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## Forensic Evidence

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- 2.2 Compare and contrast indoor and outdoor crime scene searches.
- 2.3 Explain the challenges in collecting physical evidence.
- 2.4 List the most common equipment used at a crime scene.
- 2.5 List and describe major functional areas of the contemporary forensic lab.
- 2.6 Contrast the roles of crime scene technicians and criminalists.
- 2.7 Explain the importance of documenting activities at a crime scene.
- 2.8 Explain the CSI Effect.

## Running Case: Crime Scene Analysis of Evidence at the Floridan

For the next 2 hours, Detective Bradley Macon watched Charla Lynne, the crime scene supervisor, oversee the investigation of the obvious homicide. Two crime scene investigators directed the scene search, documented evidence, and handled items. These items would either be taken for processing and lab analysis or be logged in to the property room and held in the case.

Charla Lynne immediately asked the bar owner for closed-circuit television (CCTV) footage from inside the Floridan. Watching this footage, it seemed that the victim and another man may have met and possibly argued. Bradley Macon knew that argument-based, or confrontational, homicide was the largest category of criminal homicide. Usually it involved a young man who had perceived some insult from another (usually) man. Often there had been alcohol or drug influence on the thought processes of the men, and perhaps even an “audience” of others who did nothing to break up an escalating argument, or actively encouraged it, probably never thinking it could end in someone being killed. In this case, the video showed two men on the dance floor engage in a standoff with aggressive body language. When the two men began shoving one another, it was obvious they were in a heated argument. Shortly after the fighting, they both fled the dance floor and exited the CCTV footage. Charla Lynne assigned another investigator to follow the footage to see if the men reentered it.

FTO Wes Thompson and his trainee, Officer Carl Jayden, two of the patrol officers who initially responded to the shooting, found a 9 mm semi-automatic pistol lying on top of cardboard boxes in a dumpster close to the north end of Milton Way, in the path of the person who fled. Charla Lynne photographed the weapon, gathered the pistol and “made it safe” by first noting the bullets in the gun and their position, and then removing them, then safely packaging the gun to be transported to the ballistics section of the local lab. “We’ll get this test-fired. Try to find a match with the bullet from the victim,” she said to another technician. “Order gunshot residue (GSR) testing.”

Charla Lynne and the second technician used paper to bag the victim’s hands and torso area. It would be important to rule out that the victim had not also held and fired a gun.

A uniformed officer stood outside the bar and controlled and noted who entered the scene. Milton Way was short enough that there were no intersecting streets. A half-dozen businesses had backdoors opening into the alley, and there was a streetlight at either end, though the one where Milton Way intersected Ninth had a burnt-out bulb. One of the crime scene technicians documented this with a photograph and a written notation.

Because this was a public street, the investigators did not have to obtain a search warrant, although they did assign someone to contact each business owner on either

side of the alley to ask if they had security cameras or any further information. Police department administrators had learned that a community-oriented policing approach meant keeping the business people up to date about the homicide was good policing.

In addition to the two potentially valuable pieces of physical evidence, Detective Richard Ashley was interviewing the bar employee, Bubba Paul. This quick on-scene interview would be followed by a complete one at headquarters.

By now it was 7:30 a.m. and the sun was already turning the night's dew to steam on the pavement. Satisfied that all evidence had been documented, Detective Bradley Macon prepared to leave the scene. Working with professionals, he did not need to remind anyone that reports and preliminary observations had to be completed before anyone went off-duty. By 10 a.m. that day, Sergeant Mike Joseph would be conducting the first of several formal reviews to ensure all steps were being taken. The case management software, or CMS, the department now used improved the comprehensive approach by applying a relational database and automated checklists to help avoid missing an important task or case detail.

By 8 a.m. the crime scene specialists released the victim's body to be transported to the morgue. Detective Bradley Macon left the crime scene and drove to headquarters.

*Why is it important that each action taken by personnel is fully documented? Why did officers canvass the businesses in the area?*

## Introduction

Science and technology as well as the training and education of those who wield it cannot be overemphasized as we consider identifying and collecting physical **evidence** as well as criminal investigation overall. Because various scientific methods of the last two centuries have been brought to bear to assist the investigation of crime, tremendous improvements have been made in the process and the outcomes of the criminal justice system. Few people in contemporary society have not absorbed information about science and technology specifically related to criminal justice and a fair few have succumbed to the fanciful efforts of Hollywood in believing that a criminal investigation is not complete without whiz-bang technology and the employment of science. That such a version of the intersection of crime and technology exists in society is not shocking, but it does require perception and expectation management.

These fanciful stories of crime, criminals, and the detectives-cum-scientists who solve the mysteries are tempered somewhat by reality shows such as A&E's *First 48*. There is a concern by many in the public that along with popular television and movie depictions, as well as documentaries about crime and solving crime, people are being taught how to cover up crimes and effectively evade law enforcement efforts. This is not an unreasonable concern, though there is little evidence those criminals who were not already overly cautious have grown more sophisticated in covering their tracks. Crimes such as homicide often occur

**Evidence** Facts supporting the proof of a thing.

rather quickly and lack the element of premeditation or planning. In such circumstances the perpetrator is hard-pressed to perform the professional “cleaning” that appears with some frequency in fictional portrayals. Even if some degree of knowledge gives the criminal a potential edge, the ever-increasing expertise of criminal justice personnel using increasingly sophisticated equipment likely mitigates any effect. Murderers may on the one hand try to obscure any evidence of their presence at a crime scene. On the other hand is the admonition by many professionals with a great depth of experience in death investigations (and other crimes) to stick to established protocols and remain persistent in the human process aspects of the investigation. This is captured well by Adcock and Chancellor when they point out, “If modern detectives have an Achilles heel or weak point, it is in the overreliance and dependence on forensic evidence” (2013, p. 21). As we discuss gathering and processing evidence, it is important to consider the role of officers and investigators to understand the continuity needed in matters of physical evidence.

Entire books are written on the subject of crime scene work, laboratory analyses of different types of evidence, and crime scene reconstruction. Our aim in the book is to review some of the aspects of crime scenes, some services provided by forensic laboratories, and the personnel who devote their talents and expertise to both. Just as investigations are generally categorized as either preliminary or follow-up, so too can the use of technology be divided. Tasks that patrol officers or crime scene technicians perform at an initial scene are intended to document and preserve potentially perishable evidence, whereas follow-up tests in the laboratory generally are confirmatory of what has been gathered at the crime scene. The criminalists who work to test evidence in the laboratory setting coordinate closely with detectives during the follow-up phase of an investigation.

Some of the initial questions at the scene of a crime may be about what a particular substance might be, for example, is a stain blood, or is there gunshot residue on a suspect’s clothing? So-called **presumptive tests** can provide an initial answer to such questions. Presumptive tests are also to determine if certain circumstances are drugs or explosives and if liquids at an arson may be flammable fluids or vapor residue. When certain substances are exposed to a chemical reagent they can provide a positive or a negative reaction that suggests a need for further laboratory testing for confirmation of the makeup of a substance.

#### Presumptive

**test** Analyzes a sample and determines that it is either not a particular substance or that it probably is a particular substance.

## How It’s Done

### FIELD TESTS

Field or *presumptive* tests are used to determine the probable nature of a substance found. These can include tests for human blood, semen, drugs, gun-shot residue, and more.

The initial testing done at the crime scene, if it shows a positive result, will likely need to be sent along to a laboratory for verification.

The use of field tests can assist investigators in understanding the incident and can even provide probable cause for an arrest. Importantly, though, the use of such presumptive tests can help eliminate a person from consideration as a suspect so that officers can move on to focus on more viable suspects and clues to follow.

