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Crime Scene Guidebook

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CRIME SCENE GUIDEBOOK

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Introduction

There are approximately 77,000 law enforcement and police agencies in the United States. More than 80 percent of those departments have fewer than 100 officers. The current status of crime scene response by law enforcement generally falls into two categories. The FBI, state police/department of investigation and large urban police agencies have developed highly sophisticated, extremely effective evidence response teams with extensive resources and large budgets. These teams respond to numerous scenes of various types where team personnel document and collect evidence. Most of smaller police agencies cannot afford a large crime scene investigation staff or a mobile crime scene unit to process scenes. Often detectives or even patrol officers have to carry out the crime scene process. Thus, there is a critical need to train personnel in small and medium-sized departments to recognize physical evidence, to use both basic and the newest technologies, and to collect and preserve various types of physical evidence at the scene-processing stage. This stage usually determines whether the investigators will succeed or fail solving the crime. Despite advances in forensic science, many cases remain unsolved or are lost in court due to the failure to identify or preserve evidence or because evidence is not properly recognized, enhanced or collected.

Alternately, small and medium-sized departments can take advantage of resources that are available in their region including major crime squads from federal or state agencies, larger cities, local universities with forensic science departments, or forensic centers (such as the Henry Lee Institute of Forensic Science). In addition, a regional team approach has been suggested and attempted by some jurisdictions. In those regions, each department committed at least one detective to a regional crime scene team; members of the team were trained in advanced crime scene processing techniques. Those team members responded to all major crimes in the area, thus providing skilled, experienced investigators for the whole region. This model can be further enhanced by the addition to the team of the forensic institute with its advanced technology and expertise. Such an approach was in practice in Connecticut, where the Henry Lee Institute of Forensic Science provided crime scene technology assistance and training for the local police officers. That program was supported by a recent grant provided by the Department of Justice, Bureau of Justice Assistance. (NIJ grant #2010-DD-BX-K024)

This manual is divided into three sections to assist those in detective divisions or crime scene units, especially those from smaller departments, in evaluating crime scenes and assessing what technologies and assistance may be useful in the processes of recognition, identification, documentation of physical evidence and reconstruction of a crime scene:

Section I provides an overview of crime scene investigation theory and basic crime scene process.

Section II offers information on advanced technologies that are available for use by law enforcement personnel and forensic scientists; many of these instruments may be available at the local forensic science laboratories, universities or forensic science programs. The advantages of these advanced technologies are briefly described. Any equipment or other materials specifically referenced are used for illustrative purposes only and do not serve as an endorsement by the Department of Justice, the National Institute of Justice or the authors.

Section III provides a practical guide to resources, including some useful websites, manufacturer information and crime scene references. In some cases, manufacturers may provide technical assistance as well as application information. Crime scene investigators and police officers can take advantage of the wealth of information and technology available from these sources.

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CRIME SCENE GUIDEBOOK

SECTION I: Crime Scene Investigation

Part 1. Overview

Contemporary law enforcement has greatly expanded its ability to solve crimes by the adoption of advanced forensic techniques and standardized crime scene procedures. Today, crimes often can be solved by detailed examination of the crime scene and analysis of forensic evidence and reconstruction of the crime. Knowledge of forensic evidence is not only crucial in investigations and prosecutions of criminal cases, but also vital in civil litigations, major man-made and natural disasters, and the investigation of global crimes. In addition to analysis of forensic evidence, the successful solving of cases is based upon a system that emphasizes teamwork, traditional detective work, public support, advanced investigative skills (such as GPS positioning, cell phone tracking, video image analysis, artificial intelligence, data mining), and the ability to process a crime scene properly by recognizing, collecting and preserving all relevant physical evidence.

If potential physical evidence is not recognized, collected or properly preserved and tested, the forensic value of the physical evidence is forever lost. Numerous day-to-day and high profile cases have demonstrated the harsh reality that, despite the availability of current crime scene technologies, specialized equipment, and a sophisticated forensic laboratory, the effectiveness in the utilization of physical evidence in crime solving is only as good as the knowledge and the integrity of the crime scene investigator and the objective legal system that supports those functions.

<u>Scientific Crime Scene Investigation</u>

Currently, most of the textbooks in the field limit crime scene investigation to the documentation of the crime scene and the subsequent collection and packaging of the physical evidence. The role of the crime scene investigator has unfortunately been limited to a crime scene technician who is often only involved in the documentation of the crime scene and the collection and preservation of the physical evidence from the

crime scene. Documentation of the crime scene and the collection of the physical evidence are important aspects of the crime scene investigation and must be properly performed. However, these activities are purely routine and mechanical tasks. While the completion of these crime scene tasks is essential in maintaining the integrity of the physical evidence and providing the final outcome of the criminal investigation, any investigator with minimal training and good discipline can perform these tasks with moderate precision. These tasks are extremely important; however they have a limited direct value on the solution of the crime.

Scientific crime scene investigation is a process which not only includes the above aspects of crime scene documentation and physical evidence collection, but also demands and expects more dynamic approaches such as scene survey, scene analysis, development in the links among the physical evidence, the scene and persons, and the reconstruction of the crime scene.

Crime scene investigation is based on scientific reasoning. That means that the investigation of the crime scene involves a systematic, methodical and logical approach. It begins with the initial response to a crime scene, and continues through the scene security, the crime scene documentation, recognition of the physical evidence, the physical evidence processing, the physical evidence collection, packaging and preservation, the physical evidence examination, the crime scene analysis and profile, and ultimately concludes at the crime scene reconstruction. Furthermore, systematic crime scene investigation is based on the principles of the Locard Transfer Theory as well as the Linkage Principle. The utilization of scientific knowledge in conjunction with the forensic techniques of physical evidence examination will generate investigative leads, and, thus, ultimately solve the crime.

Physical evidence obtained from the crime scene or other segments of the investigation is often the cornerstone upon which the successful outcome of the case is based. Yet, many cases are never solved or prosecuted due to the lack of physical evidence. On the other hand, some innocent people are arrested and prosecuted because of witness misidentification or the misuse of forensic evidence. While it is

theoretically possible that a near perfect crime can be committed in which the perpetrator was able to leave minimal evidence, it is more likely that the critical evidence was never recognized and found. Many investigators have obtained the necessary expertise to document, collect and preserve various types of physical evidence. However, the presumed simple task of recognizing critical evidence can often be the failure point of the crime scene investigation. The recognition of evidence, enhancement of pattern evidence at a scene, and the proper preservation of that evidence for further examination are crucial to the success of a case investigation.

One common, yet incorrect, practice at a crime scene is to collect everything that could be, in any possible manner, construed as evidentiary in nature. This approach is not only a waste of time and resources, but could potentially cause legal, scientific and investigative issues; if every object at a scene is collected and submitted to the forensic laboratory for further analysis, the forensic facility will be overwhelmed, and it is more likely that some of the evidence collected will have no probative value. Examination of materials unrelated to the incident can also provide "false leads," which will waste valuable resources and may lead to the arrest and even conviction of the wrong person. Conversely, if critical evidence is omitted, altered, or improperly preserved, no modern, state-of-the-art laboratory instrumentation and technology will be able to salvage the investigation. Hence, a system must be developed in which the relevant physical evidence is recognized and located, while superfluous materials are excluded. This will only result if the crime scene investigators understand the goals of a crime scene search, grasp the concepts and techniques for effective searching, and routinely exercise the discipline to rely on a systematic, logical, structured search process with a completely objective and open mind.

Types of Crime Scenes

There are many ways to classify a crime scene:

1. The original location at which the crime was committed (e.g. primary scene, secondary scene);
2. The type of crime committed (e.g., homicide, sexual assault, robbery);

3. The physical location of the scene (e.g., indoor, outdoor, vehicle);
4. The physical condition of the evidence (e.g., buried, underwater);
5. The boundaries of the scene (e.g., house, train, bank, computer, car);
6. The appearance of the crime scene (e.g., organized or disorganized, passive or dynamic crime scenes);
7. The criminal activity at the scene (e.g., active, passive scenes); and
8. The size of the crime scene (e.g., universal, macroscopic, microscopic scene).

Classification of crime scenes may offer a guide to the investigator on how to proceed with crime scene processing, may suggest types of evidence more likely to be found in the type of case, and may provide a basis for an investigation logic tree. However, classification of the crime scene is sometimes not a clear cut process when investigating a complex situation. Investigators should understand these classification systems and how to develop multiple alternate hypotheses. It is important to keep in mind that there is no single classification method that will satisfy all the elements of the crime scene and its investigation. It is essential that crime scene investigators develop the ability to utilize their analytical skills and logical approaches to make an initial determination regarding the number and types of crime scenes that were involved in the commission of the crime.

Once a crime scene has been defined and a "boundary" has been established, the crime scene(s) should be secured, studied, analyzed, and processed accordingly. Any actions taken at the crime scene should meet all legal and scientific standards and requirements.

Physical Evidence at the Crime Scene

Physical evidence can be classified according to its physical state, the type of crime, and the nature of the evidence, its composition, or the types of question to be resolved. Each of these classification schemes is useful for offering conceptual ideas and practical approaches in crime scene investigation. It is important for a crime scene investigator to understand the value of physical evidence as well as the limitations of physical

evidence; to appreciate the interaction of various definitions or classifications of crime scenes; to understand the theory of transfer evidence and the possible linkages among people, evidence and the scene; and to understand the proper methodologies for locating microscopic crime scenes within the more obvious macroscopic crime scenes. It is from the analysis of the crime scene that the crime scene investigator can determine what type of physical evidence will most likely be found at a particular type of scene or on a person (suspect, victim, witness), where to find the physical evidence at the crime scene, and how to recognize, collect, preserve and process the physical evidence. Finally, based upon scene observations and the laboratory examination results of physical evidence, the investigator should be able to analyze and reconstruct the crime scene accurately.

We generally perceive relevant forensic evidence to include items such as a weapon used at a homicide, a bullet found in a victim's body, or a bloodstain pattern. However, in any given case, any particular object may prove to be the crucial piece of physical evidence necessary to solve the crime. Thus, physical evidence can be best described as any evidence that can provide useful information to investigate the crime.

An alternative concept in classification of physical evidence is based upon the nature and form of the evidence: transient, conditional, pattern, transfer, medical, electronic, and associative.

1. Transient evidence

Transient evidence is a type of evidence that is, by its very nature, temporary, easily changed, modified or lost. Commonly encountered transient evidence includes odors, temperatures, color, and some biological and physical phenomenon such as rigidity of a body or the drying of blood. Due to its temporary nature, this type of evidence must be documented as soon as the evidence is observed.

2. Conditional evidence

Conditional evidence is generally produced by a set of actions or inactions. Similar to transient evidence, if conditional evidence is not observed and documented immediately at the crime scene, the evidence will be lost forever. Examples of

commonly encountered conditional evidence include: Lighting conditions; smoke or fire; condition of the victim's body or clothing; window and door positions; whether the TV, radio, computer or other device is on or off; or exact locations of specific evidence within the scene.

3. Pattern evidence

There are a variety of patterns that can be found at a crime scene. Most of these patterns are in the form of imprints, indentations, striations, or other markings such as fractures or depositions. The patterns commonly found at different crime scenes includes blood spatter or stain patterns, glass fracture patterns, fire burn patterns, furniture position patterns, projectile trajectory patterns, track-trail patterns, clothing or article patterns, tire or skid mark patterns, *modus operandi* patterns, and gun powder or residue patterns.

4. Transfer evidence

Transfer evidence, sometimes referred to as trace evidence, is generally produced by physical contact between persons, objects, or persons and objects. Some commonly found transfer evidence includes blood, fingerprints, hair, fiber, body fluids, soil, glass, drugs and chemicals. This type of evidence is the traditional forensic evidence examined in the forensic laboratory.

5. Electronic evidence

Electronic and digital devices are potential sources of extensive information in many types of investigations. Many residences and businesses have surveillance systems, entry records and alarm information that should be examined during the investigation. Digital and electronic evidence can include video cameras, cellphones, GPS devices, computers, tablets, iPods, tablets, digital cameras, recording devices, telephone answering systems and data storage devices.

6. Medical evidence

Medical evidence may be used to determine cause and manner of death or injury, medical history, or physical, physiological or mental condition. Medical evidence not only consists of location, type and degree of injury, but also the condition, number and

size of the wound. Medical history, hospital or clinical records, hospital reports, date and amount of prescriptions, toxicological analysis, drugs, and medical paraphernalia are also important in crime scene investigations.

8. Associative evidence

During the course of an investigation, specific items located at a crime scene may be used as evidence to associate a victim or suspect with a particular scene. It may also be used to associate a victim to a suspect. Examples of associative evidence include: The suspect's vehicle or wallet found at the crime scene; the victim's ring, watch or other personal belongings found on the suspect; cell phone call records; e-mail messages recovered from a suspect's or victim's computer; receipts and tickets; business cards; credit or debit card receipts; and other personal papers.

Utilization of Crime Scene Evidence

Physical evidence recognition and laboratory analysis can be helpful in directing an investigation along a productive path. Not all types of physical evidence will be able to directly link to or identify a suspect. In fact, the most common use of physical evidence found at crime scenes is to identify an unknown substance. Examples include the identification of suspected controlled substances or poisons, identification of accelerants in fire debris, blood alcohol levels, and toxicology of blood specimens. Moreover, physical evidence could provide indirect investigative information or leads to the solution of the crime. This is the most important and significant use of forensic evidence collected from the crime scene.

Not every crime scene will have a "smoking-gun" or an eyewitness, but the scene will definitely contain physical evidence that can help investigating officers. For example, in a hit-and-run investigation, a seven-layer paint chip from the victim's clothing can be used to narrow down the number and kinds of cars that could have been involved in the accident; use of this information and vehicle databases may reduce the time spent on the investigation. The size of a shoeprint found at the scene may help the investigator eliminate a shoe or indicate possible shoe characteristics. DNA profiles from the semen in a victim's sexual assault kit may lead to a potential suspect. The

number of different types of bullets found may indicate the number and types of weapons used to commit the crime. The locations of blood spatters, fingerprints and other impressions may yield information about the possible sequence of events at the scene. The condition of these patterns may also help identify the activities that occurred at the scene.

Features and Process in Forensic Examination

The objectives of crime scene investigation are to recognize, document, identify, collect, preserve, interpret and reconstruct all the relevant physical evidence at the crime scene. The major objective of physical evidence examination is to provide useful information for the criminal investigator to investigate cases. It is the interaction of these objectives of crime scene investigations and the examination of forensic evidence that defines a proper scientific crime scene investigation. Once the evidence is submitted to the laboratory, the lab examinations will be carried out based on the nature of the physical evidence – firearms analysis, handwriting comparison, DNA typing, video enhancement, etc. All these examinations must follow the basic principles of physical evidence examination:

1. Recognition of an item or pattern as potential evidence or of significance is the first critical step. Failure to recognize crucial evidence will be detrimental to the investigation by failing to establish the vital four-way linkage between the suspect, victim, crime scene and physical evidence. Successful recognition depends on the ability to know not only what might be found, but also where to look for the relevant evidence. Recognition also involves the ability to sort through numerous items and objects and determine those with potential or actual relevance from those with no value. The next level utilizes recognizable evidence at the scene to link to a potential suspect, to a possible cause, or to prove or disprove a statement. Mastery of this skill is only acquired through substantial training, knowledge and experience.

2. Identification of various forms of evidence is the next logical approach. Essentially, identification is a classification scheme. The more characteristics two or

more items have in common, the more complex or discriminatory the identification becomes. Within forensic science, items are identified by comparing selected class characteristics of an unknown object with similar characteristics of a known standard. If the selected class characteristics are essentially the same between the known and unknown samples, then the unknown object *could* have come from the same source as the known object. If these two samples share similar class characteristics further laboratory analysis is advised. If, however, there are significant differences in some of the selected class characteristics, then the unknown sample can be absolutely excluded as coming from the same source as a known object. This is the principle of mutual exclusion.

3. Individualization is unique in forensic evidence analysis. It is also the area, which is most criticized and challenged in court. The recent National Academy of Sciences (NAS) report on the status of forensic science recognized a deficiency and lack of research to support individualization for some of the forensic disciplines including fingerprints, firearms, bite marks, and bloodstain pattern interpretation. Following identification, forensic scientists may continue with their analyses to determine if a particular sample is unique, even among other members of the same class. This process is referred to as individualization. Not all types of forensic evidence can be individualized and some evidence may not have sufficient measurable characteristics to be individualized. However, laboratory examinations are conducted toward that ultimate goal. If subsequent examinations identify any characteristics that are not common between the known and unknown sample, then the samples are excluded from originating from a common source. Often times, examinations will result in a conclusion that the compared objects are similar in all measurable characteristics, but they cannot be conclusively linked to a common origin. A statistical analysis of the occurrence of the common features may be helpful to assess the significance of the similarities. These statistical interpretations are only as reliable as the populations and databases from which the conclusions are deduced. Some physical evidence can be

positively linked to a source in the absence of a database, such as a paint chip with 15 layers associated with a particular vehicle, a piece of head light lens matched to a broken headlamp from a vehicle, or a broken finger nail found at the scene physically matched to the nail of the suspect. Even in these types of scenarios, scientists are developing statistical models to describe the significance of the association.

4. Reconstruction is the final phase in the forensic examination process. This phase is entirely dependent upon proper recognition, identification, individualization and interpretation of relevant evidence. Reconstruction utilizes the investigative information, crime scene information, and laboratory analysis of the physical evidence, pattern evidence, electronic documents and witness statements. The reconstruction process involves the use of inductive, deductive and abductive logic. This can be a complex task in which many types of physical evidence, pattern information, analytical results, investigative information, and other documentary and testimonial evidence are linked into one entity. The amount of information that a reconstruction may provide is limited by these factors. The more relevant and accurate the data, the greater the chance that reconstruction attempts will be of value to the investigation.

Crime scene reconstruction requires the determination or elimination of events or actions that occurred at the crime scene through the analysis of the crime scene patterns, the location, sequence and position of the physical evidence, and the laboratory examination results of the physical evidence. Reconstruction involves scientific scene analysis or the interpretation of the scene pattern evidence and the systematic study of related information, the logical formulation of a hypothesis, testing of the hypothesis, and development of a sound theory.

Logic and Crime Scene Investigation

A logical and organized approach is key to crime scene investigation. The application of deductive, inductive and abductive reasoning when evaluating a crime scene is crucial for the successful recognition, identification, documentation and preservation of physical evidence. Investigators who have extensive crime scene

experience may rely on their "gut feelings" when looking for significant data during the crime scene process. However, such hunches can be wrong and valuable evidence may be lost because the investigator viewed the scene with a subjective rather than objective viewpoint. Logic helps the investigator identify relevant evidence and recognize associations among the victim, the scene(s), various items of evidence and patterns at the crime scene.

The crime scene investigator uses deductive and inductive reasoning during an investigation. Essentially, *deductive reasoning* involves using a general statement or hypothesis and then looks at specific information to reach a logical conclusion. This is what occurs when a theory or hypothesis is tested by the scientific method. Deductive logic allows a person to apply a principle to a specific situation. For example, knowing that blood impacting a surface at an angle will elongate, an investigator can estimate the specific angle of impact of a bloodstain by measuring the stain length and width. *Inductive reasoning* is the exact opposite of deductive reasoning. When inductive logic is applied, specific observations are used to make generalizations and to form hypotheses. It should be noted that both forms of logic can lead to error if applied incorrectly.

During crime scene investigation a third type of logic is often employed, combining both deductive and inductive logic. This is *abductive reasoning*. Abductive logic involves recognizing patterns. Through this reasoning the investigator makes observations, forms a hypothesis and then tests that hypothesis using additional observations and information. The investigator goes through the formation and rejection of a series of hypotheses until the best hypothesis or explanation is reached. As Sherlock Holmes remarked in *The Sign of the Four*, "When you have eliminated the impossible, whatever remains, *however improbable*, must be the truth."

Some practitioners have applied the common practices of logic in an orderly and systematic sequence to produce "logic trees." These logic trees serve as a guide to the investigation of a crime, providing common evidence in a class of crime and pathways to identify this evidence. When used properly, a logic tree or similar system helps those

working the crime scene to limit mistakes and to remain objective at the scene and during subsequent activities, especially when individuals are from departments that encounter few major crimes. These tools also assist members of small to medium sized departments to organize activities if no major crimes personnel are called into the scene. The use of logic and the logic tree helps the practitioner remain open-minded when investigating a crime scene.

