# 18

# Forensic Footwear Evidence

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*Topics*

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## Introduction

As persons walk about, their shoes track over a large variety of hard surfaces, acquiring dust, dirt, residue, grease, oils, blood, and moisture. The shoes then deposit these acquired materials back onto other surfaces they subsequently track over. As a result, they leave a variety of both patent (visible) and latent (invisible) two-dimensional shoe impressions. If they walk over softer surfaces, such as sand, soil, or snow, they may cause a permanent deformation of that surface in the form of a three-dimensional shoe impression.

Whether on hard or soft surfaces, the resulting direct physical contact between the shoe and the substrate results in a transfer of class and individual characteristics from the shoe to the impressions it leaves. The forensic footwear examiner will examine these class and individual characteristics to determine if a specific item of suspect footwear made the questioned crime scene impression, or if that item of footwear can be eliminated. This process begins with the detection and recovery of the footwear evidence from the scene of the crime, enhancing that evidence if appropriate, producing known impressions of the shoes being examined, and finally comparing the crime scene impressions with the footwear. The final result may necessitate the footwear examiner to produce this evidence and his or her opinion in a court proceeding.

Footwear impressions are routinely used to prove a suspect was present at the crime scene. This type of evidence is very valuable and most frequently used in homicides, assaults, robberies, rapes, burglaries, and similar crimes where the proof of an individual's very presence is incriminating.

## Forms of Footwear Impressions

### Three-Dimensional Impressions

Three-dimensional impressions are those that remain after a shoe has permanently deformed a surface. This type of impression is



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predominantly found on exterior surfaces, such as sand, soil, or snow, although other soft materials occasionally may get tracked through. Some of these impressions are very shallow and others may be very deep. Depending on the composition of the substrate, the amount of moisture, and the presence of contaminants, such as sticks, stones and other debris, the resultant quality of the impression retained in the substrate can range from those of great detail to those having little or no value. For instance, an impression in a clay-based soil will normally retain greater detail than an impression in a mixture of coarse sand and small rocks. Likewise, an impression in dry, packed snow will normally retain greater detail than an impression in wet, melting snow. Three-dimensional impressions that retain sufficient detail can be identified with a specific item of footwear.

### Two-Dimensional Impressions

**Two-dimensional impressions** are those made on nongiving surfaces, such as tile, linoleum, or wood flooring, and also include those made on paper, plastics, doors, carpet, clothing, broken glass, countertops, etc. Thus, a large number of both porous and nonporous surfaces can be stepped on or kicked by an item of footwear. In addition, these impressions are even more varied because the shoe may contain varied combinations of dusts, dirt, soil residues, grime, oily materials, or blood. The many possible surfaces combined with the many materials that a shoe sole may acquire and later deposit make the methods of recovering and enhancing those impressions more numerous and complex.

Some impressions are highly visible, and others are latent. Shoes may track across a surface that contains dust or residue, only to track later across a cleaner surface and deposit those trace materials in the form of an impression. Shoes that are wet or muddy, or that have tracked through blood or other opaque materials, can leave a variety of impressions on most surfaces. Even shoes that are relatively clean and dry can leave their impressions on paper or other surfaces such as glass or countertops that may be coated with polish, wax, grease, film, or grime. In each of these cases, the amount and type of material deposited by the shoe and how that material contrasts with the receiving surface determine how visible the impression is. It is interesting to note that very often the less visible impressions actually retain greater detail than impressions that result from heavier deposits of residue, dust, or blood. Regardless of whether the impressions are full or partial, or heavy or light, the examination results depend on the detail retained in the impression. All impressions are potentially identifiable.

## Information from Footwear Impressions

Footwear impressions located at a crime scene can provide a variety of information that assists in the investigation of a crime.

### Identification of Footwear

Based on the agreement of both class and individual characteristics, a suspect's shoe may be positively identified as the exact shoe that left one or more impression at the scene of the crime, thus proving the suspect's presence at the crime scene.

