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Analysis of firearm mechanism and crime investigation

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Abstract
Ballistics Division's task entails identifying and comparing weapons, ammunition, and parts thereof. Examining target materials is also part of the job. Standard small arms and ammunition of varied make and caliber are on display, as well as homemade/improvised weapons and ammunition, bullets, pellets, wads, propellant, cartridge casings, and the appliances used in the manufacturing of firearm ammunition. This category examines conventional and country-made guns, deadly weapons such as revolvers, pistols, assault rifles, carbines, & ammunition. This division is also responsible for the inspection of guns in possession under the Arms Act. This section also examines gunshot remnants from fired bullets, cartridges, shot holes on clothes/skin/window glasses, & so on, as well as the distance of shooting in cases of murder/assault. A comparison microscope is used to compare the striations on fired ammunitions & firing pin impressions on fired cartridge cases from the crime scene with test-fired bullets & test fire magazine cases. In this sector, scanning electron microscopy is utilized in forensic ballistic applications such as gunshot residue analysis, weapon identification (bullets and empty cartridges), and case markings comparisons.

Keywords: Firearm mechanism, crime investigation

Introduction

"Today, it may be set down as a scientific fact and a postwar discovery now first made public, that no two revolver or pistols ever leave precisely the same marks upon a bullet, and that it now is possible and practicable to link the bullet to the weapon in virtually every instance." ……. W. S. Stout Forensic ballistics is the examination of weapons, cartridges and bullets. Ballistic weapons which are used for crimes of violence can be categories into main types; smooth bore and rifled firearms. Between the two types there are various types of ballistic weapons, but suffice it to say here that a smooth bore firearm is the ordinary type of shotgun or shot-pistol, and the bullet used is the shot which consists of small lead balls or pellets. Ballistic weapons which are used for crimes of violence can be categories into main types; smooth bore and rifled firearms. Between the two types there are various types of ballistic weapons, but suffice it to say here that a smooth bore firearm is the ordinary type of shotgun or shot-pistol, and the bullet used is the shot which consists of small lead balls or pellets. The physical evidence related to ballistic weapons normally deals with the fired cartridges, empties, firearms etc. The nature of the examination in ballistic weapon cases is normally to find out whether the fired cartridge is fired from a particular firearm, nature and the type of the firearm, the direction of the firing, the distance of the firing, the range of firing of the firearm the time elapsed since the time of firing etc.

Scene Investigation of Firearms Cases

A genuine investigator has several challenges, the most common of which are:

- Identifying the crime's location.
- Go to the area & collect tangible evidence from the scene of the offense.
- Identification of the weapon used in the incident.
- Finding information from inputs.
- Providing one or more missing links in an investigative process.
- Strengthening a weak link or connections in a collection of evidence.

Many questions must be answered by the investigating agency, including: (i) what type of firearm was used? (ii) Was the firearm in functioning order? (iii) What was the firing range & position? (iv) Did the stated firearm fire the cartridge found in the decedent's body? (v) Did a specific individual discharge the firearm? Was the incident an accident, homicide, or suicide? This involves inspecting cartridges, cartridge casings, bullets, wads; firearm shot remnants, and so on. The investigator's research can be limited to small ballistic weapons such as guns, rifles, pistols, semiautomatic pistols, and magazines weapons. The lock, stock, barrels, and accessories are the components of all of these guns. A pistol or revolver has a short barrel and a curved stock, requiring the handgun to be carried in the hand when shot. Every ballistic weapon discovered at the scene of a crime should not be taken immediately. Before they can be retrieved, it must be determined if they have gone through the hands of anybody.

The bullets, or cartridges, used in contemporary ballistic weapons have three components incorporated inside them. Cartridges, propellant, and primer are the components. The cartridge is the projectile that will exit the barrels after firing. It is constructed of several metals such as brass, steel, and aluminum, as well as rubber and mood.

Firearm Evidentiary Clues

- The scene is the most important place for evidentiary clues. The investigating officer must locate, document (image, sketch and describe) and collect:
- Firearms, whether used in suicides or accidental fatalities, or their mimicked equivalents. Its location and circumstances in relation to additional proof at the scene are critical.

