droplet.

Photo 10.5a-b Husband and wife were beaten to death in their basement. Examination of the depicted blood trails, and DNA testing of samples of these blood trails assisted in the reconstruction and determining which blood trail, associated with which victim, and the sequence of events at the crime scene.

Photo 10.6 Overall view of impact splatter.

Photo 10.7 High velocity impact splatter.

Photo 10.8a Shooting experiment apparatus designed to demonstrate forward as well as backward splatter associated with high velocity impacts.

Photo 10.8b Close-up view of forward and backward high velocity impact splatter on surfaces located 6 inches from the source of blood.

Photo 10.9 Arterial gushes. Shooting victim's two arterial gushes on wall and vacuum cleaner as an intermediate target.

Photo 10.10a-b Examples of blood flow patterns.

Photo 10.11 Pattern associated with repetitive blood dripping into pool of blood.

Photo 10.12 Examples of cast-off bloodstain patterns.

Photo 10.13 Examples of contact transfer patterns formed when footwear is in direct contact with a bloody surface.

Photo 10.14 Bloody swipe patterns located on a wall directly above a homicide victim.

Photo 10.15a-c Photographing bloodstain patterns.

(a) Overall

(b) Stains identified

(c) Close-up of bloodstain

Photo 10.16 Example of road mapping technique for the photographic documentation of blood splatter patterns.

Photo 10.17 Close-up view of bloodstain patterns with ruler, markings, and proper illumination.

Photo 10.18 Glass fracture pattern depicting radial and concentric fracture lines.

Photo 10.19 Multiple bullet holes in automotive windshield.

10.20a-d (opposite)

(a) Depicts all of the diced glass fragments recovered from the scene of a shooting in which the fatal bullet penetrated the driver's door window.

(b) The fragments are sorted in preparation of a reconstruction process designed to locate and reconstruct the area of the window where the bullet penetrated.

(c) Close-up view of the reassembled bullet hole.

Photo 10.21a-d

Tire marks on the pavement and snow covered shoulder from a vehicle that went off the road at high speeds.

(a) Overall view of the tire skid and yaw marks on the pavement.

(b) Close-up view of a portion of the yaw marks.

(c) Additional skid marks before the vehicle left the paved portion.

(d) Tire marks in the snowy shoulder after the vehicle left the road.

Photo 10.22 Bloody fabric impressions on a wall.

Photo 10.23a Close-up photograph of the end of a bullet, suspected of having passed through a shooting victim. Note the red, fibrous material.

Photo 10.23b Photomicrograph of the red material removed from the bullet. This material was examined and found to be consistent with fibers from the victim's coat.

Photo 10.24a-b

(a) Black-and-white photograph of bullet hole in dark-colored polyester pants.

(b) Infra-red photograph of the same area; note the gunshot residue pattern around the bullet hole in the center of the photograph.

Photo 10.25a A bullet hole was found in the interior surface of a garage. A string was extended from the inside of the same wall also depicting the flight path of the bullet.

Photo 10.25b Optical sighting method. Hole in wooden wall found near bullet.

Photo 10.26a View through cut-out showing the general direction of the bullet trajectory.

Photo 10.26b Close-up of a bullet hole located in a wooden wall. A wooden probe was used to demonstrate the trajectory.

Photo 10.27 Use of laser light to locate bullet trajectory. A smoke agent was used to help visualize the laser beam. The tarp was held in place to reduce air flow.

Photo 10.28a-b Shell casing ejection pattern experiment. The different distribution patterns depicted in the photographs are due to a change in the shooter's hand position.

Photo 10.29a Bloodstained hand of suicide victim. Note the fine droplets among the bloody residual on the back of the hand.

Photo 10.29b High velocity impact spatter on the palm of a homicide victim's hand. The victim's hand was in close proximity to his head when he was shot.

Table captions

Table 10.1 Identification by physical and morphological properties.

Table 10.2 Serological evidence laboratory results for reconstruction.

Table 10.3 Factors influencing deflection of projectiles.