FOOTWEAR IDENTIFICATION

Michael J. Cassidy

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About the author:

Sergeant Cassidy has been a member of the RCMP for eighteen years having joined the Force in 1962 at Vancouver, B.C. He is presently stationed at Ottawa in the Identification Branch. His keen interest in footwear identification began shortly after his transfer in 1966 to identification duties and continued throughout his next ten year's service as a scene-of-crime examiner at various points in Western Canada. During this time he established that little reference or training material existed on this topic and in l977 he was transferred to Ottawa to research this relatively untapped identification medium. For the next two years he studied various methods and techniques, visited footwear manufacturers, developed training material and presented lectures at conferences, workshops and training courses. This book is the culmination of those efforts.

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Published by the Public Relations Branch
of the Royal Canadian Mounted Police
for "L" Directorate, "HQ" Division,
RCMP, Ottawa, Ontario.
PRB.080

Available in Canada through

Canadian Government Publishing Centre
Supply and Services Canada
Hull, Quebec, Canada K1A 0S9

Catalogue No. JS62-36/1980E Canada: $7.95
ISBN 0-660-10574-8 Other countries: $9.55

Price subject to change without notice.

This book has been written for the Canadian Identification Officer. However, the research, techniques and procedures will no doubt be beneficial to any police officer, forensic laboratory technician, judge, or lawyer interested in footwear identification.

Preface

The value of physical evidence to the criminal investigator has long been recognized. Courts today are often reluctant to accept a suspect's statement even though proper procedures were followed at the time it was taken. More than once an eyewitness has erred when identifying a suspect. Physical evidence, on the other hand, independently corroborates a statement or a witness. On many occasions physical evidence alone has lead to a conviction. Conversely, it has also established innocence.

Footwear impressions are only one form of physical evidence. But considering the number of times a shoe makes contact with another surface, this form of evidence should logically be the most common found. Nevertheless, the location, gathering and examination of this kind of evidence as a means of associating a suspect to a crime has never been fully pursued in Canada.

The Royal Canadian Mounted Police, which trains identification technicians for the RCMP as well as many other Canadian police agencies, recognized the need to research this medium and in 1977 I was given the opportunity to begin this formidable task.

Notwithstanding the fact that considerable literature dealing with fingerprints, hair, blood, handwriting, firearms and the like has been written, it soon became abundantly clear that little had been produced on footwear impressions. Much research was required, and various techniques had to be tested to find the ones most suitable to this subject. I have, therefore, attempted to present this information in a sequential fashion, i.e., the crime scene; identification problems and requirements; footwear, and, lastly, court presentation.

In a number of areas where I have conducted experiments, the manner in which they were performed are described, as are the results. Hopefully this information, supported by numerous photographic illustrations, will be easily understood and allow readers to draw their own conclusions.

Realizing the scene-of-crime examiner cannot afford to wait two or three hours for casts to set, I have mentioned only those methods of casting three-dimensional footwear impressions which, through experimentation, I have found to set quickly and produce successful results. Other equally good methods no doubt exist and I leave it to you to experiment and use whichever works best for you.

The potential of footwear evidence is not being fully exploited. If the information presented in this book prompts crime-scene examiners, investigators, police identification specialists and the courts to recognize the significant impact this long overlooked but important form of physical evidence can have on identifying criminals and solving crimes — then my efforts will not have been in vain.

Contents

Acknowledgements

An undertaking such as this book requires the assistance of many people and while I would like to express my gratitude to everyone who helped, in any way, to do so would require a separate chapter. I will restrict myself then, to mentioning only those without whose support, advice and co-operation this work could not have been completed.

I am deeply grateful to the Commissioner and senior officers of the Royal Canadian Mounted Police who provided the opportunity and resources necessary to conduct the required research.

I am indebted to Dr. Norman Gunn, D.P.M. (Podiatrist) for providing much information about the human foot and for taking the time from his busy schedule to ensure it was correctly interpreted.

My thanks go also for the time, patience and co-operation extended by the Canadian Footwear Industry, especially Bata Industries Ltd., American Biltrite (Canada) Ltd., Baron Rubber Ltd. and Miner Company Ltd. More specifically, perhaps, I thank Mr. G. DeBruyn of Bata Industries Ltd. Footwear Division, for confirming the accuracy of much of the detail contained in chapter four relating to footwear construction.

I am grateful as well for the assistance given by the many Canadian identification officers who, by sending in samples of actual case work, kept me in touch with reality; Garry Saunders of the RCMP Gazette Section who on his own initiative took my ramblings and made them readable; Mrs. Barbara Erwin for such an efficient job of typing and retyping my notes — always with a smile; our legal branch for their guidance and advice; and last, but of no less importance, I thank Chief Superintendent C.D. (Chris) Tiller. Without his encouragement and continual support, this book would probably not have become a reality.

Chapter 1

Scenes-of-crime examination

Footwear identification begins with the examination of the scene. In Canada, this responsibility normally falls on the "Identification Officer". His role in the police operation is basically to identify fingerprints, conduct physical comparisons, examine crime scenes, take police photographs and prepare plan drawings. Crime scene examination and locating fingerprint evidence is his prime concern. Other duties, however, also play an important part in his day-to-day function. Although this book deals with footwear evidence, this chapter will cover the crime scene examination in more general terms.

In many countries or cities the investigating officer carries out the scene examination. Any form of physical or fingerprint evidence found is turned over to a forensic laboratory or fingerprint bureau for further study. Very serious offences may see forensic laboratory personnel dispatched to the scene. Some police forces train people who specialize in only one phase of identification work; for example: photography, fingerprint examination or plan drawing. This necessitates sending a team of technicians to the scene when a crime is reported.

In Canada, the most practical approach is to train one person in all the various phases mentioned. This evolved no doubt, because of our vast geographic area and relatively small population. Most city and provincial police forces in Canada have adopted this procedure. Evidence requiring chemical or microscopic analysis is forwarded to regionally located forensic laboratories for further examination.

The identification officer should be a trained police officer with general duty experience. A good knowledge of general police procedure is essential. It provides the necessary background to conduct a proper examination of the many varied types of crime scenes encountered. The officer will also understand what kind of evidence is required for court purposes. Not all police officers are necessarily cut out to be scenes-of-crime examiners, just as they are not all suited to plainclothes or traffic detail. The preliminary years as a general duty officer will permit departments to assess those necessary qualities required. These should include good work habits, perceptive abilities, patience, thoroughness, inquisitiveness, integrity and so on.

The success of a scene examination starts when the complainant contacts someone in authority. This may be a receptionist at the police station or a peace officer. Regardless of who it is, this person can hold the key to success. The victim, witness or complainant must be advised to refrain from handling anything or walking around the area and above all to keep others away. This is often difficult.

In crimes of violence, where injuries may be involved, the role of the first police officer dispatched to the scene is to protect life. On arrival however, care should be taken to guard against destroying evidence which will be important later. Once realizing that the support of an identification officer is required, arrangements should be made, in any investigation, to protect the scene until he or she arrives. Too often valuable evidence is rendered unsuitable because the first officer on the scene does not properly protect the area or, through carelessness, destroys the evidence.

An important function of identification officers in their day-to-day contact with general duty personnel is to upgrade their awareness on the potential value of the crime scene. This in no way suggests that police in general are incompetent, rather, acknowledges the fact they have many varied functions to carry out daily. In many of the larger centres the first officer on the scene may be a beat or patrol officer who in turn calls in the detectives. In smaller centres investigation responsibility may fall upon the first officer there who may or may not be experienced in criminal investigation.

Response time to any scene can be crucial. Delay could mean the difference between locating incriminating evidence and finding nothing. Destruction of evidence by spectators, vehicular traffic, police personnel or weather conditions increases with time. Urban and rural jurisdictions present their own problems. Urban officers may be faced with a large number of calls in one day. The rural officer may be required to travel hundreds of miles to one scene. Emphasis should be placed on getting there quickly.

Dress

Upon arrival, you, the identification officer, should conduct your job in a methodical and chronological order. Wear suitable clothing; for example: coveralls, warm garments in cold weather etc., before you start. This may seem like a small point, but a person who is afraid of getting dirty or is too hot or cold will not be in the proper frame of mind to tackle the difficult job a crime scene examination entails.

Notes

Date, time, weather conditions and personnel present should be jotted down and form the beginning of your notes. This is probably one of the more important phases. You might be called upon to give evidence on this case six months or a year later. How can you remember all the detailed facts related to the case? What was the weather like prior to the offence? Was the shoe impression fresh? In which direction was it pointing? How did it relate to the crime? These and many other questions can be extremely important. A good scenes-of-crime examiner knows what is important and the types of questions he may be asked in court.

Too often we rely on photographs taken of the scene as notes. They can be of great value but in no way can they replace good notes. The use of a good quality portable tape recorder for note taking, including sketch measurements, at more serious or more complex investigations cannot be over-stressed. More complete and accurate notes can be taken down with a minimum of inconvenience particularly under adverse weather conditions. The real problem of looking at 9.8

feet on a tape measure and writing down 8.9 feet in your notes will be eliminated. (*Caution: Be sure your recorder has strong batteries before you start and periodically check the machine to ensure it is working properly. Carry a spare set of batteries as a precaution*.) The tape should be transcribed by a competent person then checked by yourself for any discrepancies. Each page should be initialled and dated as it is checked for court use. (Check with your local crown prosecutor on this procedure first).

Briefing

Get together with the investigator as soon as you arrive at the scene. He or she is usually in the best position to give a complete outline of events. At the same time ask what he or she would like you to do. This is also a good opportunity to question any witnesses or victims if they are present. They may be in a position to give you valuable information: "There was no paper on the floor prior to the offence" — "Nobody uses that door" — "The shoeprint in the flower bed was not there this afternoon" — "That window has been locked for months". Many of these questions asked by the scenes-of-crime examiner might not be asked by the investigator.

Walk through

After a briefing from the investigator you should carefully walk through the crime scene. This must be done cautiously, taking care not to alter or destroy any evidence. If witnesses accompany you they should be advised not to handle anything and to follow in your steps. You will probably have to remind them of this more than once as they have a tendency to forget and touch exhibits.

"Yes the paper was pulled from this drawer", with that they bend over and pick up the exhibit, possibly destroying any evidence; or they walk through the paper or glass lying on the floor, leaving their shoe impressions everywhere.

The walk through gives you the opportunity to work out a system for your examination. Normally this would follow chronologically, similar to the way in which the criminal travelled. Outside areas would be examined first to prevent erosion from weather etc. In a store you may sometimes want to complete the area accessible to the public first, preventing any hardship to the owner. The method of examining each case will be determined on its own merits.

Photography

Some examiners photograph the scene during the walk through. I personally prefer to wait until I have viewed the entire scene, then photograph all areas that are connected to the case. Photographs serve two purposes:

1. They permit the court to view the scene recorded at that moment in time. For this reason everything photographed should be in its original position. The courts will otherwise not permit the photograph to be entered as evidence. (The criteria for acceptability is: "the photograph must be an accurate representation of what you saw".)
2. They refresh not only your memory, but that of the witnesses as well.

Photographs of specific items important to the investigation but which may be removed subsequently as exhibits, should also be taken during the examination. This may depict an area with a series of shoeprints. Subsequent photographs may isolate a specific shoe impression. Other exhibits revealing fingerprints or other physical evidence, should be treated similarly.

Scene examination and evidence gathering

The examination of a scene requires you to call upon all your experience, shrewdness, initiative, knowledge, ingenuity, perceptive abilities and other traits acquired during your career. By backtracking steps in snow or dirt you may locate an excellent impression one or two hundred yards from the scene. This could link the culprit to the crime as long as track continuity is maintained. The best three-dimensional footwear impressions are often located where the culprit stood in one area and left a number of clear impressions. This may be at the point of entry or further away where he stood while building up his courage to carry out the offence. The track may, in fact, lead to the culprit or to hidden stolen articles.