### Elimination of Footwear

Based on confirmable differences of class characteristics, shoes may also be eliminated as possibly having left an impression at the crime scene. Elimination of a suspect's footwear may be useful in accounting for all footwear impressions at the scene, and in some cases may constitute exculpatory evidence. Because random individual characteristics on a shoe can change as old ones are worn away and new ones are acquired, and because not all individual characteristics reproduce all of the time in every crime scene impression, it is normal to find individual characteristics on a shoe that have not been retained in the impressions it leaves. For that reason, changes in or the absence of random individual characteristics are normally not used to eliminate a shoe.

### Participation in the Crime

Footwear impressions found at the crime scene and identified with the shoes of persons who had no legal authority to be there are highly significant. For instance, footwear impressions left on objects such as broken glass inside the point of forced entry, on paper items that were removed from a burglarized safe, on items that may have been knocked to the ground during an assault, or in the blood of the victim, all contribute significantly toward the proof of a suspect's presence at the scene and, in some cases, his or her participation in the crime.

### Location of Impressions

Impressions at the point of entry and exit and at other significant locations within the crime scene may provide insight into the location of other impressions or other physical evidence.

### Rebuttal or Confirmation of Suspects' Alibis

Suspects often admit their presence at a crime scene. The exact location and documentation of shoe impressions of such suspects may help to prove they are either lying or telling the truth about where they have or have not walked.

### Determination of Shoe Brand

The brand name and description of the footwear that left the crime scene impression can often be determined through **footwear databases** or by other means. In the United States, the FBI laboratory maintains a footware database that includes thousands of shoe designs. At no charge to law enforcement agencies the FBI will search crime scene impressions in an attempt to identify the manufacturer or brand of the footwear. This information may contribute toward the identification of the suspect or may be otherwise useful in the investigation.

### Linking Scenes of Crime

Databases in some laboratories can store the footwear impressions recovered from various crime scenes, often linking different crime scenes to one another. This is a particularly useful tool in investigations of repetitive crimes, such as burglaries, and in highly populated cities.

### Determination of Shoe Size

In many cases, if the manufacturer of the footwear is known, an accurate determination of the size of the shoe that made a full or partial footwear impression is possible. In other cases, the dimensions of full or nearly full impressions can allow for a general estimate of the shoe size.

### Number of Perpetrators

The location of more than one suspect shoe design at the scene of the crime may provide important information about the number of persons that committed that crime. Likewise, the absence of more than one set of footwear impressions, under certain circumstances, may indicate only one individual committed the crime.

### Association with Other Evidence

The backtracking of footwear impressions from the point of entry, or tracking impressions exiting the scene, can assist in locating discarded weapons or other evidence, and in associating the footwear impressions with tire impressions or other physical evidence.

### Gait Characteristics

Gait analysis is used primarily for medical evaluation of persons with walking problems. The measurements of a person's stride, step length, and step width change as he or she walks more slowly or quickly, and as he or she walks over different surfaces. These variables also exist when known standards of a suspect's gait are obtained. Because of these limitations, this type of information cannot be reliably used as a means of personal identification.

### Tracking

Tracking involves following the path of an individual by observing evidence that person has created as he or she passes over various surfaces. That evidence — referred to by trackers as "sign" — includes shoe prints, bare footprints, crushed debris, or displaced rocks,

and sticks, or leaves that may have been stepped on. It is most commonly used for tracking illegal aliens and for the location of missing children, but in some instances has been used to track criminals from the scene of the crime. Most trackers in the United States originate from agencies like the U.S. Border Patrol, where they routinely gain training and experience in tracking methods.

