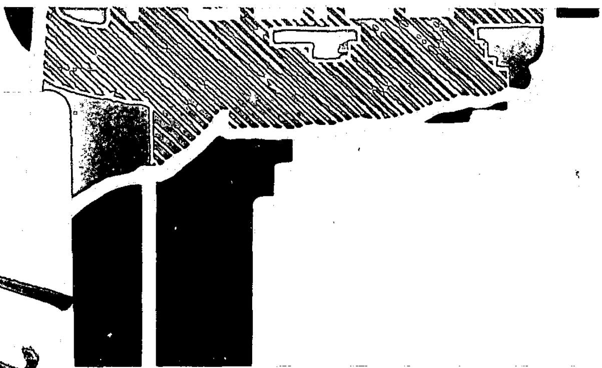

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PHYSICAL EVIDENCE

AND

FORENSIC SCIENCE

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FORENSIC SCIENCE LABORATORY
CONNECTICUT STATE POLICE

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WILLIAM A. O'NEILL
GOVERNOR

STATE OF CONNECTICUT
EXECUTIVE CHAMBERS
HARTFORD

October, 1984

The skilled and dedicated members of police and fire departments in communities throughout our State stand ready at all times to safeguard the lives, property, and rights of our citizens.

Our law enforcement officers are aided by the knowledge of every possible technique and resource which enables them to do their jobs successfully.

In criminal investigation, the proper identification, collection, handling, preservation and analysis of physical evidence are particularly crucial to precision and accuracy in each investigation.

This comprehensive manual, compiled by the Connecticut State Police, offers helpful guidelines and information to police and fire investigators to assist in the performance of their duties. It will certainly add to the tools available to all investigators, helping them considerably to combat crime and make our State a better and safer place in which to live and work.

I am confident that this manual will be a most valuable addition to our already effective arsenal against crime.

William A. O'Neill
Governor

Governor
William A. O'Neill

Col. Lester J. Forst
Commissioner
Department of Public Safety

At a crime scene, every law enforcement officer shares the responsibility of preserving and collecting as much pertinent physical evidence as possible. The objective of this handbook is to make available to police and fire investigators a practical guide for the proper collecting, preserving and handling of physical evidence.

The value of properly collected and examined physical evidence by the Forensic Science Laboratory cannot be overly emphasized. Forensic science has become a vital part of our criminal justice system. Working as a team, the field investigators and our laboratory personnel present a formidable arsenal in Connecticut's war against crime.

It is hoped that the handbook will promote the utilization of physical evidence in criminal investigations and encourage the law enforcement officer to make use of the services available at the Connecticut State Police Forensic Science Laboratory.

Colonel Lester J. Forst
COMMISSIONER OF PUBLIC SAFETY

Lt. Col. John A. Mulligan
Executive Officer
Connecticut State Police

For more than 80 years, the State Police have been involved in the prevention, investigation, and solution of crime in the State. In more recent times, scientific criminal investigation and forensic science have come to play a much greater role in the effort to control crime. The Department has been in the forefront of this trend, and has developed an outstanding full-service Forensic Science Laboratory. But the Laboratory cannot do the job alone. The proper recognition, collection, preservation, and analysis of physical evidence directed toward the solution of cases requires a team effort--investigators, crime scene personnel, and laboratory examiners working together with a common goal.

The Department realizes the importance of cooperation and communication between scene personnel, patrol officers and laboratory examiners. We are proud of the accomplishments of our State Police Forensic Lab but we know that continued success is totally dependent on a high degree of cooperation and interaction between investigators and examiners. This book is designed to assist officers in understanding the processes involved in physical evidence processing and analysis, and thus to foster cooperation between officers and the Laboratory. It will also help investigators in understanding the types of analysis that can be done, the types of results that can be obtained, and should be helpful in formulating requests for evidence analysis. We are pleased to make this book available to police officers throughout the State.

J. A. Mulligan

Lieut. Colonel John A. Mulligan
EXECUTIVE OFFICER
CONNECTICUT STATE POLICE

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We would also like to express our appreciation to Commissioner Lester J. Forst and Lt. Col. John A. Mulligan for their support and encouragement in this project, and to the members of the Connecticut State Police for their interest and support.

We extend our thanks to police and fire departments in Connecticut and all other State and local law enforcement agencies for their help in identifying the need for, and their assistance in, this project.

A special thank-you to the Connecticut Insurance Placement Facility representing the Connecticut Insurance Industry for their assistance in this project, making it available to the law enforcement community.

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INTRODUCTION

In recent years, the criminal justice agencies have become increasingly aware of the value of physical evidence as mandates of the Supreme Court dealing with the rights of individuals have imposed greater restrictions on methods of investigation. Investigators have dealt with this problem by learning to exploit the merits of forensic science.

The work of the forensic scientists is not for the benefit of either the prosecution or defense in our judicial proceedings. Their function is to use all the scientific skill and knowledge available to find out the truth. To this end, injustice shall not be done to any member of our society.

This manual is intended as a simplified introduction to the fundamentals of forensic science and scientific evidence, but not as an in-depth treatment of the subject. It should serve the law enforcement officer as a primer, the experienced criminologist as a refresher, and the general reader as a thought-provoking introduction to the field of forensic science.

PART ONE is devoted to the importance of physical evidence and the basic principles of forensic science.

PART TWO deals with the collection of physical evidence and methods of crime scene search.

PART THREE covers the submission of evidence to the Laboratory for examination.

PART FOUR discusses the individual types of physical evidence and how they are examined in the Laboratory.

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PART ONE

PHYSICAL EVIDENCE AND FORENSIC SCIENCE

I. PHYSICAL EVIDENCE

Physical evidence serves to associate the criminal with a particular crime. For example: a latent fingerprint found at a crime scene is subsequently identified by matching it with a known fingerprint; or a blood stain is later identified as being similar in genetic markers to those of a particular individual. While physical evidence may be used for reconstruction of the crime scene, it can also be used to prove the innocence of an individual as well.

Virtually any type of material can become physical evidence. It may be as small as a dust particle or as large as a train. Table 1 lists some thirty categories of the types of evidence frequently analyzed by forensic science laboratories. These listings can be divided into four groups: biological, chemical, physical (impression), and miscellaneous.

When one considers the various types of evidence mentioned in Table I, it becomes obvious that there are available to the forensic scientist many different methods of discovering the truth.

A. Areas of Specialization

In recent years, the forensic science field has grown tremendously, causing considerable expansion in forensic laboratories in both size and operations. The application of forensic science in criminal and civil investigation has rapidly diversified since physical evidence occurs in many varieties. Because a rather different expertise is required for examining each piece of physical evidence, the forensic science profession, like thrt of medicine, has shifted from general practice toward specialization. The following is a partial list of areas of specialization.

1. Criminalistics

Criminalistics may be defined as a knowledge of the collection, identification, individualization, and evaluation of physical evidence. A criminalist is a generalist by necessity, drawing upon a wide spectrum of scientific knowledge to help the investigator in the recognition and recovery of a variety of trace evidence. He also helps detectives to develop investigative leads and assists the courts in the interpretation and evaluation of findings. A major objective, aside from identification of evidence, is to individualize evidence to the maximum possible extent while attempting to

TABLE 1

TYPES OF EVIDENCE USED FOR ANALYSIS

Biological	Chemical
Blood	Fibers
Semen	Chemicals
Saliva	Glass
Other Body Fluids	Soil
Hair	Gun Powder
Botanical	Metallurgical
Pathological	Mineralogical
	Narcotics
	Paper
	Pharmacological
	Toxicological

Physical (Impression)	Miscellaneous
Fingerprints	Laundry Marks
Firearms	Voiceprint
Handwriting	Polygraphy
Indented Writing	Photographic
Number Restoration	
Footprints and Tire Marks	
Tool Marks	
Typewriting	

determine its precise, unique origin. The philosophy of individualization is unique to forensic science and has made it different from any other science.

2. Questioned Document Examination

The questioned document examiner is involved in the scientific examination of handwriting, typewriting, printing, ink, and paper as well as many other aspects of a document or written instrument. Examinations can involve: Identifying the source or writer of a document, determining if a signature is authentic or a forgery, determining the age of the document, deciphering obliterated or erased writing, detecting alterations, and examining indented writing and burned or charred documents.

3. Forensic Chemistry

Forensic chemistry involves the identification and analysis of drugs, toxic substances, accelerants, gunshot powder residue, explosives, and other chemical substances. Qualitative and quantitative methods are utilized to identify unknown substances and to make comparisons between known and unknown materials. It is also the function of the forensic chemist to attempt to trace unknown substances to a specific origin.

4. Trace Analysis

The trace analyst combines the methodology of microscopy, instrumental and chemical techniques in examination of hair, fibers, glass, soil, plant material, mineral, and air borne particles. While it is difficult to make absolute individualizations in these areas, the trace analyst can make identifications with a high degree of probability of individuality.

5. Firearms Examination

The examination of firearms, discharged bullets, cartridge cases, shotgun shells, ammunition, and various weapons are all conducted by a firearms examiner. Generally, a firearms examiner has to answer three questions: (1) What kind of weapon fired the bullet? (2) Did this particular weapon fire this bullet or cartridge case? (3) What kind of ammunition was used? In addition to answering these questions, the firearms examiner studies garments and other objects to detect firearms discharge residue and to determine the distance from which a weapon was fired. Many firearms examiners also perform tool mark comparisons. With increasing frequency, tools of many kinds are used as weapons or in the perpetration of crimes. Whenever a tool has been used to move an object, there is a good chance that the tool can be identified with reasonable certainty.

6. Latent Fingerprints

Latent fingerprint examiners are responsible for processing latent fingerprints on evidence submitted to a forensic laboratory from crime scenes. There are many chemical and physical methods for the detection and visualization of latent fingerprints. After the latent fingerprints have been developed, the examiner also has to compare the latent print with the suspect's inked prints to determine whether or not they match.

7. Voice Analysis

In cases involving tape recorded messages containing threats, false alarms, bomb threats, or other criminal violations, it may be necessary to employ the skill of the voiceprint examiner to tie the unknown voice to a particular suspect. A sound spectrograph is used to transform speech into a visual graphic display. The validity of this technique as a means of personal identification rests on the premise that the sound patterns produced in speech are unique to the individual and that the spectrogram or voiceprint displays this uniqueness.

8. Serology

Forensic serologists apply the principles and techniques of biochemistry, serology, immunology, hematology, and chemistry to the identification and individualization of blood and other body fluids. The questions which are generally answered by the examination are as follows: (1) What type of stain is it? (2) What species does the stain belong to? (3) Does the questioned stain have the same blood groups and isoenzyme patterns as a certain known sample? Major crimes such as homicide, rape, and physical assault generally involve blood as evidence.

TABLE 2

CATEGORIES FOR IDENTIFICATION AND INDIVIDUALIZATION

Identification and Individualization of Person

- Blood
- Biological
- Physiological
- Fingerprints
- Handwriting
- Footprints
- Photographic
- Voice

Identification and Individualization of Object

- Botanical
- Fibers
- Chemical
- Glass
- Gunpowder
- Metalurgical
- Narcotics
- Paper
- Pharmacological
- Toxicological
- Firearms
- Indented Writing
- Shoeprints
- Typewriting
- Laundry Marks
- Photographic
- Tire Marks

PART TWO

CRIME SCENE SEARCH

AND

COLLECTION OF PHYSICAL EVIDENCE

II. CRIME SCENE SEARCH AND COLLECTION OF PHYSICAL EVIDENCE

Generalist Concept: to properly process a crime scene for physical evidence, it is necessary to view the whole scene in its entirety and not just from the perspective of the singular operations involved in the processing, i.e., fingerprints, blood, photography, etc.

SEQUENCE OF OPERATIONS

A. Scene Preservation

1. Secure the scene. (This applies to crimes where first aid is not necessary - if it is necessary, it should be the first concern.)

2. Restrict entrance to scene.

    a. Includes officers and other investigators as well as members of news media. Anyone entering the scene should be prepared to offer court testimony as to their reason.

3. Notify Agencies.

    a. Notify the appropriate Field District Commander and its Major Crime Squad.

    b. Notify the State Police Forensic Science Laboratory.

    c. Notify the prosecutor's office, the medical examiner and any specialist that may be required.

B. Scene Observation (Crime Scene Team Leader)

1. Mentally reconstruct what has happened as it will yield probable sources of evidence.

2. Begin notes. These should include: date, time, weather, who is present, lights on or off, doors locked or open, air conditioner on or off, etc. The notes should answer the questions - who, what, where, when, why, and how? If a tape recorder is available, it is strongly recommended that it be utilized at this time.

3. Assign specific responsibilities to crew members, e.g., evidence collector, photographer, fingerprint processing, etc.

C. Photography

1. Purpose - to provide a permanent graphic representation of the appearance and position of objects and their relationship to each other at the crime scene. It serves to support testimony of the investigator as to what was found, its location, nature, and condition.

2. Crime scene photography should move from the general to the specific. It is necessary to orient objects and evidence to document their relationships and eliminate confusion for the trier of fact in judicial proceedings. Specific photography will graphically verify the condition of items of evidence as they were initially discovered.

   a. Take overall photographs first, including approaches to and surrounding areas of the crime scene.

   b. Do not disturb anything before photography is completed.

3. Bracket the scene completely by taking photos from the four compass points. Intentionally overlap these photos so that relationships between the objects shown can be established.

4. Good crime scene photography will factually portray the event, so arrange the photographs in a logical sequence to illustrate the occurrence. A systematic approach is mandatory.

5. Color as well as black and white photos should be taken as this combination may circumvent admissibility arguments in court and in certain instances may enhance the evidence.

6. Avoid distortion by taking photos from normal eye level.

7. When photographing articles of evidence, take one photograph as it appears naturally and a second with the inclusion of a scale and label for reference and identification. In many instances, consideration should be given to taking a general photograph to show the article's location in relation to the overall scene. Remember that these photos are meant to be specific so place the camera in a position to fill the entire format of the film. This will allow greater detail to appear in the photo.

8. Consider taking aerial photographs in major crimes to orient the crime scene to the surrounding area geographically.

9. Choose a camera that will have the largest film format available and still be convenient for handling at crime scenes. A larger format will allow enlargment of photographs with the least amount of loss of clarity caused by grain in the finished photographs.

   a. Additional consideration should also be given to the use of available cameras for color slides. These slides can be of invaluable assistance in court testimony as visual aids, thereby enhancing oral testimony.

10. A sketch should be made by the photographer showing the various photo numbers regarding camera locations and angles. It is not necessary to make this a scale drawing but the fact that it is not to scale should be noted on the drawing.

11. Light Meters - the addition of an incident type light meter (measures light falling on an object) to camera equipment will result in better crime scene and evidence photography. This equipment takes the guess work out of exposure saving both time and resources.

12. Tripods should be used in the following situations:

    a. When shooting with an exposure time greater than 1/30 second.

    b. For ground glass focusing or special evidence photography, e.g., footprints, tire tracks, etc.

    c. Difficult angle or camera position.

13. Illumination techniques - the crime scene photographer should be familiar with the following methods of lighting to maximize or enhance articles of evidence:

    a. Flat lighting - consisting of two light sources placed approximately 45° to the target at the same height as the camera lens. The result is that shadows will be eliminated.

b. Side lighting - a single light source placed off to the side and at a flat angle to the subject will emphasize irregularities in the subject's surface, thus enhancing detail.

c. Bounce lighting - to be used when reflective surfaces in the scene to be photographed would cause the light source to be reflected back to the lens, causing burnout on the film. This technique involves aiming the light source at the ceiling at an approximate 60° angle. The result is a soft overall light that illuminates the subject. A variation on this technique is to hold the light source to the side of the camera, which deflects the light enough so that it is not reflected right back into the lens.

14. General Recommendations

a. If it is necessary to have a large depth of field in focus in the photograph, close the lens as much as possible while compensating by increasing the length of exposure. This may mean the use of a tripod if the time exceeds 1/30 second.

b. Using normal techniques, remember if you cannot see the detail you are interested in by eye, the camera will not pick it up either.

c. Midmorning or midafternoon are usually best for outdoor detail photography. As the sun is not directly overhead, the characteristics to be photographed will not be burned out. Generally allow sunlight to come over your shoulder onto the object as it will improve detail.

D. Sketchs

1. Measurements should be made before evidence is collected.

2. Be sure to orient the sketch by including the direction of north, type of building and the room in which the crime occurred.

3. Articles should be located by at least two measurements from fixed points at the scene (see Figure 1).

TABLE 3

EXPOSURE GUIDE FOR 120 CAMERAS USING TRI-X (ASA 400) FILM

1. Set the exposure time at 1/125 second. If strobe is to be used, apply steps 2 and 3.

2. Focus on the target and read the distance shown on the focus knob of the camera for an accurate measurement of the distance to the target.

3. Using that distance, select the proper F-stop number from the chart and set the camera accordingly. Shoot the photograph.

<u>Daylight Exposure Guide</u>

Bright or hazy sun	- F/22
Cloudy bright	- F/16
Hazy overcast	- F/11
Shaded areas	- F/8

<u>Strobe Exposure Guide</u>

3 1/2 feet (half power) F/32
All other settings at full power

5 feet	- F/32
8 feet	- F/22
10 feet	- F/16
15 feet	- F/11
20 feet	- F/8
30 feet	- F/5.6
40 feet	- F/4
50 feet	- F/3.5

4. Finished scale drawings for court room use should not include measurements as this only serves to confuse the trier of fact in the case. The scale by which the drawing was made must be included on the drawing. If testimony requires measurements from the drawing, they can be made directly from it using the same scale (see Figure 2).

E. Physical Evidence

1. Many articles will contain more than one type of physical evidence. It becomes necessary to evaluate which evidence is most important and then to collect and process it first to avoid contamination.

2. Search patterns should be systematic with the best results being obtained by employing a geometric pattern such as strip, grid, and zone as illustrated in Figure 3. The actions of the perpetrator at the scene should automatically suggest that certain types of evidence will be found. This should be kept in mind as the search is conducted.

3. It is recommended that a second search of the crime scene be made within a reasonable period of time after the original search. Do not be in a hurry to give up the scene. Remember to keep the scene guarded by police personnel 24 hours a day until all processing is completed, as failure to do this results in the loss of integrity of any evidence found after the original search.

4. All physical evidence should be photographed as it is found before it is handled in any way.

5. One member of the crime scene team should have the responsibility of being the physical evidence collector. This will mean that other members of the team will point out articles of evidence to the collector, and then the collector will secure these articles after they have been photographed and sketched. This system has the advantage of keeping the chain of evidence short, thus eliminating unnecessary court testimony from other members of the team, and uniformity in packaging and individual article enumeration.

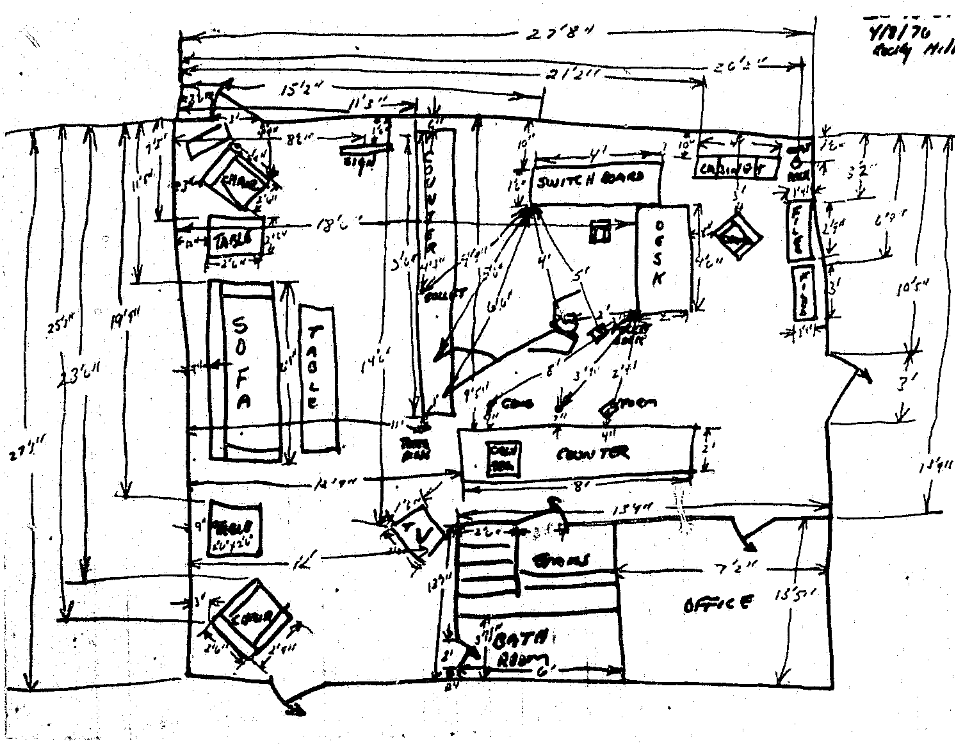


Figure 1: A rough sketch of a homicide crime scene. Note that the inclusion of actual dimensions make the sketch confusing, so it is not suitable for court room use.

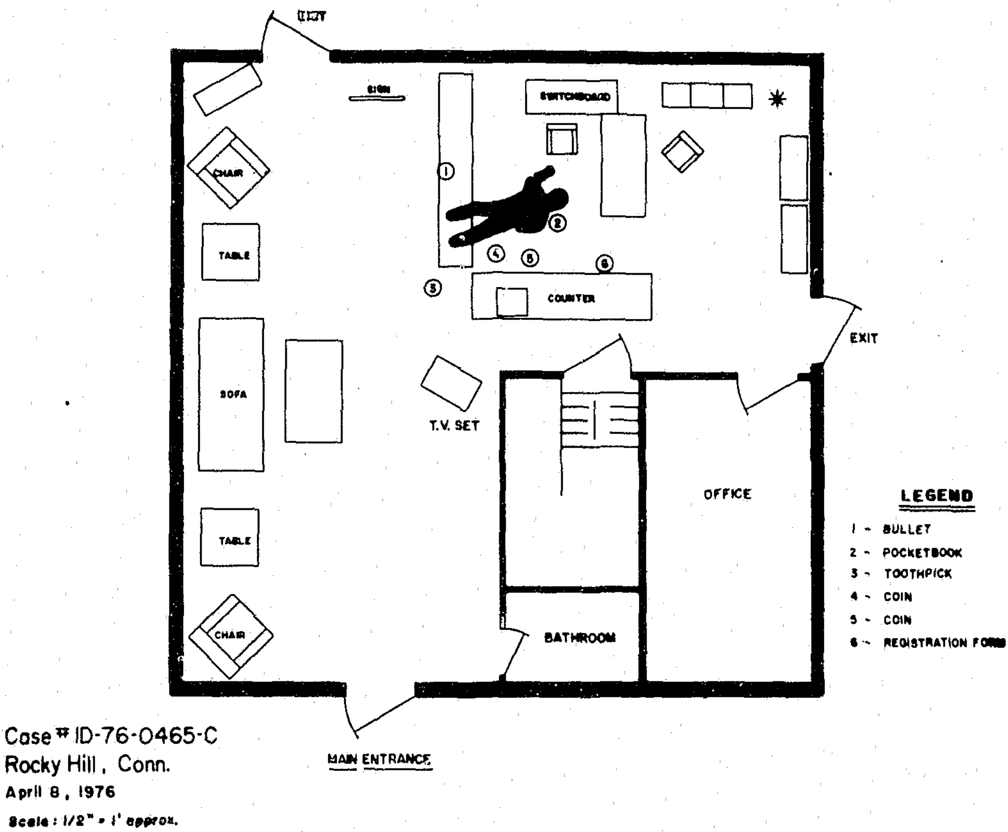


Figure 2: A finished sketch of a homicide crime scene. It is drawn to scale, and would be suitable for court room use. Note that the lack of measurements make the sketch easier to understand. When testimony is offered about the sketch, the investigator may respond to questions about dimension by simply measuring them on the sketch, using the proper scale as noted in the drawing.