## The Developing Science of Criminal Investigation

Isolated efforts at applying the science of the day to a criminal matter have been noted throughout recorded history. Observations by physicians about the cause of death have been made since the time of Julius Caesar. Various Eastern and Middle Eastern cultures utilized the uniqueness of fingerprints in business dealings. The identification of traces of poisons in the body has similarly been developed in various countries over a long period of time. These scientific periods in the evolution of U.S. and Western criminal investigation generally act as an overlay to the human and governmental efforts at progress in the investigative field. To aid you in considering the advances of science related to crime detection, the following periods illustrate how we have gotten to where we are today and why that matters in considering contemporary use of science and technology. These periods of time do not have specific beginning and ending dates; rather, they coincide with society developing, as have scientific advances.

### The Prescientific Era

The prescientific era describes the time when little or no use was made of recognized scientific methods or technological devices. The period was marked by physically harsh interrogation techniques and the questionable use of information by informers accusing and convicting with little hindrance of physical facts. We noted previously the early efforts in the 1800s at organizing the police function itself, first with Sir Robert Peel in London, and later as formal agencies were created in the larger cities in the United States before spreading west to catch up with the pioneering migration. Crime as a topic in literature has existed for a long time, yet the genre of crime fiction only began to develop in England during the 18th century. Intrepid individuals observed clues in the behavior of people to deduce guilt for the entertainment of the reader. With the slowly developing institution of policing as it moved from addressing crimes of disorder in the streets to an additional role of retroactive investigation, popular stories followed. It would be some time before the plot device of the scientific method would feature prominently in the fictional reflection of the societal endeavor of determining “whodunit.”

### The Scientific Era

By the time that Sherlock Holmes was becoming popular in the late 1800s as Sir Arthur Conan Doyle’s deductive genius, applications of the science of the day were being increasingly seen. The fictional Sherlock Holmes was patterned after real-life Frenchman Eugene François Vidocq, who, like most of the Bow Street Runners, began as a criminal himself before creating a private detective organization that evolved into France’s national police force. Vidocq (1775–1857) was first to use plaster cast shoe impressions, early ballistics, and undercover agents that grew out of the model of informers who had close ties to the criminal underworld.

Also in France, Alphonse Bertillon (1853–1914) introduced the concept of identifying people by their unique body structure and features. The system, known as anthropometry, also included scars, marks, and tattoos now standard shorthand in the lexicon of law enforcement and embraced by U.S. and UK police in the 1880s. While fingerprints were increasingly recognized as unique from person to person during the late 1800s, Sir Francis

**Biometrics**

Measurements of the human characteristics that serve to identify individuals.

**Forensic science** The application of science to criminal and civil matters of law.

Galton (1822–1911) systematized the shapes and patterns of the prints that allowed an organized classification method of using fingerprints for identification and published his findings in the book *Fingerprints* in 1892.

In addition to work in the area of **biometrics** and measuring individual human features, others examined substances by applying the scientific method and increasingly technological devices. Mathieu Orfila (1787–1853), a French chemist, is credited with a good deal of work involving the effects of poison on the human body and specifically in death cases. Orfila is credited with founding what we still refer to as toxicology, science that has aided in numerous death investigations. Calvin Goddard performed possibly the most recognized early work in forensic ballistics, writing an article of the same name in 1925. Goddard researched and wrote on ballistics and firearms identification and did much to move the fledgling field forward and creating the first private crime laboratory in the United States. Goddard also popularized the use of the comparison microscope and performing ballistics comparisons, which spread back across the Atlantic to the UK. With the ever-increasing use of firearms in American crime, the development of this particular subfield of the **forensic sciences** was inevitably important.

Edmond Locard began the first police laboratory in France in 1910. August Vollmer, then chief of the Los Angeles police department, formed a similar laboratory in 1923 using the services of an officer who received his science training as a dentist. As the 20th century unfolded, the FBI and many larger cities formed crime laboratories of their own. This brought the need for the training of criminalists that was somewhat standardized by an expectation of applicants possessing a bachelor's degree in one of the hard sciences such as biology or chemistry. Hans Gross, an Austrian lawyer, published his 1893 book *Criminal Investigation*, which further spurred the development of the field as a serious endeavor. The use of the scientific method gained more widespread support as applied to forensic science throughout the 20th century as technological advancements aided the gathering and examination of evidence to be tested by science.

### The Technological Era

The capabilities brought about through scientific examination of evidence required increasingly sophisticated and sensitive equipment to detect and collect. Cameras became common for examination and collection duties at crime as portability increased and cost decreased. Various powders and tools used to collect fingerprint evidence, magnifying equipment to observe trace evidence, and specialized tools to gather the evidence have continued to develop and to become more effective.

The technological period can be seen as beginning in the 1960s as computer databases allowed for the storage and retrieval of large amounts of information about people, vehicles, weapons, stolen property, and more. The FBI's National Crime Information Center (NCIC) was created in 1967 to aid local and state law enforcement in their efforts to identify and locate people and the various items. The resources of the federal government later led to the development of the Integrated Automatic Fingerprint Identification System (IAFIS), a repository for the fingerprint records of millions of suspects and offenders, as well as prints obtained from crime scenes and deceased victims. While many people consider the use of **deoxyribonucleic acid (DNA)** as the “rock star” in the identification of suspect presence or involvement in a crime, it is interesting to note that the method only came to prominence just over 30 years ago. But undoubtedly this application by Sir Alec Jeffries in England to

**Deoxyribonucleic acid (DNA)** Two coiled chains of molecules that carry genetic functions of an organism.



assist in a famous case there was a landmark in the technological period. Once again, the FBI provided the needed backbone to create a database to leverage this developing technology with the **Combined DNA Index System (CODIS)** in 1990.

**Combined DNA Index System (CODIS)** Searchable database of stored DNA profiles.

## Methods of Collecting and Processing Evidence

Whether a patrol officer is looking for fingerprints at a burglary scene or crime scene technicians and investigators are combing through the scene of a violent homicide, a search for evidence is combined with the methods for collecting and processing that evidence. The size, complexity, or perhaps even the notoriety of those involved may dictate the volume of resources devoted to a particular crime scene search and forensic effort. In the case of homicide, for example, research has tied the number of investigators initially assigned to a case to clearance rates in some studies. Yet it is not a simple example of how many detectives assigned results in a case closure. If a large number of officers and support personnel responded to a crime scene but there is little direction or coordination of the activities that go on, a case may actually be damaged more than it is helped.

After law enforcement officers respond to a reported crime and a decision is made to search for or collect evidence the perimeter of the crime scene must first be established. It is generally best to set the perimeter at the outermost distance that seems likely to contain evidence, since investigators can contract the scene as needed but if they have not set the scene big enough evidence may be damaged or lost before realizing the scene should expand. The division of labor at a crime scene investigation is an important aspect of managing the case. Patrol officers secure a scene and determine if suspects or witnesses are present when they arrive. Crime scene technicians will photograph, test for, and collect potential evidence at the scene. And detectives will coordinate with both to formulate further plans for carrying an investigation forward. The patrol officer is crucial at the outset of an investigation to ensure the greatest likelihood of success. He does this by the protection of the scene, the gathering of information on witnesses or others who can provide important information, and by properly notifying and briefing others who become involved in a case. Crime scene technicians and detectives are each specialists who perform specific functions and contribute to the construction of a case.