## Location and Recovery of Footwear Impressions

It is critical that the proper techniques and materials be used to locate, document, and recover footwear evidence from crime scenes. Otherwise this evidence will be either lost or reduced in evidentiary value. Unfortunately, some investigators still either ignore this evidence at the crime scene or fail to look for it aggressively and recover it properly. Success in locating footwear impressions and then recovering the maximum detail from each impression has a direct impact on the usefulness of this evidence and the results of any subsequent examination.

Impressions that shoes leave may be full, but in most cases they are partial. Some partial impressions represent only a small percentage of the shoe sole that made it. In either situation, even in the case of small partial impressions, they can potentially contain sufficient detail to be identified or eliminated as having been made by a shoe. It is not possible simply to look at a crime scene impression and determine its value. That impression's value will not be known until it is fully recovered, enhanced, examined, and compared with shoes. Therefore, all questioned footwear impressions should always be recovered from a crime scene.

Most impressions are on floor surfaces and, if the scene is not properly controlled, the shoes of other individuals can track over this evidence. To prevent this, the scene should be secured as soon as possible. This should include both the interior and exterior perimeters, because this evidence can be both inside and outside. If the crime is one in which footwear impressions would be of evidentiary value, attempts to aggressively search for, protect, and recover those impressions should be set in motion immediately.

Some impressions are obvious and can be seen immediately upon entering the scene. For instance, bloody shoe prints on a light-colored surface next to a homicide victim are hard to overlook. Locating most footwear impressions, however, requires a more deliberate effort. Making a slow visual search, followed by darkening the room and searching for impressions with a high-intensity oblique light source, often reveals many impressions that could not otherwise be easily seen. More aggressive techniques, such as searching for impressions with an **electrostatic lifting** device, may also be appropriate in certain areas, depending on the conditions. In addition, any items that may have been stepped on, such as pieces of paper or magazines that are on the floor, broken glass, or other surfaces that may have been walked over or kicked, should be closely examined. In most cases, paper items that are stepped on do not reflect visible footwear impressions, but they almost always contain highly detailed latent dust impressions that can be recovered electrostatically. Likewise, broken glass that falls inside of the point of forced entry is often stepped on and retains excellent shoe detail, yet these footwear impressions can be seen only with proper lighting. Exterior surfaces, including the areas near any forced point of entry or any logical exit path, should also be thoroughly searched.

Notes should provide information about the location and direction of all impressions as well as a brief description of each. These notes should be prepared so that they, along with the **general crime scene photographs**, can be used to document and reconstruct the scene and the relevance of the evidence. To document footwear impressions, numbered placards, such as those depicted in Figure 18.1, should be placed alongside each impression or piece of evidence. Whenever possible, general crime scene photographs should be taken to

document these impressions formally with the numbered placards, thereby enabling the documentation of each numbered impression through both notes and photography. The numbers should remain assigned to the respective impressions in any subsequent lifts, casts, or examination photography. In this way, a cast #7, or lifted impression #5, can be directly linked to both general crime scene and examination quality photographs of these impressions, as well as the notes regarding those impressions. An example of this is depicted in Figures 18.1 and 18.2. Figure 18.1 is a medium-range photograph of a burglary crime scene at the exterior forced point of entry. It depicts three pieces of evidence — two shoe impressions (7 and 8) and a discarded soda can (9) — and shows their location and relationship to the overall side of the residence and the point of entry at the window. Figure 18.2 is a close-range photograph depicting shoe impression #7. It is not intended for an examination, but simply to show more closely the position and orientation of the impressions.

Any impressions at the scene that can be carefully and safely recovered should be taken to the laboratory. This includes paper and glass pieces, scatter rugs with bloody shoe prints, and similar types of evidence that can be safely moved. If the impression is on an item that cannot be removed from the scene, it should be recovered in a prescribed and proper manner as described below. All impressions, both partial and full, are of value and should be recovered.

