Chapter 7

FINGERPRINTS AND OTHER IMPRESSIONS

Mrs. Svedstrup
Fingerprints: Major Form of ID

- Major goal of criminal and civil investigation process is to identify people.
- Fingerprinting is widely used: All individuals have unique set of fingerprints—even identical twins.
- At this time, fingerprint ridge characteristics are considered to be individual evidence.
- *Dactyloscopy*: Science of comparison of friction ridge structures.
HISTORY OF PERSONAL IDENTIFICATION

- ~ 8 AD: Deliberately impressed fingerprints have been found on Chinese and Japanese documents
- 1870’s: William Herschel British official Required palm prints & impressions of right index finger from locals in India for every contract he made
Wrote first article about fingerprint ID: 1880, *Nature* magazine

- Used fingerprints to help Tokyo police in burglary case

- Asked Charles Darwin for funding for study

- Darwin passed on request to his nephew, Sir Francis Galton, who not only failed to fund Fauld, but took credit for his discoveries
• French police expert who devised the first systematic method of personal identification
• Bertillion’s system was known as *anthropometry*
• Detailed description and precise measurements of the body, including full length photographs
• System failed after the Will West Case of 1903
Will West was taken to Leavenworth Prison
Records clerk ran his Bertillion measurements and found they closely matched another prisoner who was serving a life sentence: William West!
Even the photograph of William West closely matched new prisoner, Will West
Fingerprints of both were taken and found to differ
Value of fingerprint Identification was established
 Asserted all fingerprints were unique and did not change throughout life

Categorized patterns of fingerprints into loops, arches and whorls

Developed a classification system that allowed for a person’s fingerprints to be placed in smaller groups

Juan Vucetich, and Argentine police officer, developed first classification system, which is still used in South and Central America
Developed alternative classification system that was adopted in England

His system has been modified and still is in use in the United States and Europe

Used 5 classifications to put a set of ten fingerprints into one of thousands of classes

FBI added additional classes to make searching more practical

Henry used certain characteristics of each print—one was how many whorls present
STRUCTURE OF THE SKIN

Epidermis
Dermis
Dermal papillae
Epidermis
Dermis
Sweat gland
Pore
Blood supply
Nerve
Hair follicle
Fingerprints arise from dermal papillae, the layer of cells between outer skin (epidermis) and inner skin (dermis).

Friction ridges start to form at 8-10 weeks of gestation and become fully developed by the seventeenth week.

Friction ridges are a series of hills (ridges) and valleys (furrows) on the skin of the hands and feet.
As friction ridges develop, perspiration glands are formed and connect to pores in the epidermis.

Pores release waste materials such as sweat, oils, proteins, fats and other materials.

When finger touches surface, these wastes are deposited, forming a fingerprint pattern that matches the friction ridge pattern of the individual.
• **Patent prints**: prints easily seen such as left by blood, grease, dirt, or fresh paint
• **Plastic prints**: found as impressions on wax, clay, or butter
• **Latent prints**: invisible to the naked eye
TYPES OF RIDGE CHARACTERISTICS OR MINUTIAE

- Bifurcations - ridges split into two ridges
- Ending ridge - simple straight ridge
- Dot - tiny round ridges
- Short ridge - small isolated segment of ridge
- Enclosure - ridge that forms forks, then a complete circle, then becomes single ridge again
- Trifurcation - ridge that splits into three ridges
RIDGE CHARACTERISTICS OR MINUTIAE

a. Bifurcation

b. Dot

c. Enclosure

d. Ending ridge

e. Short ridge
3 MAJOR TYPES OF FINGERPRINT PATTERNS—ARCHES, LOOPS, WHORLS

- Categorized by the presence or absence of a *delta* (triangular intersection of ridges)
- An Arch has NO deltas
- A Loop has ONE delta
- A Whorl has TWO deltas
Arch patterns differ in severity of slope of arch
Two types of patterns: Plain Arch, Tented Arch
5% of fingerprints
Loop ridges enter from either side of the finger, re-curve and pass back along the side from which they entered.

Loops are identified by the direction loop opens to—known as radial (thumb side) or ulnar (little finger side).

