"Introduction to Crime Scene Investigation".

- In Section 1 of this course you will cover these topics:
- Introduction To Physical Evidence
- Crime Scene Search Principles Definition/Overview: Buccal Swab: A Swab Of The Inner Portion Of The Cheek; Cheek Cells Are Usually Collected To Determine The Dna Profile Of An Individual. Chain Of Custody: A List Of All People Who Came Into Possession Of An Item Of Evidence. Finished Sketch: A Precise Rendering Of The Crime Scene, Usually Drawn To Scale. Physical Evidence: Any Object That Can Establish That A Crime Has Been Committed Or Can Link A Crime And Its Victim Or Its Perpetrator. Rough Sketch: A Draft Representation Of All Essential Information And Measurements At A Crime Scene. This Sketch Is Drawn At The Crime Scene. Standard/Reference Sample: Physical Evidence Whose Origin Is Known, Such As Blood Or Hair From A Suspect That Can Be Compared To Crime-Scene Evidence. Substrate Control: Uncontaminated Surface Material Close To An Area Where Physical Evidence Has Been Deposited. This Sample Is To Be Used To Ensure That The Surface On Which A Sample Has Been Deposited Does Not Interfere With Laboratory Tests.
- Crime Scene Photography

Topic : Introduction To Physical Evidence

Topic Objective:

After studying this topic the student should be able to:

- Define Evidence
- Explain Types of Evidence
- Discuss Burden of proof
- Distinguish Problems in evidence
- Define Evidence in science
- Explain techniques of Gathering evidence
- Discuss Evidence in law

Definition/Overview:

Direct Evidence: Evidence that proves a fact without the necessity of an inference or a presumption, and, when true, conclusively establishes that fact

Circumstantial Evidence: Involves a series of facts that, although not the fact at issue, tends, through inference, to prove a fact at issue. This type of evidence is usually a set of circumstances from which an assumption can be made

Testimonial Evidence: is the Evidence given by a lay person or expert witness. The main issue for this type of evidence is credibility

Physical Evidence: is the Physical objects that are linked to the commission of a crime, it can be any type of physical object. To be of any value it must be recognized as potential evidence, collected in an appropriate manner, and preserved properly

Individual Characteristics of Physical Evidence: Individual characteristics of an object when unique to only one member of a class allows for the identification of the individual source of the evidence item. This is called individualization. Latent fingerprints are an example of individualized physical evidence

Exemplar: The term used to describe either a sample of the comparison standard that is collected or prepared from the comparison standard for the purposes of comparison with the questioned item. It must be a true representation of the known sample to be useful in the comparison process

Controls: Those items tested simultaneously with the questioned item to reveal any problems associated with the integrity of the evidence item or testing procedure

Key Points:

1. Evidence

Evidence in its broadest sense includes everything that is used to determine or demonstrate the truth of an assertion. Giving or procuring evidence is the process of using those things that are either a) presumed to be true, or b) were themselves proven via evidence, to demonstrate an assertion's truth. Evidence is the currency by which one fulfills the burden of proof.
There are many issues that surround evidence, making it the subject of much discussion and disagreement. In addition to its subtle nature, evidence plays an important role in many academic disciplines, including science and law, adding to the discourse surrounding it.

An important distinction in the field of evidence is that between circumstantial evidence and direct evidence, or evidence that suggests truth as opposed to evidence that directly proves truth. Many have seen this line to be less-than-clear and significant arguments have arisen over the difference.

2. Types of Evidence

- Direct
- Circumstantial
- Testimonial
- Physical

3. Burden of proof

The burden of proof is the burden of providing sufficient evidence to shift a conclusion from an oppositional opinion. Whoever does not carry the burden of proof carries the benefit of assumption. Whoever bears the burden of proof must present sufficient evidence to move the conclusion to their own position. The burden of proof must be fulfilled both by establishing positive evidence and negating oppositional evidence.

There are two primary burden-of-proof considerations:

- The question of on whom the burden rests.
- The question of the degree of certitude the proof must support. This depends on both the quantity and quality of evidence and the nature of the point under contention.

Some common degrees of certitude include the most probable event, reasonable doubt, and beyond the shadow of a doubt.

Conclusions (from evidence) may be subject to criticism from a perceived failure to fulfill the burden of proof.

4. Problems in evidence

The theory of evidence is a field wrought with dispute. Many of these disputes stem from the limits of human knowing, a field known as epistemology. Possibly the most salient question of evidence is how, if, and what, one can know. (Or, in other words, the question is to what extent is it even possible to fulfill the burden of proof.) This is the question of evidence's limits. Some believe all evidence to be circumstantial, denying the possibility of direct evidence.

To help deal with this problem, many fields have found it useful to talk about levels of evidence and certainty, particularly the field of law.

5. Evidence in science

In scientific research evidence is accumulated through observations of phenomena that occur in the natural world, or which are created as experiments in a laboratory. Scientific evidence usually goes towards supporting or rejecting a hypothesis.

One must always remember that the burden of proof is on the person making the claim. Within science, this translates to the burden resting on presenters of a paper, in which the presenters

argue for their specific findings. This paper is placed before a panel of judges where the presenter must defend the thesis against all challenges.

When evidence is contradictory to predicted expectations, the evidence and the ways of making it are often closely scrutinized and only at the end of this process the hypothesis is rejected: this can be referred to as 'refutation of the hypothesis'. The rules for evidence used by science are collected systematically in an attempt to avoid the bias inherent to anecdotal evidence: nonetheless even anecdotal evidence is enough to reject a theory incompatible with that evidence, if there are sufficient repeated examples.

6. Evidence in law

Many might say evidence forms the very foundation of any legal system, without which law would be subject to the whims of those with power.

In law, the production and presentation of evidence depends first on establishing on whom the burden of proof lies. There are two primary burden-of-proof considerations in law. The first is on whom the burden rests. In many, especially Western, courts, the burden of proof is placed on the prosecution. The second consideration is the degree of certitude proof must reach, depending on both the quantity and quality of evidence. These degrees are different for criminal and civil cases, the former requiring evidence beyond a reasonable doubt, the later considering only what most likely happened. The decision maker, often a jury, but sometimes a judge, decides whether the burden of proof has been fulfilled.

After deciding who will carry the burden of proof, evidence is first gathered and then presented before the court:

7. Gathering evidence

In criminal investigation, rather than attempting to prove an abstract or hypothetical point, the evidence gatherers attempt to determine who is responsible for a criminal act. The focus of criminal evidence is to connect physical evidence and reports of witnesses to a specific person. While this is supposedly a non-biased act, detectives sometimes have agendas of their own.

8. Evidence before the court

Presenting evidence before the court differs from the gathering of evidence in important ways. Gathering evidence may take many forms; presenting evidence that tend to prove or disprove the point at issue is strictly governed by rules. Failure to follow these rules leads to any number of consequences. In law, certain policies allow (or require) evidence to be excluded from consideration based either on indicia relating to reliability, or broader social concerns. Testimony (which tells) and exhibits (which show) are the two main categories of evidence presented at a trial or hearing. In federal court, evidence is admitted or excluded under the Federal Rules of Evidence.

Topic : Crime Scene Search Principles Definition/Overview: Buccal Swab: A Swab Of The Inner Portion Of The Cheek; Cheek Cells Are Usually Collected To Determine The Dna Profile Of An Individual. Chain Of Custody: A List Of All People Who Came Into Possession Of An Item Of Evidence. Finished Sketch: A Precise Rendering Of The Crime Scene, Usually Drawn To Scale. Physical Evidence: Any Object That Can Establish That A Crime Has Been Committed Or Can Link A Crime And Its Victim Or Its Perpetrator. Rough Sketch: A Draft Representation Of All Essential Information And Measurements At A Crime Scene. This Sketch Is Drawn At The Crime Scene. Standard/Reference Sample: Physical Evidence Whose Origin Is Known, Such As Blood Or Hair From A Suspect That Can Be Compared To Crime-Scene Evidence. Substrate Control: Uncontaminated Surface Material Close To An Area Where Physical Evidence Has Been Deposited. This Sample Is To Be Used To Ensure That The Surface On Which A Sample Has Been Deposited Does Not Interfere With Laboratory Tests.

Topic Objective:

After studying this topic the student should be able to:

- Define physical evidence
- Discuss the responsibilities of the first police officer who arrives at a crime scene
- Explain the steps to be taken to thoroughly record the crime scene
- Describe proper procedures for conducting a systematic search of a crime scene for physical evidence

- Describe proper techniques for packaging common types of physical evidence
- Define and understand the concept of chain of custody

Key Points:

1. Physical evidence

Physical evidence is any evidence introduced in a trial in the form of a physical object, intended to prove a fact in issue based on its demonstrable physical characteristics. Physical evidence can conceivably include all or part of any object.

In a murder trial for example (or a civil trial for assault), the physical evidence might include DNA left by the attacker on the victim's body, the body itself, the weapon used, pieces of carpet spattered with blood, or casts of footprints or tire prints found at the scene of the crime.

Where physical evidence is of a complexity that makes it difficult for the average person to understand its significance, an expert witness may be called to explain to the jury the proper interpretation of the evidence at hand.

A piece of evidence is not physical evidence if it merely conveys the information that would be conveyed by the physical evidence, but in another medium. For example, a diagram comparing a defective part to one that was properly made is documentary evidenceonly the actual part, or a replica of the actual part, would be physical evidence. Similarly, a film of a murder taking place would not be physical evidence (unless it was introduced to show that the victims blood had splattered on the film), but documentary evidence (as with a written description of the event from an eyewitness).

2. First Police Officer

Most police investigations begin at the scene of a crime. The scene is simply defined as the actual site or location in which the incident took place. It is important that the first officer on the crime scene properly protect the evidence. The entire investigation hinges on that first person being able to properly identify, isolate, and secure the scene. The scene should be secured by establishing a restricted perimeter. This is done by using some type of rope or barrier. The purpose of securing the scene is to restrict access and prevent evidence destruction.

It is the duty of the first police officer on the scene to take any steps necessary to make certain that the scene is kept as undisturbed as possible. If there too much movement at the scene by too many people, vital evidence is likely to be moved or destroyed.**:**Securing a scene can be very complicated say in the case of a fire or a road accident as the preservation of life will take precedence over anything else.

Once the scene is secured, the restrictions should include all nonessential personnel. An investigation may involve a primary scene as well as several secondary scenes at other locations. On major scenes a safe space or comfort area should be designated at the crime scene to brief investigators, store needed equipment, or as a break area.

In critical incident management the protocol that is being taught today identifies a three layer or tier perimeter. The outer perimeter is established as a border larger than the actual scene, to keep unlookers and nonessential personal safe and away from the scene, an inner perimeter allowing for a command post and comfort area just outside of the scene, and the core or scene itself. An extreme advantage will be seen by taking the time to properly teach the uniform officers and first responders to evaluate and secure the scene.

3. Recording a Crime Scene

Police officers and crime scene examiners will have limited time to investigate a scene, it is important therefore to record the scene, normally through still photography and videotaping by specialist photographers. Sketch diagrams and contemporaneous notes by attending police officers will also be important in recording the scene.

3.1 The Camera

Forensic photographers usually prefer to use 35 mm cameras, or medium format, as it tends to balance the portability and ease of use with quality images. When taking close-up photos of evidence, the camera is often mounted onto a tripod for stability to ensure the necessary quality required of photographs presented as evidence in court. Some forensic labs have their own darkroom facilities, which then enable photographers to develop the pictures themselves.

3.2 Digital Cameras

Digital cameras have a number of advantages when used in forensic photography as they require no chemical processing, can be displayed on the camera straight after being taken to ensure that the image was captured and the photos can be immediately transferred to a computer and stored in the database. However, digital photos are very easy to alter which therefore prevents them from being used as evidence in court.

3.3 Video Cameras

Video cameras also provide an easy and inexpensive way to document crime scenes and can give the jury with a more realistic sense of the crime scene than still pictures of a room. The zoom on video cameras are however,more often digital rather than optical and thus provide pictures of slightly less clarity than actual photographs. Videos are in general a good briefing tool for police officers who have not visited the crime scene.

3.4 Techniques

Close-up shots of evidence have precise requirements, such as exactness, angle taken and balance, in order to achieve the best possible shots. These pictures of evidence form a factual record and must be able to be reproduced in terms of size, shape and colour, thus, balance and accuracy is an absolute must. The use of basic camera flash and flood lights are quite sufficient for general crime scene photography, but close-up shots of evidence require careful lighting. Artificial sources of light have proved very useful in the photography of evidence. An example of this concerns oblique-angled light, whereby the light is angled or slanted towards the subject. This is used for bringing out the detail in textured surfaces, such as foot and shoe prints left in mud.

3.5 Light

With the help of coloured filters and adaptable light-guides, lamps can direct a narrow beam of light at the subject of the photograph to enhance the object details. Different light filters also allow for the exposure of distinct evidence. For example, ultraviolet light can make stains and fingerprints glow, violet makes gunshot residue and blood more visible and blue and green lights are used with enhanced fingerprints to show up fibres and urine. This is because some materials absorb the ultraviolet light, while others reflect it, causing the material to become present under the ultraviolet light and flash of the camera when the photo is taken. A crime scene is also documented by writing down what the scene was like upon discovery, sketching, videoing, evidence tables to document artifacts found, voice recording and witness interviews.

4. Systematic screening of the scene for evidence

Searching the crime scene is obviously important, how it is carried out depends on the scene. It may be as small and contained as a single room or it may be as large as a forest. It may include

the dead (or living) body of the victim. Whatever the scene the search has to be as systematic and thorough as possible. Training is important, but so also is experience as it is often the experience eye which will pick up something that does not seem "quite right".

The goal of the evidence-collection stage is to find, collect and preserve all physical evidence that might serve to recreate the crime and identify the perpetrator in a manner that will stand up in court. Evidence can come in any form. Some typical kinds of evidence a CSI might find at a crime scene include:

- Trace evidence (gunshot residue, paint residue, broken glass, unknown chemicals, drugs)
- Impressions (fingerprints, footwear, tool marks)
- Body fluids (blood, semen, saliva, vomit)
- Hair and fibers
- Weapons and firearms evidence (knives, guns, bullet holes, cartridge casings)
- Questioned documents (diaries, suicide note, phone books; also includes electronic documents like answering machines and caller ID units)

With theories of the crime in mind, CSIs begin the systematic search for incriminating evidence, taking meticulous notes along the way. If there is a dead body at the scene, the search probably starts there.

4.1 Examining the body

A CSI might collect evidence from the body at the crime scene or he might wait until the body arrives at the morgue. In either case, the CSI does at least a visual examination of the body and surrounding area at the scene, taking pictures and detailed notes.

Before moving the body, the CSI makes note of details including:

- Are there any stains or marks on the clothing?
- Is the clothing bunched up in particular direction? If so, this could indicate dragging.
- Are there any bruises, cuts or marks on body? Any defense wounds? Any injuries indicating, consistent with or inconsistent with the preliminary cause of death?
- Is there anything obviously missing? Is there a tan mark where a watch or ring should be?
- If blood is present in large amounts, does the direction of flow follow the laws of gravity? If not, the body may have been moved.

- If no blood is present in the area surrounding the body, is this consistent with the preliminary cause of death? If not, the body may have been moved.
- Are there any bodily fluids present beside blood?
- Is there any insect activity on the body? If so, the CSI may call in a forensic entomologist to analyze the activity for clues as to how long the person has been dead.

After moving the body, he performs the same examination of the other side of the victim. At this point, he may also take the body temperature and the ambient room temperature to assist in determining an estimated time of death (although most forensic scientists say that time of death determinations are extremely unreliable -- the human body is unpredictable and there are too many variables involved). He will also take fingerprints of the deceased either at the scene or at the ME's office.

Once the CSI is done documenting the conditions of body and the immediately surrounding area, technicians wrap the body in a white cloth and put paper bags over the hands and feet for transportation to the morgue for an autopsy. These precautions are for the purpose of preserving any trace evidence on the victim. A CSI will usually attend the autopsy and take additional pictures or video footage and collect additional evidence, especially tissue samples from major organs, for analysis at the crime lab.

4.2 Examining the scene

There are several search patterns available for a CSI to choose from to assure complete coverage and the most efficient use of resources.

While searching the scene, a CSI is looking for details including:

- Are the doors and windows locked or unlocked? Open or shut? Are there signs of forced entry, such as tool marks or broken locks?

- Is the house in good order? If not, does it look like there was a struggle or was the victim just messy?
- Is there mail lying around? Has it been opened?
- Is the kitchen in good order? Is there any partially eaten food? Is the table set? If so, for how many people?
- Are there signs of a party, such as empty glasses or bottles or full ashtrays?
- If there are full ashtrays, what brands of cigarettes are present? Are there any lipstick or teeth marks on the butts?
- Is there anything that seems out of place? A glass with lipstick marks in a man's apartment, or the toilet seat up in a woman's apartment? Is there a couch blocking a doorway?
- Is there trash in the trash cans? Is there anything out of the ordinary in the trash? Is the trash in the right chronological order according to dates on mail and other papers? If not, someone might have been looking for something in the victim's trash.
- Do the clocks show the right time?
- Are the bathroom towels wet? Are the bathroom towels missing? Are there any signs of a cleanup?
- If the crime is a shooting, how many shots were fired? The CSI will try to locate the gun, each bullet, each shell casing and each bullet hole.
- If the crime is a stabbing, is a knife obviously missing from victim's kitchen? If so, the crime may not have been premeditated.
- Are there any shoe prints on tile, wood or linoleum floors or in the area immediately outside the building?
- Are there any tire marks in the driveway or in the area around the building?
- Is there any blood splatter on floors, walls or ceilings?

The actual collection of physical evidence is a slow process. Each time the CSI collects an item, he must immediately preserve it, tag it and log it for the crime scene record. Different types of evidence may be collected either at the scene or in lab depending on conditions and resources. Mr. Clayton, for instance, never develops latent fingerprints at the scene. He always sends fingerprints to the lab for development in a controlled environment. In the next section, we'll talk about collection methods for specific types of evidence.

5. Chain of custody

Chain of custody refers to the chronological documentation, and/or paper trail, showing the seizure, custody, control, transfer, analysis, and disposition of evidence, physical or electronic. Because evidence can be used in court to convict persons of crimes, it must be handled in a scrupulously careful manner to avoid later allegations of tampering or misconduct which can compromise the case of the prosecution toward acquittal or to overturning a guilty verdict upon appeal. The idea behind recording the chain of custody is to establish that the alleged evidence is in fact related to the alleged crime - rather than, for example, having been planted fraudulently to make someone appear guilty.

Establishing chain of custody is especially important when the evidence consists of fungible goods. In practice, this most often applies to illegal drugs which have been seized by law enforcement personnel. In such cases, the defendant at times disclaims any knowledge of possession of the controlled substance in question. Accordingly, the chain of custody documentation and testimony is presented by the prosecution to establish that the substance in evidence was in fact in the possession of the defendant.

An identifiable person must always have the physical custody of a piece of evidence. In practice, this means that a police officer or detective will take charge of a piece of evidence, document its collection, and hand it over to an evidence clerk for storage in a secure place. These transactions, and every succeeding transaction between the collection of the evidence and its appearance in court, should be completely documented chronologically in order to withstand legal challenges to the authenticity of the evidence. Documentation should include the conditions under which the evidence is gathered, the identity of all evidence handlers, duration of evidence custody, security conditions while handling or storing the evidence, and the manner in which evidence is transferred to subsequent custodians each time such a transfer occurs (along with the signatures of persons involved at each step).