Figure 1-1 is an example of a logic tree for a sexual assault investigation. As an investigation progresses, evidence may be of various types. Most investigators concentrate on biological evidence, but valuable information may be gained from other physical evidence and pattern evidence. Data shows that nearly 1/3 of sexual assault case evidence does not produce probative DNA profiles. Because of this, the crime scene analyst should examine the area carefully so that other types of evidence are not overlooked. Linkage through weapons, imprints or even MO can assist in solving the case or linking several cases.

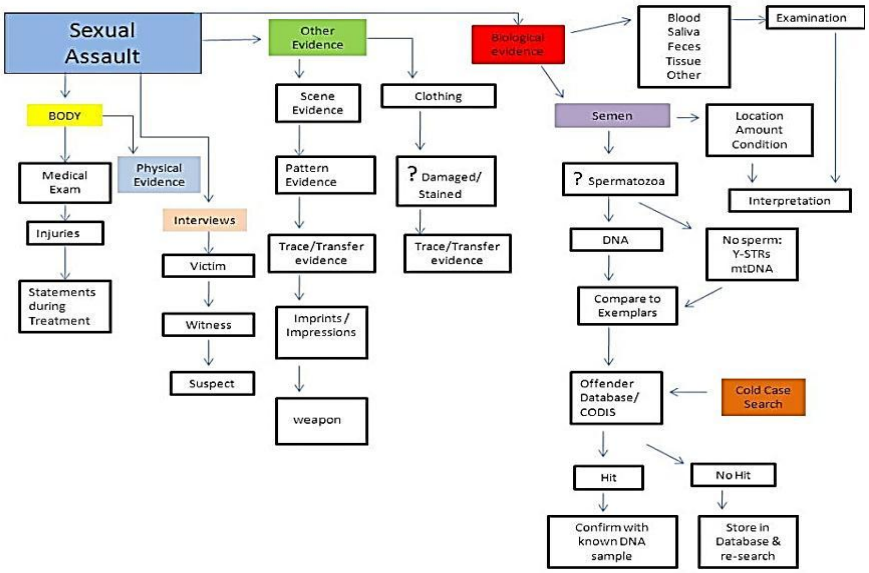


Figure 1-1. Sexual Assault Logic Tree

Logic trees can also be useful when reviewing case information and forensic analysis results. By placing information from the scene and results of analysis of physical evidence together in an organized and systematic way associations among the various

scenes, suspect and victim are more easily seen. This approach may also assist the investigator in recognizing those few cases of false reports made for revenge or other purposes. A case evidence logic tree for a murder investigation is shown in Figure 1-2. Mapping out the various items of evidence and locations, results of examinations and comparisons provides a visual depiction of key associations as well as information that may be pursued by further inquiry or analysis. For example, samples from the kitchen, bathroom, and hallway indicate the presence of small amounts of possible blood. These samples should be tested for the presence of DNA profiles, but the amount of blood indicates the original samples will be consumed by testing. This is an indicator to the investigator and the laboratory that, prior to DNA testing, attorneys in the case should be notified that no original stain material will remain; testing for these samples will be delayed until the legal issues have been resolved.

Crime scene investigation, as noted previously, is not just processing or documenting a crime scene, nor is it just the collection or packaging of physical evidence. It is the initial, most crucial step of any forensic investigation. The foundation of all forensic investigations is based upon the ability of the crime scene investigator or forensic scientist to recognize potential physical evidence – large or small, visible or latent, exculpatory or inculpatory – at a crime scene. The subsequent identification and enhancement of the physical evidence along with the determination of the possible source or origin of the evidence is the next step. Proper crime scene investigation is the starting point in the process of establishing what has happened, when it happened, where it happened, who was involved, and how it occurred. Careful processing, documentation, identification, collection and preservation of physical evidence are integral parts of this forensic process.

Crime Scene Investigation as a Component of the Forensic System

Contrary to the way it is portrayed in popular television programs such as CSI, crime scene investigation is neither glamorous nor accomplished in any easy or lackadaisical manner. It is an organized, methodical, systematic, detailed and logical process. To perform these functions properly requires not only extensive training and experience on

the part of the investigator, but also absolute objectivity along with a coordinated team effort. Perhaps the most important issue regarding crime scene investigation is the establishment of professional standards.

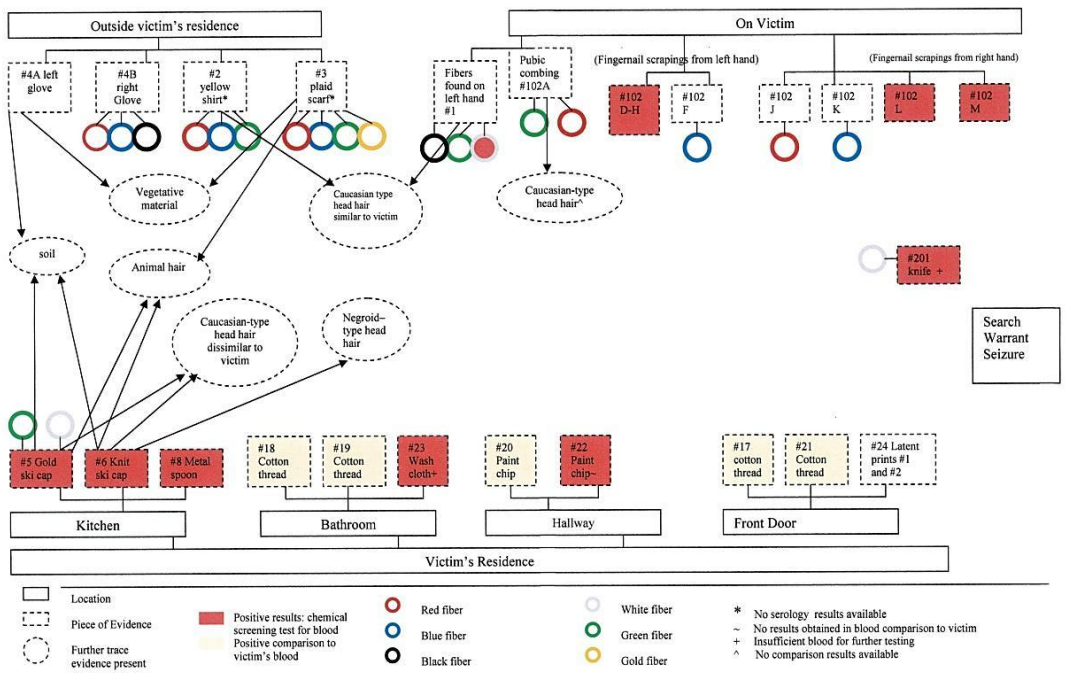


Figure 1-2. Logic Tree for evidence in a homicide investigation

All professionals involved with crime scene investigation, forensic examination and the legal system must carefully assess their roles in the security, collection, preservation, examination, interpretation and presentation of forensic evidence in the courts of law. The professionalism and ethical standards of all parties in both criminal and civil litigations should be highly developed. Specific protocols for individual departments should reflect the professional standards of the agency and the field. The use of external experts and other resources should be carefully considered, especially by those departments that have fewer officers and detectives or limited resources for crime scene investigation.

Despite the countless historical cases from which we can learn and improve, we continue to witness serious crimes going unsolved or ending without justice being served because of needless errors associated with poor crime scene investigation practices. Virtually no jurisdiction in the United States or any foreign county has

resolved this dilemma. The utilization of forensic science is at the mercy of the police officers, crime scene investigators, the prosecutors and the court. If the crime scene is not properly managed, all the technology and advancements in the forensic laboratory become useless. If the forensic evidence is not introduced during a court preceding or wrongfully presented, it will diminish the judicial system's ability to serve justice.

A high-quality crime scene process does not require an elaborate or sophisticated unit, or a large amount of manpower. Rather, simple adherence to fundamental principles and objective procedures will result in a successful crime scene investigation. The essential crime scene functions are security, recognition, documentation, identification, collection and preservations of all relevant physical evidence (pattern, conditional, transient, transfer, digital, medical and associative). If these elements are achieved, there will be a much higher probability that the case will be resolved accurately through scientific interpretation and presentation of the available facts and data in the court system.

It is the police officers, detectives, crime scene investigators, evidence technicians and forensic scientists that usually complete the crime scene search and begin the forensic investigation process. After the evidence is submitted to the forensic laboratory, it is up to the lab scientists to examine the evidence and interpret their findings according to the established professional standards of their disciplines. During the pretrial or initial litigation stages, the prosecution and defense attorneys determine which physical evidence will be utilized. During the trial or adjudication stages, the judge determines the admissibility of the forensic evidence. There is no guarantee that any of these parties who are part of the evidentiary process will sufficiently understand the potential of forensic evidence. Continued education and dialogue among the various practitioners in the criminal justice system is critical for the proper utilization of forensic evidence.

Training, education and the standardization of crime scene investigation are equally critical for the improvement of forensic services within an agency. As there is greater awareness among the public of the need for higher standards for crime scene

investigation, and a greater number of police officers acquire up-to-date information and receive new, specialized training in forensic science, the issues associated with crime scene investigation should diminish.

Part 2. Crime Scene Procedures

Introduction

Many crime scene manuals and handbooks have been published over the years that provide detailed information concerning the basic procedures that should be followed at a crime scene. This section will provide a simple overview of the process and a detailed outline of the steps in a crime scene investigation. We hope that this format will assist investigators in all types of agencies, especially those in small to medium-sized departments.

Training for crime scene investigators is essential to ensure the proper security, recognition, documentation, collection and preservation of physical evidence. Initial training should include: basic studies in crime scene and evidence photography; an overview of crime scene management; crime scene safety; types of physical evidence; forensic analysis of evidence; collection and preservation methods; prevention of evidence contamination and alteration; and crime scene pattern recognition, enhancement, documentation and reconstruction. If departments are small or have limited trained personnel, the agency should consider assistance from other law enforcement personnel, such as a major crimes squad, the state or regional laboratory, or from university forensic science faculty. Forensic experts, such as those at a major forensic institute or university, may also provide guidance related to evidence documentation and collection or provide advanced technology to facilitate crime scene processes or scene testing.

The following summary reflects some recommended practices for crime scene operations. Depending on the particular scene, there may be slight variations in the procedures followed.

1. Actions of the First Responder

The actions of the first responder are critical to the successful investigation. In cases where the first responders are not aware of the impact of their actions or inactions, valuable evidence can be lost or compromised. All police departments, even small to medium-sized organizations, should make sure that patrol officers and detectives are well versed in the principles associated with crime scene investigation and these first steps at the crime scene. The observations of the initial responding officer(s) when approaching, entering, and exiting a crime scene can provide valuable information that would otherwise be lost to investigators. As described below, the patterns, odors, and other sensed information of the first officers may provide information about important transient evidence. According to the Technical Working Group on Crime Scene Investigation as published by the National Institute of Justice (NIJ), the actions of the first responding officer typically should include:

1. Note or log dispatch information
   - address/location of incident
   - time
   - date
   - type & source of a call
   - parties involved
2. Be aware of any persons or vehicles leaving the crime scene.
3. Approach the scene cautiously.
   - Scan the entire area to thoroughly assess the scene
   - Note any possible secondary crime scenes.
   - Be aware of any persons and vehicles at the scene or in the vicinity that may be related to the crime.
4. Make initial observations
   - Note the condition and appearance of the scene
   - Identify any sounds, smells or other transient evidence
   - Ensure officer safety before proceeding.

5. Remain alert and attentive.

- Assume the crime is ongoing until determined to be otherwise.

6. Treat the location as a crime scene until determined to be otherwise.

7. Establish initial borders of security at the scene

- Maintain evidence integrity

8. Note further observations

- Weather
- Temperature of a room, car, object, liquid and similar at the scene
- Condition and position of the victim
- Condition of the person reporting the scene
- Witnesses, including name, address, phone number
- Video, CCTV, recorders, watch, or cellphone at the scene. Protect these items but do not move or alter in any way
- Condition and status of TV, radio
- Location of potential weapons, clothing, bloodstains, and other evidence
- Any forensic evidence in plain sight
- Condition of doors and windows

2. Crime Scene Security

Of course, safety of the first responder and others at the scene is the first priority. After rendering aid where necessary, the officer should begin the crime scene investigation process. This is accomplished by securing the crime scene, establishing boundaries for the scene and obtaining information from all witnesses and other persons at the scene. Establishing boundaries is critical to the preservation of potential evidence. Thus, the initial responders should consider the nature of the scene and evidence when determining the areas to be secured. Officers who are knowledgeable about the legal and scientific requirements for the search and seizure of evidence and subsequent analysis will provide the most secure environment for the crime scene investigation.

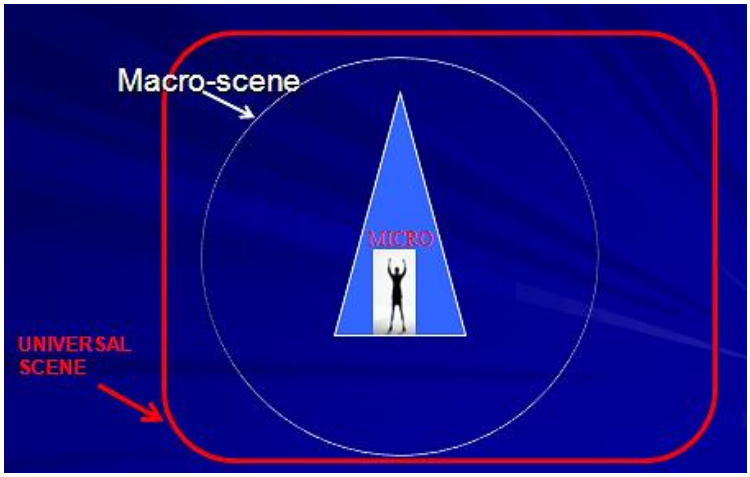


Figure 1-3. Crime scene security

1. Set up immediate, "micro" crime scene
   - Protect physical evidence
   - Limit access to area
   - Prevent changes to area before arrival of investigative team
   - Protect and document condition and clothing of the suspect, witnesses and victim

2. Establish “macro-scene.”
    - Location to establish a working area for crime scene personnel, commanding officers, and other supervisory personnel.
    - Provide quick access to the primary crime scene area without the threat of contamination or alteration of the scene or evidence.

3. Define a “universal boundary.”
    - Identify areas for the public, media and others near the crime scene
    - Prevent compromising the evidence or investigation.

4. Notification of superiors of type and condition of the scene

3. First Actions at the Crime scene

When crime scene investigation personnel arrive, the first responders should apprise the commanding officer of all observations and the conditions upon their arrival at the scene. Subsequently, the crime scene unit will assume responsibility for the management of and operations at the crime scene and set up a command post.

It should be noted that from the time of entry into the scene by the commanding officer, every precaution must be taken to prevent contamination, alteration, or destruction of physical evidence. Proper protective wear including crime scene suits, booties, gloves and other items should be worn at all times by all personnel who enter the crime scene area. These garments protect both personnel and the scene from contact and evidence transfer. Special precautions may be necessary when imprints or impressions are present or if the area may be subject to environmental onslaught. Gloves should be changed often and after handling items of physical evidence.

Depending on the particular scene there may be slight variation in the procedures described.

1. Establish a command post
   - Arrange for manpower and equipment needs
   - Obtain search warrant
   - Communication with chief/appropriate superior, prosecutor, medical examiner, forensic services/laboratory
2. Brief of crime scene personnel by the first responder.
   - provide information to the investigators about the status of the scene
   - identify persons present prior to involvement of the crime scene investigators
   - provide information about any witnesses, suspect and/or the victim
   - remain at the scene until notified otherwise.
3. Walkthrough of the crime scene by the commanding/ case officer.
   - assess the nature of the scene,
   - determine possible type of crime
   - evaluate the condition of various items of forensic evidence present.

- determine what resources are required and if any specialized units or experts should be contacted, e.g., bomb squad, fire department, Haz-mat unit
- evaluate any safety risks
- note location and condition of entry/exit
- position of on/off switches for lights, television, computers and appliances
- note temperature of rooms and any evidence, e.g. coffee, drinks, food
- determine if any animals are in the scene that require attention
- identify a location for a secure working area for the crime scene investigation team
- The composition and duties of the crime scene team are also determined at this time.

4. Documentation of the crime scene.

Through documentation of the crime scene and of physical evidence is crucial for subsequent evaluation and presentation of the scene during court proceedings. Typically multiple methods of documentation are employed at the scene to ensure that accurate representations of the condition and location of evidence, patterns and the scene itself are obtained. Documentation usually involves crime scene sketches, photographs, video, notes and audio recording. Notes should be thorough and used to associate other forms of documentation. Use of a 3D photodocumentation system as described in Section II of this handbook can provide an extra level of information, allowing for accurate scene depiction and measurements of rooms and objects using the software and laser in the system. If the agency does not have such equipment, consider contacting the university or another department that may be able to assist with digital scanning documentation.

1. Notes

- General guide
  - ✓ Should include all details, descriptions and information related to activities of the crime scene investigation
  - ✓ Ink only
  - ✓ Use a single line cross-out for any changes, initial and date
  - ✓ Include detailed descriptions of transient, conditional and pattern evidence
- Record notification
  - ✓ Method of notification
  - ✓ Date, time
  - ✓ Type of case
  - ✓ Victim information & address
  - ✓ Case number
  - ✓ Commanding officer of the scene

- Arrival information
  - ✓ Date, time
  - ✓ Personnel at the scene upon arrival
  - ✓ Additional personnel notified, time of notification & time of arrival (ME, laboratory, prosecutor, bomb squad, etc.)
- Investigation team
  - ✓ Assignments of scene duties – notes, photography, sketch, evidence collection, scene processing, other
  - ✓ Records of when and how tasks were completed
  - ✓ Evidence processing and collection
  - ✓ Start and ending times for crime scene activities
- Description of scene
  - ✓ Environment (temperature, precipitation, etc.)
  - ✓ Location (where in building, indoor or outdoor, other)
  - ✓ Vehicles
  - ✓ Adjacent buildings or structures
  - ✓ Transient & conditional evidence (odors, lighting, sounds, etc.)
  - ✓ Location & description of pattern evidence
  - ✓ Apparent weapons and other forensic evidence
  - ✓ General scene description
- Description of victim(s)
  - ✓ Gender
  - ✓ General location
  - ✓ Position
  - ✓ Apparent injuries
  - ✓ Identification on victim
  - ✓ Clothing, jewelry or its absence
  - ✓ Body condition
  - ✓ Insect or animal activity

- Physical evidence
  - ✓ Relationship to crime scene
  - ✓ Source, location and collection information
  - ✓ Interior scenes - note condition and location of furniture, clothing, walls, floors and other structures
  - ✓ Outdoor scenes – presence of shoeprints, tire tracks and other impressions, condition of terrain, condition and types of vegetation, locations of objects, adjacent structures

2. Photography

- General purpose
  - ✓ Provide an accurate visual record of the scene and related areas
  - ✓ Record initial appearance of crime scene and evidence
  - ✓ Record initial appearance of victim and suspect
  - ✓ Provide permanent documentation for subsequent investigation & the court
- General documentation
  - ✓ Overall photographs from 4 points around scene (See Figure 1-4)
  - ✓ Overall photograph of exterior, from entry to target area and to exit points

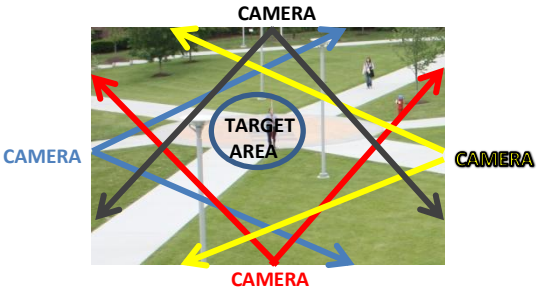


Figure 1-4. 4-point method for overall photographs

  - ✓ Photograph of contiguous areas, especially pattern evidence
  - ✓ Evidence - overall, medium and close-up with and without scales
  - ✓ Exterior of building if interior scene
  - ✓ Surrounding areas of the target scene

- Documentation of victim
  - ✓ Overall shots of victim
  - ✓ Medium and close-up shots of body & patterns on body
  - ✓ Close-up photographs of apparent wounds and patterns
  - ✓ Evidence or weapons on or near the body
  - ✓ Trace evidence, body fluids, hair, fibers, etc. on hands, face and body
  - ✓ Area after the body has been removed
- Photographic log information for *each* photograph taken
  - ✓ Camera model, lens & flash information
  - ✓ Date and time
  - ✓ Type of photograph (overall, medium, close-up)
  - ✓ Camera settings
  - ✓ Equipment used – tripod, filters, flash or other light sources, etc.
  - ✓ Brief description of photograph
- Photography of patterns
  - ✓ Use tripod
  - ✓ Position camera at 90° angle to evidence
  - ✓ Document in natural light at the three distances
  - ✓ Close-up photographs - use oblique light to reveal pattern detail.
  - ✓ Adjust light angle to reveal pattern characteristics
  - ✓ Photograph with and without scales on 2 planes/"dental scale"
  - ✓ Use an alternate light source including UV or IR, as indicated & with appropriate filter
  - ✓ If pattern is enhanced, photograph before and after enhancement

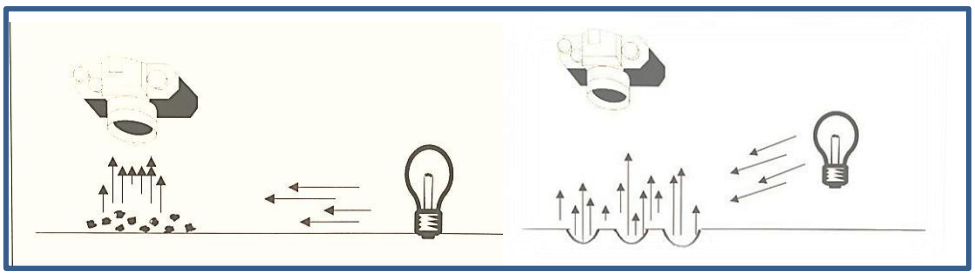


Figure 1-15. Proper placement of light to photograph 2-dimensional (left) and 3-dimensional (right) imprints.

