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Finding & Evaluating Fingerprint Evidence in Forensic Science

Fingerprints are among the oldest and most valuable types of physical evidence in criminal investigations. The fingerprints of the offender are often found at scenes in connection with a variety of crimes, ranging from larceny or burglary to homicide. Besides their use in linking a suspect to a scene, investigators also use fingerprint comparisons to determine previous arrests, to apprehend fugitives, and to identify unidentified bodies, amnesia victims, and mass disaster victims.

There are three fundamental facts that have made fingerprints good evidence for personal identification and well accepted by the courts:

1. An individual's fingerprint ridges are formed during fetal life, between 100 and 120 days of development, and remain unchanged for the remainder of a person's lifetime.

2. It is accepted that fingerprints are unique. No two persons, even identical twins, have identical friction ridge characteristics.

3. Classic fingerprint classification systems and automated fingerprint identification systems (AFIS) allow the development of files containing systematically classified fingerprints. These systems allow for the rapid retrieval of a particular fingerprint card, and AFIS systems allow searching a single latent fingerprint against the ten print cards on file.

Fingerprint patterns

The general ridge patterns observed in fingerprints can be divided into eight (8) basic fingerprint types.

1. 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.

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

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

2. Arch

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

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

b. 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.

3. Whorl

At least two delta-shaped divergences are present with recurving ridges in front of each. Whorls comprise approximately 29% of all fingerprint patterns.

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

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

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

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

Types of fingerprints

1. Inked fingerprints

Ridge impressions are taken by inking an individual's finger or palm and rolling it across a card, or other smooth surface.

2. Visible (patent) prints

Ridge impressions which are caused by the transfer of a medium such as paint, blood, ink, or other colored substances to a smooth surface.

3. Plastic prints

Ridge impressions which are indentations (three dimensional) and found in soft material such as putty, wax, clay, or other deformable surfaces.

4. Latent prints

Finger ridge impressions that are deposited on a surface by the transfer of natural body secretions and which are not readily visible. Latent prints are among the most common type of fingerprint evidence found at crime scenes and must be chemically or physically processed to enhance visibility.

INSIDE:

Collection and Preservation of Fingerprint Evidence

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. Other factors which affect this decision may include the location of the evidence, the environmental conditions where the investigator is working, e.g., outside or inside, the size of the item being processed, and the materials available to the investigator at the scene. The following describe some of the basic procedures used for processing latent fingerprints at a crime scene.

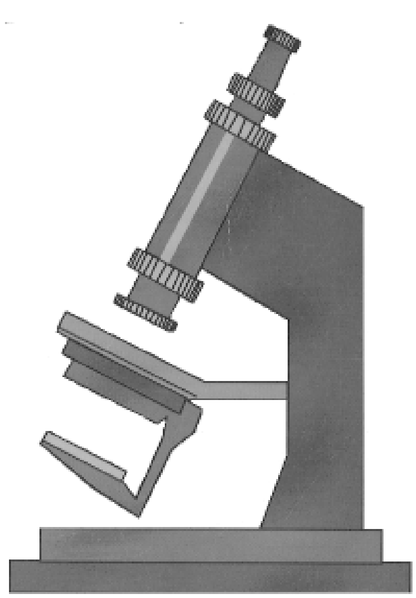
A. Dusting of nonporous surfaces

The following procedure outlines the steps for the processing of a nonporous surface using standard fingerprint powder techniques:

1. Powder

Choose a fingerprint powder of a contrasting color to the surface being processed. For example, choose Chemist Gray for dark colored surfaces, glass, mirrors or chrome, and black powder for light colored surfaces. Pour a small amount of the powder from the jar onto a piece of paper to insure that the rest of the powder does not get contaminated.

Latent prints, among the most common type of fingerprint evidence, must be chemically or physically processed to enhance visibility



2. Brush

Use a fingerprint 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 feather duster or fiberglass fingerprint brush.

3. Numbering

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

4. Tape lift

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. Lift the fingerprint with transparent fingerprint tape and place it on a backing of a contrasting color to the powder. In many instances, a second lift may provide better quality minutiae reproduction than the original lift.

5. Labeling

Initial and label all latent lifts. The package label should include the following information: Case number, lift/item number, location of the print, date, time, and person lifting the latent print.