An example of "chain of custody" would be the recovery of a bloody knife at a murder scene: Officer Andrew collects the knife and places it into a container, then gives it to forensics technician Bill. Forensics technician Bill takes the knife to the lab and collects fingerprints and

other evidence from the knife. Bill then gives the knife and all evidence gathered from the knife to evidence clerk Charlene. Charlene then stores the evidence until it is needed, documenting everyone who has accessed the original evidence (the knife, and original copies of the lifted fingerprints).

The chain of custody requires that from the moment the evidence is collected, every transfer of evidence from person to person be documented and that it be provable that nobody else could have accessed that evidence. It is best to keep the number of transfers as low as possible. In the courtroom, if the defendant questions the chain of custody of the evidence it can be proven that the knife in the evidence room is the same knife found at the crime scene. However, if there are discrepancies and it cannot be proven who had the knife at a particular point in time, then the chain of custody is broken and the defendant can ask to have the resulting evidence declared inadmissible. Chain of custody is also used in most chemical sampling situations to maintain the integrity of the sample by providing documentation of the control, transfer, and analysis of samples. Chain of custody is especially important in environmental work where sampling can identify the existence of contamination and can be used to identify the responsible party.

6. Indirect Path to Victim

The Crime Scene Investigator Role

The principal function is to document the scene with adequate and appropriate methods

- Convey scene findings via oral and written reports
- Testify as to the findings in court

Topic : Crime Scene Photography

Topic Objective:

After studying this topic the student should be able to:

- Define Forensic photography
- Explain Objectives of Crime Scene Photography
- Discuss Methods of Forensic photography
- Discuss Different Crime Scene Photography Ranges

Definition/Overview:

Film Speed: Film speed is a way of measuring sensitivity to light; the faster the film the more sensitive the film is to light. Two common measuring systems for film speed ISO and DIN

Infrared Photography. Uses infrared film, which records images formed by infrared light. It is used to locate alterations on documents. In aerial photographs it helps to locate gravesites. In the crime lab it is used to detect and document gunshot residue on bloody or dark fabrics

Ultraviolet Photography: It is used to document materials that glow under ultraviolet light such as semen, certain fibers, and latent fingerprints dusted with fluorescent powders. It is also used to photograph body wounds such as bitemarks.

Key Points:

1. Forensic photography

Forensic photography (sometimes referred to as forensic imaging or crime scene photography) is the art of producing an accurate reproduction of a crime scene or an accident scene for the benefit of a court or to aid in the investigation. It is part of the process of evidence collecting. It provides investigators with photos of bodies, places and items involved in the crime. Pictures of

accidents show broken machinery, or a car crash, and so on. Photography of this kind involves choosing correct lighting, accurate angling of lenses, and a collection of different viewpoints. Scales are often used in the picture so that dimensions of items are recorded on the image.

2. Objectives of Crime Scene Photography

- Record the condition of the scene before alterations occur
- Record the location and position of evidence items collected
- Document the point of view of principals and potential witnesses
- Document spatial relationships of pertinent items
- To supplement the other modes of crime scene documentation
- Plays an important role in the efforts to reconstruct the events of the crime

3. Methods

Crime or accident scene photographers capture images commonly in color, but also in black and white. The photograph of the skid mark was made during reconstruction at the accident scene to show how and why the ladder had slipped and caused a serious injury to the user. Color pictures are generally preferred because color may be an important aspect of the trace evidence, for example. Thus traces of paint or dye on a piece of evidence may be crucial to linking the evidence with a crime or accident. Various forces and different countries have different policies in regards to 35 mm film or digital photography. There are advantages and disadvantages to both. Conventional photography (even using disposable cameras) have a high resolution, enabling great enlargement should details in a picture need closer examination. Pictures from surveillance cameras are a growing source of evidence for courts, as are pictures taken by bystanders on mobile phones. The former are being used increasingly at accident blackspots, and bystanders may take pictures of events when no policeman or investigator is present, but yet may be critical to a case. Digital photographs usually have an automatic date and time marker on each image, so that authenticity can be verified. Conventional photographs without such marks must

be authenticated by the photographer, usually in a witness statement. Pictures of the relative position of objects (as in a Palimpsest) can establish a sequence of events at a crime or accident scene. Due to continued advances in digital technology and software, digital single-lens reflex (DSLR) cameras are increasingly being used by most Police forces.

4. Fit for court

The images must be clear and usually have scales. They serve to not only remind CSIs and investigators of the scene but also to provide a tangible image for the court to better enable them to understand what happened. The use of several views taken from different angles helps to minimise the problem of parallax.

Overall images do not have scales and serve to show the general layout (e.g. the house where the murder is thought to have occurred). Context images show evidence in context (e.g. how the knife was next to the sofa). Close up images show fine detail of an artefact (e.g. a bloody fingerprint on the knife).

Road Traffic Incident (RTI) photographs show the overall layout at the scene taken from many different angles, with close-ups of significant damage, or trace evidence such as tire marks at a car crash scene. As with crime scene photography, it is essential that the site is pristine and untouched as far as is possible. Some essential intervention (rescuing a trapped victim, for example) must be recorded in the notes made at the time by the photographer, so that the authenticity of the photographs can be verified.

5. Untampered

Like all evidence a chain of custody must be maintained for crime scene photographs. Sometimes a CSI (Forensic Photographer) will process his/her own film or there is a specific lab for it. Regardless of how it is done any person who handles the evidence must be recorded. Accident scene pictures should also be identified and sourced, police photographs taken at the scene often being used in civil cases.

Crime or accident scene photographs can often be re-analysed in cold cases or when the images need to be enlarged to show critical details. Photographs made by film exposure usually contain much information which may be crucial long after the photograph was taken. They can readily be digitised by scanning, and then enlarged to show the detail needed for new analysis. For example, controversy has raged for a number of years over the cause of the Tay Bridge disaster of 1879 when a half-mile section of the new bridge collapsed in a storm, taking an express train down into the estuary of the river Tay. At least 75 passengers and crew were killed in the disaster.

The set of photographs taken a few days after the accident have been re-analysed in 1999-2000 by digitising them and enlarging the files to show critical details. The originals were of very high resolution since a large plate camera was used with a small aperture, plus a small grain film. The re-analysed pictures shed new light on why the bridge fell, suggesting that design flaws and defects in the cast iron columns which supported the centre section led directly to the catastrophic failure. Alternative explanations that the bridge was blown down by the wind during the storm that night, or that the train derailed and hit the girders is unlikely. The re-analysis supports the original court of inquiry conclusions, which stated that the bridge was "badly designed, badly built and badly maintained".

6. Different Crime Scene Photography Ranges

As a general rule there are three main ranges of crime scene photography. The first is long range. Long range photos consist of your overall photo shots of your scene to your overall room shots inside. For example, at a burglary scene long range photo shots answer several questions needed to complete or help with the investigation. You would want to include the address of the residence connected to the residence itself. Is the residence secluded or in a residential area? Are there any fences or gates on the property where the crime occurred? Long-range photos also show the approximate time of day it is during the investigation, and the condition of the weather at the time of the investigation. Remember to take long range photos from all angles or directions of the crime scene, this is very important in order to show what is surrounding the residence.

The second type of photo range is medium range photography. Medium range photography consist of any range of photos that show more detail than long range, but not enough detail to

accurately describe any items in the scene. Remember to take these photos from a distance that they are not too close to the items in the scene, but not too far either. The key concept to this range of photos is to tie together all evidence in the crime scene. Use this range of photos to show tools used in the burglary in relation to the item(s) it was used on. To show the widow that was broken and the pattern of broken glass that was left by the suspect(s). Or show the items that are missing from the scene that the suspect(s) took (i.e. VCR, T.V.)

The final range of crime scene photography are the close-up photos. Close-up photography allows you to establish the magnification rate and size of the subject(s) in the crime scene. Close-up photos also show the specific details of the evidence in the scene in order to write a more accurate report, and to help, you the officer, remember the case two years down the road when the case finally reaches the courtroom. One important thing to remember with this range is to always take one picture without a scale or ruler, and take another picture of the same item from the same place with a scale or ruler, this will help if the picture ever needs any enlargements made or computer enhancements. Use this range of photos to show the detailed pry marks left on the back door of the residence. Any finger and/or palm prints at the scene. Any items that are going to be collected for processing back at the office. Finally, this range of photos are real useful in taking pictures of tire and shoe impressions left by the suspect(s).

Example/Case Study:

- In Section 2 of this course you will cover these topics:

Crime Scene Sketches

Latent Fingerprint Evidence

Trace Evidence

Topic : Crime Scene Sketches

Topic Objective:

After studying this topic the student should be able to:

- Define Crime Scene Sketching
- Explain Elements of Sketching
- Discuss Types of Sketches
- Discuss Drawing Measurement

Definition/Overview:

Sketch: A sketch is a rapidly executed freehand drawing that is not intended as a finished work. If in oil paint it is called an oil sketch. In general, a sketch is a quick way to record an idea for later use. Artist's sketches primarily serve as a way to try out different ideas and establish a composition before undertaking a more finished work, especially when the finished work is expensive and time consuming (as in the case of a large painting or fresco). Sketching sharpens an artist's ability to focus on the most important elements of a subject and is a prescribed part of artistic development for students.

Key Points:

1. Crime Scene Sketching

The Photograph is ordinarily a two-dimensional representation of the scene of the crime and, as such, does not provide accurate information concerning the distance between various points in the scene. The relationship existing between objects present in the scene cannot be clearly understood unless the measured distances are known. Certain objects, moreover, are not visible in a photograph or cannot be clearly identified. A drawing or crime scene sketch is the simplest and most effective way of showing actual measurements and of identifying significant items of

evidence in their locations at the scene. Sketches are divided generally into rough sketches and finished drawings.

- **Rough Sketch:** The rough sketch is made by the investigator on the scene. It need not be drawn to scale, but the proportions should be approximated and the appropriate measurements or dimensions shown. The rough sketch may be used as a basis for the finished drawing. No Changes should be made on the original sketch after the investigator has left the scene.
- **Finished Drawing**: The finished drawing is made primarily for courtroom presentation. It is generally based on the rough and drawn to scale by a person skilled in either mechanical or architectural drawing
- **Materials:** A sketch of a crime may be accomplished with little more than a pencil, a sheet of paper and a straight edge. On the other hand a finished drawing will require more advanced equipment. If the investigator wishes to draw an outdoor crime scene together with the surrounding terrain and achieve a reasonable degree of accuracy, he must possess an elementary knowledge of geometry. The following materials will be found useful although they should not be considered an absolute necessity.
- **For Rough Sketching:** For a rough sketch it is generally desirable to use a soft pencil. Graph paper is excellent for sketching as it provides a guide for lines and proportions. A clipboard or similar board of a size that will fit in the investigator's briefcase will serve as a sketching surface. The investigator should have a compass so that he/she may accurately indicate directions and also a steel tape to insure correct measurements.
- **For Finished Drawing:** When the finished drawing is to be made in the office and based on the rough sketch, the draftsman will require a drawing set a drafting board with accessories India ink, and a good grade of drawing paper. Since the drawing is made to scale, these materials are necessary to insure accuracy. If the finished drawing is to be made at the scene, the equipment of the draftsman should include a compass and steel tape.

2. Elements of Sketching

The following considerations apply generally to all sketches:

- **Measurements.** Measurements must be accurate. In portraying a large area a sufficient degree of accuracy is obtained by measurements of yards or tenths of a mile; for small areas measurements

accurate to the sixteenth of an inch may be required. Measurements should be accomplished by the sketcher himself making the actual measurement while his assistant verifies all readings. Measurements establishing the location of a movable object must be based on an immovable object. While measurements may be indicated between movable objects to establish a correlation at least one set of dimensions must reach an immovable object.

- **Compass Direction.** Compass direction must always be indicated to facilitate proper orientation of the sketch. The compass is used to determine "North. " A standard arrow of orientation will indicate this direction on the sketch.
- **Essential Items.** The sketch should portray all items that have a bearing on the investigation being conducted. The inclusion of unnecessary detail will result in a cluttered or crowded sketch and tends to hide or obscure the essential items. Simplic1ty 1s essential and sketches should be limited to the inclusion of only relevant material. For example, the sketch will include an outline of the room together with the doors, windows, chimney, and other large fixed objects. The furniture will then be indicated. The dead body or other significant object will be shown in relation to the furniture and other objects. Measurements will be made of the room, fireplace, sink, doorways, etc. The distances of the various parts of, for example, the body from these objects will be measured and recorded.
- **Scale or proportion:** The scale of a drawing will normally be dependent upon the area to be portrayed, the amount of detail to be shown, and the size of drawing paper available. It is normally advisable to use the smallest scale practicable. The actual or approximate scale of a sketch should always be shown by words and figures, graphically. If a rough sketch is made, the size of an object may be approximated as correlated to other objects. For example, if one dimension of a room is thirty feet and the other ten feet, the first line would be approximately three times the length of the second.
- **Legend:** The legend is an explanation of symbols used to identify objects in the sketch. In sketches portraying a large area, conventional signs or symbols may be used. These should be explained in the legend. If it is necessary to show considerable detail in a sketch covering a small area, the various objects may be lettered and an explanation included in the legend. Excessive lettering in the sketch generally will result in a crowded Sketch and obscure essential items.

- **Title:** The title of a sketch should contain the case identification (case-file number and offense); identification of victim or scene portrayed; location; date and hour made; and the sketcher. These data authenticate the sketch.
- **Projection:** The normal sketch will show the scene in two dimensions of one plane. When it becomes desirable to portray three dimensions to allow better correlation of the evidential facts of the scene, a projection sketch must be used. This projection sketch of the scene of a room is like a drawing of a cardboard box whose edges have been cut and the sides flattened.
- **Surveying Methods:** When portraying large areas, some of the basic surveying methods may be used to facilitate the work of the sketcher and to help insure the accuracy and clarity of the sketch. If the investigator does not have knowledge of surveying, he should enlist the services of a competent surveyor. The coordinate method, of which there are many simple variations, can be used to meet most of the problems in field sketching.

2.1 Rectangular Coordinates. The simplest way to locate points on sketch is to give the distances from two mutually Perpendicular lines. If the crime scene is a room, the objects can be mapped by using two mutually perpendicular walls as the reference lines. A chair, for example, can then be located by measuring its distance from each wall, e.g., 82 inches from the west wall and 43 inches from the south wall. If a graph paper is used for sketching and each unit of the graph paper represents 5 inches (for example) in the room, the chair is located on the graph paper by a point located 16.4 units from the vertical axis and 8.6 units from the horizontal axis, where the two axes are the left hand margin and the lower margin.

2.2 Polar Coordinates A point can also be mapped by giving its distance from some chosen origin and the direction angle which the distance line makes with a chosen axis of reference. The system is particularly useful for outdoor scenes, being commonly used in daily life. Using a door of a house as the origin, a tree can be located by saying that it is 324 yards away in a direction 42 west of south. The angle is determined by compass using the side of the house as a reference line and the distance is measured from the door to the house.

3. Types of Sketches

- Rough - locality layout sketch
- Finished
- Courtroom display sketches
- Critical accuracy sketches
- Three dimensional computer drawn sketches

4. Preparation:Suggested Procedure

- Should follow the same sequence followed in the initial survey of the scene
- The crime scene investigator should first prepare the layout sketch in order to provide a framework
- A rough sketch should be prepared for each area containing pertinent objects or evidence

5. Rough Sketches

- Locality layout sketch
- Layout sketches of smaller areas
- Detailed sketches (not to scale)
- Blowup sketches for fine details
- Exploded view sketch showing the walls lying flat
- Elevation sketches

5.1 Not to Scale Sketch

5.2 Critical Accuracy

6. Drawing Measurement

Use a measurement table for the evidence in your sketch. The table is adaptable to any coordinate system (triangulation, rectangular, baseline or even radial). The table may help in

reminding you to measure the heighth, which is frequently overlooked. Eliminating needless measurement lines will rid confusion by making your sketch look cleaner.

Item #	Description	R1-North wall	R-2 West wall	Ht.	Other
1	Lead 38 cal bullet	1 2	11 3	3 2	To #2 = 5 8
2	Ruger, Security Six, Stainless, SN123456, 5 live, 1 spent	6 4	5 11	1 8	
3	Cold, full Smittysbeer can, D23Oz65 on bottom	7 9	9 8	0	
4	Blood stain on floor	3 6	7 7	0	
5	Box of WW 38 SPL lead bullets minus 6, brass cases	4 10	6 3	1 8	
6	4 fixed blade knife, wood handle	6 9	14 4	0	
7	Blood spot	6 2	4 5	0	
8	Handwritten note signed Jake	17 3	3 1	2 6	

Instead of the walls you can use corners for triangulation. You are not limited to two reference points. Note the above "relationship" measurements. These measurements **cannot** accurately be made on a "scale" drawing at a later time.

Topic : Latent Fingerprint Evidence

Topic Objective:

After studying this topic the student should be able to:

- Know the common ridge characteristics of a fingerprint
- List the three major fingerprint patterns and their respective subclasses
- Distinguish visible, plastic, and latent fingerprints
- Describe the concept of an automated fingerprint identification system (AFIS)
- List the techniques for developing latent fingerprints on porous and nonporous objects
- Describe the proper procedures for preserving a developed latent fingerprint

Definition/Overview:

Anthropometry: A system of identification of individuals by measurement of parts of the body, developed by Alphonse Bertillon.

Arch: A class of fingerprints characterized by ridge lines that enter the print from one side and flow out the other side.

Digital Imaging: A process through which a picture is converted into a series of square electronic dots known as pixels. The picture is manipulated by computer software that changes the numerical value of each pixel.

Fluoresce: To emit visible light when exposed to light of a shorter wavelength.

Iodine Fuming: A technique for visualizing latent fingerprints by exposing them to iodine vapors.

Latent Fingerprint: A fingerprint made by the deposit of oils and/or perspiration. It is invisible to the naked eye.

Livescan: An inkless device that captures the digital images of fingerprints and palm prints and electronically transmits the images to an AFIS.

Loop: A class of fingerprints characterized by ridge lines that enter from one side of the pattern and curve around to exit from the same side of the pattern.

Ninhydrin: A chemical reagent used to develop latent fingerprints on porous materials by reacting with amino acids in perspiration.

Physical Developer: A silver nitratebased reagent formulated to develop latent fingerprints on porous surfaces.

Pixel: A square electronic dot that is used to compose a digital image.

Plastic Print: A fingerprint impressed in a soft surface.

Portrait Parl: A verbal description of a perpetrators physical characteristics and dress provided by an eyewitness.

Ridge Characteristics (Minutiae): Ridge endings, bifurcations, enclosures, and other ridge details, which must match in two fingerprints in order for their common origin to be established.

Sublimation: A physical change from the solid directly into the gaseous state.

Super Glue Fuming: A technique for visualizing latent fingerprints on nonporous surfaces by exposing them to cyanoacrylate vapors; named for the commercial product Super Glue.

Visible Print: A fingerprint made when the finger deposits a visible material such as ink, dirt, or blood onto a surface.

Whorl: A class of fingerprints that includes ridge patterns that are generally rounded or circular in shape and have two deltas.