- Remains of fired magazine casings, bullets, & explosives. The projectile may be implanted in equipment, buildings, and so on, emitting the smell of a burning power charge.
- Considering the scene's location and the ways of entrance & door, he draws the scene to measure & prepares a documentary of the incident, capturing all elements of the scene, the period of appearance, the status of entrances, spaces, ventilators, taps, and so on.
- The identity of the victim, suspicions, eyewitnesses, assistants, etc., the proof gathered the package & the collecting watchers, packaging, sealing, etc.
- Ascertain whether the firearm is cocked or not, its safety catch is on or off, the weapon is loaded or not. He records the state and acts to make the ballistic weapon safe for handling.
- Handle the ballistic weapon in such a way that even if it goes off it does not injure anybody by ensuring that nobody faces the muzzle of the ballistic weapon. Consider the weapon safe only when can see through the barrel and the magazine, if any is detached, and avoid touching the inside of the barrel. The presence or absence of rust, fouling, dust, skin, flesh, blood and other materials can lead to important conclusions. If anything is introduced in the barrel, the evidence is contaminated or lost.
- The barrel should, therefore, be capped, check the breech face of the ballistic weapon. It may bear marks in dust or grease. They are imaged. The breech face may carry enamel or paint from the cartridge fired through ballistic weapon. The materials help in the identification of the cartridge. Avoid carrying the firearm in a pocket or in a dirty or dusty container. It is likely to introduce dust or dirt in the barrel which can mislead the expert.
- Put identification marks (case number, initials with date) and get signatures of the witnesses on the firearm. The signatures are put at prominent part like barrel, action block or stock and not on interchangeable part. The detailed particulars are scratched on the ballistic weapon, at a place where there is no other evidence. Types of ballistic weapon, this weapon prohibited and prohibited ammunition or not, and arrest of person by police officer.

Mechanism of Firearms

Two key elements comprise the ballistic weapon: (1) the barrels & (2) the automated system that contains the chamber, tightening pin, extractor, and ejection device & activate. There are two kinds of barrels: (1) smooth bore and (2) smooth grooves.

All barrels are made of boiled solid steel parts. The solid steel pieces are subjected to the drilling process from one end to the other with a uniform diameter. The inner side of the barrel will later bore with a reamer to produce a smooth surface. One of the scientific significances of barrel is that due to the drilling process, the inner surface of the barrel gets various scratches and scars which supplies the individually to that barrel. Barrel grooves are of two types: (1) grooves twist towards that left-hand side and (2) grooves twist towards the right-hand side. Ballistic weapon examiners may be called upon to determine if weapons are operating properly or to conduct firearm powder shot pattern tests. In addition, examinations of questioned ammunition case may be assisting in ascertaining the type of firearm used in a crime. The bomb expert can analyze fragments of bombs to determine their original composition and possible sources of raw materials. The barrel is the metal tube in which the charge is placed ready for firing and in which it is exploded. This tube compresses the gases developed during combustion and gives the missile its proper direction. Now-a-days the barrel is always made of steel: formerly we find it constructed of iron and even bronze, copper, brass, and other metals.

The stock is that part by which the firearm is held and which supports the barrel. It not only enables us to hold and manipulate the arm, but to it also fixed the lock plate and revolvers it may be of horn, ivory, vulcanite, and even metal. When trigger is pulled, it further pulls the firing pin, a hard steel rod that is holding inside the hole drilled through the breech assembly.

General Characteristics of Firearms

The following class characteristics are common to large numbers of firearms:

Caliber

Manufacture is indicated by the name or initial stamped on the head in the case or by initial or trade-mark in the case of .22 calibers. The shape can be divided first into rim or rimless and second into straight, tapered, or necked. Caliber is stamped on center fire case generally. Composition may be brass, nickel-plated, copper, plated steel, or paper.

Chamber

The chamber marks are observed rarely on the fired bullet from standard chambers. Ordinarily some defect or some deposit in the chamber imprints its negative profile on the tubular portion of the bullet case may also tend to get imprinted with the chamber mark.

Extractor

Extractor marks like chamber marks are rarely prominent. They permit the identification of the ballistic weapons of the firearm whenever they are imprinted clearly. Extractor marks help in fixing the orientation of the bullet in the chamber. The orientation is often helpful in locating the part of the breech block (or other parts) which may have imprinted the marks on the bullet case. In automatic and semi-automatic ballistic weapons, the ejector marks the bullet case when it strikes against it, in its backward motion. The ejector is so positioned that the fired shell after striking the device is pushed out the weapon.