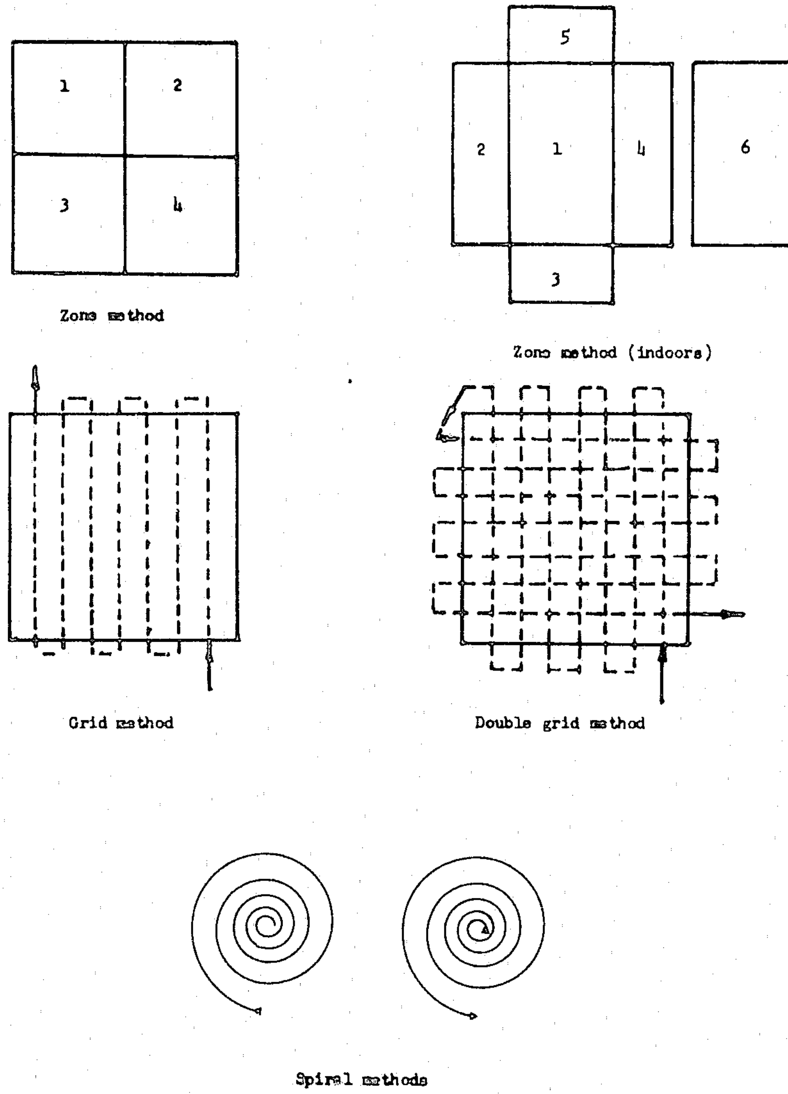


Figure 3: These examples of common search patterns should be utilized at crime scenes to insure the systematic location of physical evidence.

6. Fingerprints

a. Latent prints - the determination of whether to process an article of evidence for latent fingerprints at the crime scene or to package that article and submit it to the laboratory is largely dependent on the surface involved. If it is a porous surface, the laboratory is better equipped to process it with chemical methods. As such, the article should be packaged and submitted accordingly. However, if it is a smooth surface, fingerprint powder will adhere to the perspiration and oils left by the pores in the friction ridges of the fingers; this operation is easily performed at the crime scene.

i. Choose a fingerprint powder of a contrasting color to the surface being processed, i.e., chemist gray for dark colored surfaces, glass, mirrors or chrome; black powder for light colored surfaces. Pour a small amount onto a piece of paper to insure that the rest of the powder does not get contaminated by the various objects dusted.

ii. Use a polyester brush for initial processing after first shaking out the excess powder. Dip the brush into the fresh powder and apply the brush to the object moving it in a rotary motion to pick up the circular patterns of the fingerprints. You will be aided in this process if a flashlight is held to the side and at a low angle to the area being processed. The fingerprint may be enhanced by brushing out excess powder between the friction ridges with a short bristled camel hair brush.

iii. Number each latent print in sequence using a grease pencil or marker and record that information, as well as the location of the print, in notes. Photos should then be taken utilizing both one to one (actual size) and overall photography to show location relative to the object the print is on.

iv. Lift the fingerprint with transparent fingerprint tape and place it on a clear plastic slide. Position the tape so that it also picks up the grease pencil markings which will then yield the print's identification number on the completed lift. In many instances, a second lift may provide better quality minutiae reproduction than the original lift.

v. Evidence to be processed at the laboratory should be packaged in a manner which avoids friction on the print-bearing surface. It is advisable to avoid simply placing the article in a plastic bag as this can also be a source of friction. The key to handling this kind of evidence is to immobilize the article in a fashion that allows transportation.

vi. General recommendations

(a) Do not dust visible prints; prints in paint, grease or blood. It will not make them any clearer and may make them worse in quality. Do photograph them and transport the whole article to the lab.

(b) Do not use the side of the dusting brush as it will smear the latent print. Do use only the end of the brush.

(c) Do not dip the brush directly in the bottle containing the fingerprint powder. Do pour a small amount on paper - dip the brush into that to insure that the whole bottle does not get contaminated with debris.

(d) Do not process wet items. Let them air dry naturally.

(e) Do not use heat lamps or blowers to accelerate drying as they may cause excess evaporation of oils and perspiration.

(f) Do allow items exposed to freezing temperatures to warm up before attempting to process them.

b. Post-mortem fingerprints - to obtain a positive identification of the deceased the investigator must first dry the fingers and palms of cadaver. They are then inked directly using an ink roller or pad and regular fingerprint ink. The individual fingers are then pressed into the "Fingerprint Spoon," (curved metal plate capable of holding a fingerprint card), and released. Palm prints are taken by inking the palms in the same manner and then rolling a large cylindrical object, such as a beaker or bottle, wrapped in plain bond paper secured by elastic bands, over the palms of the cadaver.

i. If fingers are decomposed, as with "floaters", technicians at the Forensic Laboratory should be asked for assistance as other methods may be utilized to obtain the fingerprints.

7. Impressions and Imprints

a. Shoeprints and tire prints will fall into two general categories:

i. Residue print - found on hard flat surfaces where the actual replica of the shoe or tire has been left behind in a two dimensional form by residue deposited by the shoe or tire itself. This replica results from the shoe or tire contacting some colored medium such as dirt, grease, blood, mud, etc. and then being deposited by the article on the surface bearing the print.

ii. Impression print - results from a shoe or tire passing through a soft medium and then leaving a three dimensional negative replica of the original object making the print.

b. Recording the impression is a two-stage process. The first stage is to record it with photography.

i. The camera must be set up so that the film plane is parallel to the plane of the surface containing the impression. In addition, the camera must be located directly above (90°) the center of the print to avoid distortion. A tripod is recommended for this procedure. Careful attention to focus of the camera is mandatory to record the pertinent detail necessary for examination. Lighting should be set at an oblique angle to enhance and highlight the detail of the print. While the camera is to remain stationary in relation to the impression, additional photographs should be taken after moving the light source 90° to the next compass point until one full orbit has been completed. It is absolutely essential that a scale be included in the field of view of the camera and also that the camera be positioned so that the impression takes up the entire film format.

ii. The second process involves lifting the print itself, or making a positive replica of the impression through Plaster of Paris or silicone casting.

(a) Residue prints can be lifted through use of commercially manufactured lifters in the same fashion as latent fingerprints. Note: It is preferable that the investigator obtain the object bearing the impression and package the article in a manner to preserve the print and prevent its obliteration.

(b) A positive replica of an impression footprint or tire mark is made by plaster casting. This replica will often yield class characteristics for identification, but will seldom yield the necessary detail for an individualized identification unless unusual damage or wear to the tire or shoe has been reproduced in the cast. The procedure for making a plaster cast follows: (See also Figures 4 through 13).

1) The area to be cast should be examined and large, loose articles of foreign matter should be carefully removed without disturbing the surface of the impression.

2) Because the material (such as soil or sand) to be cast is easily moved and damaged, it must be protected by spraying either lacquer or shellac onto a cardboard or paper held above the print at a 45° angle so that the sprayed liquid falls by gravity onto the print and protects it by hardening the surface to be cast. Approximately 15 minutes should be allowed as drying time.

3) A light sprinkling with talcum powder or spraying with silicone will facilitate separation of the plaster cast from the impression upon completion.

4) A physical barrier acting like a dam must be set up around the impression. Commercially manufactured steel frames are available for this purpose, but anything that will restrict the flow of the plaster and confine it to the immediate area of the print will suffice.

5) A rubber mixing bowl is recommended for the mixing of the Plaster of Paris as flexing of the bowl after pouring facilitates cleaning.

6) If the Plaster of Paris is at all lumpy, it should be sifted through a flour sifter or screen. An amount of water approximately equal to the print to be cast is placed in the mixing bowl. Plaster of Paris is slowly added to the water, stirring constantly with a spoon or spatula until the mixture has the consistency of pancake batter.

7) A pour can now be made by holding the bowl close to the print and deflecting the pouring liquid off of the spoon or spatula just before the liquid reaches the impressing. The pour is to be continued around the area of the impression until it has reached a depth of one half inch.

8) Reinforcement in the form of screen or wire should now be placed on top of the plaster. The investigator must exercise caution so as not to press the reinforcements into the plaster to the point where they interfere with the impression being cast.

9) The pour is now continued in the same manner as described until a thickness of one inch is reached. After allowing the cast to dry for approximately 10 minutes, identification data is scratched into the top of the cast and it is then allowed to complete the drying process. After the cast has been allowed to dry for 30 minutes, it can be removed from the impression. No attempt should be made to clean the soil from the bottom of the cast as it takes 14 hours for the complete drying process. The soil and debris which clings to the newly completed cast also makes an excellent known sample for soil comparisons on other evidence.

Figure 4: An overall view showing the shoeprint as it was originally found (prior to the removal of any debris).

Figure 5: The camera must be placed directly over the footprint as shown to insure that no distortion will appear in the resultant photograph.

Figure 6: This photograph was taken in daylight with the use of a flash held at an oblique angle to insure the enhancement of detail in the footprint. Note that the inclusion of a scale makes possible examination from the photograph alone.

Figure 7: As the soil containing the footprint may be quite fragile, a hardener such as shellac should be sprayed onto a baffle and allowed to fall onto the shoeprint as shown to avoid damage to the shoeprint.

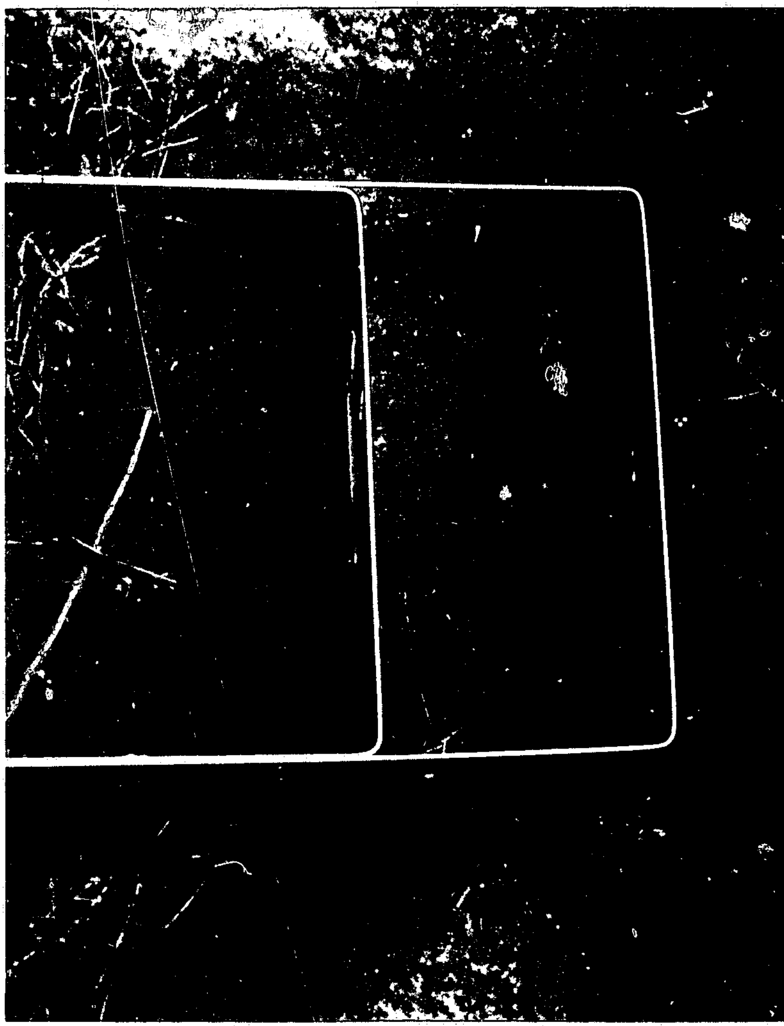


Figure 8: A physical barrier must be placed around the shoeprint to retain the Plaster of Paris as it is poured onto the shoeprint.

Figure 9: The plaster is added to water to make the necessary amount to cover the footprint to a thickness of approximately one inch. When the mixture reaches the consistency of pancake batter, it is ready to be poured onto the footprint.

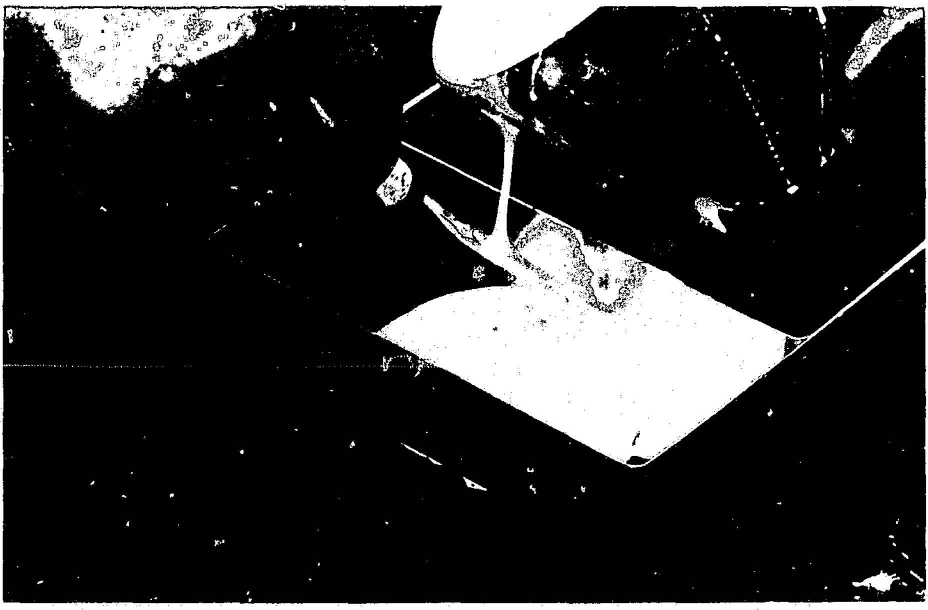


Figure 10: The Plaster of Paris should be poured into the mold by being deflected as shown to insure that the footprint is not damaged.

Figure 11: When the thickness of the Plaster of Paris has reached approximately one-half inch, reinforcements are added to give strength to the finished cast.

Figure 12: The pouring is now continued until the cast reaches a thickness of approximately one inch.

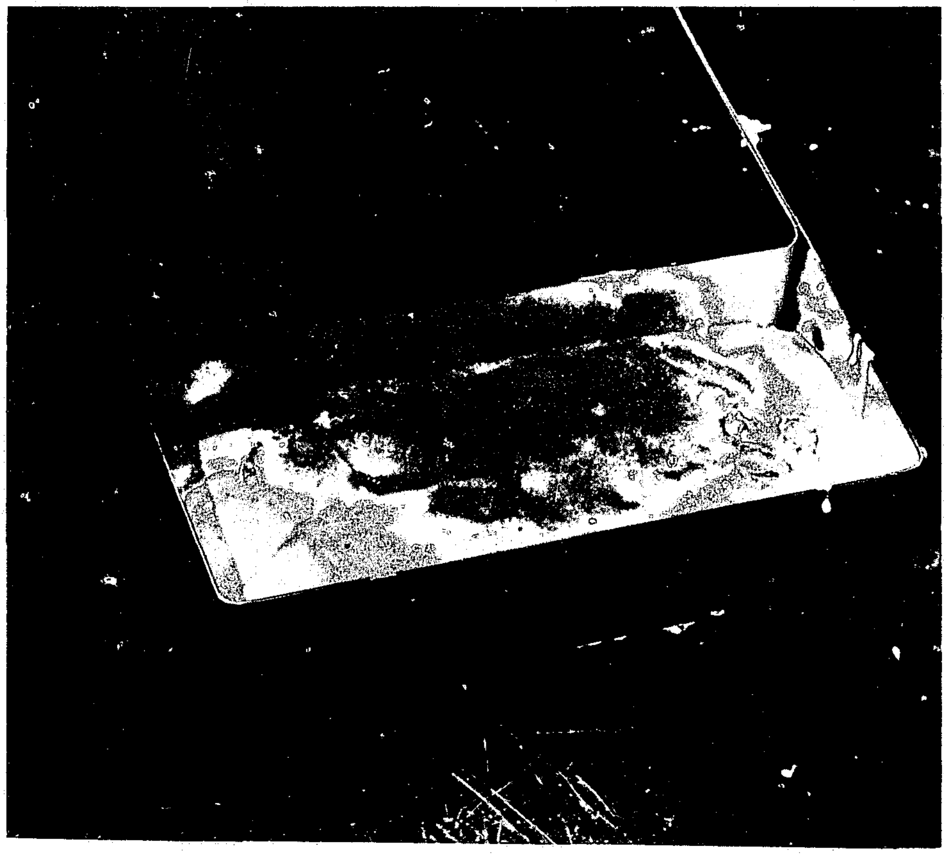


Figure 13: When the cast is almost dry, the investigator should mark identification data into the cast itself.

10) The finished cast should be placed in a cushioned rigid container, wrapped in paper, and sent to the laboratory.

(c) Known standards - suspected shoes should be obtained as soon as possible to preclude additional wear markings appearing on the shoes and the possible obliteration of those already reproduced in the casting.

(d) Known standards - tires. As the original impression was made with the weight of the vehicle bearing upon the tire, the investigator must duplicate this condition when making the known standard for comparison purposes.

1) Jack the vehicle up so that the suspect tire clears the ground.

2) Ink the entire tread circumference of the tire with fingerprint ink.

3) Place an approximate 10 foot length of wrapping paper under the tire.

4) Let the vehicle down onto the paper and slowly drive it along the paper until the tire has completed one revolution.

5) Place identifying data including which tire made the mark (position on the vehicle) which side of the tire mark was facing inboard or outboard of the vehicle.

6) Repeat the entire process until all tires on the vehicle have been completed. It is necessary to submit the known standards to the laboratory along with the cast or photos of the tire impression. The submission of the actual tire, in most cases, is <u>not</u> necessary.

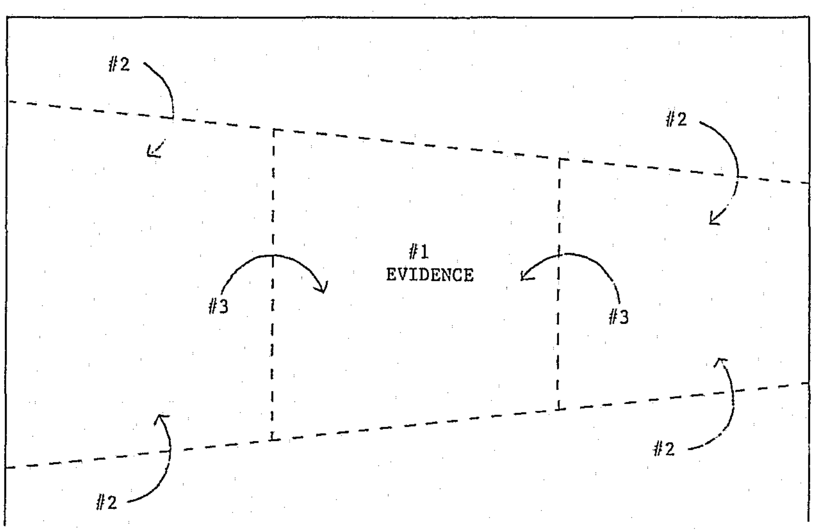
8. Hair

a. Usually individual hairs may be picked up by the fingers or by tweezers, however, this task may also be accomplished through the use of vacuum sweepers. The hair is then placed in a paper that is folded in the "druggist fold," which in turn is placed in an envelope properly labeled with identification data and sealed (See Figure 14).

Figure 14 - The Druggist Fold

Directions

1. Place the article of evidence in the center of paper.
2. Fold paper lengthwise twice in non-parallel folds so that the flaps overlap.
3. Fold over ends tucking the smaller end inside of the larger end.
4. Place the resultant packet in a conventional envelope and seal.



b. Known standards - the sample area should first be combed to remove all loose hairs. These loose hairs should be packaged separately. The standards should then be pulled so as to include the root. Head hair samples should be taken from the various parts of the head, i.e., crown, neck, sides, front. Collect a minimum of 12 hairs. A less preferred method of obtaining standards is to cut the hairs as close as possible to the skin or scalp.

9. Fibers

a. Collection of fibers as evidence is best accomplished by picking up the fibers with the fingers or with tweezers. It is also possible to collect fibers through use of a vacuum sweeper fitted with an in-line canister attachment in the hose. The canister must contain a filter that must be changed with each use. A third method is to use tape to pick up this type of evidence. Picking up the evidence with fingers, tweezers, or tape has the advantage of not contaminating the samples.

b. Packaging - Vacuum sweepings should be placed in separate containers in accordance with their origin and labeled accordingly. If small amounts or individual fibers are picked up, place them in paper folded in the "druggist fold," which is in turn sealed in a paper envelope labeled with identification data.

c. Other fiber evidence:

i. Cloth - photograph as to location and collect as evidence.

ii. Fabric marks - collect the entire article and then submit it to the laboratory. If this is impossible, photograph the marks with the inclusion of a scale or through use of one to one (actual size) photo equipment.

10. Debris - soil - safe insulation

Collection of samples - best taken directly from the footprint or tire mark after is has been photographed and cast. Two tablespoons of soil or debris are generally sufficient. Additional samples of the same size should be taken from the four compass points surrounding the area of interest at a radius of a few feet and then a second set at a radius of 25 feet. The purpose of these samples is to determine the individuality of the area of interest. Samples should be kept separate by being placed in clean cardboard containers. Careful notes should be maintained containing the origin of these samples. If the samples are not dry, they should be allowed to do so before being sealed in their respective containers. If the soil or debris is on a suspect's clothing, the clothing should be packed in paper with paper between any folds or layers.

a. In hit and run cases, every effort should be made to preserve the chunks of soil commonly found at the scene. These should be packaged in cartons containing a cushioning of paper to preserve their condition for layering examination at the laboratory. When taking known samples in this type of case, samples should be taken from all four fenders of the offending vehicle as the layering will vary considerably.

11. Glass

a. Photograph the fractures both generally and specifically as information such as direction of force and sequence of fractures may be determined. Be sure to include a scale.

b. With small articles, submit all pieces as a physical match may be possible.

c. With large articles, known standards from the area of the break must be taken for possible future comparison to glass found on any suspects. The known standards should be marked indicating which side of the glass faced outside and which side faced inside.

d. If fingerprints are not a consideration, the glass should be packaged by taping the pieces to a rigid container after cushioning to prevent further damage. Be sure to submit all pieces as a physical match may be possible.

12. Paint

a. Photograph the area in question both with and without a scale.

b. Collection of paint evidence may be accomplished with the use of tape to insure getting intact pieces of the paint.

c. Known standards may be obtained by chipping the paint to the underlying surface, intact, to insure layer sequence. Allow these chips to fall into paper which is to be folded in the "druggist fold", which in turn is placed in a labeled envelope and sealed.

i. Collect known standards adjacent to the area of interest to be used as a control and package in the same manner as previously mentioned.

13. Tool marks

a. Begin by taking overall photos of the object containing the tool mark to show its nature and relationship to the scene.

b. Take a second set of photos that will show the tool mark specifically so that detail can be seen. (Note that as tool marks are three dimensional and photographs are two dimensional, examinations cannot be made from photos alone).

c. Collection of tool mark evidence

i. By far, the best method for comparison of tool marks is to secure the actual item containing the mark and submit it to the laboratory along with the suspected tool. Care must be taken to protect the working area of the suspect tool by wrapping it in paper. Under NO circumstances should the investigator attempt to fit the tool into the mark as it may destroy the very evidence that is to be examined by the expert.

ii. In dealing with large articles or non-removable articles, the tool mark itself may be cut out of the object bearing it. If this is impossible, the investigator has the option of making a silicone cast to the tool mark. Silicone is recommended for this replica as it will reproduce the necessary detail for examination. Plaster of Paris is NOT recommended for this type of casting.

(a) Silicone kits are commercially available and the individual kit instructions should be followed. The investigator may press the strings of an identification tag into the edges of the casting material in a way that will not affect the cast itself. This tag can then be filled out with the proper identification data.

