Forensic Fingerprints
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• 1000 BC - archaeological evidence of ancient civilizations using fingerprints to sign legal documents

• 1880 - Dr Henry Faulds, an English physician, published a letter in the journal Nature suggesting the use of fingerprints for identification

• 1883 - Bertillon system (anthropometry)

• 1892 - English scientist Sir Francis Galton published a book entitled Finger Prints with a method for classification of fingerprints

• 1897 - Indian Police officer Sir Edward Henry proposed a modified classification system which was adopted by Scotland Yard in 1901 and is still the basis of the systems used in most English speaking countries

• 1901 - First official use of fingerprints in the USA by the New York City Civil Service Commission

• 1930 National fingerprint file set up in America by the FBI
Fingerprints

- Fingerprints form by contact of friction ridges on hands, feet, or lips with an object.
- Pore openings present on the surface of the friction ridges.
- Fingerprints are formed underneath the skin in the dermal papilae. As long as that layer of papilae is there, fingerprints will always come back, even after scarring or burning.
- Prints are left because a body is constantly secreting water, oils, etc. through pores.

![Diagram of skin layers](image-url)
1. A fingerprint is an individual characteristic
   - The number, location and shape of specific ridge characteristics, (known as minutiae) are individual
   - Most courts require at least 14-16 matched minutiae for a positive match

2. A fingerprint will remain unchanged during an individual’s lifetime
   - They are formed before a person is born
   - For a permanent scar – damage must extend 2 mm below surface of skin. Scars become part of fingerprint
   - Acid scarring and sanding fingerprints only remove a layer or two of skin, which quickly grows back with same characteristics

3. Fingerprints have general ridge patterns that permit them to be systematically classified
• Gloves don't necessarily stop fingerprints. Prints can be left through surgical gloves. Gloves can also be turned inside out to yield fingerprints from the inside surfaces.

• Leather gloves leave prints that is unique to that glove and no other – (leather comes from cow skin, similar to human skin).
Forensic Fingerprints Patterns

Three basic fingerprint patterns: Loops, Whorls and Arches

Loops 60 - 65 %
Whorls 30 - 35 %
Arches 5 % population

- African ancestry tend to have frequent arches.
- European background have frequent loops.
- Asians/Oriental ancestry tend to have a fairly high frequency of whorls.
Loop

• 1 or more ridges entering from one side, re-curving and exiting from the same side.

✓ **Ulnar loop** – loop opens toward little finger

✓ **Radial loop** – loop opens toward thumb

✓ Usually curving around a **Delta**. Loops have at least 1 delta.
Whorl

Types

- Plain
- Central Pocket
- Double Loop
- Accidental

- A plain or central pocket whorl has at least one ridge that makes a complete circle.
- A double loop is made of two loops.
- An accidental is a pattern not covered by other categories.

- Whorls have one or more deltas and a core.
Plain Whorl

Central Pocket
Loop Whorl

Double Loop

Accidental
Arch

• An arch has friction ridges that enter on one side of the finger and cross to the other side while rising upward in the middle.
• They do NOT have type lines, deltas, or cores.

Types

- Plain – wave-like
- Tented - Center rises to a spike; inside angle less than $90^\circ$
Ridge Characteristics - individualization

- Within these patterns are **minutia** points - about thirty different types of minutiae points exist
Fingerprint Classification

- Primary Classification:
  
  **Henry System** – 1\textsuperscript{st} step in FBI system
  
  - 10 finger system which pairs up fingers
  - Based on presence or absence of whorl pattern
  - Any finger having an arch or loop is assigned a value of 0
  - Allows fingerprint cards to be divided into 1024 groups
  - Provides the examiner with a number of candidates with indistinguishable sets of prints in the system’s files
The Henry—FBI Classification
Each finger is given a point value

Ex.
Whorl patterns found on right index and right middle fingers

<table>
<thead>
<tr>
<th>Finger #</th>
<th>Pattern</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 whorl</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>3 whorl</td>
<td>8</td>
</tr>
</tbody>
</table>

= (16) + 1 = 17

= (8) + 1 = 9
Automated Fingerprint Identification Systems (AFIS)

- Uses an automatic scanning device that converts the image of a fingerprint into digital minutiae.
- Computer determines the degree of correlation between location and minutiae between the latent print and the database print.
- Can make thousands of comparisons per second.
Other Useful Prints

- Lip Prints (glasses, cigarettes, napkins, etc.).
- Ear Prints (windows, doors and walls).
Types of Crime Scene Prints

- **Latent Prints** - invisible to the naked eye and must be developed to see (Transfer of body oils to the surface of an object)

- **Visible Prints** - Made after the ridges have been in contact with a colored material
  - Blood, paint, grease, ink

- **Plastic Prints** - impressions of fingerprints in soft media
  - Soap, putty, wax,

Fingerprint in putty common in burglaries.
Visualizing Fingerprints

1. **DUSTING**

   - Uses a fine powder that adheres to the traces of oil and sweat
   - Suitable for hard and/or non-aborbent surfaces (glass, tiles, mirror, painted wood, etc)

**Examples:**
- Aluminum dust (grey and highly visible on dark and mirrored surfaces)
- Carbon black (white surfaces)
- Luminescent powders (fluoresce under ultraviolet light)
- Magnetic Powders
Luminescence

- An excited molecule will lose energy with the electron falling to the ground state. For some molecules the excess energy is lost in the form of light, it is this process that is known as luminescence.
Luminescence

- A common application of luminescence is washing powder that contains optical brightener. The optical brightener is a fluorescent dye that shows a blue luminescence when excited by the ultraviolet radiation present in sunlight.
Visualizing Fingerprints (continued)

2. **Chemical Methods**
   - Used for porous surfaces like paper or cloth

Examples:
   - iodine fuming
   - Ninhydrin
   - superglue fuming
   - Physical developer
Iodine Fuming

- Iodine sublimes at room temperature.
- Object is placed in a chamber with crystals of iodine.
- Fingerprint on the object will appear as brownish prints.
- The iodine is believed to dissolve in the skin oils that make up the print.
- Temporary and will fade, so must be photographed.
Ninhydrin Method

- Colorless compound reacts with amino acids in sweat to form a purple colored compound.
- Sprayed on a porous surface and prints begin to appear within 1-2 hours; weaker prints may be seen after 24-48 hours.
- Used to develop latent prints on paper as old as 15 years.

Ninhydrin -> Ruhemann’s Purple

![Chemical structure of Ninhydrin and Ruhemann’s Purple]
Superglue Fuming

- Used on nonporous surfaces – metals, electrical tape, plastic bags, leather.
- 98-99% cyanoacrylate ester which reacts with and visualizes latent prints
- Fumes adhere to print, resulting in a white latent print
- The visible prints produced are white, but are often treated with a fluorescent dye to improve visibility