Key Points:

1. Fingerprint

A fingerprint is an impression of the friction ridges of all part of the finger. A friction ridge is a raised portion of the epidermis on the palmar (palm) or digits (fingers and toes) or plantar (sole) skin, consisting of one or more connected ridge units of friction ridge skin. These are sometimes known as "dermal ridges" or "dermal papillae". These ridges assist in gripping objects and may also serve to amplify vibrations triggered when fingertips brush across an uneven surface, better transmiting the signals to sensory nerves involved in fine texture perception. Fingerprints may be deposited in natural secretions from the eccrine glands present in friction ridge skin (secretions consisting primarily of water) or they may be made by ink or other contaminants transferred from the peaks of friction skin ridges to a relatively smooth surface such as a fingerprint card. The term fingerprint normally refers to impressions transferred from the pad on the last joint of fingers and thumbs, though fingerprint cards also typically record portions of lower joint areas of the fingers (which are also used to make identifications).

Fingerprints collected from a crime scene, or from items of evidence from a crime, can be used in forensic science to identify suspects, victims and other persons who touched the surface in question. Fingerprint identification emerged as an important system within various police agencies in the late 19th century. This system replaced anthropometric measurements as a more reliable method for identifying persons having a prior record, often under an alias name, in a criminal record repository. The science of fingerprint identification stands out among all other

forensic sciences for many reasons because of its superiority and reliability. Worldwide, fingerprinting has served all governments during the past 100 years to provide accurate identification of criminals. No two fingerprints have ever been found alike in the billions of human and automated computer comparisons. Fingerprints have become the very basis for criminal history foundation at almost every police agency.

The first forensic professional organization, the International Association for Identification (IAI), was established in 1915. It established the first professional certification program for forensic scientists, the IAI's Certified Latent Print Examiner program in 1977, issuing certification to those meeting stringent criteria and revoking certification for serious errors such as erroneous identifications. Fingerprints remain the most commonly used forensic evidence the world over. In most jurisdictions, fingerprint examination cases outnumber all other forensic examination casework combined. It continues to expand as the premier method for identifying persons, with tens of thousands of persons added to fingerprint repositories daily in America alone - far outdistancing similar databases in growth. Fingerprinting has outperformed DNA and all other human identification systems to identify more murderers, rapists and other serious offenders (fingerprints solve ten times more unknown suspect cases than DNA in most jurisdictions).

Although some reporters and authors claim that fingerprints have long enjoyed a mystique of infallibility, the opposite is true. Fingerprint identification was the first forensic discipline in 1977 to formally institute a professional certification program for individual experts, including a procedure for decertifying those making any investigative errors. Other forensic disciplines later followed suit in establishing certification programs whereby certifications could be revoked for any error found. Fingerprint identifications lead to far more positive identifications of persons worldwide daily than any other human identification procedure. The American federal government alone effects positive identification of over 70,000 persons. A large percentage of the identifications, approximately 92% of US Visit identifications, are affected in lights-out, no human involved computer identification process with 100% accuracy based on only two fingerprints

2. Fingerprints as used for identification

Fingerprint identification (sometimes referred to as dactyloscopy) or palmprint identification is the process of comparing questioned and known friction skin ridge impressions from fingers or palms to determine if the impressions are from the same finger or palm. The flexibility of friction ridge skin means that no two finger or palm prints are ever exactly alike (never identical in every detail), even two impressions recorded immediately after each other. Fingerprint identification (also referred to as individualization) occurs when an expert (or an expert computer system operating under threshold scoring rules) determines that two friction ridge impressions originated from the same finger or palm (or toe, sole) to the exclusion of all others. A known print is the intentional recording of the friction ridges, usually with black printers ink rolled across a contrasting white background, typically a white card. Friction ridges can also be recorded digitally using a technique called Live-Scan. A latent print is the chance reproduction of the friction ridges deposited on the surface of an item. Latent prints are often fragmentary and may require chemical methods, powder, or alternative light sources in order to be visualized.
When friction ridges come in contact with a surface that is receptive to a print, material on the ridges, such as perspiration, oil, grease, ink, etc. can be transferred to the item. The factors which affect friction ridge impressions are numerous, thereby requiring examiners to undergo extensive and objective study in order to be trained to competency. Pliability of the skin, deposition pressure, slippage, the matrix, the surface, and the development medium are just some of the various factors which can cause a latent print to appear differently from the known recording of the same friction ridges. Indeed, the conditions of friction ridge deposition are unique and never duplicated. This is another reason why extensive and objective study is necessary for examiners to achieve competency.

3. Fingerprint types

3.1 Latent prints

Although the word latent means hidden or invisible, in modern usage for forensic science the term latent prints means any chance of accidental impression left by friction ridge skin on a surface, regardless of whether it is visible or invisible at the time of deposition. Electronic, chemical and physical processing techniques permit visualization of invisible latent print residue whether they are from natural secretions of the eccrine glands present

on friction ridge skin (which produce palmar sweat, consisting primarily of water with various salts and organic compounds in solution), or whether the impression is in a contaminant such as motor oil, blood, paint, ink, etc.

Latent prints may exhibit only a small portion of the surface of the finger and may be smudged, distorted, overlapping, or any combination, depending on how they were deposited. For these reasons, latent prints are an inevitable source of error in making comparisons, as they generally contain less clarity, less content, and less undistorted information than a fingerprint taken under controlled conditions, and much, much less detail compared to the actual patterns of ridges and grooves of a finger.

3.2 Patent prints

These are friction ridge impressions of unknown origins which are obvious to the human eye and are caused by a transfer of foreign material on the finger, onto a surface. Because they are already visible they need no enhancement, and are generally photographed instead of being lifted in the same manner as latent prints. Finger deposits can include materials such as ink, dirt, or blood onto a surface.

3.3 Plastic prints

A plastic print is a friction ridge impression from a finger or palm (or toe/foot) deposited in a material that retains the shape of the ridge detail. Commonly encountered examples are melted candle wax, putty removed from the perimeter of window panes and thick grease deposits on car parts. Such prints are already visible and need no enhancement, but investigators must not overlook the potential that invisible latent prints deposited by accomplices may also be on such surfaces. After photographically recording such prints, attempts should be made to develop other non-plastic impressions deposited at natural finger/palm secretions (eccrine gland secretions) or contaminates.

4. Fingerprint capture and detection

4.1 Livescan devices

Fingerprint image acquisition is considered the most critical step of an automated fingerprint authentication system, as it determines the final fingerprint image quality, which has drastic effects on the overall system performance. There are different types of fingerprint readers on the market, but the basic idea behind each capture approach is to

measure in some way the physical difference between ridges and valleys. All the proposed methods can be grouped in two major families: solid-state fingerprint readers and optical fingerprint readers. The procedure for capturing a fingerprint using a sensor consists of rolling or touching with the finger onto a sensing area, which according to the physical principle in use (capacitive, optical, thermal, etc.) captures the difference between valleys and ridges. When a finger touches or rolls onto a surface, the elastic skin deforms. The quantity and direction of the pressure applied by the user, the skin conditions and the projection of an irregular 3D object (the finger) onto a 2D flat plane introduce distortions, noise and inconsistencies in the captured fingerprint image. These problems result in inconsistent, irreproducible and non-uniform contacts and, during each acquisition, their effects on the same fingerprint results are different and uncontrollable. The representation of the same fingerprint changes every time the finger is placed on the sensor platen, increasing the complexity of the fingerprint matching, impairing the system performance, and consequently limiting the widespread use of this biometric technology.

5. Methods of Fingerprint Detection

Since the late nineteenth century, fingerprint identification methods have been used by police agencies around the world to identify both suspected criminals as well as the victims of crime. The basis of the traditional fingerprinting technique is simple. The skin on the palmar surface of the hands and feet forms ridges, so-called papillary ridges, in patterns that are unique to each individual and which do not change over time. Even identical twins do not have identical fingerprints. Fingerprints on surfaces may be described as patent or latent. Patent fingerprints are left when a substance (such as paint, oil or blood) is transferred from the finger to a surface and are easily photographed without further processing. Latent fingerprints, in contrast, occur when the natural secretions of the skin are deposited on a surface through fingertip contact, and are usually not readily visible. The best way to render latent fingerprints visible, so that they can be photographed, is complex and depends, for example, on the type of surface involved. It is generally necessary to use a developer, usually a powder or chemical reagent, to produce a high degree of visual contrast between the ridge patterns and the surface on which the fingerprint was left.

Developing agents depend on the presence of organic materials or inorganic salts for their effectiveness although the water deposited may also take a key role. Fingerprints are typically formed from the aqueous based secretions of the eccrine glands of the fingers and palms with additional material from sebaceous glands primarily from the forehead. The latter contamination results from the common human bahavious of touching the face and hair.

The resulting latent fingerprints consist usually of a substantial proportion of water with small traces of amino acids, chlorides etc mixed with a fatty, sebaceous component which contains a number of fatty acids, triglycerides etc Detection of the small proportion of reactive organic material such as urea and amino acids is far from easy.

Crime scene fingerprints may be detected by simple powders, or some chemicals applied at the crime scene; or more complex, usually chemical techniques applied in specialist laboratories to appropriate articles removed from the crime scene. With advances in these more sophisticated techniques some of the more advanced crime scene investigation services from around the world are now reporting that 50% or more of the total crime scene fingerprints result from these laboratory based techniques

Although there are hundreds of reported techniques for fingerprint detection many are only of academic interest and there are only around 20 really effective methods which are currently in use in the more advanced fingerprint laboratories around the world. Some of these techniques such as Ninhydrin, Diazofluorenone, and Vacuum Metal Deposition show quite surprising sensitivity and are used operationally to great effect. Some fingerprint reagents are specific, for example Ninhydrin or Diazo-fluorenone reacting with amino acids. Others such as ethyl cyanoacrylate polymerisation, work apparently by water based catalysis and polymer growth. Vacuum metal deposition using gold and zinc has been shown to be non-specific but detect fat layers as thin as one molecule. More mundane methods such as application of fine powders work by adhesion to sebaceous deposits and possibly aqueous deposits for fresh fingerprints. The aqueous component whilst initially sometimes making up over 90% of the weight of the fingerprint can evaporate quite quickly and most may be gone in after 24 hours. After work by Duff and Menzel on the use of Argon Ion lasers for fingerprint detection a wide range of

fluorescence techniques have been introduced, primarily for the enhancement of chemically developed fingerprints but also some detection of inherent fluorescence of the latent fingerprints.

The International Fingerprint Research Group (IFRG) which meets biennially, consisting of members of the leading fingerprint research groups from Europe, the US, Canada, Australia and Israel leads the way in the development, assessment and implementation of new techniques for operational fingerprint detection.

One problem is the fact that the organic component of any deposited material is readily destroyed by heat, such as occurs when a gun is fired or a bomb is detonated, when the temperature may reach as high as 500C. In contrast, the non-volatile, inorganic component of eccrine secretion remains intact even when exposed to temperatures as high as 600C.

Within the Materials Research Centre, University of Swansea, UK , University of Swansea, UK, Professor Neil McMurray and Dr Geraint Williams have developed a technique that enables fingerprints to be visualised on metallic and electrically conductive surfaces without the need to develop the prints first. The technique involves the use of an instrument called a scanning Kelvin probe (SKP), which measures the voltage, or electrical potential, at pre-set intervals over the surface of an object on which a fingerprint may have been deposited. These measurements can then be mapped to produce an image of the fingerprint. A higher resolution image can be obtained by increasing the number of points sampled, but at the expense of the time taken for the process. A sampling frequency of 20 points per mm is high enough to visualise a fingerprint in sufficient detail for identification purposes and produces a voltage map in 23 hours. So far the technique has been shown to work effectively on a wide range of forensically important metal surfaces including iron, steel and aluminium. While initial experiments were performed on planar, i.e. flat, surfaces, the technique has been further developed to cope with severely non-planar surfaces, such as the warped cylindrical surface of fired cartridge cases. The very latest research from the department has found that physically removing a fingerprint from a metal surface, e.g. by rubbing with a tissue, does not necessarily result in the loss of all fingerprint information. The reason for this is that the differences in potential that are the basis of the visualisation are caused by the interaction of inorganic salts in the fingerprint deposit and the

metal surface and begin to occur as soon as the finger comes into contact with the metal, resulting in the formation of metal ion complexes that cannot easily be removed.

Scanning Kelvin Probe scan of the same casing with the fingerprint clearly detected. The Kelvin probe can easily cope with the 3D curvature of the bullet casing increasing the versatility of the technique.

Currently, in crime scene investigations, a decision has to be made at an early stage whether to attempt to retrieve fingerprints through the use of developers or whether to swab surfaces in an attempt to salvage material for DNA fingerprinting. The two processes are mutually incompatible, as fingerprint developers destroy material that could potentially be used for DNA analysis, and swabbing is likely to make fingerprint identification impossible.

The application of the new SKP fingerprinting technique, which is non-contact and does not require the use of developers, has the potential to allow fingerprints to be retrieved while still leaving intact any material that could subsequently be subjected to DNA analysis. The University of Swansea group hope to have a forensically usable prototype in the near future and it is intended that eventually the instrument will be manufactured in sufficiently large numbers that it will be widely used by forensic teams on the frontline.

There has recently been significant worldwide interest in the technique with articles appearing in/on BBC.co.uk, Sky News , S4C news, TheDaily Mail, FHM magazine, AOL, Yahoo news, Telegraph.co.uk, The Hindu, Taipei times, Sydney Morning Herald, San Francisco Gate, The Mercury (South Africa), Brisbane Courier Mail and many others. There has also been significant interest from the Home Office and a number of different police forces across the UK.

More information about the technique has been published in a number of scientific journals .

6. Classifying fingerprints

Before computerization replaced manual filing systems in large fingerprint operations, manual fingerprint classification systems were used to categorize fingerprints based on general ridge formations (such as the presence or absence of circular patterns in various fingers), thus permitting filing and retrieval of paper records in large collections based on friction ridge patterns independent of name, birth date and other biographic data that persons may misrepresent. The most popular ten-print classification systems include the Roscher system, the Vucetich system, and the Henry Classification System. Of these systems, the Roscher system was developed in Germany and implemented in both Germany and Japan, the Vucetich system was developed in Argentina and implemented throughout South America, and the Henry system was developed in India and implemented in most English-speaking countries.

In the Henry system of classification, there are three basic fingerprint patterns: Arch, Loop and Whorl. There are also more complex classification systems that further break down patterns to plain arches or tented arches. Loops may be radial or ulnar, depending on the side of the hand the tail points towards. Whorls also have sub-group classifications including plain whorls, accidental whorls, double loop whorls, and central pocket loop whorls.

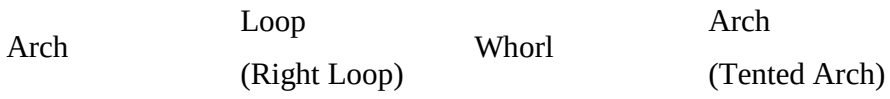

Figure 2. Classifying fingerprints

Topic : Trace Evidence

Topic Objective:

After studying this topic the student should be able to:

- Review the common types of physical evidence encountered at crime scenes
- Explain the difference between the identification and comparison of physical evidence
- Define and contrast individual and class characteristics of physical evidence
- Appreciate the value of class evidence as it relates to a criminal investigation

Definition/Overview:

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

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

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

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

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

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

Key Points:

1. Physical Evidence

Physical evidence is any object that could link a suspect to a crime scene, a victim to a crime scene, or it can tell us something about whether a crime has taken place or not. Now, what is an object? That in itself is pretty interesting. An object can be anything such as a gun or it can be a bullet, but it also can be something as small as a human cell, because with current technology we can extract information from a single cell that can tell us something about the DNA type of an individual that was present at the crime scene. So I use the term 'object' very loosely. It can be anything from the large to the infinitely small.

2. Types of Physical Evidence

There are certain items that we see on a repeated basis at crime scenes, such as hairs, fibers, paint chips, glass, guns, bullets, cartridges, and different types of ropes. Also, what's interesting and very important are these carriers of physical evidence - things that we see at scenes that somebody may have touched with their lips or their fingers and have deposited a finger print or DNA onto. We're not going to know much about that until we get it back to the crime lab and we have it analyzed.

The types of physical evidence that can be collected from crime scenes vary greatly and depend heavily on location and type of crime. For example, the physical evidence available for collection at the scene of a robbery is quite different from that available at a murder scene. Physical evidence might include marks on a victim's body, such as abrasions or bite marks. Fingerprints on a door or a window frame also constitute physical evidence, as does blood left

behind by a likely perpetrator. Trace evidence is a type of physical evidence that can be collected and forensically examined; this kind of evidence is commonly depicted in CSI episodes. Trace evidence is found when a small amount of material has transferred from either one location or person to another location or person. Examples of trace evidence include gunshot residue and fibers from clothing or carpeting.

2. Trace evidence

Trace evidence might include gun-shot residue (GSR), paint residue, chemicals, glass and illicit drugs. To collect trace evidence, a CSI might use tweezers, plastic containers with lids, a filtered vacuum device and a knife. He will also have a biohazard kit on hand containing disposable latex gloves, booties, face mask and gown and a biohazard waste bag.

If the crime involves a gun, the CSI will collect clothing from the victim and anyone who may have been at the scene so the lab can test for GSR. GSR on the victim can indicate a close shot, and GSR on anyone else can indicate a suspect. The CSI places all clothing in sealed paper bags for transport to the lab. If he finds any illicit drugs or unknown powders at the scene, he can collect them using a knife and then seal each sample in a separate, sterile container. The lab can identify the substance, determine its purity and see what else is in the sample in trace amounts. These tests might determine drug possession, drug tampering or whether the composition could have killed or incapacitated a victim.

Technicians discover a lot of the trace evidence for a crime in the lab when they shake out bedding, clothing, towels, couch cushions and other items found at the scene. At the CBI Denver Crime Lab, technicians shake out the items in a sterile room, onto a large, white slab covered with paper.

The technicians then send any trace evidence they find to the appropriate department. In the Denver Crime Lab, things like soil, glass and paint stay in the trace-evidence lab, illicit drugs and unknown substances go to the chemistry lab, and hair goes to the DNA lab.

2.1. Body fluids

Body fluids found at a crime scene might include blood, semen, saliva, and vomit. To

identify and collect these pieces of evidence, a CSI might use smear slides, a scalpel, tweezers, scissors, sterile cloth squares, a UV light, protective eyewear and luminol. He'll also use a blood collection kit to get samples from any suspects or from a living victim to use for comparison.

If the victim is dead and there is blood on the body, the CSI collects a blood sample either by submitting a piece of clothing or by using a sterile cloth square and a small amount of distilled water to remove some blood from the body. Blood or saliva collected from the body may belong to someone else, and the lab will perform DNA analysis so the sample can be used later to compare to blood or saliva taken from a suspect. The CSI will also scrape the victim's nails for skin -- if there was a struggle, the suspect's skin (and therefore DNA) may be under the victim's nails. If there is dried blood on any furniture at the scene, the CSI will try to send the entire piece of furniture to the lab. A couch is not an uncommon piece of evidence to collect. If the blood is on something that can't reasonably go to the lab, like a wall or a bathtub, the CSI can collect it by scraping it into a sterile container using a scalpel. The CSI may also use luminol and a portable UV light to reveal blood that has been washed off a surface.