When items of physical evidence are located within the crime scene it is especially important that these be thoroughly documented *in situ* prior to collection and packaging. Typically at least three photographs are taken of each item of evidence – distance shot to show the overall location of the item (with and without a number plate), medium range shot, and a close-up photograph of the item with and without a scale. Additional perspectives, such as an aerial shot of an outdoor scene may be important to obtain as soon as possible after the scene itself if processed.

Documentation may also be facilitated by the use of digital media to take notes and to forward images of the scene and objects to experts for review, to police department commanding officers and to others, such as prosecutors. Use of a specialized system that includes encryption and recording features when distance communication is carried out will maintain security and preserve the exchange of information and images for legal and scientific purposes.

3. Crime Scene Sketch

A crime scene sketch provides a record of the exact size and distance relationships of the crime scene and various items of physical evidence. It supplements the crime scene photographs, but does not replace them. The crime scene sketch may be used to provide a simplified version of the scene and significant items of evidence or patterns for study or presentation. Use of a computerized sketch system that is compatible with advanced computer design programs (CAD) may be used by the crime scene investigator to generate a sketch of the crime scene after input of crime scene dimensions and evidence information.

- Information on the sketch
  - ✓ Case number
  - ✓ Type of investigation
  - ✓ Location & victim's name
  - ✓ Date & time
  - ✓ Name of sketcher & verifier
  - ✓ Scale used or "not to scale"
  - ✓ Legend
  - ✓ Compass North indicator
  - ✓ Type of program or equipment used to generate the sketch
- Basic sketch materials
  - ✓ Graph paper
  - ✓ Measuring devices
  - ✓ Pens & pencils
  - ✓ Stencils with basic shapes
  - ✓ Computer – assisted sketch software
- Types of sketches
  - ✓ Rough sketch
  - ✓ Final sketch
  - ✓ 3-dimensional

- Rough sketch
  - ✓ Completed before evidence collection
  - ✓ Show location of evidence to be collected & major structures
  - ✓ Include measurements of distance and size
  - ✓ Locate items using triangulation, rectangular coordinate or other system (Figure 1-6)

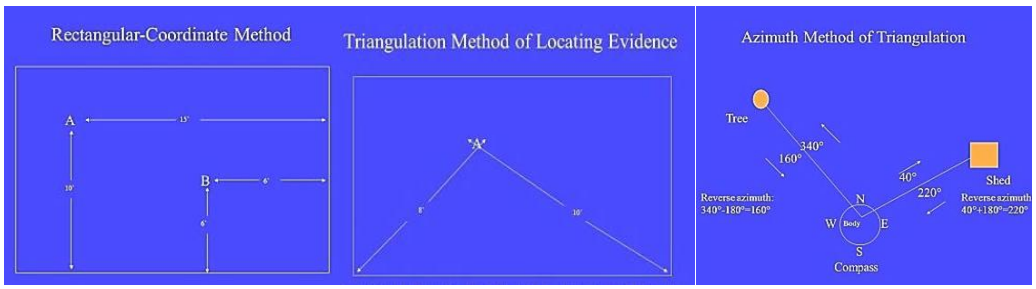


Figure 1-6. Three location measurement methods for crime scene sketches

- Finished sketch
  - ✓ Drawn to scale
  - ✓ Contains essential information as with a rough sketch
  - ✓ Simplified, precise depiction of scene & major items

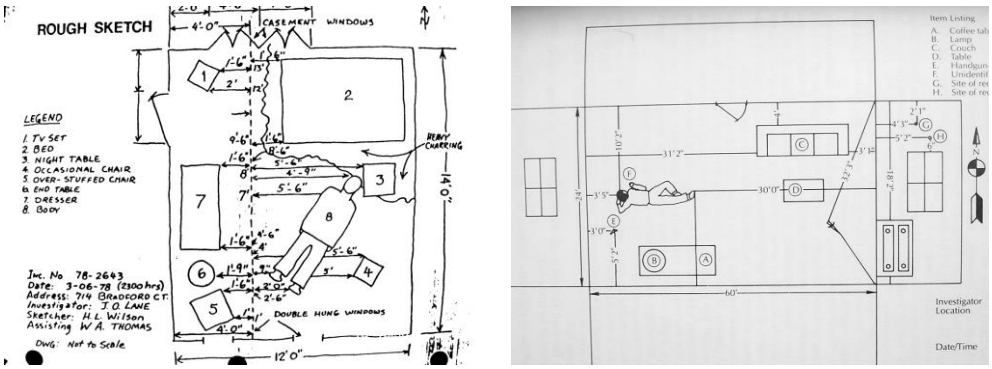


Figure 1-7. Examples of a Rough sketch (left) and a Finished cross-projection sketch (right)

5. <u>Location of Physical Evidence</u>

During the walk-through and documentation stages of the crime scene investigation, the crime scene personnel have an opportunity to evaluate the physical evidence that is present and its nature. A thorough search for evidence at the scene is important for the success of the investigation. The search method chosen depends on several factors including the type of crime scene, the location of the scene, the availability of personnel, and the nature of the evidence.

- Crime scene search patterns
  - ✓ Provide a systematic structure to a search
  - ✓ Method used depends on area and resources
  - ✓ Most common methods vary spatial, geometric patterns (Figure 1-8)
- Link Method
  - ✓ Based on association of scene, victim, object and/or suspect
  - ✓ Logic applied to observed evidence or patterns
- Line or strip Method
  - ✓ Divides crime scene into lines or strips
  - ✓ Evidence along strip is identified & collected
  - ✓ Useful for large areas & outdoor scenes
- Grid method
  - ✓ Equivalent of a 2-directional line search
  - ✓ Allows more thorough examination of same area by different investigators
- Zone method
  - ✓ Identifiable areas or zones are searched systematically
  - ✓ Typically used in indoor scenes with different rooms or vehicles
  - ✓ Allows prioritization and targeting of specific areas
- Wheel method
  - ✓ Search outward from a central point along rays
  - ✓ Divides micro/macro scene into separate wedge-shape sectors

- Spiral Method
  - ✓ Inward / outward spiral, clockwise/counter clockwise spiral
  - ✓ Best when used for a limited scene area or space
  - ✓ Central point identified as point of interest
  - ✓ Move out or in at a fixed change in diameter

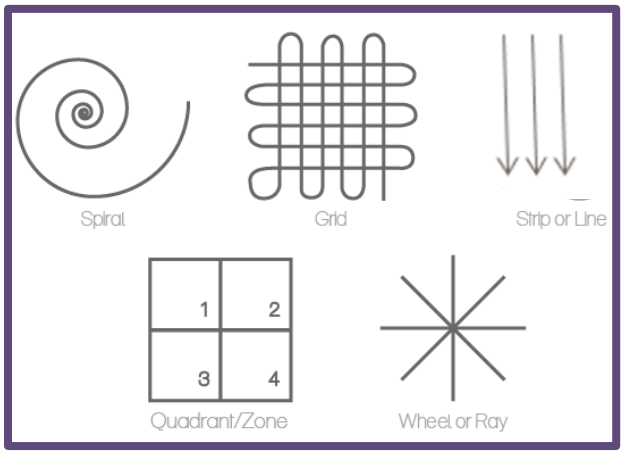
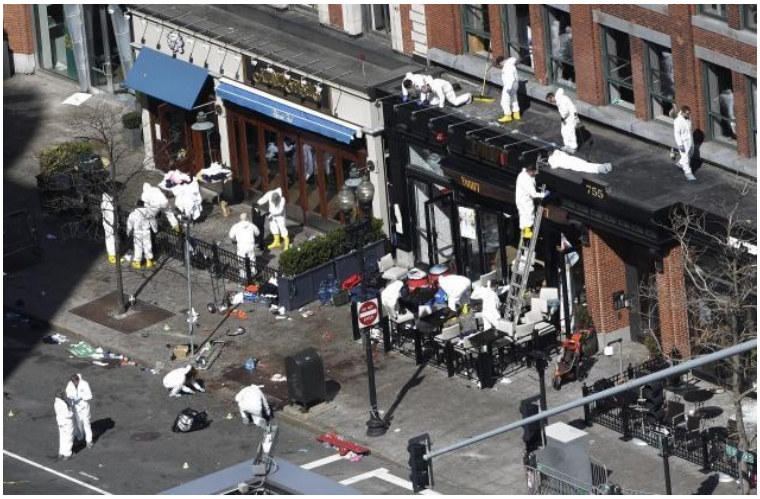


Figure 1-8. Common search patterns



Multiple areas of evidence Search at the scene of the Boston Marathon bombing

6. Collection and Preservation of Physical Evidence

One person should be assigned as the evidence officer prior to the collection of physical evidence. Subsequent items should be collected using recommended procedures and techniques to avoid contamination, alteration or loss of evidence. Computerized evidence management systems may be employed to facilitate the chain of custody information and history of the evidence transfers.

A variety of materials should be compiled for the general collection and preservation of evidence after it is documented. (See Section III.) Some evidence may require more specific collection materials or special techniques or preservation. Refer to Appendix 2 for a brief guide on the collection and preservation of various types of physical evidence. The following sections will outline the general steps for evidence collection and those methods commonly employed for specific types of physical evidence that are commonly encountered at crime scenes. Any questions concerning collection and preservation of specific types of evidence should be addressed to the forensic science laboratory or other forensic authority. The proper collection and preservation of evidence helps to ensure its legal admissibility and scientific integrity.

Some scene personnel begin collecting evidence in the area of the victim and moving out from this area in a logical pattern. Others recognize evidence from entry to areas of activity and collect it accordingly. The actual sequence of collection may vary depending on the nature of the scene and the number of personnel available. In all cases care should be taken to thoroughly document the evidence, package it appropriately, and label it correctly. Once evidence is packaged it should be maintained in a secure area until it is removed from the scene. All legal requirements relating to the evidence chain of custody and scientific requirements for preservation of the evidence should be followed.

1. **General Procedures**
    - Document the item, condition, shape, color other characteristics
    - Observe any trace materials or any patterns on the item

- Document trace & pattern evidence on items prior to packaging. Collect if concerns about loss of evidence exist
- Conduct field screening tests (See Part 3.) if warranted and only if sufficient sample is identified
- Collect fragile or time-sensitive items first
- Change gloves frequently and after each item of evidence is collected
- Primary container should be appropriate for the type of evidence (see descriptions in following sections)
- Package each item separately
- Seal all openings of container with tamper-evident tape, initial and date seal
- Label each evidence container with chain of custody information
    - ✓ Case number
    - ✓ Item number
    - ✓ Item description
    - ✓ Location from which collected
    - ✓ Name of person collecting evidence
    - ✓ Date & time of collection
- Secure evidence and transport to storage as soon as feasible

Figure 1-9. Evidence package with seal and chain of custody information. Bar-coded seal also attached.

2. **Biological Evidence**

- General Considerations
  - ✓ Document all stains and patterns prior to packaging
  - ✓ Avoid talking over evidence
  - ✓ Wear masks and gloves. Change gloves after each item
  - ✓ Wet items should be dried prior to packaging
  - ✓ Never place bloodstained items in airtight containers
  - ✓ In general, package in paper
  - ✓ Store evidence in temperature controlled area at room temperature
  - ✓ Package swabs in a specialized swab box or similar collection tool designed to protect against loss and continue drying of the swab (figure 1-10)
- Liquid blood
  - ✓ Collect on sterile cotton swabs, then air dry
  - ✓ Larger volumes may be collected into a sterile syringe and transferred to a sterile blood tube. Store refrigerated
- Bloodstained items
  - ✓ Photograph & document any bloodstain patterns
  - ✓ Smaller, movable items – package the entire object in paper
  - ✓ Hard surface, immovable items
    - Moisten a sterile swab with sterile water or saline
    - Remove as much stain as possible from the area onto the swab tip
    - Air dries the swab before packaging.
  - ✓ Absorbent surface, immovable or large items
    - Cut out the stain using a sterile scalpel or similar blade
    - Package the cutting in a paper packet
    - Place packet with cutting in a clean envelope or paper bag

- Known blood samples (if required)
  - ✓ Medical personnel must collect these samples
  - ✓ Collect into a purple-top (EDTA) tube
  - ✓ Label with evidence tag
  - ✓ Secure the tube or package in envelope with tamper-evident seal
  - ✓ Store known blood samples refrigerated until forwarded to the lab
  - ✓ Keep *all* known- source samples (victim, suspect(s), elimination samples) away from other physical evidence and the crime scene

Figure 1-10. Bloodstain swab secured in swab box

- Body fluids
  - ✓ Search with alternate light or UV light to aid identification of evidence
  - ✓ Liquid semen or saliva
    - Collect on swab
    - Air dry
    - Package in swab box
  - ✓ Liquid urine
    - Use sterile syringe or pipette to collect larger volume of urine
    - Place liquid urine in sterile vial or jar
    - Refrigerate prior to submission to the lab
  - ✓ Body fluid stains on hard surfaces
    - Collect as described for bloodstains
  - ✓ Body fluid stains on skin & bite marks
    - Photograph marks with scales and document
    - Examine the bite mark area with alternate light source

- Moisten a single swab with a minimum of sterile water
- *Lightly* swab the area while rotating the swab. Avoid excess pressure
- Air dry the swab
- Place in a swab box
- Store in controlled environment at room temperature

✓ Cigarette butts or electronic cigarettes

- Collect each cigarette individually
- Note any trace material or stains such as lipstick on the mouth end
- Handle with forceps near the burned end (away from mouth end)
- Package in paper fold
- Place paper fold in envelope or small box
- If removed from an ashtray, photograph before collection, note and mark location of cigarettes in ashtray. Do not place the contents of an ashtray together in a container.

✓ Cups, bottles & glasses

- Handle to protect biological evidence and potential fingerprint evidence
- Collect any liquid contents using a sterile syringe or pipette. Place contents into a clean tube and label as a separate item
- Place cup/bottle/glass in an upright position in a box.
- Secure the item to prevent movement and friction.
- If necessary to prevent loss or contamination, use a sterile swab wet with distilled water to swab the area of the glass or bottle for body fluid or blood.

3. **Body**
    - General documentation
        - ✓ Location and position of the body
        - ✓ Sex
        - ✓ Race
        - ✓ Apparent age
        - ✓ General appearance
        - ✓ Length and orientation
        - ✓ Clothing
        - ✓ Evidence of injury
        - ✓ Transfer evidence & location
        - ✓ Pattern evidence & location

    - Condition of the body
        - ✓ Rigor mortis
        - ✓ Lividity
        - ✓ Decomposition
        - ✓ Insect activity or larvae
        - ✓ Loss of blood
        - ✓ Blood or body fluids on the body

    - Wounds
        - ✓ General appearance
        - ✓ Number and orientation
        - ✓ Locations
        - ✓ Evidence of defense wounds or marks

4. **Digital Evidence**
    - General considerations
        - ✓ Review search warrant to determine the scope of the search
        - ✓ Document location and type of digital equipment
        - ✓ Keep electronic evidence away from heat, magnets, radios and other devices
    - Computer
        - ✓ Do not touch power switch on the computer
        - ✓ If the computer is on, photograph the screen and record the information viewed
        - ✓ Pull the power plug from the wall
        - ✓ Insert a prepared/wiped disc in any disc drive, cover with evidence tape
        - ✓ Tag and label all cables, connections and peripherals

- Storage media
  - ✓ Collect and package each item separately
  - ✓ Collect any instruction manuals

- Cell phone, GPS and similar equipment
  - ✓ Do not turn on the device
  - ✓ Do not allow device to lose its charge
  - ✓ Collect all cables, storage media, and related items

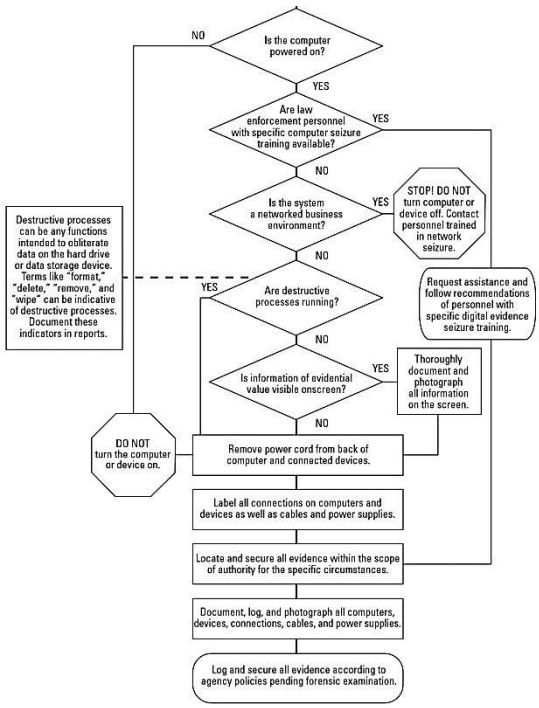


Figure 1-11. Flow chart for the collection of digital evidence

5. Drugs and Medications

- General considerations
  - ✓ Photograph items in place and showing label, if any
  - ✓ Package each item individually
  - ✓ Do not open containers
  - ✓ Handle to preserve fingerprint and trace evidence
  - ✓ Limit exposure to suspected controlled substances
  - ✓ If encountering a suspected clandestine laboratory, call the forensic lab, DEA or forensic expert for assistance
- Controlled substances
  - ✓ Package loose vegetation in paper to prevent mold. Plastic is permissible if the vegetation is totally dry
  - ✓ Use sealed plastic bags or plastic containers for other suspect materials

- ✓ Suspected drugs found in bindles or individual bags should be handled to prevent loss of controlled substances and other evidence, such as latent fingerprints. Place in sealable plastic bags
- ✓ Do not open packages at the scene to prevent contamination or loss
- ✓ Syringes should be handled to prevent loss or injury (Caution: biohazard!)
    - Remove contents of syringe to sterile tube
    - Package syringe separately in puncture-proof container

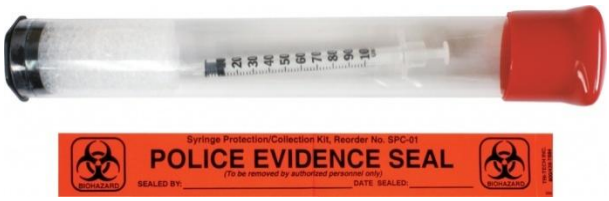


Figure 1- 12. Proper packaging of syringe evidence

- Medications
    - ✓ Photograph containers & labels
    - ✓ Record information on label
        - Name of the patient
        - Name of the medication
        - Dosage
        - Date filled
        - Number dispensed
        - Physician's name
        - Pharmacy that dispensed the order
        - Number, color and size of pills remaining in vial

6. Fingerprint and imprint evidence

- General considerations
    - ✓ Search using varied light sources for oblique lighting
    - ✓ Document in situ with & without a scale
    - ✓ Lift print, photograph 1:1 or transport object to laboratory
    - ✓ Enhance as indicated by surface, location and imprint material
    - ✓ Lift and place on backing card

- "Plastic"/ 3-D impressions
    - ✓ Photograph with light to reveal details
    - ✓ Cast if feasible. Collect trace evidence before casting
    - ✓ Collect item and protect imprint area

- Physical Methods for development
    - ✓ Use on dry, non-porous surfaces
    - ✓ Choose contrasting powder

- ✓ Fluorescent powders –
  - suitable for multi-colored surfaces
  - used with an alternate light source, usually at 500-550 nm-green or 420-485 nm - blue
- ✓ Magnetic powder – smooth, shiny, non-magnetic surfaces
- ✓ Nano-powders – specialized to enhance detection of drugs and other chemicals

- Chemical Methods for development (See Part 3 for formulations)
  - ✓ Superglue
    - Fume with wand or in portable chamber
    - Wear protective mask
    - Photo-document fuming result
    - Dust after fuming with contrasting or fluorescent powder.
    - Photograph.
    - Lift and place on backing card.