Firing Pin

The firing pin impression is a mark on the surface of the primer, which comes under the general class characteristic showing that a particular firearm had discharged a casing. The initial identification of class characteristics will be based on the shape of the tip of the firing pin. The surface of the action block surrounding the firing pin (and opposite to the cartridge base in a loaded gun) is called the breach face. The basic requirement of a test projectile for the evaluation and comparison of marks on fired buckshot, as already seen, is that the projectile should carry marks from the whole surface of the barrel. This is achieved by pushing a tight-fitting slug made of lead, about two centimeters long, through the barrel, without circular motion. In case of firing

by hammerless firearm that is, firearms having unexposed hammers, the firing pin after pressing the trigger is pushed ahead by the sear action and does not automatically return to its original position unless opened.

Magazine

A magazine is generally a long, slender spring-loaded container for some rounds, which can be inserted in the firearm when needed. In few ballistic weapons, notably magazine rifles, the magazine remains in the firearm at all times. However, the distinction here is merely on of attachment of the magazine, the functioning of either type being exactly alike. Few magazines contain only a single row of bullets, but a double (staggered) row is also common. To provide longer periods of continuous fire than are possible with separable magazines (which seldom exceed thirty rounds), means have been devised to feed a long belt containing cartridges at close intervals through the firearm. These belts are of many forms. They may be either of metal or of woven fabric.

Clips

Considerable differences of opinion exist as to what is called a clip and what is called a charger. A clip will be defined here as a holder for a small number of bullets, so designed that the clip and its bullets are placed together in the magazine of a firearm without removing the cartridges from the clip. The clip remains in the firearm until all the bullets are fed and fired from it or until the firer unloads the firearm. A clip has no spring of its own, the bullet being fed out of it by the action of the magazine spring and the bolt of the firearm.

Photographs

Image can be complex matter involving a wide range of expertise; the investigator's basic knowledge should include grasp methods necessary to image the crime scene, specific items and objects, and fingerprints. Image may be used: to record evidence, to provide proof of an injury or wound, to illustrate details of a scene, to present court etc. First of all, the whole crime scene should be imaged with relative positions of ballistic weapon, ammunitions etc. this could be helpful for the reconstruction of the scene in later stages.

Sketches

The most important of the three types of sketches, the measured field sketch is used to complete the final or scaled sketch. It should be an accurate portrayal of the scene, including an indication of direction and measurements between objects. The key to successful sketching is simplicity; unnecessary details should be omitted. However, if there is some doubt about the importance of an item it should be included.

Fingerprints

The fired bullet, found at the scene of occurrence, in a rare case may carry fingerprints. They have great evidentiary value as they alone can connect the crime and the criminal. The location of the fired bullet at the scene should be carefully established through images, sketches and descriptive notes and witnessed by the eye-witness. They often assume great advantage in the reconstruction of the crime, especially in those cases where non-homicidal death is claimed.

Range of Fire

Range of a particular weapon is defined for forensic purposes, the distance where the effectiveness of the projectile drops to the threshold value so that no penetration can occur in human target. The range, therefor, in forensic sense is not a usefulness of the weapon from the point of view of accurate aim. The range of fire is important aspects of Forensic Ballistics. The determination of the range of fire is possible if proper images, sketches, description of the injuries, the suspected weapon and the bullet, cartridge similar to the one used in the commission of crime are available.

Muzzle Pattern/Velocity

In general, an average of a ten-round series of velocities might give accuracy as close as 25 feet per second. When a weapon, pressed against the target, is discharged, the muzzle leaves its imprint on the target. The muzzle pattern, therefore, indicates a contact injury. The contact injuries are usually observed in suicide cases but they are also seen murder cases. In such injuries the whole charge will enter into the target. No scorching, blackening & tattooing are observed around the entry hole. Often the entrance hole bears a tear on the cloth or skin in the form of a cross. The measurement of velocity in scientific work consists in calculating the lethal effects of projectiles.

Wads distribution

A number of wads are found in firearm ammunition. They are propelled along with the other charge. They may enter the target up to about three meters. If they do not come across any obstruction they can travel up to five meters. If the distance between the victim and the wads is known, the range of fire can be determined.

The base wad is made out of a rolled paper layer glued along their length. It has a hollow center which fits around the percussion chamber. When the steel ring or paper cups are not provided, base wad is glued to the inner side of the paper tube and holds its firmly pressed against the steel head.

Tattooing

Tattooing is also known as peppering. Tattooing, as its name indicates, is the making of an object caused, in the case of weapons firing bullets, by unburnt or partly burnt powder grains, which is much more common with revolvers and self-loading firearm than with rifles, owing to the less complete combustion of the powder in short barreled weapons with shotgun firing pellets there will also be mark of the pellets, or even the pellets themselves.