I recall one case where two individuals approached a house at night on an Indian reservation. They positioned themselves in a clump of trees approximately 150 feet from the kitchen window and opened fire on a number of people sitting around a table in the kitchen. Two occupants were seriously wounded. There were no eyewitnesses to the event. Investigators removed the injured first and then secured the area. A couple of suspects were immediately arrested.

When I arrived at the scene, the area had been well preserved. The suspects' footwear was in our possession and we were able to locate a fresh trail in snow leading up to a clump of trees in line with the kitchen window. Expended shell casings were found lying on top of the deep snow along with definite traces of at least two persons; one wearing cowboy boots and the other sneakers. These impressions were followed for approximately 200 yards in deep snow, out to the edge of a municipal road where better impressions of the sneaker were located. Although this evidence was not suitable for positive identification, it went a long way in placing the culprits at the scene. Footwear impressions in this instance led to the shell cases which were later matched to the culprits' weapons. Had the first investigators wandered around the area in the dark, we might never have found the exact spot from where the shots were fired, retrieved the expended casings, or located the footwear impressions. It is doubtful a conviction would have been obtained without this evidence.

The experienced crime scene examiner learns to recognize items that appear to be out of place. Responsibility does not end with just a fingerprint examination. Hair, blood, paint chips, fibres, footwear or tire impressions, combustible material, matches and many other forms of physical evidence may also prove valuable in solving the crime. In many of these areas you must have an appreciation of their importance and what the forensic examination can reveal, as you are acting as an extension of the laboratory.

In one indecent assault offence, the victim was a young girl, nine years old, who did not get a good look at the suspect because it was too dark. Investigators had a suspect in custody. Footwear impressions, although not suitable for identification, suggested the investigators had the right person. The offence had taken place in a small shed. Upon opening the door the first thing visible was a

burnt match on the wooden floor. Examination of the area revealed a number of fibres similar in colour to those on an old mop in the corner, samples of which were taken for control purposes. A search of the suspect's residence turned up a shirt with similar foreign fibres adhering to it. A book of matches was also found in the pocket of a pair of pants which were in his bedroom. The fibres and the match, along with the clothing and the match book, were sent to the crime detection laboratory. The laboratory technician was able to state the match came from the match book. The foreign fibres on the shirt were similar in material and colour to the mop head, which in itself was not too significant. However, rodent hairs were located in control samples removed from the mop. Obviously, a mouse had made a nest there. The same type of hair was also located on a fibre removed from the suspect's shirt. He tried to circumvent the evidence by accusing another occupant of the house where he lived. Although this person had a similar shoe style, they were not the same size and could not have made the impressions at the scene. The evidence gathered at the scene corroborated the girls statement and eventually a conviction was obtained.

Only one individual should collect laboratory exhibits. Police department policy and circumstances surrounding a particular investigation will generally determine who does this. This procedure eliminates continuity problems when the time comes to have exhibits entered as court evidence. It also reduces the number of witnesses required.

Measurements

This phase of scenes-of-crime examination should follow evidence gathering. This will prevent accidental obliteration and you will be sure all pertinent information is recorded. Many forms of physical evidence; blood, hair, semen, shell casings and so on, will be put into perspective with the help of a floor plan. This type of evidence should be retrieved during the initial examination and the areas identified using number blocks, spray paint, marking pencils and so on. The area can then be rephotographed including the marking devices, which can then be related to your notes.

Some crime scenes such as rape, murder, armed robbery and automobile accidents, require more than photographs to be properly recorded. The preparation of a scale plan drawing brings out one more dimension which will assist the court and witnesses. Some scenes cover large areas which could not be properly photographed. Automobile accidents in many cases depend on accurate plan drawings to determine culpability.

Debriefing

The scene investigation should end with an informal debriefing of all investigators present. This is a good time to advise the person in charge what areas have been covered, the various forms of evidence located and what follow-up work will be required. The importance of the evidence found should also be discussed.

Don't be afraid to ask the investigator if there is anything you may have overlooked. More than once I have been asked to check out something I missed and obtained the culprits footprints or fingerprints. The investigator will also

become actively involved with a part of your job, which can prove beneficial to him when he is conducting his investigation. He becomes very aware of the physical evidence he has to back up the word of witnesses or the victim.

Summary

Examination of a crime scene is a very specialized part of criminal investigation. The criminal in all likelihood will leave some form of evidence behind. By getting to the scene as quickly as possible and in the right frame of mind, your chances of locating evidence increase. Although every crime scene is different, your chances of error will be reduced by applying a similar examination methodology.

The successful scenes-of-crime examiner continually asks himself questions and looks for answers. "If the shot was fired here, the expended casing should be there". "If he crawled through the window, he would grab the window frame like this". "Shoeprints should be on the top surface of the broken window glass".

Although this book deals specifically with footwear evidence, do not overlook anything when examining the scene. No piece of evidence is too insignificant.

The successful conclusion to any case is seldom the result of one person's efforts. The statement of confession may require corroborative evidence from a laboratory witness.

Fingerprints are usually identified as a result of diligence on the part of the investigator. All steps in the judicial process can be viewed as a chain. You are but one link in that chain and not necessarily the most important one. Your responsibility is to ensure your link does not break.

Chapter 2

Three-dimensional footwear impressions

A three-dimensional impression is defined by three separate measurements: length, width and depth. These are usually located outdoors in surfaces such as sand, clay, mud, or snow. They can sometimes also be found indoors in flour, sugar, dust, fire extinguisher propellant, etc. The three-dimensional impression, in most cases, is used as an investigational aid and as corroborative evidence when size, shape and pattern design agree. Most police forces in Canada rely on photography to record this type of evidence. Small and medium format cameras are gradually taking over from the larger 4 x 5 press model. When available, colour is replacing black and white film.

Over the past twenty-five to thirty years, making casts has all but disappeared in this country as a method for reproducing three-dimensional impressions. Most scenes-of-crime examiners think photography is better, easier, and quicker. Many believe there is little in three-dimensional impressions that justifies the extra effort involved in making casts.

From my own experience there are those who would on occasion have liked to have made a cast but, because they were never taught how and didn't want to appear incompetent if unsuccessful, took a photograph instead, telling the investigator a cast would serve no useful purpose.

Time taken to prepare a cast is minimal, up to 30 minutes at most. The main secret of success is to have a handy well stocked kit prepared in advance. The number of accidental characteristics recorded in the three-dimensional impression will surprise you.

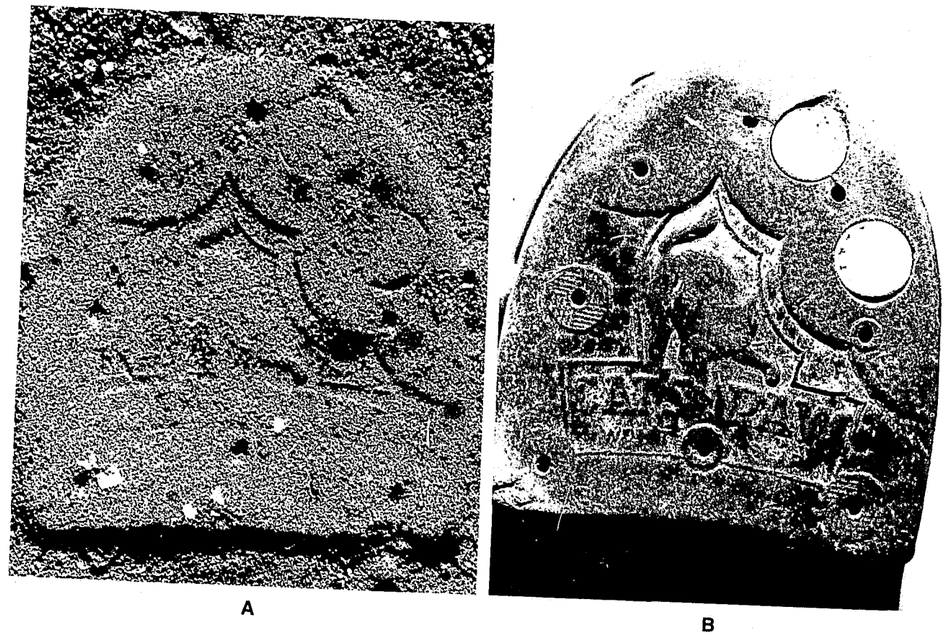
Figure 1-2 is an example of a good impression located in dry sand with the suspect boot beside it. How many accidental characteristics can you see?

Figure 2-2 is a cast taken from this sand impression and the suspect boot. Six accidental characteristics are illustrated.

Dry powdery sand, such as this, is a poor quality type of soil for identification purposes. Gravel or very coarse sand will unlikely reproduce suitable impressions. Garden soil is good, and damp or wet clay is excellent.

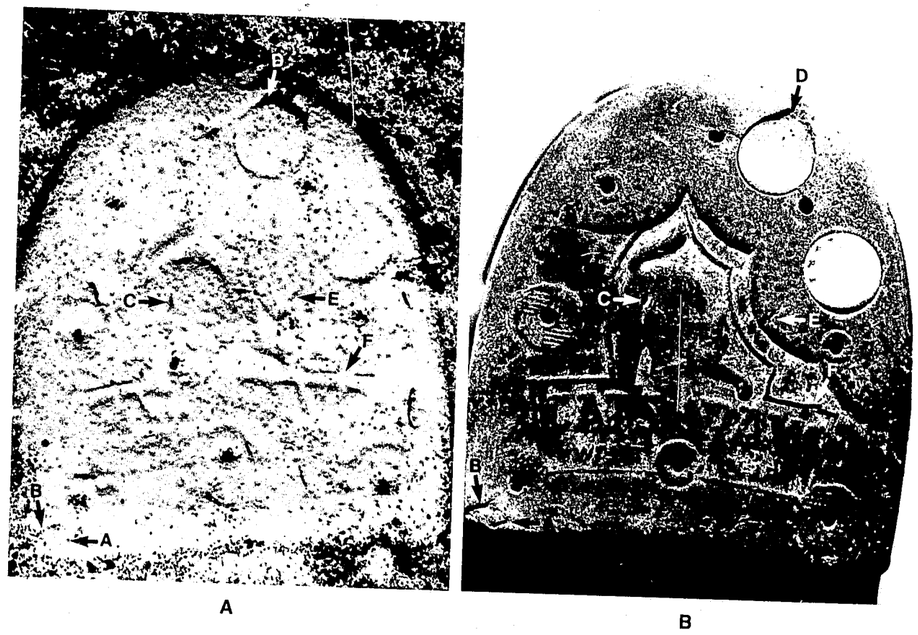
Look at Figure 3-2, which is a rubber overboot impression located in wet clay. There are many areas in the country with this type of soil. Do you feel there is much chance of identifying it? Figure 4-2 shows the same impression and the suspect boot. Can you locate areas of agreement?

Now let's look at Figure 5-2. This time we will compare one small area in the heel to a cast of the impression. The area of concern has been enlarged using a low power microscope. Sufficient agreement of accidental characteristics exist in this one small area alone to warrant positive identification.



A B

FIGURE 1-2: A) Impression in dry sand. B) Suspect's boot. How many accidental characteristics can you see?



A B

FIGURE 2-2: A) Cast of sand impression. B) Suspect Boot. Six accidental characteristics illustrated.

