Fingerprint Development & Recovery Techniques

for the Crime Scene Investigator

Presented by: Imprimus Forensic Services, LLC
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WEB PREVIEW SAMPLE

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Fingerprint Development & Recovery Workshop

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Historical Overview

For thousands of years, humans have been aware of the intricate designs present on their fingers, palms and foot soles. Prehistoric drawings and fingerprints in ancient clay tablets bear testament to man's understanding of the presence of friction ridge detail. Many individuals have employed these patterns as a means of identification but it was not until relatively recently that the usefulness of these unique patterns in criminal investigations was realized. The late 1800's and early 1900's were a time of significant focus on attempts to identify those involved in criminal activity. Linking unknown offenders to crime scenes and establishing the identity of individuals taken into custody were both areas of concern.

In the late 1800's, Alphonse Bertillion, a clerk with the Paris France police department had developed his anthropometric system of identification. This system required police officers to take measurements of various body parts on arrested persons. These measurements were recorded on cards and stored with the arrestee's information in a searchable file. When someone was taken into custody, their measurements were compared to the records on file in an attempt to identify the individual and locate previous arrests. While this system had limited successes, it was adopted by police departments worldwide including those in the United States.

Also developing in the late 1800's were various attempts at classifying fingerprints and identifying persons through fingerprint records. The majority of these efforts came out of England and a competition of sorts developed between the idea of fingerprint identification and the anthropometric method of identification.

Ultimately it was the fingerprint system that won out and is still in use today. More than 100 years have passed since the adoption of fingerprint identification by law enforcement in the United States. This extended period of use has established that fingerprints are

- Unique to only one individual
- Are permanent throughout a person's lifetime
- The most positive and practical means of identification

The patterns, known as friction ridge detail, that make up our fingerprints, exist not only on our fingers but also cover the entire palmar surface of our hands as well as the soles of our feet.

The following is a brief timeline of fingerprint history

1684 – Nehemia Grew

Mr. Grew was an English plant morphologist who is credited with being the first person to describe in his writings ridges, furrows and pores that make up friction ridge detail. He made drawings of fingerprint and palm patterns that were included in his writings.

1770 – Thomas Bewick

Mr. Bewick was an artist and engraver who used a woodcut of his fingerprint to authenticate his books. Like others before him who had come to realize the uniqueness of fingerprint patterns, Mr. Bewick failed to recognize the value that these prints could have in criminal investigations.

1823 – Johannes Evangelista Purkinje

A Czech physiologist, Purkinje was the first to describe specific types of patterns on the fingers. He originally identified nine pattern types; one arch, one tent, two loops and five whorl patterns. Persons who followed later in the study of fingerprints narrowed these nine patterns to three basic patterns (arch, loop and whorl) with each pattern type having sub-pattern categories.

1858 – Sir William Hershel

A collector for the English government in India, Sir Hershel began the practice of affixing the fingerprints of natives to business contracts. While done primarily to play on the superstitions of the local people and not as a serious means of identification, Sir Hershel has been identified as the first person to practice taking the fingerprints of others.

1877 – Dr. Henry Faulds

Dr. Faulds was a medical missionary in Tokyo and experimented with removing the top layer of skin from the fingers to see if the patterns remained the same when the skin healed and grew back. Dr. Faulds solved a series of thefts from his laboratory by using fingerprints to identify the offender.

1889 – Alphonse Bertillion

While he speculated that no two people were alike, Bertillion believed that taking and recording the measurements of specific body parts was the best means of identification. While his Anthropometric system was adopted world-wide, it met with limited successes. Quite obviously, one of the shortcomings of this system was that it could not be used in crime scene investigations.

1891 – Juan Vucetich

Mr. Vucetich was a police official in Argentine South America. He devised a fingerprint classification system that was used in South America and is given credit for being the first person to identify the offender in a major criminal investigation with his matching of a bloody fingerprint from a murder scene to the perpetrator (1892).

1892 – Sir Francis Galton

Sir Galton devised the first scientific method for classifying fingerprints. He took Purkinje's nine pattern types and broke them into three main patterns of arch, loop and whorl. He also identified specific characteristics of these patterns, now referred to as Galton's Points.

fingerprint records has greatly enhanced law enforcement's ability to identify persons involved with crime.

For additional detailed information on the history of fingerprints, go the SCRO – Scottish Criminal Record Office web site "History of Fingerprints – A Time Line" at http://www.scro.police.uk/fingerprint_history.htm

Physiology

Friction ridge skin, also called papillary skin, is only found on the palms of the hands and soles of the feet. It is comprised of

- Ridges
- Furrows
- Pores

The patterns formed by the friction ridges of the skin extend through both the outer layer of skin (epidermis) and the lower layers of skin (dermis). The friction ridge pattern may be altered by disease or injury, however these changes usually do little to prevent identification.