14. Firearms

a. Photograph the weapon as found at the crime scene and mark the location of the weapon on the sketch.

b. It must be noted that any weapon found at a crime scene may contain fingerprints. Bearing this in mind, the weapon should only be handled by the surfaces that normally would not yield fingerprints, i.e., checkered grips, edges of the trigger guard or knurled, finned or roughly machined surfaces manufactured into the weapon for the purpose of creating friction for gripping.

   i. The investigator should also be alert for the presence of other trace evidence such as hair, blood, tissue, bone fragments, glass, and fibers. Under no circumstances should the weapon be cleaned or wiped off as this trace evidence may be destroyed. If the investigator suspects that this evidence may be present, this fact should be made known in the form of a request for trace examination to the person receiving it at the laboratory.

c. Notes should include information on: the time the weapon was found, the condition of the weapon (i.e., safety on or off, hammer cocked, slide back, jammed, etc.), the position of any live rounds or cartridge casings near or inside the weapon, and all identification data on the weapon, i.e. make, model, caliber and serial number.

d. When picking up the weapon, DO NOT ALLOW ANYTHING TO BE PLACED IN THE BARREL.

e. Unload the weapon noting the location of fired and unfired cartridges. Sketch cylinder when dealing with revolvers, noting the type and condition of each chamber. Cartridge casings and bullets should <u>NOT</u> be marked in any way. They should be placed in individual envelopes, marked with identification data and then sealed. The purpose of this is to keep the bullets or casings from scratching each other thus altering or obliterating the marks that the firearms examiner will use for identification.

f. In dealing with pistols and other weapons that load from a clip, remember to unload the live round that may be in the chamber. It is not necessary to unload the live rounds from the clip after it has been removed from the weapon.

g. Since the identification data such as serial number, make, model, and caliber have already been recorded in the investigator's notes, it is not necessary to mark the weapon physically. The exception to this would be if the serial number is missing due to being ground off. However, a tag should be attached to the weapon containing such information as case number, investigating officer, town of crime, and accused.

h. If the weapon is to be transported to the laboratory for fingerprint processing, it should be immobilized in a fashion to prevent surface friction from obliterating the prints. The most common method of doing this is to mount the weapon on cardboard with string.

i. If the weapon is not unloaded at the crime scene for any reason, the seizing officer should personally transport it to the laboratory at the first opportunity. Any packaging should bear the words, "CAUTION LOADED FIREARM", in plain sight.

j. If any additional ammunition for the weapon found at the crime scene is found, it should be collected for use as a known standard.

k. In the event that the weapon is recovered under water, it should be transported to the laboratory as soon as possible before any further deterioration from rust occurs.

15. Obliterated serial numbers

a. Handle as any other evidence by preserving the area of interest and then submitting it to the laboratory for number restoration (see Figure 15 & 16).

16. Body fluids

a. Clothing that is wet with any body fluid should be allowed to air dry naturally. Identification data is to be marked away from the stained area on the garment which is to be packaged in <u>clean wrapping paper or paper bags</u>. Folding of garments through stained areas should always be avoided. Under no circumstances should this type of evidence be placed in any plastic or air tight container as the putrefaction of the evidence will take place readily, making it useless for analysis. Do not shake out the clothing as it is packaged and <u>DO</u> place paper between the layers of folded clothing. If articles are found in a pile, note their order in the pile as they are picked up and packaged as it may aid in the reconstruction of the crime.

Figure 15: An obliterated (ground off) serial number is shown just to the upper right of this pistol's grip, over the trigger.

Figure 16: The obliterated serial number is visible after being raised by members of the firearms section of the laboratory.

b. Blood (See Tables 4 and 5)

i. Liquid samples - if present, efforts should be made to collect a sample of it before it coagulates. Samples should be taken by using a clean pipette or medicine dropper. The blood should be placed in a sterile stoppered test tube with EDTA an anticoagulant and kept under refrigeration but not frozen. The sample should be delivered to the laboratory as soon as possible. An alternate method is to place sterile gauze in the blood, allow it to dry and then package it in paper.

ii. Dried blood stains - if possible, the entire article containing the stain should be transported to the laboratory. If this is not possible, the stain should be cut out of the article and then packaged in paper. In those cases where the stain is on something solid and non-absorbent, there are two methods:

(a) The stain may be scraped off the article into a paper. This paper is then folded in the "druggist fold", placed in an envelope and sealed.

(b) The stain may be eluted onto cotton thread moistened in saline solution by rubbing the thread on the stained area. The threads are then allowed to dry and are placed in a paper envelope which is then labeled and sealed. Always obtain a control by repeating the same procedure in an area adjacent to the suspected blood stain.

iii. Blood stains on clothing - if the victim is alive and it becomes necessary to cut the clothing off, avoid cutting through the stained area or holes that may have been caused by a bullet or weapon as this will destroy valuable physical evidence.

iv. Known standards - if it is possible to obtain two tubes of liquid blood sample from the victim and the accused, it should be obtained by a doctor - one tube should contain EDTA and one tube should have no anticoagulant. This step should not be overlooked by the investigator since the typing of liquid blood samples greatly facilitates the information available to the case in terms of quick results and further management.

TABLE 4

COLLECTION OF BLOOD STAINS AT CRIME SCENE

Blood Location	Collection Mode
Crusts of dried blood	Scrape into clean vial
	Scrape into paper envelope
	Collect material from surrounding area as a control
Stained knives, rocks	Bring to lab intact
Upholstery, rugs (fabric)	Cut out section and bring to lab
	Cut out unstained section and bring to lab
Stains on walls	
Small stains	Moisten unused 3/8 inch cotton thread (#8) with water and swab stained area gently until thread has uniform deep red or brown color -- collect as many threads as possible
	Also collect a control area
	Let air dry in unstoppered vial
Very small stains	Use thinner thread
Large stains	Scrape the stain into paper envelope
Clothing	Air dry at room temperature
	Keep out of direct sunlight
	Put each item in a separate bag and staple shut -- never use plastic bags

TABLE 5

COLLECTION OF WHOLE BLOOD AT CRIME SCENE

Blood Condition	Collection Mode
Fresh-wet-not clotting	Use hyprosyringe - Put blood into EDTA vial
	Disposable glass pipette equipped with suction bulb - Put blood into EDTA vial
Fresh-wet-thick-clotting	Add equal volume physiological saline to preserve red blood cells
Wet blood from suspects	Collect 2 tubes EDTA (not NAF) - one with anticoagulant - the other without any anticoagulant
	Transport to lab
	Keep cold if overnight storage is necessary Do not freeze

v. Blood patterns - It is necessary to photograph blood patterns regardless of whether the sample is liquid or dried in order to facilitate the reconstruction of the crime. Much information can be gained through the study of these patterns, i.e., direction of blood flight, objects or persons present or absent during the crime, motion of victim or weapon, etc.

vi. Field tests for blood (presumptive)

A positive reaction by any of the following tests will only indicate the possible presence of blood. Suspect stains should then be subjected to confirmatory crystal tests at the laboratory. If the chemicals have been tested on known standards of blood prior to testing on the suspected blood stains, the lack of a reaction on the unknown stain can be deemed as absent blood. A positive reaction only indicates the possible presence of blood and does not indicate the species of the donor. Since all presumptive tests are subject to false positive reactions, confirmatory testing is performed at the laboratory.

(a) Phenolphtalin (Kastle-Mayer reagent) - conducted by rubbing a cotton swab that has been moistened in a saline solution on the suspected blood stain. A drop of the phenolphtalin-alcohol reagent is added to the swab, and then a drop of hydrogen peroxide. A positive reaction will turn the swab pink within 20 seconds.

(b) Leuco Malachite Green Test (LMG) - performed by rubbing a saline moistened swab on the suspected blood stain and then applying the prepared reagent and hydrogen peroxide to the swab. A positive reaction is indicated by a greenish-blue color that will appear almost immediately.

c. Ortho-Tolidine Test - Application is similar to other presumptive test reagents. A positive reaction is indicated by an intense blue color. There are reports to indicate this reagent might be carcinogenic.

TABLE 6

FIELD INVESTIGATION KIT

BLOOD COLLECTION EQUIPMENT

Sterile bandage gauze

Cotton thread

2 dozen disposable pasteur pipettes & 2 rubber suction bulbs

Small bottle distilled water

1 dozen EDTA blood collection tubes

1 dozen blood collection tubes

CONTAINERS

Scotch tape dispenser

Manila envelopes (2 dozen each of 4 sizes)

3 3/8" x 6", 6" x 9", 9" x 12", 11 1/2" x 14 1/2"

One-half (1/2) dozen small screw cap vials

2 dozen corked test tubes

Rubber bands

MISCELLANEOUS SUPPLIES

Large and small tweezers (plain, uncorrugated tips)

Scapel and spare blades

Straight-bladed scissors

Disposable tissues

1 package 3" x 5" cards

(d) Luminol Test - the reagent is simply sprayed onto the object to be checked for the presence of blood, but it must be viewed in total darkness. A positive reaction will luminesce within 5 seconds.

c. Seminal Stains

i. Because spermatoza are quite brittle in a dry form, the investigator must be careful in handling suspected stained areas. It is recommended that handling of the evidence be kept to a minimum and that under no circumstances should any article suspected of containing a semen stain be folded through the stain as the tails of the spermatoza are likely to be broken off, making them difficult to locate under a microscope. An additional advantage to minimum handling is that articles of trace evidence, such as pubic hair, will not be lost.

ii. After making certain that the articles containing stains are dry, the evidence should be packaged in paper and transported to the laboratory.

(a) If the article is too large to be taken as evidence, first photograph it in its virgin condition, then cut out the portion of that article that contains the stain. The evidence should then be packaged as previously mentioned and submitted to the laboratory.

(b) The investigator should make attempts to obtain a saliva sample from any suspect so that his secretor status can be determined at the laboratory.

d. Saliva

i. Saliva has greater evidentiary value than other body fluids, with the exception of semen, as it contains a high concentration of blood group antigenic substances. It is commonly found on cigarette butts at crime scenes. If these butts are not contaminated with dirt or other foreign matter, it is possible to obtain ABO blood typing if the smoker is a secretor. It is not possible to do this with cigars.

Additional evidence containing saliva may include toothpicks and chewing gum. When handling this form of evidence, the investigator should take care not to handle it on the stained area as it may be contaminated by the perspiration of the evidence collector.

ii. Known origin saliva samples should be obtained from rape victims and suspects alike to determine their secretor status. They may be collected directly in clean filter paper by allowing the fluid to dry and then circling the stained area with pencil.

(a) An alternate method is to have the donor chew either a small piece of filter paper or sterile gauze until it is saturated with saliva, allow it to dry, and then place the sample in a labeled paper envelope and submit it to the laboratory.

(b) Liquid saliva sample could be collected into a test tube.

e. Other body fluids

i. Approximately 80% of the population are secretors. ABO blood group antigens can be found in their body fluids such as perspiration, saliva, urine, tears, mucus, feces, and vaginal secretions. These antigens can be identified at the laboratory and the blood group of the donor can be determined.

ii. As most body fluids encountered in crime scene processing are in the form of dried stains, they should be handled in the same manner as dried blood stains. If possible, the stained object should be submitted to the laboratory. If this is not possible, the stained area should be cut from the object and packaged in paper in a fashion to avoid folding it through the stain. In this instance, a portion of the object that is not stained should also be cut from the object and submitted to the laboratory for use as a standard. This standard should be packaged separately.

(a) If the samples are in liquid form, they should be collected in glass containers and sealed. No preservatives are necessary.

17. Accelerants

a. Suspected accelerants at arson scenes should be collected by the investigator as soon as conditions at the fire scene permit. By their very nature, accelerants will tend to evaporate quickly, therefore, articles suspected of containing them must be placed in airtight metal containers as soon as possible.

b. Containers. The preferred type of container is a new metal paint can. The investigator must bear in mind that the container must remain airtight and that many accelerants dissolve plastic and rubber. Glass jars are acceptable but should be packaged in a manner to avoid breakage of the container itself. When choosing a container for arson evidence, choose one that will allow head space within the container to allow the accelerant to evaporate into. It is from this head space that samples will be taken for analysis at the laboratory. (See Figure 17)

c. Crime scenes. The investigator must bear in mind that it is of utmost importance to locate the point of origin and all of any mechanical, chemical, or other simple devices used to ignite the accelerant or to spread the fire (trailers). It is also possible that, due to the intensity of the fire or the nature of the accelerant, there will be no traces of the accelerant readily detectable. As such, absorbent materials in the area of the point of origin should be sampled and packaged as mentioned above. Absorbent materials may include wood floors, wall board, wood paneling, soil, fabrics, paper, and debris. It is quite likely that these materials will contain traces of the accelerant.

   i. Liquids. Collect them in a glass jar or small, clean, airtight test tube.

18. Documents

a. Questioned samples. The investigator must exercise care in the handling of document evidence, particularly regarding the presence of latent fingerprints. The document must be handled as little as possible while being placed in a clear plastic envelope. Tweezers or tongs should be employed for this task to avoid the investigator's fingerprints appearing on the evidence. No additional folds should be made nor should the investigator mark any identification data on the face of the document. As document evidence

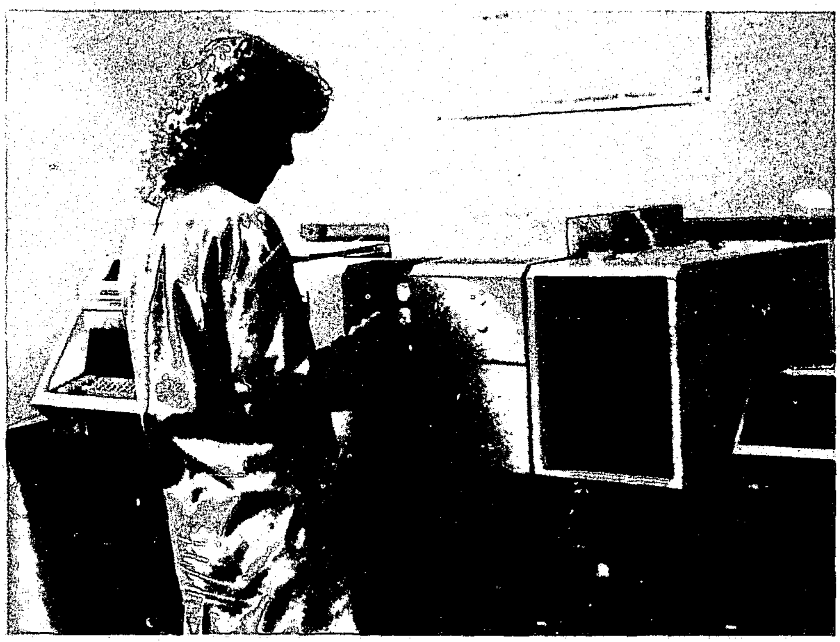


Figure 17: The gas chromatograph, which is used to examine arson evidence, is shown here.

is not automatically processed for fingerprints, if this is to be a consideration, the submitting agency should so indicate in their letter of transmittal. This letter should be affixed to the outside of the envelope containing the evidence. It is necessary to inform the laboratory of the dual processing as the chemical processing for latent prints will cause the paper to discolor and may also dissolve certain inks. Therefore, the document must be photographed by the laboratory prior to the application of the fingerprint processing chemical.

b. Known standards. The most important thing for the investigator to remember is to duplicate the conditions under which the questioned document was made as closely as possible regarding writing instrument, type and size of paper, context of the written message, and writing type or style. Known standards should be dictated to the suspect by the investigator to preclude the suspect seeing and then imitating the questioned sample. The known samples should be removed from the view of the suspect as soon as they are written. The suspect should be encouraged to write the entire questioned sample verbatim several times, if possible, until the investigator is satisfied that the subject is writing naturally and has given up any attempt to disguise the sample. Additionally, the suspect should be required to repeat the process using the unnatural hand. There should be no attempt to assist the suspect in spelling or with grammar. Seat the suspect in a chair placed at a table to insure comfort and natural writing conditions. The situation in which the suspect has been placed is inherently stressful, since the sample is to be used in a police investigation. Efforts to obtain samples that are commonly found on documents filled out in the usual course of business should be made. (See Table 7 for suggested handwriting sources). These samples will normally be free from any attempts at disguise and for this reason may be superior to the requested samples.

   i. Known standards for typewriters or business machines. Attempts should be made to secure the suspected machine and to submit it to the laboratory along with the questioned sample. If this is impossible, at least three reproductions of the text of the questioned sample and three reproductions of all the characters on the suspect machine should be made. The investigator should not overlook the fact that many typewriters now use "one time" ribbons. Such a ribbon could have the text of the message being examined embosed on it. In such an instance, the ribbon should be taken off the machine and submitted as evidence.

TABLE 7

WHERE TO FIND HANDWRITING SAMPLES

Sources of Genuine Writings

1. City Records
   Building Department permits
   City Auditor: canceled checks
   City Clerk: licenses (peddler, tavern, special permits, etc.); voters registration lists
   Personnel Department: Civil Service applications

2. County Records
   County Clerk: Civil Service applications, claims for services or merchandise, fishing, hunting, marriage licenses
   Department of Taxation: State income tax returns
   Purchasing Department: bids and contracts
   Register of Deeds: deeds, birth certificates, public assistance applications, ID card applications
   Selective Service (local board): registrations appeals

3. Department Store Records
   Complaints and correspondence
   Credit applications
   Receipts for merchandise
   Signed sales checks

4. Drug Store Records
   Register for exempt narcotics, poisons

5. Education Documents
   Applications for entrance
   Athletic contests
   Daily assignments
   Examination and research papers
   Fraternity and sorority records
   Receipt for school supplies (laboratory, athletic gear)
   Registration cards and forms
   Federal and State Loan and Grant applications

6. Federal Records
   Customs documents: immigration and naturalization records
   Department of Justice (FBI): fingerprint cards, National fradulent check file, checkwriter standards file, safety paper standards file, rubber stamp and printing standards file, typewriter standards file
   Military records
   Patent office applications
   Post Office Department: P. O. box application, registered and special delivery receipts

TABLE 7 (CONTINUED)

Social Security Administration: applications for numbers, benefits
U.S. Treasury: canceled payroll checks
Veterans Administration: application for benefits (veterans and widows)

7. Financial Documents
Canceled back checks
Contracts and related correspondence
Credit applications, for example, to a department store
Deeds
Deposit slips
Expense accounts
Insurance documents including health and accident
Lease agreements
Loan companies records
Microfilm bank records
Pension applications and checks
Promissory notes
Safety deposit vault register and applications: bankruptcy proceedings, cash received slips, withdrawal slips
Title companies documents

8. Hospital Records
Admission releases

9. Library Records
Applications for cards

10. Miscellaneous Documents
Administrator, estate
Airplane logs
Answers to decoy letters
Architects plans
Asylums
Auctions
Bail Bonds
Building after hour registers
Close associates
Complaint bureaus generally
Copyright applications
Death certificates
Decoys, deliber receipts, return receipts for registered mail
Exchanges
Express company, cartage, mover's receipts
Express records and receipts
Furniture contracts
Guardian
Janitors (wastepaper)
Legal papers, generally
Messengers receipts
Neighbors
Newspaper reporters

TABLE 7 (CONTINUED)

Notaries
Office boys
Partners
Permit to open mail
Railroad passes
Rent receipts to tenants

11. Military Documents
Bases and stations: National Guard, Army, Air Force, Navy, Coast Guard, Marines
General service related papers: tax exemption fillings and lean, real estate, pension, medical educational
Record depots (for ex-service men)
Selective Service (draft board) records

12. Motor Vehicle Documents
Applications for registration
Court documents relating to accidents
Credit card applications and invoices based thereon
Hotel and motel registration and reservations based upon routes of travel, as gleaned from credit purchases
Installment contracts on vehicle purchases
Insurance papers
Operator's and chauffeur's licenses and applications therefor
Orders for service
Reports of accidents
Report of loss or theft

13. On the Person
Contents of wallet (signed ID cards of all types, and photographs)
Letters, postcards
Notebooks
Passport

14. Personal Documents
Autograph albums
Automobile repair work order receipts
Back of photographs
Bank account books
Birth and baptismal certificates and records
Book contracts
Books in general (flyleaf signatures)
Canceled checks
Check stubs
Correspondence and postcards
Diaries
Family Bible
Greeting cards
Hospital and medical records
Insurance policies
Labeling on cans, bottles, etc. (kitchen, workshop)
Marriage documents
Memoranda about home and office such as a note to milkman, etc.
Military service records

TABLE 7 (CONTINUED)

Pages of photograph albums
Passports
Personal notebooks
Prescriptions
Rent receipts (receipts in general, i.e., movers, credit)
School yearbooks
Telephone and correspondence listings
Wills

15. Police Sheriff's Department Records and General Criminal Documents
Arrest Records (including fingerprint cards)
Complaints and reports to police departments, sheriffs, district attorneys, etc.
Court of Claims
Court clerks
Exemplers obtained incident to booking procedures
Jail and penitentiary records
Jury records
Juvenile Court
Parole and probation reports
Receipts for returned property
Writings obtained by other agencies in prior investigations
Writings obtained by your own agency in prior investigations

16. Public Utility Records (Corporate Documents)
Applications for service: cable television, electricity, garbage, gas, telephone, water
Book of account
Invoices
Minutes
Original telegram messages
Reports to intre and interstate and commerce agencies

17. Real Estate Records
Property listing agreements

18. Relatives
Letters and cards of all types

19. Social, Recreational, Fraternal Documents
Documents relating to: civic organizations, clubs (luncheon, sports, etc.), loges, nonprofit groups, political groups, PTA organizations, religious organizations

20. State Records
Conservation files: boat, fishing, hunting licenses
Corrections files: probation and parole reports
Incorporation documents (these filed with state agencies)
Motor vehicle files: drivers files, title files
Personnel files: Civil Service applications and examinations
Secretary of State: applications for notary public
State Treasurer: canceled checks
Taxation files: beverage and cigarette tax applications

TABLE 7 (CONTINUED)

21. Vocational Documents
    - Account books
    - Applications for employment
    - Applications for professional and vocational licenses
    - Canceled payroll checks
    - Civil Service papers
    - Clients checks
    - Credit Union paperwork
    - Employment bureau and personnel office papers
    - Labor union documents
    - Order blanks
    - Professional rolls
    - Public examinations (Civil Service, etc.)
    - Receipt books
    - Receipted bills
    - Receipts for pay
    - Reports and surveys
    - Secretary
    - Stenographic and clerical memoranda
    - Time cards
    - Vacation and petty cash requests
    - Withholding exemption forms

This table is taken from "Crime Scene Search and Physical Evidence Handbook" by Richard Fox and Carl L. Cunningham, published by U.S. Dept. of Justice Law Enforcement Assistance Administration - National Institute of Law Enforcement and Criminal Justice, Oct. 1973.

ii. Charred Documents. Because of the fragile nature of this particular evidence, care must be exercised in picking up and packaging. The best method of picking up charred documents is to slip a thin but stiff piece of paper under the evidence and then place it in a cotton cushioned cardboard container that will allow complete protection without crushing it.

iii. Indented Writing. This type of evidence should be handled in the same fashion as charred documents, i.e., package in a manner to prevent crushing or flattening of the evidence. Only the container holding the evidence should be marked by the investigator. Under no circumstances should pencil be applied to the evidence in an effort to make the text legible as this will likely destroy it. The best method of viewing the text is to view it with a light source held at an oblique angle to the document and then to record the message with photography.

19. Voice Identification

a. Questioned sample. In the vast majority of cases, the only equipment needed to obtain the unknown sample (telephone calls) is a good quality recorder and an induction telephone pickup coil. The victim can easily be taught to activate the recorder as the telephone rings for each incoming call. If the call is recorded by an automatic system as is commonly found in a police or fire department, it becomes necessary to make a second or dubbed recording for laboratory analysis. This is accomplished through the use of a second recorder and a patch cord attached directly between both recorders, thus eliminating any noise occurring in the environment of the recorders. If this method is utilized, no significant information for identification is lost. Should there be an absence of jack outlets on the original recording machine, the microphone for the second recorder may be placed in front of the speaker of the original recorder. This is the least desirable method as the resultant tape will now contain any additional noise present in the recording site plus a loss of information that was present on the original tape. Should this seem to be the only method available, the Voice Identification Unit of the Laboratory should be consulted for an alternate means of recording the sample.

b. Known samples. It is of primary importance that the context of both samples be identical. Random conversations will not be sufficient for comparison purposes. The investigator should make every effort to duplicate the questioned sample as closely as possible regarding context and conditions under which it was recorded, i.e., telephone, live conversation, or radio. Remember that while the quality of the questioned sample cannot be controlled, in many instances the quality and the environment in which the known sample is recorded can. To insure uniformity between the samples, efforts should be made to record them in surroundings that are free from other sounds which may mask the samples. It is necessary in longer samples to have a transcription of the unknown sample. This will assist the investigator in obtaining a known sample and will also assist the Voice Identification Technician in examining the samples. The investigator should make every effort to insure that the suspect repeats the context duplicating inflection, speed, and, if possible, the emotion shown in the unknown sample. As reading out loud produces flat, robot-like samples, it is preferable that the investigator read the sample, a phrase at a time, to the suspect for repetition by that suspect. The entire sample should be repeated for the recording three times so that it is a more natural sample of the suspect's normal speaking habits. It is perfectly permissible to have the investigator's voice on the tape as well as the suspect's voice. The tape should be prefaced with information containing the identity of the speaker, who is present, and the date and time of the recording. Known samples may be obtained -- voluntarily or by court order. Should the investigator need more information on methodology, he may contact the Voice Identification Unit at the Laboratory.