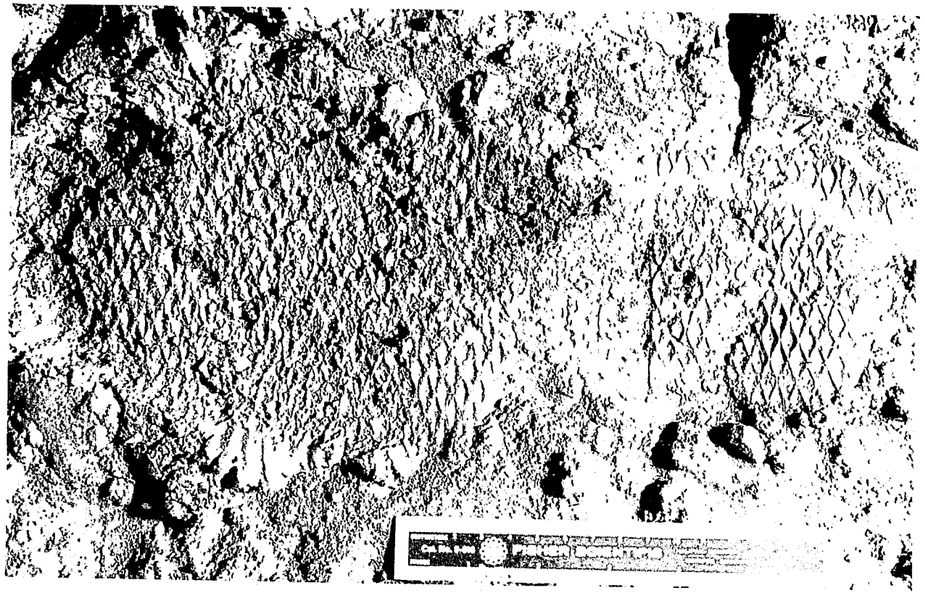
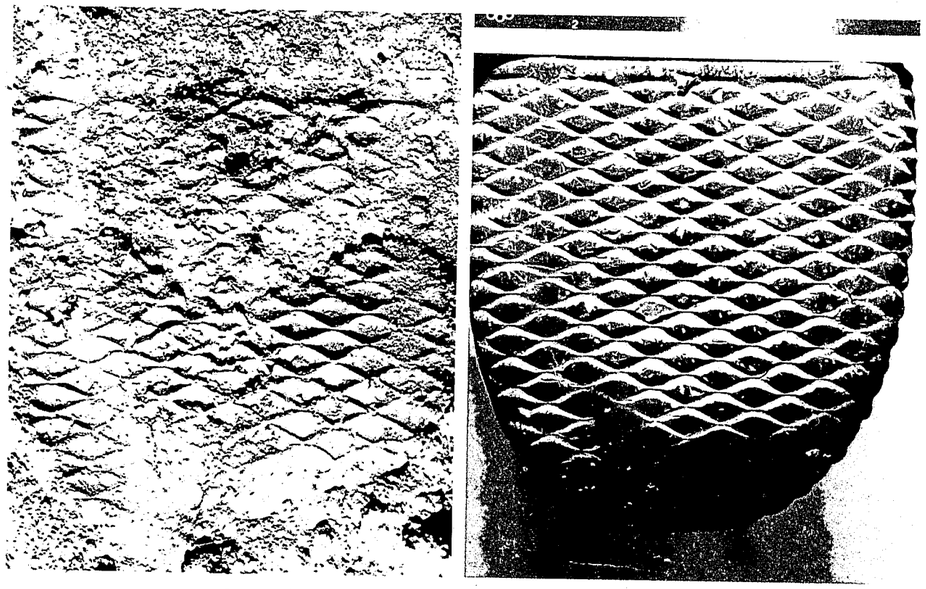
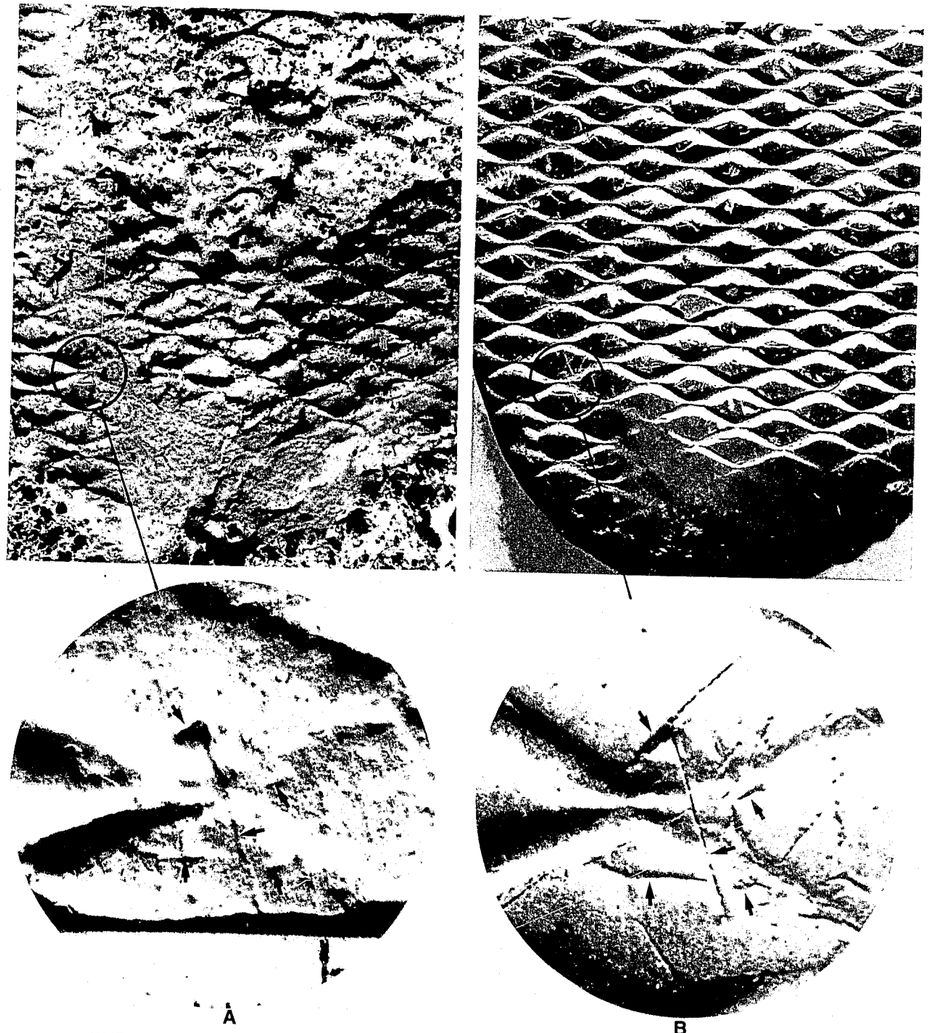


FIGURE 3-2: Footwear impression in wet clay. What value is it?



A B

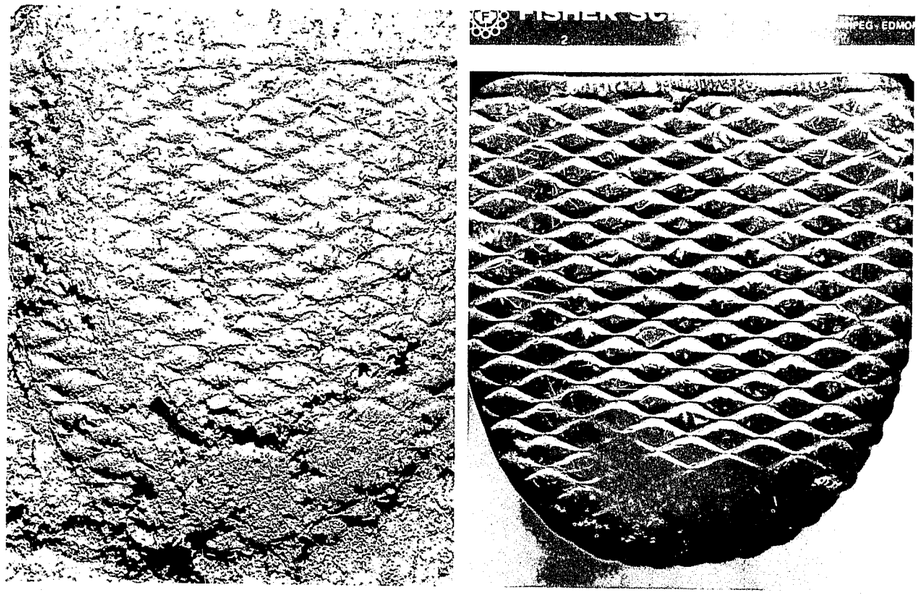
FIGURE 4-2: A) Heel area of figure 3-2. B) Suspect's boot. Can you locate areas of agreement?



A B

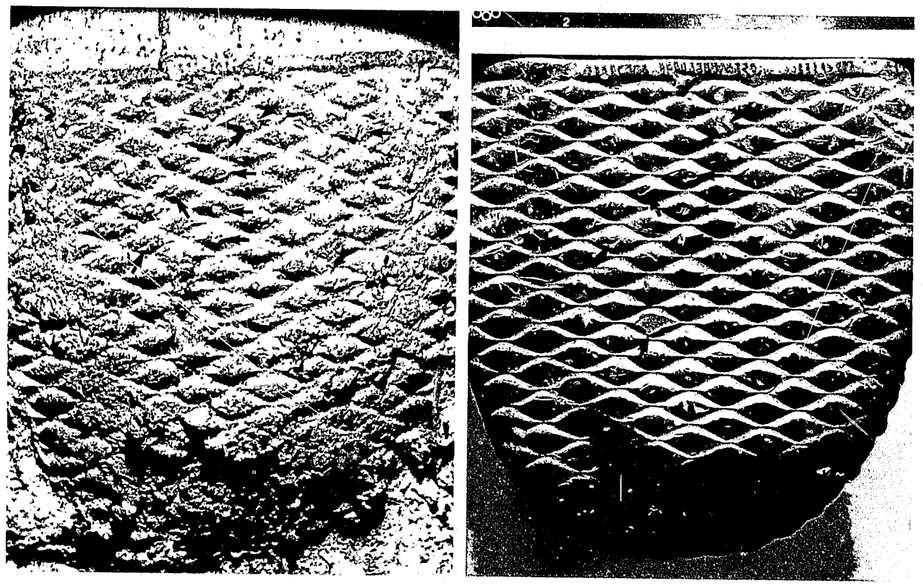
FIGURE 5-2: A) Cast of mud impression. B) Suspect's boot. Small area examined under low power microscope.

A further example is an impression in damp clay. It is hard to detect accidental characteristics on initial examination of the photographs in Figure 6-2. Figure 7-2 depicts a cast made from the same impression with areas of agreement marked out.



A B

FIGURE 6-2: A) Impression in damp clay. B) Suspect boot. What value is this impression?



A B

FIGURE 7-2: Same impression as 6-2 cast. Nine areas of agreement.

Not every footwear impression you locate should be cast. First you must with some accuracy be able to substantiate that the print belongs to the crime. This can often be established by the location alone, e.g., footsteps leading to the point of entry, or prints in an isolated area where the offence was committed. On many occasions, the investigator will have a suspect in custody and is looking for evidence to prove or disprove his presence at the crime scene. Once satisfied the print is related to the crime, you should determine whether soil conditions are conducive to good casting. In other words, there is not much sense in casting on a gravel road.

Many identification officers believe a cut or scar must be quite large before it can be reproduced. From numerous tests I have conducted this is not so. As you can see from previous illustrations, some marks are really quite small.

A study of 70 shoes photographed from persons arrested in a small Ontario city showed 43 percent had accidental characteristics which would probably record well in dirt or snow. Seventy-five percent of the shoes had a significant amount of wear which would be valuable when establishing a three-dimensional identification. The point is that the chance of a criminal's shoes leaving impressions suitable for identification is good. A person who leads an active criminal existence and who breaks windows during forced entry will have numerous cuts on his soles and heels caused from the glass.