If there is blood at the scene, there may also be blood spatter patterns. These patterns can reveal the type of weapon that was used -- for instance, a "cast-off pattern" is left when something like a baseball bat contacts a blood source and then swings back. The droplets are large and often tear-drop shaped. This type of pattern can indicate multiple blows from a blunt object, because the first blow typically does not contact any blood. A "high-energy pattern," on the other hand, is made up of many tiny droplets and may indicate a gun shot. Blood spatter analysis can indicate which direction the blood came from and how many separate incidents created the pattern. Analyzing a blood pattern involves studying the size and shape of the stain, the shape and size of the blood droplets and the concentration of the droplets within the pattern. The CSI takes pictures of the pattern and may call in a blood-spatter specialist to analyze it.

2.2. Hair and Fibers

A CSI may use combs, tweezers, containers and a filtered vacuum device to collect any hair or fibers at the scene. In a rape case with a live victim, the CSI accompanies the victim to the hospital to obtain any hairs or fibers found on the victim's body during the medical examination. The CSI seals any hair or fiber evidence in separate containers for transport to the lab.

A CSI might recover carpet fibers from a suspect's shoes. The lab can compare these fibers to carpet fibers from the victim's home. Analysts can use hair DNA to identify or eliminate suspects by comparison. The presence of hair on a tool or weapon can identify it as the weapon used in the crime. The crime lab can determine what type of animal the hair came from (human? dog? cow?); and, if it's human, analysts can determine the person's race, what part of the body the hair came from, whether it fell out or was pulled and whether it was dyed.

2.3. Fingerprints

Tools for recovering fingerprints include brushes, powders, tape, chemicals, lift cards, a magnifying glass and Super Glue. A crime lab can use fingerprints to identify the victim or identify or rule out a suspect. There are several types of prints a CSI might find at a crime scene:

- Visible: Left by the transfer of blood, paint or another fluid or powder onto a surface that is smooth enough to hold the print; evident to the naked eye
- Molded: Left in a soft medium like soap, putty or candle wax, forming an impression
- Latent: Left by the transfer of sweat and natural oils from the fingers onto a surface that is smooth enough to hold the print; not visible to the naked eye

A perpetrator might leave prints on porous or nonporous surfaces. Paper, unfinished wood and cardboard are porous surfaces that will hold a print, and glass, plastic and metal are non-porous surfaces. A CSI will typically look for latent prints on surfaces the perpetrator is likely to have touched. For instance, if there are signs of forced entry on

the front door, the outside door knob and door surface are logical places to look for prints. Breathing on a surface or shining a very strong light on it might make a latent print temporarily visible. When you see a TV detective turn a doorknob using a handkerchief, she's probably destroying a latent print. The only way not to corrupt a latent print on a non-porous surface is to not touch it. Proper methods for recovering latent prints include:

- Powder (for non-porous surfaces): Metallic silver powder or velvet black powder

  A CSI uses whichever powder contrasts most with the color of material holding the print. He gently brushes powder onto the surface in a circular motion until a print is visible; then he starts brushing in the direction of the print ridges. He takes a photo of the print before using tape to lift it (this makes it stand up better in court). He adheres clear tape to the powdered print, draws it back in a smooth motion and then adheres is to a fingerprint card of a contrasting color to the powder.

- Chemicals (for porous surfaces): Iodine, ninhydrin, silver nitrate

  The CSI sprays the chemical onto the surface of the material or dips the material into a chemical solution to reveal the latent print.

- Cyanoacrylate (Super Glue) fuming (for porous or non-porous surfaces)

  The CSI pours Super Glue into a metal plate and heats it to about 120 F. He then places the plate, the heat source and the object containing the latent print in an airtight container. The fumes from the Super Glue make the latent print visible without disturbing the material it's on.

2.4. Footwear Impressions and Tool Marks

A latent fingerprint is an example of a two-dimensional impression. A footwear impression in mud or a tool mark on a window frame is an example of a three-

dimensional impression. If it's not possible to submit the entire object containing the impression to the crime lab, a CSI makes a casting at the scene.

A casting kit might include multiple casting compounds (dental gypsum, Silicone rubber), snow wax (for making a cast in snow), a bowl, a spatula and cardboard boxes to hold the casts.

If a CSI finds a footwear impression in mud, she'll photograph it and then make a cast. To prepare the casting material, she combines a casting material and water in a Ziploc-type bag and kneads it for about two minutes, until the consistency is like pancake batter. She then pours the mixture into the edge of the track so that it flows into the impression without causing air bubbles. Once the material overflows the impression, she lets it set for at least 30 minutes and then carefully lifts the cast out of the mud. Without cleaning the cast or brushing anything off it (this would destroy any trace evidence), she puts the cast into a cardboard box or paper bag for transport to the lab.

For toolmark impressions, a cast is much harder to use for comparison than it is with footwear. If it's not feasible to transport the entire item containing the tool mark, a CSI can make a silicone-rubber cast and hope for the best. There are two types of tool marks a CSI might find at a crime scene:

- Impressed: A hard object contacts a softer object without moving back and forth (for example, a hammer mark on a door frame). The tool mark is an impression of the tool's shape. It's difficult to make a definite match with an impressed tool mark.
- Striated: A hard object contacts a softer object and moves back and forth (for example, pry marks on a window frame). The tool mark is a series of parallel lines. It's easier to make a definite match with a striated tool mark.

In toolmark analysis, the lab might determine what sort of tool made the mark and whether a tool in evidence is the tool that made it. It can also compare the tool mark in evidence to another toolmark to determine if the marks were made by the same tool.

2.5. Firearms

If a CSI finds any firearms, bullets or casings at the scene, she puts gloves on, picks up the gun by the barrel (not the grip) and bags everything separately for the lab. Forensic scientists can recover serial numbers and match both bullets and casings not only to the weapon they were fired from, but also to bullets and casings found at other crime scenes throughout the state (most ballistics databases are statewide). When there are bullet holes in the victim or in other objects at the scene, specialists can determine where and from what height the bullet was fired from, as well as the position of the victim when it was fired, using a laser trajectory kit**.** If there are bullets embedded in a wall or door frame, the CSI cuts out the portion of the wall or frame containing the bullet -- digging the bullet out can damage it and make it unsuitable for comparison.

2.6. Documents

A CSI collects and preserves any diaries, planners, phone books or suicide notes found at a crime scene. He also delivers to the lab any signed contracts, receipts, a torn up letter in the trash or any other written, typed or photocopied evidence that might be related to the crime. A documents lab can often reconstruct a destroyed document, even one that has been burned, as well as determine if a document has been altered. Technicians analyze documents for forgery, determine handwriting matches to the victim and suspects, and identify what type of machine was used to produce the document. They can rule out a printer or photocopier found at the scene or determine compatibility or incompatibility with a machine found in a suspect's possession. Whenever a CSI discovers a piece of evidence at the scene, she photographs it, logs it, recovers it and tags it. An evidence tag may include identification information such as time, date and exact location of recovery and who recovered the item, or it may simply reflect a serial number that corresponds to an entry in the evidence log that contains this information. The **crime scene report** documents the complete body of evidence recovered from the scene, including the photo log, evidence recovery log and a written report describing the crime scene investigation.

2.7. Bite Marks

Bite marks are found many times in sexual assaults and can be matched back to the individual who did the biting. They should be photographed using an ABFO No. 2 Scale with normal lighting conditions, side lighting, UV light, and alternate light sources. Color slide and print film as well as black and white film should be used. The more photographs under a variety of conditions, the better. Older bitemarks which are no longer visible on the skin may sometimes be visualized and photographed using UV light and alternate light sources. If the bitemark has left an impression then maybe a cast can be made of it. Casts and photographs of the suspect's teeth and maybe the victim's teeth will be needed for comparison. For more information consult a forensic odontologist.

2.8. Fracture Matches

Fracture matches can positively link broken pieces at the scene with pieces found in the possession of a suspect. For example, headlight fragments found at the scene of a hit and run could be positively matched to a broken headlight (just like putting together a jigsaw puzzle) on a suspect's vehicle. Larger fragments should be placed in paper bags or envelopes. Smaller fragments should be placed in a paper packet and then placed in an envelope.

3. The Fire Tetrahedron

The fire triangle is a useful teaching tool, but fails to identify the fourth essential element of fire: the sustaining chemical reaction. This has led to development of the fire tetrahedron: a triangular pyramid having four sides (including the bottom). Some fire suppression agents do not remove or reduce any of the three necessary components, but rather interfere with their chemical combination, such as Halon. In most fires, it does not matter which element gets removed; the fire fails to ignite, or it goes out. However, there are certain chemical fires where knowing only the fire triangle is not good enough.

Combustion is the chemical reaction that feeds on a fire more heat and allows it to continue. With most types of fires, the old fire triangle model works well enough, but when the fire involves burning metals (known as a class-D fire in the American system of fire classifications, involving metals like lithium, magnesium, etc.), it becomes useful to consider the chemistry of combustion. Putting water on such a fire could result in the fire getting hotter (or even exploding) because such metals can react with water in an exothermic reaction to produce flammable hydrogen gas. Therefore, other specialized chemicals must typically be used to break the chain reaction of metallic combustion and stop the fire.

- In Section 3 of this course you will cover these topics:
- Biological Fluid Stain Evidence
- Firearms Evidence
- Impression Evidence

Topic : Biological Fluid Stain Evidence

Topic Objective:

After studying this topic the student should be able to:

- Define Biological Fluid Stain Evidence
- Explain Blood Evidence Value
- Discuss Other Body Fluids of Significant Value
- Discuss Collection Of Sample And Standards
- Explain Biological Reference Collection Kit
- Discuss General Collection Information

Definition/Overview:

Genetic Marker: A genetic marker is a known DNA sequence. It can be described as a variation, which may arise due to mutation or alteration in the genomic loci, that can be observed. A genetic marker may be a short DNA sequence, such as a sequence surrounding a single base-pair change (single nucleotide polymorphism), or a long one, like minisatellites.

Nuclear DNA: has a chromosomal component from each parent

Mitochondrial DNA: have mitochondria in the cell

Restriction Fragment Length Polymorphism: A Restriction Fragment Length Polymorphism (or RFLP, often pronounced as "rif-lip") is a variation in the DNA sequence of a genome which can be detected by a laboratory technique known as gel electrophoresis. Analysis of RFLP variation was an important tool in genome mapping, localization of genetic disease genes, determination of risk for a disease, genetic fingerprinting, and paternity testing.

Polymerase chain reaction: The polymerase chain reaction (PCR) is a technique widely used in molecular biology. It derives its name from one of its key components, a DNA polymerase used to amplify a piece of DNA by in vitro enzymatic replication. As PCR progresses, the DNA thus generated is itself used as template for replication. This sets in motion a chain reaction in which the DNA template is exponentially amplified. With PCR it is possible to amplify a single or few copies of a piece of DNA across several orders of magnitude, generating millions or more copies of the DNA piece. PCR can be extensively modified to perform a wide array of genetic manipulations.

Combined DNA Index System: The Combined DNA Index System (CODIS) is the FBI-funded computer system that solves crimes by searching DNA profiles developed by federal, state, and local crime laboratories.

Key Points:

1. Biological Fluid Stain Evidence

Evidence in this category includes blood of human or animal origin, semen, saliva, urine, and skin tissue submitted for the purpose of identification and characterization according to genetic factors such as isoenzymes and DNA profiles. This evidence is called biological evidence. It does not include samples of blood or urine submitted for the determination of the presence of drugs, alcohol, or poisons. See the section on Toxicology for such evidence.

DNA typing is based on the understanding that no two persons, except identical twins, have the same DNA. Conventional serological techniques may still be employed to eliminate suspects. If the suspect cannot be eliminated by conventional techniques, the samples will then be forwarded for DNA analysis. DNA analysis gives an extremely high power of discrimination. DNA profiles from semen stains in sexual assault cases are maintained in a computer database. This database is routinely searched against itself and also a separate database containing DNA profiles from persons convicted of specific felony offenses.

2. Blood Evidence Value

Blood evidence is of value in such crimes as murder, rape, assault, robbery, burglary, hit-and-run accidents, and game law violations. Blood evidence may aid an investigation by locating the crime scene, by identifying the weapon used, by proving or disproving a suspect's alibi, and by eliminating suspects. DNA profiling can be performed on any biological substance. It can also be used for the identification of bodies when samples from parents and/or children of the missing person are available.

Information Determined

- Analysis must be performed on a stain to determine that it is blood, since the appearance of blood varies greatly depending on the age, weather, and other factors.
- If the sample is blood, the species origin must then be determined. Usually, it is necessary to determine if the blood is human; in certain cases, however, it must be determined from what animal non-human blood stain originated. This can be done, but, in most cases, only to the level of the taxonomic family used in animal classification.
- If the blood is human, further classification will be achieved by isoenzyme and DNA analysis. Different individuals have different types due to the genes they received from their parents. Each type has a certain percentage of occurrence in the population. By multiplying together the frequency of occurrence of each type found, the number of people who could have been the source of that bloodstain can be determined. If one blood type is different, a person is eliminated as the possible source.
- DNA profiling of bloodstains is now regularly performed when necessary.
- Additional information can be obtained from the size, shape, and distribution of blood spatters at the scene. This information can be used to reconstruct the events that occurred during the commission of the crime. This examination sometimes needs to be performed at the crime scene. Blood spattered clothing and other items can be evaluated at the laboratory. Detailed photographs taken at the scene showing measurements of the bloodstains can greatly aid the analysis. Contact the nearest laboratory for further information.
- The sex of the person from whom the sample originated can be determined by DNA typing.
- Private laboratories are used to do DNA analysis in cases requiring paternity determination.
- Generally, DNA analysis will be limited to three or four samples per case, the victim's blood, suspect's blood, and one or two questioned samples.

3. Other Body Fluids of Significant Value

Depending on circumstances of the case, it is sometimes helpful to identify seminal stains, saliva, or urine. DNA profiling is performed on seminal stains in order to determine if the unknown sample matches the DNA profile of the standard blood sample or not. A differential extraction technique is used on seminal stains that will separate sperm cells from the cells from

the vaginal secretions allowing the generation of separate DNA profiles from the male and female portions of the stain.

There are no specific tests to identify feces; therefore, it should not be submitted for identification.

Information Determined.

- Seminal stains. A suspected seminal stain may be identified by testing for the presence of prostatic acid phosphatase, spermatozoa or P-30 protein. Semen may be further identified by DNA typing.
- Saliva stains. The presence of amylase is indicative of saliva. Saliva may be further identified by DNA typing.
- Urine. The presence of creatinine and urea is indicative of urine; however, urine cannot be typed.
- Skin tissue. It is sometimes possible to DNA type body tissues such as skin, muscle, etc.

4. Collection Of Sample And Standards

Since blood and other body fluid evidence is biological and is rapidly decomposed by bacteria and mold, it is absolutely essential that such evidence is handled properly. Please follow these instructions carefully for each type of situation in which stains of blood or other body fluids are found.

Remember safety measures for biological hazards. Always wear disposable gloves when handling material stained with blood or other body fluids. To prevent cross contamination of samples, these gloves should be changed often if they should become soiled with a biological substance. Utensils used to collect evidence should be cleaned with 10% bleach between each item collected. A mask or other protective clothing may be advisable in some cases. Please check with your agency's safety protocols for biological hazards.

5. Stains on Garments or Fabrics

- Make sure that all stains and clothing are DRY! If the stain is wet, it must be air dried away from heat and sunlight, preferably in a secure, ventilated room. The victim's items should be separated from those of the suspect during drying.

- Package each item separately to avoid contamination and in paper to avoid further decomposition. Paper bags are recommended. DO NOT USE PLASTIC since plastic does not "breathe" and holds in moisture, permitting bacterial and fungal growth.
- Avoid unnecessary handling of garments with blood or seminal stains.
- Each item should be initialed and dated in an area away from the stain.

6. Stains on Surfaces

- Items to be checked for blood should not be dusted for prints. Consult with the laboratory first.
- Whenever possible, submit the bloodstained item itself for analysis. If this is impractical, detach or cut out the part with the stain for submission. Carefully package to avoid contamination or loss. Do not put any tape directly on the stain.
- Bloodstains can be swabbed off items which cannot be submitted. Swab the blood onto a cotton-tipped applicator that has been slightly dampened with distilled water, in a manner which concentrates the sample. Swab an unstained area of the same surface in the same manner for a control. Air dry and package the stain and control swabs separately in paper.
- Concentrated stains on walls, floors, etc. (i.e., items that cannot be cut out and submitted), can be scraped off into a piece of paper which is the carefully folded and then placed in a pillbox or other suitable container. This container and the paper should be initialed and dated or otherwise identified.
- If the stain is moist, let it air dry first, or swab it onto a cotton tipped applicator then air dry.
- A control sample of the reagents used during the collection process should be submitted to the laboratory. Moisten a cotton tipped applicator with the distilled water. Allow to air dry and submitted to the laboratory labeled as "Reagent Control".
- Collect generous portions of the samples to be analyzed.

7. Standard samples for comparison

If blood, semen, or saliva groupings are requested, blood samples are required from the victim, the suspect, and from anyone else who may have contributed blood, semen, saliva, or any other body secretion to the stain in question. Blood samples should be drawn in purple-capped tubes (i.e., tubes with EDTA as the preservative). The sample should then be submitted to the lab as

soon as possible, along with the rest of the evidence. In the period between obtaining the blood sample and transporting it to the lab, keep it refrigerated, not frozen.

8. Shipment.

Deliver biological evidence to the laboratory as rapidly as possible, since certain blood group factors decompose within a few days. It is best to deliver the evidence in person; however, if this is impossible, the evidence should be sent in a styrofoam cooler containing a freezer brick, not ice, by certified mail to that laboratory. Please avoid using staples since they easily puncture disposable gloves and skin and are a possible source of infection. The outer package should be marked to the attention of the Serology Section. An envelope containing the laboratory request form should be taped to the outside of the package. Liquid blood samples should not be mailed because heat may cause deterioration. Blood stained items-should also be kept away from heat. Even an hour in a car trunk in hot weather is destructive to grouping factors. The request form should have listed the names of the victim(s) and suspect(s), and their age, race, and sex. Each item submitted should be listed along with the specific examinations desired. The package should be marked with a biohazard label.

9. Rape Evidence

Evidence normally collected in rape or sodomy cases includes a variety of samples which are relatively constant from case to case. This hair, fiber, and biological evidence is covered in separate sections in this manual, but, because of the relatively constant type of evidence required, a separate section was considered necessary to explain rape evidence.

Evidence in rape cases is likely to link the suspect to the victim or the individuals to some location. Semen, blood, hair or foreign fibers may be transferred during a sexual assault. While the specifics of each type of evidence are discussed in the sections on serology and hairs and fibers, this section will deal with these types of evidence as they relate to rape cases. The Kentucky State Police Forensic Laboratories have sexual assault evidence collection kits available free of charge. One is for the victim (female or male) and one for the suspect. This evidence is essential for effective forensic analysis.

10. The Sexual Assault Evidence

This kit for victims consists of labeled packages for properly collecting and storing evidence, a set of instructions, a Victims Medical History and Assault Information Form, and a Request for Examination form. Each item will be discussed in order so that the investigator can understand why such a sample is requested. All envelopes should be sealed with tape and properly labeled.