PART THREE

EVIDENCE SUBMISSION

III. EVIDENCE SUBMISSION TO THE LABORATORY

After packaging evidence as indicated, it is necessary to draft a cover letter or letter of transmittal to the Laboratory. In this letter should be information as to the nature of the case, date, location, suspect or accused, and the victim's identity. The letter should also include an inventory of all the evidence submitted, listed by exhibit numbers which shall run in consecutive order for all the evidence in the case, even if it is not submitted at that particular time. All examinations on articles of evidence should be specifically requested. The formats, shown in Figures 18 and 19, are recommended.

REQUEST FOR EXAMINATION
OF PHYSICAL EVIDENCE
SP-997-C (Rev. 10/83)

Department of Public Safety
Division of State Police
Forensic Laboratory
294 Colony Street
Meriden, CT 06450-2098

FOR LABORATORY USE ONLY
Lab # ________
Receipt # ________

SUBMITTING AGENCY: ________	TYPE OF CRIME/INCIDENT: ________
ADDRESS: ________	________
TELEPHONE NUMBER: ________	LOCATION: ________
CASE NUMBER: ________	DATE: ________
CASE PREVIOUSLY SUBMITTED? [ ] YES [ ] NO IF YES, LAB ID#: ________	EVIDENCE EXAMINED BY ANY OTHER AGENCY? [ ] YES [ ] NO

VICTIM(S) NAME	D.O.B.	RACE	SEX	SUSPECT(S) NAME	D.O.B.	RACE	SEX

SUMMARY OF CASE:

LIST ITEMS SUBMITTED BELOW *(NOTE: Each item must bear an evidence tag or label.)*

ITEM #	NAME AND DESCRIPTION OF ITEM TO BE EXAMINED	EXAMINATION REQUESTED

(IF THIS SPACE IS INSUFFICIENT, CONTINUE LIST ON THE REVERSE SIDE OF THIS FORM.........)

REMARKS:

NAME OF PERSON REQUESTING EXAMINATION:	DATE:

Figure 18

CONTINUATION OF LIST OF ITEMS SUBMITTED

ITEM #	NAME AND DESCRIPTION OF ITEM TO BE EXAMINED	EXAMINATION REQUESTED

Figure 18 continued

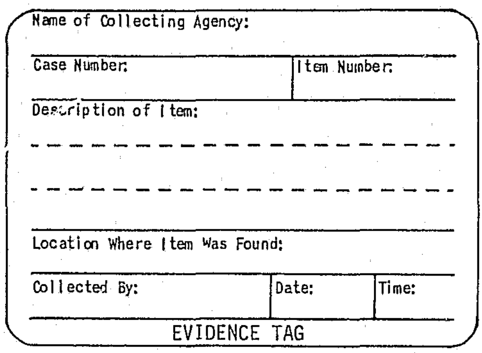


Figure 19: Suggested Format of an Evidence Tag (giving the minimum information required).

TABLE 8

PHYSICAL EVIDENCE PACKAGING CHART

ACCELERANTS		Submit a small amount in either a metal container or a glass bottle capped with a top without a plastic gasket-for liquid samples. For debris containing suspected accelerants, use new paint cans with airtight tops. Fill the container approximately half full to allow for head space for testing at the laboratory.
BLOOD	(liquid)	Collect and place in a clean glass stoppered container. Refrigerate and deliver to the laboratory as soon as possible.
	(dry stain)	Submit the whole article to the laboratory or cut out that portion containing the stain. If the stain is on a solid object that cannot be taken, scrape the stain off into a paper using a clean razor blade. Fold the paper into the "Druggist Fold" and place it in a paper envelope bearing the proper identification data.
BULLETS	(not live rounds)	DO NOT MARK IN ANY WAY. Package each bullet SEPARATELY and label with identification data.
LIVE ROUNDS		DO NOT MARK IN ANY WAY. Package separately in envelopes to preserve any markings on them.
CARTRIDGE CASINGS		DO NOT MARK IN ANY WAY. Place in SEPARATE envelopes, seal and mark with identification data.
CLOTHING		If wet with blood or other body fluids, air dry at room temperature. Do no accelerate drying with a fan or heater. Mark garment with identification data and package it in PAPER using additional paper between folds as needed. DO NOT USE PLASTIC BAGS.
CHARRED DOCUMENTS		If found in container, package the entire container and submit to the laboratory. If found loose, slip cardboard under the document, place in a container partially filled with cotton to restrict movement, package and transport to laboratory.

PHYSICAL EVIDENCE PACKAGING CHART (continued)

DOCUMENTS/CHECKS		Place in plastic envelope using tongs or tweezers. Seal envelope after placing label on the face of the envelope containing identification data. DO NOT HANDLE THE DOCUMENT WITH FINGERS AS IT WILL RUIN FINGERPRINT EVIDENCE.
FINGERPRINTS	(latent)	Immobilize article in a way to prevent friction on the fingerprint bearing surface. Submit the entire article to the laboratory.
	(visible)	Photograph and then submit entire article to the laboratory. DO NOT ATTEMPT TO PROCESS BY DUSTING WITH FINGERPRINT POWDER.
FIREARMS		Unload the weapon taking care not to ruin possible latent fingerprint evidence. Note manufacturer's name, caliber, model, serial number and the presence or absence of ammunition and shell casings. Immobilize the weapon by mounting it on cardboard with string and transport to the laboratory. During this process, the weapon should be handled by the checkered grips or edges of the trigger guard.
GLASS		Package in paper, taking care to protect any broken edges in case it is possible to make a physical match. Place wrapped glass in a solid protective container labeled with identification data.
HAIR AND FIBERS		Place samples in paper folded in the "Druggist Fold". The paper is then placed in an envelope and sealed. The proper identification data is then placed directly on the envelope.
PAINT		Handle as hairs and fibers. If the chips are large and a physical match is possible, the chips must be protected by placing them in a pill box or other protective container.
PLASTER CASTS		Package in a large firm container containing newspaper to cushion the cast and prevent breakage. Do not attempt to clean the bottom of the cast as damage may result. Identification data should be marked into the cast before it is completely hardened.

TABLE 8 (CONTINUED)

PHYSICAL EVIDENCE PACKAGING CHART (continued)

SOIL/SAFE INSULATION	Place in cardboard pint containers. Label with identification data and be sure to include the precise location of the origin of the sample.
TOOLS	The edges of tools must be protected from damage by wrapping in newspaper. Identification data should be written on a tag which should be attached to the tool. Regarding tool marks-secure the entire article or cut out that portion conaining the mark. If this is not possible, make a silicone cast of the mark.

PART FOUR

LABORATORY EXAMINATION OF PHYSICAL EVIDENCE

IV. LABORATORY EXAMINATION OF PHYSICAL EVIDENCE

In recent years, there have been rapid advances in scientific knowledge and instrumentation techniques. These advances have found their way into and become an important integral in the scientific criminal investigation. For example: Lasers are now being used in soil, glass, and fingerprint examinations, X-Ray powder diffraction, atomic absorption spectroscopy, and SEM-EDX have been used extensively for the identification of chemicals, metals, and other trace. TLC, LC, GC, GC-MS, and HPLC are used routinely in drug, explosive, and arson cases. Cellulose acetate electrophoresis, starch gel electrophoresis, immunoelectrophoresis, immunofixation, crossed immunoelectrophoresis, electrofocusing, isotachophoresis, and two dimensional electrophoresis have provided powerful and sensitive tools for examination of blood, hair roots, seminal stain, tissues, and other physiological evidence.

PART FOUR is devoted to briefly introducing the current state of the art in various areas of forensic science and the newest developments in the criminalistics field and by no means is it to be considered complete.

A. Accelerants

1. *Types of accelerants*

   a. Petroleum distillates: Most accelerants fall into this category.

      i. Straight run products: Those mixtures which are produced during the distillations process with little further processing. These include lighter fluid, kerosene, fuel oils, and others.

      ii. Processed products: Extra steps in the distillation process are necessary for the production of benzene, toluene, gasolines, and other products.

   b. Non-petroleum accelerants: Turpentine, alcohols, and mineral spirits.

2. *Laboratory analysis of accelerants*

   a. Visual examination: All evidence is quickly macroscopically and microscopically examined for other types of physical evidence.

   b. Liquid sample analysis: These may be used as supplied or "dried" as necessary.

i. Gas chromatography: A small sample is injected into the instrument and peak patterns and retention times are compared to known standards. (See Figure 20).

ii. Infrared spectroscopy: If the liquid is a pure sample, spectra are run and compared to known organic substances.

iii. GC-IR or GC-Mass spectroscopy: Interfaced with the gas chromatograph, the infrared spectrophotometer of mass spectrophotometer allows for analysis of each component upon separation in the GC.

iv. Determination of physical properties: Refractive index, boiling point, and flash point of the liquid sample can be determined and are characteristic properties.

v. Thin layer chromatography: Many liquids, such as gasolines, contain dyes which can be removed from the accelerant and separated on a TLC place. These dyes may help to identify the manufacturer of the accelerant.

c. Solid samples: Recovery of accelerants from submitted solid samples (usually debris) is necessary for proper analysis using the gas chromatograph.

i. Cold head space: A sample of the atmosphere above the specimen within the sealed container is withdrawn and injected into the GC for analysis.

ii. Heated head space: After the above sample is removed, the container is heated to 100°C, causing the release of more vapors into the atmosphere surrounding the debris. A sample of this vapor is also removed and injected into the GC.

iii. Distillation: The debris may be placed in a flask and heated with steam. Upon cooling of the vapors produced, liquids of the more volatile hydrocarbons are collected.

iv. Solvent extraction: Debris is placed in a solvent and the mixture of soluble components and solvent is concentrated before injection into this GC.

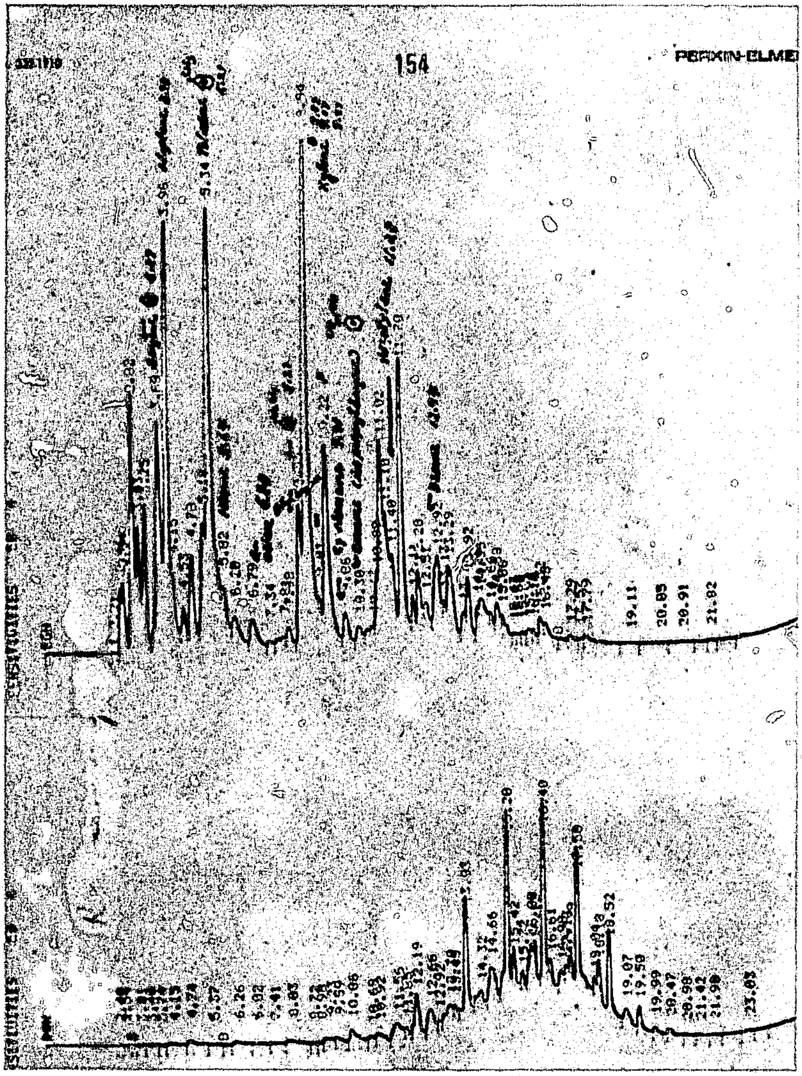


Figure 20: These chromatograms, showing the analysis of kerorene on the lower portion of the photograph and gasoline . · the upper portion, illustrate the differences in retention time of the components of the chemical compositions.

3. New Developments

   a. Carbon adsorption: Debris is heated and the vapors released are passed through a charcoal tube which will adsorb these components. Extraction from the carbon is then performed. The recovery of this method is extremely high.

   b. Capillary column (see Figure 31).

B. Blood

1. Identification of blood

   a. Presumptive tests: These tests are based on the reaction of a portion of hemoglobin with chemical reagents, such as o-tolidine, phenolphthalin, luminol, benzidine, and leucomalachite green.

   b. Confirmatory tests: These are not as sensitive as the presumptive tests, but are necessary to prove that the suspect stain is, in fact, blood.

      i. Microcrystal tests: Chemical reagents react with heme components of the blood producing characteristic crystals.

      ii. Chromatographic test: Paper or thin layer chromatography is used to identify hemoglobin.

      iii. Spectral test: Instrumental analysis based on the way hemoglobin absorbs light.

      iv. Immunological test: Anti-human hemoglobin is used. This test also confirms that the blood is human.

2. Species tests

These tests determine the origin of a bloodstain. In the immunological precipitin test, anti-serum for a particular species, such as anti-human serum, gives a visible reaction with serum proteins.

3. Blood typing in dried bloodstains

Various antigens, antibodies, and serum proteins can be identified in blood evidence. Factors such as the age and condition of the stain affect testing.

   a. Detection of antibodies in serum (Lattes test): Addition of red blood cells of known type causes them to be agglutinated if antibodies against them are present in the stain.

b. Detection of blood group antigens: Three methods have been used for the detection of an antigen on the red cell surfaces. (See Table 9) They are:

i. Absorption - Inhibition

ii. Absorption - Elution

iii. Mixed Agglutination

c. Typing of red blood cell isoenzymes: Separation of genetic markers on the red cells based on the electrophoretic mobility of these substances gives additional grouping information. (Table 10)

d. Typing of serum proteins: Separation of serum proteins by electrophoretic and detection by immunofixation techniques. (Table 11)

4. New developments

Many new developments have occurred for analysis of different genetic markers:

a. Isoelectric focusing: Separation of protein mixtures on the basis of differences in their isoelectric points. For example, the typing of red cell PGM by isoelectric focusing shows 10 different patterns instead of the 3 patterns seen with regular electrophoresis. (Figure 21)

b. Multi-system electrophoresis: Several genetic markers are analyzed by single electrophoresis run. For example, PGM, EsD and GLO systems can be typed with a single blood thread.

c. Gm and Km system: The serum protein Gm and Km factors can be typed by means of specific antibodies. These markers have reportedly been typed in bloodstains several decades old.

d. HLA system: Human leucocyte antigen system consists of a large number of factors and these factors are not only found on white blood cells, but also on tissue.

e. Sexing of bloodstain: RIA (Radio-Immunoassay) - immuno assay techniques have been used to detect the male and female hormones.

Table 12, following, shows the current state of the art in examinations of blood evidence.

TABLE 9

BLOOD-GROUP SYSTEMS

The approximate values for the white and black populations in the United States for many of the systems are shown in the following table.

		Approximate occurrence, %, In U.S. populations	
RED CELL SYSTEM	TYPES	WHITE	BLACK
ABO	A	40	27
	B	11	20
	O	45	49
	AB	4	4
Rh	Rh_o	2	48
	Rh_1rh	34	20
	Rh_1Rh_1	18	2
	Rh_2rh	12	14
	Rh_2Rh_2	3	1
	Rh_1Rh_2	13	3
	Rh	14	6
	Rarer types	4	6
MNS_s	MS	6	2
	MSs	14	6
	Ms	9	15
	MNS	3	3
	MNSs	24	12
	MNs	24	35
	NS	1	2
	NSs	5	5
	Ns	14	20
Kell	KK	<1	<1
	Kk	9	2
	kk	91	98
Duffy	Fy(a+b-)	17	9
	Fy(a+b+)	51	4
	Fy(a-b+)	32	23
	Fy(a-b-)	--	64
Kidd	Jk(a+b-)	27	55
	Jk(a+b+)	52	38
	Jk(a-b+)	21	7

TABLE 10

RED-CELL ISOENZYME SYSTEMS

SYSTEM (USUAL ABBREVIATION)	TYPES	Approximate occurrence, %, In U.S. populations WHITE	BLACK
Phosphoglucomutase (PGM)*+	1	59	66
	2-1	35	29
	2	6	5
Adenylate kinase (AK)*	1	93	99
	2-1	7	1
	2	<1	<1
Acid phosphatase (ACP; EAP)*	A	12	7
	BA	42	32
	B	40	58
	CA	2	1
	CB	4	2
	C	<1	<1
Glyoxalase 1 (GLO)*	1	18	14
	2-1	52	41
	2	30	45
Esterase D (ESD)*	1	79	84
	2-1	20	15
	2	1	1
Adenosine deaminase (ADA)*	1	90	97
	2-1	10	3
	2	<1	<1
Glutamate-pyruvate transaminase(GPT)	1	29	67
	2-1	49	29
	2	22	4
Uridine monophosphate kinase (UMPK)	1	91	98
	2-1	9	2
	2	1	<1
6-Phosphogluconate dehydrogenase(PGD)*	A	96	93
	AC	4	7
	C	<1	<1
Carbonic anhydrase II (CA)*#	1	100	81
	2-1	--	18
	2	--	1
Glutathione reductase (GSR)#	Usual	100	75
	Usual-variant	--	23
	Variant	--	2
Glutathione peroxidase (GPX)#	Usual	100	94
	Thomas variant	--	6
Peptidase A (PEPA)#	1	100	90
	2-1	--	8
	2	--	2

* Can be typed in dried bloodstains.
\+ Shows 10 types if isoelectric focusing or electrophoresis under special conditions is employed.
\# Significantly polymorphic only in black populations.

TABLE 11

SERUM GROUP SYSTEMS

SYSTEM (USUAL ABBREVIATION)	TYPES	Approximate occurrence, %, In U.S. populations WHITE	BLACK
Haptoglobin (Hp)*+	1	17	29
	2-1	48	39
	2	35	19
	2-1M	1	10
	0	1	3
Group-specific component (Gc)*#	1	50	76
	2-1	42	22
	2	8	2
Transferrin (Ti)*@	C	99	95
	CE	1	--
	CD	1	5
Protease inhibitor or α_1-antitrypsin(Pi)±	Many		
Immunoglobulin markers (Gm and Km)	Many		

* Can be typed in dried bloodstains.

\+ Hp 2-1M and Hp 0 cannot be diagnosed reliably in bloodstains. Hp 1 can be subtyped but not routinely in stains;

\# Gc 1 can be subtyped, but this is not done in stains

@ Ti C, the common electrophoretic type, can be subtyped by isoelectric focusing, but this is not done in stains.

± Pi has many electrophoretic variants; the common electrophoretic type Pi M can be subtyped by isoelectric focusing.

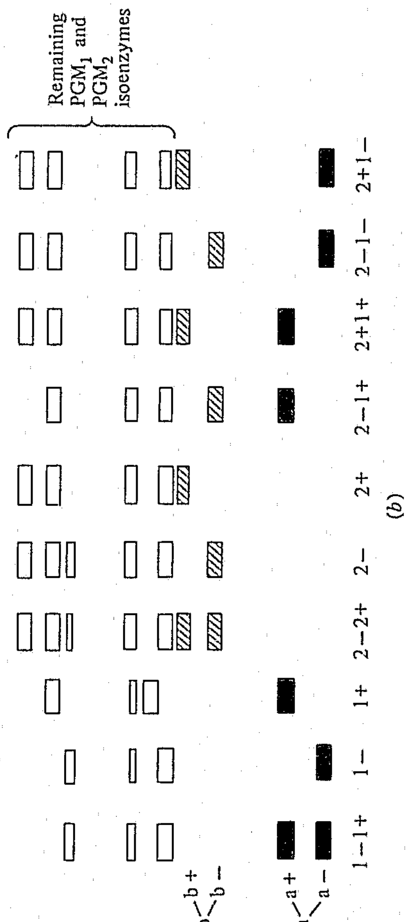


Figure 21: PGM Patterns with Isoelectric Focusing.

TABLE 12

THE PRESENT APPROACHES TO THE INDIVIDUALIZATION OF BLOODSTAINS

- BLOOD
  - IDENTIFICATION
    - PHYSICAL PATTERN
      - SIZE
      - SHAPE
      - PATTERN
    - HISTOLOGICAL
    - CHEMICAL
    - IMMUNOLOGICAL
  - SPECIES DETERMINATION
    - SEX
      - **BARR BODIES***
      - X,Y CHROMOSOME
      - T/E RATIO
    - AGE
      - COLOR CHANGES
      - α-RATIO
      - PROTEIN PATTERNS
      - G/A RATIO
    - RACE
      - Hb- HbS, HbC
      - Gm, Pep A
      - BLOOD GROUPING
    - MENSTRUAL BLOOD
      - LDH
      - FIBRINOGEN
  - INDIVIDUALIZATION

CELLULAR ANTIGENS	SERUM PROTEINS	CELLULAR PROTEINS
ABO - A_1, A_2	Km (Inv.)	PGM
MNSs	Gm	AK
Rh	Gc	ADA
Kidd	Hp	G6PD
Duffy	Transferrin*	6PGD
P	Albumin*	EAP (ACP)
Kell	PCE	Pep A
Lewis	LDH	CA
Lutheran*	C_5	EsD
Diego*	Ag system*	GSR
I*	Pi system*	GPX
Xg*	Etc.*	UMPK
Dombrock*		PGI
Etc.*		Hb
		GLO
		GPT*
		Etc.*

* Not applicable as yet to bloodstain.

C. Body Fluids

1. Identification

a. Saliva: The presence of a starch-digesting enzyme in high concentrations is the most common method of saliva identification.

b. Urine: Detection of urine is based on its physical and chemical characteristics. Many color and crystal tests for the detection of chemicals in high concentration have been developed, e.g., the Jaffe reaction for creatinine.

c. Perspiration: This fluid is often detected on clothing submitted for examination and the possible presence of perspiration must always be considered.

d. Semen: This is the most common form of body fluid evidence encountered or sought in sexual assault cases. Many methods exist for the identification of semen.

i. Microscopical examination: Identification of spermatozoa in a stain or fluid is proof that semen is present. If no spermatozoa are identified, tests for the presence of seminal fluid components other than sperm must be carried out. (Figure 22).

ii. Microcrystal tests: These are not specific for semen, but detect the presence of spermine and choline, which are present in large quantities in semen. (Figure 23).

iii. Acid phosphatase test: This test can be qualitative or quantitative. Factors such as the age of the stain and the presence of other body fluids affect the results obtained.

2. Species tests

Determination of species of origin of a seminal stain is carried out by immunological tests, if necessary.

3. Determination of individual characteristics in body fluids.

a. Detection of blood group antigenic substances

i. Approximately 80% of the population secretes ABO blood group substances in their body fluids.