Photography

Photographs should always be taken prior to casting. Large format cameras do a better job than small format equipment. Many photographers would argue this point, contending that a 35mm can do the job equally well.

A survey of police personnel in Canada indicated that the quality of 35mm photographs was poor. The primary faults were poor focus and bad lighting. The convenience and handling ease of a 35mm camera enables impressions to be photographed without a tripod. However, it becomes very awkward to hold a camera in one hand, direct the flash with the other, and still press the shutter release button. Many photographs taken today are in colour which may mean the police investigator will not get a copy for a period of two days to three weeks, depending on film processing time. If 4 x 5 camera equipment is available, the simple insert of a "polaroid" back gives you an excellent "polaroid" camera. With this equipment you know when lighting and focus are properly adjusted. An added advantage: the investigator gets immediate copies. Once the impression has been properly photographed the polaroid back can be removed and replaced with sheet film which then becomes your copy. Basic rules of photography apply when taking these impressions. Film plane and lens should be parallel to the impression. Be sure to include a scale ruler in the photograph. If you decide the impression should be cast, you should still take proper photographs of the impression first.

These photographs are used in conjunction with the cast when making an identification. They are of great assistance when determining whether a particular mark in the cast was accidental or caused by some foreign material such as rocks, twigs, etc.

Two photographs, with and without flash, should be taken in daylight. Use a flashlight to determine proper flash angle in low light conditions. We can see three-dimensional impressions because of shadows created by the raised portion

in the pattern. In a shoe print, the area normally coming into contact with the ground will probably retain accidental characteristics. It is "this" area that falls within the shadows of the photograph. (See Figure 8-2). (The use of a white deflector card can improve the shadow area by as much as one full shutter stop by redirecting some of the light.)

When examining a photograph of a three-dimensional shoe impression, you are normally looking at the negative image of the shoe. This makes it very difficult to view the area where characteristics will appear. Even experienced examiners find difficulty in discerning what the actual object will finally look like, except for very simple pattern designs. A phenomenon which often occurs in photographs of this kind is the inversion effect or the way an indented image becomes raised. (See Figure 9-2.)

The mind interprets the light as coming from the same direction. This creates an illusion. One impression appears indented and the other raised. The same effect can be created by staring at a photograph for a few seconds then turning it 180°. It does not always work but in most cases it will. You'll find it much easier to examine a shoe impression from a photograph when you have created a positive or raised image. Also, accidental characteristics in the impression are easy to visualize in a raised image. A word of caution: *any measurements of size or accidental characteristic positioning should be obtained from a photograph depicting the impression as an indented image — otherwise a false measurement may result.*

Stereoscopic photographs

Normally a photograph is viewed in two dimensions which consitutes a main disadvantage. With very little effort, footwear impressions can also be photographed to give a three-dimensional appearance. The third dimension is partially created when both eyes view an object from a slightly different perspective. By taking two photographs of one impression from lateral points two to six inches apart, and then viewing the two pictures approximately 60-65mm apart with the aid of two fingerprint glasses or a stereoscopic viewer, the impressions will take on the third dimension. It takes a little manipulation to line them up properly, but once the two impressions become one, the third dimension will be evident. Employing this simple technique could be useful under certain conditions. It takes little extra work to take the second photograph. Stereoscopic photographs should never replace or substitute casts.

Enhancement of three-dimensional impressions in dirt and snow

A simple but useful method to enhance three-dimensional impressions is to spray them with a contrasting flat paint or powder. Paint in a spraycan or powder in an atomizer can be used. Hold the applicator approximately 3 feet away from the print to start with and apply the paint or powder across the impression until detail is adequately developed. (See Figure 10-2). Care should be taken not to apply too much paint or powder otherwise detail and characteristics will be filled in. Talcum powder can serve two purposes when casting impressions in dirt: it is an excellent

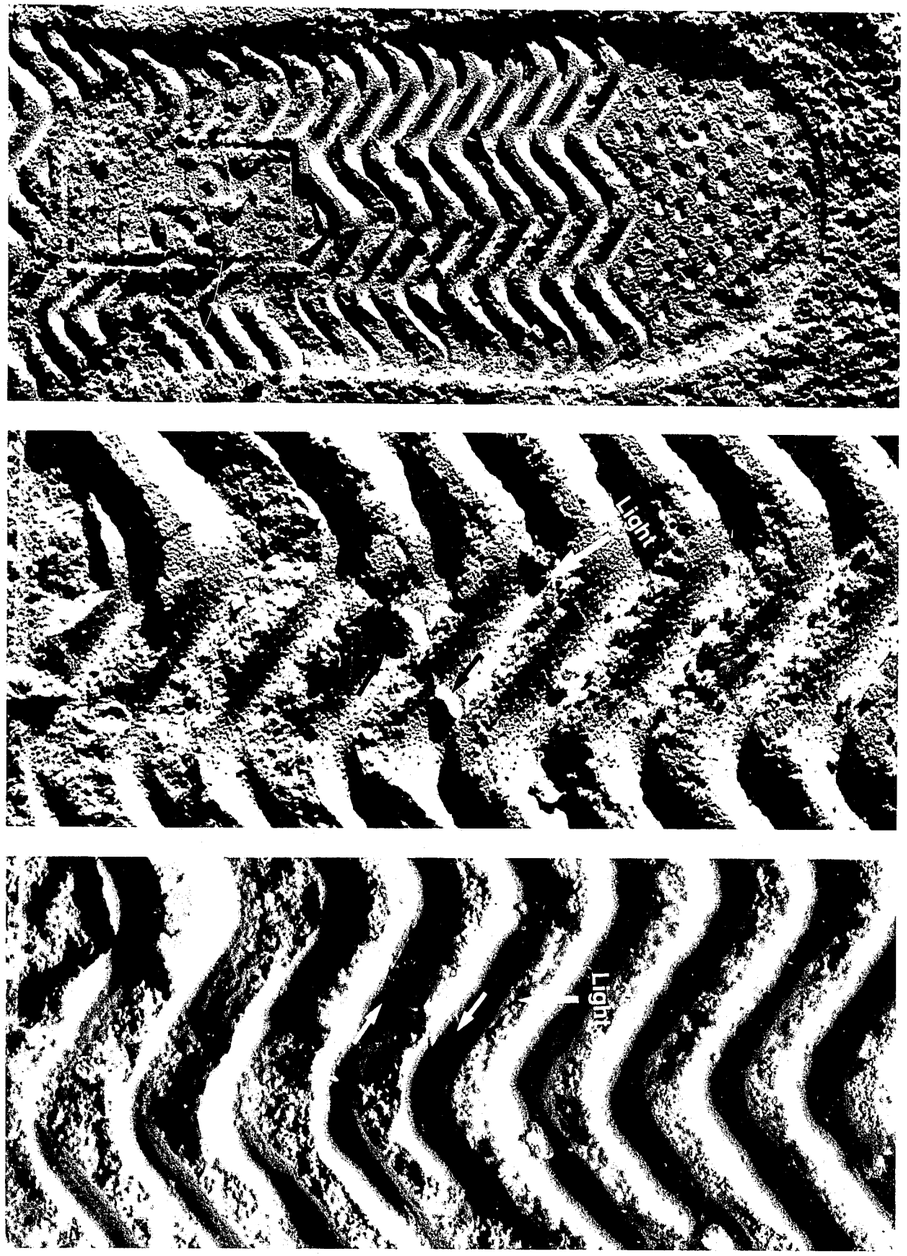


FIGURE 8-2: Two accidental characteristics disappear in shadow area when light direction changes.

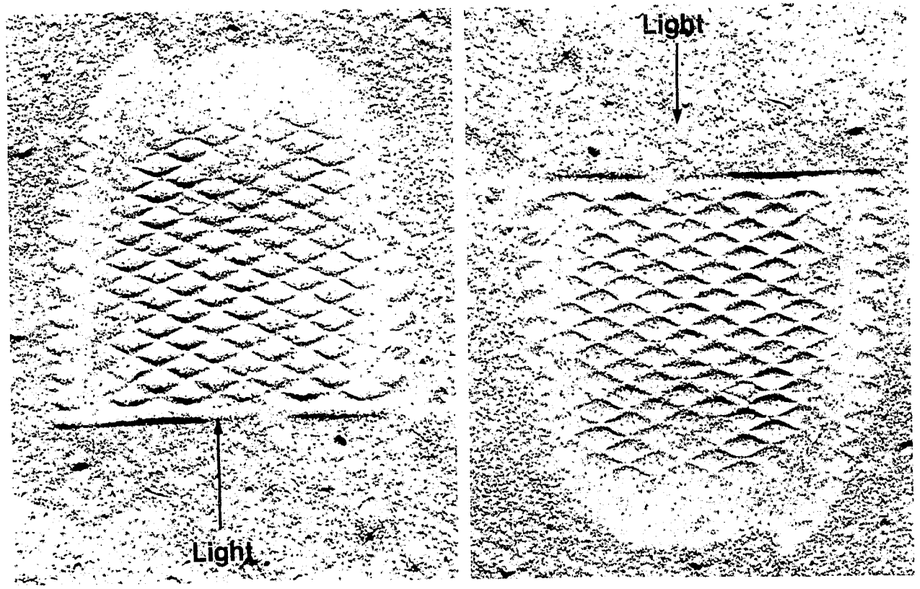
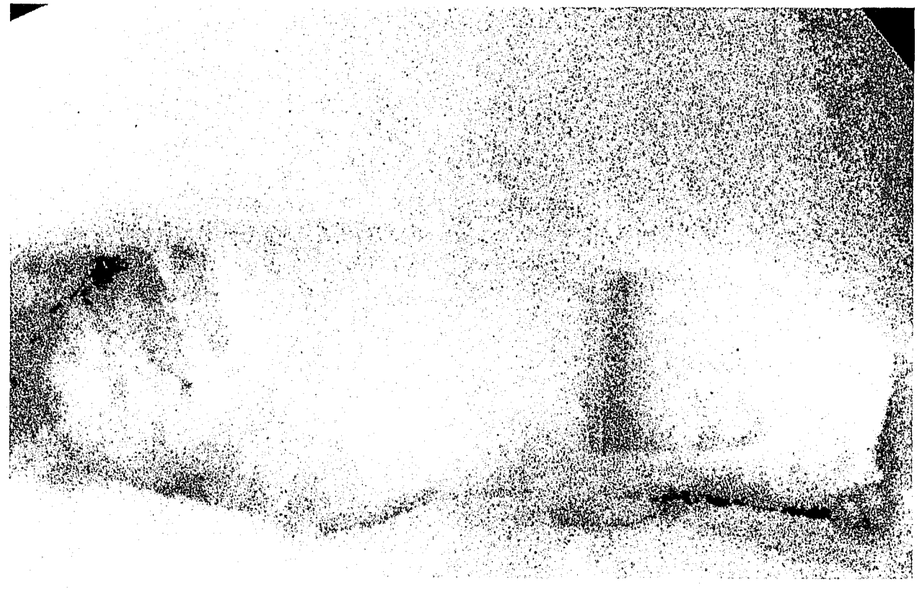


FIGURE 9-2: Inversion phenomenon — identical photographs one turned 180°. One image raised, one indented.