- Pubic hair combings. A paper towel, a comb, and an envelope are provided to collect any loose hair and fibers from the pubic region. This sample will be used to determine if any foreign hair matching that of the suspect is present or if any fibers that might be a link to the suspect or a scene might be present.
- Pulled pubic hairs. An envelope for at least 15 pubic hairs pulled from various pubic locations is provided. This sample is necessary for any hair comparison to give a determination of the range and variability of hair known to have come from the victim.
- Pulled head hairs. An envelope for at least 15 head hairs pulled from various locations from the head is also provided. This sample is necessary for any head hair comparison to give a determination of the range and variability of head hair known to have come from the victim.
- Blood sample. Blood should be drawn into an EDTA tube then placed on the filter paper cards provided. This is used as a standard.
- Buccal sample. Two cheek swabs are requested. These are sometimes used as a back-up DNA standard.
- Vaginal or Penile swabs. Four vaginal or penile swabs are requested. These are necessary to detect semen and to determine the DNA profiles present. These must be air dried and placed in the provided white envelope.
- Control swabs. If swabs were moistened with water or saline in any step, moisten the two control swabs with the same fluid, then allow them to air dry and place in the provided white envelope.
- Vaginal smear sample. One cardboard microscope slide mailer is provided for a vaginal smear preparation for the determination of the presence of sperm cells.
- Other evidence swabs. There are two envelopes containing four swabs each for use for other specimens to be taken as the case indicates. There is a check off area on the envelope for marking whether the swabs are anal swabs (for cases involving anal sodomy), oral swabs (for case involving oral sodomy), external genital swabs, or dried secretion swabs. If more than one

sample is required, please be sure the samples are separated from each other and properly marked as to type of sample.

- Underpants. Collect any underwear worn by the victim after the assault.
  It is not recommended that bedding be routinely submitted to the lab. Screening of bulky evidence by the investigator greatly expedites the analysis. Clothing items submitted should be individually packaged in paper bags.

11. Biological Reference Collection Kit

This kit for suspects consists of labeled packages for evidence, instructions, and a Request for Examination form. Each item will be discussed in order so that the investigator can understand why such a sample is requested. All envelopes should be sealed with tape and properly labeled.

- Penile swabs. This sample consists of four swabs dampened with water and then used to swab the outer surface of the penis. This sample may include vaginal secretions from the victim. These must be air dried and placed in the provided envelope.
- Pubic hair combing. A paper towel, comb, and envelope are provided to collect any loose hair and fibers in the pubic region. This sample is used to determine if any foreign hair or fibers are resent.
- Pulled pubic hairs. This sample consists of at least 15 pulled pubic hairs from various pubic locations. This sample is necessary for any hair comparisons.
- Pulled head hairs. This sample consists of at least 15 pulled head hairs from various regions of the scalp. Like all pulled hair samples, it is used as a standard necessary for hair comparisons.
- Blood sample. Blood should be drawn into an EDTA tube then placed on the filter paper cards provided. This is used as a standard.
- Buccal sample. Two cheek swabs are requested. These are sometimes used as a back-up DNA standard.
- Control swabs. If swabs were moistened with water or saline in any step, moisten the two control swabs with the same fluid, then allow them to air dry and place in the provided white envelope.
- Other evidence swabs. There is an envelope containing four swabs for use for other specimens to be collected as the case indicates. There is a check off area on the envelope for listing whether the swabs are dried secretion swabs or other swabs. If more than one sample is required, please be sure to separate each type of swab from the other and to properly mark the samples.

It is sometimes appropriate for the suspect's underwear or other clothing to be submitted. Each item of clothing should be packaged separately in a paper bag.

Please note that swabs are provided in the kits. The suspect's samples, except the blood sample, can be collected by an investigator or by the suspect himself under supervision.

12. General Collection Information

- Blood standards are necessary from any individual who may have contributed to a stain in order for complete analysis to be performed.
- Hair analysis cannot be performed without an adequate standard sample for comparison.
- Never lick the seal of the envelopes containing biological samples. Use tape and not staples to seal packages.
- Try to minimize the amount of the bulk evidence that is submitted. This particularly applies to bedding.
- Be sure all envelopes and bags are properly identified as to subject, the collector of the evidence, and the date and time of collection.
- Do not cross contaminate evidence by packaging two items in the same package.
- Be especially thorough in relating the facts of the case to the analyst. The request form should bear the race, age, and sex of all victims and suspects.
- Remember to use disposable gloves in handling items with stains or blood and other body fluids and use any other protective equipment as directed by your agency. All packaged evidence containing such materials should also be marked as "BIOHAZARD".

Topic : Firearms Evidence

Topic Objective:

After studying this topic the student should be able to:

- Define Firearms
- Explain Evidence firearms-handling and safety:
- Discuss Unloading revolvers
- Discuss Trace evidence and fingerprints
- Explain Biological Reference Collection Kit
- Discuss Gun ballistics
- Explain Gunshot residue (GSR)

Definition/Overview:

Semi-automatic: A semi-automatic, or self-loading firearm is a gun that requires only a trigger pull for each round that is fired, unlike a single-action revolver, a pump-action firearm, a bolt-action firearm, or a lever-action firearm, which require the shooter to manually chamber each successive round. For example, to fire ten rounds in a semi-automatic firearm, the trigger would need to be pulled ten times (once for each round fired), in contrast to a fully automatic firearm, which can continue to fire as long as the trigger is held or until it runs out of ammunition.

Gunshot residue: Gunshot residue, or more technically, gunshot primer residue, is expelled as tiny particles from the barrel of a firearm when it is fired. Among other materials, gunshot residue contains the heavy metals barium, lead and antimony. Modern forensic methods require the presence of these metals to identify trace evidence as gunshot residue.

Neutron Activation Analysis: Neutron Activation Analysis (NAA) is a nuclear process used for determining certain concentrations of elements in a vast amount of materials. NAA allows discrete sampling of elements as it disregards the chemical form of a sample, and focuses solely on its nucleus. The method is based on neutron activation and therefore requires a source of neutrons; a range of different sources can be used.

Atomic Absorption Spectroscopy: In analytical chemistry, atomic absorption spectroscopy is a technique for determining the concentration of a particular metal element in a sample. Atomic absorption spectroscopy can be used to analyze the concentration of over 62 different metals in a solution.

Scanning Electron Microscope: The scanning electron microscope (SEM) is a type of electron microscope that images the sample surface by scanning it with a high-energy beam of electrons in a raster scan pattern. The electrons interact with the atoms that make up the sample producing signals that contain information about the sample's surface topography, composition and other properties such as electrical conductivity. This particular type of microscope is exceedingly useful.

Key Points:

1. Firearms

Firearms evidence is usually encountered in crimes against persons such as homicide, assault and robbery; but may also be found in other crimes such as burglary, rape, and narcotics violations. While comparisons of bullets and cartridge cases to specific firearms are the most common examinations requested, other examinations are possible such as: distance determinations based on powder residue or shot spread; examination of firearms for functioning or modification; sequence of shots fired and trajectories; list of possible weapons used; serial number restoration and ownership tracing. Evidence of firing or handling a firearm may be detected through the analysis of gunshot residue collected from a persons hands or other body surfaces.

2. Evidence firearms-handling and safety:

The location and condition of firearms and related evidence at a crime scene should be diagramed and photographed before recovering and securing. Although physical evidence is important, safety must be the first consideration. Each situation should be evaluated before deciding to unload an evidence firearm. (Caution, treat a firearm at all times as if it were loaded). If the weapon is a type that can be safely transported in a loaded condition, this can be done. However, depending on the circumstances it may be unnecessary or unwise to transport a loaded firearm. It should then be unloaded, with care taken to preserve all types of possible evidence. This evidence includes fingerprints, blood, hair or fibers, cylinder "halos", and debris in the barrel and/or cylinder. The weapon should be handled on those areas least likely to retain latent fingerprints such as knurled or checkered areas.

3. Unloading revolvers:

Prior to moving the cylinder it should be marked to indicate its position as found. This can be done by two pen or scribe marks on the top of the cylinder along each side of the top strap of the frame. The position of each cartridge/case in the cylinder should be recorded in field notes as diagramed below. All cartridges/cases removed should be handled so as to preserve possible fingerprints. Each cartridge case should be packaged separately and referenced to the information in the field notes. Do not mark the actual cartridge/case.

4. Trace evidence and fingerprints

Examine the weapon for possible trace evidence such as blood, hair, fibers, tissue, or paint that may be relevant. If it doubt, do not dust for prints. Submit in person to the laboratory and request that the firearm be processed for prints.

5. Transportation to laboratory

Personal delivery is preferred. A loaded handgun may be transported in a specially constructed box which has a means of securely holding the firearm and has a metal plate blocking the muzzle. If the firearm is to be sent by mail it must be unloaded and securely packaged.

6. Gun ballistics

Gun ballistics is the study of projectiles from the time of shooting to the time of impact with the target. Gun ballistics is often broken down into the following four categories, which contain detailed information on each category:

- Internal ballistics, the study of the processes originally accelerating the projectile, for example the passage of a bullet through the barrel of a rifle;
- Transition ballistics, (sometimes called intermediate ballistics) the study of the projectile's behavior when it leaves the barrel and the pressure behind the projectile is equalized.
- External ballistics, the study of the passage of the projectile through space or the air; and
- Terminal ballistics, the study of the interaction of a projectile with its target, whether that be flesh (for a hunting bullet), steel (for an anti-tank round), or even furnace slag (for an industrial slag disruptor).

Forensic ballistics involves analysis of bullets and bullet impacts to determine the type. Separately from ballistics information, firearm and tool mark examinations involve analysing firearm, ammunition, and tool mark evidence in order to establish whether a certain firearm or tool was used in the commission of a crime.

Rifling, which first made an appearance in the 15th century, is the process of making grooves in gun barrels that imparts a spin to the projectile for increased accuracy and range. Bullets fired from rifled weapons acquire a distinct signature of grooves, scratches, and indentations which are of value for matching a fired projectile to a firearm.

The first firearms evidence identification can be traced back to England in 1835 when the unique markings on a bullet taken from a victim were matched with a bullet mold belonging to the suspect. When confronted with the damning evidence, the suspect confessed to the crime.
The first court case involving firearms evidence took place in 1902 when a specific gun was proven to be the murder weapon. The expert in the case, Oliver Wendell Holmes, had read about firearm identification, and had a gunsmith test-fire the alleged murder weapon into a wad of cotton wool. A magnifying glass was used to match the bullet from the victim with the test bullet.

Calvin Goddard, physician and ex-army officer, acquired data from all known gun manufacturers in order to develop a comprehensive database. With his partner, Charles Waite, he catalogued the results of test-firings from every type of handgun made by 12 manufacturers. Waite also invented the comparison microscope. With this instrument, two bullets could be laid adjacent to one another for comparative examination.
In 1925 Goddard wrote an article for the Army Ordnance titled "Forensic Ballistics" in which he described the use of the comparison microscope regarding firearms investigations. He is generally credited with the conception of the term "forensic ballistics," though he later admitted it to be an inadequate name for the science.
In 1929 the St. Valentine's Day Massacre led to the opening of the first independent scientific crime detection laboratory in the United States.

7. Fired cartridge cases, wads and pellets

- **Cartridge Cases:** It may be possible to determine the position of a shooter by the location of ejected cartridge casings. Make a sketch with ACCURATE measurements of the location of fired cartridge cases. Again, package each item separately and mark the packages with the pertinent information.
- **Shot Wads:** When a shotgun is fired, the wads travel along with, or behind, the shot charge for a short distance. In those cases involving close shots, wadding may be found in either the victim's bodv or in his clothing. Follow same packaging procedure as for bullets.

- **Shot Pellets:** For pellets embedded in wood, plastic, etc., handle in same manner as bullets embedded in solid objects. If it is not possible to submit the material in which pellets are embedded, pellets may be dug out, taking care not to mutilate them any more than is absolutely necessary. In removal of pellets from the body of a deceased person, x-rays can help locate the pellets. Use special care in recovering pellets so that there will not be undue damage to them. Rubber-tipped forceps should be used. After washing, wrap collected pellets in soft tissue paper and place in a labeled pill box, or small envelope.
- **Loaded Shells Or Cartridges**: Collect and submit to the laboratory all ammunition associated with a case. It can be used for test firing and distance determinations. Exactly duplicating the ammunition used may be critical. Document where such ammunition was found. If the number of cartridges are relatively few, they can be handled in the same manner as fired bullets. Large quantities should be placed in a cardboard box or wooden container. Label, seal, and deliver to the laboratory. Note: Postal regulations prohibit shipment of explosive substances through the mail. Loaded ammunition should be personally delivered or sent by UPS with the proper warning labels.
- **Distance Determinations:** In some cases, such as suicides and alleged struggles for the gun, the distance between the muzzle of the gun and the victim may become an issue and it will be desirable to examine garmets for powder residue and other indications of close firing. For protection in transporting, the clothing of the victim should be rolled (after air drying) with paper on each surface. Package separately so that the area surrounding the bullet hole does not rub against other clothing or objects. When bullets have passed through garmets into the body, a clear photograph of the bullet hole positions in the victim is desirable. Include a ruler in all photographs. Submit the firearm and the unfired ammunition associated with the incident. The use of identical ammunition is an essential part of firing distance determinations.

8. Gunshot residue (GSR)

Gunshot residue (GSR), or more technically, gunshot primer residue, is expelled as tiny particles from the barrel of a firearm when it is fired. Among other materials, gunshot residue contains the heavy metals barium, lead and antimony. Modern forensic methods require the presence of these metals to identify trace evidence as gunshot residue.

Through the 1990s the presence of two or more of these heavy elements was sufficient to conclude the chemicals were the result of a gunshot. New, more rigorous standards for gunshot residue testing are now being required by many courts. The trend is toward a standard that requires the presence of at least one Pb-Ba-Sb particle (lead-barium-antimony) exhibiting characteristic GSR morphology and supported by a sufficient number of atomically identified GSR supporting particles in the remaining particle population.

Investigators may test a suspect's hands, arms and face for particles of gunshot residue as evidence of having recently handled or fired a gun. Current testing methods are inconclusive as a suspect's clothing or body can easily become contaminated after the firing from sources such as being handled by police officers or being transported in contaminated police vehicles.

Topic : Impression Evidence

Topic Objective:

After studying this topic the student should be able to:

- Define Impression Evidence
- Explain Tool marks
- Discuss Unloading revolvers
- Discuss Developing Latent Footwear
- Explain Recovering Three-dimensional Impressions
- Discuss Preserving Impression Evidence -- Plaster Casts

Definition/Overview:

Casting: Evidence left via impressions can generally be recovered utilizing a plaster cast. Initially the impression is isolated by framing the area with a solid boundary. Following this a plaster mix can be gently poured inside the frame, it is generally considered not best practice to pour directly onto the impression. In some cases where the surface is not ideal for casting prior techniques can be utilised to gain a better cast of the impression. Sand can often be fixed in place by applying an aerosol resin or glue although hair spray is often used. Wet mud impressions can be dried using a combination of pipetting water from the surface and applying hot air, often in the form of a hair dryer.

Lifting: Footwear impressions can be lifted from surfaces with tools such as adhesive lifters, gelatin lifters or electrostatic lifting devices.

Footwear outsole impression: Footwear outsole impressions are impressions left on an object that was caused by contact with a piece of footwear. These can left on the ground or raised surface by persons treading over it, left on doors or walls by persons attempting to kick or climb over a wall or even left on other persons after being kicked or stomped on.

Latent footwear outsole impressions: Latent impressions are caused impressions that are not easily visible to naked eye. Such prints can be on many different surfaces such as floor tiles, concrete or even carpet. Latent impression may not be easily visible to the naked eye and its detection may require the use of additional specialized light sources such as portable UV lighting. Recovery typically includes photography as well as lifting with "gel" or "electrostatic" dust lifters.

Footwear Insole imprints: Footwear insole imprints are imprints left in the inside of footwear caused by contact from the persons foot. Analysis of the insole imprints can be used to link a person(s) to a piece of footwear.

Footwear trace evidence: Footwear trace evidence is trace evidence that is recovered from footwear. Types of trace evidence that could be recovered include skin, glass fragments, body hair, fibres from clothing or carpets, soil particles, dust and bodily fluids. The study of this trace evidence could be used to link a piece of footwear to a location or owner.

Key Points:

1. Impression Evidence

Impression evidence is simply where several objects are pressed or stamped against one another allowing the objects to transfer and retain characteristics from one another. Footwear, tire tracks, and tool marks may be some of the most overlooked types of physical evidence left at a crime scene. Extreme patience and common sense are needed to find and recover these impressions.

In other impressions there are two categories or types of impressions likely to be deposited at a crime scene. This impression evidence would be deposited either on top of a hard surface or into a softer surface. Two (2D) dimensional impressions illustrating length and width, are usually found indoors on surfaces like counter tops, glass, paper, cardboard, or ceramic and waxed floors. Three (3D) dimensional impressions that have 3 measurements, length, width and depth, are usually discovered outdoors in surfaces like dirt, sand, clay, mud, tar, or snow. I can not explain to you how to recover 3D impressions in snow. It is something that I have never had the opportunity to do. The only white that is encountered down here comes in a block referred to as a kilo.

2. Tool marks

Tool marks are usually found at areas of forced entry. Regardless of whether the force was by cutting, prying, pinching, or sheering. The investigator has an ability to recover some of these items of evidence.

A rubber base or silicone impression material is used to recover the tool mark impression. There are several such items on the market that will duplicate the fine material detail of the tool mark.

A large latent backing card can be used as a mixing surface. A line of the base material is laid on the card. On the card, beside the rubber base, a line of the hardening agent or catalyst can be laid. A tongue depressor can be used as a stirring instrument. The compounds can be thoroughly mixed until it is a single color. The mixed compound can then be scooped up with the tongue depressor and pressed against the tool mark. The tongue depressor can be left to harden in the mix. The tongue depressor becomes a handle to remove the casting compound with when it is dry. It also gives the investigator somewhere to label the compound with all of the information needed to identify the item with. The mixed casting compound will dry in approximately 15-30 minutes depending on the climate.

The impression cast is packaged in a small plastic container or small box for its safety and protection during transporting to the lab.

The investigator should try each of the various brand of commercial compounds to see which item works best for his/her recovery task. In a 4-hour work shop that I teach the student takes a quarter and after documenting the quarter with photography techniques he/she uses all three (3) compounds, available on the market, to recover 3 individual cast of the quarter to simulate the fine tool marking detail duplicated with the casting compounds. The student also develops and recovers latent fingerprints from light bulbs, door knobs, and other irregular shaped surfaces to see the versatility of the products and their many uses.

3. Developing Latent Footwear

Developing latent footwear (2D) impressions may be as simple as in developing latent fingerprints. The same equipment and enhancement techniques can be used in recovery of both. Mechanical processing, using a brush and powder is one method used to enhance the impression for recovery. These impressions are found indoors on tile floors, glossy finished wood floors, counter tops, chair bottoms, or cabinets. After the impression is mechanically developed it is lifted with tape or a latent lifting medium and placed on a piece of sketching paper or a shirt box top

The lifted item is then slid into plastic to protect the lift from being wadded or folded. Consideration as to comfort is needed during the development stages, since the investigator will be moving about continuously and in odd positions. The suggestion of a kneeling or knee pads would be a consideration.