  - ✓ Ninhydrin
    - Use for protein and bloody imprints
    - Requires time or heat to develop
    - *Do not heat* if DNA analysis will be requested
    - Pink-purple product

  - ✓ Amido Black
    - Use for protein-rich patterns
    - Spray lightly or use wash procedure
    - Blue-black product

  - ✓ Crystal violet
    - Use for protein-rich patterns
    - Used often for adhesive tape surfaces
    - Red-purple product

  - ✓ Bloody Print Enhancement Reagent
    - Relies on color tests to detect blood
    - Highly sensitive
    - If ether-based reagent is used, wear respirator
    - Blue – green product (color can vary depending on presumptive test chemical used)

  - ✓ Small particle reagent
    - Use with wet surfaces
    - Spray small amounts of fine mist

        - Rinse step necessary

    - ✓ Fluorescein
        - Detects blood
        - Best for dark background contrast
        - Examine at 420nm to 485nm with filters
        - Photograph with scale

7. Firearms Evidence

- General considerations
    - ✓ Safety should be the primary consideration
    - ✓ Consider other types of evidence that may be on firearms and handle accordingly
    - ✓ Package for safe transport

- Firearms
    - ✓ Document type of weapon and condition
    - ✓ Handle to preserve fingerprints, biological, trace and other evidence
    - ✓ Note
        - Make
        - Model
        - Caliber
        - Serial number
        - Color
        - Condition
        - Trace materials (e.g., blood, tissue, fibers, hairs, fingerprints)
    - ✓ Ammunition in weapon
        - Revolver – diagram and note locations of cartridges
        - Semi-automatic – note condition of slide and number of rounds in magazine, chambered round
    - ✓ Unload before packaging

Figure 1-13. Properly packaged and secured firearm

- Projectiles
    - ✓ Do not mark on the projectile

- ✓ Do not clean or remove trace materials
- ✓ Wrap in gauze or soft, lint-free paper
- ✓ Place in box, envelope or other second container

- Spent cartridge cases
  - ✓ Document location and orientation of each
  - ✓ Collect individually
  - ✓ Wrap in gauze or soft, lint-free paper
  - ✓ Do not remove trace materials or clean
  - ✓ Place in secondary container

- Ammunition in package
  - ✓ Note number and type of ammunition
  - ✓ Handle carefully to preserve fingerprints or other evidence
  - ✓ Package in envelope or bag

- Gunshot residues
  - ✓ Collect as soon as feasible
  - ✓ Collect GSR
    - Collection by Trained personnel
    - Use GSR collection method preferred by the forensic laboratory
  - ✓ GSR on person
    - Collect within 6 hours of incident
    - Wear latex, not nitrile, gloves
    - If deceased, collect before body is moved
  - ✓ GSR on clothing
    - Photograph with standard & IR camera with scale
    - Carefully remove clothing
    - Package flat on paper so particles are not disturbed
    - Do not fold or cut clothing item
    - Place in box or on flat cardboard covered with paper

Figure 1-14. GSR collection disc for SEM

8. **Imprints & Impression Evidence**
   - Imprints
     - ✓ Two-dimensional prints
     - ✓ Residue prints
       - Non-Porous surfaces – document and lift with tape lifters or electrostatic lifter
       - Porous surfaces
         - Gel lifter -use contrast colored backing, store at room temp
         - Electrostatic lifter – place plastic film flat and protect from loss

   - Impressions
     - ✓ 3-dimensional evidence
     - ✓ Photograph with oblique lighting
     - ✓ Cast using appropriate material for type of surface

   - General procedure for casting impressions
     - ✓ Spray surface with snow wax, hair spray or similar spray
     - ✓ Insert barriers around perimeter of impression
     - ✓ Mix casting material just before use
     - ✓ Pour mixture without disturbing impression
     - ✓ Add mix until entire impression is covered
     - ✓ Insert supporting rods or wire, as necessary
     - ✓ Allow appropriate drying time
     - ✓ Place dry cast in box and cover with paper
     - ✓ Do not use plastic due to residual moisture in cast

   - Tire tracks
     - ✓ Photograph prior to casting
     - ✓ Use oblique lighting technique, with & without scales
     - ✓ Use a tripod for stability
     - ✓ Ensure camera is parallel to imprint
     - ✓ Collect hair, fiber, blood, tissue or other evidence
     - ✓ Cast according to general cast procedure
     - ✓ Mark cast with date, case number and initials
     - ✓ Do not remove debris from cast prior to packaging

   - Tire exemplars
     - ✓ Record tire information & photograph each tire
     - ✓ Secure approximately 6 feet of paper for each tire
     - ✓ Ink the tire using fingerprint ink or paste shoe polish
     - ✓ Take the exemplar of each tire separately
     - ✓ Note tire location, brand, date and initials on each exemplar
     - ✓ Do not fold exemplars

- Tool marks
  - ✓ Whenever possible remove the entire portion of evidence with tool mark. Package to prevent motion and damage to markings
  - ✓ If area cannot be removed, cast tool mark with microsil or similar material. Follow general casting guidelines
  - ✓ Casts of tool marks should be made *only* by investigators with extensive experience making doing so

- Tool exemplars
  - ✓ Package tools for exemplars securely to prevent loss of trace materials or other evidence on the tools
  - ✓ Never cast, make test marks or attempt to fit suspect tools in the tool mark
  - ✓ If necessary, collect the trace evidence (hair, fibers) to prevent loss
  - ✓ Do not bring the suspect took in the area of the tool mark for comparison or photography

9. Ropes & Cordage

- General considerations
  - ✓ Submit entire rope or cord
  - ✓ Leave knot intact
  - ✓ If cord must be cut, specify ends which and how ends were cut or reconnect with clean string
  - ✓ Handle carefully to prevent contamination or the loss of biological or trace evidence
  - ✓ Package in paper

- Exemplars for comparison
  - ✓ Submit entire length of any known samples for comparison
  - ✓ Handle to prevent contamination or loss of trace evidence

10. Trace Evidence

- General Considerations
  - ✓ Package small particles or fibers in paper druggist fold
  - ✓ Seal druggist fold, label and initial
  - ✓ Place paper fold in second container, e.g. envelope, bag
  - ✓ Do not place trace evidence directly into envelopes

- Fibers
  - ✓ Fibers on moveable objects – collect entire object
  - ✓ Fibers on immovable objects
    - Pick, tape lift or vacuum
    - Avoid damage or crushing of fiber

        - Collect known fabric from object for comparison standard

    - ✓ Individual fibers
        - Remove with cleaned tweezers or tape lift
        - Package individually in paper fold
        - Avoid pressure that may damage fiber

- Hairs
    - ✓ General considerations
        - Samples may be collected by picking, combing or tape lift
        - Collect with disposable or cleaned forceps
        - Wear mask or do not talk while collecting hair
        - Keep hairs from different locations separate
        - Package in clean paper fold first, then envelope
        - Avoid pressure to hair that may damage or break the hair

    - ✓ Known hair samples
        - Do not obtain hair combings as <u>known</u> standards
        - Pull a total of 25-50 hairs from 4 areas of the head (front, back, left side and right side
        - Collect at least 20 hairs from the public region from different areas
        - Place hairs from each area in a druggist fold
        - Place paper fold in labeled outer envelope

- Glass
    - ✓ Wrap movable objects in paper
    - ✓ Remove glass particles from immovable object individually with forceps or tape lift
    - ✓ Place larger pieces of glass in cardboard
    - ✓ Package to prevent loss
    - ✓ Collect samples of suspected source of glass if available

- Paint
    - ✓ Wrap clothing and movable items in paper
    - ✓ Individual paint chips
        - Collect with forceps or tape lift
        - Place in paper fold
        - Use rigid outer container (plastic vial, pill box) or small envelope
        - Larger paint chips should be protected from damage due to physical match potential
    - ✓ Paint on vehicles and other large objects

        - Note and document location and description of smears and scrapes
        - Remove entire area of transfer if possible
        - Collect known paint samples for comparison from areas near damage or paint smears
- Soil
    - ✓ Collection from impression area
        - Collect samples at least 1 tablespoon in size
        - Collect from 4 compass points around impression

    - ✓ Comparison samples
        - Collect along area of contact at the scene
        - Collect examples of visibly different soils in the area
        - Metal containers should not be used

    - ✓ Soil on objects or clothing
        - Package movable items in paper to prevent loss
        - Scrape soil areas of immovable objects into paper or plastic container.

11. Weapons

- General Considerations
    - ✓ Secure object in box to prevent friction
    - ✓ Avoid areas where fingerprints or biological evidence may be deposited
    - ✓ Package for safe transport
    - ✓ Document, but do not remove blood, body fluid or trace materials from the item unless they start to flake away from the surface.

Figure 1-14. Improper and proper packaging of a weapon

7. Final evaluation and walk through

After the documentation of the scene is completed and the forensic evidence is documented and collected, the crime scene investigators, scene commanding officer should review the scene and observations prior to release of the scene.

- Debriefing by team members
  - ✓ Review the documentation completed
  - ✓ Review evidence collected
  - ✓ Determine if additional information of materials are needed
  - ✓ Prioritize evidence for examination
- Conduct preliminary scene reconstruction
  - ✓ Review chain of custody for all evidence
  - ✓ Count the number of items, especially number of latent lifts, swabs, etc.
- Final Survey
  - ✓ Visually inspect each area of the crime scene
  - ✓ Determine that all significant evidence has been collected
  - ✓ Determine that all evidence is accounted for
  - ✓ Remove any remaining materials or debris from the crime scene process
  - ✓ Report any hazardous or dangerous materials or conditions

8. Release scene

Scene commanders should remember that once the scene is released the integrity of any evidence that remains at the scene cannot be guaranteed. The complete and proper investigation of a crime scene is imperative to serve justice. If the experience or size of the crime scene unit may result in a longer process, the scene commanding officer should identify this problem up front to avoid issues associated with releasing the scene too early.

Part 3. Enhancement Reagents and Field Tests

Chemical Enhancement Methods for Imprints & Patterns

1. General Considerations

- Determine the nature of the imprint material
  - ✓ Blood
  - ✓ Other protein-containing substance
  - ✓ Soil
  - ✓ Vegetation
  - ✓ Other
- Consider the nature of the substrate containing the imprint
  - ✓ Chemical composition
  - ✓ Color
  - ✓ Location
- Consider subsequent testing that may be required
- Photograph and document imprint prior to treatment
- Lift or photograph after treatment

2. Bloody Print Enhancement Reagent

Ingredients:

Acetate Buffer:	10 g	sodium acetate
	100mL	distilled water
	86 mL	acetic acid

Tetramethylbenzedine (TMB)	0.12 g
Sodium perborate	0.20 g

Collodion mixture:	
Collodion	15 mL
Ethanol	6 mL

Ethyl ether**	60 mL

**Caution: highly flammable and volatile. Wear mask and keep area well ventilated.
**Can be substituted with additional ethanol, but solution will drip if over-applied. Guar gun or similar thickener may also substitute for Collodion.

Directions:

- Dissolve TMB and sodium perborate in 4 mL acetate buffer
- Add collodion mixture to ether and stir
- Add TMB-perborate solution to 60mL of collodion-ether mixture
- Pour into sprayer
- Spray surface *lightly.* Do not overspray. Avoid drips.
- Blue color should develop within 30 seconds – 1 minute
- Photograph developed prints
- Lift or remove imprint from surface

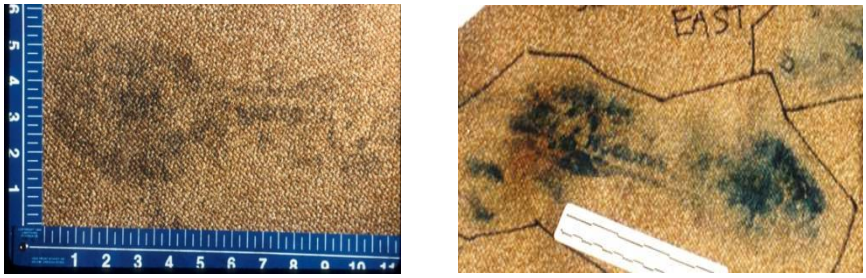


Figure 1-12 Bloody imprint on carpet before (left)and after enhancement (right). Note "Reebok" logo

3. Amido Black – Proteins enhancement

- **Amido Black solutions can be purchased premade from crime scene equipment/chemical suppliers**

Ingredients – Water-based Method:

Citric Acid Staining Solution:

Amido black 10B	2.0	g
Citric acid	20.0	g
Water (distilled)	1. 0	L

Fixing Solution:

5-sulphosalicylic acid	20.0	g
Water (distilled)	1.0	L

Directions Water-based Method:

- Apply fixing solution or immerse evidence to fix sample for 5 minutes.
- Apply citric acid solution or immerse evidence for 3 minutes
- Rinse with distilled water for a few minutes to remove excess stain
- Developed imprint will be dark blue-black

Ingredients - Methanol –based Method

- Before using methanol check an area without stain to ensure the methanol will not destroy the substrate surface

Methanol Staining Solution:

Amido black 10B	2.0 g
Glacial acetic acid	100.0 mL
Methyl alcohol	900.0 mL

Methanol De-staining Solution:

Glacial acetic acid	100.0 mL
Methyl alcohol	900.0 mL

Directions

- Treat surface with methanol for 5 minutes to fix blood
- Spray or immerse item in methanol staining solution for 3 minutes
- Rinse with de-staining solution for a few minutes to remove excess stain. Repeat if necessary.

Figure 1- 13. Bloody shoeprint before (left) and after (right) amido black enhancement

4. Crystal violet (gentian violet)

- **Crystal violet solution can be purchased premade from various crime scene suppliers**

Ingredients:

Stock solution:

Crystal violet	1.5 g
Ethyl alcohol	100.0 mL

Working solution:

Stock solution	2.0 mL
Water (distilled)	100.0 mL

Directions :

- Spray to cover or immerse evidence in working solution. If staining adhesive tape, separate tape from surface before staining.
- Soak for 5 minutes
- Rinse with distilled water
- Protein – rich imprints will stain purple

5. Ninhydrin

- **Ninhydrin pre-made solutions may be purchased from crime scene suppliers**

Ingredients

2,2 Dihydroxy-1.3-idanedianoe monohydrate (ninhydrin)	25.0 g
Acetone	4.0 L

Directions

- Dissolve ninhydrin in acetone. Store in a dark bottle
- Lightly spray surface with ninhydrin solution.
- Allow sample to dry. Repeat if necessary
- Develop at *room temperature* if DNA testing may be required.
- Enhance development by heating with a steam iron or blow dryer if no DNA testing will be done.
- A purple-colored product will develop in samples that contain amino acids.

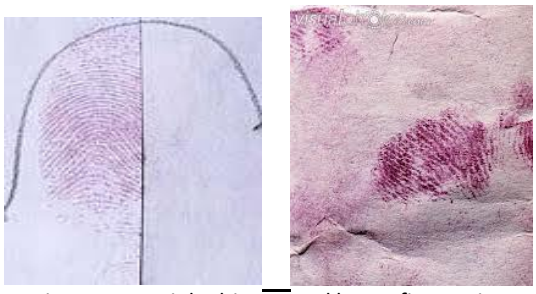


Figure 1-14. Ninhydrin-treated latent fingerprints

6. **Luminol**
   - **Luminol solutions may be purchased from crime scene suppliers**
   - **Best results when used for the detection of diluted blood samples**
   - **Other commercial chemiluminescent reagents such as "BlueStar"® or "Starlight Bloodhound"® may also be used for this purpose**

Ingredients

Solution I:

Luminol (3-aminophthalhydrazide)	0.1	g
Distilled water	50.0	mL
Ethanol	20.0	mL

Solution II:

Sodium carbonate	0.5	g
Sodium perborate	0.7	g
Distilled water	30.0	mL

Directions

- Immediately before using mix Solution I and Solution II in a spray bottle
- Spray area with suspected blood
- Area must be totally dark to view reaction
- Luminescence develops within a few seconds and last for a short period.*

  * Some commercial products claim a longer period of luminescence. You should use the sample with known diluted blood prior to use at the crime scene.

Figure 1-15. Bathtub with diluted blood before (insert) and after use of luminol

7. **Merbromin (mercurochrome)**
   - **Solutions A & B can be purchased premade from crime scene suppliers**
   - **Use caution when spraying this chemical. Avoid inhalation.**
   - **Effective to develop bloody stains on dark surfaces**

Ingredients

Stock Solution:

Merbromin (mercurochrome)	0.45 g
Ethanol	100 mL
Formic Acid	15 mL
Mossy Zinc	10 g

Reflux until clear and pale in color.

Working Solution A:

Stock solution	10 mL
Acetone	30 mL

Working Solution B:

3% hydrogen peroxide	30 mL
Acetone	70 mL

Directions

- Place solutions A and B in separate spray bottles
- Apply a fine mist of Solution A onto the surface
- Apply a fine mist of solution B onto the surface
- Allow the surface to dry
- Examine with alternate light at 530 nm (green) and 460 (blue)
- Patterns in blood appear as a yellowish-colored fluorescence

Figure 1-16. Merbromin- enhanced imprint in blood on a dark surface.

8. Fluorescein

- **Solutions of fluorescein reagent (fluorescin) may be purchases from crime scene suppliers**
- **Thickening agent may be added to reduce running after spraying**
- **Does not require total darkness for observation**
- **Wear appropriate protective equipment**

Ingredients

Fluorescin Stock Solution:

Fluorescein	0.50 g
Sodium Hydroxide	50.0 g

Distilled water	50.0 mL
Zinc powder	5.0 g

Hydrogen peroxide (3%)

Directions

- Mix fluorescein, sodium hydroxide, water and zinc.
- Allow zinc to settle. Pour off stock solution, which is now reduced fluorescin, for use.
- Mix 20 mL stock solution + 140 mL distilled water in a spray bottle as a working solution.
- Gently spray the area to be tested with working solution. Wait 15 seconds
- Spray lightly with 3% hydrogen peroxide
- Blood will appear as greenish fluorescence under ALS at 450 nm and orange filter
- As fluorescence fades, the pattern may be lightly sprayed again with peroxide

Field Tests for Screening Potential Evidence

1. **General Considerations**
    - Do not test samples in the field if contamination or consumption are an issue
    - Test chemical reagents on control samples before testing potential evidence
    - Observe appropriate procedures for use and disposal of chemicals
    - Wear appropriate personal protective equipment to limit exposure
    - Photograph and document the area before any testing or enhancement
    - If you have any questions, consult an expert as soon as possible

Tests for the Presence of Blood

1. **General Procedure for presumptive blood tests**
    - Moisten the tip of a sterile swab with 1 drop of sterile saline
    - Remove a small amount of the suspect stain
    - Add 1 drop of test reagent (Kastle-Meyer, Leucomalachite Green, etc.)
    - Check for a color change . A color change at this point indicates a "false" reaction.
    - Add 1 drop of 3% hydrogen peroxide to the swab.
    - Color change within 15 seconds is considered a positive test. A positive test indicates that blood may be present.
    - Collect the remainder of the stain according to recommendations for the type and size of the evidence.

2. **Phenolphthalin (Kastle-Meyer, KM)**
    - **Prepared solutions of phenolphthalin solution can be purchased from crime scene suppliers**
    - **Phenolphthalin (reduced phenolphthalein) powder can be purchased from chemical supply houses to avoid refluxing.**
    - **Keep solution in a cool environment**

Ingredients

Stock phenolphthalin solution:

Phenolphthalein	2.0	g
Potassium hydroxide	20.0	g
Distilled water	100	mL
Zinc powder	20.0	g

Reflux the above mixture for at least 2 hours until the solution becomes colorless. Store refrigerated in a dark bottle with added zinc powder.