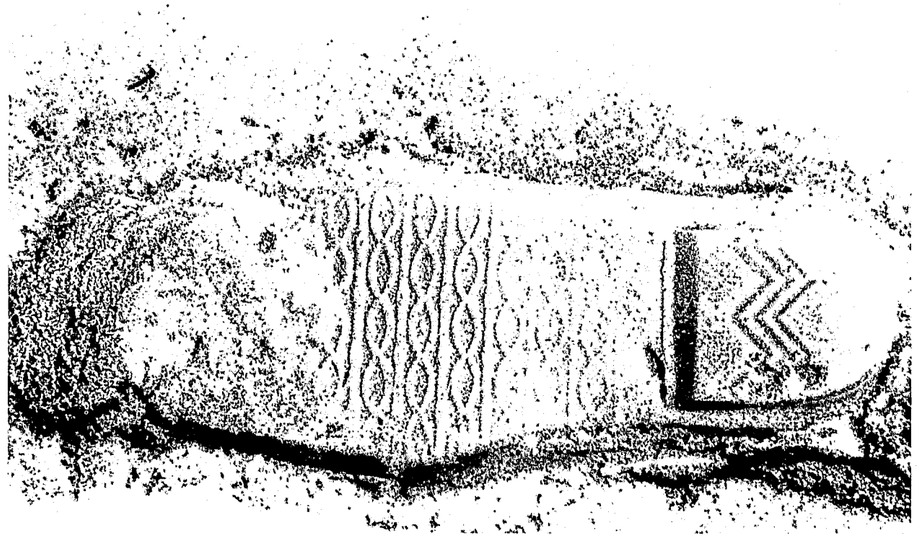


FIGURE 10-2: Impression located in snow before and after applying flat black paint.

release agent while at the same time works well as a means to enhance the impression. Care should also be taken with snow impressions on sunny days when the temperature is near the melting point — the use of black spray paint or powder can cause rapid deterioration as black absorbs the sun's rays. (*Do not spray snow impressions that you are going to cast.*)

Filled-in snow impressions

Impressions in snow frequently will be damaged by particles of snow falling into the impression when the foot is removed; drifting snow after the impression is made; and, a fresh snow fall.

These impressions may be restored to their original state with a compressed air can (used in darkrooms for blowing away dust). Figure 11-2 illustrates one print which had been filled in with light fresh snow and the same impression cleaned out.

Before blasting the impression with air, try it out in the immediate surrounding area first to determine how closely you should start. Remember, in most cases you are starting out with very little evidence, so you have everything to gain. It would be wise to practice before using this method at a crime scene. Be sure not to shake or tip the new can too much, as propellant may be expelled which may damage the fragile print.

Sketches

Recordings of footwear impressions in two or three dimensions should always be supplemented by a sketch depicting pattern design, shape, size, and any observable accidental characteristics. Measurements of total length, heel size, and sole width should also be shown.

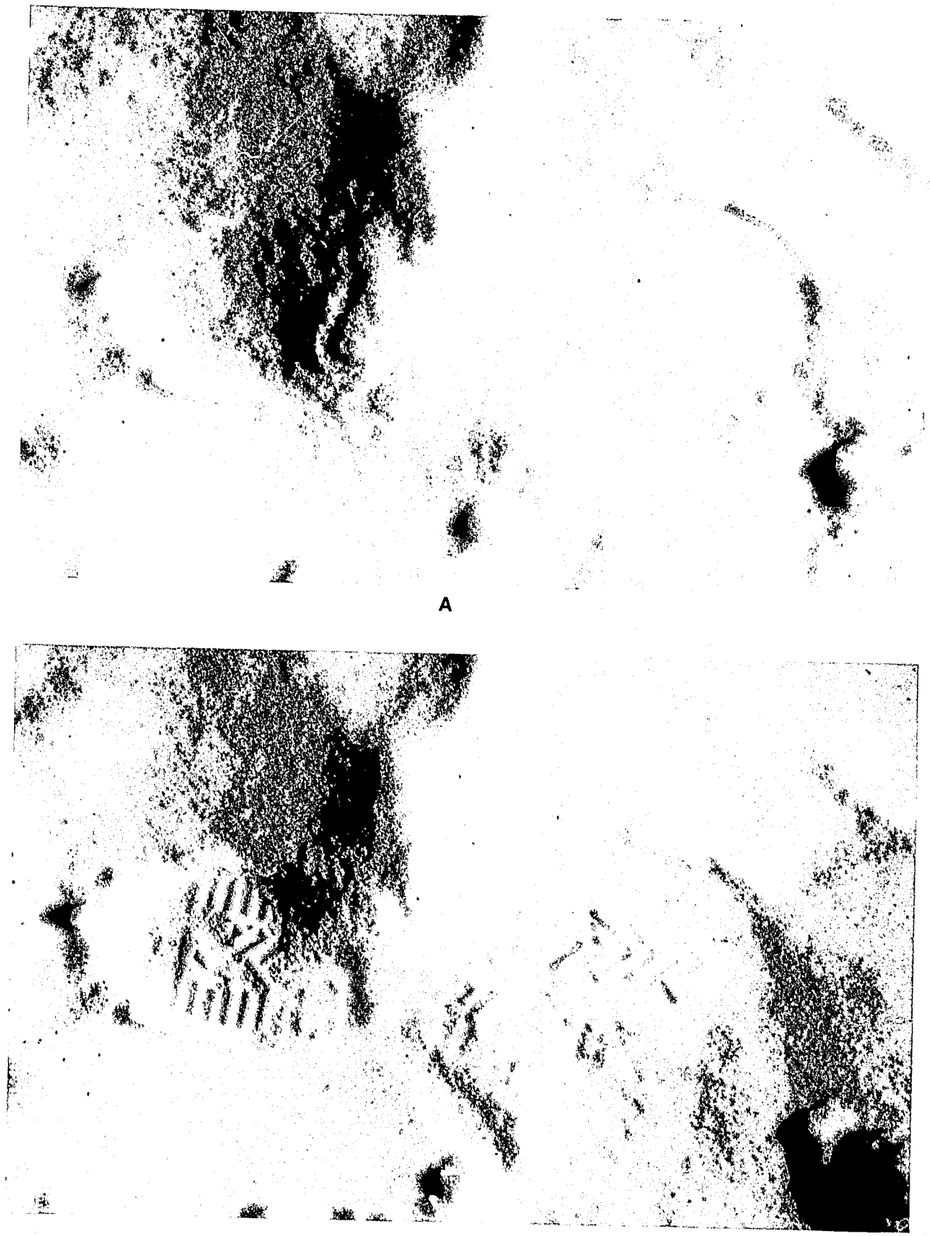
The possibility that your cast and/or photographs may not turn out always exists. The sketch may then be useful as an additional aid, especially if you have not taken a polaroid camera along. Obtaining accurate measurements of the impression at the scene is often more reliable than trying to get this information from a photograph or cast. Shoe impressions can sometimes vary from one impression to another because of shrinkage, expansion or slippage. A number of impressions can be measured and recorded in a sketch for later analysis. Figure 12-2 demonstrates one way of recording this information.

Dental stone casting

Preparing and using dental stone for casting impressions is really quite simple. The secret to any cast-making technique is to have all the necessary equipment and ingredients close at hand. This means carrying them in some form of kit in your vehicle. Appendix I lists the make up of a basic casting kit.

Preparation of impression

The first job after taking photographs is to remove any twigs leaves or stones from the peripheral area which will interfere with the placement of the retainer wall.



A

B

FIGURE 11-2: A) Impression filled in with light snow fall. B) Same impression cleaned with compressed air can.

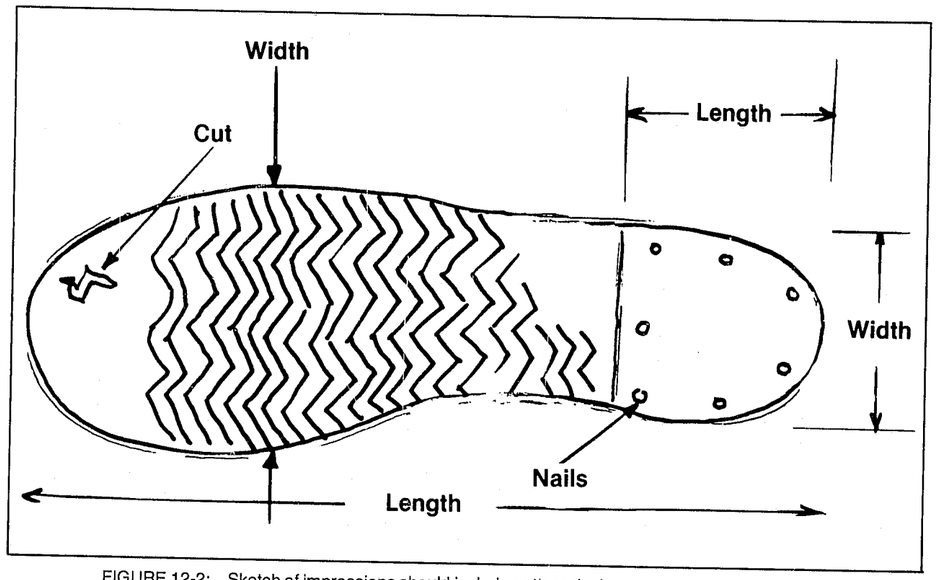


FIGURE 12-2: Sketch of impressions should include pattern design, measurements and unusual markings.

Take out any foreign objects which have blown or fallen into the impression. Do not damage the impression by removing these objects. Remove leaves or stones with tweezers. Blow out smaller objects with an ear syringe. Small bits of dirt and debris can generally be removed by dampening a long handled Q-tip in oil and carefully touching the object.

The impression should now be covered with some form of release agent to allow the dirt to come away from the cast with ease.Various agents from frying pan sprays to oil can be used for this purpose. However, from tests conducted I have found baby powder to be an excellent release agent. It allows easy cast cleaning, strengthens fragile impressions such as dry sand, and prevents damage when pouring the plaster. The talc should be drifted over the impression using a small atomizer or aerosol can plus a deflector card. Apply the talc so the impression is evenly coated. Do not put it on thickly or in lumps as this may cause marks in the cast. This can all be done before photographs are taken.

The next step is to place a retainer wall around the impression. Allow one-half inch of clearance to prevent the sides from caving in when the retainer wall is pushed down. This wall can either be commercially obtained or made from strips of cardboard (bristol board) two inches wide and about eighteen to twenty inches long. If you use cardboard strips, paper clips are excellent for joining them together.

Preparation of plaster

Make sure, prior to mixing the dental stone, that equipment and materials are four to five feet away from the impression in case you upset the mixture. Insert a

plastic bag into the container as a liner. This will make it faster and easier to clean afterwards by simply removing the bag. With the liner in place, pour a volume of water equal to the amount it would take to fill the impression: approximately 25-30 ounces for a full-size shoe impression. Add a teaspoon of potassium sulfate to the water. This speeds up plaster hardening time considerably and permits the cast to be removed within 15 minutes, regardless of temperature. Without it you might waste 30 to 60 minutes before the cast is strong enough to be removed. Ordinary house salt can also be used to speed setting time but this is not recommended. It considerably weakens the cast's tensile strength. Accurate measuring devices to determine proportions of plaster to water are unnecessary.

Sprinkle the plaster over the water surface slowly, allowing it to settle before adding more. The plaster thus becomes properly saturated. Repeat until the plaster cones out of the water and is no longer submerged.

Do not stir the mixture until this point is reached. Once the plaster is coned begin stirring the mixture for about one minute. Air bubbles in the plaster can be brought to the surface by gently tapping the container on the ground.