Footwear impressions that cannot be removed and taken to the laboratory must be photographed in a special manner to provide high-quality photographs for a forensic examination. This type of photography is known as *examination quality photography*. These photographs are taken from directly over the impression. The impression in the general crime scene photograph in Figure 18.2 now has been photographed for purposes of examination (Figure 18.3). Examination quality photographs of impression evidence are taken for only one purpose: later examination with suspected footwear. A camera with a negative format of 35 millimeters or larger, and capable of manual focus, must be used. At this time, most digital cameras do not have the resolution necessary for this type of photography. Although digital photographs printed at a $4 \times 6$-inch size appear to be excellent, the same digital images do not contain sufficient detail to permit enlargement to the size needed for examination. The enlargement of a photograph of a full

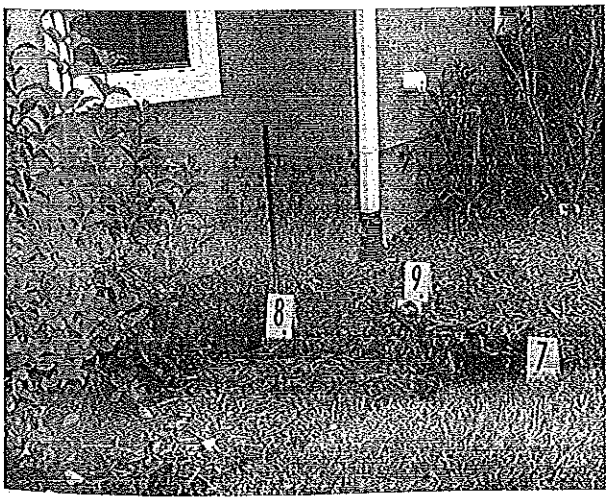


*Figure 18.1* A general crime scene photograph, taken from a medium range, to document the position of shoe prints and other evidence.

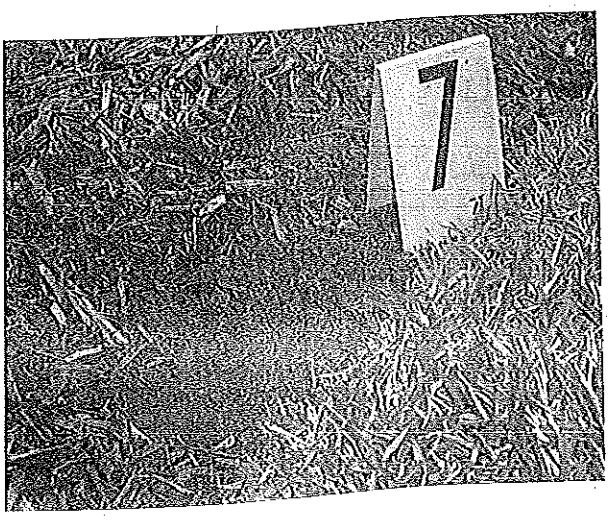


*Figure 18.2* A general crime scene photograph, taken from close range, to document the individual evidence items, such as the shoe impression labeled #7. This type of photograph is for documentation only and is not intended or satisfactory for a comparison with suspect shoes.

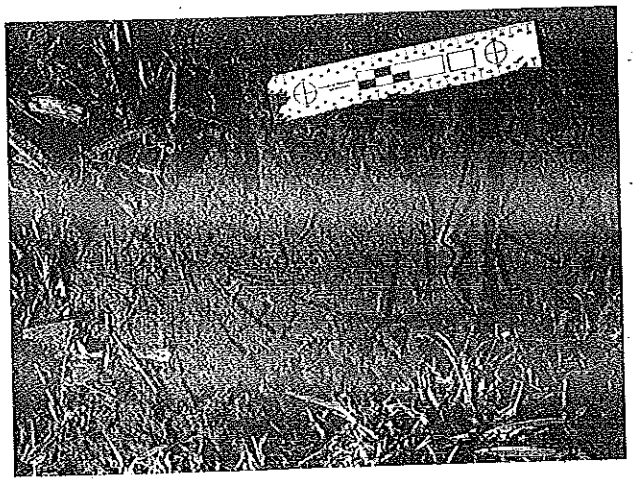

*Figure 18.3* An examination-quality photograph of the shoe impression #7, featured in Figures 18.1 and 18.2. This photograph was taken with a ruler and with oblique lighting, with the camera on a tripod positioned directly over the top of the impression. By using the scale of the ruler, this type of photograph can be enlarged to a natural size and then compared with the suspect shoes.