Working solution:

Phenolphthalin stock	20	mL
Ethanol	80	mL

Directions

- Follow general procedures for presumptive blood tests
- Pink to red color develops within 15 seconds of addition of peroxide
- Detects blood diluted up to 1:100,000
- Store refrigerated in dropper bottle when not in use
- Discard if working solution begins to turn pink

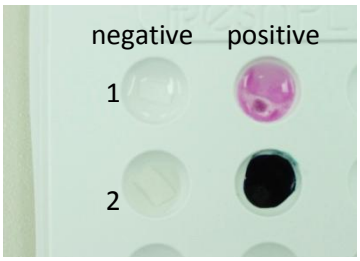


Figure 1- 17. (1) Kastle-Meyer and (2) Tetramethylbenzedine Presumptive tests for blood.

3. **Leucomalachite Green (LMG)**

Ingredients

Leucomalachite green	0.1 g
Sodium perborate	3.2 g
Glacial acetic acid	66 mL
Distilled water	33 mL

Directions

- Follow general procedures for presumptive blood tests
- Blue-green color develops within 15 seconds
- Detects blood diluted 1:20,000
- Store refrigerated in dropper bottle when not in use

4. Tetramethylbenzedine (TMB)

Ingredients

Acetate buffer:

Sodium acetate	5.0 g
Glacial acetic acid	43 mL
Distilled water	50 mL

Tetramethylbenzidine Solution (TMB)

3,3',5,5' tetramethylbenzidine	0.4 g
Acetate buffer	10 ml

Directions:

- Follow general procedures for presumptive blood tests
- A blue-green color will develop within 15 seconds.
- Mixed with collodion it can also be sprayed on vertical surfaces (See bloody print enhancement reagent)
- Detects blood diluted 1: 1,000,000
- This is a potential cancer causing agent. Avoid direct contact with the skin. Do not inhale.

Tests for the presence of body fluids

1. General Considerations

- Search areas with an alternate light source for potential body fluid stains
- Do not test samples in the field if contamination or consumption are an issue
- Test chemical reagents on positive and negative control samples before testing potential evidence
- Observe appropriate procedures for use and disposal of chemicals
- Wear appropriate personal protective equipment to limit exposure

2. Acid Phosphatase Test for Semen

- **Acid phosphatase test solutions can be purchased premade from crime scene suppliers**

Ingredients

Color solution:

Fast Blue B salt	2.0 g
Distilled water	100 mL

Substrate solution:

Sodium alpha-napthylphosphate	189 mg
Sodium acetate	2.0 g
Glacial acetic acid	1.0 mL
Distilled water	100 mL

Divide solutions into volumes of about 3 mL each. Freeze until use. Thaw only the number of tubes of each solution needed at the scene.

Directions

- Wet a sterile cotton swab with one drop of sterile saline
- Remove a small portion of stain to the swab
- Add 1 drop of substrate solution to the swab. Wait 15 seconds.
- Add 1 drop of color solution to the swab.
- A pink-purple color that develops within 30 seconds indicates the presence of acid phosphatase, a component of semen
- Discard unused, thawed color and substrate solutions

Figure 1-18. Swabbing a suspect stain (left) and positive acid phosphatase test on the swab (right).

3. **Jaffe test for Creatinine in urine**
    - **Characteristic Odor is often used as an indicator of urine stains**
    - **Use Caution with picric acid**
    - **Test strips for the detection of urine are available from biochemical vendors**

Ingredients

Picric Acid Solution:

Picric acid	2.0 g
Distilled water	100 mL

Sodium Hydroxide Solution (10%)

Sodium hydroxide	10.0 g
Distilled water	90 mL

Directions

- Wet a sterile cotton swab with 1 drop sterile distilled water
- Remove a small sample of the stain with the swab
- Add one 1 drop 10% picric acid solution to the swab
- Add 1 drop sodium hydroxide solution
- An orange-red color will develop if creatinine is present. A positive result indicates urine may be present.

Immunological tests for blood and body fluid

- Commercially available test strips and cartridges
- Separate tests for blood, semen, saliva, and urine
- Affected by pH and some other chemicals
- **Not recommended for field use except in controlled circumstances**

Tests for gunshot residue and explosives

1. General Considerations

- Consider the use of portable instrumentation rather than screening tests for powder residues
- Screening tests are not specific as to source of the chemical detected
- Laboratory analysis for these materials is generally the preferred method

2. Detection of Nitrates/Nitrites (Diphenylamine, DPA)

- Nitrate residues may be detected after discharge of a weapon or in nitrate/nitrite explosives
- Caution! Solution is highly corrosive. Wear appropriate protective equipment
- Chemicals may be sprayed onto the surface to visualize patterns of particle distribution
- Photograph the area before and after the test
- Always conduct tests with positive and negative control samples before testing potential evidence

Ingredients

Diphenylamine	0.5 g
Sulfuric acid	90 mL
Distilled water	10 mL

Directions

- Wet a sterile cotton swab with 1 drop distilled water
- Remove a small portion of residue onto the swab
- Add 1 drop DPA solution
- A dark blue color will develop immediately, indicating the presence of nitrates/nitrites

3. Test for nitrites (Modified Griess Test)

- **Not recommended for field use**
- **Do not conduct this test until all other examinations are completed**

Ingredients

Sulfanilic acid solution:

Sulfanilic acid	0.5 g
Distilled water	100 mL

alpha- napthol solution:

alpha-Napthol	0.28 g
Distilled water	100 mL

Acetic acid solution:

Glacial acetic acid	150 mL
Distilled water	850 mL

Directions

- Mix equal parts sulfanilic acid and alpha-napthol solutions
- Desensitize photographic paper by soaking in this mixture
- Let paper air dry
- Place evidence with the residue side down on photographic paper
- Soak cheesecloth in the acetic acid solution and wring out excess acid
- Place the cheesecloth on top of the evidence item (There now are 3 layers)
- Press all 3 layers with a steam iron
- Discard cheese cloth and remove evidence
- Orange colored areas indicate the presence of nitrite residues.

4. **Test for lead residues (Sodium Rhodizonate)**
    - **Do not spray this test on an entire evidence item unless all other GSR testing is completed.**

Ingredients

Saturated sodium rhodizonate in distilled water

Tartrate Buffer (pH 2.8):

Sodium bitartrate	1.9	g
Tartaric acid	1.5	g
Distilled water	100	mL

Hydrochloric acid solution:

Hydrochloric acid	5.0	mL
Distilled water	95.0	mL

Directions

- Wet a sterile swab with sterile distilled water
- Remove a small portion of residue to be tested
- Spray with / add 1 drop of saturated sodium rhodizonate
- Spray with / add 1 drop tartrate buffer. A pink color develops in the presence of lead.
- Spray with/ add 1 drop 5% hydrochloric acid solution. Pink color fades and leaves a blue-purple color. Color may fade quickly
- A positive result indicates the presence of lead.

Figure 1-19. Untreated (left) Modified Griess test (middle) and Rhodizonate test (right). Shot fired 3 inches from target.

Part 4. Crime Scene Reconstruction

Sometimes it is necessary to examine the crime scene and arrive at conclusions about what occurred, the sequence of events, or when or how an incident happened. This reconstruction of the incident scene and related events may lead to a "theory" of what happened, and can be crucial in cases such as a motor vehicle accident, homicide, arson, bridge collapse, and many other types of incidents. Reconstruction combines the facts of the analysis of crime scene patterns and evidence, results of laboratory examinations, medical reports, and other related information to arrive at a logical hypothesis. Logic is the basis of crime scene reconstruction. As such, it is sometimes possible to provide only partial reconstructions related to a specific event or sequence, depending on the information that is available and the scientific facts that can be determined. If the crime scene is not intact or is not documented thoroughly, valuable data may be lost, which limits the extent to which the scene can be reconstructed. In such cases, a partial reconstruction addressing certain facts or aspects of the incident may still be possible.

When a crime scene reconstruction is done, all crime scene photographs, autopsy photographs, video, measurements, notes, reports, and physical evidence must be thoroughly examined. This is another reason for the most complete documentation of and recognition of evidence at the crime scene possible. Databases can also play a key role in a reconstruction by providing identification or pattern information. Whenever feasible, the individual who will be conducting the crime scene reconstruction should directly observe the crime scene as soon as possible after the incident.

Figure 1-20 depicts the stages of the reconstruction process. These stages involve the use of inductive, deductive and abductive logic to arrive at the probable reconstruction as indicated by the data from various sources. The four stages of a reconstruction include:

1. Data collection.

All information related to an incident or obtained at the crime scene must be compiled. In addition to the scene documentation materials, data should also include statements of witnesses, hospital or autopsy reports, information concerning the condition of the evidence, patterns observed and related investigative and documentary evidence.

2. Information verification.

Each piece of information, documentation, and all photographs should be verified for accuracy and authenticity prior to relying on these materials for reconstruction.

3. Hypothesis formation.

Initially, the crime scene investigator may make a conjecture as a possible explanation of the crime scene observations. However, it is important that the reconstructionist maintain an open mind and continue to acquire data, after which the conjecture is tested against the scientific facts and observations. Various possible explanations will eventually be eliminated as data is reviewed and the most probable explanation of the sequence of events of the nature of a scene will result in the formation of a hypothesis.

4. Testing of a hypothesis.

Once a hypothesis is formed it must be further tested. Data obtained from analysis and comparison to known samples will occur at this time. Well-conceived experiments and verified results are also done at this stage of the reconstruction to support the hypothesis about a mechanism that produced a particular pattern. At any time during this stage data may be produced that results in proving the hypothesis flawed, and additional information and testing will be necessary to formulate a new hypothesis.

5. Theory formation.

After the hypothesis has been thoroughly tested and verified, the results of laboratory tests, scene documentation and other data must be held up to scrutiny. After this careful examination, the hypothesis may be considered a theory. The theory must address all relevant investigative information and scientific evidence. Only when

the theory explains the observed facts can it be accepted as a probable explanation of the event.

Reconstructions, including the reconstruction of bloodstain and other patterns at a scene, should be completed *only* by experienced and well-trained personnel. Crime scene specialists should have training and hands-on experience recommended by professional organizations. It is also important to maintain an independent view of the crime scene and related data; this ensures that the reconstruction does not reflect bias, but provides the most probable interpretation of the scientific facts developed from the scene investigation and verified results of evidence analysis. Experts with the appropriate experience may be available in your department, but if crime scene personnel have limited experience and training, you should reach out to practitioners at your local forensic laboratory, scientific experts at the Institute or other experts associated with universities or forensic science organizations for assistance.

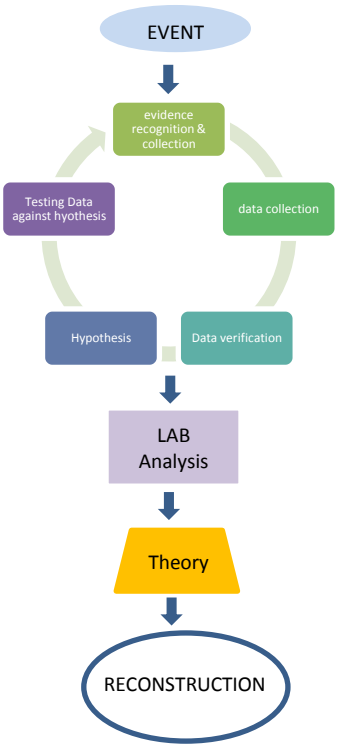


Figure 1-15. The Reconstruction Process

SECTION II
ADVANCED TECHNOLOGIES & METHODS FOR CRIME SCENE INVESTIGATION

1. Introduction

It is clear from the previous discussions that the proper recognition, documentation, collection and preservation of evidence at the crime scene are critical for the successful investigation of an incident. Overall methods employed during each step in this process are discussed in Part I of this publication. Standard procedures are sometimes sufficient to provide the necessary information during the crime scene search and subsequent laboratory analysis or crime scene reconstruction. At times, however, the crime scene analyst or the forensic scientist must employ more advanced techniques at the crime scene to locate evidence or to document that evidence. In addition, advanced technologies may facilitate evidence collection or bring forensic analysis of physical evidence to the crime scene. There is a growing trend to employ these advanced technologies at crime scenes for various purposes including to:

(1) Search the scene for and enhance physical evidence

(2) Provide better documentation methods for record and reconstruction purposes

(3) Screen physical evidence for association or elimination

(4) Enhance pattern evidence for reconstruction

(5) Conduct preliminary forensic analysis at the crime scene

The following sections provide an overview of some of the more recent developments in crime scene technology and their use. Some effects of these technologies on the downstream processes of analysis and reconstruction are also provided. This is not an exhaustive list -- advances in technology and their forensic applications are continually being developed. Practitioners should monitor these developments and work to validate those techniques and applications that may provide more thorough and useful data from the crime scene and the evidence.

It is not practical for many departments to purchase many of the advanced technologies discussed in this section either because they are used infrequently or are too expensive or too difficult to maintain as part of a limited operations budget. The Institute of Forensic Science has developed a regional advanced technology task force that has trained local department members to use many of this equipment. Experts at the Institute and members of the team are

available to assist various departments in their investigations by bringing advanced technology to the scenes as needed and assisting scene investigators by employing these technologies. This collaboration provides access by all departments to advanced technology without extensive cost. As part of the investigative process these tools can provide valuable information to crime scene and field investigators, save time and resources in subsequent laboratory analysis, and allow timely response in critical situations. This team model is a useful paradigm that could be pursued by other regions to take full advantage of facilities and resources in their areas.

Many resources are available that identify equipment that is typically recommended for crime scene investigation. An example of these materials can be found in Appendix II. This section looks at some examples of specialized or advanced technology used for various phases of crime scene investigation to enhance the standard methods commonly employed by practitioners. It is by no means an exhaustive list, but includes technology that is commonly used in more than one forensic science discipline or helpful for unique tasks at a crime scene.

2. Advanced Techniques to Search for Evidence

Alternate Light Sources (ALS)

The use of various wavelengths of light to locate physical evidence is well known. Various studies [citation] have shown that searching with alternate wavelengths of light enhances the ability to recognize various types of evidence, most notably body fluids and certain trace materials. For many years ultra-violet light were the wavelengths of choice for searching evidence. Due to the hazards of using UV light and the weak fluorescence noted with some samples, practitioners began experimenting with light sources of other wavelengths as they became available and portable. Today, there are many brands of alternate lights on the market, each with advantages such as low cost, light-weight and safe operation systems. The most useful are those ALS systems that are hand-held, that can easily change wavelengths and that hold a charge or have adaptors for longer use. While many are aware of the value of using alternate light at the crime scene, key to optimal use of this technique is understanding the combinations of wavelengths of light and filters to reveal different materials. The chart below represents work that was done by Palmbach et.al. using an ultralight forensic light source®.

Material	Wavelength (color)	Filter
Body fluids	320-400nm (UV)	clear
Body fluids, general trace	450-475 (blue)	Orange, yellow
Fingerprints, some trace	480-500 (cyan)	Orange, yellow
Fingerprints	510-540 (green)	Red
GSR, Blood on dark surface	770 – 900 (IR)	Use special camera

Figure 2-1. Use of alternate light and filters for various components.

Ground Penetrating Radar

Ground penetrating radar (GPR) is a specialized instrument designed to provide information of structures or disturbances in soil that cannot be seen from the surface. Used for many years to evaluate and inspect structures, roads, historic buildings and other areas to determine underlying structures and deterioration. Archaeological applications include the identification of potential gravesites and building remnants underground. The GPR identifies disruption in the natural deposit of soil layers or building materials. This instrument has been used to identify potential gravesites under concrete slabs, buried weapons caches and other items. GPR can be very useful when searching large areas, which can be mapped out, and potential bury sites. GPR can assist law enforcement and crime scene investigators in locating evidence behind brick or concrete, wooden floors or in hidden compartments. Ground penetrating radar can also rule out suspect areas in a short period of time.

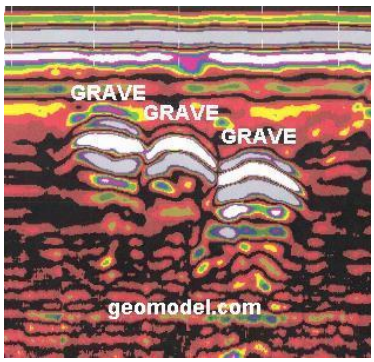


Figure 2-2. Use of the GPR (left) and a typical screen showing gravesites (right).

Portable x-ray

A portable x-ray device can be used as various types of scenes to determine the structure of and location of various components in or behind physical barriers and building materials. The portable X-ray adds the ability to examine areas of a structure that cannot be removed and taken to a lab. For example, investigators use portable X-ray equipment to examine debris for ignition devices, wood for missing bullets, heating pipes, bombs and weapons. Battery powered X-ray systems are easy to maneuver, so they can be used to examine objects that vary in size and shape. For example, this instrument has been used at crime scenes to locate a bullet that passed through several layers of wall at a homicide scene and to check a sealed container for the presence of skeletal remains. Examinations of skeletal remains for damage, portions of broken weapons, bullets and other artifacts have also been carried out at during crime scene investigations. Because portable X-ray equipment produces ionizing radiation with associated health hazards, this instrument should be operated by individuals who have appropriate training and are aware of the hazards of use of x-rays. These instruments do have many safety features that warn the operator of X-ray emission and limit exposure to radiation outside the X-ray beam.

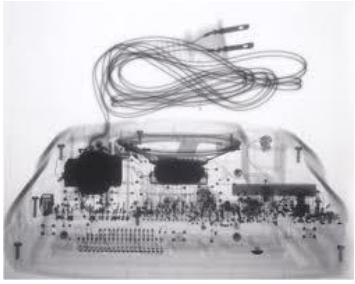


Figure 2-3. Portable x-ray system (left) and a sample x-ray of container contents (right)

Portable Digital Evidence Collection

Digital evidence is key to the investigation of many types of crimes. In the past, the use of digital evidence for investigative purposes required the submission of electronic devices to the laboratory before information could be collected to aid the investigation. Encase has addressed this problem with a portable version of its software that can be used at the crime scene by investigators or forensic examiners to collect and triage a case without compromising the digital evidence on the computer. Encase Portable® provides immediate, real-time review by the crime scene investigator of the information stored on the computer. Using this software may also save time and decrease evidence analysis backlogs in the forensic laboratory by eliminating the submission of unnecessary digital evidence or files. As always, the investigator must ensure that the proper search warrants are in place prior to using Encase Portable® or any digital evidence triage software.

Remote Transmission systems

Today's technology allows for the examination of crime scenes with the transmission of images from that scene to a resource center, such as the Henry Lee Institute of Forensic Science, where the scene and evidence can be examined by various experts in real time. This type of equipment provides the potential to search a crime scene more efficiently and effectively, consulting with experts who may be hundreds or thousands of miles from the actual scene. The use of HD cameras, iPads, iPhones and other portable devices to "scan" the area gives experts a view of the scene that allows them to evaluate patterns and the condition of the scene while guiding scene investigators to the location of potential physical evidence. Essentially these systems act as another set of experienced eyes in the recognition process. Once potential evidence is located, the imaging systems can allow for the quick identification of the material and its inclusion as significant physical evidence in the investigation. Since any portable, digital device will work with these systems, evidence recognition and evaluation can be enhanced by the use of equipment such as portable microscopes.

Reflective Ultraviolet Light Imaging System

Examination of crime scenes for latent prints can be a tedious and messy task, and often requires the scene investigator to dust with different contrasting powders just to determine whether a latent fingerprint is present in a given location. Reflective ultraviolet light imaging systems enhance the observation of latent fingerprints on smooth, non-porous surfaces prior to treatment, often saving time, and preventing alteration that occurs when processing large areas with traditional powder methods. When no latent prints are noted using the RUV light systems on untreated surfaces, areas can be lightly fumed with superglue and re-scanned for latent prints. Using reflected ultraviolet light untreated oily prints will appear as black ridges while untreated latent prints that are primarily from sweat will be white, reflective ridges; fumed prints will appear as sharp ridges on a black background. The RUV light imaging system can also be used to enhance the observation of post-luminol treated areas, bite marks and other UV fluorescent materials.

Figure 2-4. A reflective ultraviolet light imaging system used for scene searches

3. Advanced Methods for Crime Scene Documentation

Infrared – Ultraviolet Camera

The use of a high-quality, digital camera is common in today's crime scene investigation. These systems are useful for documentation of evidence and patterns at scenes found in many circumstances. The addition of an IR-UV camera system enhances the capabilities of the practitioner, especially when contrast or chemical patterns must be considered. Another important aspect of photo-documentation is the use of appropriate filters and light sources that can result in the demonstration of patterns, such as gunshot residue patterns, on skin and clothing that may be overlooked or poorly visualized without specialized equipment.