Pouring plaster

Pouring the plaster mixture into the impression is a crucial step. It is during this phase that most damage can occur. On very fragile or large impressions, where pouring the mixture directly from the mixing container is difficult, use a ladle. When you are casting smaller impressions or a portion of an impression requiring less mixture, it can be directly poured. A small amount of the mixture should be poured outside the retainer wall first to see if it is too thin or thick. Should it be too thin wait until it starts to thicken. Should it be too thick dump it out and start over. Rather than pouring the plaster straight onto the impression use a four inch putty knife placing it close to the ground outside the actual impression and pour the plaster slowly onto the spatula directing the plaster towards the retainer wall. The plaster will flow over the impression slowly taking its own course. Once an area is covered you can move the spatula over the area always pouring onto a bed of plaster. In this way no damage will be done to the impression. If you have not prepared enough plaster a second mixture can be quickly prepared and poured for added thickness and strength. Ensure that the base is completely covered with the first mixture. The finished cast should be at least one inch thick. Most books written on pouring plaster casts of footwear impressions recommend placing some form of re-enforcement material such as damp twigs, strips of wire, cloth, etc. into the cast when it is half poured. Tests I have conducted with dental stone indicate re-enforcement material is unnecessary. Dental stone is much stronger than plaster of paris and while normal care should ensure it does not break remember a cast is an exhibit and it should be treated as such.

Removal and cleaning

Dental stone dries at the scene in two stages. First, the mixture turns a dull white. Secondly, it generates heat. There is a surprising amount of heat generated during the second stage and you can feel this by placing your hand on the cast. When the heat reaction reaches its peak and starts to cool, the retainer wall can be taken off and the cast removed. Removal of the cast follows a 15 minute to 1 hour

FIGURE 13-2: **Soil cast**

Removing foreign debris.

Applying talcum powder as a release agent.

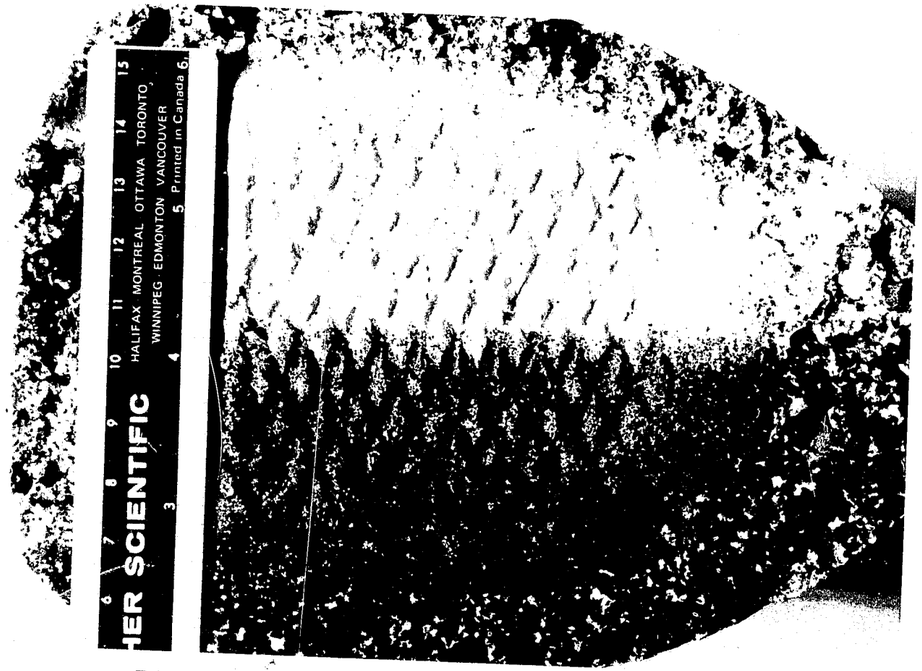
Placing retainer wall. Allow 1/2" minimum clearance.

Dental stone coned out of water ready for mixing.

Pouring plaster. Note spatula used to redirect plaster flow back towards retainer wall.

What to expect when cast removed.

Removing dirt and debris with water and brush.



Talcum powder as a release agent. White area illustrates where talc was applied.

wait depending on whether or not a rapid hardener has been added. Identification data must be inscribed into the cast prior to its removal. This data should include a number collating the impression to your notes and photographs, especially if you have photographed or cast more than one impression. Your initials and the date should also be included.

Turn the cast over by slowly pulling up on one side. Disappointment will be your first reaction if you have never made a cast before. Instead of seeing a well preserved shoe impression there will probably be one mass of dirt or sand. An urge will come over you to scrape the dirt away so both you and the investigator can get a glimpse of the impression. *This could be fatal*! Put the cast in your vehicle and leave it there. You should not attempt to clean the cast at this time. Plaster reaches its maximum strength in about 24 hours. Ideally, this is when the cast should be cleaned. Plaster is slightly water soluble, so don't soak the cast in water for long periods. A gentle stream of water from the tap is the safest way to remove dirt and sand. Should debris be embedded do not pry it out as you will only risk damaging the cast and it will not reveal detail anyway. After removing initial dirt and debris the cast can be further cleaned by light brushing with a soft tooth brush or gentle rubbing with your finger. Before brushing the cast rub the reverse side to ensure the brush does not damage the plaster. It is during the cleaning stage that you will appreciate having used dental stone and baby talc. Figure 13-2 illustrates the various stages of plaster casting.

J.V. Vandiver and J.W. Walcott recently conducted a study on the best type of plaster for footwear and tire mark casting.[1] Basically their study determined setting

times and resistance to abrasion in various types of plaster. Setting times were determined by marking the surface of the cast repeatedly with a No. 2 pencil until it recorded a pencil mark. Abrasive tests were conducted by rubbing the surface of the cast 25 times in one direction with a wet stiff bristled toothbrush.

They concluded that dental stone outperformed all other forms of plaster both in strength and setting times. Their tests also revealed that using table salt (sodium chloride) as an accelerator weakened plaster strength by 30 percent but potassium sulfate at room temperature increased plaster of paris tensile strength by 25 percent. My own experiences comparing dental plaster, dental stone, salt and potassium sulfate confirm their findings.

Impression in water

Occasionally, you might come across a shoe impression under water, e.g., at the edge of a creek or a mud puddle (tire marks frequently are found in water). Not only could it reveal excellent detail but can be cast as well. Often the surface dirt of a mud puddle is fine silt. The water covering the impression acts to protect it from rain, wind or sun. Figure 14-2 is an impression underwater.

How do you cast this type of impression? To begin with care must be taken when walking near it to ensure the fine silt is not disturbed. Do not attempt to drain the water from the impression. This will only cause turbulence which will disturb the silt. Place a retainer wall around the impression, higher than the water, allowing a one inch border at least. If there is less than an inch clearance, it will tend to force the sides of the impression in when the retainer wall is pushed down. Potassium

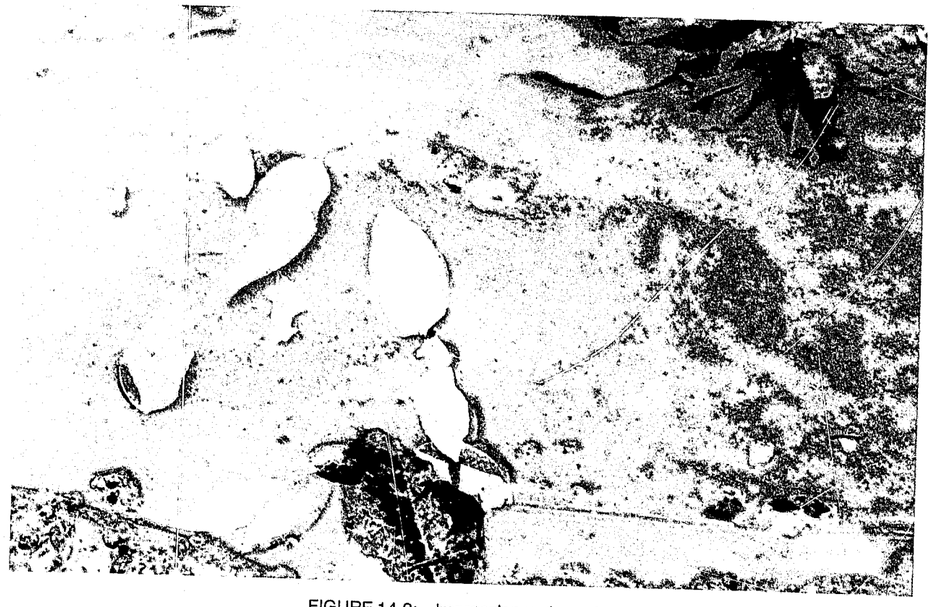


FIGURE 14-2: Impression under water.

sulfate is then sprinkled into the water to increase plaster setting time. Break any lumps of potassium sulfate up before adding. Rather than mixing a batch of dental plaster and pouring it into a water-filled impression, sprinkle the plaster directly into the impression area, being careful not to dump large quantities in any one spot. (See Figure 15-2.) This is continued until the water is completly saturated with dental plaster and it starts to show above the water level. At this stage, a regular batch of plaster is mixed in a container and poured on top of the plaster in the water which now acts to protect the impression surface. This second batch should be thicker than usual because a fair amount of water remains in the frame. Plaster being heavier will cause any excess water to come to the top. The only purpose of this batch is to add thickness and strength to the final cast. When preparing for this type of cast everything should be set up and ready so when the second batch of plaster is made it can be done quickly. Once the plaster is poured the same procedure is followed as in the normal cast and it can be removed within 15 to 20 minutes. Figure 16-2 is a cast from the water-filled impression.

Cast enhancement

The properly cleaned cast should be photographed using oblique light as a first enhancement method. Light direction and angle can only be determined by trial and error. Some characteristics may be visible with the light directed one way. Change the position and others may appear while others may disappear. More than one photograph of the cast using different lighting may therefore be

FIGURE 15-2: Sift dental stone into impression surrounded by retainer wall.

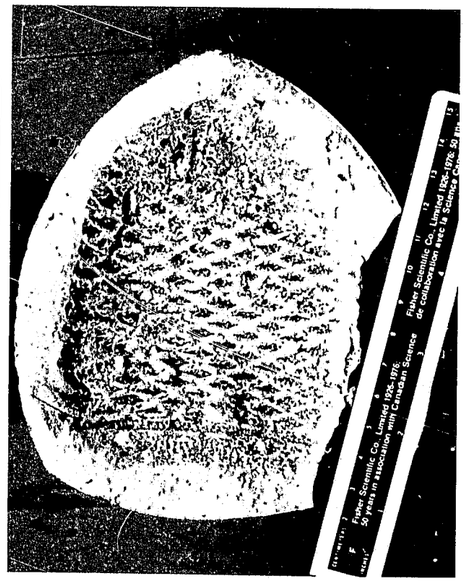


FIGURE 16-2: Impression cast under water.

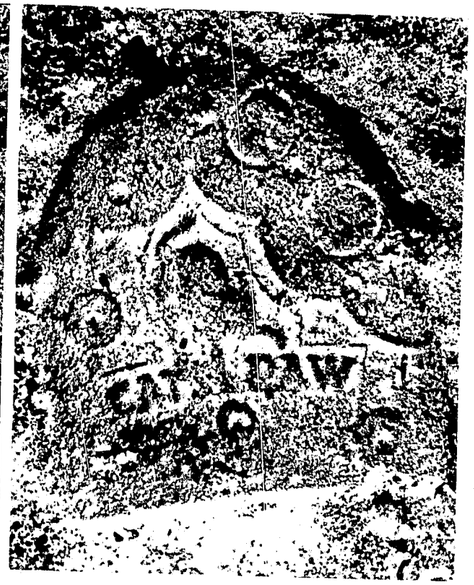


FIGURE 17-2: Dusting cast with black fingerprint powder will sometimes enhance impression areas.

necessary. With the photographs taken, you can now attempt to develop more cast detail by dusting the surface with black fingerprint powder. This procedure will generally improve it. If it does not, however, immediate washing will remove most of the powder. (See Figure 17-2).

Impressions in snow

Casting impressions in snow creates additional problems. Plaster will normally destroy the impression during the hardening process. The created heat causes the impression to melt resulting in a distorted impression or nothing at all. Some methods for casting snow impressions with plaster do exist, however you must be good at it. Chances are you will still wind up with a poor cast.