### Crime Scene Searches: Inside, Outside, All Around

Searching even a relatively simple crime scene requires a plan. Ideally, patrol officers will have closed off the access to an indoor crime scene if they are awaiting other personnel to respond to conduct the processing. Outdoor crime scenes can be challenging to secure if they are in a public place or somewhere of high traffic volume. An additional challenge of the outdoor scene is weather. Evidence can be moved or washed away in a storm, covered by snow, or simply degraded due to heat or exposure to sunlight for a lengthy period of time. Securing either type of scene is a function intended to protect potential evidence from inadvertent or intentional damage as well as to limit access to witnesses who need to be interviewed and to reduce the distractions for official personnel working at the scene of a crime.

The initial crime scene walk-through allows investigators and technicians to develop the plan and approach for locating and collecting evidence. For a large or complex crime scene there may be multiple individuals performing both functions. The planning phase



What are some challenges these technicians may face when processing this outdoor crime scene?

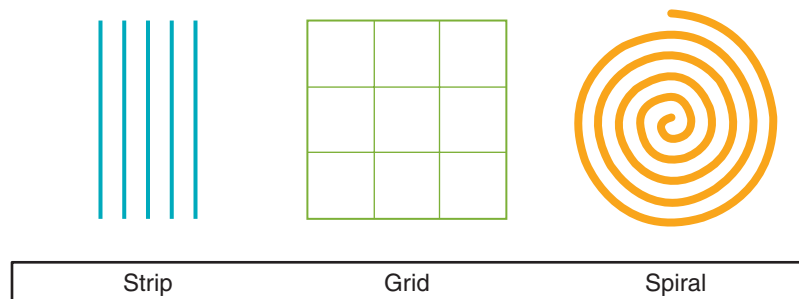
Ben Torres/Stringer/Getty Images

tance from neighboring departments or volunteers who can maintain a perimeter until a search can be conducted. Some volunteer efforts involve the search of large areas such as open fields or woods trying to locate victims, weapons, or other items of evidence. Searchers are given a description of what is sought and clear instructions not to touch the evidence but to signal search leaders to examine what has been found and determine whether it is to be collected for processing.

Search efforts often follow one of several patterns (Figure 2.1) that segment an area to allow searching smaller sections one at a time. This can be done by having a number of people side-by-side walking in a *lane search* or *strip* pattern to try and locate what is directly in their path, or followed with an additional lane search proceeding perpendicular to the first path resulting in a *grid* pattern to increase the possibility of finding an item missed on the first path done in a different direction. A search may also be done in a *spiral* pattern that starts at a central location and works its way outward in an expanding circle shape.

Some crimes may involve multiple scenes at which one or more criminal actions occurred within the same reportable incident. Imagine an individual accosted on the street where he is pulled into a vehicle, driven to another location where he is further harmed, put into a different vehicle where he subsequently dies en route to yet another location, where his body is dumped. Many crime scenes, one criminal incident. Each scene, if it can be located, must be processed with the intention of tying suspects and evidence together in a

■ FIGURE 2.1 Search Patterns





meaningful way. The early and thorough processing of crime scenes is critical, as they generally represent the one best opportunity to identify and collect physical evidence that may be essential in reconstructing a criminal act and identifying those responsible.

Photography and sketching are two methods of documenting a crime scene. Both are important. Patrol officers may sketch a simple layout of a crime scene to assist them in later writing their incident report. Crime scene technicians can perform extensive photography, videography, and computer mapping to create elaborate and precise drawings or animations of a scene. A cautionary note here is that some people including jurors after the fact may expect a sophisticated level of crime scene reconstruction that is not necessarily needed to establish what happened and who was responsible. This is one aspect of the CSI Effect discussed later in this chapter.

## How It's Done

### WHERE WOULD YOU SEEK OUTSIDE ASSISTANCE?

Many local agencies are too small to have specialized personnel to process crime scenes. Departments will often rely on cooperative agreements with state or other local agencies to provide crime scene processing (Hough, McCorkle, & Harper, 2019). Often, the evidence will also be stored at another agency, and

laboratory processing is typically handled by regional or private crime laboratories with only the largest departments housing their own labs. Ballistics examination, fingerprint analysis, and documents, let alone DNA processing, are just some of the specialized analyses requiring well-trained criminalists and laboratory scientists.

In the majority of cases access to the suspected scene of a crime is not at issue. This is when an authorized person gives voluntary consent to officers for the search of a building, a car, or other location. In some circumstances, an emergency may be believed to exist that permits an officer access to a place without consent. If officers can articulate probable cause that someone may be destroying evidence or preparing to flee with it they may be able to enter and search long enough to secure the evidence before gaining a search warrant. Officers may also have a reasonable suspicion that someone's safety or life is in jeopardy, and this too would allow them access to a location. However, in some instances investigators must seek a search warrant from the court to allow access to a location. If there is no imminent threat to life or safety or evidence, or consent from an authorized individual, officers will likely need to present probable cause to the court to obtain a search warrant to seek evidence. The Fourth Amendment to the U.S. Constitution is implicated in these searches, and courts have provided guidance about the circumstances when a warrant is not required.

Whether the officer or technician is searching a building, a private residence in the area closely surrounding it (curtilage), a vehicle, or even a garbage can, the same organized method should be used in each case. Such an approach allows for a thorough examination, as personnel systematically examine one area at a time. As with searching live suspects or dead victims, a structured search method will reduce or eliminate distractions or a lapse in searching. For live suspects this also has implications for officer safety.

## Types of Physical Evidence and Its Processing

Almost any object could be physical evidence, and each type of physical evidence involves specific methods of collecting and subsequently processing. Physical evidence that most people are familiar with includes blood and other fluids, fingerprints, hair and fibers, marks or impressions from tools or weapons on or in the surface of an object, and the list goes on. Physical evidence is also referred to as “material” or “real” evidence and is often presented in court for the judge or jury’s consideration. Once evidence has been recognized as such and documented as to location, officers or crime scene technicians must collect the evidence and arrange for it to be transported to the agency’s property room, laboratory facility, or outside laboratory. This identification, documenting, and collecting, taken all together, is referred to as processing the crime scene. The physical evidence, once identified, may be compared to a **control specimen** to see if they came from the same source. Fiber and paint evidence may be compared in this way to determine if their presence on the suspect or his car, for example, are similar to the same type evidence found on a victim or at a crime scene. One type of analysis that the forensic laboratory can provide are the characteristics of an item of evidence. **Class characteristics** are those that put an item in a category of like items. An example would be width of a blade impression indicating a tool mark to be made by a screwdriver. **Individual characteristics** distinguish an item from others within a category. An example might be a gouge within the screwdriver’s blade that other screwdrivers do not possess.

**Control specimen** Allows comparison between a known sample and an unknown item of evidence.

**Class characteristics** Those attributes of an item that place it within a broader group of objects.

**Individual characteristics** Narrow down the class characteristic that put an item into a group of objects to one emanating from a single source.

**Automated Fingerprint Identification System (AFIS)** Database that allows computer matching of unknown to known fingerprints.

## Advanced Scientific Methods and Sophisticated Technology

Some of the technology that makes its way into movies and shows does exist. The availability of such technology to all agencies is not consistent and often has a waiting time that may render the technology all but irrelevant. Consider DNA samples waiting 6 months or more to be tested. An investigation may have concluded based on other factors or a suspect may flee because sufficient probable cause does not exist without the test results. However, the availability of DNA evidence in, for example, cold cases allows the matter to be reopened when little other physical evidence appeared to link a suspect to a crime (Kirsch, 2006). The idea of DNA comparison results in less than a day is not realistic. A television show may use a computer that automatically scans fingerprints to find a match. This device is the **Automated Fingerprint Identification System**, or AFIS. In real life, once a “hit” or match is located, a trained technician must still examine and compare the prints to determine a match.