Digital infrared photography can be used by crime scene investigators as a nondestructive test for examining gunshot residue (GSR) on dark and multi-colored fabrics found at the crime scene. When a firearm is discharged a plume of gunshot residue exits the barrel and creates a visible powder pattern on light-colored clothing at specific muzzle-to-target distances. GSR consists of nitrates and nitrites from burned and partially burned smokeless powder and carbon. When GSR patterns are found on dark or multi-colored clothing, the GSR pattern is not readily visible because of the background color of the cloth. The detection and enhancement of GSR patterns has been demonstrated with the use of 35 mm infrared film in single lens reflex cameras; digital cameras simplify the process of producing infrared images. Digital infrared photography reveals GSR details on dark and multi-colored fabric because the human eye is not sensitive to this region of the electromagnetic spectrum.

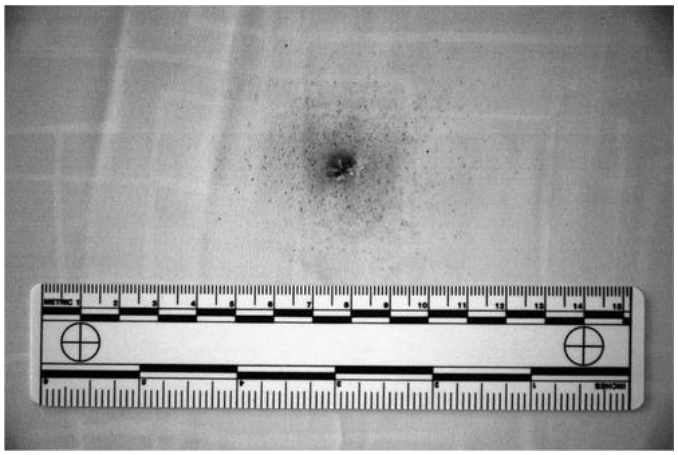


Figure 2-5. Infra-red photography of gunshot residues on a dark, patterned cloth

Researchers have also shown that IR photography is useful to document bloodstain patterns on darkly-colored – black clothing and surfaces. At the crime scene this may be useful for demonstrating patterns on carpeting, furniture cushions and other surfaces.

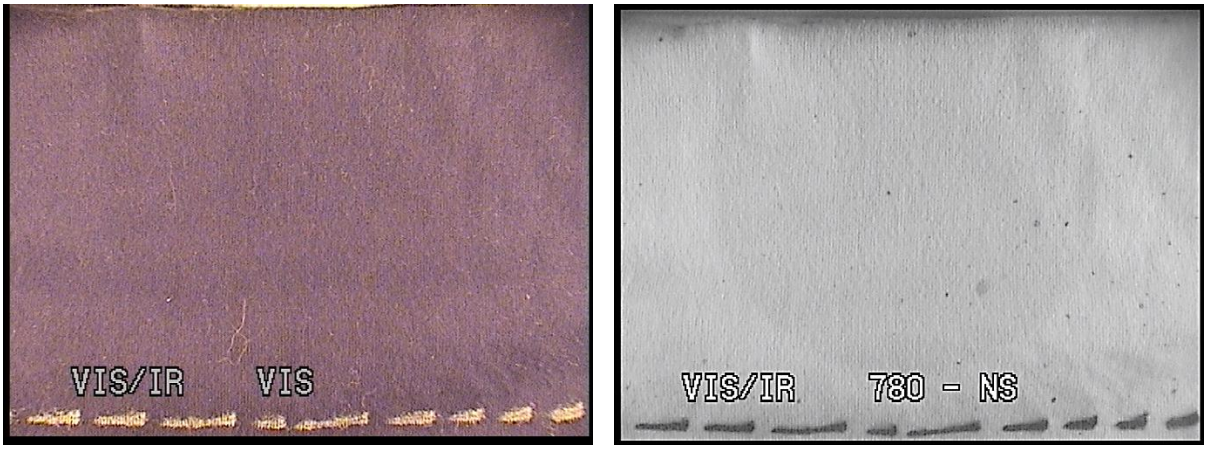


Figure 2-6. Minute bloodstains on a black t-shirt under visible light (left) and with infrared camera and filter (right). (photographs courtesy of Kim Rumrill)

“3-D imaging” and scene mapping

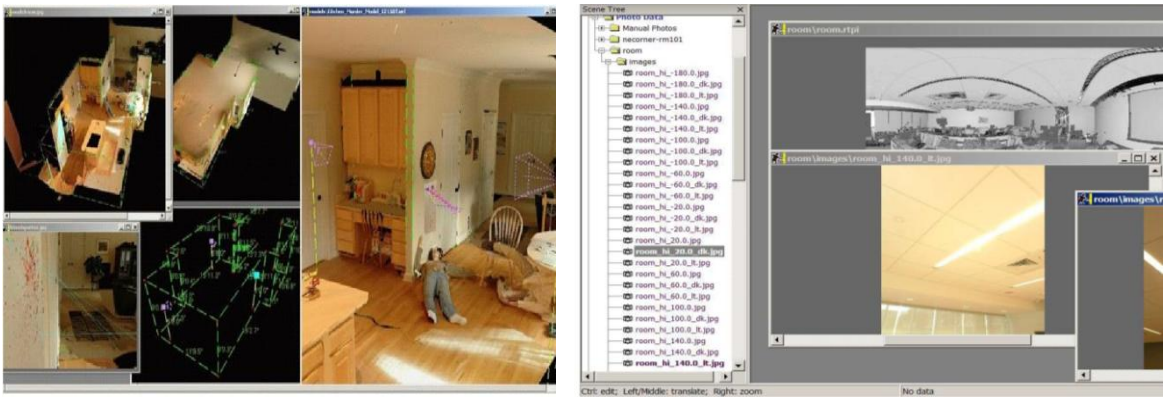


Figure 2-7. Examples of scene scans and imaging products.

2D scene diagram and “3D imaging” software have been designed by various companies such as 3rd Tech, Leica, and others to obtain accurate photographic documentation and measurements using the latest laser and digital camera technology. Each area of a scene can be scanned to obtain data is quickly with basic interaction by scene investigators. This data is then used to build computer graphics models, determine measurements and demonstrate patterns at the scene. Capturing a complete scene or object often requires scanning from more than one location in order to see both sides of an object or part of a surface 'behind' another object. Software provides functions to quickly and easily 'align' scans to produce a single scene model and fast measurement functions for finding the distance between any points in a scan, perpendicular distances, angle measurements, and intersections of lines and surfaces. The value of these systems lies in the completeness of the data obtained and the ability to obtain measurements or other data after the team has left the scene. The use of the scanned images allows any viewer to essentially revisit a crime scene at any time after the images have been taken. The scanner is also useful for documenting and evaluating scenes for homeland security and related areas.

Total Station

Forensic mapping using a total station is a system to document physical evidence at some critical incident, much like documenting physical evidence at the scene of highway crashes. The system uses an absolute polar coordinate system of measuring in comparison to the base line coordinate or a triangulation system. Polar coordinate refers to fixing the location of evidence by an angle and radius. The instrument transmits an infrared laser beam which is reflected back off an object or a mirrored prism. The time it takes for the beam to travel is converted by an on-board computer into units of spatial measure. Distances, angles, and other information so gathered can then be stored in a data collector and later downloaded into computers loaded with software designed to convert measurements into maps and other analytical reports

Figure 2-8. Officers practice using total station during training course.

Computer Aided Drawing Tools

Computer aided drawing tools, or CAD, can produce accurate and clear crime scene diagrams, especially useful for courtroom and reconstruction purposes. These systems are vector-based programs that use the investigators' measurements to accurately place significant items of evidence, patterns and other scene markers. The relationship between items can be clearly shown as well.

Many of these programs contain libraries of pre-drawn objects such as furniture, bodies and building structures that the investigator can place in the crime scene diagram. Data that is collected via Total station or other digital 2D and 3D systems can also be imported into many of these software packages.

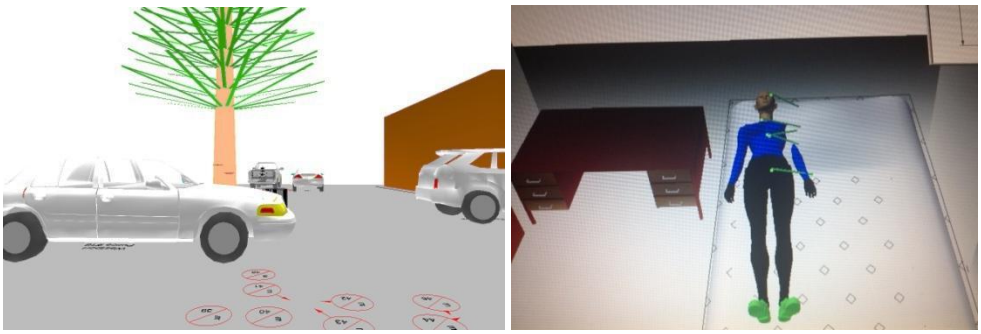


Figure 2-9. Two CAD diagrams, an outdoor and an indoor crime scene.

The CAD systems are particularly useful for the diagraming of accident scenes. Additional features of software included materials for the calculation and positioning of vehicles and related objects. CAD can also generate useful information such as bullet trajectories and distance, which makes this system useful for visualizing various hypotheses during a crime scene reconstruction examination. These programs also give the investigator the ability to view evidence and objects from different viewpoints, which can help to support or disprove a witness's statement.

Digital Image Enhancement

The use of digital images from CCTV and other monitoring devices during an investigation has greatly increased during the past decade. Sometimes these images are not clear due to movement, the technology used or poor placement of the recording device. The background may also interfere with using data that is in an image.

Avid system or similar software can sometimes be used to enhance or to restore the images and provide significant investigative information. Using the algorithms developed by the software manufacturer, images can easily be enhanced to modify the contrast or brightness of an image, make the image more focused or target a portion of the image to enhance a particular object, such as a license plate or weapon. Enhancement can also remove background in many cases, making portions of an image more clear and useful. This enhancement technique is particularly useful when viewing images of latent fingerprints and other patterns on multi-colored surfaces.

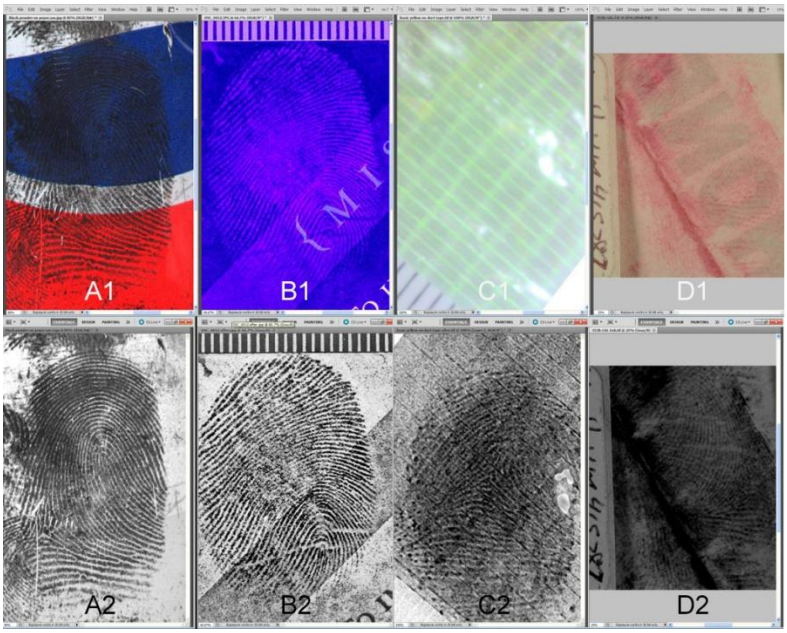


Figure 2-10. Image enhancement of latent fingerprints (NIST)

4. Use of Databases to Aid Investigations

Case Evidence and Management Systems

Many police departments use evidence management systems to assist with the evidence records related to a crime investigation. Through use of these systems the chain of custody and other pertinent information about the evidence can be maintained, often utilizing bar code technology. A case management system, such as that developed by CSI Technology at the Henry Lee Institute, goes beyond the basic evidence tracking system. Case management systems allow the investigator and the scientist to conduct data mining processes, which can be so important in suspected serial offender cases and cold case investigations. By searching documents, records, and other information for key words, activities, types of evidence and other self-determined categories, associations may be made more quickly. The use of the management tool allows the investigator to search quickly through witness and victim statements, laboratory reports, law enforcement reports and other materials for a particular item, comparing and collating data for that piece of evidence or information.

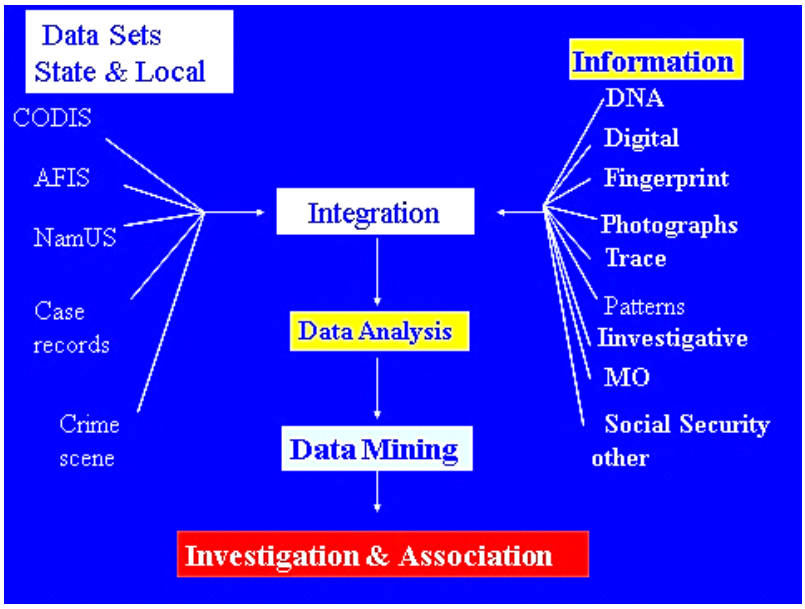


Figure 2-11. Case Analysis and Integration

SICAR Footwear / Tire tread database

SICAR®6 is the management system for shoe print and tire mark evidence The patterns within tires and shoeprints contain many individual features which, when coded, provide a powerful set of search parameters. Both shoe print and tire marked evidence can be entered into SICAR®6 and stored with casework data.

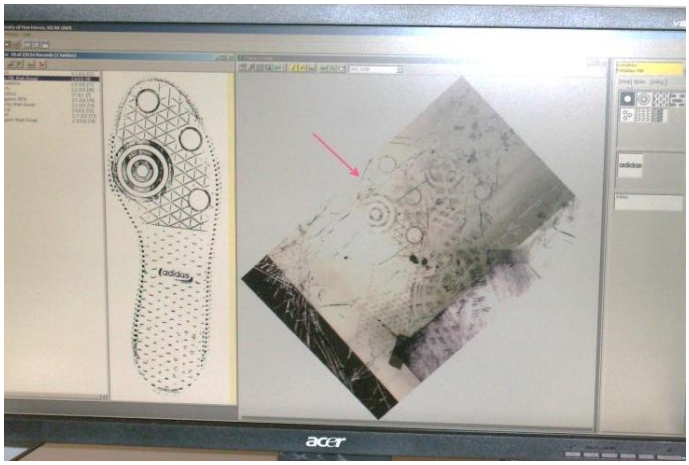


Figure 2-12. A SICAR comparison

in easy-to-search databases that help us link crimes with suspects or other crimes via the footwear or vehicles. By searching databases, potential source(s) of a shoe print can be identified and provided to law enforcement for investigative purposes. Each feature is assigned a specific code, so that the set of codes becomes a powerful search parameter. When no specific suspect can be identified, the make, model and pictorial images of a shoe or tire associated with a crime become valuable in the search for a suspect. Two reference databases, SoleMate® for shoes and TreadMate® for tires, can provide this vital information. Essential to each database record is a set of codes that represent the pattern of the tire tread or shoe sole, derived using the same scheme as that provided in SICAR®. They provide the means of identifying the unknown shoe or tire associated with the crime, in a database enquiry. The databases are extensive, dating back to 1995. Currently, SoleMate® holds 22,000 records and TreadMate® 7,838 records. The Henry Lee Institute maintains a SICAR system to assist police departments by providing investigative leads

related to footwear patterns located at crime scenes. Forensic laboratories throughout the country also provide these services.

This system archives crime scene shoe print and tire mark evidence.

- Archives suspect shoe and tire data.
- Matches suspects' shoes or vehicle tires to crime scene evidence.
- Identifies a brand of shoe or tire using updated reference collections.

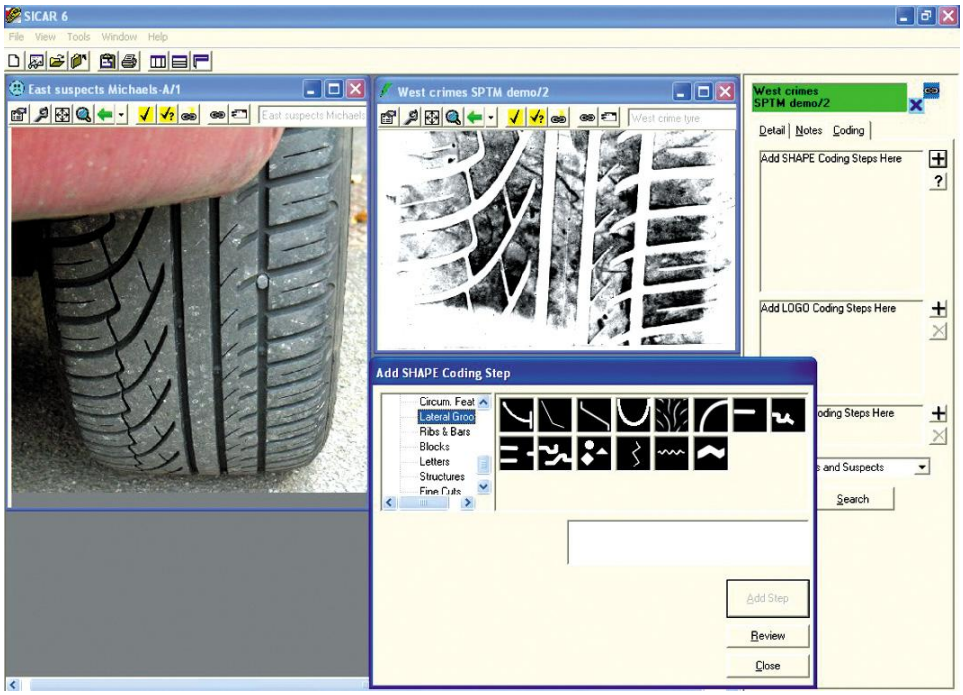


Figure 2- 13. TreadMate Search and Comparison screen

IBIS Firearms Database

A system designed to both acquire and analyze spent bullets and cartridge cases, IBIS has undergone numerous changes and improvements over the years. A state-of-the-art 3D cartridge case imaging station **IBIS®** BRASSTRAX-3D™and **IBIS®** MATCHPOINT+™,a comparative analysis station for examining 2D and 3D images,

Figure 2-14. The IBIS BrassTrax System.

and an HD system have been developed by Forensic Technology. IBIS now offers the only truly integrated ballistics identification systems in the world for both fired bullets and cartridge cases that can capture and help you examine three-dimensional as well as two-dimensional images. Using the IBIS matchpoint program after entering cartridge case information allows:

- Independent correlation scores for each image type captured
- On-site and remote access to 2D and 3D images
- Ability to manually view and compare all exhibits in the IBIS database
- Ability to view results and images in a tile screen format
- Ability to compare exhibits in a side-by-side mode
- Dynamic visualization tools including the ability to view images in 2D and 3D, to change the magnification, and to control the intensity and direction of the light
- Ability to view cross-sectional profiles of 3D bullet images
- Ability to determine and view consecutive matching striae (CMS)
- Ability to manage and link potential matches and positive identifications

Government-supported databases

Several government supported databases are available at the state or local level that are commonly used to provide investigative leads with the appropriate evidence and analysis. Among the more active databases are:

- CODIS:

The combined DNA identification system was established by the FBI and contains millions of DNA profiles from offenders across the U.S. When a profile from an unknown source is developed during a case investigation the authorized state or local laboratory can search against the database to identify the unknown source. If no "match" is found in the database at the time of search, the system will automatically re-search the profile after a set amount of time. In addition, the forensic database will tell the investigator if there are other cases that have been submitted to CODIS that showed the same DNA profile. Thus, cases from different jurisdictions may be linked through the CODIS database. Currently, only laboratories and data that meet certain criteria may work with the CODIS database. Some states have set up state-wide or local databases that may have different restrictions for use. The following figure shows the 13 core loci, soon to be expanded to 20, of the CODIS database.