Fresh snow usually leaves impressions which record excellent detail. But snow deteriorates with age to a coarse, granular, crystalline appearance and this type of snow does not produce good footwear impressions. Best results will be obtained from either fresh snow or from snow which is just starting to melt. When this happens an ice covering is formed after the foot is removed. Normally, by the time the investigator arrives this type of impression would have melted. Sometimes a culprit will leave this type of impression as the temperature is dropping. If found, it reveals good detail. It is usually seen as an ice impression and the detail is not readily visible.

The traditional method of casting snow impressions is with molten sulphur. The sulphur in powder form is heated to approximately 115° Celsius and then the molten mass is rapidly poured into the snow impression where it solidifies

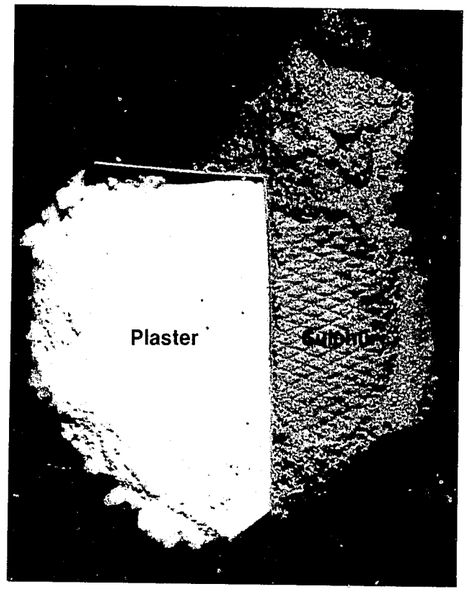


FIGURE 18-2: One half of impression cast in sulphur; one half cast in dental stone. Sulphur portion of cast is much clearer.

accurately capturing the impression's detail. Figure 18-2 shows a comparison of a plaster and sulphur cast.

Preparation of impressions

Preparation of impressions is quite simple. With those that are not too deep (surface impressions) build a wall of snow around the impression and include a pocket into which the molten sulphur can be poured. The pocket should be higher than the impression and designed to allow the sulphur to run down into it. On deeper impressions pack down an area 3 to 4 inches from the heel or toe to be used as a pouring pocket. Ensure that it is higher than the impression. Run a trough from the impression to the pocket. You are now ready to prepare the sulphur for casting.

Preparation of sulphur

Place enough sulphur into the pot to cover your impression. It will take a little testing to judge just how much is required. Heat it, stirring constantly. Sulphur does not give off any odour, unless it starts to burn, at which time sulphur dioxide is released. When inhaled, mucuous membranes in your nose, throat and lungs are affected by resultant sulphurous acid which will cause discomfort. Sulphur dust can also injure your eyes, so you should handle any form of powdered sulphur carefully. Once melted, remove from heat stirring constantly until small crystals

start to form on the surface. These crystals are visible by looking at the surface at a slight angle and are similar to ice forming on water. When crystals are formed, you know the sulphur temperature has reached a critical point where it is about to solidify. *It is important to wait until these crystals appear, otherwise the sulphur will be too hot and could cause some snow breakdown*. At this point pour the sulphur rapidly into the impression. A few lumps of unmelted sulphur may still remain. These will not show or affect the cast surface. Pour the sulphur into the packed down area outside the impression and be sure the entire impression is covered. Additional sulphur cannot be added later as it will flow under the cast destroying the evidence. Initially you will think that you have destroyed the evidence, however, after a few minutes the cast can be turned over and you will be amazed to see the impression accurately recorded. You would be wise to wait 10 minutes before handling, to ensure the centre portion of the sulphur is solidified. During examination at the office you may wish to dust the cast with fingerprint powder, which may enhance accidental characteristics. It should however, be photographed with oblique light first. During my experiments I added fingerprint powder to the initial molten flours of sulphur which caused the final cast to appear black. I personally found it easier to examine. These are things with which you could experiment to determine which is best for you. Casts can also be sprayed with a dulling spray (used for eliminating highlights in photography), which makes them easier to examine and photograph.

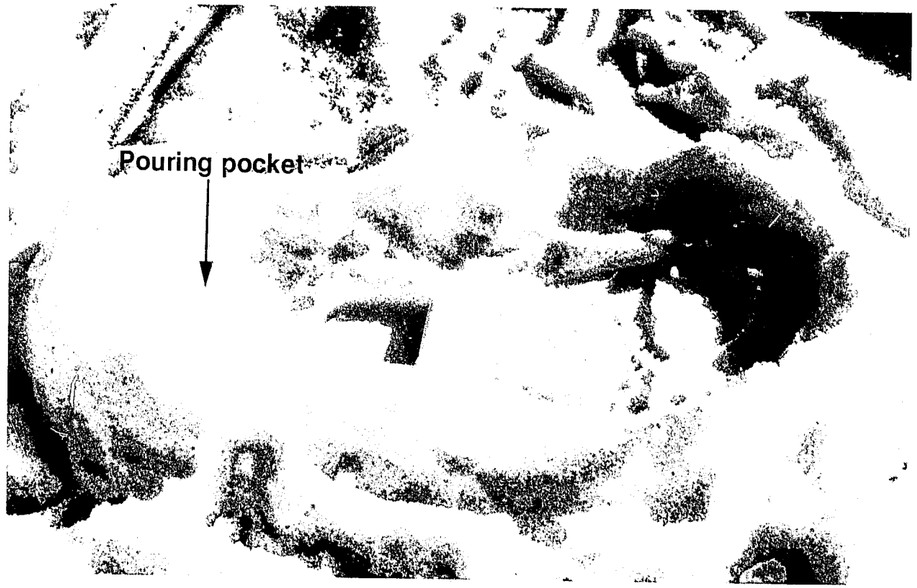
The method you choose to melt your sulphur is a personal choice. For investigators always working in urban areas, some form of electrical heating pot may work fine. Investigators who also work rural areas, may find electricity not always readily available. Some form of fueled heating device would probably work well such as a butane portable burner, kerosene burner, camp stove, etc. *The heating device used for melting sulphur must have a large heating surface* otherwise the sulphur will not melt properly. A number of investigators have experienced trouble melting sulphur outside in winter conditions because they used inadequate heating devices.

Articles written on sulphur casting normally refer to using flours of sulphur. I have found after many tests, flours of sulphur, powdered sulphur, and sublimed sulphur are quite difficult to melt. It becomes very "toffee-like" prior to liquification and a large amount of powder is needed to produce a small amount of liquid.

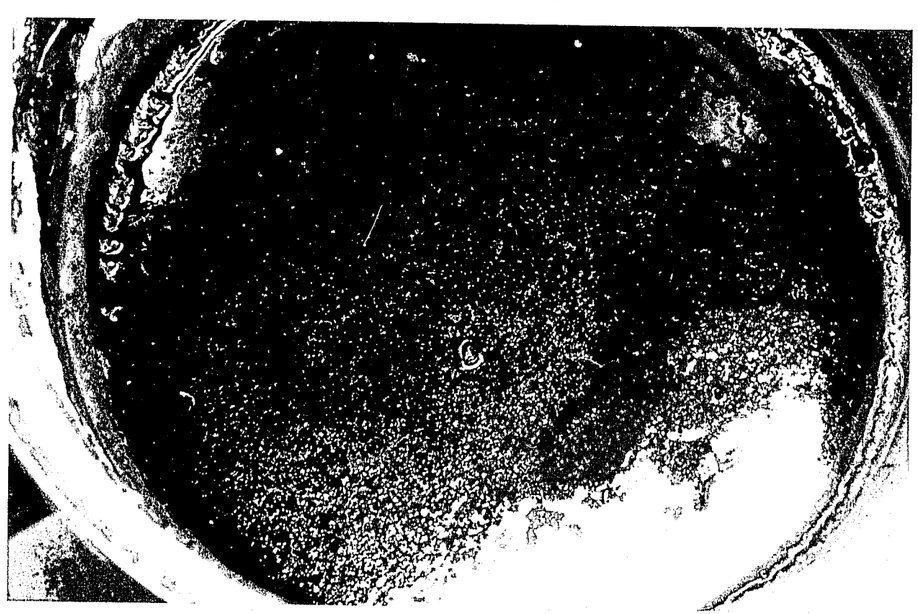
Sulphur, in Canada, originates in the Alberta gas fields as a waste product of natural gas. Once separated from hydrogen sulphide, it is cured for about three months. During this stage, the crystalline structure changes from a one pointed crystal (monoclinic), to a six sided crystal (rhombic).[2] After curing, the sulphur is ground into fine dust or small chunks. I found, quite by accident, that sulphur which had been previously used for snow casting was much easier to melt and appears to do a much better job of reproducing impressions. Apparently, when melted and cooled, it reverts back to a one pointed crystal. Cooled rapidly, it remains permanently in this state. Snow cools the sulphur rapidly and changes the crystal structure.

A commercial product called "Prill Sulphur" exists, which has been rapidly cooled and comes in small pellets the shape of B.Bs. This sulphur is, in effect, the same as recycled sulphur and I would recommend it over flours of sulphur. If Prill Sulphur is unobtainable, melt and rapidly cool flours of sulphur before using. Figure 19-2 illustrates sulphur casting.

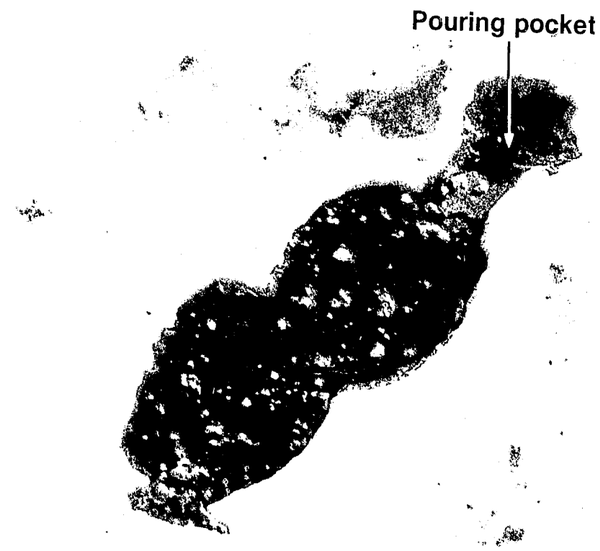
FIGURE 19-2: **Sulphur casting stages.**



Snow built up around area to be cast. Pouring pocket built outside.

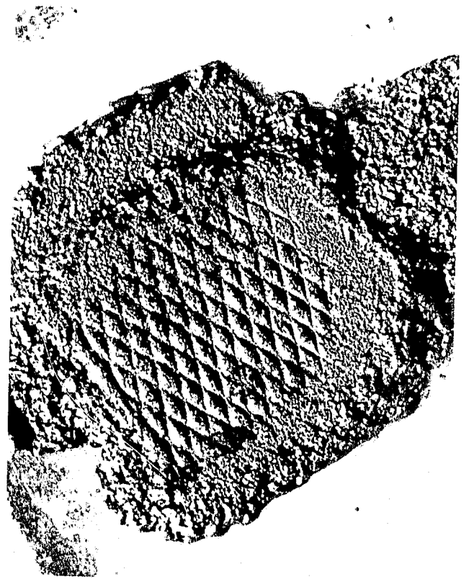


Melted sulphur starting to crystalize at 115°C.



Sulphur poured into impression. Note pouring pocket.

Cast removed after 10 minutes.



Close-up view of sulphur cast.