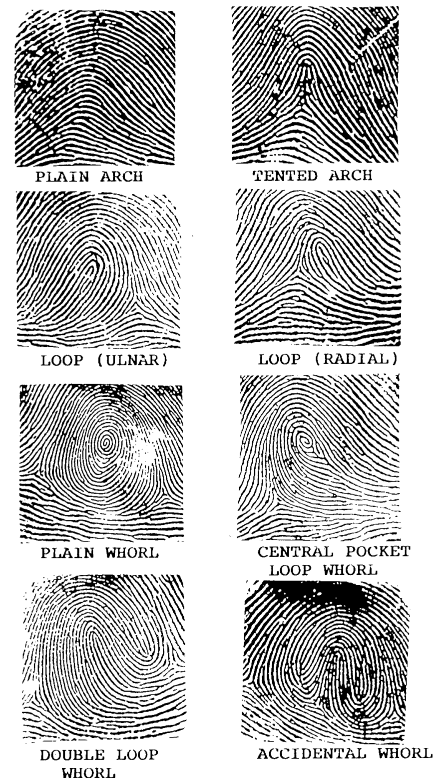
B. Alternate processing methods

Many techniques are now available for use at the crime scene which extend the capability of the scene investigator.

1. The "super glue wand"

The "super glue wand" is a portable system which allows for fuming of larger items, such as automobiles, and nonmoveable surfaces at a crime scene. If used with appropriate safety procedures at the scene, this method offers the advantages of super glue processing which often provides latent print development superior to dusting. Thus the portable wand moves the super glue technique from the laboratory to the field in some cases.

The Basic Fingerprint Pattern Types



2. Alternate light source

Portable alternate light sources, with appropriate filters, used in conjunction with fluorescent chemicals and powders may make it easier to locate latent prints on certain surfaces.

C. General recommendations

1. Do not dust visible prints, such as prints in paint, grease or blood. It will not make them any clearer and may destroy them. Do photograph them and transport the whole article to the laboratory, if possible.

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

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

4. Do not process wet items. Let them air dry naturally or submit these to the laboratory immediately for special processing.

5. Do not use heat lamps or

blowers to accelerate drying, as these may cause excess evaporation of oils and perspiration.

6. Do allow items exposed to freezing temperatures to warm up before attempting to process them.

7. Chemical processing or instrumental techniques should be used under the supervision of laboratory personnel, or only after proper training and experience.

D. Collection of fingerprint evidence not processed at the scene

Items transported to the laboratory

Smaller items not processed by the investigator may be submitted to the laboratory for processing and lifting of latent fingerprints. Bring to the laboratory any item which requires chemical processing, such as paper materials, or evidence which will require alternate light examinations, such as use of the laser. In addition, any object which requires multi-disciplinary examinations should be submitted to the laboratory for these procedures.

1. In all cases, package physical evidence to minimize movement of the object and to immobilize it during transport.

2. Evidence to be processed at the laboratory should be packaged in a manner which avoids friction on the print-bearing surface; abrasion by movement within the packaging could alter or destroy any fingerprints which are present on the item. It is advisable to avoid simply placing the article in a plastic bag as this can also be a source of friction.

3. Place latent fingerprint lifts in an appropriately labeled envelope for submission to the laboratory.

Post-mortem fingerprints

1. To obtain fingerprints from a deceased person, the investigator must first dry the fingers and palms of the cadaver.

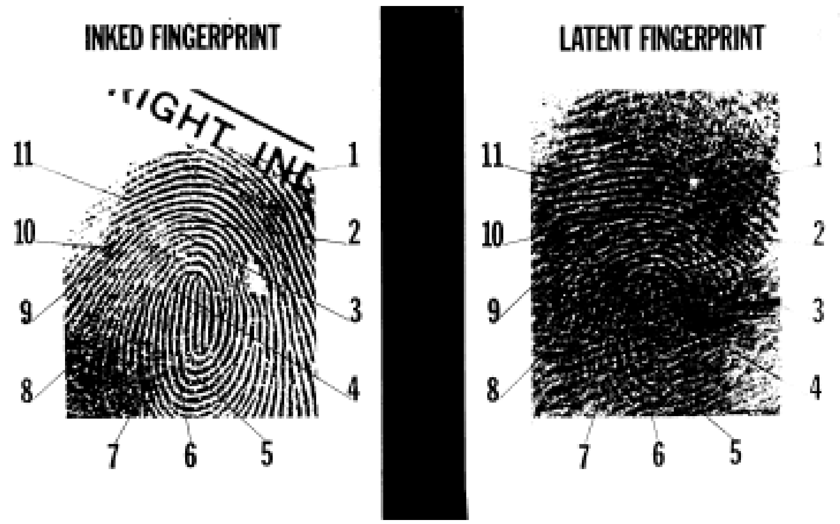
2. The fingers are then inked directly, using an ink roller or ink pad.