footwear impression to its natural size normally results in an 11 × 14-inch photographic print. Only the top of the line SLR digital cameras operated by very knowledgeable digital photographers are capable of creating a digital photograph that can be enlarged to this very large size and still retain adequate detail for examination. Thus, the 35-millimeter camera format still remains the minimal format for this photography. A ruler, used as a scale, should be positioned next to the impression in every photograph and must be placed on the same plane (level) as the bottom of the impression. This ruler provides a way to enlarge the photograph accurately to a natural size for examination. If the ruler is not used, or if it has not been placed on the same plane as the impression, it will significantly reduce the ability to use the photograph for an examination. In order to hold the camera in the proper position and to maintain focus, the camera must be placed on a tripod. The camera and tripod should be positioned directly over the impression so that the impression and ruler fill the entire negative. The camera should be focused on the bottom of the impression, not on the ruler. This should be done with manual focus, not with the camera's auto focus. Oblique lighting should be used from the proper height and from at least three sides in the proper manner to provide increased contrast in both two- and three-dimensional impressions.

Certain three-dimensional impressions, such as those in white sand or snow, are very difficult to photograph with contrast. For impressions in snow, Snow Print Wax™ or a dark-colored aerosol paint can be carefully applied lightly at an oblique angle to highlight the ridges or high spots of the impression, thus adding some contrast in the photographs. The left side of Figure 18.4 depicts an impression in snow. On the right is a photograph of the same impression after it was highlighted with the red-colored Snow Print Wax.

## Two-Dimensional Impressions

Once the impression has been photographed, two-dimensional impressions, in many cases, can be lifted. Lifting of two-dimensional impressions improves the visibility and detail of the impression by transferring it to a surface

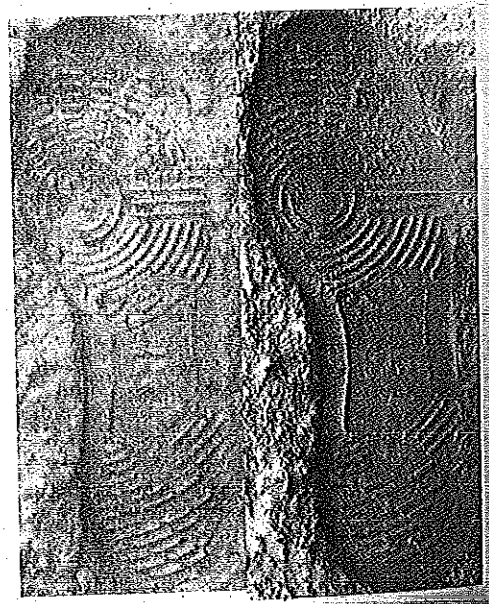

*Figure 18.4* Impressions in snow are difficult to photograph. On the left is an impression as it would appear in a normal examination quality photograph. The impression was then highlighted with a light spray of Snow Print Wax™ and rephotographed. The highlighted impression provides much better contrast and detail for examination. This is an excellent way to document impressions in snow.