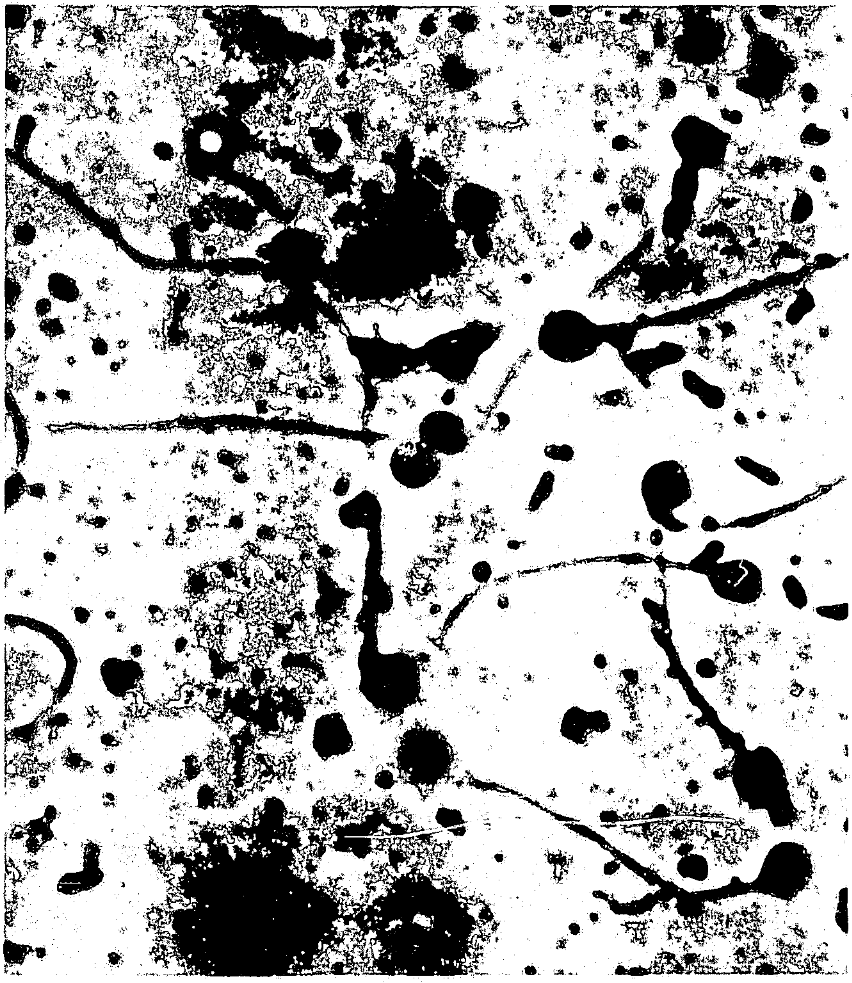


Figure 22: A photography view of ʟpermatozoa in a semen stain.

Figure 23: As a major component of semen is choline, the serology section will commonly test unknown stains for its presence. Here, the microscopic view shows the formation of rhombic crystals which indicate choline is present.

ii. Absorption-inhibition techniques can detect the presence of these substances in body fluids and their stains.

b. Certain isoenzymes can be detected in some body fluids where they are present in large quantities. The demonstration of these depends on the amount of stain present, the age and nature of the stain, and the conditions under which the stain was stored.

These enzymes include PGM, PGD, ESD, and PEPA systems.

4. New Developments

a. Anti-P30: An immunological test was developed to detect a specific seminal protein P-30. This protein is specific to seminal plasma and not found in other body fluids, organs, or vaginal material.

b. Serum protein markers: Gm, Km and Tf. Serum protein markers have been found in human seminal fluid. These markers can be detected by serological or electrophoretic methods.

c. Sperm diaphorase: DIA is an isoenzyme in sperm cells. This system has potential value in individualization of semen.

D. Documents

1. Documents: Any written, printed, or typed material is considered a document. If the origin is unknown or the authenticity of the document is in doubt, the article is considered a "questioned document."

2. Types of document examination

a. Handwriting comparisons: After sufficient handwriting standards are either requested or collected, certain characteristics of the handwriting in each are looked for and carefully compared (See Figure 24).

b. Comparison of writing materials: Types of pen, inks, paper, and mechanical devices are determined and compared according to physical and chemical properties.

c. Determination of alterations: These include erasures, additions, deletions, obliterations, and eliminations.

d. Determination of common origin or "Authorship": Examination and comparison may determine the manufacturer of inks, papers, and identification of the mechanical device producing the marks.

e. Reconstructions: Charred or indented writing can be "raised" using various techniques. Matching of torn edges of the questioned document with another sample found at the scene, on the victim, or in the possession of the suspect may also be included in this type of examination.

3. Laboratory analysis of documents

   a. Analysis of writing materials: Various chemical, microscopical, and instrumental techniques are employed for analysis of the writing instruments, ink, and paper.

   b. Handwriting analysis: Class and individual characteristics of the questioned document and a known standard are analyzed and compared.

   c. Typewriting analysis: Questioned typewritings can be compared with a known standard to determine the possible style, manufacturers, and possible individual source.

   d. Alterations: Any change in the original writing on a document can be examined by (1) microscopic examination; (2) infrared microscopy and photography, and (3) ultraviolet photoghaphy techniques for alteration. (See Figures 25, 26, 27 and 28).

   e. Printing and photocopying: These examinations are similar to handwriting or typewriting analysis. Through careful analysis, identification of the class and individual characteristics is carried out. Photocopies show marks due to damage to the glass or drum, as well as other unique markings; since many photocopied documents may be made from part of the original it becomes more difficult to examine these types of evidence.

   f. Indented writing: Impressions are sometimes left on a surface underlying the one upon which the writing occurred. Special techniques, such as oblique lighting, iodine fuming, etc., are employed when this type of evidence occurs (see Figure 29).

   g. Charred documents: If a document is partially destroyed through burning, the writing can sometimes be made visible by the use of IR light and photography (see Figure 30).

   h. Determination of document age: Determination of age is carried out by analysis of the components of the documents such as ink and paper.

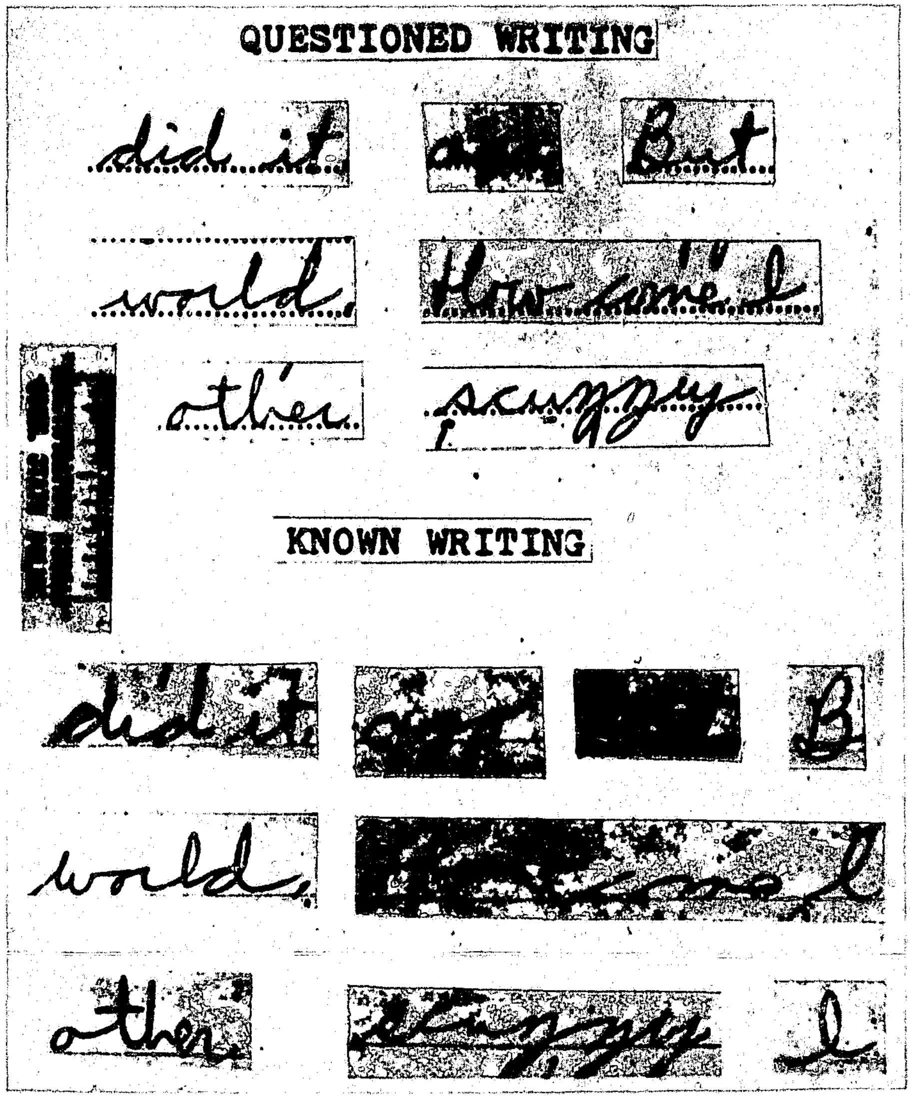


Figure 24: A comparison chart showing an identification of handwriting suitable for court use.

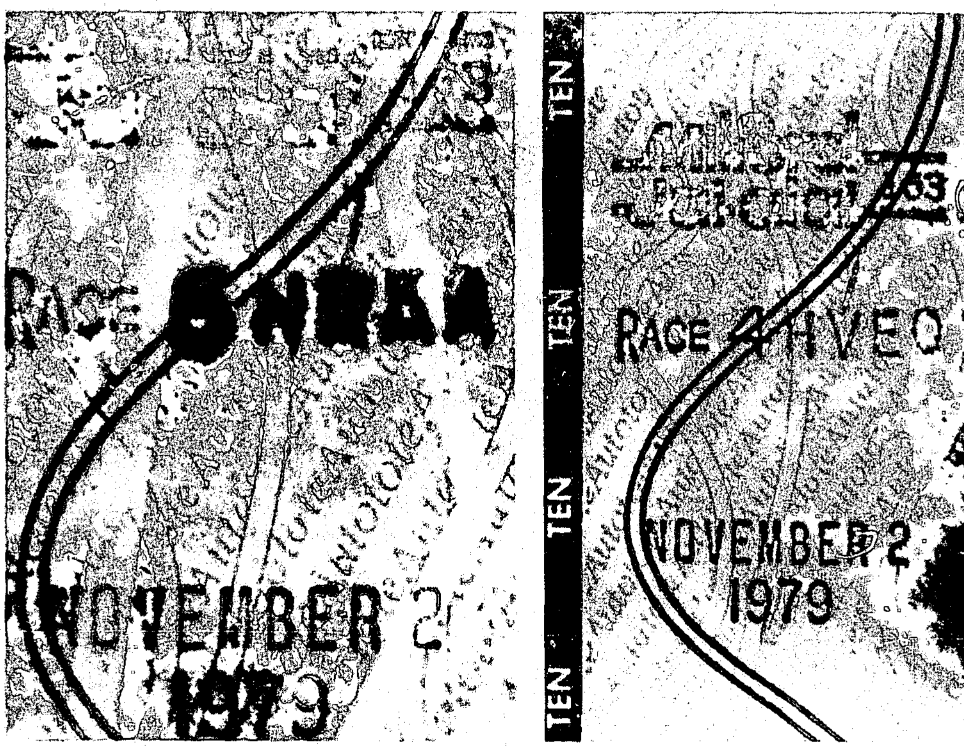


Figure 25: This photograph, taken with infrared film, shows that the Jai-alai ticket on the right has been altered.

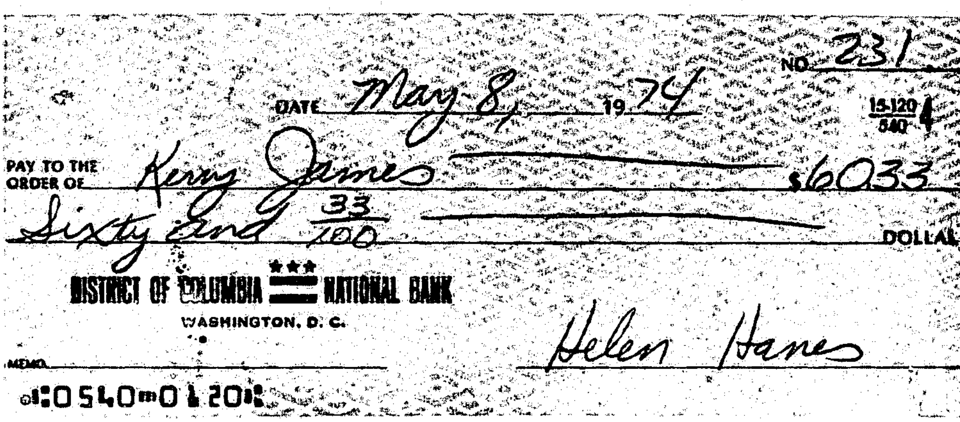


Figure 26: This check, originally written for $6.03, has been altered. The infrared luminescence technique of detecting alterations will cause one of the inks to become less visible and the other to become more visible. This photograph shows the check as it appears under normal photographic conditions. The following photographs (Figures 27 and 28) show the alterations as photographed utilizing the infrared luminescence technique.

Figure 27: Altered check photographed utilizing infrared luminescence technique.

Figure 28: Altered check photographed utilizing infrared luminescence technique.

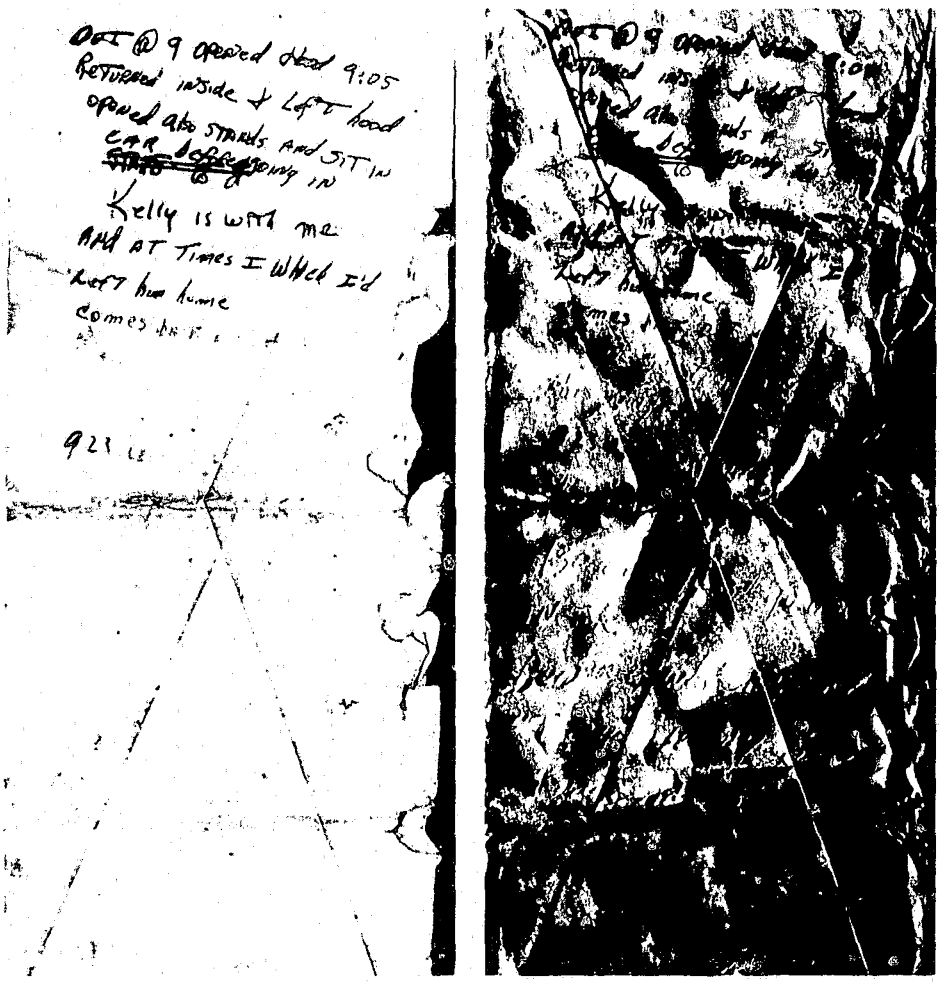


Figure 29: Indented writings can be made visible through use of photographic oblique lighting techniques.

Figure 30: Legibility of the contents of burned or charred documents is a problem often encountered by the investigator. In many cases, the Document Section of the laboratory is capable of restoring the text of the message.

4. New developments

a. Electrostatic detection apparatus (ESDA): ESDA is a new instrument recently made available for detecting indented writing. ESDA employs some type of principles of xerography to produce a transparenc? of indented impressions on documents.

b. Visible microspectrometry (NanoSpec-10): Visible spectra hav, been measured from minimal quantities of commonly-encountered ballpoint ink and fiber-tip pen inks by using a NanoSpec-10 visible microspectrometry. Comparison of these spectra provides a degree of discrimination between similiar-colored inks.

E. Explosives

1. Types of explosives

a. Burning or low: Stable under ordinary conditions, violent explosions will occur if these explosives are confined and initiated. Examples are black and smokeless powders.

b. Primary high (Primer): These explosives are sensitive to heat and shock and used to initiate secondary high explosives.

c. Secondary high: Insensitive to heat, shock, or friction, these are used as a booster charge. Common secondary explosions are TNT, RDX, dynamite, and nitroglycerin.

2. Laboratory analysis of explosives

a. Microscopical examination: Soil and debris are examined for the presence of unexploded or partially-burned explosives.

b. Acetone extraction: When residues are difficult to locate or separate, acetone is added to dissolve most of the residue. The extract is then filtered and evaporated to recover the explosive residue.

c. Chemical color tests: Various reagents for components of explosive residue will react with acetone solutions to give characteristic colors (see Table 13).

d. Microcrystal tests: Small quantities of residue are added to reagents. The resulting crystal formation is microscopically characteristic.

TABLE 13

COLOR TEST REAGENTS AND REACTIONS FOR EXPLOSIVES

Explosive or Component	Color reaction with: Griess*	Diphonylamine+	J-acid#	Alcohol KOH @
Chlorate	No color	Blue	Orange-brown	No color
Nitrate	Pink to red	Blue	Orange-brown	No color
Nitrite	Red to yellow	Blue-black	Orange-brown	No color
Nitrocellulose	Pink	Blue-black	Orange-brown	No color
Nitroglycerin	Pink to red	Blue	Orange-brown	No color
PETN	Pink to red	Blue	Orange-brown to red	No color
RDX	Pink to red	Blue	Orange-brown	No color
Tetryl	Pink to red	Blue	Yellow to orange	Red
TNT	No color	No color	No color	Red-violet

* Griess reagent: Solution A = 1 g sulfanilic acid in 100 mL 30% acetic acid; Solution B = 1 g α-naphthylamine in 230 mL distilled water.
\+ Diphenylamine reagent: 1 g diphenylamine in 100 mL conc. sulfuric acid.
\# J-acid reagent: 1 g 6-amino-1-naphthol-3 sulfonic acid in 100 mL conc. sulfuric acid.
@ Alcoholic KOH reagent: 10 g potassium hydroxide in 100 mL absolute ethanol.

e. Thin layer chromatography: Acetone solutions of the residue are spotted on a plate, developed, and compared to known explosives.

3. Instrumental analysis

Detection of various components using instrumental techniques has been extremely successful.

a. Organic components: Infrared spectra of a residue can be compared to know standards to identify an explosive according to the types of organic components present.

b. Inorganic components: Atomic absorption, atomic emission, and NAA aid in the detection of inorganic substances. Use of the scanning electron microscope is also possible.

4. New developments

a. Explosive tagging program: Some time ago, ATF instituted an explosive tagging program. Color-coded 8 layer taggant particles were added to the explosive material for tracing the origin of explosives. However, this program has been terminated.

b. New instrumental procedures: Several new instrumental procedures utilize HPLC (High Performance Liquid Chromatography) to detect various explosives.

F. Fingerprints

1. Basic patterns

There are eight basic fingerprint patterns (see Figures 32 and 33).

a. Loop: The ridges flow inward and then recurve in the direction of the origin. A single delta-shaped divergence must be present in front of the recurving ridges.

i. Radial loop: Ridges flow from the recurve toward the radius or thumb side of the hand; approximately 5% of all fingerprint patterns.

ii. Ulnar loop: Friction ridges flow from and recurve toward the ulna or little finger side of the hand, approximately 60% of all fingerprint patterns.

b. Arch: Ridges enter on one side of the impression and tend to flow out the other side with a rise in the center.

i. Plain arch: Ridges enter, wave or rise, and exit smoothly.

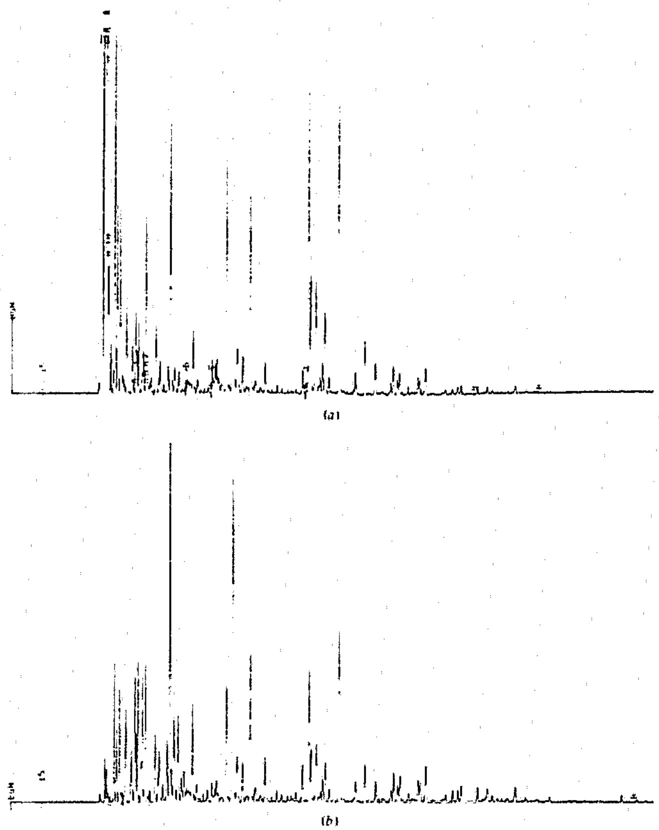


Figure 31: Gas chromatograms of gasoline. The upper curve is a chromatogram of a known gasoline sample. The lower curve is a chromatogram of a burned gasoline sample recovered from a piece of wood. Note the loss of early emerging peaks (low boilers) in the burned sample. A special high-resolution column known as a capillary column was used for these chromatograms. Note the large number of peaks and their sharpness.

Plain Whorl

Central Pocket Loop

Accidental

Double Loop

Figure 32: Fingerprint patterns.

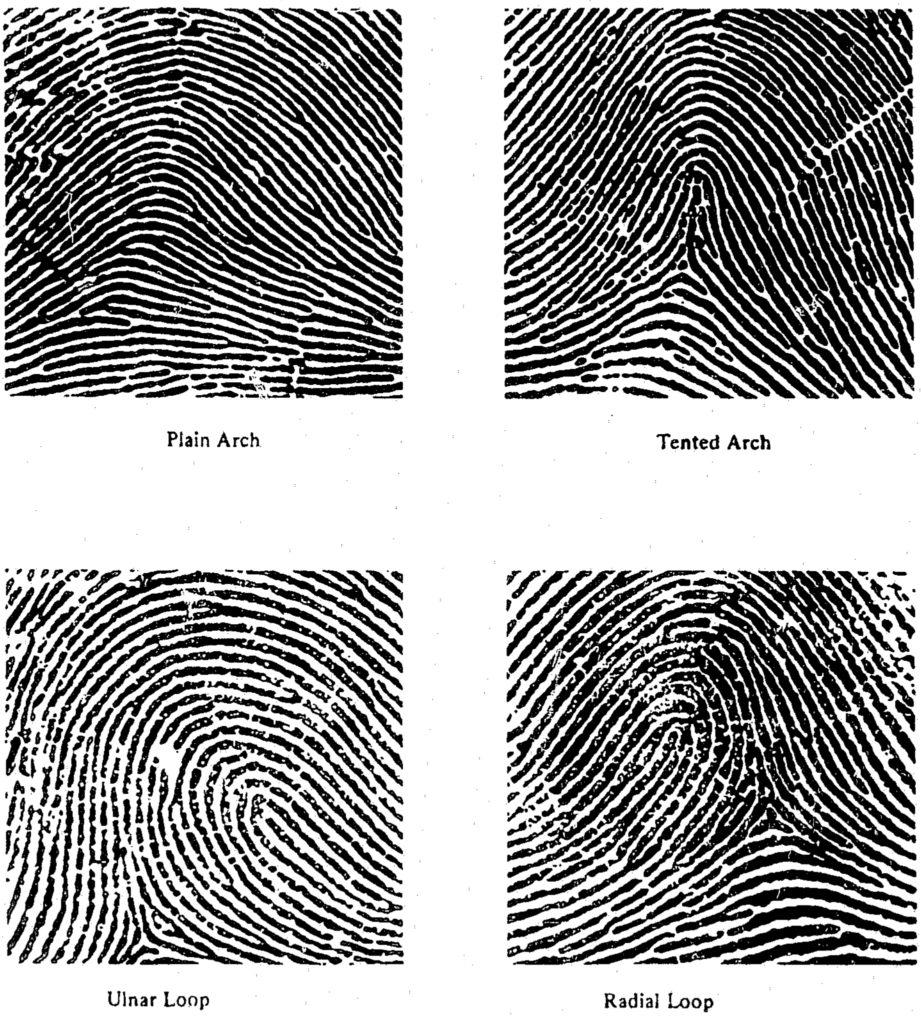


Figure 33: Fingerprint patterns.

ii. Tented arch: Ridges in the center thrust upward to give an appearance similar to a tent. Both types of arches combined comprise approximately 6% of all fingerprint patterns.

c. Whorl: At least two delta-shaped divergences are present with recurving ridges in front of each.

i. Plain whorl: One or more ridges form a complete revolution around the center.

ii. Central pocket whorl: Some ridges form a loop pattern which recurves and surrounds a central whorl.

iii. Double loop: Two separate loops are present, which sometimes surround each other.

iv. Accidental: Any pattern which does not conform to previously described patterns.

v. Whorls compose approximately 29% of all fingerprint patterns.