3. The investigator then presses each finger into the "fingerprint spoon," (curved metal plate capable of holding a fingerprint card), and released.

4. 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.

5. If fingers have begun to decompose, as with "floaters," consult examiners at the forensic science laboratory, medical examiner's office or members of an identification unit as to other methods which may be used to obtain the fingerprints.

Fingerprint Comparision Chart



The points of comparision are numbered indicating a positive identification

Laboratory Examination of Latent Prints Evidence

A. Processing of physical evidence for latent fingerprints

Physical evidence submitted to the forensic laboratory can be processed by various methods, depending on the nature of the print and the substrate upon which it is deposited. In addition, photographic techniques may also be employed to enhance visible characteristics. The following describe some of the methods used in the laboratory.

1. Powder dusting

A powder of contrasting color to the surface being dusted is chosen. Impressions on objects such as metal, plastic, glass, tile and other non-porous surfaces are easily processed with various fingerprint powders. Occasionally, a magnetic fingerprint brush can be used to advantage. The "powder" is made of fine steel particles which can develop the latent fingerprints on certain surfaces better than traditional fingerprint powders.

2. Iodine fuming

Vapor from warmed iodine crystals dissolves in the skin oils in a latent print, yielding a yellow brown print. Photograph the developed latent prints immediately, or chemically fix for a permanent record, because they fade rapidly.

3. Ninhydrin

The ninhydrin reagent is sprayed on the medium and reacts with amino acids and peptides from body secretions, giving a violet color. Placing the object in a humid atmosphere, in the dark, enhances latent print development, which may require up to forty-eight hours to maximize.

4. Silver nitrate

A dark image is produced when the silver nitrate solution reacts with salts in the latent print, in the presence of light.

5. Fluorescent reagents

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

6. "Super glue" method

This process relies on the fumes of cyanoacrylic esters chemically forming cyanoacrylic polymers in the presence of water and amino acid molecules present in the latent print. "Super glue" fuming can also be followed by dusting with various colored or fluorescent powders or swabbing with solutions of fluorescent dyes to enhance visibility.

7. Alternate processing methods

Many laboratories now employ various techniques, relying on technological advances in instrumentation and illumination with great success.

a. Argon laser: In the proper optical setup, various components of body secretions fluoresce and may be photographed. This technique is nondestructive, but expensive, and requires specialized equipment. Use of fluorescent powders and sprays produce much brighter fluorescence and allow visualization of even very weak prints.

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 occasionally on skin.

c. Vacuum coating: A metal vapor is produced in a vacuum chamber and allowed to deposit on an object thought to hold a latent print. Prints on paper, fabrics, and plastics have been developed in this manner.

d. Alternative light illumination: Use of various wavelengths of light to illuminate a latent fingerprint may enhance the print. Varying the wavelength and intensity of light and the filters used to view the print may reduce or eliminate background or contaminant interferences.

e. Special chambers which control vapor pressure and humidity are used to make cyanoacrylate processing even more effective.

B. Development of latent prints on skin

Prints on skin can be difficult to obtain, especially if the cadaver has been exposed to adverse environmental conditions.

1. Iodine-silver method

A thin, polished silver plate is pressed on a area which has been iodine-fumed and then exposed to light, which turns it black at ridge locations.

2. Cyanoacrylate fuming and laser/ alternative light source detection

The areas of interest on the body are fumed with super glue and then dusted with fluorescent powders, which are easily detected with alternate light sources.

3. Decomposed bodies

Some laboratories are equipped to make identifications of fingerprints from decomposed bodies. Silicone or glycerin 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, even with badly decomposed bodies.

C. Comparison of fingerprints

Comparison of fingerprints for identification is based on the recognition of general patterns and minutiae (ridge ends and bifurcations). Figure 46 depicts an example of a fingerprint comparison chart.

A 1973 International Association for Identification (I.A.I.) study concluded that no valid basis exists for requiring a predetermined minimum number of friction ridge characteristics to be present in two impressions in order to establish positive identity. The I.A.I. has officially rejected the notion of "possible" or "probable" identifications of questioned fingerprints. In the August 1979, Identification News, 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."

D. Fingerprint classification systems

The modified Henry System is the most common in use in the United States today. It is a tenfinger classification system which allows the examiner to locate a reasonable number of appropriate fingerprint cards with which to make the comparison, even with very large files.