Without question, technology has benefited society in general and the investigation of crimes in particular. Many have noted that technological advancement requires careful reflection about the morality of its usage as well as evolving issues in the law. While the public at large is often unaware of or only somewhat concerned with the seizure, for example, of DNA samples from arrestees, there are others who point out that such broad gathering of individual data may have implications for individual rights and carries a possible unjustified stigma that predicts future offending. Some jurisdictions gather DNA samples from virtually everyone arrested, which may have unintended consequences (Cole, 2007). The criminal justice system for a variety of reasons does not always function with the exactitude that everyone would expect or hope for. As Fourth Amendment issues continue to be considered by the courts the laws governing the gathering of DNA samples may certainly change (Maclin, 2006). At the same time, we should note that DNA analysis has also brought the exoneration of people who were wrongly convicted.

## Collecting and Preserving DNA Evidence

While the variety of evidence gathered at a crime scene is almost boundless, DNA has received a great deal of attention because of the ability to match a sample to a specific person or, in some cases, a group of related individuals. DNA evidence and other items examined through scientific methods are given sometimes inordinate consideration by jurors. The profiles arrived at through DNA analysis, for example, are probabilities. As with any of the physical sciences, the probabilities can be quite high—almost to the point of statistical preclusion—and still be called into some question. And while the DNA matching process within the Combined DNA Index System (CODIS) is not exact, the 1 in 7 billion chances of incorrect identification are compelling to most jurors. DNA has been used to exonerate individuals inappropriately convicted of crimes and eliminate those suspected of some crimes. Crime scene technicians are trained and aware of the challenges of gathering DNA evidence, specifically how it can be contaminated during collection or analysis (Aronson & Cole, 2009). Because of the need to always search for additional and more effective methods of analysis, research to improve and supplement CODIS is ongoing (Widyanto, Soedarsono, Katayama, & Nakao, 2010).

Aside from physical challenges to gathering such evidence, DNA gathering from people arrested has raised questions by some people on ethical grounds. The balance of individual rights against the public's crime control mandate sets up the tensions. Some argue that widespread gathering of DNA samples from even those charged with minor crimes can compromise protections from the 4th and 14th Amendments.

CODIS and other local databases aid in solving crimes, even though the volume of requests often result in the criminal justice system awaiting results on backlogged tests (Gabriel, Boland, & Holt, 2010).

Given the challenges that DNA can present during analysis and subsequently in court, technicians and agencies must take every precaution to gather DNA evidence correctly. Still, evidence may not be viable, through no fault of technicians or law enforcement. The National Institute of Justice (NIJ) provides guidelines for the collection and preservation of DNA evidence (NIJ, 2000). NIJ recommends the following precautions:

- Wear gloves. Change them often.
- Use disposable instruments or clean them thoroughly before and after handling each sample.
- Avoid touching the area where you believe DNA may exist.
- Avoid talking, sneezing, and coughing over evidence.
- Avoid touching your face, nose, and mouth when collecting and packaging evidence.
- Air-dry evidence thoroughly before packaging.
- Put evidence into new paper bags or envelopes, not into plastic bags. Do not use staples.

## Firearms, Explosives, and Arson

The use of a firearm in a murder presents a number of opportunities for evidence. Some of the well-known aspects of firearms evidence are the spent projectile and bullet casing and

**Gunshot residue**

**(GSR)** Particulates left on the skin or clothing of someone discharging a firearm or in close proximity to one that has been fired.

attendant markings from the weapon used to fire them, the possibility for **gunshot residue (GSR)**, fingerprints on the firearm, and—if the weapon is recovered—the potential for determining ownership or possession. In reconstructing the circumstances of a death case involving a firearm, the statements of suspects and witnesses may be corroborated by the firearms evidence. Distance between the firearm and the victim may be able to be determined with a reasonable degree of accuracy within certain threshold distances.

According to Fisher, “Firearms identification . . . refers to the study of firearms and includes the operation of firearms, cartridges, gunshot residue analysis, bullet and cartridge case comparisons, powder pattern determination, and the like” (2003, p. 329). This should not be confused with the term *ballistics*, which Fisher defines as generally referring “to the trajectory taken by a projectile and assumes an understanding of physics” (2003, p. 329). Determining the trajectory of a projectile is also useful in reconstructing the crime. Young and Ortmeier (2011) note that it may be possible to obtain:

- Path of the bullet,
- Location of the shooter,
- Sequence of shots fired,
- Which bullet holes or impressions are entry, exit, or ricochet.

The markings imparted by the lands and grooves of a firearm’s barrel to the expended bullet and cartridge casing are unique. If the same type of cartridge is fired from the same gun, it is possible to use a comparison microscope to compare the marks (striations) on both spent bullets as well as both cartridges. Even without the firearm, class characteristics such as a bullet’s caliber can often be obtained from recovered projectiles and cartridge casings. While some in the legal community have challenged the validity of tool mark and firearms identification, the scientific community generally accepts and supports the rigor and validity of the discipline (Nichols, 2007).

As with CODIS for DNA evidence and AFIS for fingerprints, databases were created for projectile and casing information. While the FBI and the ATF both created such information databases, the two merged in 1999 to create the **National Integrated Ballistics Information Network (NIBIN)**. If a “hit” is obtained potentially matching two or more entered records, a firearms examiner compares the items. This protocol is the same as with the other automated systems for fingerprints (AFIS) and DNA (CODIS).

The striations imparted to a projectile from a firearm or the extractor marks left on a casing from a firing pin are two examples of *tool marks*. More generally, marks made by tools or other items used as tools are found at various scenes. Photographs of marks at the scene are collected and then, hopefully, the item that has such marks. Marks can show general size and shape of a tool and, possibly, unique abnormalities of the object that left a mark. If the tool or object is recovered it will be sent on to the crime lab for comparison to the marks left on other evidence as well as to a standard.

Gunshot residue (GSR) may also be discovered at a scene or on the clothing or person of a suspect or victim. When a firearm is discharged, a cloud of residue issues from the muzzle of the weapon’s barrel and possibly from around the chamber (of a revolver). Part of the residue can travel several feet as the projectile moves forward. Some of the residue may settle on the clothes or skin of the shooter and some of the residue may land on other items in close proximity, including the victim or his clothing. This GSR will be tested at the

**National Integrated Ballistics Information Network (NIBIN)** Computerized network available to law enforcement for the comparison of ballistic evidence.

laboratory using a scanning electron microscope (SEM). As some changes in ammunition have occurred, science and technology must keep pace with new analysis methods sensitive to rounds that may not contain lead as in traditional bullet projectiles.

While firearms may leave tool mark impressions on projectiles, employing explosives or accelerants and igniting devices may leave some amount of residues or other physical evidence. Technology has the potential more than ever before to detect, collect, and identify such substances. While criminal homicide in the United States is not frequently accomplished by arson or explosives, arson may be used to attempt to cover a homicide. Most people are familiar with the tremendous explosive destruction and death caused by Timothy McVeigh and Terry Nichols in the bombing of the Alfred P. Murrah federal building in Oklahoma City in April 1995. This homicidal attack killed 168 people and injured more than 680. Forensic testing showed traces of residue in and on McVeigh's clothing that corresponded with the ammonium nitrate and fuel oil used in the bomb. The use of explosives to commit murder in the United States is not frequent, despite the extensive media coverage of this infamous case.