2. Types of fingerprints

a. Inked prints: Ridge impressions are taken by inking an individual's finger or palm.

b. Visible prints: Ridge impressions which are caused by the transfer of a medium such as paint, blood, ink, or the like.

c. Plastic prints: Ridge impressions which are found in soft material such as putty, wax, clay, or the like.

d. Latent prints: Ridge impressions which are caused by the transfer of natural body secretions. These are among the most common types of fingerprint evidence found at a crime scene and must be processed for visual comparison. The composition of these secretions may be found in Figure 34, following.

3. Laboratory examination of latent prints

a. Prints on nonporous surfaces: Impressions on objects such as metal, plastic, glass, tile, and the like are easily processed at the scene.

i. Powder dusting: A powder of contrasting color to the surface being dusted is chosen. This is extremely important for obtaining good prints.

SECRETIONS OF SWEAT GLANDS OF THE FINGERS

- Latent secretion
  - 98.5% water
  - 1.5% solids
    - 1% organic materials
      - fatty acids and lipids, formic acid, acetic acid, butyric acid, amino acids, peptides, albumin, other proteins, vitamins, riboflavins, pyridoxin, urea, ammonia
      - isoagglutinogens
    - 0.5% inorganic materials
      - K^+ (potassium), Na^+ (sodium), Cl^- (chloride), Ca^{++} (calcium), PO_4^{3-} (sulfate)
      - $SO_4^{=}$ (phosphate), $CO_3^{=}$ (carbonate)

Figure 34

ii. Magna-brush method: Fine steel particles are used as powder and a magnet as a brush.

b. Prints on porous, absorbent surfaces: Impressions on paper, cardboard, leather, wood, etc. must be chemically treated and must be developed in the laboratory. Some common chemical methods are:

i. Iodine fuming: Vapor from warmed iodine crystals reacts with the oils deposited, yielding a yellow-brown print. These must be photographed immediately or fixed chemically.

ii. Ninhydrin: Reagent is sprayed on the medium and reacts with amino acids from body secretions, giving a violet color.

iii. Silver nitrate: A dark image is produced when the silver nitrate solution reacts with salts in the latent print after exposure to light.

iv. Fluorescent reagents: Fluorescamine and o-Phthalaldehyde react almost instantaneously with amines from body secretions, yielding highly fluorescent patterns. These reagents are useful on multi-colored surfaces.

c. Prints of human skin

i. Paper transfer method: Hard-surfaced paper and Polaroid® coating stick are used to lift the print.

ii. Iodine-Silver method: Iodine-fumed prints are exposed to a tin polished silver plate, turning it black at ridge locations.

4. New developments

Various techniques using advanced technology have been employed with some success.

a. Argon laser: In the proper optical setup, various components of body secretions fluoresce and may be photographed. This technique is non-destructive, but expensive, and requires specialized equipment.

b. X-Ray detection: Prints are dusted with lead powder, producing distinct images on photographic film when exposed to X-rays. This is useful on many objects and on skin.

c. Vacuum coating: A fine vapor of metal is developed in a vacuum and deposits on the print. Prints on paper, fabrics, and plastics have been processed in this manner.

d. Super glue method: This process relies on the fumes of cyanocrylic glue chemically reacting with the water and amino acid molecules.

Table 14 summarizes various methods used for visualizing latent fingerprints.

5. Decomposed body

The laboratory is equipped to make identifications of fingerprints from decomposed bodies. Silicone or glycerine may be injected into the fingers; in some cases, the skin is removed, mounted on a glass slide and photographed from the back of the skin thus making the patterns visible. Ultimately, identifications are made in many cases.

6. Comparison of fingerprints

a. Identification and comparison of fingerprints is based on the recognition of general patterns and ridge characteristics (see Figure 35).

b. A 1973 International Association for Identification (I.A.I.) study has concluded that no valid basis exists for requiring a predetermined minimum number of friction ridge characteristics which must be present in two impressions in order to establish positive identity.

c. In the August Identification News 1979, the I.A.I. reported the passage of Resolution VII which states in part:

"Whereas the delegates of the International Association for Identification, assembled in their 64th annual conference in Phoenix, Arizona, August 2, 1979, state unanimously that friction ridge identifications are positive, and officially oppose any testimony or reporting of possible, probable or likely friction ridge identification."

7. Fingerprint classification system (See Table 15)

a. Henry System: The most common in use in the United States today. It is a ten-finger classification system that is easily retrieved from files.

TABLE 14

METHODS OF VISUALIZING LATENT FINGERPRINTS

METHODS	PRINCIPLE	SURFACES TO WHICH APPLICABLE
Physical Powder dusting	Adherence of inert material to fingerprint residues	Smooth, nonporous surfaces, such as metals, glass, plastics, tile, and finished woods.
Oblique lighting and photography	Natural residues of fingerprints	Smooth and non-reflective surfaces.
Laser	Luminescent material in fingerprint residue	Smooth, nonporous or slightly porous surfaces, such as plastic, and paper (non-fluorescent)
X-ray	Adherence to lead powder to fingerprint residues	Smooth, nonporous, and slightly porous surfaces, such as human skin.
Vacuum coating	Adherence of gold, silver, or cadmium to fingerprint residues	Smooth surfaces, such as plastic films, polyethyle and paper.
Chemical Iodine fuming	Chemical interaction of iodine with fatty acids and lipid in residues	Smooth surfaces, such as paper, human skin
Ninhydrin	Chemical interaction with amino acids, peptides, and proteins of residue	Paper, cardboard
Silver nitrate	Chemical interaction with chloride in residue	Paper
Fluorescamine, phthalaldehyde, dansyl, chloride	Chemical interaction with amino acids in residue	Paper, multi-colored absorbent surfaces (non-fluorescent)
Nitric acid, hydrofluoric acid	Chemical reaction with surfaces without destroying residues	Glass, cartridge cases
Super Glue (cyanoacrylate)	Chemical reaction with amino acid & water molecule	Plastic, metal glass, cloth, etc.

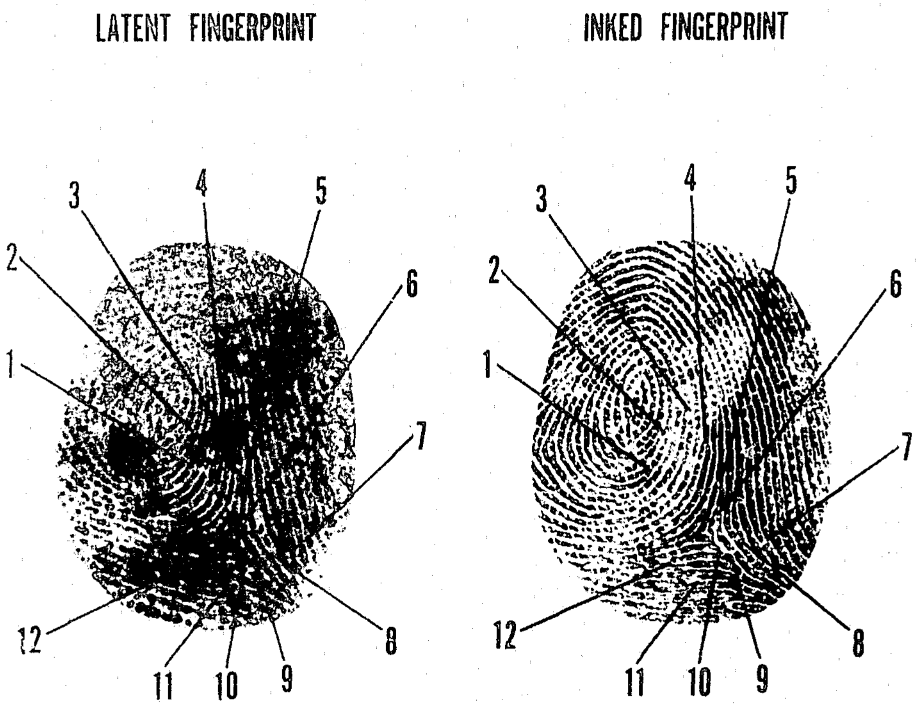


Figure 35: Fingerprint comparison charts showing the points of identification which indicate a positive match.

TABLE 15

FINGERPRINT CLASSIFICATION

Classification	Formula	Description
Primary	17 L 10 U IOM 19 W OII 10	Obtained through the summation of the value of the whorls as they appear in the various fingers
Secondary	17 L 10 U IOM 19 W OII 10	The type or pattern appearing in the index fingers
Subsecondary	17 L 10 U IOM 19 W OII 10	The value of the ridge counts of loops or tracing of whorls of index, middle, and ring fingers.
Final	17 L 10 U IOM 19 W OII 10	The ridge count of loops of little fingers
Major	17 L 10 U IOM 19 W OII 10	The value of the ridge counts of loops or tracing of whorls of thumb
Key	17 L 10 U IOM 19 W OII 10	The ridge count of the first loop appearing in fingers other than the little finger

b. NCIC: Is a system used by the National Crime Information Center. This method is a modified Henry System written in a format that yields quicker retrieval from computers.

c. American System: A modified Henry System in use in the New York Identification and Intelligence System.

d. Canadian System: Also an adaption and modification of the Henry System.

e. Vucetich System: The predominant system in use in South America.

f. Finder System: This computerized system was developed by the FBI based on the presence of certain small details on the inked print. The electronics of the method permit computor enhancement of the print for more clarity of minutiae. This is particularly important in classifying poor quality inked prints for ultimate storage within the computer.

g. Battley System: A system for storage and retrieval of single fingerprints.

G. Firearms Evidence

1. Major components of firearms

a. Barrel

i. Rifled: A series of spiral grooves cut inside metal tube, leaving raised areas called "lands"; these make characteristic markings for identification.

ii. Smooth-bored: No lands or grooves present.

iii. Caliber: Gun barrel diameter measure between opposite lands.

b. Firing mechanism: The firing pin, breechlock, ejector, and extractor make characteristic marks on cartridge casings which can be used for identification and comparison.

c. Ammunition

i. Projectile: Bullet of lead/alloy, pellets, or slugs.

ii. Jacket: Some bullets are either completely or partially encased in a harder metal.

iii. Cartridge case: Contains the ignition system and powder, and is usually made of brass.

iv. Primer: Chemical mixture which detonates the powder.

v. Powder: Its explosion forces projectile along its path; a smokeless powder is used in modern weapons.

Figure 36 shows cutaway views of cartridges.

2. Basic information which can be gathered from firearms evidence (see Figure 37).

   a. Bullets: Caliber, manufacturer, type and make of weapon, pellet or shot size.

      The following Tables, 16 and 17, provide some information on shot size and gauge number.

   b. Cartridge or shell case: Type of weapon, caliber, gauge of shotgun, factory or handload.

   c. Weapon: Manufacturer, functional characteristics.

3. Bullet comparisons

   Bullets are "test fired" from a weapon and compared to those found at the scene.

   a. Class characteristics: Caliber and type of bullet may be determined from metallic composition, weight, size and shape, manufacturer's markings, etc..

   b. Individual characteristics: Striation marks resulting from the pressure of the bullet on the individual weapon's lands and grooves as it passes down the barrel; matching of patterns is done using a comparison microscope.

4. Cartridge case comparison

   Markings result on the casing during firing which will reproduced on the test cartridge and then compared using the comparison microscope.

   a. Firing pin impressions: The negative impression of the firing pin varies in size, shape, impression, and location or may show imperfections from production or use.

   b. Breechface marks: When the shell or cartridge case is forced backward, individual striations from the file or cutting tool used on the breechface form.

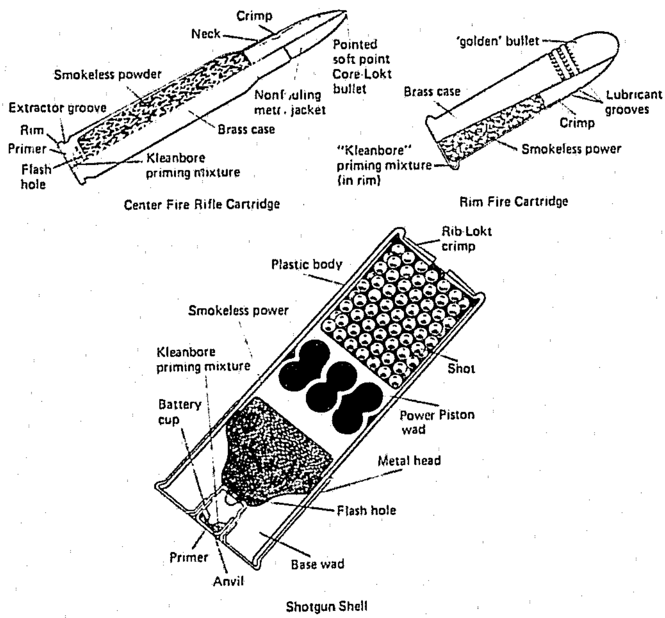


Figure 36: Cutaway views of cartridges.

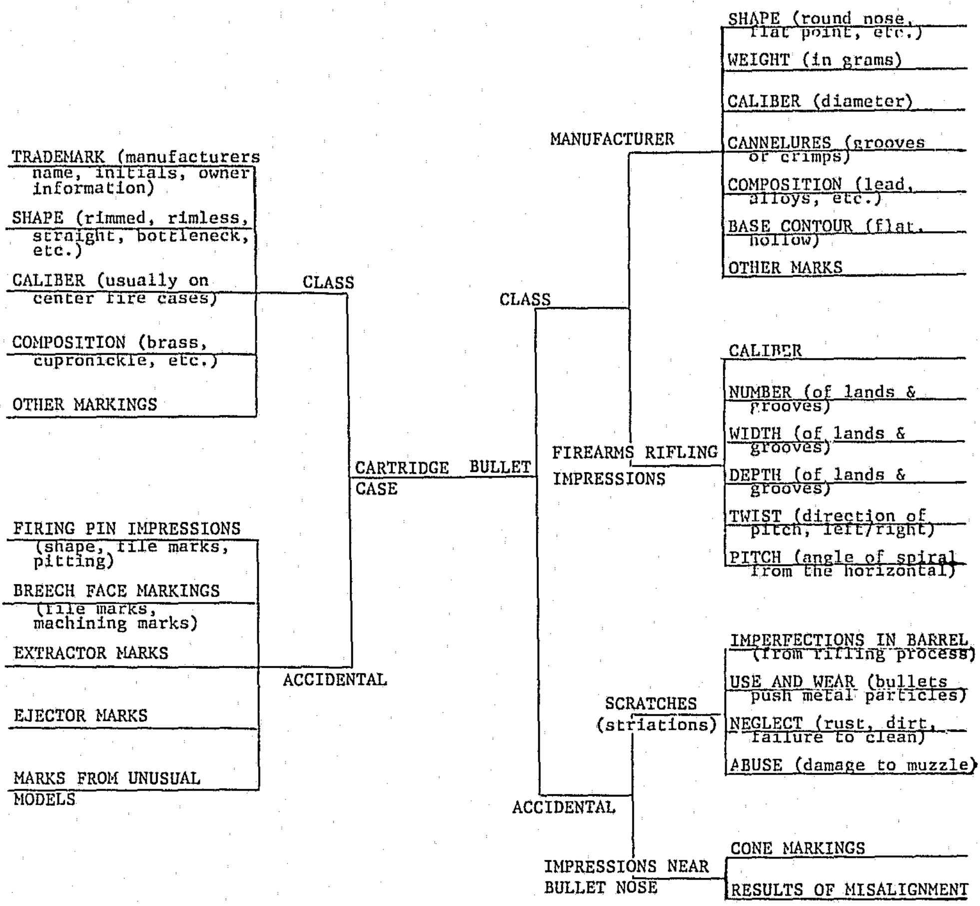


Figure 37: Schematic Analysis of Firearms Identification

KEY: IDENTIFICATION (characteristics)

TABLE 16

SHOT COMPARISON TABLE

Shot number	Diameter, In.	Diameter, mm	Mass, g	Weight, gr	Approximate number of pellets per gram	per grain	per pound	per ounce
12	0.05	1.27	0.012	0.188	83	5	37,300	2330
11	0.06	1.52	0.021	0.324	48	3	21,600	1350
10	0.07	1.78	0.033	0.515	30	2	13,600	850
9	0.08	2.03	0.050	0.769	20	1	9,100	570
8	0.09	2.29	0.071	1.09	14	1	6,400	400
7½	0.095	2.41	0.083	1.29	12	1	5,400	340
7	0.10	2.54	0.097	1.50	10	1	4,700	290
6	0.11	2.79	0.130	2.00	8	–	3,500	220
5	0.12	3.05	0.168	2.60	6	–	2,700	170
4	0.13	3.30	0.214	3.30	5	–	2,100	130
2	0.15	3.81	0.328	5.06	3	–	1,400	86
Air rifle	0.175	4.44	0.521	8.04	2	–	870	55
BB	0.18	4.57	0.567	8.76	2	–	800	50
#4 buck	0.24	6.10	1.34	20.7	–	–	340	21
#3 buck	0.25	6.35	1.52	23.5	–	–	300	19
#1 buck	0.30	7.62	2.63	40.5	–	–	170	11
#0 buck	0.32	8.13	3.19	49.2	–	–	140	9
#00 buck	0.33	8.38	3.50	54.0	–	–	130	8

TABLE 17

MEASUREMENTS OR PROPERTIES OF LEAD BALLS JUST FITTING BORE

Gauge	Approx. diameter		Weight or mass		No. of balls	
	In.	mm	grams	grains	per pound	per ounce
4	1.05	26.7	113	1750	4	.250
8	.84	21.2	57	875	8	.500
10	.78	19.7	45	700	10	.625
12	.73	18.5	38	583	12	.750
14	.69	17.6	32	500	14	.875
16	.66	16.8	28	437	16	1.000
20	.62	15.6	23	350	30	1.250
24	.58	14.7	19	292	24	1.500
28	.55	14.0	16	250	28	1.750
32	.53	13.4	14	219	32	2.000
"70"	.41	10.3	6	100	70	4.375

c. Extractor and ejector marks: The surface of the extractor and ejector mechanism may possess individual characteristics from manufacturing.

d. Chamber marks: The force of the explosion causes expansion of the bullet within the chamber, leaving the marks of the irregularities of each chamber.

e. Miscellaneous markings: Individual markings due to scraping, scratching, and pressure in automatic and repeating weapons.

4. Examination for identification

It is the examination of the land and groove impressions found on the bullet that produce the answer to the question, "Did a particular weapon fire a particular bullet?" The manufacturer's processing in machining the rifling in a barrel, although within certain specified tolerances, is unique to each barrel due to wear on the cutting tools, variations in the metal of the barrel, and other variables. The end result is that, if closely enough examined, each barrel is unique. This coupled with normal wear caused by the firing of the weapon, causes each barrel to mark any projectile it fires in a particular manner which is recognized by the firearms examiner through examination of the striations caused by the lands and grooves on the bullet. As a result, firearms examiners can positively identify a particular weapon as having fired a particular projectile (see Figures 38 and 39).

5. Tool marks

Generally, tool marks will fall into one of two categories: compression and sliding. A compression tool mark results when force is applied between two objects in a perpendicular direction. There is no lateral movement between the surfaces. In this instance, the harder material will mark the softer material in a three dimensional replica of that portion of the harder material which is making contact. A sliding tool mark will show striations caused by a lateral movement resulting from the harder material being forced into the softer material from an oblique angle (see Figures 40 and 41).

Because of the lengthy time period necessary to reproduce the questioned tool mark with a particular tool, unless the suspect tool or weapon can be associated with the perpetrator through the investigation, a comparison of a tool left at the crime scene with a tool mark does not justify the time necessary to make the examination.

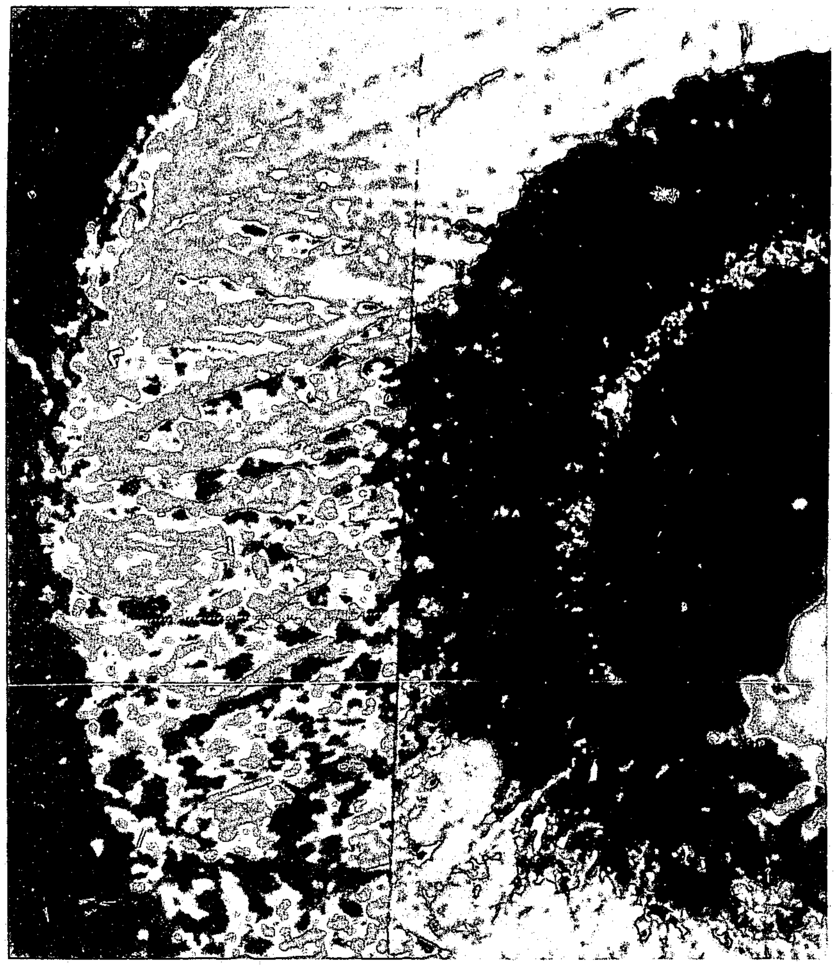


Figure 38: A view through the comparison microscope showing that the breech face markings on the two shell casings shown here were made by the same source.