that provides better contrast. It also enables the removal of the impression from the crime scene to the laboratory. There are many methods and materials for lifting. Electrostatic lifting is a method that utilizes a high-voltage power source to create a static electrical charge that enables the transfer of a **dry origin impression** from the surface to a special black lifting film. A person walking across carpet or other dusty surfaces who then steps on a cleaner surface, such as paper or a tile floor, will create dry origin impressions on those surfaces. These impressions can be electrostatically lifted. Electrostatic lifting is normally used first, since it is often unknown if the impression was of a dry or **wet origin**. Should the electrostatic lift be unsuccessful, the evidence will not be harmed, and other lifting or enhancement methods can still be used. Figure 18.5 depicts the value of electrostatic lifting. On the top of Figure 18.5 is a paper folder containing some dry-origin dust impressions. On the bottom is the electrostatic lift of those impressions on the black lifting film. The increased contrast provided by the electrostatic lift allows for the visualization of much greater detail, and thus a more productive examination. Electrostatic lifts are fragile. They must be stored properly and must be photographed before they can be fully utilized in an examination.

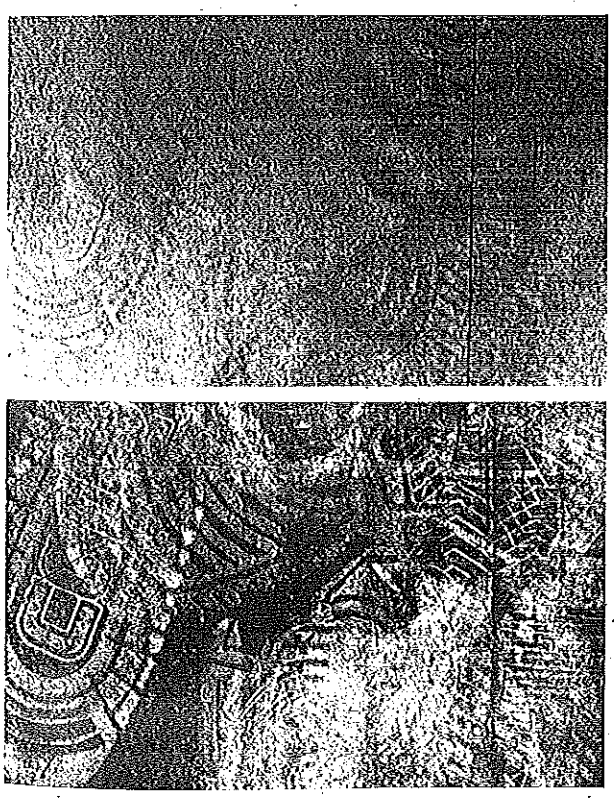

*Figure 18.5* The top photograph is a high-contrast photograph of shoe impressions on a folder. The bottom is a photograph of the impression on the black lifting film after it has been electrostatically lifted. Electrostatic lifting not only increases contrast but reveals dry-origin latent shoe impressions on evidence and floor surfaces that may have been walked over.

If an impression will not lift with the electrostatic method, the impression is either a wet-origin impression or is composed of other materials that have bonded to the surface. In some cases, fingerprint powder can be used to enhance the impression. If the lift is successful, the impression should be rephotographed and then lifted with a gelatin or adhesive lifter or with Mikrosil®. Mikrosil comes in either white or black. Unlike adhesive and gelatin lifters, Mikrosil lifts the entire powdered impression, making it a very important choice for impressions that have been developed with fingerprint powder but are still very faint. Whatever lifting material is used, it should be of a color that provides good contrast with the color of the fingerprint powder.

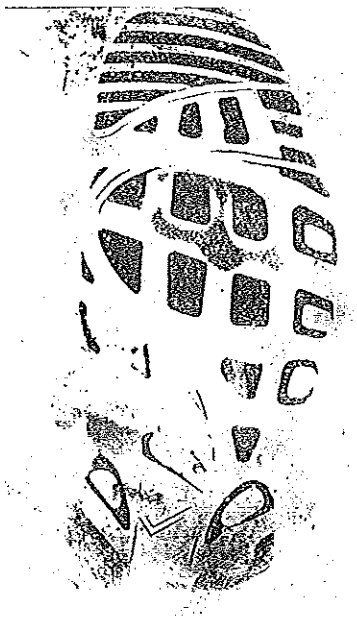

*Figure 18.6* A white adhesive lift is one method of lifting a shoe impression that has been enhanced with black fingerprint powder on a nonporous surface.