Fires occur where fuel of some type and heat come together in an environment with oxygen. Firefighters and arson investigators are trained to look for artificially introduced oversupply of any of these three elements required for a fire. When an abnormal amount of fuel, heat, or oxygen is present at a scene it can be an indicator of intentional fire-setting. In arson cases there is frequently the presence of an **accelerant**, a liquid fuel source such as gasoline or kerosene intended to ensure the fire builds and spreads. For the laboratory analysts such presence of a liquid accelerant brings into play the gas chromatograph. The gas chromatograph is used to analyze liquids to determine their ingredients. Matching liquid residue possessed by a suspect to a similar residue at the scene can provide important evidence. A spectrophotometer may be used to examine trace evidence found at the scene. This instrument analyzes the waves of energy that make up the characteristic colors given off when a substance is burned. When the various colors are exposed on film they allow for identification of the burned material.

An important consideration in arson cases is the cooperation needed with other agencies. Typically, an arson investigation involves one (or more) fire department and a law enforcement agency. Such cases can, however, involve a task force or the use of state or federal agencies with the expertise and resources to assist. Insurance companies often also have a stake in the outcome of a fire investigation. This fact can lead to assistance from an insurance company, or occasionally interference based on the insurance company's investigators pursuing their own agenda at a scene or in follow-up investigation. Whether it is gun-shot residue, tool marks, or trace accelerant, the discovery and analysis of physical evidence may be the key to solving a case.

### Expert Witnesses

In conjunction with the use of advanced scientific methods and sophisticated technology comes a need for **expert witnesses** to conduct testing and subsequently testify about their methods and results. This expertise is obviously necessary, but there can also be a tendency among some jurors to defer to expert testimony if the jurors simply do not grasp the science (Singer, Miller, & Adya, 2007). The expert opinion can be critical to proper understanding of a case, but as an opinion, the trial judge has to determine if the expert will be allowed to testify based on her credentials and the reliability and relevance of the evidence

**Accelerant** Any substance used to increase the speed that a fire burns or spreads. The substance or mixture may be liquid or solid.

**Expert witness** A person whose experience, training, and education provide the basis for acceptance by a court to testify to his or her opinion on matters before the court.



to be given. This is required based on what is called the *Daubert* standard (*Daubert v. Merrell Dow Pharmaceuticals*, 1993). Jurors must still *weigh* the testimony of experts. Experts must use the accepted methods of analysis in their particular field to evaluate information and arrive at the opinions they offer to the court. Jurors are instructed that though the analysis and information provided are intended to give them a better understanding of a particular process or topic, it is an opinion nonetheless and each juror will determine what weight to give such testimony. The *Daubert* standard was extended to apply to the testimony of non-scientist experts as well (*Kumho Tire Co. v. Carmichael*, 1999).

## Equipment Utilized in Investigations

As we mentioned earlier, the tools used in the location, collection, identification, and comparison of physical evidence are varied—some simple, some quite complex. Just as with the preliminary and follow-up investigations, the equipment utilized in these two phases of the investigation can generally be distinguished. Initial recording of a scene involved one or more photographic and video recordings, measurements and sketches, in-depth descriptions of the scene, and narrative accounts of what personnel did at the scene. The narrative would also include what contamination or human incursions were observed or known.

### Basic Crime Scene Equipment

Patrol officers commonly have access to basic crime scene equipment that allows them to perform rudimentary examination of the scene and perhaps dust for fingerprints and take limited photography. Processing and photography by patrol officers are limited by the equipment the officers have available. Various powders, chemicals, and the applicators to apply them are used for **latent fingerprint** development of oils left behind and visible after applying fingerprint powder, while those impressed in a soft surface, or **plastic print**, collection may be achieved through photography and possibly the use of a casting substance. A bloody fingerprint is an example of a **patent print** where a substance is transferred from someone's fingertips to a surface resulting in the print image being visible. In what is called sequential processing, each print may be processed in more than one way, but in every instance a photographic record should be made before the attempt to process the print in case it is smudged or otherwise degraded. A technician may use an **alternate light source (ALS)** to better view evidence before photography or collection. Basic equipment for the officer will also include lifting tape and print cards to collect latent prints revealed through the use of powders.

An officer may have casting material for impression evidence. Processing this type of physical evidence would also follow photographic documentation, which would include the use of a ruler, scale, or other **reference** in the picture to indicate relative size. The picture is also taken without the reference to ensure adjacent evidence is not covered by whatever item is used for size comparison. Crime scene technicians and specialists also use a variety of basic equipment including measuring devices, plastic forceps for gathering evidence that may otherwise show pressure impressions such as spent bullets, or lighting equipment to facilitate their work. Officers or technicians may carry a variety of presumptive test kits for different types of drugs. Cotton swabs and swatches may also be used to gather fluid or wet evidence, which may be allowed to air dry before transportation and placed into paper containers that can breathe as opposed to plastic or glass, which would seal moisture and often result in degrading or destruction of a wet sample through microorganism growth.

**Latent fingerprint** Visible print after powder is applied to the residue from oils of the hand.

**Plastic print** Impression of a print left in a soft surface.

**Patent print** Transfer of material from a print to the surface leaving an impression.

**Alternate light source (ALS)** Used to discover various types of evidence; ultraviolet light, for example, illuminates natural substances such as semen or saliva.

**Reference** An item of evidence from a known source that allows comparison from a suspect source.

An important piece of basic equipment is often a roll of crime scene tape for the officer to use to erect a visual barrier around the area until it can be properly searched. For crime scene technicians, basic equipment would also include a variety of bags, both paper and plastic, and other containers suited to gathering various types of physical evidence. In addition to items commonly thought of to gather evidence are important pieces of **personal protective equipment (PPE)**. These include filter masks or re-breathing equipment if necessary, impermeable gloves to prevent transmission of chemicals or liquid-borne contaminants to the technician, and clothing covers of various types to limit exposure to harmful agents or the transfer of evidence from a scene to the clothing of an investigator or technician.

**Personal protective equipment (PPE)** Items such as goggles, helmets, and protective clothing that shield an individual from various hazards or injuries.

### Advanced Crime Scene Equipment

More advanced equipment, even at the crime scene, may now include devices to scan for fingerprint evidence, chemicals present at the scene, trace materials of many sorts, and measurement and photographic capabilities of great sensitivity and accuracy. Back at the laboratory, science and technology combined have reached new heights in identification of substances in the linking of such substances to people and to places. While tweezers may be viewed as basic equipment, they are used to gather extremely small or fragile pieces of evidence such as hair and fibers that can then be examined through more advanced devices in the laboratory.

It is not uncommon to use vacuum devices to attempt to gather small evidence at some crime scenes.



Investigators use orange powder that fluoresces under ultraviolet light. What role might these fingerprints play in an investigation?

U.S. Air Force photo/Airman 1st Class Micaiah Anthony/RELEASED

### Personnel Safety

The safety of all personnel who assist in processing a crime scene is paramount. From the patrol officer who first arrives at a scene with often unknown people, substances, and evidence, to the crime scene technician tasked with identifying and collecting all manner of items, professionals should be furnished with (and use) personal protective equipment (PPE). Various scenes may contain chemical hazards such as those associated with clandestine drug labs, biological hazards from blood-borne pathogens, and physical hazards from sharp and broken objects or even loaded firearms. Each agency should have established safety protocols to be followed by all personnel. Assessing risk at a crime scene is essential and should be done while also planning the processing of a scene. Various types of protective apparel and equipment exist to safeguard the hands, eyes, respiratory system, and more of employees.

