Stringing a Crime Scene to Determine Trajectories

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by

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Background

Today's understanding of crime scene interpretation, combined with long-term experimentation under similar conditions, allows the investigator to gather, test, and formulate theories of origin based on the factual tests conducted by the investigator. The position of cartridges, cartridge cases, and bullets is just as important to the determination of origin as the position of drops of blood. From their placement, it may be possible to deduce the position of firing, the direction of the shot, and in certain cases, the path of the bullet [1]. The test results often establish or refute claims made by witnesses and suspects.

"Stringing" (i.e., using a string to illustrate) a crime scene in order to determine a point of origin has a historical setting dating back to 1939 [2, 3]. Stringing crime scenes involving shootings where two or more holes are made by one bullet may be feasible to determine the line of fire and the firing position of the shooter. Such determinations are made by sighting through the holes to trace the line of f light back to the source [4].

The determining of trajectory originated in the realm of the firearms examiner. The transition from exclusive use by firearms to other areas of crime scene interpretation began in early 1955 with the pioneer work in blood spatter analysis conducted by Professor Herbert L. MacDonell, who applied the same type of trajectory determination to the new discipline. Professor MacDonell deserves major credit for applying established principles of physics to a new scientific discipline. Geometry applied to ballistics is the same as geometry applied to bloodstains [5].

Expert Opinion

As crime scene investigators, it is possible to track the paths of the bullets; trace their trajectories; and video, diagram, or photograph the results. These are basic interpretations of the scene. Anytime you insert a protrusion rod into a bullet hole to show the trajectory of a bullet, you are rendering an expert opinion as to the direction of travel of the bullet based on your training, knowledge, and prior investigative experience. Once we enter the area of calculation adjustment; correction for angles of drift, drop-off, deflections; and the position of the body when the shooting occurred, we are entering into areas of expertise, which is usually the area of the ballistics examiner [6].

Tools Necessary for Trajectory Determination

Tools necessary for trajectory determination include, but are not limited to, the following:

1. String (various types can be used)

2. Adhesive tape (any kind)
3. Measuring tapes (25 ft and roller tape)
4. Protractor (clear plastic)
5. Inclinometer (determines angles and slope)
6. Compass (any 360E camping type)
7. Marking pens
8. Adhesive markers (numerical and alphabetical)
9. Bubble or torpedo level
10. Laser pointer

A crime scene presents the investigator with a specific scenario, such as a shooting, where there may be spent casings present along with one or more bullet impact sites. The method of operation will depend on the specific circumstances at the crime scene. However, there are some general guidelines to follow:

Vehicles:

1. If a vehicle with bullet holes in the windows is involved, swab the interior surrounding the holes for possible gunpowder residue testing. It may become an issue in the future.
2. Examine the impact site and crater of the glass to visually determine whether the bullet originated from the outside to inbound or from the inside to outbound.
3. Note the location of spiral fractures to determine which impact was first.
4. Fiberglass rods or wooden dowels (steel and aluminum may be too heavy for shattered glass) may be inserted into the bullet holes to establish the paths. String can be attached to continue the path, which can later be verified with the use of the laser light beam.
5. If the hole in the glass is less than two inches in diameter, pass a string through a drinking straw, then attach the string to a small spring that can be inserted through the bullet hole. A common toothpick can then be inserted through the opposite end of the spring and this allows the string to be pulled tight with light tension [7]. The string is then attached to the pole at the appropriate level based on the trajectory and laser light indications.
6. When the vehicle string placement is complete and the locations, measurements, and horizontal and vertical angles have been measured, the completed product is photographed and charted by diagram. It is important to photograph the vehicle from the horizontal plane and to also photograph the stringed angles from the vertical plane via use of a ladder. The combination of the two views complements the diagram and allows both views to confirm each other.

There are certain environmental conditions to consider when conducting trajectory exams. In the case of a vehicle, tire pressure may be a factor. Measure the pounds of pressure in each tire at the time of the initial forensic examination because tire pressure may leak out after the vehicle has been parked for a long time. A change in tire pressure can affect the results of your determination. (The angle can raise or lower, depending on the impact site and which end of the vehicle loses pressure). Measure the ground and determine whether the scene has a slope and, if so, the degree of the slope.

Buildings:

1. If the scene is a building structure, similar steps are taken to reconstruct the event. Slightly different tools may be necessary. Tape, nails, hammers, extra poles, and so forth may be employed to accomplish the testing process. Many of the previously described steps are repeated when examining buildings.

Recommended Testing

Once a visual inspection of projectile impact sites has been catalogued by diagram, measurements, and photography (video included), a preliminary test should be conducted by use of the laser beam. This may well provide the investigator with a baseline of information with which to conduct further testing.

The second part of the examination is to attach the string from the impact site outward in the direction from which the projectile was fired. It is beneficial to have a set of PVC upright poles to attach the string to once the angle of impact has been determined. The attachment position is based on the angle backtracked from the impact location and angle. The shooter's relative position and distance from the target can often be determined from this test.

Upon completion of the string attachment and pole placement, it should be double-checked with the laser pointer. Minor adjustments are often made during this review; however, the original test results are confirmed at this time.

Injury Analysis on Live or Dead Subjects

Usually when death has occurred, the measurements are documented by the coroner or medical examiner. Most of the measurements are comprehensive, in so far as the location on the body, the direction of travel, and the final resting place or exit of the bullet. The physical examination of the victim will generally include x-ray photographs showing the location of projectiles within the body. The entrance point of the wound and the subsequent path traveled provide a sound basis for angle determination, unless the path direction is deflected by bone material.

What is rarely seen in medical reports is a measurement based on the victim's reported stance at the time of the shooting, from the bottom of the foot to the entry and exit wounds, an angle determination based on a horizontal and vertical basis. This is nothing more than a combination of an anatomical chart combined with a basic graph or coordinate system.

Another factor to consider is the type of footwear. The thickness of the heel must be factored in and can change the height. When the height is altered, the angle and distance changes (the greater or lesser the angle, the greater or lesser the distance becomes). A quick demonstration can be done with a common protractor. Draw a right angle, extend a line from the base and a second line two or more degrees different, and observe the difference: As the lines get farther apart, the longer the lines become.

Consideration must be given to multiple wounds because the person will most likely be reacting to the threat by rotating, crouching, or moving in some other way for defense posturing or evasion purposes. In the case of deceased victims, ballistic rods are an invaluable tool for showing direction and allow an angle determination from a horizontal and vertical plane. (This form of examination should only be performed under the supervision of, and with permission from, the medical examiner or coroner.)

When examining living persons, verbal descriptions are usually accepted as described; however, the stress of the event often leaves the facts somewhat cloudy. Proper measurements and stringing the scene can often confirm the accuracy of the victim's statement.

Any firearm examinations necessary for the investigation (rifling characteristics, ejector marks, extractor marks, breach face marks, etc.) should be done before any shell ejection testing by the investigator. In cases where the shooter's approximate position is significant (e.g., officer involved shootings), it may be necessary to take similar weapons (i.e., make and model) for testing three areas: the initial distance the shell is ejected; the secondary roll to a final resting place; and the angle at which the ejected shell exited the weapon (taking into consideration types of surfaces, for example, concrete, asphalt, sand, grass, gravel, and so forth). Multiple shots should be fired from each weapon (at least ten shots) to establish a known average of minimum and maximum distances. It will quickly be established that no two casings come out at the same angle, same distance, and same roll; however, there will be a general pattern established.

Problems with String

The use of string presents two challenges that are difficult to overcome. The first problem is the droop factor. String pulled from one point to another will eventually droop because of the weight of the string and the tension on the fibers that make up the string. String is generally attached to the item with some form of tape and is likely to droop while being attached to the second area. The longer the length of string, the more the weight will shift toward the center of gravity, creating the droop factor.

The droop factor is created by the bulk of unsupported material and will seek the center of gravity regardless of the size or length of string used. If the ends are attached at different levels, the center of gravity will shift to the lower end.

A second factor with string is the strength of it. The stronger the string, the larger the diameter of the string. The larger the diameter, the heavier the weight of the string. The heavier the weight, the greater the droop factor. (A new type of nylon string being marketed for use in low light conditions is a ref lective string, which reacts well when illuminated with a f lashlight or photo f lash.)

Problems with Laser Light

The laser light beam has certain benefits, such as specificity, because the light beam travels in a straight line at a constant speed of 186,272 miles per second to the target. The drawbacks in using laser light are that it is somewhat difficult to work with in the daytime; it does not provide a complete sequence of beginning, middle, and end (beginning and end only); it is subject to movement by the holder; it is unsteady in windy conditions; and it generally has a short range in bright sunlight conditions (generally works best in dark or night conditions).

Demonstration of a Laser Light Problem

A quick, easy demonstration of trajectory determination is to take a small piece of presentation foam board, carve a groove in it, place the laser in the groove, and tape it in place. Place the

board on a flat surface and mark (with tape) where the light beam strikes, then elevate one corner of your choice, and watch the location difference. This has a dramatic visual effect on observers.

Demonstration in Open Court

The value of a simple demonstration in open court before a jury carries tremendous demonstrative weight, because it transforms the investigator's testimony from verbalization to what becomes a part of the immediate experience of the jury. Having a vertical measurement of the bullet impact, place the protractor on the measurement site, and use the bubble level to level the protractor. Attach the string to the center of the protractor and then run the string out on the angle and direction determined from the crime scene. Attach the end to a pole or microphone stand, double-check your string placement with a laser pointer, and confirm the position. Used properly, the stringing of a crime scene can be compelling demonstrative evidence.

New methods and innovative techniques have their place in the scientific community. The International Association for Identification's annual educational conference is an excellent place where scientists and practitioners meet each year to review, demonstrate, and refine advances in crime scene processing and physical evidence interpretation. Both new and traditional techniques are often taught during the educational conferences. Some are presented as poster presentations, and others are presented in the form of case presentations or lectures before a general session audience. This process of demonstrating new techniques allows the crime scene investigator to gain the opportunity to legitimately employ the techniques described with the support of the general scientific community. The application of relative trajectory determination by use of string in crime scene reconstruction has been demonstrated since 1973 in 58 bloodstain evidence classes offered during the annual International Association for Identification's educational conferences.

Conclusion

The use of string in reconstructing crime scenes for certain types of evidence is a relatively simple, inexpensive, and accurate method of demonstrating trajectory. Caution is emphasized that the determination is not exact but is more of a general, or relative, position fixing method. The use of string is still valid and remains as only one of several methods of determining the point of convergence or origin. When feasible for use in court, it remains an excellent demonstrative tool.

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