Scorching

The scorching of the target is caused by the flame or by hot gases. It is a sure sign that a weapon has been fired from a close range. The hot gas can travel forward only to a limited distance, which varies from some centimeters in the case of pistols and revolvers, to a decimeter in the case of the shoulder firearms. Scorching range will depend upon the length of the barrel of the weapon and the quantity and age of the propellant and other constituents of the cartridges.

Powder Patterns

All ballistic weapons, regardless of the type of projectile fired, release burnt, unburnt, and partially burnt powder

material from the muzzle end at the time of firing. Powder patterns are often found on the clothing of the victim and around the area of the cartridge hole in close range shooting.

Identification of the Pellets

The concept that buck-shots and pellets can be linked to the weapon which fired them is recent. It is of a great importance in forensic firearm. A shotgun is firearm of choice with the criminals in India; firstly, because the firearm and the weapon of choice with the criminals in India; firstly, because the ballistic weapons and the bullets, cartridges are easily available. Secondly, the ballistic weapon can be easily homemade. The surface characteristics of the weapon which scratches the marks on a pellet are like the barrel of a rifled weapon which scratches its thumbprint on a cartridge. The identification of marks on the buckshot is possible because: (i) the projectile charge of a firearm cartridge, ordinarily, move in the form of a compact cylinder during their passage through the barrel. Even if there is few turning movement of the projectile inside the barrel, the extent is practically insignificant.

Blackening

The blackening around the injury is caused by the deposition of smoke by all types of propellants, when the shots are fired from close range. The intensity of the colour is maximum with the firearm powder, less in semi-smokeless powder, and the least in smokeless powder, when fired from the same range and with equivalent quantities of powders used in the bullet, cartridge.

Time of Fire

It may often be required to determine the time of fire when a ballistic weapon is involved in a crime. If the barrel of the suspected ballistic weapon is examined, there may be growth of cobweb in it indicating that the firearm was not used for a long time. If the firearm is used recently, then trapped gases may be present in the barrel. The concentration of gases can be estimated which will approximate the time of fire. The presence of gaseous products in the bullet cases may also specify the approximate time of fire.

Direction of Fire

It may help to verify the claim by defense counsel of suicidal or accidental firing. The direction of fire can be ascertained by the shape and nature of entry injury. The system study of the cartridge hole at the point of entry, path and the point of its location in the body or the exit injury may help establish the direction of fire. During the passage of a cartridge through the rifled barrel and through a defective and roughened bore, small fragments of metal are cut and propelled in the direction in which the projectiles are ejected.

Fired Bullet identification

The tip of all bullets is pointed for penetrating the air as well as the target. For best penetration, the lead bullets will be covered with a copper alloy partial jacket. There are high and low velocity bullets. High velocity bullets are fully jacketed for deep penetration. Low velocity bullets will cause additional damage to the target. Apart from these types, mushrooming or expanding bullets are available for transferring maximum energy to the target and also for heavy destruction of the target. In forensic firearms the construction and the composition of bullets are very important since it is useful for determining the bullets collected from the crime scenes and the target. The other important part is the propellant. Forensic test for identification of a ballistic weapon also follow the method of examining a fired bullet, if extracted from the victim's body or otherwise obtained at the scene of crime.

Bullet Recovery Box

For the purpose of comparison, it is essential to obtain test samples from the suspected firearm. Fired cartridge shells do not pose any difficult in respect of recovery as the fired shells either remain in the chamber of the firearm or can be found at the place of firing in case of auto/semi-auto firearm. But when comparisons of markings on the projectiles are required, the fired bullets/shots should be recovered by special contrivance. For the test specimens, the bullet recovery box which is packed with cotton wool having cardboard partitions with at regular intervals.

If bullets (unfired) are removed from a firearm, the location of each within the firearm should be noted in the report.

Cartridge Cases

Block-and gang technique is made applicable for automatic conversion of the primed cases into perforated steel plate, containing about two hundred-three hundred chambers, for proper accommodation of components of .22 caliber cartridge. The technique involves in: (i) shaking of mouth of the individual primed cartridges upwards, into suitable size plates, (ii) determination of lack of piercing or primers, or scars/blemishes, or the like, by way of inspection of the plated filled with the primed cartridge cases, (iii) introduction of exact quantities of power into each individual cartridge case through the exactly positioned individual chambers over the cases, (iv) period collection of empties from outside the magazine.