## The Contemporary Forensic Laboratory

As discussed earlier, the current technological era has built upon the scientific era to provide modern investigators with tools and testing capable of great sensitivity and accuracy for the

examination of many types of physical evidence. Some of the capabilities found in various laboratories include trace evidence including fibers and residues, fingerprint comparison, firearm ballistics and tool marks examination, questioned documents (e.g., forgery), DNA testing, other chemical testing including blood, semen, saliva, drugs, and explosives components, to list just a few. Due to the cost of equipping and maintaining such laboratories, as well as acquiring highly trained technicians, criminalists, and scientists, many are run by the federal government or state governments. Some local or regional labs may handle only certain types of analyses, while sending on other types of evidence to larger or private laboratories for lengthier or less common analyses.

While there is no centralized requirement for laboratories to become accredited, many in the United States voluntarily participate in the accreditation offered by the American Society of Lab Directors. As with many accreditations in various fields, it signifies that the facility or organization adheres to accepted best practices and meets the standards set within the profession.

## Personnel

The story of technology and forensics is also the story of the professionals who conduct investigations and examinations. Markedly different from the “triple-threat” fictional characters from television shows such as *CSI*, these real-life professionals do not simultaneously work crime scenes, conduct laboratory analyses, and interrogate suspects. They also do not generally wear high heels or tight suits while visiting crime scenes. We hope you are not surprised by this. Many undergraduate college students enter course or degree programs believing that this type of omni-skilled, high-fashion career awaits them. Each role in forensics is fascinating and important, and requires a singular focus on the requisite skill sets and functions.

### Crime Scene Technicians at the Initial Scene

At the initial scene examination, crime scene technicians locate, document, and collect evidence at the various scene locations. Patrol officers frequently fill this role as well. The job of crime scene technician has gradually transitioned from one occupied by certified law enforcement officer to one of highly trained civilian employees of an agency. This follows the civilianization trend of other positions including communications specialist (dispatchers and call-takers). This evolution recognizes that the higher salary cost of certified officers is not needed for crime scene work and that by having personnel who only conduct scene investigations, the level of specialization increases and results in higher quality work at scenes.

The variance in qualifications for the job is based on factors such as departmental budget, crime rate and volume, top management philosophy, or available interagency assistance. Undergraduate students with various related degrees have had success in acquiring crime scene technician positions. Some retired officers also seek out the job of technician. Hands-on training after joining an agency can be the primary source of training in the various functions of the job.

Crime scene technicians may perform virtually all documentation and evidence collection functions, or there may be role separation resulting in crime scene photographers distinct from technicians who locate and collect evidence as well as perform limited

presumptive testing. The photographer may also perform digital mapping of a crime scene or sketching as appropriate. Once again, this varies with available resources and personnel.

### Laboratory Technicians

Beginning in the early 1900s crime laboratories began to be established, though these were available to relatively few agencies. The FBI established a laboratory in 1932 to make forensic science available to law enforcement agencies around the country. While this marked a step forward in the use of science in criminal investigations, the general lack of sophistication of medium- and small-sized agencies in applying science meant that fully exploiting new and developing capabilities was still some time off.

Personnel who analyze evidence in the lab are generally referred to as **criminalists**. Some crime scene technicians choose to eventually transition to laboratory work. The qualifications for criminalist typically include at least a bachelor's degree in biology, chemistry, biochemistry, pharmacology, or a related core forensic discipline. In some cases a person with a degree in criminal justice who completes a diverse selection of courses in the hard sciences may be accepted to laboratory training programs.

In the laboratory setting criminalists may work in any of a number of sciences, including anatomy, anthropology, bacteriology, biology, chemistry, entomology, pharmacology, and even psychology. Different labs provide different services around the country. Just as with other key areas of public safety resources, the federal government has been a leader in establishing and funding laboratory services.

Crime laboratory growth has been significant, but there is much concern that insufficient national standards exist to ensure the thoroughness of qualifications for personnel and solid integrity of testing protocols for the labs. Various court decisions over the second half of the 20th century required law enforcement agencies to rely more on physical evidence and science in building cases against suspects. This too led to the proliferation of laboratories in the United States. No doubt that the tremendous volume of drug cases inundates labs with testing, as well as the rapid increase in the use of DNA in forensic identification since the mid-1980s.

Technology and forensic capabilities for testing may or may not be readily available to various-size agencies. Large local agencies routinely assist smaller agencies. State law enforcement agencies similarly assist local-level departments in large or complex cases. Additionally, the FBI has various programs and personnel available to assist with coordination, training, and other forms of assistance. The National Center for the Analysis of Violent Crime (NCAVC) is the central entity to facilitate assistance. Within the NCAVC the Behavioral Analysis Units (BAU) are most known to laypersons. The Violent Criminal Apprehension Program, or ViCAP, works to identify linkages among crime locations and methods for homicides, sexual assaults, and unidentified or missing persons.

**Criminalist** An individual (usually degreed) who applies scientific knowledge to analyze evidence.



A lab technician examines an article of clothing for residue. What types of evidence might be obtained from this shirt?

AP Photo/Steve Helber



## Documenting the Crime Scene and Actions

Documentation begins when a department is notified of a potential crime. The call-taker or communications specialist will enter some amount of information, typically, into a computer-aided dispatch (CAD) system, which may integrate to a records management system (RMS) as well as to supply information to an officer in her squad car via a mobile computer terminal (MCT). The initial officer dispatched can enter additional notes via her car computer or terminal, which may also act as a laptop that can be dismounted from the squad car to allow the officer to bring it into a crime scene or location where she is completing an incident report. Developing skills in notetaking and report writing are among the most crucial for law enforcement officers and criminalistics personnel.

### Case Management Software

As the preliminary and follow-up investigations move forward, officers and technicians are documenting their observations and actions through notes and official reports. The management of all information available as well as activities assigned to and completed by various personnel have long been the focus of management efforts to ensure a comprehensive investigation. Modern case management software assists in this effort by more efficiently tracking activities and linkages among many factors present in a given case. Relational databases and other software algorithms feature search capabilities that provide investigators and supervisors a powerful tool. Crime mapping, already mentioned, can further guide investigators to examine whether a pattern exists in reported crimes.

Few would question the impact of the microchip on the world. The original mission of Microsoft to put a computer on every desk and in every home has largely been fulfilled, and this has been a boon to investigators worldwide. It would likely be difficult to locate a law enforcement agency that does not have access to and benefits from personal computers, as well as networked systems that give officers in agencies access to an overwhelming volume of information. Laptop computers are normally found in squad cars, and these devices not only allow officers to query various databases for wants, warrants, driver's license, and other information, but integrate with records management systems to upload reports and information from the investigations officers conduct. The same input capability and database functions allow supervisors to monitor investigative progress. In addition to accountability, computer programs allow various criminal justice and court personnel to upload relevant files and media to the building computer-based record of a case. Crime scene technicians utilize computer-aided drawing programs in the normal course of their duties where before such computing power would be reserved to perhaps architects and engineers.

Because officers and agencies can search and access nearly unlimited sources of information and connect with personnel and other criminal justice agencies with relative ease, intelligence efforts are far more fruitful than ever before, which in turn leads to more effective investigations and the apprehension of offenders. The enhanced effect brought about through application of computer technology also improves the efficiency and effectiveness of police or private contract laboratories processing the evidence located and collected by criminal justice personnel. The exaggerated time frames for processing evidence seen in fictional dramas do a disservice to the complexity of the testing and the high level of skill of the criminalists conducting testing on evidence. The public is generally unaware that circumstantial (also known as indirect) evidence and testimonial evidence are still far more



common than the direct evidence results of esoteric laboratory analyses in securing convictions. And this point is important for prosecutors to make during a trial as jurors await sci-fi-like presentations filled with motion and animated recreations that simply do not exist—and are not necessary in the case at hand. Because resources are sometimes limited and the reality of available forensic testing does not match the fictional depiction on television, agencies often send evidence to private outside laboratories for tests to be performed. Even priority cases take time to process, let alone the backlog that exists for a great deal of evidence at crime labs across the country. And, of course, when those results finally arrive, they may not link a suspect to a crime or a scene (Roane, 2005).