The friction ridge patterns of the fingers are comprised of three broad categories, each of which has sub categories of pattern types.

Loops **Whorls** **Arches**

Within the friction ridge detail are small points or characteristics that make up the pattern. These characteristics are referred to as *Galton's Points* or *Details* or minutiae. The most common types of minutiae are

- Bifurcation 
- Dot 
- Enclosure 
- Ridge Ending 

The patterns formed by friction ridge skin can be transferred to surfaces that we touch, handle or walk upon. The transfer occurs when material that is present on the friction ridge skin transfers to items that are contacted. The material on the skin can be sweat, body oils or some other contaminant (e.g. paint or blood).

There are three different forms of friction ridge detail that can exist at a scene

- Latent
- Patent
- Plastic

Latent Prints

Latent prints are those prints that are not readily visible to the naked eye. These are the prints that require the application of various development processes (e.g. powders and chemicals). Once these prints have been developed, they can be recovered through photography, lifting mediums or retention of the item bearing the print.

The method used for developing the latent print will depend on the nature of the surface being processed. There are two types of surfaces that need to be dealt with – porous and nonporous.

Patent Prints

Patent prints are those prints that can be viewed as they exist without any development processes being applied by the investigator. Typically patent impressions result when the friction ridge surface leaving the print is contaminated with some type of material. Examples of contaminants include dirt, dust, paint, grease and blood.

Depending on the contaminant, a patent print may be further enhanced through the application of appropriate chemicals. Recovery techniques for patent prints will include photographing the print and if possible, collecting the item that bears the print. Patent prints that exist in dust-like materials may frequently be lifted with conventional lifting mediums (e.g. tapes or putty).

Plastic Prints

Plastic prints are three dimensional impressions of the friction ridge detail made in a soft surface. Examples of soft surfaces that can retain friction ridge detail are paint, putty and damp earth. Because of their three-dimensionality, these types of prints are best documented through object recovery and/or casting.