Home-Made Firearm

Iron tubing of different size, sanitary pipes, bicycle frames are used for manufacture of barrels, metal strips for action body and frame, wood pieces for butts, metallic wires, nut-bolts and cheap quality of nails, and at times, jute or cotton threads are used for assembly. The entire manufacturing process is done in indigenous work-shops of a blacksmith with the assistance of ordinary instruments. The barrels are made from cheap quality iron tubing which is never tested for the desired strength. There is no special fabrication of chamber, nor there does any chamber cone. The chamber and other parts of the barrel are in one continuation. There is hardly any polishing or lapping of the bore. The firearms generally are chambered for those cartridges which are easily available. Popular bore/calibers are 12 bores, 0.41 bore, 0.303 rifle, 0.32/7.65 mm pistol, 9 mm pistol/sten gun, 0.38 revolver and 0.22 rim fire cartridge.

Forwarding Letter

The forwarding letter should contain the following particular essentials:

- Name of the Police Station:
- Case number & under section:
- Date and time of origin:
- Name of the investigator:

- A brief of case history:
- Date, time and place of evidence collection:

Name of person who collected or produced the articles from the crime scene of his possession:

- Description of articles in each package:
- Facsimile of the seals used on the parcel:
- The nature of examination required:
- Certificate of authority to open the parcel for examination:
- The following documents should be sent an along with the exhibits:
- Copy FIR
- Postmortem report
- Copies inquest
- Sample seal on a separate paper sheet.
- Any other document relevant for examination ballistic weapons.

Forensic Lab

Ballistic weapon and ammunition examination, the firearm expert may be able to provide further information of interest to the investigation. A major consideration in many crimes is the distance from which the shot was fired. By conducting comparative tests, the lab can assist the investigator in cases where suicide or a claim of self-defense is involved. In addition to determining distance by studying firearm patterns, the firearm expert can often conduct an analysis of powder pattern resulting from the discharge of rifled weapons. Generally, the further the firearm is from the target, the larger will be pattern.

The study in Forensic firearms involves identifying the firearms that have been recovered or used. The law of originality is the cornerstone of identity. When a firearm is found, it might be necessary to determine if the firearms are properly produced or are created illegally. The sequential number, manufacture & model, kind & firearms bore/caliber must also be recognized as part of the laboratory examination. Sometimes the criminal removes the serial number to avoid identifying or to be requested by the legitimate firearms owner. It is the responsibility of the laboratory to address all such queries. The concept of identification is laid forth in the legislation itself in such circumstances.

Conclusion

A ballistics specialist is familiar with the many marks that weapons make on bullets when they are shot, such as the rifling marks on a barrel and other striations on the projectile. They may also model the scene to determine where a firearm or explosion was used, as well as conduct chemical analysis to determine the weapon used. In court, ballistics specialists typically show graphics, video, or other explanations of the results of their study. Forensic ballistics professionals generally work at forensic science labs for public, state, and central agencies. Ballistics Division's task entails identifying and comparing weapons, ammunition, and parts thereof. Examining target materials is also part of the job. Standard small arms and ammunition of varied make and caliber are on display, as well as homemade/improvised weapons and ammunition, bullets, pellets, wads, propellant, cartridge casings, and the appliances used in the manufacturing of firearm ammunition. This category examines conventional and country-made guns, deadly weapons such as revolvers, pistols, assault rifles, carbines, & ammunition. This division is also responsible for the inspection of guns in possession under the Arms Act. This section also examines gunshot remnants from fired bullets, cartridges, shot holes on clothes/skin/window glasses, & so on, as well as the distance of shooting in cases of murder/assault. A comparison microscope is used to compare the striations on fired ammunitions & firing pin impressions on fired cartridge cases from the crime scene with test-fired bullets & test fire magazine cases. In this sector, scanning electron microscopy is utilized in forensic ballistic applications such as gunshot residue analysis, weapon identification (bullets and empty cartridges), and case markings comparisons. A ballistics specialist is familiar with the many marks that weapons make on bullets when they are shot, such as the rifling marks on a barrel and other striations on the projectile. They may also model the scene to determine where a firearm or explosion was used, as well as conduct chemical analysis to determine the weapon used. In court, ballistics specialists typically show graphics, video, or other explanations of the results of their study. Forensic ballistics professionals generally work at forensic science labs for public, state, and central agencies.

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