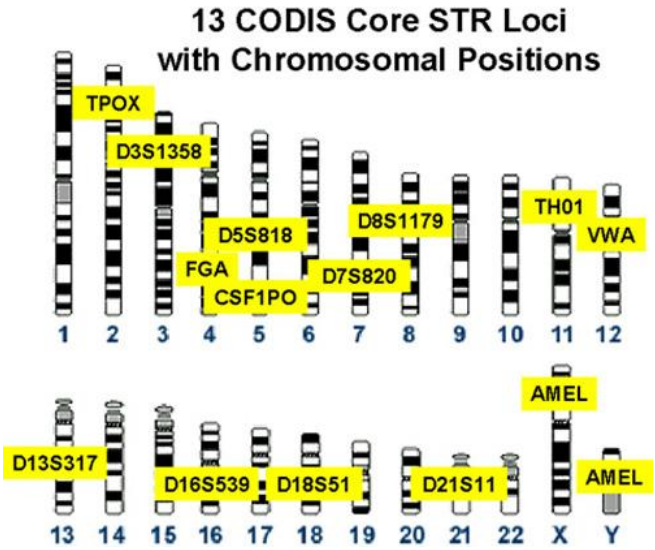


Figure 2-15. The CODIS Core Loci

- IAFIS:

  The FBI has established the most extensive biometric database in the world. According to the FBI, the Integrated Automated Fingerprint Identification System that responds to requests 365 days per year to prevent crime and identify criminals. The IAFIS provides automated fingerprint search capabilities, as well as latent print search, electronic storage and electronic exchange of fingerprints and responses. In addition to the fingerprint file the system contains corresponding criminal histories; mug shots; scars and tattoo photos; physical characteristics like height, weight, and hair and eye color; and aliases.

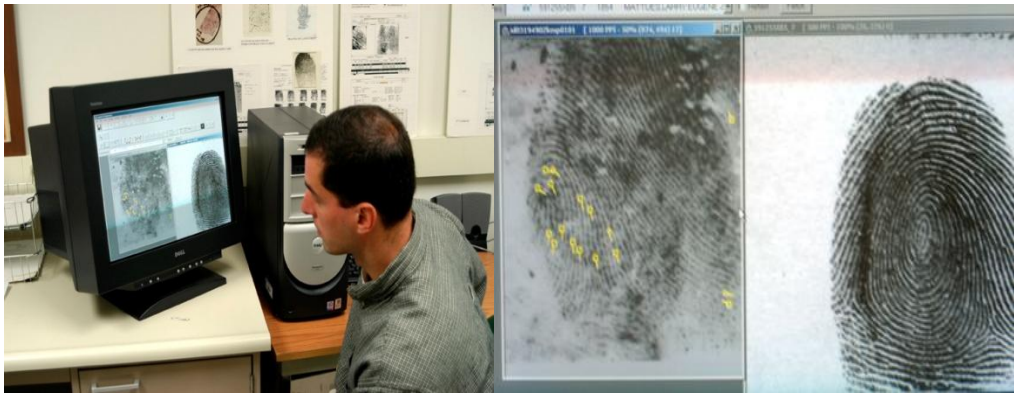


Figure 2-16. An analyst using an IAFIS System and a close up of the comparison screen

- NamUS:

  The National Missing and Unidentified Persons System (NamUs) is a national centralized repository and resource center for missing persons and unidentified decedent records. NamUs is a free online system that can be searched by medical examiners, coroners, law enforcement officials and the general public from all over the country in hopes of resolving these cases. The NamUS system contains three databases: the missing persons database; the unidentified persons databases; and the unclaimed persons database. The Missing Persons Database contains information about missing persons that can be entered by anyone; however before it appears as a case on NamUs, the information is verified. The Unidentified Persons Database contains information entered by medical examiners and coroners. Unidentified persons are people who have died and whose bodies have not been identified. Anyone can search this database using characteristics

such as sex, race, distinct body features and even dental information. The newly added UnClaimed Persons database contains information about deceased persons who have been identified by name, but for whom no next of kin or family member has been identified or located to claim the body for burial or other disposition. Only medical examiners and corners may enter cases in the UCP database.

- NIBIN:

  The National Integrated Ballistic Information System (NIBIN) is a program supported by the ATF that provides federal, state and local law enforcement with an automated ballistic imaging system. NIBIN provides digital images of shell casings collected at crime scenes or from test fires that can be linked by the system to provide information to aid investigations and subsequently identify firearms users. To use NIBIN, firearms examiners enter cartridge cases into the system. These images are then correlated against the database. Examiners can search against evidence from the local juristion, region or across the nation the system.

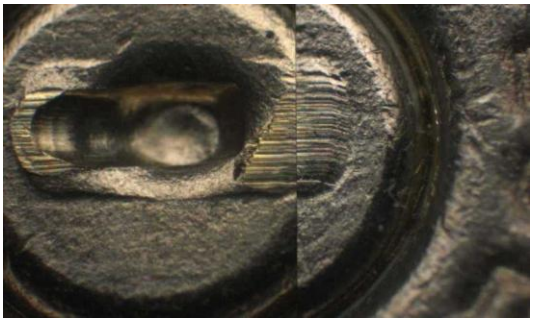


Figure 2-17. A view of the NIBIN sytem (left) and cartridge case comparison (right)

Locally-generated databases

Several police departments around the country have established their own DNA databases to use as investigative tools within their towns and surrounding areas. These databases are supported by available commercial systems, such as the LODIS® and currently are not compatible with the CODIS database due to particular requirements established by the FBI for entry into CODIS. With the advent of rapid DNA analysis systems that are designed to be operated outside the forensic science laboratory, more police departments may be generating their own DNA profiles to establish these local

DNA databases. Due to the fact that law enforcement may need to review and interpret data that is produced by the rapidDNA systems, most practitioners recommend that police departments form partnerships with the local laboratory or other experts in the area of molecular biology to ensure the integrity and usefulness of any local databases produced at the law enforcement level.

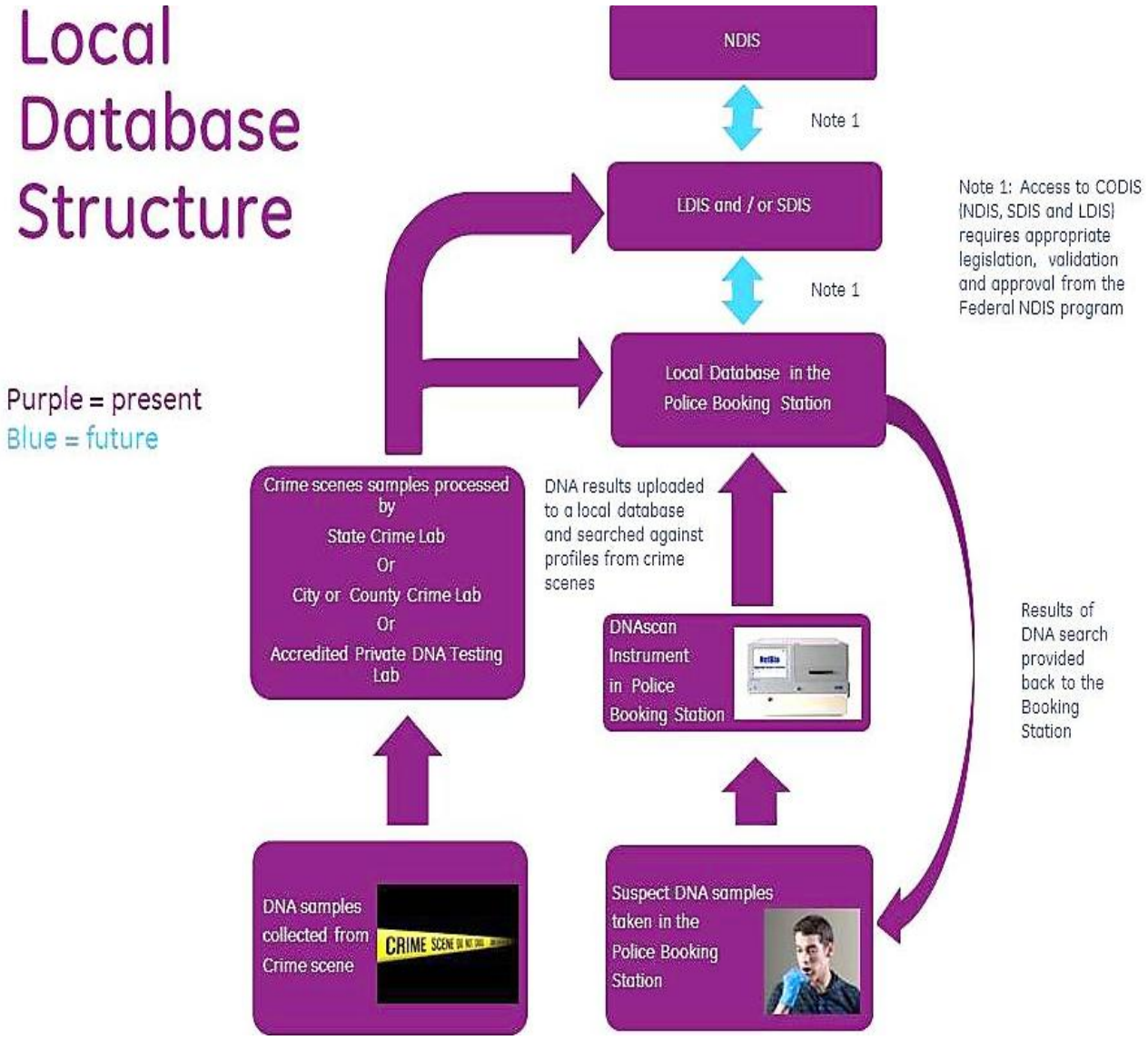


Figure 2-18. The Local Database Structure (Photograph courtesy of GE Healthcare)

5. Use of Portable Instrumentation for Evidence Identification

Portable Raman Spectrometer

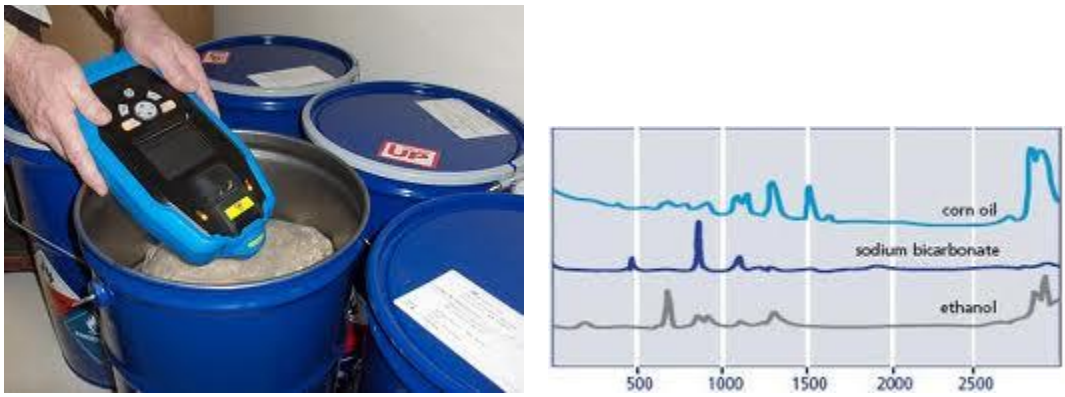


Figure 2-19. The portable Raman (left) and Raman spectra (right)

The portable Raman instrument allows for rapid, accurate identification of unknown chemicals in the field. Within a few minutes, examination and identification of a substance can take place in the field with minimal preparation and no sample destruction. Many materials may be tested right in packaging in which they are found. This quick identification of unknown materials can provide investigative leads, and eliminate unnecessary delay while determining if a sample is safe or if it is potentially a significant item of evidence. Advances in this technology have improved speed and ability for scientists to work with the data obtained from a scan.

- Quickly identifies unknown solid and liquid chemicals from a vast sample library including: explosives, toxic industrial chemicals (TICs), toxic industrial materials (TIMs), chemical warfare agents (CWAs) white powders, narcotics and more
- Mixture analysis software identifies mixture components in seconds including solid/liquid combinations and aqueous solutions
- Analysis can be reviewed on-site by comparing chemicals in the library with the result obtained from the unknown substance

X-Ray Fluorescence & Diffraction

For years physical evidence has been analyzed using X-ray fluorescence (XRF) and diffraction (XRD) technologies, as well as other analytical techniques, to support the identification of illegal substances. Most analysis is limited to laboratory work. As a result, the integrity of the evidence must be maintained while it is transported to a lab and then analyzed, always following the chain of custody. With the development of portable XRF and XRD systems the identification of explosives, clandestine drug reagents and products, metals, bullets, soils and other materials can be analyzed in the field. These instruments are used to identify critical elements present in materials located at crime scenes such as lead, barium and antimony in gunshot residues or gold in dental materials. Forensic anthropologists also find these instruments useful for the determination of strontium ratios in bone fragments or trace metal deposits on or in bone samples.

Infrared Spectrometer

Fourier Transform Infrared Spectroscopy (FTIR) has been used for many years to identify both organic and inorganic materials. The availability of portable systems allows the scene investigator and forensic scientist to identify even small amounts of an unknown substance *in situ.* Current techniques do not require sample preparation and sample identification based on comparison to a library of known materials can be carried out in minutes. These instruments have been used successful at border patrol stations and other areas to identify drugs and other controlled substances , and at scenes of suspected terrorist bomb-making activity.

6. DNA Field Testing

In recent years several companies have developed equipment that is designed for use outside the forensic science laboratory that extract DNA and produce DNA profiles. The current focus for these instruments is to develop a full DNA profile from a sample that is of high concentration and a single source, such as a buccal swab from a suspect or arrestee. Results are obtained in less than 1.5 hours. This equipment will assist police departments in creating a local database, as described above.

Figure 2-20. The DNAscan rapid DNA system (left- courtesy of GE Healthcare) and the DNA RapidHit system (Right- courtesy of IntegenX)

The future focus of portable DNA equipment is likely to be an instrument that can be used at crime scenes with materials containing lower quantities of DNA. Another focus of some rapid DNA research is to develop and instrument that can screen and potentially distinguish samples at the crime scene for investigative purposes. Screening of samples for non-victim DNA would be done at the scene, providing there is sufficient sample to submit a portion of the stain to the forensic lab for testing under standard operating conditions. Use of these tools will require training of crime scene and other police personnel and association with the local forensic DNA laboratory to ensure expert review of profiles that are obtained through the rapid DNA method.

SECTION III: CRIME SCENE RESOURCES

1. STANDARD EQUIPMENT FOR CRIME SCENE INVESTIGATION

Security:

- Markers
- Crime scene tape
- Security signs
- Cordage
- Poles & barriers
- Emergency lighting
- Fluorescent markers
- Stepping plates

Personal Protective Equipment:

- Nitrile* or latex gloves
- Disposable suits & booties
- Face mask
- Hepa filter masks
- Disposable wipes
- Eye protection (goggles or safety glasses)

* Do not use nitrile gloves to handle shooting-related evidence

Digital equipment:

- Computer or tablet with camera[§]
- Portable printers
- GPS system
- Cell phone[§]
- Audio recorder
- Range finder

[§]Used for documentation, communication, and digital image transmission

Documentation:

- Digital camera with auxiliary flash, close-up lens, filters
- Specialized camera set-up for UV-IR photography
- Dental scales, rulers & adhesive scales
- Tripod
- High-definition video camera
- Sketching materials & templates
- Laser measuring devices or tape measure
- Compass
- Tape measure
- Tape recorder

Recognition:

- Alternate light source(s) and filters
- Screening tests for blood, body fluids, drugs, etc.
- Enhancement reagents for imprints

Evidence Collection:

- Disposable tweezers, scalpels and instruments
- Sterile cotton swabs
- Casting materials
- Gel lifters or tapes for lifting
- Paper/ weighing paper for evidence folds
- Assorted tools
- Sterile water or saline

Evidence Packaging:

- Paper bags, envelopes (various sizes)
- Large sheets or roll of butcher-type paper
- Tamper-evident tape
- Plastic evidence or zip-lock bags
- Sterile plastic containers for liquid
- Cardboard boxes (various sizes)
- Sharps collection containers
- Swab storage boxes
- Sexual assault evidence collection kits (victim & suspect)
- Drug facilitated sexual assault evidence collection kit
- Evidence tags or labels

Specialized Evidence Collection Materials:

- Latent fingerprint – colored powders, lifters, backing cards, magnifiers
- Impressions – casting materials, electrostatic dust lifter, evidence walk bridges, large lifters, reservoirs, retaining borders
- Electronic evidence collection kits
- Document collection folders

2. RESOURCES FOR EXPERTISE OR ADVANCED TECHNOLOGY
   - University – forensic science programs or institutes for specialized expertise, technology
   - Forensic Science / Crime Laboratory – Specialized area expertise, photography, pattern interpretation
   - State Department of Health – Biohazard or chemical hazard questions
   - State or Local Police – various units depending on the nature of the crime, equipment and assistance needed
   - State or Local Police Major Crime Units – Crime scene personnel, equipment
   - Fire Department / Emergency services
   - Animal Control Unit
   - ATF – explosives, firearms and related materials
   - NIST- the federal technology agency that works to develop and apply technology, measurements, and standards. Provides access to recommended standard reference samples and studies.
   - DEA – clandestine labs, "grow sites", drug-related materials
   - FBI – major investigations, evidence examination (laboratory), homeland security
   - Homeland Security – security, terrorism, surveillance, internet crime
   - Local manufacturers/ industry - specialized knowledge experts
   - Scientific Working Groups – National working groups for evidence collection and examination provide guidelines and reference materials

3. Forensic Centers of Excellence

Forensic Technology Center of Excellence - RTI International
www.Forensiccoe.org
The Forensic Technology Center of Excellence, funded by the National Institute of Justice, provides testing, evaluation, technology assistance, and other services for use by crime laboratories, forensic service providers, law enforcement and other criminal justice agencies.

Electronic Crime Technology Center of Excellence
www.ectcoe.net
The ECTcoe works with NIJ to address the high-priority criminal justice needs. Information at this site includes training, tools, interactive tools and publications related to electronic crime and digital evidence

National Law Enforcement and Corrections Technology Center System
www.justnet.org for large municipalities & states regional center
www.srtbrc.org for small, rural, tribal regional center

The NLECTC national and regional centers for excellence serve as an authoritative resource for tools and technology used by criminal justice professionals.

4. Some URLs of interest

Note: listing of websites and references does not constitute an endorsement. Many sites are available related to particular areas of investigation and forensic science. Major organizations have links to other reputable sites and information. The following are a few sites that are commonly accessed for general information and standards in crime scene investigation.

www.ncjrs.orgj
Department of Justice publications. Search by topic or title to obtain recent research publications and monographs on crime scene investigation, death investigation and other related topics.

www.theiai.org
The home page of the International Association for Identification. This site links to other websites of interest and also the certification programs and requirements for latent fingerprint examiner, crime scene and bloodstain pattern analyst certification.

www.acsr.org
Website of the Association for Crime Scene Reconstruction. Organization goals include exchange of information, professional development, and research. A newsletter contains case studies and articles on techniques and technology.

www.aafs.org
The home page of the American Academy of Forensic Sciences. *As stated on their website, t*he American Academy of Forensic Sciences is a multi-disciplinary professional organization that provides leadership to advance science and its application to the legal system. The objectives of the Academy are to promote professionalism, integrity, competency, education, foster research, improve practice, and encourage collaboration in the forensic sciences.

www.nij.gov/topics/forensix/lab-operations/standards/scientific-working-groups.htm
Provides a link to the currently active Scientific Working Groups, NIJ and not-NIJ sponsored groups. SWGs provide guidelines, standards, and references in various areas applicable to crime scene investigation, notably SWGSTAIN (bloodstain pattern analysis), SWGMDI (medicolegal death investigation), SWGDVI (disaster victim identification), SEGDOG (dogs and orthogonal detection). Information on evidence collection for other specific disciplines in other SWG materials.

www.crime-scene-investigator.net
Information related to evidence collection and crime scene protection, photography and basic criminalistics.

http://forensic.to/forensic.html
A general website, "Zeno's Forensic Site", provides links to various websites for specific types of evidence.

www.poliisi.fi/wgm/index.htm
European Network of Forensic science Institutes website. Reflects the work of over 25 countries focused on imprint and impression evidence.

www.cji.net/forensic/preservation.html
Crime scene preservation strategies and tips to avoid contamination.

www.fbi.gov/programs/lab/handbook/safety.htm
FBI evidence collection handbook addressing proper collection, preservation and submission procedures.

www.americanbar.org
The home page of the American Bar Association. Access to current cases related to evidence and crime scene issues, recommendations and other information on the criminal justice system.

http://www.nij.gov/topics/technology/assistance.htm#about
Summary of the NIJ law Enforcement and Corrections Centers of Excellence Program and links to the regional centers for states & major cities, small & rural centers, and Alaska. Center sites contain articles, publications and, in the future, video of research and for practical guidance.

www.henryleeinstitute.com
Website for the Henry C Lee Institute of Forensic Science. Provides a link to training and access to experts associated with the Institute

www.nfstc.org
Website for the National Forensic Science Training Center. Provides a link to training and research in forensic science and crime scene investigation.

www.swganth.org
Scientific working group for forensic anthropology. Co-sponsored by the FBI and the DOD, SWGANTH was formed to develop consensus guidelines and minimum practice standards for forensic anthropology. This site contains documents and guidelines related to forensic anthropology.

www.swgstain.org
Scientific working group on bloodstain pattern analysis. The website of the bloodstain analysis working group provides consensus documents related to bloodstain pattern interpretation, validation of new procedures for bloodstain analysis, educational guidelines and admissibility resources, among others.

www.swgde.org
Scientific working group on digital evidence. The scientific working group on digital evidence brings together agencies and individuals actively involved in digital and multimedia evidence analysis. Manuals, best practices and other related materials are available at this website.

www.swgfast.org
Scientific working group on friction ridge analysis, study and technology. This group provides guidance for imprint development and analysis among the many resources available at this site.

www.swgmat.org
Scientific working group for materials analysis. Provides guidelines and best practices as related to hairs, fibers, glass, paint and tape.

