Firearm Forensics

Firearms: Ballistics

- **Ballistics** - the science of the travel of a projectile in flight. The flight path of a bullet includes: travel down the barrel, path through the air, and path through a target.

Firearms

- **Caliber** - diameter of the bore; usually in 1/100 inch or mm (.22 cal or 9mm)
- **Gauge** - refers to the diameter of a shotgun barrel in terms of # of lead balls it would take to weigh one pound (10 gauge, 12 gauge)

- **Firearm Identification:**
  - Size and shape of bullet/case
  - Rifling match
  - Firing pin/Case impression match
  - Striations on bullet match
  - Serial numbers (restoration)

Firearm Nomenclature: Semiautomatic

- Slide
- Barrel
- Extractor
- Trigger
- Hammer
- Safety
Firearm Nomenclature

- Breechface
- Ejector
- Firing Pin Aperture
- Extractor

Ammunition

- Cartridge (unfired)
  - Bullet
  - Gun Powder
  - Cartridge Case
  - Primer

Bullet cartridges

- A long, heavy needle would go right through the target without dispersing any of its energy
- Spheres would be slowed down the greatest and release more energy, but might not get to the target
Bullet Design

- “Bullet” refers to the projectile(s) which actually exits the barrel of the gun when fired
- Bullets vary in shape and composition
- Most types are variations on three main shapes and three basic compositions

Three Main Shapes

- Round Nose
- Hollow Point
- Wadcutter
Round Nose

- Maximum penetration
- Cheapest shape to manufacture
- Easily loads into chambers

Hollow Point

- Spreads or mushrooms on impact
- Causes additional damage to target
- Inhibits penetration

WadCutter

- Used exclusively as a practice load
- Minimizes penetration
- Intended to cut target paper cleanly to facilitate easy and accurate scoring

Three Basic Compositions of Bullets

- Lead
- ½ Jacketed
- Jacketed (Full metal jacket)
Basic Compositions of Bullets

- **Lead Round Nose**: An elongated projectile made of a lead alloy with a rounded nose
  - Cheap
  - Dense but soft
  - Easy to mold

- **½ Jacketed**: a lead bullet designed with a jacket, typically copper, surrounding the lower portion.
  - Used primarily for hollow points
  - Copper improves exit velocity
  - Lead promotes mushrooming

- **Jacketed (Full metal jacket)**: the bullet jacket (copper) encloses the entire bullet
  - Used to hold the shape of the bullet to maximize penetration

Gun Comparisons

- Gun barrels are a solid steel tube hollowed out by drilling.
- Inner tube has rifling to spin the bullet (better trajectory - no tumbling).

Manufacturing of Firearm Barrels

- Firearm barrels have grooves cut, or pressed, in the bore which produces **rifling**
- The grooves are cut in a spiral pattern
- Between the grooves are raised areas. These are called **lands**.
- Various rifling techniques include: broach cutting, button rifling, and hammer forging

Rifling

- Grooves
- Lands (original barrel surface)
Rifling: Broach cutter

- Broach cutters: cuts all the grooves simultaneously by forcing cutter down barrel and rotating the cutter.

Rifling: Hammer Forging

- **Hammer Forging**: A mandrel with correct rifling is inserted into an oversized bore and the barrel compressed around the mandrel by rolling or hammering.
- Lands and grooves having a rounded profile (*Polygonal Rifling*).

Button Rifling

- **Button Rifling**: A hardened metal plug with a rifled cross section. It is pushed or pulled through a drilled barrel under high pressure. Uses no cutting but compresses metal.

Rifling

- The faster the spin, the less likely a bullet will turn sideways and tumble.
- Increasing the twist of the rifling to 1 in 7 will impart greater spin than the typical 1 in 12 spiral (one turn in 12 inches of barrel).
Bullets become scarred by rifling as they travel down the barrel of a gun.

Manufacturing of Firearm Barrels

- The results of rifling gives a barrel its class characteristics.
- Each barrel has four class characteristics:
  1. Caliber
  2. Number of lands and grooves
  3. Direction of twist (Left or right)
  4. Width of lands and grooves

Class Characteristics

- All class characteristics are measurable.
  - Caliber
  - Number of lands and grooves
  - Width of the lands and grooves
  - Direction of twist (left)

Groves and Lands

Each class of firearm has fixed groove-land info that doesn't not change.
**Bullet Comparison**

- Impression are made on a soft bullet
- Since the rifling is worn away irregularly by each shot, the grooves make a unique impression on the bullet (striations).
- No two rifled barrels, even those manufactured in succession, will have identical striation markings.