Just like any other technique used in recovering evidence, the investigator should familiarize himself/herself with the process to assure skills are up to standard in performing the task.

4. Recovering Three-dimensional Impressions

The impression is recovered by casting. Casting is simply filling the 3-dimensional form. This is done by using a material that will duplicate and retain the characteristics of the impression. Fixatives such as spray paints, talc and a retaining wall are not necessary unless the impression is in an uneven, elevated or extremely soft surface.

The water is simply poured into the zip lock bag containing the compound. The bag is sealed, a fold is put at the top sealed portion of the bag for added stability and the compound is mixed by gently squeezing the outside bottom portion of the bag. This allows the water and powdered compound to mix into a liquid form. The mixing should continue until the compound has the feel and consistency of a pancake batter. Then it is ready to pour. Just a note; some of the compounds that are available will start the hardening process as soon as the water is poured in. If you are not aware of this the mix could start setting and began to harden before it is thoroughly mixed to its consistency. This will make the mix lumpy and extremely hard to remove from the bag. Once the mix is at the right consistency it can be poured right from the bag. This keeps the process from becoming a messy chore.

The mixture dries in 30 to 45 minutes depending on the climate. If to much water is put into the mixture then either more of the compound can be added or it will take a tad bit longer for the mix to dry. A light touch on the top of the cast will tell the investigator/technician when the cast is dry. If it is tacky feeling to the touch then it is still in the drying process.

To mark the cast with the appropriate information for identification, the investigator has a choice. While the cast is still tacky a sharp stick or pencil can be used to mark directly into the cast. I prefer to wait until the cast is dry and use a permanent marker to write across the top of the cast.

Once the cast is hard and smooth to the touch it is ready to remove. Take a putty knife or long chisel and gently work the entire surrounding edge of the cast loose from the surface. Once the entire edge of the cast is loosened, the cast will lift from the surface easily. If a mistake is made and the cast begins to crack as you are attempting to loosen the edge, just cautiously allow the cast to rest back to the surface. Mix another bag of the casting material and pour it on top of the existing cast. The new casting mixture will flow into the cracked area and reseal itself.

Once the cast is lifted **do not attempt to clean the surface material from the cast**. The exterior layer of the cast will be dry. It takes approximately 48 hours for the entire cast to dry throughout. If you attempt to wash and clean the cast you will possibly wash away some of the fine detail from the cast.

The cast would be packaged in a sturdy box to protect it from cracking or breaking. Do not stack any items on top of the box containing the cast impression during transportation.

5. Tire Prints

Tire marks work the same way as footprints, although tire marks are much easier to identify. Initially, a tire mark can tell an investigator the brand of tire a criminal used, but that only narrows things down slightly. Further inspection, however, can reveal more -- defects and wear on a tire tread caused by nails, gravel, patches and alignment problems can identify a unique set of tires.

6. Preserving Impression Evidence -- Plaster Casts

When approaching a crime scene with the intention of recording impression evidence, the first thing forensic investigators are taught to do is to secure and preserve the area. Because impressions are easily disturbed and often overlooked, a scene filled with too many people walking around could quickly become worthless to someone looking for footprints.

Once a perimeter is secure, investigators walk inward, looking for impressions and reconstructing the events of the crime to the best of their knowledge. They try to determine important facts such as the direction of travel or the number of suspects at the scene. Special lighting techniques can uncover hidden impressions, including the use of **oblique lighting**. By shining a light source diagonally at the ground, not vertically, the ridges of an impression create shadows which alert investigators to disturbed and uneven surfaces. Photographs of discovered impressions are also taken for visual documentation.

Although impression evidence is extremely fragile, if left undisturbed it can remain for long periods of time. As long as a crime scene area isn't harmed by weather (mainly wind, rain and snow) or disturbance from other shoes, tires or tools, there are two major techniques experts use to gather impression evidence:

- **Latent (two-dimensional) impressions** - Latent impression recovery is very similar to basic fingerprinting. This technique is used for difficult-to-preserve, two-dimensional impressions on materials such as tile floors, wood floors or chairs. Powder is applied with a brush to make the print more visible, and then tape or a lifting machine records a visual of the impression.
- **Casting -** To recover larger, three-dimensional impressions such as tire marks or footprints left in muddy conditions, experts use casting. The process works in very much the same way as an orthodontist makes a model of a patient's teeth: A substance is poured into the impression, hardened, and then removed, providing a cast of the print on the ground. Investigators use a variety of products to create casts, but dental stone, in fact, is widely considered the best casting material due to its strength, accuracy and ease of use.

As available equipment and techniques for forensic science improve, many in the field are realizing the importance of impression evidence. Although easy to overlook and difficult to locate, footprints and other impression evidence left at the scene of a crime are typically even more prevalent than fingerprints, and they can provide important clues to mysterious cases.

- In Section 4 of this course you will cover these topics:

Drug And Alcohol Evidence

Document Evidence

Vehicle Investigations

Topic : Drug And Alcohol Evidence

Topic Objective:

After studying this topic the student should be able to:

- Define Drug Evidence
- Explain Major Physiological Categories of Illicit Drugs
- Discuss DEA Schedule of Controlled Substances
- Discuss Developing Latent Footwear
- Explain Field Testing
- Discuss Evidence of DUI

Definition/Overview:

DUI: Driving under the influence of alcohol ('driving while intoxicated, drunk driving, drinking and driving, drink-driving), is the act of operating a motor vehicle (and even a bicycle, boat or horse in some jurisdictions) after having consumed alcohol, or other drugs, to the degree that mental and motor skills are impaired. It is a crime in most countries around the world.

Blood alcohol content: Blood alcohol content (BAC) or blood alcohol concentration is the concentration of alcohol in blood. It is usually measured as mass per volume. For example, a BAC of 0.02% means 0.2 (permille) or 0.02 grams of alcohol per 100 grams of individual's blood, or 0.2 grams of alcohol per 1000 grams of blood. Blood alcohol concentration is measured in many different units and in many different fashions, but they are all relatively synonymous for each other.

Key Points:

1. Drug Evidence

Consists of those materials defined as controlled substances and the chemical and equipment used for the illegal manufacture of controlled substances Controlled substances are also classified according to their origin: 1) naturally occurring, 2) synthetic, and 3) semisynthetic.

2. Major Physiological Categories of Illicit Drugs

- Narcotics (heroin, morphine)
- Psychoactive (LSD, MDMA)
- Sedatives (secobarbital, methaqualone)

- Tranquilizers (oxazepam, diazepam)
- Central nervous system stimulants (cocaine, methamphetamine)

3. DEA Schedule of Controlled Substances

- Schedule Ia high potential for abuse, and no currently accepted medical use. Examples are heroin, LSD and methaqualone
- Schedule IIhave a high potential for abuse but have a currently accepted medical use in the U.S. Examples are morphine, PCP, cocaine, and methamphetamine
- Schedule IIIhave a potential for abuse below that of the schedule II drugs. These drugs have a currently accepted medical use. Examples are anabolic steroids, codeine, and hydrocodone
- Schedule IVhave a lower potential for abuse than schedule III and currently have an accepted medical use. Examples are Darvon, Talwin, Valium, and Xanax
- Schedule Vhave a low potential for abuse and have a currently accepted medical use. Example is codeine in cough syrup

4. Collection of Drug Evidence

- Usually involves the search of a residence, a vehicle, or a person
- Use caution due to the possibility of hypodermic needles
- Drug evidence should be packaged in containers specifically designed for this purpose

5. Field Testing

- There are a number of drug field testing kits available for presumptive testing of suspected drug evidence
- Presumptive means that a positive reaction indicates but does not prove

6. Field Test Kit Considerations

- Because many of the chemicals used in these kits are corrosive it is essential that the officer wear protective gloves and eyewear
- The kit directions must be followed explicitly

- Use a small amount of the substance for testing
- The test is only presumptive so the results must be confirmed in the crime lab

7. Clandestine Laboratories

- Drugs most often found in these type labs are methamphetamine, LSD, and PCP
- The chemicals used to produce these illicit drugs are flammable, toxic, corrosive, explosive, or a combination of these factors
- It is imperative that only a properly trained team process a clandestine lab

8. Alcohol Evidence

Each state has a standard level for blood alcohol above which the individual is presumed to be driving under the influence (DUI)

9. Blood Alcohol Concentration

- 0.00-0.04: sobriety range
- 0.01-0.08: impairment
- 0.05-0.25: intoxication
- 0.18-0.50: comatose
- 0.30-0.60: death
- Tolerance levels are categorized as high, normal, or low

10. Evidence of DUI

- The drivers drinking behavior
- The field sobriety tests
- Field breath alcohol screening tests
- Laboratory analysis of blood and urine specimens
- Expert interpretation of blood alcohol level evidential tests

11. Collection of Alcohol Specimens

- **Breath specimens** require that the subject has not had anything to eat or drink for at least 15 minutes prior to the test; 2) the test is administered on a properly maintained evaluating instrument
- **Blood specimens**the blood should be drawn from the antecubital vein of the arm. The specimen should be transported as soon as feasible to the crime lab. In postmortem patients the blood should be drawn from the heart or a major blood vessel and refrigerated.

Topic : Document Evidence

Topic Objective:

After studying this topic the student should be able to:

- Define the term questioned document
- List some important guidelines for the collection of known writings for comparison to a questioned document
- Know what common individual characteristics are associated with handwriting

Definition/Overview:

Charred Document: Any document that has become darkened and brittle through exposure to fire or excessive heat.

Erasure: The removal of writing, typewriting, or printing from a document. It is normally accomplished by either chemical means or an abrasive instrument.

Exemplar: An authentic sample used for comparison purposes, such as handwriting.

Indented Writings: Impressions left on papers positioned under a piece of paper that has been written on.

Infrared Luminescence: A property exhibited by some dyes that emit infrared light when exposed to blue-green light.

Natural Variations: Normal deviations found between repeated specimens of an individuals handwriting or any printing device.

Obliteration: The blotting out or smearing over of writing or printing to make the original unreadable.

Questioned Document: Any document about which some issue has been raised or that is the subject of an investigation.

Voiceprint: A pictorial representation of the frequency, duration, and amplitude of human voice sounds.

Key Points:

1. Questioned document examination

Questioned document examination (QDE) is the forensic science discipline pertaining to documents that are (or may be) in dispute in a court of law. The primary purpose of questioned/forensic document examination is to answer questions about a disputed document using a variety of scientific processes and methods. Many examinations involve a comparison of the questioned document, or components of the document, to a set of known standards. The most common type of examination involves handwriting wherein the examiner tries to address concerns about potential authorship.

A document examiner is often asked to determine if a questioned item originated from the same source as the known item(s), then present their opinion on the matter in court as an expert witness. Other common tasks include determining what has happened to a document, determining when a document was produced, or deciphering information on the document that has been obscured, obliterated or erased.
The discipline is known by many names including forensic document examination, document examination, diplomatics, handwriting examination, or sometimes handwriting analysis, although the latter term is not often used as it may be confused with graphology. Likewise a forensic document examiner is not to be confused with a graphologist, and vice versa.

Many document examiners receive extensive training in all of the different aspects of the discipline. As a result they are competent to address a wide variety of questions about document evidence. However, this "broad specialization" approach has not been universally adopted.
In some locales, a clear distinction is made between the terms forensic document examiner and a forensic handwriting expert/examiner. In such cases, the former term refers to examiners who focus on non-handwriting examination types while the latter refers to those trained exclusively to do handwriting examinations. Even in places where the more general meaning is common, such as North American or Australia, there are many individuals who have specialized training only in certain relatively limited areas. As the terminology varies from jurisdiction to jurisdiction, it is important to clarify the meaning of the title used by any given individual professing to be a "forensic document examiner".

Questioned document examination is a branch of forensics which focuses on the analysis of documents which are disputed. A questioned document examiner will look at the document in question and use a variety of techniques to analyze it, and he or she may even be called as a witness in a case, depending on the outcome of the examination. Many forensic laboratories keep a forensic document examiner on staff, and some people in this field also work independently, offering their services to anyone who wishes to pay their fees.

The training required for a career in questioned document examination varies. At a minimum, a candidate must have extremely good perception skills and eyesight, with colorblindness tending

to exclude someone from the field. He or she may also be encouraged to take tests with basic samples to see whether or not he or she can notice subtle differences between materials. Someone who is good at spot the differences puzzles in the Sunday paper might be a good candidate. Questioned document examiners can either apprentice with people in the field, or attend university programs which offer training in a laboratory setting.

When a questioned document examination is ordered, the first goal is to determine whether or not the document is genuine. Once the veracity of the document can be proved or disproved, the questioned document examination focuses on identifying or eliminating potential authors of the document. The examiner will then produce a complete report, discussing the findings and their ramifications, and he or she may be asked to testify in court about the document.

All sorts of documents can be included in questioned document examination, from checks which are suspected to be forged to questionable wills. A questioned document examiner generally has extensive knowledge of printing techniques, and he or she may know a lot about inks, pencils, rubber stamps, seals, and other tools which could be used to verify the identify of a document and its author. Handwriting analysis is another important skill in this field, as questioned document examination may include a comparison of handwriting samples to find out whether or not someone truly penned a note.

Stock certificates, notes, letters, birth certificates, wills, and an assortment of other materials can be subjected to questioned document examination. It is important to remember that the skills of questioned document examiners vary quite widely; if you require one, you may want to seek a recommendation from a professional forensic association, especially if you think that the document may become critical in a court case.

2. Scope of document examination

A forensic document examiner is intimately linked to the legal system as a forensic scientist. Forensic science is the application of science to address issues under consideration in the legal system.

Common criminal charges involved in a document examination case fall into the "white-collar crime" category. These include identity theft, forgery, counterfeiting, fraud, or uttering a forged document. Questioned documents are often important in other contexts simply because documents are used in so many different contexts and for so many different purposes. For example, a person may commit murder and forge a suicide note. This is an example wherein a document is produced directly as a fundamental part of a crime. More often a questioned document is simply the by-product of normal day-to-day business or personal activities.

A forensic document examiner deals with items that form part of a case which may or may not come before a court of law. The many types of possible examinations include the following:

- Handwriting (cursive / printing) and Signatures
- Typewriters, Photocopiers, Laser printers, Ink Jet Printers, Fax machines
- Chequewriters, Rubber stamps, Price markers, Label makers
- Printing Processes
- Ink, Pencil, Paper
- Alterations, additions, erasures, obliterations
- Indentations
- Sequence of Strokes
- Physical Matching

ASTM Standard E444-98 (Standard Description of Scope of Work Relating to Forensic Document Examination) indicates there are four components to the work of a forensic document examiner. It states that an examiner "makes scientific examinations, comparisons, and analyses of documents in order to:

- establish genuineness or nongenuineness, or to expose forgery, or to reveal alterations, additions or deletions,
- identify or eliminate persons as the source of handwriting,
- identify or eliminate the source of typewriting or other impression, marks, or relative evidence, and
- write reports or give testimony, when needed, to aid the users of the examiner's services in understanding the examiner's findings."

Some forensic document examiners limit their work to the examination and comparison of handwriting but most inspect and examine the whole document in accordance with this ASTM standard.

3. Documents Examined

Documents feature prominently in all manner of business and personal affairs. Almost any type of document may become disputed in an investigation or litigation. For example, a questioned document may be a sheet of paper bearing handwriting or mechanically-produced text such as a ransom note, a forged cheque or a business contract. Or it may be some material not normally thought of as a 'document'. Forensic document examiners define the word "document" in a very broad sense as being any material bearing marks, signs or symbols intended to convey a message or meaning to someone. This encompasses traditional paper documents but also includes things like graffiti on a wall, stamp impressions on meat products, or covert markings hidden in a written letter, among other things.

4. Candidacy

A person who desires to enter a career of forensic document examination must possess certain traits and abilities. First and foremost, excellent eyesight is required in order to see fine details that are otherwise inconspicuous. The aspirant must also pass a form blindness test in order to ensure that the aspirant does not suffer from the condition of being unable to tell apart two similarly-appearing, yet different, items. Similarly successful completion of a test for color perception is normal. A bachelor of science degree is also typically required, as it gives the aspirant a scientific background with which to approach the work in an objective manner, as well as bestowing necessary biological, physical, and chemical knowledge sometimes called upon. ASTM Standard E2388-05 (Standard Guide for Minimum Training Requirements for Forensic Document Examiners) has "an earned baccalaureate degree or equivalent" as one of several requirements. Additional desirable skills would include knowledge of paper, ink, printing processes, or handwriting.

5. Training

There are three possible methods of instruction for an aspiring document examiner:

- Self-education is the way in which the pioneers of the field began, as there was no other method of instruction.
- Apprenticeship has become the widespread manner in which many examiners are now taught. In fact, This Is The Method that is recommended by ASTM in Standard E2388-05. To conform with the ASTM standard such training "shall be the equivalent of a minimum of 24 months full-time training under the supervision of a principal trainer" and "the training program shall be successfully completed in a period not to exceed four years". The training program must also include an extensive list of specific syllabus topics outlined in ASTM Standard E2388-05.
- College and/or university programs are very limited at this time. This is due, in part, to the relatively limited demand for forensic document examiners. It also relates to the need for extensive practical experience; particularly with respect to handwriting examination. It is difficult to include this degree of practical experience in a normal academic program. Nonetheless, a few academic programs directly related to forensic document examination are:
  - Universidad Autonoma de Barcelona (Catalua,Espaa)
  - Oklahoma State University Grad Program in Forensic Science
  - L'Universit de Lausanne Institut de Police Scientifique (Lausanne, Switzerland)
  - University of Lancashire, MSc in Document Analysis (Lancashire, UK)
  - Institut fur Schrift- und Urkundenuntersuchung (Mannheim, Germany

  A more extensive listing relating to forensic training may be viewed at the website for the Canadian Society of Forensic Science

  There are some distance learning courses available as well. These are taught through a virtual reality classroom and may include an apprenticeship and/or a correspondence course.

  A forensic document examination trainee must learn how to present evidence before the court in clear, forceful testimony. Fledgling examiners in the later stages of training can get a glimpse into the legal process as well as a better sense of this aspect of their work through participation in a mock trial or by attending actual court hearings to observe the testimony of qualified examiners.

6. Examination

6.1 Handwriting

The examination of handwriting to assess potential authorship proceeds from the principle of identification which can be expressed as: "Two writings are the product of one person if the similarities, when taken in combination, are sufficiently individual and there are no fundamental unexplainable differences."

Generally, there are three stages in the process of examination. In brief, they are:

- Analysis: The questioned and the known items are analyzed and broken down to directly perceptible characteristics.
- Comparison: The characteristics of the questioned item are then compared against the known standard.
- Evaluation: Similarities and/or differences in the compared properties are evaluated and this determines which ones are valuable for a conclusion. This depends on the uniqueness and frequency of occurrence in the items.
- Optionally, the procedure may involve a fourth step consisting of validation or peer review.
- ASTM International has published a standard guide for the examination of handwriting entitled "E2290-03: Examination of Handwritten Items".

Topic : Vehicle Investigations

Topic Objective:

After studying this topic the student should be able to:

- Define Vehicle Investigations
- Explain General Automobile Search
- Discuss Traffic Crash Investigation
- Discuss Photographs at the Accident Scene
- Explain Field Testing

- Discuss Vehicle Lights

Definition/Overview:

Hit-and-run: Hit-and-run is the crime of colliding with a person, their personal property (including their motor vehicle), or a fixture, and failing to stop and identify oneself afterwards.