<u>Porous Surfaces</u>

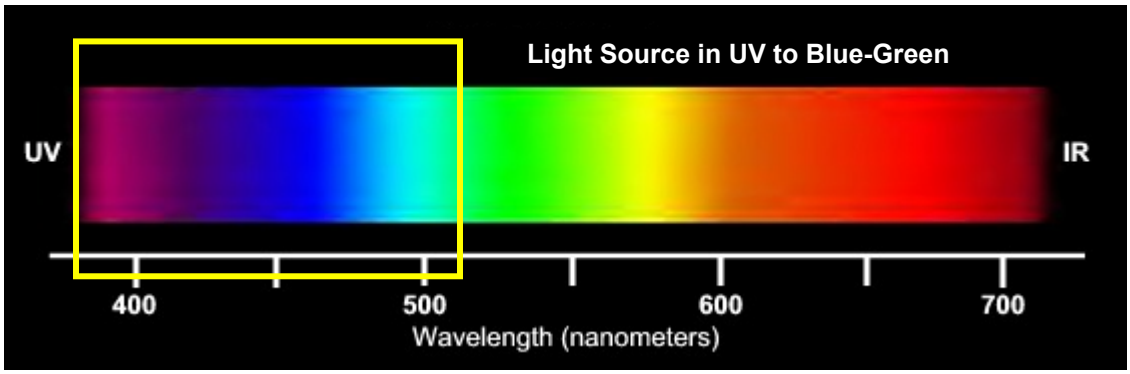
Examples of porous surfaces are

- Paper
- Raw wood
- Cloth

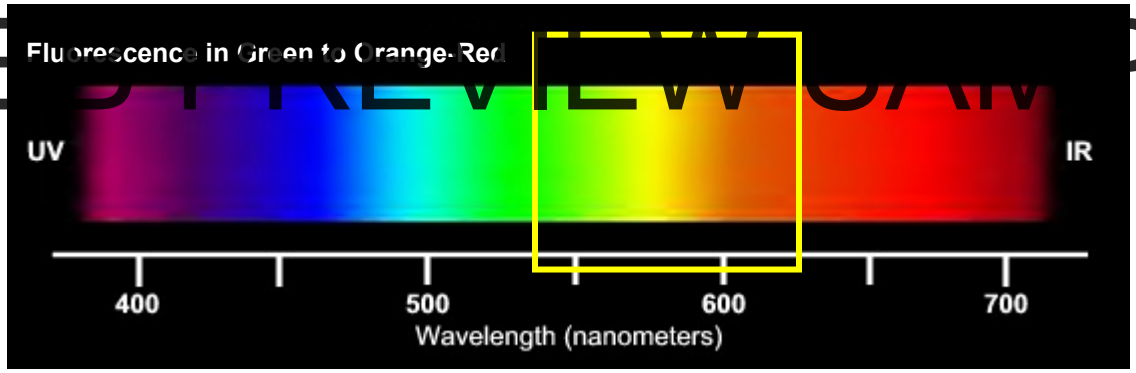
In most instances, porous surfaces will require the application of chemical development processes. These processes react with the various components that make up a fingerprint (e.g. amino acids, lipids, etc.) and have been absorbed into the porous surface.
The processing of porous items for latent prints is not something that is typically done at crime scenes. Items suspected of bearing latent prints are recovered and processed in a lab environment.

stains and fingerprint powders have this quality. They can be effectively used to provide contrast between the developed impression and the surface that it is on.

Typically, light wavelengths of 365 (UV) – 510nm (blue-green) are best suited for fluorescing these materials. Using a light source that can be tuned to produce a very specific wavelength within this range will generally produce better results.



Typical light wavelengths used to fluoresce latent print powders and dye stains range from long wave UV (365 nm) to 510 nm (blue-green).



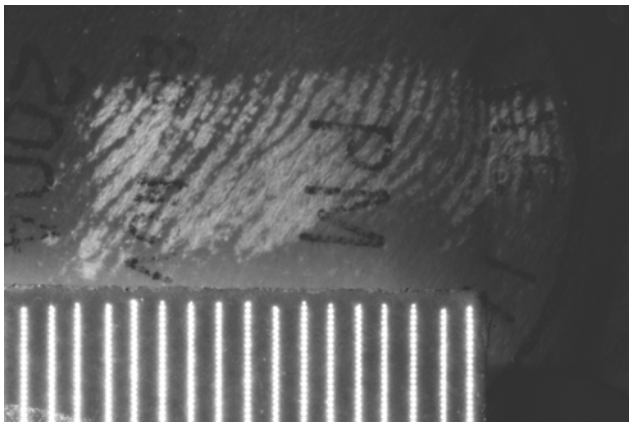
Substances that fluoresce will emit light at a wavelength longer than the excitation light source. Thus, fluorescence typically occurs in the green to orange-red wavelengths of light.

Barrier Goggles / Viewing Screen

When using light in the blue to blue-green range of the spectrum, additional visual enhancement can be achieved by wearing orange or yellow glasses or viewing the object through an orange or yellow viewing screen. These colors will block the excessive blue or blue-green light and make impressions developed with yellow, orange or red fluorescent stains / powders much more visible.

The following combinations of light wavelengths and barrier goggles can be used in specific situations:

Examination	Wavelength	Viewing Goggles
Low Background Fluorescence	350-520 nm	Yellow / Orange
Moderate Background Fluorescence	465-525 nm	Orange
Strong Background Fluorescence	470-550 nm	Orange
Polyethylene Examinations	490-550 nm	Orange
DFO – Low Background Fluorescence	350-510 nm	Yellow / Orange
DFO on Bright Paper	475-550 nm	Orange
DFO – Further Background Reduction	490-590 nm	Red
Crystal or Gentian Violet	500-590 nm	Red
Ninhydrin	350-470 nm	Orange
Ninhydrin / Zinc Chloride	465-525 nm	Orange
Cyanoacrylate Dyes	350-470 nm	Orange
Riboflavin (Doje's Gold Dust)	455 nm	None. Riboflavin will absorb and darken at this wavelength.
Safranine-O	470-550 nm	Orange / Red



Example of a DFO developed latent print on an envelope being fluoresced with an ALS at 455 nm and photographed using black & white film. A #23A red barrier filter was used on the camera lens.

Magnetic Powders

Magnetic powders are made up of conventional fingerprint powder mixed with finely powdered iron that is used as a carrier for the powder. They are applied through the use of a magnetic "wand" that is used to pick up the powder/iron combination. Magnetic powders typically offer excellent sensitivity and because there are no brush bristles that come in contact with the surface, magnetic powder application is generally considered a "softer" and less destructive method than conventional powders used with a brush.

Magnetic powders are well suited for some types of plastic surfaces and surfaces that have a slight texture. They are also ideal to use on extremely smooth surfaces where brushing with a fingerprint brush may wipe away the print. These powders work well on porous surfaces like paper and can also be used on non-ferrous metal objects (e.g. aluminum cans). Because of their sensitivity, magnetic powders may have a tendency to "paint" a surface with fingerprint powder. Prior to processing an item with magnetic powders, a small area should be tested. If the powder coats or "paints" the surface, a different processing method should be used.