Nearly 2/3 of prints are loops.
• Whorls: many circular ridges are common
• Four types of whorls
  • Plain
  • Double loop
  • Central pocket loop
  • Accidental
• Make up about 30% of fingerprints
• **Plain Whorl** is located between two deltas of the whorl pattern and has a minimum of one ridge that is continuous around the pattern.

• **Central Pocket Loop Whorl** is not located between two deltas of the whorl pattern and has a minimum of one ridge that is continuous around the pattern.

• **Double Loop Whorl** is made up of two loops that swirl around each other.

• **Accidental Whorl** is a pattern that combines two or more patterns, excluding the plain arch, and/or does not clearly meet the criteria for any of the other patterns.
Patent and plastic prints are generally easy to discover.

Major challenge lies in attempting to recover latent prints from crime scene.

Different surfaces present different challenges.

Locating and visualizing prints can be done:

- Reflected Ultraviolet Imaging System
- Powder dusting—regular powder and magnetic
- Chemical enhancement methods
Chemical Methods of Fingerprint Visualization

- **Iodine fuming**
  - oldest chemical method
  - iodine crystals sublimate to iodine gas
  - gas adheres to fats in the fingerprint residue

- **Silver Nitrate**
  - reacts with ions in the sweat residue

- **Ninhydrin**
  - most popular
  - used for developing on porous surfaces
  - reacts with amino acids to form a colored compound known as Ruhemann’s Purple

- **Cyanoacrylate (superglue fuming)**
  - reacts with amino acids, proteins, and fatty acid residues
• Fingerprint residues contain substances that will fluoresce when exposed to certain wavelengths of light
• Argon-ion lasers have been used
• After cyanoacrylate fuming is done, Rhodamine 6G, which is a dye, was applied. This fluoresces and emits yellow light
• Argon laser aimed at print and photo is taken using a special filter
• Crime scene prints compared to known prints
• Ten print card: used to collect fingerprints
• Rolled print: fingerprint rolled from cuticle to cuticle
• Tap prints: fingerprints that are tapped in ink and then placed at bottom of ten print card
**DIGITAL FINGERPRINTING**

- **Live Scan: 1990’s**
  - replaces inked ten print card
  - captures friction ridge image and stores digitally in computer database
Two types of fingerprint comparisons

First is to identify a particular person from his or her fingerprints

Prints are taken and sent to database (such as one FBI maintains) classification system

Henry system uses several methods to classify prints, each based on a different set of characteristics. One method is classifying fingerprints based on whorls.
The Henry Classification System

<table>
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<th></th>
<th>1) R Thumb</th>
<th>2) R Index</th>
<th>3) R Middle</th>
<th>4) R Ring</th>
<th>5) R Little</th>
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<td>16</td>
<td>8</td>
<td>8</td>
<td>4</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>6) L Thumb</th>
<th>7) L Index</th>
<th>8) L Middle</th>
<th>9) L Ring</th>
<th>10) L Little</th>
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<td>Value</td>
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<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

The sum of the values of the white squares that contain a Whorl (plus one) is the numerator of the primary classification.

\[
\frac{8 + 1}{1 + 1} = \frac{9}{2}
\]
• Umbrella group of fingerprint experts
• Decided in 1990 no standard minimum number of points would be necessary for positive identification
• Three level of friction ridge details would be used to identify prints
Level 1
- general features and patterns
- can be used to exclude a print only

Level 2
- includes particular ridges (minutiae) in same place that allow individualization of an unknown print

Level 3
- requires low power microscope
- identifies minute imperfections, such as scars, edge shapes, sweat gland pores
- so unique their presence virtually assures individuality
AUTOMATED FINGERPRINT IDENTIFICATION SYSTEMS (AFIS AND IAFIS)

- Allow for automated search process of fingerprints
- Vast sets of ten print cards made it almost impossible to search for prints
- FBI, National Institute for Standards and Technology (NIST) and National Crime Information Center developed standard format for fingerprint data
- Revised in 1999 by FBI through IAFIS
Operates by anchoring position of fingerprint and searching database using two types of ridges:
- Bifurcations
- Ridge endings

Database works by querying prints to find ones with same number of ridges in relative positions

Most likely matches are displayed for comparison by a fingerprint examiner
• Entirely digital system
• Compares a person’s set of ten fingerprints against a database of millions of prints in a few minutes
• Problems of incompatibility of formats is being solved by development of workstations that generate input directly into system
In most cases, the act of alteration will make the fingerprints *easier* to ID by adding cuts/scars to the ridge structure.