Key Points:

1. Vehicle Investigations

During a criminal investigation the crime scene investigator or evidence recovery technician may be assigned the task of processing a vehicle or vessel. That vehicle or vessel may not be a primary scene in the investigation however it will deserve the same attention.

As with any investigation the primary function of the crime scene investigator or evidence recovery technician involves the documentation and the collection of physical evidence. The evidence found in the vehicle may hold an important key to solving that particular investigation. The types of evidence that may be found in the vehicle will be dependent on the criminal act that is being committed.

As an example, a burglary to the vehicle may yield fingerprints to identify a person who gained entry into the vehicle. Where as a vehicle that was used in a homicide involving the shooting, stabbing, or transporting of a victim may yield an assortment of physical evidence.

It is important that the crime scene investigator or evidence recovery technician in the field establish an organized approach to processing the vehicle. As with any scene in an investigation the first task is to gather the information need to identify the vehicle and its contents. This starts

with an initial examination of the vehicle. Careful examination of the vehicle will give the investigator or technician an idea of what types of evidence might be present.

After the examination the investigator will then need to thoroughly document the vehicle as it is seen. This will be done by a series of photographs depicting the vehicle. The photographs should start with the exterior and be taken from each side, each corner, front, rear, tag, vin, any decals, any damage or custom accessories. The interior of the vehicle should be photographed from the front drivers area, from each side with the doors open, the ignition area, the dash, the glove box, the instrument panel, the rear seat area, and the trunk area.

With the photographs completed an organized search will then need to be done. The purpose of the organized search is to find items of evidence not observed during the initial examination. The vehicle can be divided into sections (similar to an organized zone search pattern) for the search. It should make no difference what area of the vehicle the investigator chooses to start with, only that the investigator get into a habit to always consistently start from the same area each time he-she processes a vehicle.

The investigator or technician needs to practice on the side of caution when searching under seats and hard to see areas. He-she does not want to stick there hands under a seat and risk being punctured by a contaminated needle or other item. A small mirror and flash light will allow the investigator to check these areas without the risk of exposures or injuries.

If other items of evidence are located during the search, the investigator or technician can then place a series of evidence marking stands alongside the items of evidence to take a series of photographs depicting the location and relationship of any evidence found. If the search for pathways and directions of projectiles becomes the task at hand, the investigator can insert string or dowel rods to track the flight paths. A note to remember is that two (2) points of reference are needed to determine the flight paths of a projectile. The primary purpose of using the string or dowel rods is to illustrate and document the directions of the projectiles for flight paths to assist in locating the projectile.

The next step in the process would be the collection of evidence. The investigator or technician will usually want to start with the most fragile evidence. Evidence becomes fragile by the

passing of time, exposure to the elements or environment, any movement, and of course improper handling. The most fragile of the evidence types would be any trace evidence aboard. With the new developments in DNA an area to consider would be swabbing samples of the steering wheel, inside door handle and of course the driver's seat belt buckle.
Last but not least would come the mechanical processing for any latent fingerprints. The investigator or technician should search the common sense areas working a border of approximately 6 inches wide around the sides, hood, trunk, roof support post, and windows of the exterior of the vehicle. Common sense would also alert to the areas of the fenders surrounding the wheel weld if a tire is missing. For the interior, the door handles rear view mirror, seat belt buckles, windows, and any other nonporous item will need to be checked. An organized system in place allows a tedious task to be more simple and mistake free.

2. General Automobile Search

- Normally search pursuant to a search warrant when a vehicle is involved with a crime
- The vehicle should be photographed and sketched
- The vehicle should be examined closely for trace evidence

3. Traffic Crash Investigation

What use to be commonly referred to as a traffic accident investigation is giving way to the more modern terminology of vehicle crash investigation. Most departments have assigned traffic investigative units or traffic homicide investigators. These specially trained units are given the duties of investigating serious or fatal car crashes. Their specialized training deals with accessing the structural damage to a vehicle or other items, taking measurements and drag factors to determine speed, movement, and points of collision for traffic incident reconstruction.

4. Crime Scene Involvement

Crime scene investigators or evidence recovery technicians are support units for department entities and other agencies. We are responsible for assisting all investigative sources when requested. Our specialization deals with physical evidence used in determining some sort of

identification. Unlike the crash investigators, most crime scene investigators or evidence recovery technicians are not specifically trained in crime scene reconstruction. Our specific qualifications and training in the reconstruction process are the assured proper documentation of the scene. This allows the trained expert from the various forensic disciplines to reconstruct or duplicate the events and conditions that occurred at the crime scene. Unlike with the crash investigator, the information obtained from the evidence at a crime scene for specific reconstruction are points of impact, points of contact and points of origin.

Crash investigators are accustomed to having the vehicles present at the scene during their investigations. The crime scene investigator has been called upon to use his expertise due to the trend of hit-n-run incidents, where the vehicle is no longer present on the scene. The crime scene investigator is being asked to assist by searching, documenting and recovering the evidence that will give the information to identify and determine:

- a driver of a vehicle
- a vehicle to the scene of the incident
- the victim to a vehicle

These are the common task that we perform at any other type of scene. Most of the crash investigators that we have worked with are appreciative of the assistance and are determined for a successful investigation.

In the few cases that we have been called upon to assist there are some things that the investigator will want to check. Determine that you have a legal right for the work that you are about to begin. A warrant should be obtained by the crash investigator prior to any examination.

5. The Examination

The vehicle should be taken to a location equipped with a hydraulic lift. The most important evidence is usually going to be found on the undercarriage of the vehicle. To properly examine the undercarriage the vehicle will need to be raised above the surface.

The groups of evidence that will be searched for, on the undercarriage of the vehicle, are transfer or trace evidence. Remember the Locard exchange principle, contact between two boundaries will result in the transferring of items. These microscopic items (hair, clothing fiber, tissue, blood) will require an intensive examination of the undercarriage to be located, documented and collected. Make sure that you involve the crash investigator. Take the time to explain the

examination process and any findings. Make sure to clarify any follow ups that the crash investigator will need to complete concerning standards or exemplars that might be needed by the lab.

6. Photographs at the Accident Scene

- Overview of the scene
- The point of impact
- The position where each vehicle came to rest
- Damage to each vehicle
- The view each driver had while approaching the accident site
- Point of view of each witness to the accident

7. Accident Scene Sketches

- Accuracy of the measurements
- Predesigned scene sketch forms
- Types of sketches - layout (overview), a detailed sketch of the entire scene, and a blow up sketch of the point of impact
- Finished sketches - CADD program

8. Hit-and-run:Vehicle Versus Pedestrian

- Sketches of the scene
- Photographs of the scene
- Photographs of each evidence item
- Photographs of the point of impact
- Search of suspect vehicle
- Look for fabric impressions in the vehicles paint
- Smears of blood or body tissues on the vehicle
- Fibers and other trace evidence embedded in the paint
- Paint standards

- Victims garments and shoes
- Transfer paint samples
- Bloodstained garments
- Glass fragments
- Injuries to the victims

9. Hit-and-run: Vehicle Versus Vehicle

- Entails a search for vehicle components at the scene and paint transfers from the responsible vehicle to the victim vehicle
- Glass fragments
- Paint transfers and standards
- Headlights and lightbulbs

10. Vehicle Lights

- Determine if the light switch position is on or off; do not under any circumstance turn the switch on if in the off position as this could destroy the lightbulb filament
- Collection and packaging
- Intact lights and bulbs
- Broken lights and bulbs
- Headlight filaments

- In Section 5 of this course you will cover these topics:
- Sexual Assault Investigations
- Homicide Investigations
- Crime Scene Reconstruction

Topic : Sexual Assault Investigations

Topic Objective:

After studying this topic the student should be able to:

- Define Vehicle Investigations
- Explain Careful collection in sexual assault cases
- Discuss Standards in sexual assault cases
- Discuss Collecting Physical Evidence in sexual assault cases

Definition/Overview:

Child sexual abuse: Child sexual abuse refers to sexual abuse of a child by an adult or some other person significantly older or in a position of power or control over the child, where the child is used for sexual stimulation of another person. In addition to overt sexual interactions, child sexual abuse also includes invitations or requests by an adult regarding sexual forms of kissing, hugging and any other sexual activities. Effects of child sexual abuse include depression, post-traumatic stress disorder, anxiety, propensity to re-victimization in adulthood, and physical injury to the child, among other problems. Sexual abuse perpetrated by a family member is a form of incest, and is associated with more serious and long-term psychological trauma, especially in the case of parental incest.

Sexual assault : is any assault of a sexual nature on another person. Although sexual assaults most frequently are by a man on a woman, it may be by a man on a man, woman on a man or woman on a woman. While sexual assaults are associated with the crime of rape, it may cover assaults which would not be considered rape.

Key Points:

1. Collecting Physical Evidence

Many of the items used for evidence collection are available in sexual assault kits. However, these commercial kits vary widely, and basic minimums should be considered.

Vaginal, oral and/or anal swabs should be taken from the victim using sterile cotton swabs. These swabs should then be air-dried, appropriately labeled, initialed by the examiner and packaged separately. In most assaults involving vaginal penetration, two to four vaginal swabs and two cervical swabs areadequate for analysis. In cases of oral or anal sodomy, oral or anal swabs should be obtained from the victim. Two clean swabs taken from the same package as the unstained control swabs should be submitted to show that any useful serology results obtained during analysis were due to body fluids and not any contaminant initially on the swabs.
Smear slides, unfixed and unstained, are sometimes useful for demonstratingthe presence of sperm cells (spermatozoa). Vaginal, oral and/or anal smear slides should be obtained from the victim using the same swabs mentioned above. The smear slides should be appropriately labeled and should indicate which individual swab was used to create which microscope smear slide. Examining physicians in some jurisdictions prepare and microscopically examine smear slides to determine the presence of motile sperm cells indicative of recent sexual activity. In such cases, examining physicians may be required to testify in court proceedings regarding their observations. In any event, stained and fixed smear slides are useless for further serological analysis and should not be submitted to crime laboratories.
Pubic combings should be taken from the victim to identify any foreign hairs or fibers that may have been transferred during the assault. The physician should comb the pubic area and submit the comb and any resultant debris in an appropriately marked, sealed envelope. Head hair combings should be obtained from the victim in cases where other evidence is insufficient to show interpersonal contact. Pubic and head hair combings should also be obtained from the suspect if appropriate to the investigation.

Any obvious debris (soil, fibers, hair, grass, etc.) observed during the examination of the victim should be collected and submitted in a separate envelope describing the location of the debris. The examining physician should also scrape all residue from under the fingernails of each hand

of the victim and place the residue in a specimen envelope or clip the fingernails and place the clippings in separately labeled envelopes.

Using a sterile pad that has been moistened lightly with distilled water,the physician should swab the vulva and the inner portion of the victim's thighs adjacent to the vaginal area. The genital swabbing pad should then be air-dried and submitted for laboratory analysis in an appropriately labeled specimen envelope.

The physician should swab any dried secretions observed during the examination of the victim, i.e., saliva around bite marks, using a sterile pad that has been moistened lightly with distilled water. The pad should also be air-dried and submitted for analysis. In cases where dried blood or encrusted semen is observed, the material should be scraped from the body into a specimen envelope and submitted for analysis. Encrusted matter should never be re-hydrated, since it dilutes the sample. The location of each sample should be noted on a body diagram. Pubic or head hair containing encrusted semen should be carefully clipped and placed in a labeled specimen envelope.

In the event of oral ejaculation, gagging, swallowing or regurgitation during the assault may force air carrying semen through the nasal passages. The victim should blow her nose, very hard, several times into the center of filter paper. The resultant nasal mucous sample should be allowed to air dry and then submitted for analysis.

2. Standards

Head hair and pubic hair standard samples should be obtained from the victim and any suspects developed from the sexual assault investigation. The hair samples should be pulled with the bulb intact, not clipped. Head hair samples should be taken from four separate areas of the scalp. Twenty-five full-length hairs are generally considered adequate to represent an individual's hair characteristics.

Liquid blood samples should also be obtained from the victim, any consensual sexual partners from at least 72 hours prior to the assault, and any developed suspects. Known blood and saliva samples from a suspect in a sexual assault case must usually be obtained through a court order issued by a judge or local magistrate. Blood samples from each individual should be collected in

both red-topped and purple-topped blood collection tubes. Red-topped tubes are used for traditional serological analysis, such as ABO grouping, secretor status and enzyme electrophoresis. A red-topped tube indicates that the collected blood is exposed to no preservatives or blood anticoagulants. Purple-topped tubes are used for DNA profiling only. These tubes contain a chemical chelator(EDTA) that inhibits the action of enzymes that would normally act to breakdown the DNA molecules in the blood samples. In the event that toxicology examinations will be requested, an additional blood sample taken in a grey-toppedtube (containing sodium fluoride) and a 10 cc. urine sample should also be collected. All of the collected blood and urine should be refrigerated, not frozen, and submitted for analysis as soon as possible.

Dried saliva samples should also be obtained from the victim, from consensual sexual partners from at least 72 hours prior to the assault, and from any developed suspects. The donor should expectorate on filter paper to produce a stain approximately 1 1/2 inches in diameter. Saliva should be clean and undiluted. Prior to giving the sample, the donor must have abstained from eating (food, gum, chewing tobacco), drinking and smoking for about 30 minutes. The stain should be circled in pencil before the drying is complete. When the samples have air-dried completely, they should be placed in a specimen envelope that has been dated and initialed.

3. Miscellaneous Samples

The officer should make sure that the clothing worn by the victim during the sexual assault is collected. The victim should always disrobe over examination paper. The victim's panties, pantyhose, jeans, shirt, shoes, socks, dress, or nightgown should be separated and individually packaged as appropriate. Any physical evidence from the crime scene that may bear suspected semen stains, such as bed sheets, towels, wash cloths, paper towels, toilet paper or tissue paper, should also be collected. The examination paper should also be submitted for analysis in the event that hair or fiber mixtures from the assault fell from the victim while disrobing.

The collected items should be clearly described for the laboratory, including whether the items came in contact with the victim and/or suspect before, during, and/or after the assault. Stained areas believed to exhibit evidence of the assault should be described or highlighted. For example, only a small area on a bedsheet may be relevant to the investigation. Therefore, forensic

examination of the entire bedsheet for semen may not only be unnecessary and wasteful of forensic services but may also dilute the effectiveness ofthe examination.

4. Preservation And Packaging

Bacteria begin to degrade biological fluids immediately after deposition. They especially thrive on the rich nutrients present in semen. If unchecked,contaminant bacteria can completely destroy DNA and other genetic markers of value. To counteract this phenomenon in all of the above instances in which moist body fluids are collected, it is imperative that the samples be completely dried. After drying, the specimen(s) should be placed into breathable paper bags or envelopes and frozen or refrigerated until submittedto the laboratory for analysis. All collected items of evidence should be properly catalogued with preserved chain-of-custody records for court presentation purposes. All items should be dated and initialed by the collector. In cases where samples were taken by health professionals, they should identify, date and initial the items and hand the evidence to the investigating officer. Whenever possible, collection of known blood, urine and saliva samples should be performed under the supervision of the investigating police officer.

5. First response

Perpetrators of sexual assault, like any other predator, generally target a victim easy to access and overpower. Targets are often women, children and thoseincapacitated mentally or physically. Victims in circumstances where they are vulnerable to attack, such as prostitutes, are common targets. Therefore, when responding to a sexual assault scene, the way the offender gained access to the victim is important in determining the scope of the crime scene. There also may be primary, secondary or multiple scenes.

The first thing needed to preserve physical evidence is to secure the scene, ensuring the safety of the victim and witnesses. A log of all persons at the scene is important, including emergency personnel. They may be required to submit samples of hair, DNA, etc., at a later date to rule them in or out as a source of the evidence at the scene.

In some cases emergency personnel may have arrived on the scene before the police. They may have noticed a vehicle or person of interest upon arrival. They may also have experienced transient evidence, such as odors, at the scene. Witnesses should be separated and asked for the basic facts as well as any vehicle descriptions or descriptions of people leaving the scene. Medical personnel can be asked to help preserve evidence in several ways. First, if there are pools of liquid, such as blood on the ground or floor, the stretcher can be carried around the material rather than wheeled. Wheel tracks through liquid or soil can contaminate the material. Any clothing removed from the victim can be placed in a clean paper evidence bag and sealed.

If the victim has sustained bruises, bite marks, stab wounds, gunshot wounds or tool marks from other weapons, it is important medical personnel avoid inserting chest tubes, needles or IVs through these marks. Of course this may not be possible but preservation of the injury patterns can be important.

Normally, no evidence is removed from a crime scene before being photographed and added to the crime scene sketch. The victim is the only part of the crime scene that is removed from the scene prior to processing, and much of the physical evidence may be on the victim's body. If the victim is being transported to a hospital, efforts can be made to preserve evidence by bagging the hands and hair. Of course if this causes the victim further trauma it should be avoided.

To maintain the chain of custody where evidence on the victim is concerned, whenever possible an officer should accompany the victim to the hospital. If clothing or other items are removed from the victim, the officer can properly bag and label them. If it is not possible to accompany the victim in an ambulance, then simply giving the ambulance personnel some evidence bags (paper for clothing) and asking them to place the victim's clothing in them may help preserve DNA, hair, fiber, glass, gunshot residue and all sorts of other trace evidence.

The hospital can be advised en route that a sexual assault nurse examiner (S.A.N.E.) is required. These nurses (sometimes doctors) are specially trained in examining sexual assault victims. They also are trained to recognize and preserve unique evidence of sexual assault. These nurses are most often emergency nurses who work as sexual assault examiners on an on-call basis. The nurses work with the police, medical staff and victim services to preserve evidence with out further traumatizing a victim. In remote communities there may be no immediate access to

specially trained personnel. It is advisable to know the location of the nearest hospital equipped to conduct sexual assault exams and provide counseling if needed.
Once the victim and witnesses have been removed from the scene, and the evaluation of the scope of the scene is done, collection of evidence can proceeds

6. Careful collection

There is no particular order in which evidence is collected. The investigator in charge can determine the order based on where the scene starts and ends. Evidence in danger of contamination or degradation is usually collected first.

Always wear gloves and change them each time a new piece of evidence is collected. Avoid smoking, spitting, eating, sneezing, coughing, and using the washroom at the scene. DNA is contained in body fluids, even in small amounts, and these activities can contaminate a scene. Wear a mask if biological material seems to be present. Be careful not to place collection kits on furniture inside the scene. This can cause contamination of the evidence collection materials.

Do not allow civilians or family members access to the scene. This may sound obvious, but in the Jon Benet Ramsey case, the family and several friends were allowed to stay in the home for hours. In an attempt to alleviate their restlessness, the lone officer at the scene allowed them to search the house.
The girl's body was found by her father in the basement, which had not been previously searched. In this case potential suspects were allowed to roam freely about the scene. Even if they were not the perpetrators of the crime, they surely contaminated and destroyed evidence.

7. Forensic evidence: What to look for

Almost anything imaginable can be evidence at the scene of a sexual assault. If something looks out of place, collect it even if its connection to the crime or identification is unknown. The following are some of the more common types of evidence.