Like conventional powders, magnetic powders are available in standard contrasting colors (black, white, gray), fluorescent colors and specialty formulations such as dye-based powders. Unlike conventional powders, magnetic powders are cleaner and less wasteful.

Conventional Powder

Conventional powders continue to be the workhorse of most crime scene investigators. Basic powders like black, white and gray have been supplemented by additional colors to provide contrast against the background of the object being processed. Typically these powders are applied through the use of a fiberglass or feather brush that are relatively gentle in their application of powder. Because the brush must contact the surface being processed, there is a chance that the print may be partially or totally destroyed if it hasn't been protected through some other process like CA fuming.

Resin based fluorescent powders are also available and have the advantage of providing good contrast against backgrounds that do not have an interfering fluorescence. They are very useful on multi-colored surfaces and may also work well on more textured surfaces. Because of their sensitivity, fluorescent powders may also "paint" the surface and they should be tested on the object being processed. If a lift is made of a latent developed with fluorescent powder, the lift should be mounted on a black backing card. Along with the other information that is typically recorded on the backing card, the wavelength of light used to fluoresce the powder should also be noted.

NOTE: Some fingerprint lifters and lifting tape may also fluoresce depending on the wavelength of light being used. The technician needs to be certain that the lifting medium will not interfere with subsequent viewing of the developed lift.

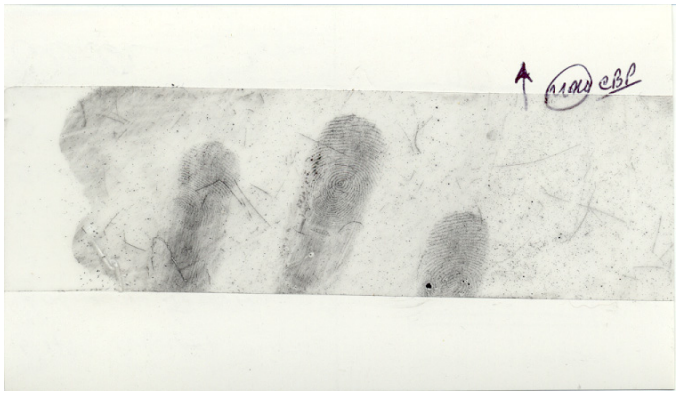
Conventional powders are best suited for relatively smooth surfaces.

Proper documentation and collection of latent lifts is critical because it can help the examiner determine the finger(s) most likely to have left the impression(s) at the scene. This can help speed up the latent print comparison process. The example below shows how this can be done.

Whenever possible, the technician should lift a related group of developed latent impressions together as shown below.

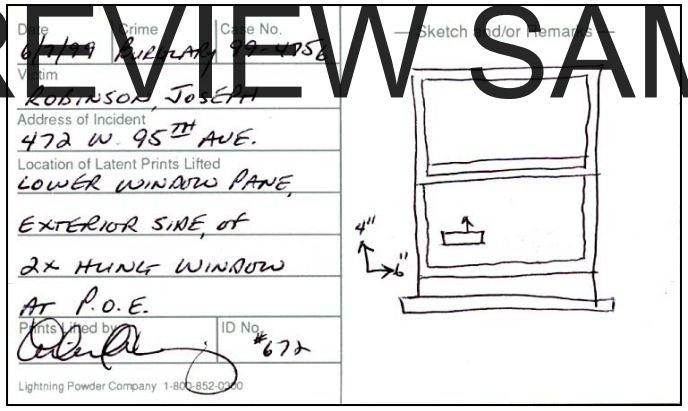
This set of three fingers collected together, clearly shows their relationship.

Most likely these are the index, middle and ring fingers from one hand.



An appropriate reference sketch on the back of the lift card can help the examiner identify the most likely hand.

Given this additional information, it appears that these fingers are most likely from the left hand.



Methods for documenting the location of recovered lifts include:

- Sketching
- Photography
- Notes & Reports

The diagram shown on the next page shows a method for documenting a large number of recovered lifts in a single sketch. This technique allows the recovering officer to avoid drawing a thumbnail or reference sketch on the back of every lift card recovered. The lift cards only need to be numbered to correspond to the marked locations in the diagram.