For instance, a white adhesive lift of a black-powdered impression, such as that pictured in Figure 18.6, provides excellent contrast. If the powder were gray or silver, a black gelatin lift would provide the best contrast. Transparent gelatin and transparent adhesive lifters are not recommended because they do not provide sufficient contrast with the impression or powder.

### Three-Dimensional Impressions

All three-dimensional impressions should be cast with **dental stone**. Dental stone, like plaster, is a gypsum product. But dental stones, unlike softer plasters, set much harder and have a higher compressive strength and provide a quicker and easier way to recover impressions. Dental stones having a compressive strength of around 8000 pounds per square inch or greater are sufficiently hard to be cleaner without loss of detail. Although dental stone can be mixed in a bucket, it has become more popular to prepare and have on hand several ziplock bags of dental stone in 2-pound portions. The proper amount of water for the 2-pound portion can then be added to the bag at the crime scene. A dental stone having a consistency of 30 and a compressive strength of 8000 pounds per square inch requires approximately 9.5 ounces of water. The exact amount of water will depend on the powder-to-water ratio on the product information sheet. The water and powder should be mixed in the ziplock bag for a minimum of 3 minutes. The casting material can be carefully poured next to the impression and allowed to flow quickly into the impression. The dental stone material will harden in approximately 20 minutes, after which it can be lifted and placed where it can dry further. In 24 to 48 hours, after all of the water inside the cast has evaporated, the cast becomes fully hardened and then is safe to clean by immersing it in water and using a soft brush to remove the soil. Figure 18.7 depicts a dental stone cast of the impression featured in Figure 18.3 and a picture of the shoe suspected of making it. Impressions in snow can also be cast with special methods and materials.

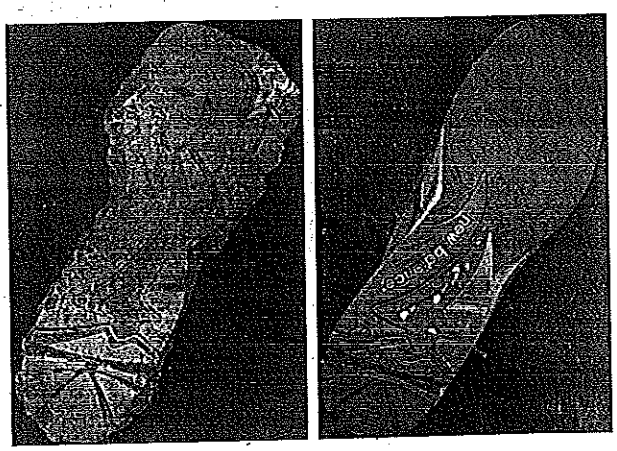

*Figure 18.7* A cast of impression #7 in Figure 18.3 recovers the three-dimensional information in excellent detail. A cast should *always* be made after three-dimensional impressions are photographed. Alongside the cast is the suspect shoe.

## Enhancement Methods

Many crime scene impressions are indistinct, have poor contrast with the surfaces they are on, or are altogether invisible. There are several ways to develop and enhance these impressions, thus providing more detail for later examination. Some of these methods reveal latent footwear impressions that would otherwise go undetected. In other instances, visable, yet faint or indistinct, footwear impressions are also improved visually after enhancement.

### Forensic Photographic Methods

Specialized lighting and photographic techniques are nondestructive and, therefore, a good first method of enhancement. The use of oblique light, high contrast, ultraviolet, infrared, and other special photographic methods, as well as equipment, such as alternate light sources, can provide increased contrast and visibility of many impressions.

### Physical Methods

These primarily include various methods of lifting impressions, powdering impressions with fingerprint powder, and detecting indented footwear impressions on paper items.