### Photography

As previously mentioned, photography has become an important and expected practice at serious crime scenes and in many instances involving cases that may benefit from a visual record. Improved digital photography, images, and recording have also become relatively inexpensive for agencies to acquire. This extends to the use of such photographic devices in jail facilities for booking an arrestee and helping to manage the inmates throughout their time in the correctional system. Patrol officers routinely use photography to document crime or incident scenes, graffiti or damage to public areas, and to take pictures of suspects, witnesses, or informants. For arrestees as well as suspects, witnesses, and informants, pictures of tattoos and other distinguishing marks can be useful later in an investigation or to identify individuals. Sometimes unidentified bodies have limited identifying features but might have tattoos or scars that can be recorded and noted in state or nationwide databases.

Photos and videos aid the work of detectives and technicians as well as tell the story in court of a crime and the actions taken as a result of the crime. While it is generally true that more photos are better than fewer, personnel should be deliberate in recording images and noting their relevance in the officer's report so that the picture is also authenticated as having been taken by a specific person. Photography is immediate, and though lacking multiple dimensions, can provide a faithful representation of what was seen by the photographer of the evidence or scene. The photos can help present the overview during case preparation. While we again caution about the CSI Effect, we also note that photos can be linked by software to present something of a walk-through that can help the case team, prosecutor, court, and jurors understand the setting. Capture technology allows a three-dimensional mapping of a scene, though this is rarely needed. And while the photographs of a scene can be helpful, the prosecutor must be mindful that the picture can also be cluttered with too many items not relevant to the crime or investigation.

The use of digital or video recording at the scene of some crimes provides perspective that goes beyond photos and aids court testimony by personnel. Scene photography will proceed from the general to the specific. Personnel take pictures of the approach to a scene, overall views, and then photographs that move closer to specific items or aspects of a scene. Close-up views allow examination of evidence in greater detail once the overall state of the crime scene is understood. Poor camera work that wanders or creates distractions is a downside to some use of recording. Photos and videos are also useful in the training of crime scene technicians, lawyers, and obviously, law enforcement officers. **Body-worn cameras (BWC)** for officers continue to grow in usage across the United States, and images are useful in many investigations. Other uses of photography include static and dynamic surveillance, mug shots and lineups, and scene management by crime scene technicians. For detectives

**Body-worn camera (BWC)** Camera devices typically attached to the uniform of a police officer to gather evidence, enhance officer safety, and improve public relations through accountability of officer actions.

and crime scene technicians, the photography allows them to inventory the scene and identify the locations of key pieces of evidence. Technicians may render a drawn-to-scale sketch using computer software generated by the measurements taken at the scene. Case-management software and criminal justice system databases available to court personnel can also make use of uploaded photography and video.

## How It's Done

### CRIME SCENE PHOTOGRAPHY

Crime scene photography is a blend of personnel and equipment. Crime scene technicians follow established methods of photography that include long-range photos to provide perspective on overall layout of a scene that could include how someone may have gotten into or exited from a location, medium-range pictures that give views of specific areas around a crime scene to focus attention, and close-range images of items of evidence. Personnel use a variety of still and video recording and have available film or digital imaging to accomplish documentation of the scene.

While the presence of recording devices in the public is ubiquitous, it is still necessary to explain the context and overall place that a given picture or piece of video has in a full understanding of a scene or event. Dashboard-mounted cameras in police cars, body-worn cameras (BWC) used by many agencies, and

closed-circuit or other pictures and recordings in public areas or in private homes and businesses can all aid investigators.

In general:

- Photograph the exterior of a scene or location first.
- Take photos to provide a sequential depiction of the crime scene narrative.
- Take close-up shots of evidence as well as pictures that provide the broader scene to situate the item of evidence.
- For small or unique pieces of evidence, use a ruler to show scale of the item.
- Use evidence placards to ensure later clarity in referring to individual items of evidence.

### Diagramming

**Computer-aided drawing (CAD), or computer-assisted drafting and design (CADD)** Software used to facilitate design.

Whether preliminary handmade estimates of a scene on the notepad of a patrol officer, or the finished quality of **computer-aided drawing (CAD)**, or computer-assisted drafting and design (CADD) renderings of a crime scene technician, the “drawing” of a scene can be a useful if not critical component of documenting an investigation. The crime scene sketch has value by telling quite a bit about a scene without the embellishment of words that may unintentionally misdirect or place too much emphasis on one item or another. The available reports, and certainly the statements or testimony of the person completing the sketch, can add narrative to the graphic depiction. The sketch is not a replacement for the reports of investigating personnel by any means.

Sketches give perspective to others—and from different angles, depending on the manner in which the sketch was completed. The sketch can aid a witness in recall, refresh officers

and investigators as they review evidence or testify, and help jurors understand the interconnections between pieces of evidence and the actions of those who were involved.

A rough sketch, much like initial notes, can be completed later in detail. The accuracy of the measurements are important so that the final sketch or drawing will be a scaled representation of the scene so the context of witness, offender, and victim actions are understood as well as possible. Multiple sketches may illustrate the larger area outside the crime scene itself, as well as smaller areas of the scene blown up to more clearly understand small items of evidence or their relationship to objects or people.

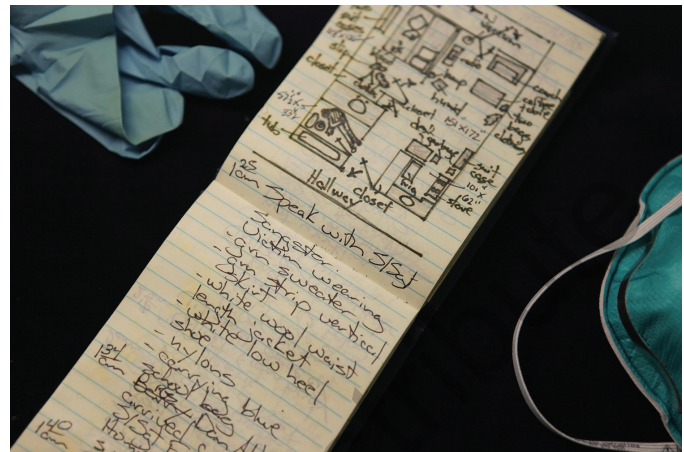
As with other aspects of a criminal investigation, a local department may not have speciality personnel or equipment to produce high-quality sketches. A larger agency may have the resources to assist, and this cooperative agreement should be established against the eventuality of needing large-scale or complex drawings and sketches. Graphic designers can also fill this need for a department. For the purpose of understanding the common tasks of a crime scene, let's briefly look at two of the most common measurement methods for sketching: rectangular coordinates and baseline, and triangulation.

The rectangular coordinate method is perhaps the most simple and involves measuring the position of an object from two other fixed points. This is often done by drawing a *baseline* between the two fixed points, working from left to right, and then noting the distance along and away from the baseline. Triangulation is an overhead perspective sketch that locates the item in question via straight-line measurement from two or more available points of reference.