Example: John Dillinger (1930’s) put acid on his fingers, but did not destroy his ridges completely.

Recently *Mythbusters* did a segment on making casts of fingerprints and overlaying them.

http://www.youtube.com/watch?gl=BR&hl=pt&v=MAfAVGES-Yc
FOOTWEAR AND TIRE TREADS

- Impression—one object makes physical contact with another leaving some of its physical characteristics on the recipient
- Soft or pliable materials leave three dimensional impressions—putty, mud, concrete, soft dirt
- Hard surfaces have two dimensional impressions—dirt, dust, blood, ink
Fingerprints

Tire tracks

Footprints

Firing pin impressions
Footwear impressions may be left at crime scenes, and in entry and exit locations of scenes.

Footwear evidence may be overlooked due to:
- May be nearly invisible
- On uneven ground
- Trampled by other footwear
- Footwear evidence is misunderstood or undervalued by police, detectives, judges, and juries

Footwear evidence can be fragile—must use photography and make casts of impressions.
New shoes without wear: generally *class* evidence

With wear and tear: imperfections, alterations and random markings cause shoes to *individualize*

Abundance of unique details allows a competent examiner to conclude the impression came from a particular shoe

No agreed upon standards for:
- number of points of identification
- type or quality of the ID points

From a good impression—size and type of shoe

Manufacturing imperfections add discrimination
ATHLETIC SHOE WITH UNIQUE PATTERNS

- *wear patterns* highlighted
- *imbedded materials* highlighted
FOOTWEAR IMPRESSIONS

- Formed by a shoe deforming a surface
- May leave three dimensional impressions
- Trace evidence may be transferred from shoe to surface (positive impression)
- Trace evidence may be transferred from surface to shoe (negative impression)
- Static electricity build up can increase transfer of material
Photograph footprints
Photograph footprint with ruler or measuring tool for court testimony
In two dimensional footprint cases, photo will be used for comparison
Three dimensional footprints are casted: using material that fills impression and then hardens to capture impression image
The primary material of choice to cast footprints is dental stone due to its hardness and ability to capture detail.

Captures detail of footprint to a much greater extent than other materials, such as Plaster of Paris.
Tire tread: part of tire in contact with road

Tread serves to increase friction at point of contact and minimize slippage

Tires are mass produced: few unique or individual characteristics

With time and wear, tires pick up details that set them apart from other tires
John Dunlop developed the air filled (pneumatic) tire with no tread in 1888.

Harvey Firestone developed first traction design treads in 1907.

Tires are designed today to provide gripping power and channel water to prevent hydroplaning.
• **P215/65R15** stands for:
  - **P**—stands for passenger tire (LT- for light truck)
  - 215- cross section measure of tire in millimeters
  - 65 is aspect ratio—measure from seal of tire to rim to top of tread (actual percentage of height to width)
  - **R** stands for radial (D-diagonal bias and B-belted)
  - 15- Last number stands for diameter of wheel rim
EVIDENTIARY VALUE OF TIRE IMPRESSIONS

- 2/3 of crimes involve automobiles
- Many crime investigators overlook this evidence
- Tire impressions must be photographed and cast if an association is going to be made with an individual tire for evidence
- Tire impressions must be documented with photographs or casting quickly before weather factors destroys them
Tire impression casts made with dental stone are much bulkier and harder to handle due to their size.

Three dimensional casts make negative (opposite) impressions.

Document with photographs.

Use casting wax on tire impressions in snow.
• Tire impressions can also assist in determining other information about vehicle
- Wheelbase may be determined (distance from center of front wheel hub to center of rear wheel hub)
- Stance may be determined (distance from centerline of right tire to centerline of left tire)
• Impressions are compared to inked treads of known vehicles for identification