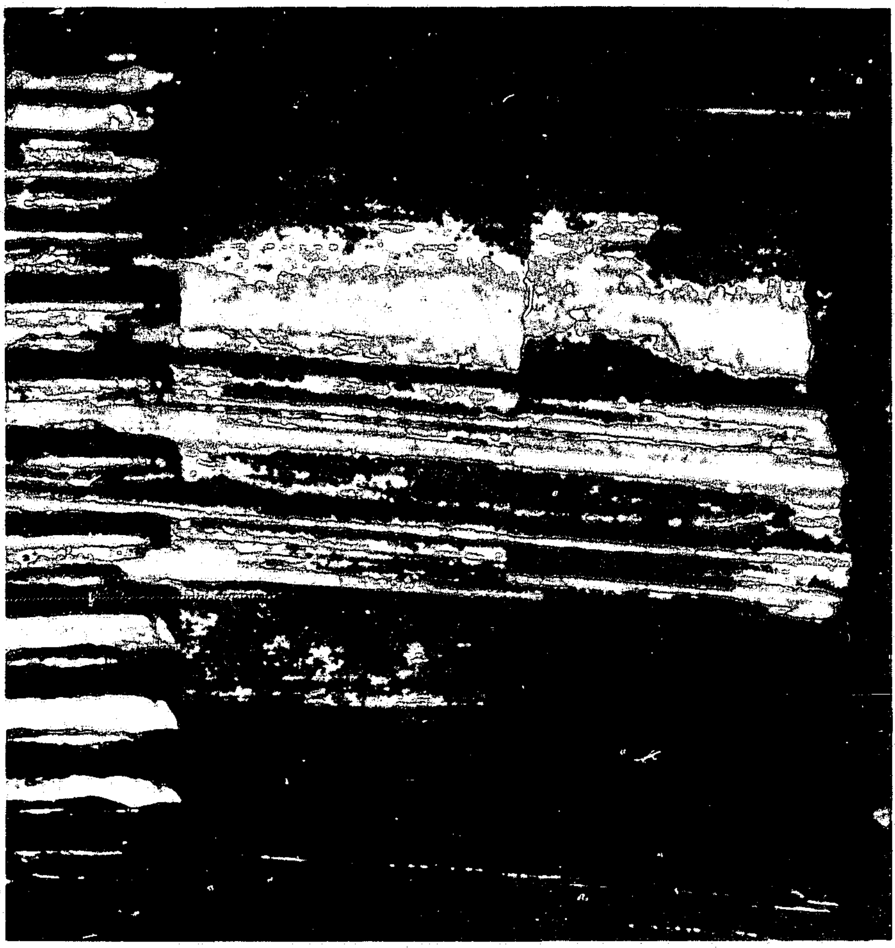


Figure 39: A positive match is indicated between two bullets, as seen under the comparison microscope. Left side is a questioned bullet, right hand side is a known test bullet.

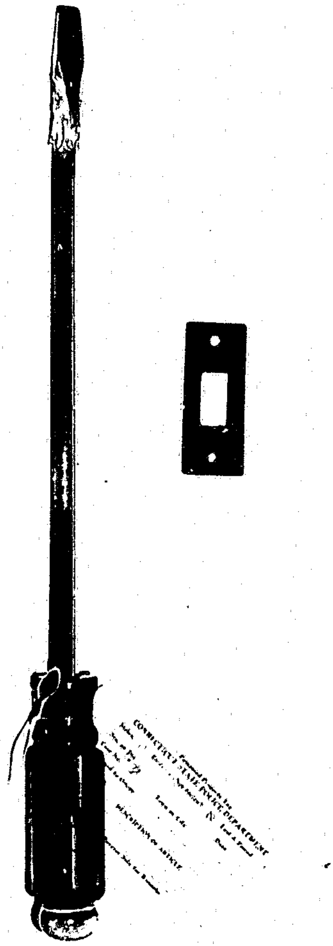


Figure 40: A tool mark comparison between a forced door frame striker plate and a screw driver found in the possession of a suspected burglar, linked him to the crime.

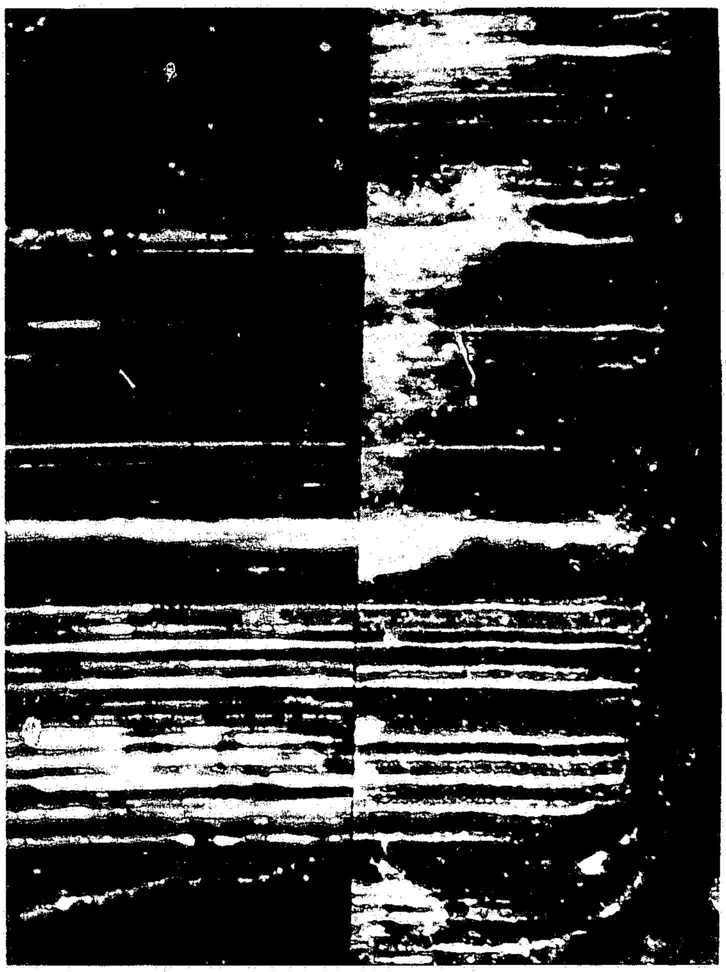


Figure 41: Tool mark comparisons can also be made through use of the comparison microscope, as illustrated in this photograph. It shows that the suspected screw driver (in Figure 40) did in fact make the striations on the striker plate.

H. Gunshot residue

1. Source of gunshot residue

When a gun has been fired, gunshot residue can originate from:

a. Primer: Primer consists of 4 basic components.

i. Initiating explosive - Lead styphnate

ii. Oxidizing agent - Barium Nitrate, Barium Peroxide, Lead Nitrate, Lead Peroxide.

iii. Fuel: Antimony sulfide, Calcium Silicide

iv. Sensitizing agent: Tetracene

b. Propellant, powder

i. Black Powder - 75% potassium nitrate
- 15% sulfur
- 10% charcoal

ii. Smokeless Powder - Nitrocellulose (single base)
- Nitrocellulose & Nitroglycerin (double base)

c. Lubricants

d. Metal from projectile, bullet, jacket, and casing metals: Lead, Copper - trace elements, Zinc, Antimony, Arsenic, Bismuth, Chromium, etc.

e. Gun barrel

2. Laboratory analysis of gunshot residue

a. Microscopical analysis: Examination for the presence of gun powder particles, smudges, and burns around a bullet hole or in swabbings of the hands.

b. Chemical tests for nitrates and nitrites.

i. Reagents react with these components to give a colored pattern. This is useful for showing the distribution of residue on clothing or in paraffin lifts.

ii. Commonly occurring substances such as cigarette smoke, urine, and fertilizer also react with these reagents.

c. Detection of trace elements: Barium, antimony, bismuth, and lead concentrations can be determined. These are usually in low concentrations on the hands of an individual who has not recently fired a weapon.

   i. Microchemical tests: These tests may be highly specific, but requires larger quantities of metal than instrumental methods.

   ii. Neutron activation: Extremely sensitive, NAA can detect very low concentrations of metals.

   iii. Atomic absorption: Also detects low concentrations of metals in the samples. Neither NAA or AA gives information about patterns of gunshot residue deposits. Levels of trace metals in "hand blanks" must be determined for proper interpretation of AA results.

3. Pattern analysis

Pattern analysis is useful in reconstructing shooting events, especially in distance estimation. Interpretations are dependent upon the weapon used, type of ammunition, load, etc. (see Figure 42).

a. Close range: Residues are deposited around the bullet hole with black shot and smoke. The pattern is small and dense.

b. Medium range: (1½ - 3 feet) Scattered gunshot residue is present without black deposits. The pattern spreads out as the distance increases.

c. Long range: Powder residue is usually not found.

4. New developments

a. Paraffin test: It is also referred to as "dermal nitrate test". The GSR (Gun Shot Residue) particles are identified by reaction of nitrate or nitrite with diphenylamine. This test yields positive reaction with fertilizer, tobacco, urine, soil, and many other compounds. It is currently considered unreliable for GSR testing.

b. SEM - EDX: The GSR particles can be identified by Scanning Electron Microscope. The particles are further analyzed by X-ray. A finding of the elements lead, barium, and antimony confirms that the particles are GSR.

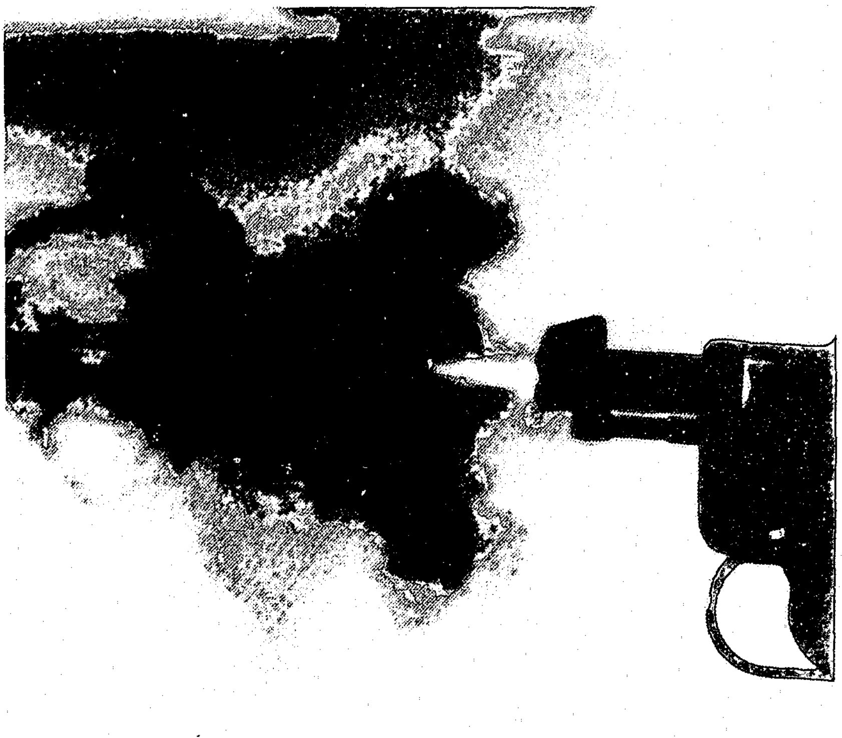


Figure 42: High-speed photograph of a revolver during discharge. Note the expanding cloud of residue. Leakage around the cylinder, although undoubtedly present, is not readily apparent in this photograph.

I. Hairs

1. Characteristics of hair

Hair is produced at a constant rate by cells within the skin hair follicle and becomes a non-living substance as it reaches the surface. During the formation and growth of hair, certain characteristic areas are noted which are useful for comparison. (See Figures 43 and 44 for cutaway views of a human hair.)

a. Cuticle: A layer of scales covering the hair shaft.

i. Coronal (Crown-like): Scales appear as stacked cups; this type is seldom found in human hairs.

ii. Spinuous (Petal-like): Triangular-shaped and frequently protruding from the shaft.

iii. Imbricate: Flattened, overlapping scales, the usual type in humans and other animals.

b. Medulla: The central core of cells, which may or may not be present in one of the following forms:

i. Fragmented: Small sections of irregular size.

ii. Discontinuous: Segments of the medulla are longer but spaces are present.

iii. Continuous: There are no breaks in the medulla throughout the hair shaft. There are several forms including amorphous, serial, vacuolated, and lattice.

c. Cortex: The main portion of the hair, the cortex is made of elongated cells, and often contains many inclusions.

i. Cortical Fusi: Irregularly-shaped small air spaces, normally near the root, but may also be present throughout the hair shaft.

ii. Pigment Granules: These small solid structures vary in color, size, and distribution within a hair, an individual, or species.

iii. Ovoid bodies: Large solid structures which are spherical or oval in shape.

2. Microscopical examination of hairs.

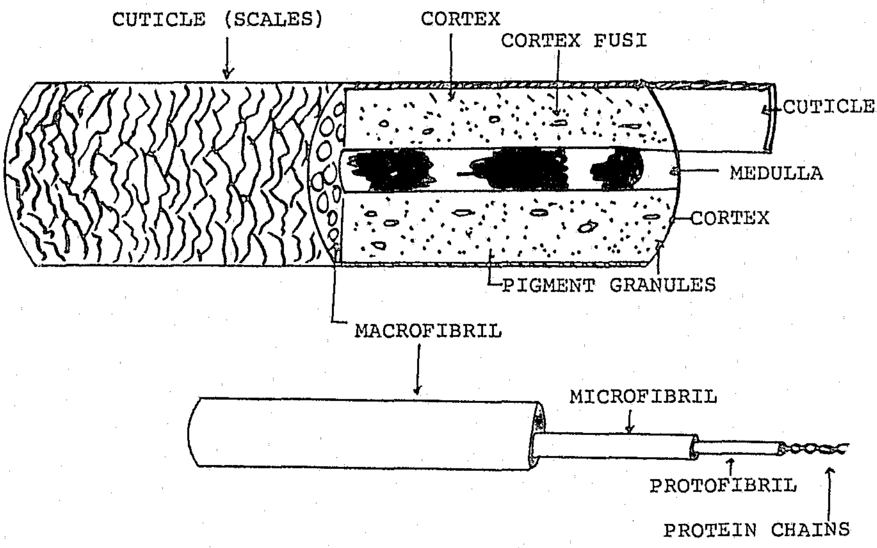


Figure 43: Cutaway view of a human hair.

PARTS OF THE HUMAN HAIR

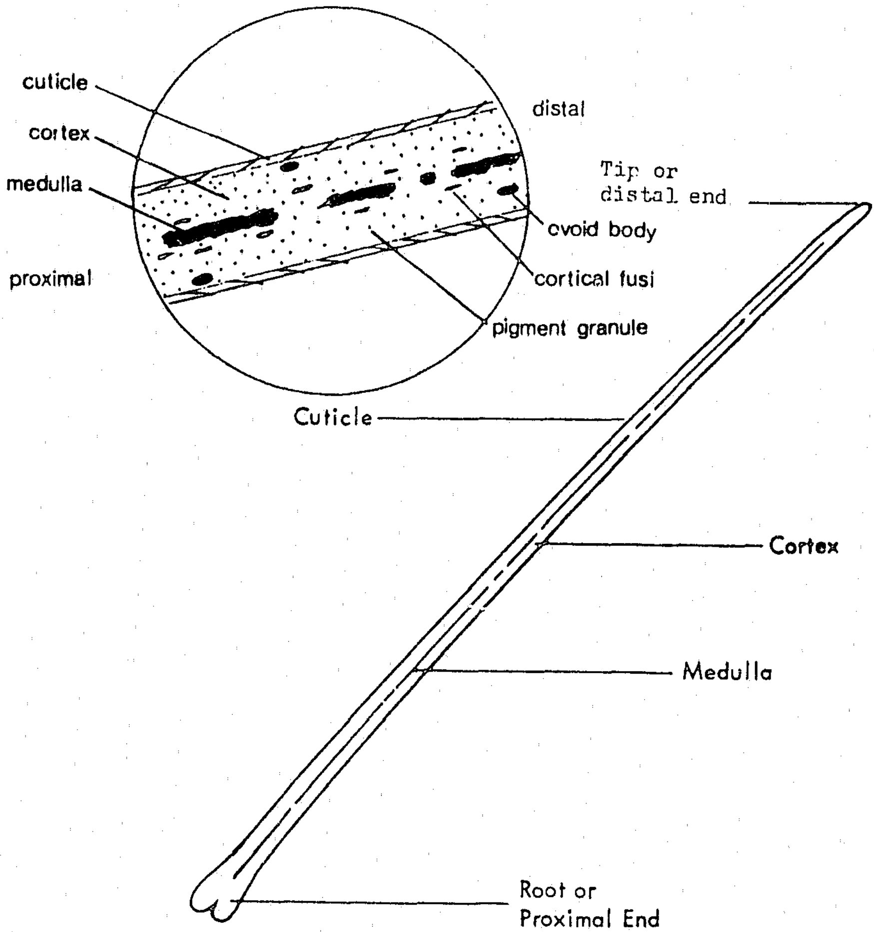


Figure 44: Data which can be gained from the examination of...
the root - whether the hair was pulled out or fell out naturally.
the shaft - cosmetic information, i.e., curled, dyed, etc.
the tip - whether the hair was cut or is natural
the cuticle - the species
the cortex - the color, pigment
the medulla - the species

The above structural characteristics of hair lend themselves to measurement and comparison. The following Table lists some of the parameters and terminology used for microscopic studies. It should be noted that microscopic examination of hairs is not a conclusive means of individualization. (Table 18)

3. Instrumental techniques

   a. N.A.A.: Trace elemental analysis of the hair shaft is possible in this manner, but results are difficult to interpret due to the variations caused by diet, health, hygiene, and environment.

   b. IonMicroprobe: Elemental analysis to determine the distribution of trace elements. This procedure is highly expensive at this time.

   c. Pyrolysis-G.C.: Efforts to individualize hairs by decomposition and then separation of components by gas chromatography have been made, but have yet to yield conclusive results.

4. New developments

   a. ABO grouping of hair: The ABO blood group substances are present in hair. Absorption-Elution Method has been used for the detection of blood group antigens in hair samples.

   b. Isoenzyme analysis of hair: Isoenzyme PGM was found in the external root sheath cells of human hairs. Only anagen hairs are of value for these procedures.

   c. Sexing of hair: Two methods have been used for determining the sex of the donor of a hair. Barr bodies and Y chromosomes have been used to determine the sex of the donor of a hair.

J. Imprint and impression evidence

1. Imprint evidence

   Imprint evidence is formed when an object comes in contact with another object or substance, with recognizable patterns resulting.

2. Types and occurrence of imprint evidence

   a. Three-dimensional impressions: These are visible or easily-made-visible prints, such as tire tracks in mud. When a force is applied such that the three-dimensional characteristics are reproduced, details about the object which formed it can be distinguished.

TABLE 18

ANALYSIS FACTORS IN THE COMPARISON OF HAIR

Scale pattern:	coronal - spinous - imbricate
Medulla:	absent - fragmentary - discontinuous - continuous
Medulla pattern:	uniserial - multiserial - vacuolated - lattice - amorphous
Diameter:	constant - vary - range
Length:	fragment - segment
Color:	white - blonde - light brown - brown - dark brown - gray - black - red
Reflectivity:	opaque - translucent - transparent - clear
Tip:	cut - broken - split - pointed - round
Root:	normal - stretched - absent - bulbous - germ - follicular
Special configuration:	straight - curved - wavy - curly - kinky
Cross section:	polygonal - flat - oval - round
Pigment:	absent - granular - chain - clump - dense - opaque
Cortical fusi:	absent - few - bunched - abundant
Cuticle:	ragged - serrated - looped - layered - narrow - wide
Cortical pigment:	central - periphery - oneside - root
Cosmetic treatment:	bleached - dyed - length of treatment - curled
Damage:	cut - crushed - broken - burned
Race:	Caucasian - Negroid - Mongoloid - Mixed
Body area:	head - pubic - body hair - beard
Special characteristics:	disease
ABO grouping:	A, B
PGM phenotype:	1, 2-1, 2

b. Two-dimensional impressions: A flat residue deposited after an object or individual passes through, a fine colored substance often shows the detail of that object. Shoe impressions on window-sills or chairs and bloody fabric impressions are examples to two-dimensional impressions.

c. Occurrence of imprints: Imprints may be found at any scene where soft or transferable materials are present. They are often useful in reconstruction and in giving some information about the criminal. The most commonly encountered types of imprint evidence are footprints and tire tracks.

3. Laboratory analysis of imprint evidence

Determination of class and individual characteristics of an impression allows for identification of the type of object which made the impression and, at times, the manufacturer. The comparison of imprints with known samples or other imprints is also performed.

a. Class characteristics: General structural properties such as size, shape, pattern, and design are noted. If the imprint is a footprint, for example, the size should be determined using standard footwear scales. Manufacturers often produce characteristic patterns and logos on their footwear.

b. Individual characteristics: Individual characteristics are those which are specific for a particular object.

   i. Wear, damage, irregularities, and other accidental marks are unique to a particular article.

   ii. The exact location, size, and shape of each individual mark is documented.

c. Comparison of impressions with knowns

   i. Class characteristics of the known and the impression are compared. If the two demonstrate common class characteristics, a positive statement may be made about the similarity of the articles.

   ii. If individual characteristics of the known and the imprint agree, it can be concluded that the known produced the impression. As with other types of physical evidence comparisons, no exact number of points of matching has been identified as necessary for a match.

iii. When making comparisons with casts, the shrinkage of casting materials must be considered. Charts and formulae exist to aid in these determinations.

iv. The conditions present when the impression was made should be reproduced as much as possible when making a print or impression of the known for comparison.

K. Pattern evidence

1. Pattern evidence may contain both class and individual characteristics and can thus form the basis for identification, for individualization, and for reconstruction.

2. There are many types of pattern evidence that can be found at a crime scene; some are obvious, others are more subtle. Some examples are:

   a. Blood patterns

   b. Glass fracture patterns

   c. Projectile-Trajectory patterns

   d. Gunshot residue patterns

   e. Footprints and tiretrack patterns

   f. Furniture disarrangement patterns

   g. Tool mark patterns

   h. M. O. patterns

   i. Skid marks patterns

   j. Fire burning patterns

3. Bloodstain patterns

   The patterns obtained when blood hits a surface is dependent upon the nature of the surface, its texture, absorbancy, etc. Care must be taken when interpreting patterns to consider the effects of the surface.

   Blood patterns may provide information about the circumstances of the crime, victim, or suspect.

   a. Shape of the stain gives information about the distance and angle from which the blood is dropped on a non-absorbant surface (see Figures 45 and 46).

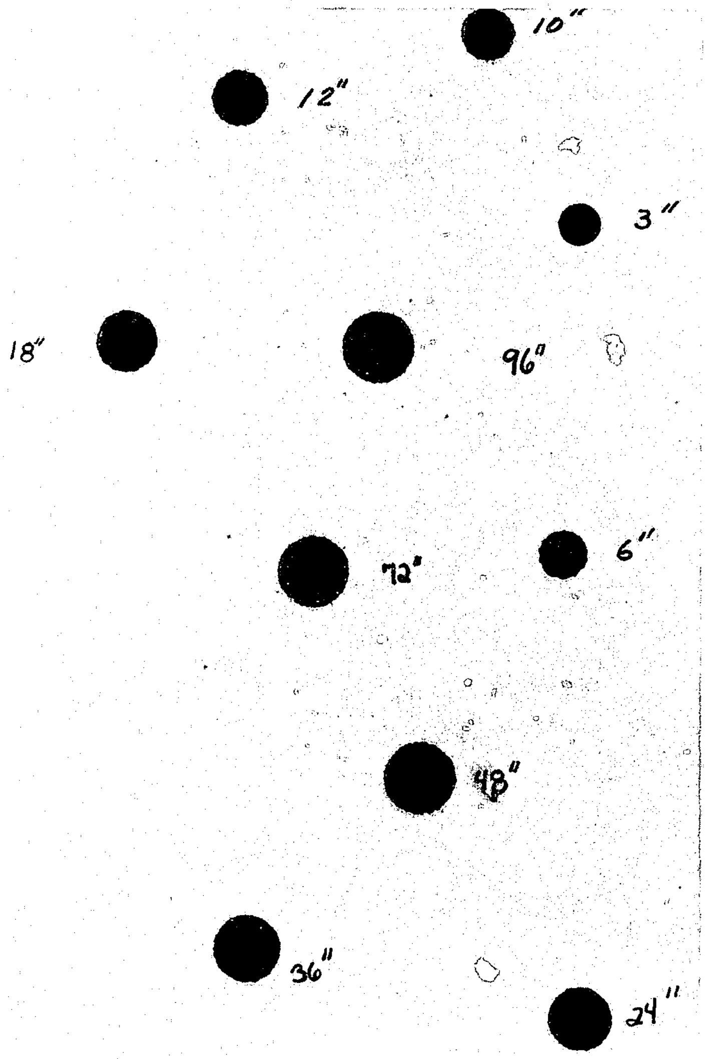


Figure 45: The height from which a drop of blood has fallen can be estimated from the diameter of the stain and the texture of the target surface.