E. Automated fingerprint identification systems (AFIS)

Many jurisdictions have developed and implemented computer-based identification systems for the storage and retrieval of fingerprint files and the comparison of latent fingerprints with print records in these files.

1. Types of AFIS systems

a. Index systems: These systems store information such as "MO" (modus operandi), individual characteristics, fingerprint classifications and other information. Primarily, these systems serve as a computerized method of sorting information available to the examiner prior to a manual search of fingerprint files, thus eliminating some individual cards.

b. Ridge-angle systems: The angle of ridge flow at certain points on a ten-print card are stored. This information, combined with stored classification information, allows for comparison to and search of the reference file.

c. Encoded minutiae systems: Ten-print cards or latent fingerprints are scanned and the minutiae (bifurcations and ridge endings) of the print are mapped as to location and angle, and the data stored in a convenient format. Bifurcations are areas in

Typical Forensic Laboratory

the print where a single ridge splits into two ridges. Each result may be examined and edited, if necessary. The fingerprint(s) can then be compared against a stored file.

2. Use of AFIS

In addition to automating the classification and filing of 10-print cards, AFIS systems may have the following capabilities:

1. Search and comparison of 10-print card against known identification files.

2. Comparison of an unidentified latent print against a 10-print card in the file.

3. Search of a latent print against the unidentified or known latent prints on file.

4. Input into the file of unidentified latent prints.

5. Image enhancement to clarify the latent by background removal, "fill-in," or elimination of dust particles or other interferences in the latent fingerprint.

As AFIS systems have grown and developed interconnectivity, their value has increased enormously, and they have become a powerful investigative tool.

This article is an excerpt from Physical Evidence in Forensic Science by Henry C. Lee and Howard Harris, item #5564, hardcover; and item# 5563, softcover, © 2000, published by Lawyers & Judges Publishing Company, Inc. Call us at (800) 209-7109 to purchase a copy.

GUEST CONTRIBUTORS:

Dr. Henry C. Lee

Dr. Henry C. Lee was born in China on November 22, 1938. He graduated in 1960 from the Taiwan Central Police College with a degree in Police Science. After working in the Taipei Police Department for several years as a police captain, he came to the United States to pursue further study. In 1972 he earned his B.S. degree in Forensic Science from John Jay College of Criminal Justice in New York. He went on to study science and biochemistry at New York University, earning his M.S. degree in 1974 and a Ph.D. in biochemistry in 1975.

He has been a distinguished fellow of the American Academy of Forensic Sciences since 1982. He was elected as distinguished member at the International Association of Identification. He is an editor for seven academic journals, including the editorial board of the Journal of Forensic Sciences. Dr. Lee has authored or coauthored 20 books, major chapters and reports; and has published approximately 300 articles in professional journals.

Dr. Lee has assisted law enforcement agencies and investigated 6,000 major investigations and cases around the world. He has test)fied over 1,000 times in both criminal and civil cases.

Dr. Lee and his wife, Margaret, have two children. Daughter Sherry Lee was a graduate from Massachusetts Institute of Technology, and son Dr. Stanley Lee was a graduate the University of Pennsylvania.

Dr. Howard A. Harris

Howard A. Harris is currently the Director of the Forensic Science Program at the University of New Haven. His educational background is in chemistry (A.B. Western Reserve University, M.S. and Ph. D. Yale University) and law (J.D. St. Louis University). He was admitted to and has maintained his membership in the Missouri Bar. Dr. Harris was a research chemist for seven years before entering the forensic field as the Director of the New York City Police Department Police Laboratory. After holding that position for twelve years, he moved upstate to become the Director of the Monroe County Public Safety Laboratory in Rochester. He held that position for eleven years before taking early retirement to make a career change to academics. He assumed his current position at the University of New Haven in the fall of 1996. Dr. Harris and his wife, Carolyn, have one daughter, Lauren, who graduated from Northwestern University and now teaches mathematics.

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Interview with our Acquisitions Editor, Barb Gray

Barb Gray, acquistions editor, comes to Lawyers & Judges Publishing Company with a combined background of law and education. "This job provides a good combination of my work in education and my legal practice. I enjoy being able to meet and talk with forensic experts who are outstanding in their field."

Barb worked with Drs. Lee and Harris on *Physical Science in Forensic Science*, an excerpt of which appears in this issue. Both authors are renowned in the field of forensic science, and this book project has been very successful since its inception.

Currently, Barb is compiling a book on children and injuries.

If you are interested in developing a book project with Lawyers & Judges, please feel free to contact Barb at (800) 209-7109 or by email a:

barb@lawyersandjudges.com

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