Photography

Traditionally, many SOP's or fingerprint recovery guidelines required the photography of fingerprints before they were lifted. The purpose was to document the print in the event that it was ruined or destroyed during the lifting process. One of the big problems years ago, was a lack of suitable lifting materials to recover prints from difficult surfaces. Transparent tape was about the only lifting option a crime scene or fingerprint technician had.

Today, crime scene technicians have a wide choice of lifting mediums. They include flexible plastic tapes, rubber/gelatin lifters and casting materials like Mikrosil® and AccuTrans®. While these lifting mediums have not eliminated the need to photograph prints altogether, they have certainly lightened the photography workload.

Situations where fingerprints should be photographed include

- Various stages of progressive processing, particularly when using chemicals that might destroy the print or substrate.
- Bloody prints prior to the application of blood reagents.
- Prints in fragile mediums like dust.
- Any time that the technician feels the print will be difficult to lift and may be destroyed during the lift.

Required Equipment

Having the proper equipment always makes a difficult job easier. We recommend the following

- Close-up capabilities; macro lens or close-up filters or 1:1 adapter (macro-lens preferred) - this is mandatory.
- Tripod or copy stand or other stabilizing device (mandatory)
- Assorted scales (mandatory)
- Cable or remote release
- Ring light or ring flash
- Appropriate filters if doing fluorescent photography

An example of one of the newer LED ring lights made to mount at the end of your camera lens. The lights provide diffuse even lighting and are great for photographing prints on non-reflective surfaces. The model shown is mage by Digi-Slave. There are other lights available from other manufacturers, including lights with blue, purple and green LED's.

Fingerprints v. DNA

Fingerprints are still the only means of identifying a person as a unique individual. Identical twins will have identical DNA profiles but different fingerprints. The newest DNA technology however, has the ability to be highly sensitive and highly discriminate

With the current DNA technology available, crime scene technicians need to consider DNA as a viable alternative to fingerprints. DNA profiles may be obtained from surfaces that have been handled by suspects and the evidentiary value of these items must be recognized and they must be protected. These items may include the handles of tools, grips of guns and steering wheels of cars.[1] In many instances, these surfaces may not provide satisfactory results when processed for latent prints but trace amounts of cells suitable for DNA analysis may be collected from these surfaces by swabbing. In one study conducted by the RCMP, it was found that the major DNA profile found on the steering wheel of a car was always that of the last driver, even if that person was not the primary driver of the car.[2]

While most fingerprint processing techniques will not destroy DNA evidence, application of processing techniques may make this evidence harder to recover. CA fuming a gun for example may result in a film of polymerized CA that covers the trace DNA material on the grip making it difficult to recover by subsequent swabbing. The crime scene technician should take steps to recover DNA material from surfaces that are not likely to yield useable fingerprints prior to processing for latent prints.

In the example shown above, both the inside and outside surfaces of the bottle mouth are swabbed to collect DNA evidence prior to fuming the bottle for prints using Cyanoacrylate. The tools needed to properly swab are shown at right and include sterile or distilled water, sterile swabs and clean packaging materials.

[1] Wickenheiser, Ray A. Trace DNA:A Review, Discussion of Theory, and Application of the Transfer of Trace Quantities of DNA Through Skin Contact. Journal of Forensic Sciences 2002;47(3):442-450.

[2] Ibid

A list of the most common fingerprint terms and their definitions appears below. For a far more extensive dictionary of terms, visit **Michele Triplett's Fingerprint Terms** at http://www.fprints.nwlean.net

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Amido Black: A common protein stain used to enhance the appearance of bloodstains against a substrate. Amido black will dye the stain a dark blue-black color and is best suited for light backgrounds.

Amino Acids: A component of sweat. Amino acids will react with Ninhydrin, turning a purple color. Because amino acids are water soluble, Ninhydrin cannot be used after a water based development process or on porous items that have been wet.

Arch: One of three basic fingerprint patterns. Arch patterns are characterized by ridges that enter on one side of the impression and flow through to the other side. Arch patterns have no deltas. Arches represent about 5% of all fingerprint patterns.

Catalytic Presumptive Test: A presumptive test for blood that relies on the hemoglobin in blood to speed up the reaction between an oxidizer and the reagent involved in the test. The subsequent rapid oxidation of the reagent typically results in a color change of the reagent.

Chemical Processing: A latent print development technique that relies on a chemical reaction between the processing chemical being used and a chemical component of the latent print. An example is the purple color formed when Ninhydrin reacts with the amino acids in a latent print.

Dermis: The under layer of skin.

Delta: A "Y" shaped ridge pattern found only in Loop and Whorl patterns. When rolling fingerprints, primary consideration should be given to recording the delta(s). Loop patterns have one delta, Whorl patterns have two.