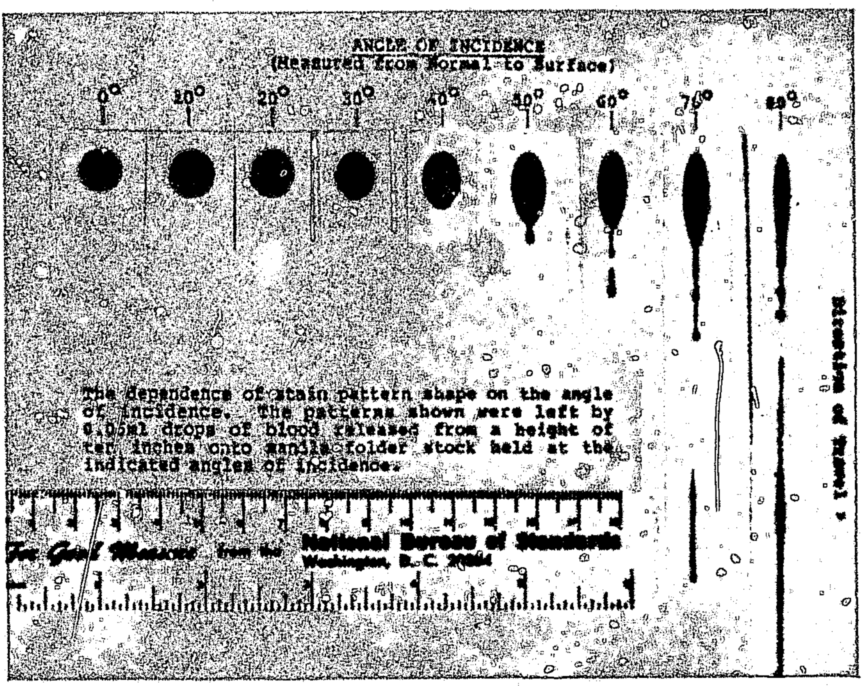


Figure 46: Patterns left by 0.05-ml drops of blood released from a height of 10 in. onto manila folder stock held at the indicated angles of incidence. Direction of travel: top to bottom.

i. Circular: Indicates a short distance (less than 12 inches).

ii. Jagged: Indicates a falling distance greater than 12 inches.

iii. Splatter: Indicates a distance greater than 3 feet.

iv. Bludgeon-shaped: Indicates the angle of impact with small spots trailing in the direction of the fall.

b. The size of the pattern and droplets gives information about the speed and force of formation, keeping in mind the effects of surface and distance on the pattern.

i. Low velocity: Small force, droplets form with little scattering.

ii. Medium velocity: Intermediate force, ragged edges on the droplet and some secondary scattering of blood.

iii. High velocity: Great force, extensive scattering, very fine droplets form around and point toward the central area of initial impact.

c. Other types of blood patterns

i. Radial spatter patterns from blows

ii. Arc patterns from swinging weapons

iii. Patterns from artery spurts

iv. Trail patterns

v. Contact and transfer patterns

vi. Patterns from shooting

vii. Patterns of droplets

4. Glass fracture patterns

a. Types of fractures: When force is applied to glass, there is an initial stretching of the surface on the opposite side to the applied force. Once the elastic limits of the glass have been exceeded, radial cracks form looking much like the spokes of a wheel. As the force continues to build, concentric cracks begin to form on the same side as the applied force since this surface of the glass has now been placed under tension.

Thus, every glass break is a failure of the surface under tension with the break following a bending away from the direction of the applied force. The surface opposite the force under tension breaks first. Note that the concentric cracks being circular in shape have as their center the original point of impact (see Figure 47).

Generally, from glass fracture patterns, the forensic scientist could make the following six (6) types of determination:

i. Radial fractures vs concentric fractures.

ii. Determine the point of impact.

iii. Determine the entrance and the exit.

iv. Determine the velocity of projectile.

v. Determine the sequence of impacts.

vi. Determine the nature of impact force.

b. Glass fracture examination

i. Determining the direction of force (see Figure 48)

(a) Crater at the point of impact - a projectile passing through or striking but not penetrating through the glass will leave a cone-shaped crater with the smallest diameter on the same side as the applied force and the larger diameter on the side opposite the applied force.

(b) Examination of the edge surfaces of the various fractures will also yield information on the direction of force. The "Three R Rule" can be of assistance in this problem. It states "Radial cracks will have Right angles on the Reverse side of applied force." If the observer looks at the edges of a radial crack, shaped lines will be seen with one end of the "C" being at a 90° angle to the surface opposite the applied force. The converse of this rule is true when looking at the edges of concentric fractures due to the physics involved in the actual fracture, i.e., concentric cracks will have right angles on the side of the force.

(c) Sequence of multiple fractures - the order of occurence can be determined by observation of

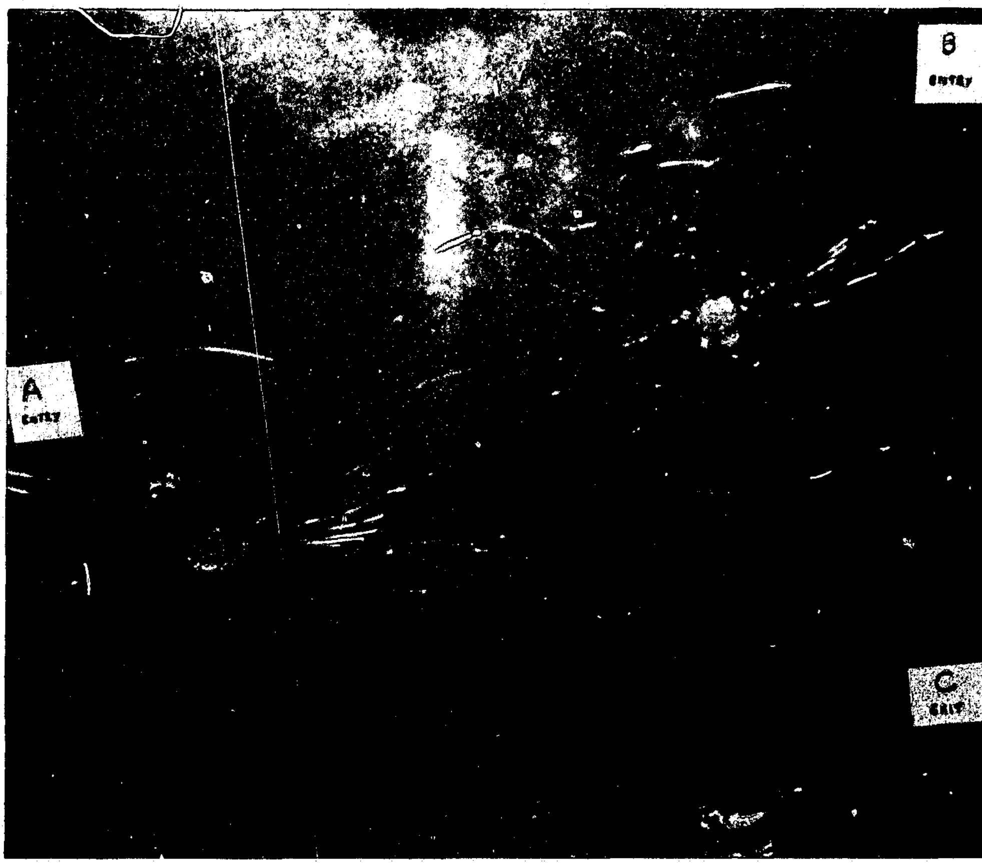


Figure 47: Reconstruction of the sequence of bullet holes in window glass. The sequence of shots fired through a pane of glass is usually obvious from an examination of the fracture lines. When this information is combined with that from a determination of direction, it should be possible to tell which of two shooters on either side of the glass fired first.

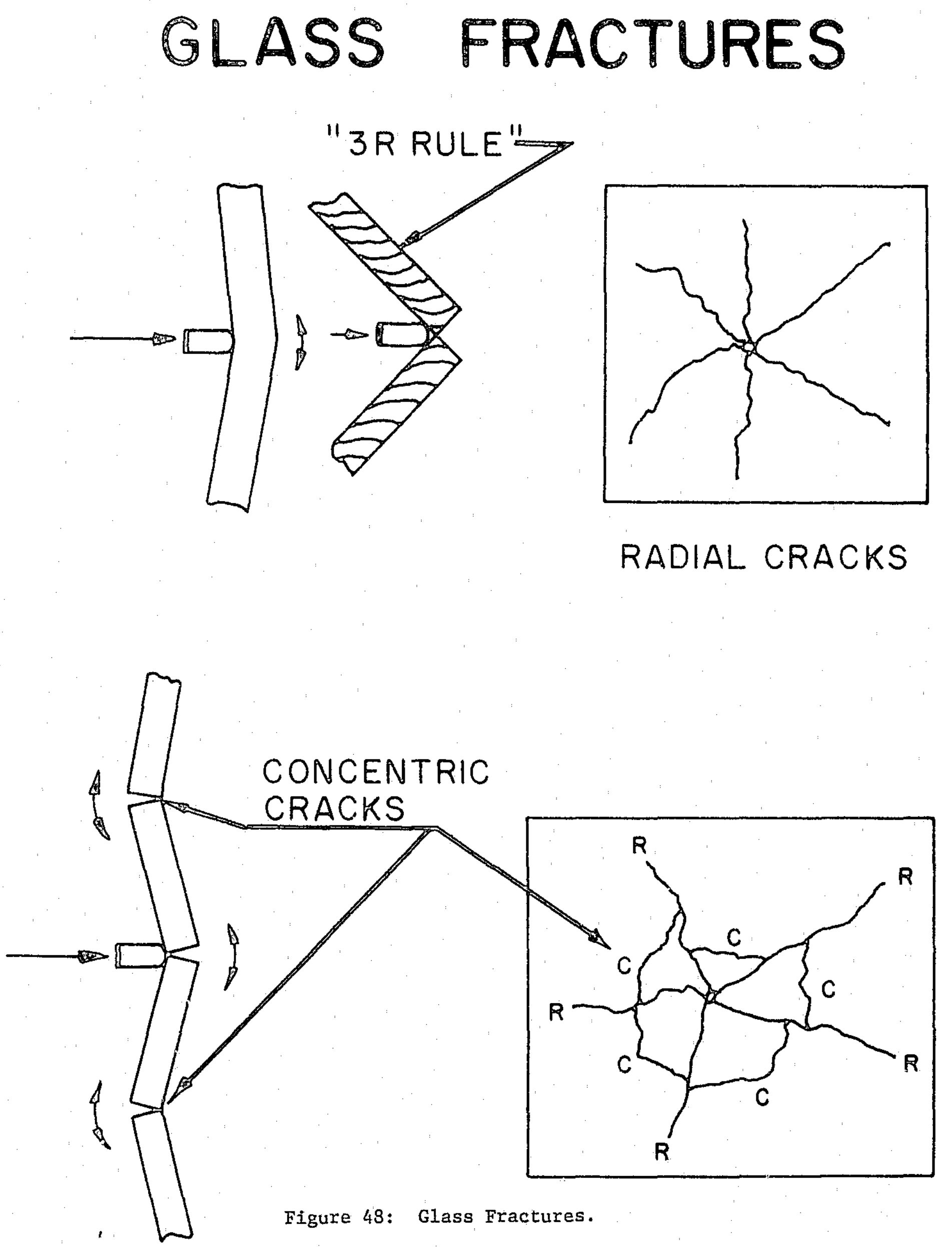


Figure 48: Glass Fractures.

the fracture lines. Once the initial fracture has been made, subsequent fractures will terminate at the original fracture lines thus, observation of these fractures endings will provide sequence information.

(d) "Blow Back Effect" - small particles of glass will be sprayed back toward the direction of applied force in any glass fracture. It is these particles that may be found in the hair and garments of the person breaking the glass and, as such, should be compared to the glass standards taken from the crime scene.

ii. Direction of travel of the break: Examination of the edge of a broken piece of glass shows curved, rib-shaped lines which are perpendicular to the glass surface where the crack began and nearly parallel at the end of the crack. This can be used to determine whether the break was inward or outward--assuming that it is known which side of the glass was in/out originally.

ii.. Sequence of breaks: Radial lines which end at the junction with a second radial line fracture must have been formed by a later force.

iv. Individualization: A physical match proving that two pieces of glass fit together exactly is the only conclusive individualization possible.

L. Photography section

1. In addition to processing all film shot by members of the Division of State Police, the Photography Section also has the ability to exercise various techniques to visually enhance physical evidence and, in many instances, to make comparisons by other laboratory sections possible. These techniques include.

   a. Transmitted lighting: Where light is passed through the object being photographed, and contrasting detail on the face of the object becomes visible. Examples would include glass and documents (see Figures 49 and 50).

   b. Vertical illumination: Where it becomes necessary to light the interior of small tubular-type objects without shadows falling on the interior. An example would be the interior of a firearm barrel.

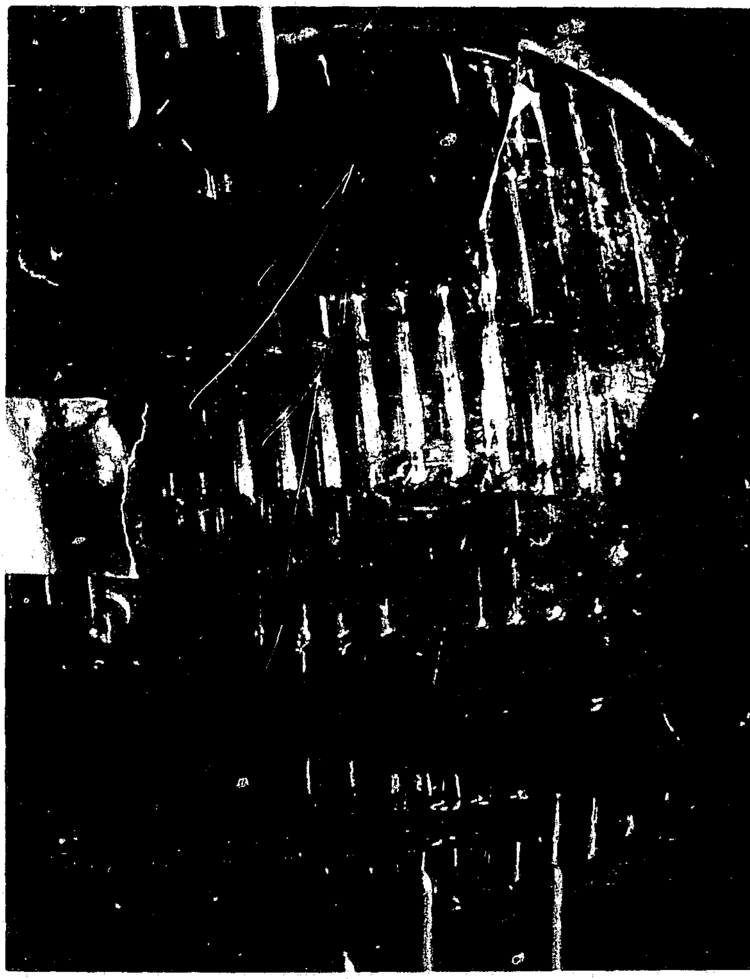


Figure 49: Note the difference that lighting can make when photographing a translucent object. The object in this photograph is lit from the front, while, in Figure 50, it is lit from behind.

Figure 50: Back lighting is a suitable method for showing detail in a translucent object.

c. Infrared, infrared luminescence and ultraviolet photography: Very effective in detecting alterations on documents, and restoring obliterated writing and laundry marks (see Figures 51 and 52).

d. Tent lighting: Where it is necessary to photograph shiny or reflective objects without characteristic burnout caused by the light source. This technique will also remove the possibility of shadows appearing in target areas (see Figure 53).

2. The Forensic Science Laboratory Photography Section also provides services in the following specialized areas:

   a. Aerial photographs

   b. Forensic photographs

   c. Photo enlargement and enhancement

   d. Specialized color photographs

   e. Mug shot photographs

   f. Photo training

M. Reconstruction

1. Types of reconstruction

There are two general types of reconstruction services currently provided by the Connecticut State Police Forensic Science Laboratory.

   a. Accident reconstruction

      i. Traffic accident reconstruction

      ii. Other accidents

   b. Crime reconstruction

2. Traffic Accident Reconstruction

The Traffic Accident Reconstruction Team utilizes the physical evidence and information produced by a collision of a motor vehicle with another vehicle, object, or person to reconstruct the events preceding and resulting from an accident.

Based upon scene photographs, line drawings, the condition of the vehicle involved, the statements of the investigating officers and witnesses, physical evidence resulting from the

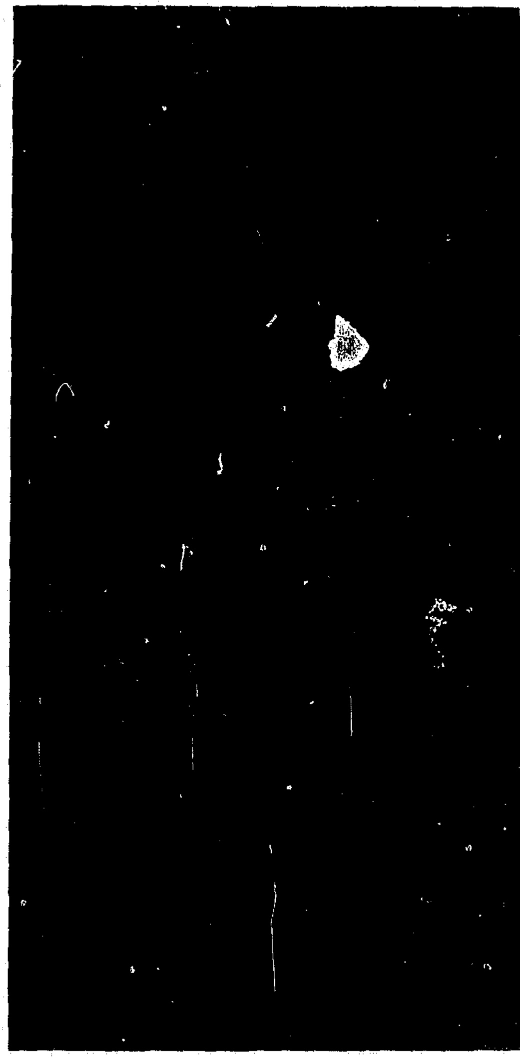


Figure 51: This "copy" shot illustrates a handkerchief as it appears under normal photography. Utilizing ultra-violet light, the laundry mark becomes visible (Figure 52).

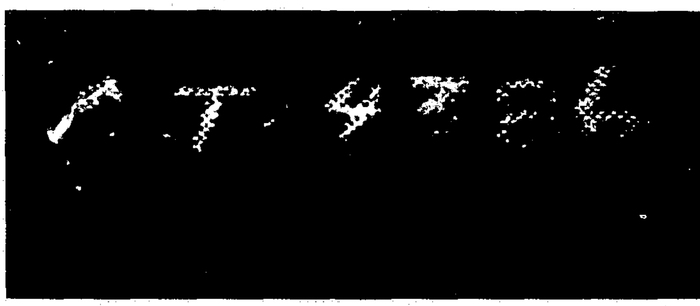


Figure 52: Laundry mark on handkerchief becomes visible under ultra-violet light.

[redacted] [redacted]

accident, and the known data available, the Reconstruction Team may provide the following information regarding the accident:

a. Stopping distances determination

b. Momentum and speed determination

c. Vehicle function determination

d. Degree of damage estimation

e. Diagram and sketch assistance

f. Sequence of events determination

g. Accident scene analysis

h. Time and distance analysis

N. Trace evidence

1. Trace evidence includes many types of materials which are deposited or transferred as a result of direct contact. The most commonly encountered trace evidence includes:

a. Fibers & feathers

b. Glass & soil

c. Food & oils

d. Wood & vegetation

e. Paint & insulation

f. Metals & building materials

g. Plastics & rubber

h. Oil & grease

i. Pollens & spores

j. Chemicals & others

2. Types and classification of fiber and glass

a. Type of fiber evidence

i. Natural fibers

(a) animal fibers

(b) vegetable fibers

(c) mineral fibers

ii. Derived and regenerate fibers

iii. Synthetic fibers

3. Examination of trace materials

a. Physical match: In larger samples, physical matching of two pieces of material may be possible. Physical matching can be achieved through a direct fit and match method, or an indirect pattern match method.

b. Microscopical examination: Color, texture, shape, pattern, layer structure, and surface striation can be compared with microscopical examination.

c. Microchemical tests: Various chemical reagents are available to solubility, color, or crystal tests.

d. Physical property determination: Physical characteristics such as hardness, melting point, density, ash formation, and tensile strength can be measured.

e. Poliarizing Microscopy: Various types of determination, such as birefringent, dispersion, extinction angle, optic sign, sign of elongation, and refractive indices can be made using the polarizing microscope.

f. Instrumental methods: Organic and inorganic composition of the trace evidence can be analyzed using IR spectroscopy, pyrolysis G.C., AA, NAA, X-ray, mass spectroscopy, and emission spectroscopy.

4. New developments

a. Ion Microprobe mass analyzer (IMMA): This is a new and sensitive technique for elemental analysis. IMMA can be used to determine the distribution of trace elements within a miscroscopic sample.

b. Microinfrared spectrophotometer (NANOSPEC/20-IR): Nano Spec 20-IR provides molecular analysis in areas, or of samples, as small as 20 X 20 um. This technique can be used to determine the organic composition of trace sample (see Figure 54).

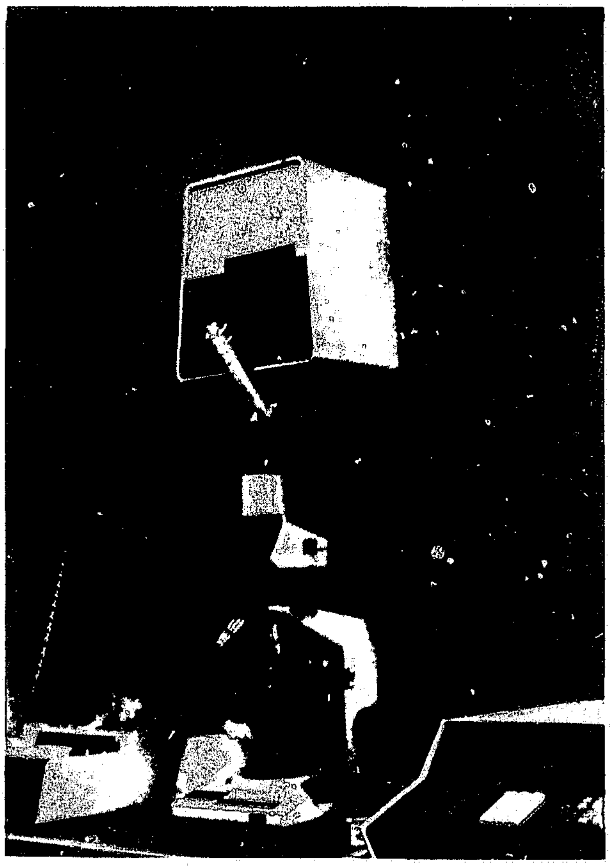
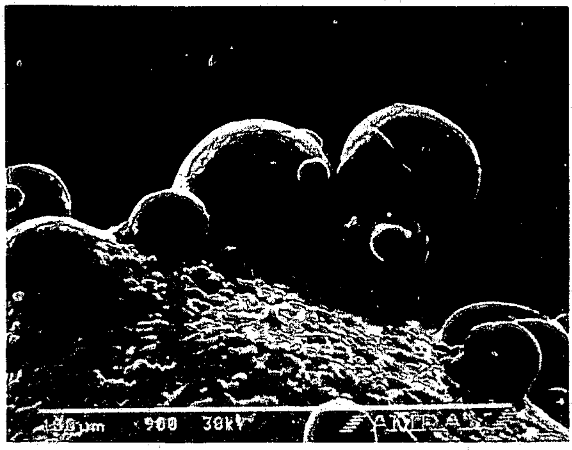


Figure 54: The microUV-visible spectrophotometer (NANOSPEC/10)

c. SEM-X-Ray: Scanning Electron Microscope with the attachment such as energy-dispersive X-ray spectrometer or wave-length-dispersive X-ray spectrometers have been used for morphological and elemental analysis of trace evidence (see Figure 55).

(a)



(b)

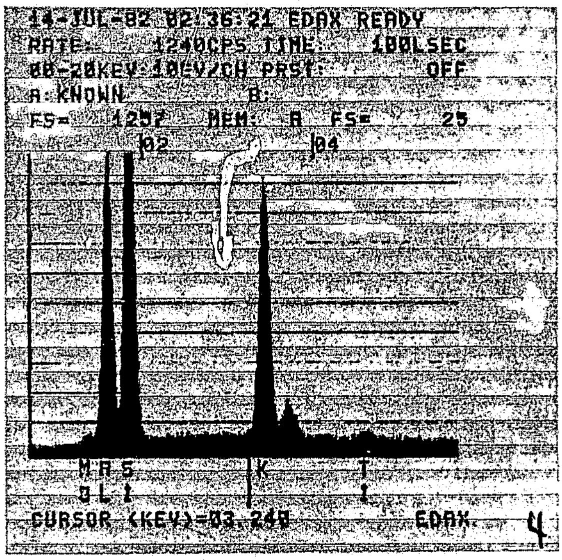


Figure 55: (a) Scanning electron micrograph (900x)
(b) Elemental analysis data by EDAX.