Other SWGs may also be accessed by searching “scientific working groups”.

5. References on Crime Scene and Reconstruction

Many textbooks and monographs have been written about various aspects of crime scene investigation and reconstruction. This is by no means an exhaustive list. This list does not imply endorsement of the texts or theories of the listed authors.

Bevel, T. and R.M. Gardner. *Bloodstain Pattern Analysis, 3rd Ed*. Boca Raton, FL: CRC Press. 2008.

Chisum, W. J. and B Turvey. *Crime Reconstruction. New York, NY: Academic Press. 2007.*

Dutulle, A. *An Introduction to Crime Scene Investigation, 2nd Ed.* Burlington, MA: Jones & Bartlett. 2014.

Fisher, B. and D. Fisher. *Techniques of Crime Scene Investigation, 8th Ed*. Boca Raton, FL: CRC Press. 2012

Gardner, R. M. Practical Crime Scene Processing and Investigation. *2nd. ed*. Boca Raton, FL: CRC Press. 2011.

Geberth, V. *Practical Homicide Investigation Checklist and Field Guide.* Boca Raton, FL: CRC Press. 1997.

Houk, M., F. Crispino, and T. McAdam. *The Science of Crime Scenes.* New York, NY: Academic Press. 2012.

Lee, H. and H. Harris. *Physical Evidence in Forensic Science, 3rd ed*. Tucson, AZ: Lawyers & Judges Publishing co., Inc. 2011.

Lee, H., M. Miller & T. Palmbach. *Crime Scene Handbook*. New York, NY: Academic Press. 2001.

Maloney, M. *Death Scene Investigation Procedural Guide*. Boca Raton, FL: CRC Press. 2012.

National Medicolegal Review Panel. *Death Investigation: A guide for the Scene Investigator. (ncjrs 167568).*Washington, D.C.: U.S. Department of Justice. 1999.

National Institute of Justice. Electronic Crime Scene Investigation: A guide for first responders, 2nd ed. Washington, D.C.: U.S. Department of Justice. 2008.

Ogle, R.R. *Crime Scene Investigation and Reconstruction, 3rd Ed.* Upper Saddle River, NJ: Prentice Hall. 2012.

Ostenburg, J and R.Ward. *Criminal Investigation, 7th Ed.* Bridgewater, NJ: Elsevier. 2013

Ramirez, C. and C. Parish-Fisher. Crime Scene Processing and investigation Workbook. Boca Raton, FL: CRC Press. 2011.

Ramtowski, R. *Lee and Gaensslen's Advances in Fingerprint Technology, 3rd ed.* Boca Raton, FL: CRC Press. 2012.

Technical Working Group for Crime Scene Investigation. *Crime Scene Investigation: A guide for law enforcement.* (ncjrs 178280). Washington, D.C.: U.S. Department of Justice. 1999.

U.S. Department of Justice. *The Fingerprint Sourcebook*. National Institute of Justice. 2012.

Wonder, A. and A. Y. Wonder. *Bloodstain Pattern Evidence: Objective Approaches and Case Applications Ebook.(Available at* http://onlinebookplace.com) New York, NY: Academic Press. 2011.

Young, T. and P.J. Ortmeier. Crime Scene Investigation. New York, NY: Prentice hall. 2011.

6. Some Crime Scene Equipment Suppliers

This is by no means an exhaustive list. This vendor list does not imply endorsement by the Department of Justice or the authors.

EVI-PAQ PO Box 18276 Tuscon, AZ 85731 www.evipaq.com	Fisher Scientific Pittsburgh, PA www.fishersci.com	Foster & Freeman 25 Swan lane Evessham, Worcestershire, UK www.fosterfreeman.com
Government Scientific Source 8460 Tyco Road Vienna, VA 22182 www.govsci.com	Kinderprint Company Inc PO Box 16 Matinez, CA 94553 www.kinderprint.com	Grainger (formerly Lab Safety Supply) www.grainger.com
Forensics Source 13386 International Pkwy Jacksonville, FL 32218 www.ForensicsSource.com	Evident Crime scene Products 739 Brooks Mill Road Union Hall, VA 24176 www.EvidentCrimeScene.com	Misonix Inc. 1938 New Highway Farmingdale, NY 11735 www.misonix.com
Payton Scientific Int. 244 Delaware Avenue Buffalo, NY 14202 www.paytonscientificinternational.com	Lynn Peavy Company PO box 14100 Lenexa, KS 66285 www.peavycorp.com	TriTech Inc. 4019 Executive Park Blvd SE South Port, NC 28461 www.tritechusa.com
The Sirchie Group 100 Hunter Place Youngville, NC 27596 www.sirchie.com	Spex Forensics Horiba Instrument Corp www.spexforensics.com	Crime Tech, Inc 11111 San Jose Blvd. Suite 70-20 Jacksonville, FL 32223 info@crimetech.net
Arrowhead Forensics 11030 Strang Line Road Lenexa, KS 66215 www.arrowheadforensics.com	Crime Scene 3440 N 16th Street Phoenix AZ 85016 www.crimescene.com	Faurot Forensic Products P.O. Box 99146 Raleigh, NC 27624 www.faurotforensics.com

APPENDIX 1: LEGAL ISSUES FOR CRIME SCENE INVESTIGATION

Introduction

In addition to search and seizure issues, which have been addressed previously by the authors, the crime scene investigator should be aware of legal issues that have been raised specific to the processing and analysis at a crime scene. These issues are usually related to the improper collection of evidence, the failure to preserve evidence or the admissibility of results or techniques that are used at the crime scene. Anyone working as a crime scene investigator should be aware of these issues and be prepared to address any questions raised by protocols used within their department. While the use of guidelines published by various professional and working groups and organizations often help answer some critics, this does not remove the responsibility from the crime scene analyst to answer any challenges that are brought about the crime scene process.

Issues concerning evidence collection

In essence any evidence collection process must meet the following three important requirements: The evidence must be preserved for subsequent testing; collection methods must support the reliability of the process; and collection must preserve loss, contamination or significant alteration of the evidence. The best way to support the reliability of the evidence is to properly document the evidence prior to collection and chain of custody after packaging. By photographing and diagramming the evidence *in situ* with overall, medium and close-up shots, questions related to the actual location and condition of the evidence should be addressed. This includes making sure that photographs are taken with a scale so the size and orientation of the evidence are also known. In one recent murder case, for example, a key piece of evidence was only visible in a distance shot; the crime scene investigator did not photograph the evidence in a perpendicular, close-up shot with a scale. Such a photograph would have shown the size of the item and any stains on the item visible as it lay in its original position. During trial the evidence introduced in court was challenged as not being the item depicted; if a photograph existed that clearly showed the item's size and some bloodstains on the item, this challenge would have been quickly addressed or not even offered.

Maintaining a thorough chain of custody also removes many questions associated with the integrity of the evidence. Documentation of the item of evidence, unique item number, case number, time and date seized where the item originated and the name and signature of the officer seizing the evidence must be provided. Any subsequent transfer should show the date, time, and name/signature of the person to whom the evidence was transferred. Even a temporary transfer to another location or individual within the same department should be documented in the chain of custody. Failure to maintain a proper chain of evidence will surely result in a challenge during any subsequent trials, as in the Lee case (*U.S. v. Lee* , 502 F. 3d 691, 2007) where appellant claimed evidence of GSR on the cuff of a jacket was unreliable because of failure to protect the jacket from contamination by maintaining a proper chain of custody. Use of electronic transfer equipment and scanners can facilitate this process and save time during transfers of the evidence at the scene at other locations.

While this is well known and standard practice at crime scenes, when only a few individuals are available to work a scene there may be times when crime scene activities might become rushed. If the scene involves a number of items of evidence or an area that will take time to process, the police department may consider providing additional assistance by patrol officers for basic functions or seeking assistance from other agencies or experts to ease the burden of the crime scene investigators.

Destruction of Evidence

The loss of evidence, its consumption or unalterable change has been raised several times in the courts across the country. In general, the courts have ruled that the consumption or destruction of evidence does not deny due process of the accused if such acts were not the result of a bad faith effort or intentional failure to preserve the evidence. (*Arizona v. Youngblood,* 488 U.S. 51, 1989) Similarly, in the *State of Washington v. Furman (858 P. 2d 1092,* 1992*)*, the court ruled that the failure to preserve the evidence in its original condition went to the weight of the evidence during a trial, not its admissibility. While the *Arizona* and other decisions are usually applied in situations involving laboratory analysis, some activities at the scene can result in the destruction of evidence. For example, the crime scene investigator should be aware of the effect of any enhancement process on subsequent analysis of physical

evidence. Similarly, the destruction of clothing or other items from a decedent found some time after death should be considered only after weighing the potential evidentiary nature of this evidence.

Admissibility of Testing Procedures Used at the Crime Scene

The crime scene investigator often uses screening or presumptive tests to evaluate evidence in the field. These results are an important part of the recognition and identification process. Whether the results of these screening tests can be testified to in court has been the subject of challenges across the country, with various outcomes. When the presumptive test is for blood, many states have admitted the results of these tests by crime scene and laboratory personnel, as shown in *Missouri v. Taylor* (298 S.W.3d 482, 2009) and *North Carolina v. Goode* (461 S.E. 2d 631, 1995) . On the other hand, in the case *State of Connecticut v. Moody* (573 A. 2d 716, 1990) the Connecticut supreme court ruled that results of presumptive tests alone could not be presented as evidence of possible blood due to the potential prejudice of misinterpretation as *proof* of blood by the trier of fact. Other screening tests, including screening for GSR, drugs, body fluids and accelerants have all been accepted in the courts.

The production of crime scene photographs and diagrams to document the scene has also been challenged by defendants in criminal cases. In *Gosser v. Kentuck*y (31 S.W.3d 897, 2000), the appellant argued that crime scene photographs showing evidence markers and outlines made by scene investigators and a computer-generated crime scene diagram should have been excluded on the basis that they were not an accurate depiction of the scene at the time of the incident and that they were composites created by a police officer. That court ruled that certain photographs depicting the locations of witnesses, victim and weapon should not have been admitted during trial because they were prepared without first-hand knowledge of the officer completing the diagram. The court explained the basis for the admissibility of photographs and any crime scene diagrams, including any computer-generated materials: Depictions must be relevant and must be authenticated by testimony of a witness who has *personal* knowledge of the subject matter and that the diagram is accurate. These factors are important to remember, especially in police departments where computer-generated scene

diagrams and other demonstrative materials may be created by individuals who were not at the crime scene.

When the challenge has been to an interpretation or reconstruction of evidence, such as bloodstain pattern evidence, the courts in the past have generally accepted conclusions based on bloodstain pattern and fire pattern interpretation (*Mitchell v. Oklahoma*, 136 P. 3d 897, 2006) . Since the report by the National Academy of Sciences and some high-profile cases such as the [ ] case in Texas, there is a tendency to be much more critical of these techniques and of who is conducting the analysis (*Duyst v. Rapelje*, 2012 U.S. App LEXIS 10115). If bloodstain or other pattern interpretation is required as part of a scene investigation, only a well-trained, experienced expert should provide a formal interpretation and report of these findings. While training in these reconstruction areas is important for all crime scene personnel, one should not offer a definitive report without the proper scientific background and extensive training.

Testimony by multiple investigators

It is a common practice during an investigation for tasks at the scene to be divided among the trained personnel in the unit. In the past, the crime scene commanding officer from the federal or state agency or the evidence officer often testified to much of the information related to scene testing and evidence recognition, collection and preservation. Recent Supreme Court decisions, such as *Melendez-Diaz v. Massachusetts (557 U.S. 305, 2009?)* and *Bullcoming v. New Mexico (*131 S.Ct. 2705, 2011) have stated that the defendant has the right under the 6th Amendment Confrontation Clause to question all persons who handled evidence and conducted analysis that resulted in a final report from the laboratory. Whether these same rulings, which require all individuals who conducted testing or handled evidence to testify to their activities and findings, apply to the investigators at a crime scene is unknown at this time. Since many departments already have individuals testify about each phase of the investigation for which they were responsible, including photography, sketches, evidence packaging, presumptive tests, etc., the impact of these cases on crime scene investigators may be slight. For those departments that rely on a team leader/ evidence coordinator to testify to all significant activities and screening tests, crime scene practices may be challenged in the future.

Summary

If the investigator follows accepted practices before beginning any crime scene activities, maintains meticulous notes and considers all legal and scientific requirements for the proper collection and maintenance of evidence, challenges to the admissibility of evidence should be limited and unsuccessful. For smaller departments that do not conduct extensive major crime scene investigations on a regular basis, it is important to establish guidelines for the crime scene unit and to conduct regular training for the units in the event of a major incident. The commanding officer should also consult with the local district attorney, laboratory personnel, forensic experts in universities and other professionals who can assist the department during crime scene investigations and reconstructions.

APPENDIX 2: EVIDENCE COLLECTION GUIDELINES

SPECIMEN TYPE	ID LOCATION	PACKAGING	STORAGE	COMMENTS
Fingerprints				
Porous surface	Outside container	Box, paper	Package to prevent contact with other surfaces	
Smooth surface	On lift	Individual labels on lifts in sealed envelope, number in sequence	Process with contrasting powder & lift print	Only trained persons should attempt to dust and lift fingerprints
Visible print (blood, oil, etc.)	On container	Entire item / relevant portion for lab processing	Prevent contact and chemical exposure	Chemical enhancement may be necessary
Post-mortem prints	On collected prints	Envelope, once set	If finger tissue is removed, preserve in glycerol or other non-drying fluid	Dry hands of cadaver thoroughly; take both finger and palm prints. Call laboratory for assistance if decomposition is advanced.
Imprints				
Smooth surface	Non-imprint area	Box original surface or lift	Prevent contact with imprint	Lift only if residue Photograph appropriately prior to collection
3D impression	Non-imprint area	Paper wrap or box	Make casting	Photograph prior to cast
On moveable item	Non-imprint area	Wrap flat in paper	Avoid contact with imprint	Submit entire item
Hairs				
Individual hairs	On packet	Paper chemist fold / packet	Packet into outer envelope	Individual hairs may be picked up with forceps. Vacuuming is not recommended.
On moveable item	On item	Wrap in paper	Place in paper bag	Avoid unnecessary activity and movement of item
Known hair standards	On packet	Place in paper with chemist fold / packet	Packet into outer envelope	Pulled hairs are best, 15-20 / area. If cut, place scissors against skin to get entire length of exposed hair.

Pubic/head hair combings	On packet	Comb over paper. Fold paper into chemist fold/packet.	Place in an envelope and seal.	
Fibers				
Individual fibers	On packet	Paper chemist fold / packet	Packet into outer envelope	Individual fibers may be picked up with forceps. Vacuuming is not recommended.
On moveable item	On item	Wrap in paper	Place in paper bag	Avoid unnecessary activity and movement of item
Known fibers	On packet	Paper chemist fold / packet	Packet into outer envelope	Sufficient sample should be collected to obtain all fiber types, weave, etc. in the fabric
Rope, Twine, cordage				
Any cord type	Tag or mark container	Entire length	Wrap securely in clean paper. If small strands place in folds as fibers.	If cut during collection, clearly label ends as cut by you and their association
Soil/Mineral/drugs/ other powders				
Trace amounts	On container	Plastic or paper sealed container with no seams	If moist be sure to use sturdy container. Dry at lab.	Submit as soon as possible to avoid mold growth or deterioration. If on moveable item, collect entire item
Standard samples	On container	At least 2 tblsp. In a sealed plastic or paper container	If moist be sure to use sturdy container.	
Glass/paint				
Fragments	On container	Individual fragments in paper fold	Place folds in an envelope or sealed container	Maintain separate packets for individual samples
Standards	On container	Individual paper fold / sample	Place each fold in an envelope or sealed container	Collect known standards as close to damaged area as possible
Firearms/Weapons				
Entire weapon	On weapon away from other evidence	Secured to prevent motion and abrasion	Avoid excessive contact with the object.	Handle for safety. May contain trace materials & body fluids. Do not place anything in the

				barrel of a gun.
Bullet, cartridge	On package	In paper packet or box	Avoid cotton in package. Do not wash. Handle to avoid loss of trace materials.	Do not place multiple projectiles or cartridges together.
Unknown material				
Powder	On package	Place in paper chemist fold before secondary package	Chemist fold into envelope. Avoid plastic bags to prevent loss by static.	Handle all unknown powders as potential infectious or hazardous material.
Liquid	On container	Up to 5 ml if homogeneous appearance in glass or inert plastic container	Seal around container opening. Place in plastic zip lock bag to protect against loss.	
Body Fluids				
Urine/other liquid body fluid	On container, identifying type or appearance of material	Use a clean bottle or test tube with leak proof stopper.	Keep samples separate. Refrigerate, if possible.	Entire liquid sample should be collected. At least 30 ml if voided urine. If diluted, collect a representative sample.
Stains on clothing	Tag or mark clothing item.	Fold entire item in paper. Place in paper bags. NEVER use plastic.	Avoid marking or folding in area of staining.	Handle carefully to protect stain patterns and to prevent loss of other trace materials. Do not roll item.
Organs/Tissue				
Tissue sample, product of conception, excised injury area, etc.	On container.	Sterile glass jar or plastic container *without* additional liquid or preservative.	Keep cool or refrigerate. Freeze for longer storage.	NEVER use chemical preservative or alcohol with tissues if DNA or other testing may be required.
Blood				
Liquid - draw	On container,	Sterile tube with EDTA or no preservative. Prevent breakage.	Refrigerate, do not freeze.	Handle as biohazardous material
Liquid - small quantity	On container	Sterile tube with EDTA or no preservative. Package to prevent damage or breakage.	Refrigerate, do not freeze.	Collect entire sample, up to 5 ml.
Dry stain	On packet and outer	Use a sterile swab wet with a small	Air dry swab under natural	Maintain in cool, dry place.

	container	amount of dH_2O. Dried swab in envelope.	conditions or in swab dryer. Maintain at room temperature in controlled environment.	Do not lick envelope to seal.
Stained clothing, fabric, etc.	Label tag or mark directly on clothes.	Fold in paper. Each item separately packaged. Place in paper bag.	If wet when collected, air dry under natural conditions. Maintain at room temperature in controlled environment.	Do not use heat to dry. Do not place bloody clothing in plastic bags.
Volatile liquids				
Accelerants, alcohols, etc.	On container	Collect debris in clean paint cans. Liquid samples in air-tight glass containers.	Maintain in a cool, dry place or refrigerate.	
Digital Evidence				
computers	On container	Tape seal ports and note plugs	Maintain in cool environment	Keep away from magnets and electronic readers
Cell phones & other digital devices	On container	Place in envelope to prevent friction	Maintain in cool environment	Do not turn on cell or handle excessively
Storage materials	On package	Place in envelope, package separately		Do not insert into computer or other device at scene
				Consult digital evidence laboratory if concerns or questions

NOTES: