Chapter 16.3: Forensic Impression Evidence

Introduction

Impression evidence, items that carry the lasting and observable marks from contact with another object, comes in many forms. So far, we have discussed how individualistic patterns are transferred from our fingers, hands, feet, and even lips and ears to other objects (Chapter 7) and how analyzing them can aid in identifying one person’s actions from among those of all others. Similarly, earlier in this chapter the analysis of permanent marks on gun barrels, bullets, extractors, and other parts of weapons and ammunition was shown to be powerful a way to establish very strong linkages between a recovered bullet and one particular weapon. But, there are many other types of impression evidence where marks of contact can be effectively used to show that the two particular objects were once in intimate contact. These include footprints, tire tracks, bite marks and tool marks, among others. While these other types of impression evidence could just as suitably be presented elsewhere in this text, they will be covered here due to the similarities that often exist between the techniques used in firearm examinations and those employed for the analysis of impression evidence.

Impression Evidence Basics

Impression evidence arises from imprinting or pressing a patterned or shaped object upon another object to leave behind some sort of image of the original patterned object. Impression evidence provides several key types of forensic information that includes:

- Identification of the objects that came into direct contact – both from class characteristics (e.g., make, model, and type of objects) and potentially from individual characteristics (e.g., wear marks, imperfections and unique structural patterns) that helps to establish an unambiguous linkage between two items;
- Determination of how many people and objects were involved in the incident;
- Description of the movements of the participants and objects (e.g., weapons, vehicles, furniture, etc.)

Figure 16.3.1. Impression evidence (footwear prints) being used to identify tracks found at a crime scene by comparing prints found at the scene with those produced by the suspect’s shoes.

Figure 16.3.2. A positive footprint (left) and negative footprint (right). The positive print occurs from leaving something behind on the surface (such as ink on paper) and the negative print comes from removing materials from the surface, such as removing sand or dust from a surface.
during the incident;

- Establish a timeline and sequence of actions that occurred during an incident – what happened first, next, and so on;
- Support or refute eyewitness, suspect, and victim accounts of what occurred.

Impression evidence can take several forms, depending upon the types of objects and surfaces involved. Impression information can be either two-dimensional or three-dimensional in nature. Two-dimension impressions typically result when an object comes into direct contact with a hard surface or material. The hard surface is not indented or molded by contact with the object but patterns can be transferred to the surface, such as when a fingertip comes into contact with a glass or a vehicle tire rolls over a concrete roadway. The print formed from this type of contact may produce either a positive or negative image (Figure 16.3.2). A positive image is made when the object leaves something behind on the surface that can be visualized. This happens when an object is covered with ink, blood, oil, soil, moisture or another substance that is transferred to the surface, similar to the way printing is done on paper (Figure 16.3.3). Most fingerprints on an object are positive prints resulting from the transfer of oils and secretions to the surface that remain to be detected later. A negative image is formed, in contrast, when some covering material is removed from the surface through contact. For example, dust, snow or blood distributed on the floor in a thin layer can adhere to a tire or shoe and be removed when a vehicle drives over the area or someone walks across the surface (Figure 16.3.4). After the contact, the resulting

**Figure 16.3.3.** Positive image footprint in mud on a floor (dnawriters.blogspot.com/2011_02_01_archive.html).

**Figure 16.3.4.** Shoe prints form a negative image on a dusty surface by removing some of the dust from the surface (http://reference.findtarget.com/search/Forensic%20footwear%20evidence/).

**Figure 16.3.5.** 3-dimensional impression evidence from footwear: (left) a negative imprint in mud, (center) an positive imprint in the form of a casting, and (right) the shoe that made the original impression. (www.csic贴近blog.com/2011/01/footwear-the-missed-evidence.html).
pattern of the tire or shoe remains in areas where the coating has been removed.

Impression evidence can also be three-dimensional in nature. In this case, an object comes into contact with a soft or moldable substance (called a “plastic” material) to leave behind an exact three-dimensional imprint of the original object. The image formed is actually a negative impression of the original object since “high points” in the original object are recorded as “low points” on the print. Making a casting (see below) of the 3-dimensional imprint “inverts” the impression to form a positive of the original – high points in the cast correspond to high points in the original, as shown in Figure 16.3.5.

Impressions can also be divided into three basic types, just as was done in Chapter 7 with fingerprints: visible, latent, or plastic impressions. **Visible** impressions are those that are readily observable without any visualization aids. Examples include prints from inked fingers, tracks in mud, scratch marks on a door lock, and bite mark wounds on a victim. **Latent** impressions are those that are not immediately observable but can be “developed” using a variety of techniques to make the image visible. Special light sources, chemical reagents, powders and spectroscopic techniques have all been used effectively to visualize latent impression patterns. For example, Figure 16.3.5 shows a latent print from a shoe that held minute traces of blood, far below that which can be seen with the unaided eye. The “invisible” minute amounts of blood transferred to the floor from the shoe were effectively visualized by treatment of the area with luminol and illumination with ultraviolet light. Finally, **plastic** impressions are those that have been formed when an object is imprinted into a soft, moldable material.

The processing of most types of impression evidence usually follows several basic common practices. These steps usually involve localization, photography, documentation, casting (for 3D impressions) and lifting the impression.

Usually, the process begins by sweeping the area to locate and extensively photograph the evidence. Special lighting, fluorescent techniques and various powders are often used quite effectively for locating even very difficult to see impressions. Photographs must have a scale indicator of some sort within the image and the set of pictures needs to include both wide-field pictures that place the impression...
within the context of the larger crime scene and close-up detail shots. Pictures are usually taken directly above the impression with the light source moved to different angles relative to the surface. One especially useful technique for finding and photographing impressions uses oblique lighting, light that comes in at a low (or oblique) angle relative to the surface (Figure 16.3.6). This technique gives highlights and contrast to the topology of the impression – much as the setting sun causes shadows over hills and valleys to give a clear three-dimensional picture of a landscape.