7.1 Body fluids

Body fluids such as semen, saliva, urine, sweat or mucus contain DNA. As well, these types of biological samples can be used for toxicological and serological testing. These tests can reveal the use of particular drugs (toxicology) or things such as blood type (serology). Common sources of this type of evidence are:

- Sheets and other bedding, as well as fabric off furniture and vehicle upholstery
- Window panes and sills outside the residence

  There have been cases where perpetrators watched their victims from outside and left body fluids on windows, etc. Cigarettes may be found in locations where the perpetrator hid outside. These are also a source of DNA. Both saliva and skin cells can be found on cigarettes.
- Garbage cans may contain tissues and used condoms
- Anything that may have been used as a weapon may have skin cells or blood on it
- Broken windows and other glass fragments may have blood from the perpetrator on it.

  Perpetrators can cut themselves while breaking windows or other glass items.
- Partially eaten food or gum
- Swabs from the victim's mouth, anus or vagina
- Clothing from the victim or suspect

7.2 Drugs

Standard toxicological screening of the victim's or suspect's blood, urine or saliva can reveal whether drugs (prescription or street) or alcohol were present. The lab can be asked to test for the presence of chemicals associated with benzodiazepines such as Rohypnol.

- Date rape drugs

  Rohypnol is one of the more prevalent drugs used in the United States as a date rape drug. Originally it was produced as an anti-depressant and a sleeping pill by Hoffman La Roche Pharmaceuticals for use in Europe but has never been approved for use in the states. It was introduced to the country via Mexico in the 1990s.

The drug Rohypnol was originally produced as a white tablet embossed with the word "Roche." It eventually became known as a "date rape" drug, which was commonly administered to unsuspecting victims by mixing it into an alcoholic drink. The manufacturer changed the color, and it is now a green pill implanted with a blue dye, which is easily detected if mixed into a drink. In the United States, the older white pills are most common.

Rohypnol can be smoked, injected or ingested. The effects usually last between 8 and 12 hours. The important thing in terms of forensic evidence is that Rohypnol has a half-life of 9 to 25 hours. After this period it is not detectable in blood samples. It will be detectable in urine samples within 2 to 5 days if the lab is directed to look for significantly smaller concentrations than is the standard.

The first case of the drug being used as a date rape drug occurred in Florida in 1992. To date, several thousand cases have been reported around the country. This figure is probably just the tip of the iceberg due to the low rate of reporting (less than 5 percent). This drug is usually used in combination with alcohol which can produce memory loss. Victims may feel they don't remember enough about the assault to report it.

Rohypnol is known by many street names. Some of the more common names are "roofies," "ruffies," "R-1 and R-2" (indicated in the dosage), "RTF" and "Mexican valium," but new names appear regularly.

- GHB

Gamma-hydroxybutyrate is most commonly known as Ecstasy. It is actually a chemical produced naturally in the cells of all mammals. Originally produced in the 1920s, it has been used as an anesthetic and later by athletes as a steroid. It was also available as a pain killer for horses and cattle up until the 1980s, readily available at livestock supply stores.

The drug is often used at raves. It is added to water or other drinks. The effects make the user seem to display the signs of being drunk.

Forensically the drug is very difficult to detect. The half-life is a mere 20 minutes. It is detectable in blood for about 4 hours after use. In urine it is present for about three days.

There are several street names for GHB such as "aminos," "Georgia," "liquid ex.," "goop," "salty water" and "soap" but "Ecstasy" is the most common.

7.3 Fibers

Fibers are commonly found on bedding, carpets and furniture which may have come into contact with the victim or suspect's clothing. Points of entry and exit such as door jams and window sills can have bits of fiber from clothing caught on them. Trees and bushes along the point of entry and exit may have fibers adhering to them.

Scraping from under the victims fingernails may contain fibers. Buttons, zippers and belt buckles from either the victim's clothing or the suspect's may have cross transferred fibers caught in them.

7.4 Weapons

Weapons can be anything from a bottle or tree branch to a firearm. If the type of injury is apparent it is easier to search for the type of weapon used. Weapons create unique tool marks in the form of injury patterns on a victim. The suspect may have left blood or fingerprints on a weapon. Alternately, vagina secretions or blood from a victim may be on a weapon.

7.5 Glass

Fragments of glass from broken windows, bottles, etc., can tell an investigator many things. Various types of glass are unique in their properties and density. These variations can be used to determine the source of the glass such as window glass or bottle glass. Glass fragments caught in the suspect's clothing which are associated with the crime scene can help place the suspect at the scene.

Radial and concentric fractures as well as stress fractures can determine the direction of impact as well as the point of impact.

7.6 Entomological

Entomological evidence may be present in the form of head or crab lice. It can also be present as insects or parts of insects caught in the victim's or suspect's hair and clothing.

The presence of head or crab lice can be important in linking a suspect to a victim. Entomological evidence can also indicate a location such as indoors or outdoors, country or city or season because all insect have a particular niche in which they live.

7.7 Sexually transmitted disease

The presence of any STD can link a victim to a suspect or vice versa. Only in rare cases is this definitive. Unless the victim has been celibate for years as in the case of someone in a coma, someone institutionalized for mental incapacity or too young to engage in sexual activity it is hard to prove the source of the STD.

7.8 Wound patterns

Wounds incurred in a sexual assault can be of any nature. It may be the victim or the suspect that is wounded.

Of particular interest in sexual assault cases are the wound patterns a victim may have sustained. The victim may lie about the circumstances he or she is in or be unaware what has happened to them. He or she may present themselves to medical staff or police as a recent victim when in reality the assault has occurred several days prior. Having a trained S.A.N.E. nurse or doctor assess the bruising and wounds to see if the time line fits is advisable.

Whether there is bruising around the vulva or tearing at either the 6 or 12 o'clock position is important. This alone is not indicative of sexual assault, but can be a red flag to investigators.

Restraint marks from bondage such as tape, wire, clothing, etc., also can be red flags for investigators. Bruising on the upper arms and inner thighs of both female and male victims may be present. In victims who have been anally penetrated, while on their stomachs, there may be bruising or lacerations between the naval and pubic line. This is caused by friction between the penetrating object and floor.

Bite marks are fairly common in sexual assault and tend to have patterns according to the sex of the victim. Females tend to be bitten on the neck, shoulder, breast and inner thigh and the buttocks. Men tend to be bitten on the upper back, shoulder and scrotum. Any of these injuries are indicators of a sexual assault when in combination with other evidence.

For any of the physical evidence remember to collect exemplar samples from points not associated with the areas where physical evidence is found. For example take fiber samples from areas of bed sheets not associated with stains. This can rule out accidental contamination or false positive results.

Topic : Homicide Investigations

Topic Objective:

After studying this topic the student should be able to:

- Define Homicide Investigations
- Explain Additional Needed Personnel
- Discuss Protection of the Body During Removal
- Discuss Area Beneath the Body
- Define Trace Evidence
- Discuss Wrap-up Conference

Definition/Overview:

Homicide: Homicide refers to the act of killing another human being. It can also describe a person who has committed such an act, though this use is rare in modern English. Homicide is not always an illegal act.

Vehicular Homicide: In most states in the United States, vehicular homicide is a crime. In general, it involves death that results from the negligent operation of a vehicle, or that results

from driving whilst committing an unlawful act that does not amount to a felony. In general, it is a lesser charge than manslaughter. In the Model Penal Code there is no separate category of vehicular homicide, and vehicular homicides that involve negligence are included in the overall category of negligent homicide. It can be compared to the offence of dangerous driving causing death in other countries.

Forensic anthropology: Forensic anthropology is the application of the science of physical anthropology and human osteology (the study of the human skeleton) in a legal setting, most often in criminal cases where the victim's remains are more or less skeletonized. A forensic anthropologist can also assist in the identification of deceased individuals whose remains are decomposed, burned, mutilated or otherwise unrecognizable. The adjective "forensic" refers to the application of this subfield of science to a court of law.

Forensic entomologists: Forensic entomologists are those involved in the branch of entomology that involves insects and violent crime or the law, known as forensic entomology. This includes three main branches: medicocriminal entomology, urban entomology, and stored product entomology. It takes discipline and accomplishment to perform the tasks of all the diverse jobs forensic entomologists perform such as: crime scene investigation, research, and teaching at universities. The education required to become a forensic entomologist is extensive and falls into two major categories: undergraduate and graduate level study. Forensic entomologists today are performing new research to broaden our knowledge of insects and how they can be beneficial to the population. Many network with each other by forming groups such as the American Board of Forensic Entomology(ABFE) and the North American Forensic Entomology Association (NAFEA). Often their expertise can then be used in the court system to solve various cases. Forensic entomologists work has played a major role in some famous cases as well as daily life.

Key Points:

1. Homicide Investigations

- Processed in the same systematic manner as other crime scenes
- Most jurisdictions require the presence of a deputy coroner or deputy medical examiner at all homicide scenes
- Forensic scientists may be needed at the scene to help determine the date or time of death
- Are by their very nature team investigations

2. HIRT

- Homicide Investigation Response Team
- The best approach to efficient and effective processing of the crime scene
- Consist of the first responder, the detective in charge of the investigation, a criminalist or supervisory crime scene investigator in charge of the scene, and a crime scene investigator
- Each member should be fully trained and experienced in their primary duties and conversant with the duties of the other members

3. Additional Needed Personnel

- Criminalist and other forensic scientists
- Pathologists
- Prosecuting attorney
- Fire department personnel
- Forensic anthropologists
- Forensic entomologists

4. Crime Scene Factors(Body)

- Position of the body
- Postmortem lividity
- Wounds and signs of struggle on the body (clothing tears)
- Signs of struggle at the scene

- Presence/absence of notes (possible suicide)
- Nude bodies
- Time of death considerations
- Bloodstains and blood stain patterns

5. Protection of the Body During Removal

- Take precautions to avoid loss of trace evidence
- Gunshot residue tests cannot be done at the scene, place paper or plastic bags over hands to preserve evidence
- Wrap the body in a new clean sheet before placing in a body bag, preserve sheet for possible trace evidence

6. Area Beneath the Body

- Check the area
- Document evidence present
- Recover evidence present
- Excavate the site if the victim has penetrating bullet wounds
- Search the scene a second time for physical evidence
- Preserve the scene until after autopsy is complete if feasible

7. Preautopsy Conference

- Vital part of postmortem autopsy
- Dictates many of the procedures needed at the autopsy
- Determines additional tasks to be completed at the scene
- Identifies what information is needed by each member of the team

8. Postmortem Examination Photography

- General identification photographs
- General and close up views of the clothed body
- All trace evidence
- Notes and sketches of the location of each item photographed

- After clothing removal

9. Trace Evidence

- Photograph trace evidence before removal
- Note and sketch the location of each item on the body
- Collect each item of trace evidence
- Collect all debris from each wound
- Consider having a pathologist excise wounds for further study
-

10. Procedures for Nude Bodies

- Examination of the body
- Trace evidence collection
- Latent print processing
- Tape left technique for fibers and other trace evidence

11. Additional Evidence Collection

- Hair standard samplesScalp and pubic
- Fingernail scrapings
- Gunshot residues
- Condition of teeth/dentures
- Fingerprints/palm prints/footprints

12. Gunshot Wounds

- Photographs of each wound
- Description of each wound
- Collecting loose residues
- Photographs with probes in place
- Photographs after the scalp hair is shaved
- Rephotograph each wound site after the body is cleaned
- Recover bullets
- Re-examination of the wounds after embalming

13. Sexual Assault Homicides

- Examine for sexual assault evidence in the same manner as for live victims
- Optimum is to have sexual assault examination done in cooperation with autopsy pathologist at the time of the autopsy
- Generally use a commercially prepared sexual assault kit

14. Vehicular Homicides

- Collection of clothing
- Impressions on body surfaces
- Examine injuries for glass or paint
- Hair samples
- Toxicology samples
- Blood for DNA typing and alcohol analysis

15. Decomposed Remains

- X-rays of the remains may locate bullets, fragments, knife blades etc., and can also aid in identification of an unidentified victim
- Inked finger/palm/sole impressions
- Search area beneath the remains
- Additional forensic specialists needed at the autopsy of decomposed remains; Forensic Odontologist, Forensic Anthropologist, Forensic Entomologist

16. Body Fluids and Toxicology Specimens

- Sample for blood alcohol determination
- Sample for blood typing
- Sample(s) for toxicology

17. Wrap-up Conference

- Have all necessary procedures been done?
- Are all items properly packaged and labeled?

- Should the body be secured in a locked bag pending further information from the scene or witnesses?
- Can any member of the team think of anything else that needs to be done?
- Remember you may not have a second chance to collect evidence after the autopsy.

Topic : Crime Scene Reconstruction

Topic Objective:

After studying this topic the student should be able to:

- Define Reconstruction
- Explain The Concepts Of Crime Reconstruction
- Discuss The Scientific Method Of Crime Reconstruction

Definition/Overview:

Crime scene reconstruction: Crime scene reconstruction is the use of scientific methods, physical evidence, deductive reasoning, and their interrelationships to gain explicit knowledge of the series of events that surround the commission of a crime. It is a isciplined and principled approach towards objectively understanding a crime scene. Using evidence found at proper crime scene you can reconstruct what happened and possibly find more clues.

Bloodstain pattern analysis: Bloodstain pattern analysis (BPA) is one of several specialties in the field of forensic science. The use of bloodstains as evidence is not new, however the application of modern science has brought it to a higher level. New technologies, especially advances in DNA analysis, are available for detectives and criminologists to use in solving

crimes and apprehending offenders. The science of bloodstain pattern analysis applies scientific knowledge from other fields to solve practical problems. Bloodstain pattern analysis draws on biology, chemistry, maths, and physics among scientific disciplines. As long as an analyst follows a scientific process, this applied science can produce strong, solid evidence, making it an effective tool for investigators.

Key Points:

1. Reconstruction

Reconstruction involves the use of scientific method, logical reasoning, sources of information on people, criminology, victimology, and experience or skill to interpret the events that surround the commission of a crime. Bevel & Gardner define it as determining the most probable sequence of events. Reconstruction begins when detectives conduct a walk-through of a crime scene, simulating the events that may have happened in their minds. They sometimes call it getting a "feel" for the crime scene, but the process is as much cognitive as emotional. They are attempting to prove and disprove any sequence of events that may have happened. Some argue it has been a part of detective work for a long time and is what Osterburg & Ward call reconstructing the past. Although crime scene reconstruction involves walking through a crime scene, it should not be confused with crime scene analysis (or investigation) which is a standard part of police work. We are concerned here with forensic science, not investigative science.

Reconstruction is frequently done by senior criminalists, senior detectives, retired investigators, and a loose conglomeration of consultants from fields as diverse as anthropology, sociology, history, religion, and engineering. Most consultants (including profilers) can be best utilized by visiting the crime scene while fresh, but they can sometimes work with information and documentation afterwards involving the physical evidence, witness statements, and the reports of other experts. Information such as the angles of shots, length and width of bloodstains, and wound patterns are highly important to most experts.

It is important to note that reconstruction is not the same as re-creating the crime scene or re-enacting the crime scene. Crime reenactment has nothing to do with criminalistics or scientific principles. Reenactment is typically seen in courtrooms when defense lawyers stage a jury show or present some sort of computer-animated virtual reality presentation to bolster their version of what they say happened.

2. The Concepts Of Crime Reconstruction

A number of terms require definition to fully understand reconstruction. Induction is the process of reasoning where experience, skill, and observation are applied to the particulars of a case and a conclusion or generalization is drawn. Deduction is the process of reasoning that starts with a generalization or premise and then considers the logical consequences of any particulars that follow. Abduction is the process of cycling through both inductive and deductive reasoning by adding known facts until one is able to reject or retain a hypothesis. Typology (aka classification or taxonomy) is the process of arranging known facts into mutually exclusive categories. Synthesis is the process of combining separate parts or elements. Analysis is the process of starting with the whole and breaking it down into its separate parts. A hypothesis is a tentative assertion subject to verification or falsification. A theory is a somewhat verified hypothesis. Serendipity is the factor of chance or luck. Some of these terms, and others, are used in different ways by detectives:

- **Pattern**s -- series of similarities that usually indicate the same person or the same modus operandi is involved in different crimes
- **Leads** -- clues or breaks in the case that help move an investigation forward, usually something in a witness statement that was overlooked, or it could be something that comes up after a records search or lab report
- **Tips --** leads provided by citizens or informants. Tips by definition involve specifics, like names, dates, places, addresses, phone numbers, or license plates
- **Theories --** these are beliefs about the case that take you in one direction, at the exclusion of other possible directions
- **Clues** -- these are pieces of evidence that are consistent with the corpus delecti or elements of the crime believed to have been committed or that the suspect will eventually be charged with

There's also certain steps or priorities that a seasoned investigator will take depending upon the crime he or she is investigating. While most textbook training is based on the homicide exemplar, in the real world, a seasoned investigator would probably investigate the following crimes using the steps in the order listed below:

Homicide:	Rape:	Robbery:	Burglary:
1- focus on deceased 2 -crime scene 3 - crime lab	1- focus on victim 2 - medical reports 3 - crime scene 4 - usual suspects	1 - modus operandi 2 - crime scene 3 - police records	1 - focus on scene 2 - records check 3 - property check

Modus Operandi can be defined as those behaviors, taken by the offender, that were necessary to commit the crime. MO is learned behavior. It is somewhat dynamic and can change over time. Signature behaviors, by contrast, are those behaviors committed by offenders that serve psychological and emotional needs. Records checks are similar to background checks, involving sources of information on people, up to and including garbageology, since it is not illegal to search through abandoned property. Police records refer to the databases and resources that only police departments have access to.

Information Needed for Reconstruction

Generally speaking it is best to go to the scene, preferably at the time of the incident. Information may come from physical evidence, witness statements, and the reports of other experts. The reconstructionist should examine all scene photographs, autopsy protocol and photographs, measurements, drawings, notes, reports and items of evidence. Complete and accurate documentation of the scene is essential. Depending on the type of reconstruction being done this may include some different things such as the height and vertical/horizontal angles of shots into a wall, or the length and width of a bloodstain.

3. The Scientific Method Of Crime Reconstruction

Crime reconstruction typically starts with inductive reasoning, then proceeds to deductive reasoning, then involves a breaking down or analysis of facts, and then involves a building up of facts or synthesis. The number and kind of facts, together with any ambiguity or doubt associated

with them, determine the level of evidentiary value. The process is almost exactly the same as the scientific method:

- Step 1 State the problem by looking at what type of crime was committed, the legal elements of the crime, and the characteristics of the jurisdiction where the crime was committed
- Step 2 Form a hypothesis by looking at the physical evidence and interviewing the victim or witnesses to determine motive and possible suspects
- Step 3 Collect data by doing records checks and police checks, re-interviewing the victim, witnesses, and suspects, while trying to obtain additional witnesses and exemplar or comparison samples from suspects
- Step 4 Test hypotheses by evaluating how truthful and reliable the stories are of each party to the crime, and weigh their stories against the physical evidence and any known physical laws that could possibly reinterpret the physical evidence
- Step 5 Follow up on the most promising hypotheses (theories) with any and all procedures (e.g., surveillance, stings) that might prove or disprove a particular suspect is the offender
- Step 6 Draw conclusions that are supported by court-admissible evidence leading to the arrest, prosecution, and conviction of the offender.