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

- <u>Caliber</u> diameter of the bore; usually in 1/100 inch or mm (.22 cal or 9mm)
- <u>Gauge</u>- 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



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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 softEasy to mold

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• <u>½ Jacketed</u>- 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 <u>RIFLING</u>
- The grooves are cut in a spiral pattern
- Between the grooves are raised areas. These are called <u>lands</u>.
- Various rifling techniques include: broach cutting, button rifling, and hammer forging







<u>Rifling: Broach cutter</u>

• 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)



* Association of Firearm and Tool Mark Examiners Glossary 4th Edition

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





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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).





Right Twist

Left Twist²

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



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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.





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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- requires reflective light

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Comparison Microscope



Split-image comparison of firing pin





Bullet Comparison

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



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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.



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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.



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Tests done:

Examine microscopically for presence of gunpowder residue

- Sodium rhodizoante test (lead)
- Greiss test presence of Nitrates

Gunpowder particulate residue around bullet entrance hole.



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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)

Scanning Electron Micrograph of GSR

Diagram of the SEM pattern of GSR



1.6 %E 54/SB 51/SN 50 6.7



Most primers contain lead, antimony and barium containing compounds.

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.



Serial Number Restoration

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

Before restoration







Serial Number Restoration

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









Tool Marks

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

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



Other Impression Evidence

- Footprints
- Bitemarks
- Tire/wheel tracks



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

Other Impression Evidence

• Footprints



Footprints



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Footprints



7. Mark Box for Identification

Dental/Bite Marks





- Dental Impression of gum, food, vicitms, 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).