Forensic photographers also use alternative light sources (als) that essentially employ light of different wavelengths (colors) to visualize the components of the impression (Figure 16.3.7). Since different chemicals, such as drugs, body fluids, dust, minerals, pigments and others, fluoresce at different wavelengths of light, alternative light source can be used to selectively visualize and photograph the evidence (Figure 16.3.8). Latent impression evidence of many varieties can be visualized using techniques developed for latent fingerprint examination. For example, magnetic powders, visualization reagents (e.g., ninhydrin, crystal violet and luminol), “super-glue” methods, and others can be quite effective for footwear, tire tracks and other forms of latent impressions.

Documentation of the evidence often involves written descriptions and sketches/drawings of the crime scene, relating the positions of the evidence with fixed points of reference. As with other types of documentation for crime scenes, computer-assisted and GPS methods help spatially locate the important aspects of the scene, including footprint and other types of impression evidence (Figure 16.3.9).

For three-dimensional impressions, such as footprints, tire tracks and tool marks, castings are taken whenever possible. Castings provide actual-sized, permanent reproductions of the original impression, often with great detail - even to the microscopic level depending upon the quality of the original impression. Casts may also preserve detail beyond just the bottom surface of the original object. In deep, three-dimensional impressions, details from the sides of the object that are very difficult to photograph can be remarkably well preserved. Casts also provide a permanent record of the short-lived impression and provide tangible support for the photographic records that have been made, allowing later re-visitation to examine the impression for further analysis.
Figure 16.3.10. Preparing a cast of a footprint using dental stone. (1) the impression is first photographed with a scale marker for future reference, (2) the impression is bordered to contain the casting material, (3) the dental stone is mixed with water and (4) poured into the frame. (5) After curing, the cast can be removed and (6) carefully cleaned of debris to yield a positive print of the impression. (www.evidentcrimescene.com/cata/cast/dscasting.html).

Forming castings involves pouring a rather thin liquid material into the impression that slowly sets
into a solid material that retains the detailed features of the original pattern (Figure 16.3.10). Most often, dental stone or dental silicone are used in preparing these casts, an improvement over the older Plaster of Paris methods. Dental stone, a gypsum product, forms a hard, strong solid that doesn’t require reinforcement to be very stable – much harder and more durable than Plaster of Paris. Dental silicone forms a rubber-like material that, when set, retains the details of the original impression. Casts can be made of impressions in a variety of conditions and materials. Casts are readily taken from impressions made in sand, mud, soil, cement, and even snow (Figure 16.3.11).

Two-dimensional impressions can often be lifted and preserved using techniques developed for fingerprints. Depending upon the situation, powders can usually be lifted using clear plastic sheets. Other dry impressions can be lifted using an electrostatic lifting device that allows charged dust and dirt particles to adhere to a charged metal plate that then accurately transfers the particles to a plastic sheet for preservation and analysis. If the impression is wet instead, it can either be directly lifted using a gel or indirectly lifted first by powdering with fingerprint dusting powder and then lifting the powder as a dry image. In any case, standardized methods have been developed to lift and preserve many types of two-dimensional impression evidence.

Footprints

Footwear impressions, probably the most common type of impression evidence found at crime scenes, can be especially useful in identifying the presence of individual people at a crime scene. Footwear evidence can be found not only on floors, but also on doors, walls and elsewhere when suspects kick these surfaces. Footwear evidence has even been recovered from people’s skin in cases of violent assaults (Figure 16.3.12). Investigators also can look inside a person’s shoes to find skin friction ridge

Figure 16.3.11. Wax casting of a footprint in snow (the red color is the color of the spray wax used to make the casting)

Figure 16.3.13. Differences in new shoes arising from imperfections in the molding process. The arrows depict the mold variations in each of the different shoes (above each enlargement) along the outside end of the shoe (www2.fbi.gov/hq/lab/fisc/backissu/july2009/review/2009_07_review02.htm).
Footwear impressions may often be individualized by identifying molding imperfections (Figure 16.3.12) and wear and damage marks (Figure 16.3.13) in the sole patterns. These imperfections found on evidence from a crime scene can then be compared to the shoes of suspect by looking for similar (or missing) tread pattern damage.

Information based on footwear can also provide a very rough estimate of the approximate height of the wearer since a rough correlation between shoe size and height follows a statistical distribution pattern (and sometimes a very approximate stature estimate is quite useful). Height can also be approximated by measuring the distance between successive footprints and correlating the stride length statistically with limb dimensions – longer limbs suggest a taller stature. The order in which a series of footprints were laid down can also sometimes be determined by looking for overlapping footprints – the most recent footprint impresses its pattern over that of a previously existing print. Finally, whether a person was simply standing or moving and, if

Figure 16.3.12. Footprint evident on a victim’s forehead caused during a robbery and assault, (www.telegraph.co.uk/news/sknews/law-and-order/4375625/Police-use-footprint-left-on-victims-forehead-to-track-his-attackers.html).

Figure 16.3.13. Comparison of identifying characteristics in the impression (found at the crime scene (left) with features observed on the sole of the known shoe (right). The five red arrows indicate the position of unique identifying characteristics from wear and damage to the sole of the shoe (www2.fbi.gov/hq/lab/backissu/july2009/review/2009_07_review02.htm).

Figure 16.3.15. Comparison of a cast tire track (left) with a test print of a suspect tire (http://site.utah.gov/dps/impressions-tire-informationfromevidence.htm).