**Comparison Microscope**

- Most important tool for firearms examiner
- Two compound microscopes combined into one unit
- Viewer looks through the eyepiece and a field divided into two equal parts is observed
- Bullet comparisons require reflective light

**Bullet Comparison**

- Obtain sample bullet.
- Fire similar bullet from suspect gun (into water cotton-filled tank or ballistics gel).
Bullet Comparison

- The first step in comparing fired bullets is examining the land and groove width
- These bullets have different land and groove width

Striations

- Striations form the individual characteristics of the barrel.
Cartridge Cases

- Pulling trigger releases the firing pin that then strikes the primer and ignites the powder.
- The bullet case is propelled backwards (as the bullet moves forward) and is imprinted by the breechblock (back of barrel).
- The shape of the firing pin will be impressed into the relatively soft metal of the primer on the cartridge case.
- Spent case extractors also leave identifiable marks.

Cartridge Case Comparisons

- Areas of comparison
  - Breech face marks
  - Firing Pin impressions
  - Extractor marks
  - Ejector marks
  - Chamber marks

Computerized Imaging

- Make it possible to store bullet and cartridge surface characteristics
- National Integrated Ballistics Information Network (NIBIN) produces database files from bullets and cartridge casings retrieved from crime scenes or test fires from retrieved firearms, often linking a specific weapon to multiple crimes.
- Final comparison will be determined by the forensic examiner through traditional microscopic methods.
- Used to link multiple crimes to a single weapon.

Gunpowder Residues

- The firing pin of a firearm strikes the primer of a cartridge.
- Gunpowder in the cartridge case burns, causing it to change from a solid material to a gas creating pressure.
- When the bullet exits the muzzle, pressure behind it blows the gunshot residues out of the firearm’s barrel under high velocity.

Visible gunshot residues around bullet entrance hole.
Gunpowder Residues

- Firing a weapon does not fully consume all the gunpowder
- Unburned and partially burned propellant with smoke are emitted.
- Can be used to determine firing distance (if smoke, etc. is on victim, pattern of residue deposition, etc.).
- Chemical analysis of residues.

Tests done:
Examine microscopically for presence of gunpowder residue
- *Sodium rhodizionate test* (lead)
- *Greiss test* – presence of Nitrates

SODIUM RHODIZONATE TEST

- Tests for the presence of lead.
- Converts lead to lead rhodizonate.

GRIESS TEST

- Tests for the presence of nitrites.
- Converts nitrites to nitrates.
Gunpowder Residues (GSR)

- Most primers contain lead, antimony, and barium-containing compounds.

Scanning Electron Micrograph of GSR

Diagram of the SEM pattern of GSR

Serial Number Restoration

- Many manufactured items made of metal have serial numbers stamped in them for identification.

Before restoration

After restoration

Serial Number Restoration

- Scratched out serial numbers can be restored since stamping marks on metal deform layers deep into the metal structure.
- Apply etching agent to show original numbers.
- Magnaflux method: Uses magnetic properties (iron or steel) – non-destructive

Gunpowder Residues

Soot is seen on the hand of a suicide victim, giving an indication that he was holding the weapon when it was fired.
Tool Marks

Defined as any impression, cut, gouge, or abrasion caused by a tool coming into contact with another object

- Typical features (class characteristics)
- Cuts, tears, gouges or other wear marks are used to individualize the tool.

Rubber hoses cut by the same knife
Tool Marks: Preserving Evidence

Silicone casting material

Si Cast

UNDER NO CIRCUMSTANCE SHOULD THE CRIME SCENE INVESTIGATOR ATTEMPT TO FIT THE SUSPECT TOOL INTO THE TOOL MARK

Other Impression Evidence

• Footprints
• Bitemarks
• Tire/wheel tracks

Other Impression Evidence

• Footprints
Footprints

Dental/Bite Marks

- Dental Impression of gum, food, victims, etc.
- At Left: A. Chewing gum found at crime scene. B. Dental impressions of victim and suspect. Unique root canal work of suspect found on gum.

Dental/Bite Marks

- Ted Bundy picked up for murder two sorority women at FSU using fake name and ID.
- One victim had bite marks on buttock.
- Casting of Bundy’s teeth taken (forcibly). Found to overlay (match) exactly the bite wound.
- Defended himself but convicted and sentenced to death.
- Before execution admitted to more than 40 other murders (but gave no info or details).