### Report Writing and Notetaking

Report writing begins with notes: the more comprehensive the better. The initial notes taken allow personnel to re-create the sequence of actions they took including notification of others and assisting other personnel in various tasks. Patrol officers, crime scene technicians, and investigators must all complete thorough reports documenting what they found at the scene of a crime and incorporating information from as many of their senses as apply. It is not unusual for experienced firefighters and arson investigators to note specific smells at fire scenes; officers familiar with the odor of burning marijuana will recognize it on a traffic stop or at the scene of a crime (which also may provide probable cause for certain searches). Each of these personnel may also create sketches and record various photographic or video records.

Officers also document all the information they take in about evidence, suspects, and other persons involved in a crime. Some agencies provide a template or structure to the narrative portion of reports to ensure major aspects of a case are covered. Description of the crime scene, a brief reconstruction of the crime, all investigative actions taken by the reporting officer, and synopses of victim and witness statements provide the basis of a report. The notetaking begins almost immediately and continues as time and activity allow. The notes, while taken sequentially by the officer, will likely be piecemeal and require reordering to construct a



How might these investigator's notes, complete with an initial sketch of the crime scene, be used later in the course of the investigation?

Creative Touch Imaging Ltd./  
Alamy Stock Photo

chronologic description. Officers develop their own method of taking note, including abbreviations and other shorthand to allow quick chronicling of information or statements. Some officers may use a mix of recording notes and writing based on the circumstances.

The formal written report should be thorough and written in clear language without jargon or emotion-laden terminology. An officer or investigator states known facts and not opinions or suppositions. If a victim, witness, or informant makes a statement that is not verified by the officer, the statement should be noted as such. Once all of the information is gathered in the officer's notes, she must organize it and complete the report. No written work is complete without proofreading for spelling and grammar as well as assessing whether all required elements have been included.

### The CSI Effect

The so-called CSI Effect refers to the general belief by laypeople and some in the criminal justice system that they know a good deal more about forensic science and technology than they actually do. Watching any television crime drama and many movies will give one the sense that all things evidentiary in all crimes are vulnerable to a well-dressed technician-detective-scientist who (in the space of 45 minutes and a few commercial breaks) will solve the matter. In an equally misguided alternate version, scores of personnel from various disciplines will descend upon a scene to process every particle, interview every witness, and have someone hand the lieutenant in charge a clipboard to sign every few minutes. We can assure you that neither view is particularly accurate.

The reality of technological aids to investigation is no less impressive just because they are not used as universally on all crimes and with the same emphasis on an eclectic assortment of team members including the cyber-guru ripping and pasting critical pieces of data from, well, everywhere, in time to move the team onto the next exciting scene. Prosecutors must establish juror expectations early on when a case opens at trial when it comes to the contributions of science and technology to a specific case. Lovgren (2004) points out that jurors need to be made aware that neither crimes nor investigations always provide for conclusive physical evidence. Finding trace evidence is not simple and in some cases is beyond the capabilities of the equipment and personnel available. There may also have simply been little evidence at a scene. In this event, technicians and investigators must be prepared to explain what collection efforts they did make and observations that support why potential evidence was not collected. Attorneys on both sides of a case should be up to date on technological capabilities in forensics so that they can request appropriate tests, and formulate a court strategy respecting of the realities.

Prosecutors have become acutely aware that they must educate jurors from the moment when they are selected to serve. If one or more jurors hold unrealistic expectations of what forensic evidence should be present in a case, the result may in effect be an entertainment media-based acquittal. Prosecutors always devote a significant amount of attention to jury selection. Even during this selection process, attorneys may remind prospective jurors that crime, evidence collection, and court are not like what they have seen on TV. In a strategy designed to counteract the CSI Effect, prosecutors may request more scientific evidence to sate the technology appetite of jurors (Hayes-Smith & Levett, 2011). The presentation of more physical evidence, whether it shows guilt or not, can be used to win over the jury.

Research has also shown that people who watch CSI-type programs had higher expectations than those who did not (Shelton, 2008). However, these higher expectations did not directly translate into an acquittal when scientific evidence is not presented.

The higher expectations of both the prosecutor and law enforcement is one of four ways the CSI Effect has been described as influencing people (Smith, Patry, & Stinson, 2007). When the state fails to meet the unreasonable standards of evidence brought about by media expectations, jurors tend to side with the defense. This reality brings a second way the CSI Effect is described; prosecutors have had to change how they present their cases in order to deal with CSI-watching jurors. Third, the CSI Effect has created a huge increase in college students who are interested in the study of forensic science. A fourth impact of the CSI Effect is how it has “educated” some criminals in how to avoid leaving physical evidence or obliterating it to the point it is beyond the capability of many agencies to gather.

### EXPLORE THIS

Navigate the web to the FBI's Handbook of Forensic Services at <https://www.fbi.gov/file-repository/handbook-of-forensic-services-pdf.pdf/view>. In addition to sections on submitting evidence and evidence examinations, the handbook contains a section on crime scene safety. How might this information from the FBI impact the training and preparation of crime scene technicians?

## SUMMARY

Technology is the basis for the application of much of forensic examination and testing. Science and technology have developed over time to provide investigators increasingly sensitive and powerful tools to discover and analyze evidence. From the comparison of tools marks to biological samples, laboratories have become quite effective in linking trace or other evidence from one person or place to another. Computers have also had application for several decades, and they will continue to power aspects of analysis, including crime scene drawings and databases that allow matching of evidence such as CODIS, AFIS, and NIBIN.

Some concern has been voiced that the universal awareness of forensic methods can lead criminals to be better at covering their tracks. However, the professionalism and expertise of criminalists and investigators, in addition to the sensitivity of equipment and testing methods, make us believe that law enforcement will stay ahead in this race. The presence of realistic and nonrealistic

depictions of forensic technology on television and in the movies has led to the CSI Effect with which prosecutors and others must contend. The specialties and subspecialties in forensic personnel and laboratory examination will likely increase. In our brief treatment of technology and forensic examination we did not, for instance, discuss glass fragments, soils and minerals, documents, digital evidence, drugs, hair and fiber evidence, and many other items and corresponding analyses.

Technology plays an important role at the scene and later in the laboratory. At various scenes technology allows crime scene technicians to thoroughly search for evidence and then document and gather the evidence. Photography and videography continue to feature prominently during investigations and in preparing for and presenting cases in court. At the laboratory, criminalists employ many devices and databases to analyze and compare evidence gathered and establish links or connections between objects and suspects.



## KEY TERMS

Accelerant 35	Control specimen 32	Patent print 36
Alternate light source (ALS) 36	Criminalist 39	Personal protective equipment (PPE) 37
Automated Fingerprint Identification System (AFIS) 32	Deoxyribonucleic acid (DNA) 28	Plastic print 36
Biometrics 28	Evidence 25	Presumptive test 26
Body-worn camera (BWC) 41	Expert witness 35	Reference 36
Class characteristics 32	Forensic science 28	
Combined DNA Index System (CODIS) 29	Gunshot residue (GSR) 34	
Computer-aided drawing (CAD), or computer-assisted drafting and design (CADD) 42	Individual characteristics 32	
	Latent fingerprint 36	
	National Integrated Ballistics Information Network (NIBIN) 34	

## DISCUSSION QUESTIONS

1. How have science and technology changed over the three periods of criminal investigation discussed in the chapter?
2. Compare and contrast indoor and outdoor crime scenes.
3. List and explain at least three challenges in the collection of physical evidence.
4. What are the differences between crime scene technicians and criminalists?
5. What is the CSI Effect and how does it impact the criminal justice system?
6. What types of presumptive tests are used at crime scenes? Why?



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