Casting with paraffin wax

A recent development in materials for snow casting is "Paraffin Wax". This method of casting *snow prints* was developed in Solna, Sweden.[3] Wax was suggested as a means of casting sand impressions some years ago.[4] When I first read these articles, I more or less disregarded them as an offbeat method, of no practical use. However, after conducting many experiments, I am now satisfied wax can be used under certain conditions when sulphur is not available.

Paraffin wax can be used on dirt as well as snow impressions. In describing how it is applied, let me deal with snow first.

Preparation of impression

Same as Sulphur

Preparation of wax

Once the impression is prepared the wax must be melted. Wax melts at approximately 50°C which makes it much easier to melt than sulphur, especially during severe weather. It is also non-toxic. The wax can be melted in the same manner as sulphur. When the wax is completely melted pour it into the pouring trough fairly quickly.

I recommend coloured as opposed to white wax. It makes cuts and abrasions easier to see and photograph. Colouring wax is very simple, just add a coloured wax crayon while melting the paraffin. (See Figure 20-2.)

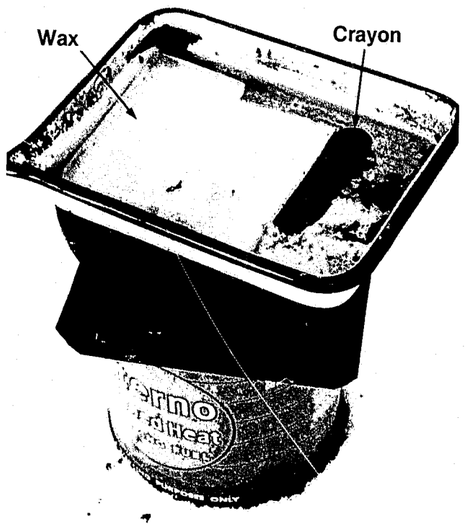


FIGURE 20-2: Melting wax and crayon together adds colour to wax.

The article written in Sweden recommended spraying the impression first with "snow spray", a christmas decoration material. I found this procedure harmed the cast. Snow spray quite visibly eliminated the pattern area. Eventually I obtained better results by not using it at all. Deeper impressions are more problematical. Wax tends to break through impression sides running through the snow. This can be eliminated by carefully cleaning some of the snow away first and packing the remainder down. You should, however, exercise a good deal of care when casting in deep snow.

Once the wax has been poured and a skin of hard wax forms over the top, the cast should be cooled quickly to prevent distortion of the impression surface. Carefully cover the cast with snow to accomplish this. *Distortion is the major drawback of casting snow impressions with wax*. If temperatures are above -17°C or 0°F and the sole or heel pattern is fairly smooth you can expect distortion to be significant. Soles or heels with an intricate pattern covering the entire surface seem to dissipate the heat quicker and more evenly thus eliminating the problem. Figure 21-2 illustrates the distortion difference between the two surfaces. These casts were made when the air temperature was -10°C.

The cast should be about one-half inch thick for a full sized impression. Anything less than that risks breaking the cast and more than half an inch takes too long to set with more chance of distortion. Distortion is caused when the impression surface melts. Although the impression is preserved the wax, still warm, will bend of its own weight. The snow surface may not melt evenly and the final cast may thus be uneven. Quick cooling will help prevent this. It is imperative the cast be left in the impression until *solid* throughout. Cast removal prior to the centre being solid will cause a fallen cake effect.

Once the cast is solid and no longer warm it can be removed.This should take 5 to 10 minutes depending upon external temperatures. Once removed the cast is ready for comparison and requires no cleaning. If external temperatures are very cold, handle the cast with care. It may tend to be brittle.

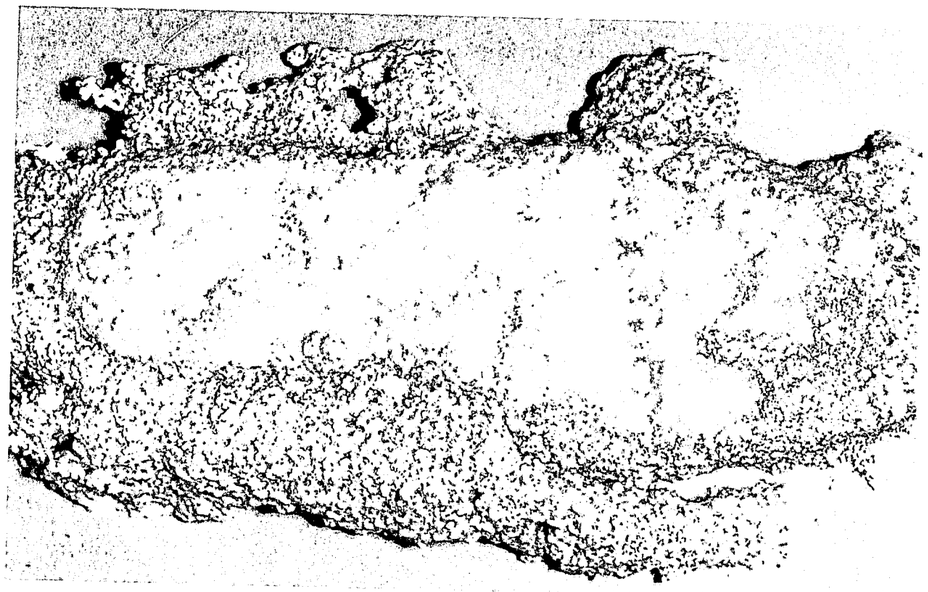
Problems: Wax may not be hot enough when poured into the impression. If the wax is too cool air bubbles will be trapped on the impression surface. These can be detected as shiny pockets in the cast. (See Figure 22-2.) A second problem: if the wax is not hot enough or poured too slowly, lines form across the impression surface. When wax is poured into an impression it flows across the surface like a river delta. These flows eventually come together as more and more wax is poured. The lines form in the cast because the wax has started to solidify. (Illustrated in Figure 23-2.)

The correct temperature of the wax just prior to pouring is 60°C. This can be determined with a suitable thermometer.

When discussing snow impression photography, I mentioned spraying the impression with dull black spray paint to enhance detail. This should be omitted on any impression you plan to cast with wax as the paint adheres to the wax, causing considerable "interference". (Black fingerprint powder will not affect the cast). The procedure of spraying snow impressions with paint should only be done on secondary impressions which are not being cast.

Wax casting in dirt

Casting impressions in soil with wax is not recommended except under unusual circumstances. (e.g. no other materials available).



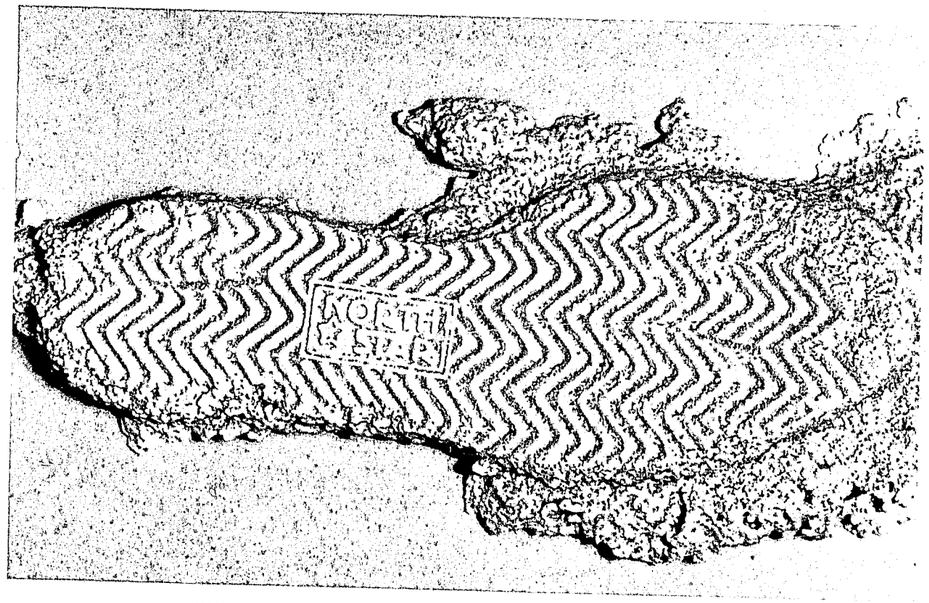


FIGURE 21-2: Wax casts. Note distortion between two types of surfaces.

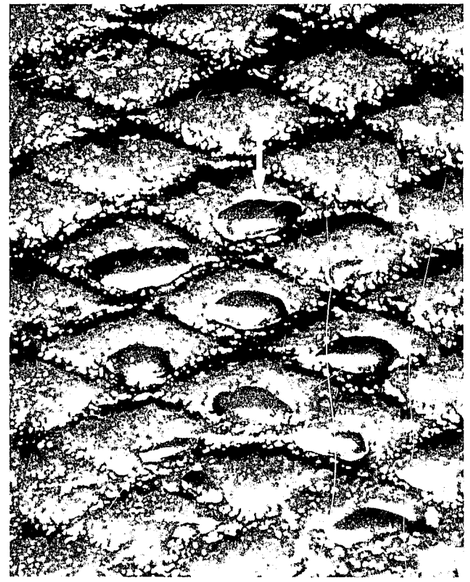


FIGURE 22-2: Shiny pockets in the cast are air bubbles caused by wax being too cool when poured.

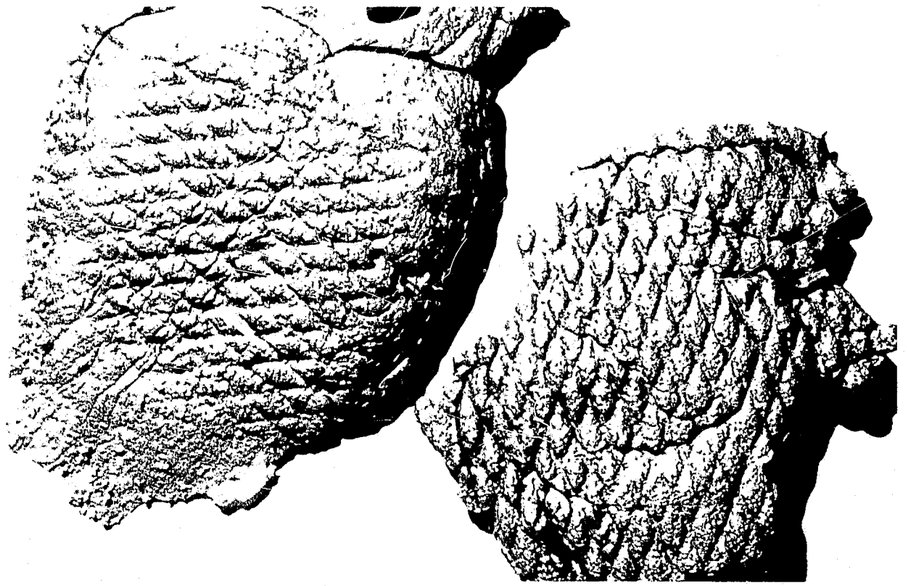


FIGURE 23-2: Lines visible in cast caused by wax not being hot enough when poured.

This procedure will not work when the outside temperature exceeds 20°C or 70°F. Wax will not solidify. To enable wax to be used as a casting medium in dirt, the secret is that *the impression must be thoroughly dampened*. Wax is lighter than water and as long as the impression is fairly wet there is no problem with cleaning away the dirt. In most cases a water sprayer is adequate for wetting the soil. Spray the impression surface until it is thoroughly dampened but not to the point where water forms visible droplets. If droplets of water do form wait until they have disappeared, otherwise these water droplets will be visible in the cast. The soil impression should be cleaned out in the same manner described for plaster casting. Do not dust the impression with talc. When using wax the water acts as a release agent.

Surround the impression with a one inch strip of cardboard, leaving enough area around the impression so the sides will not cave in. Once the wax has been melted (as described for snow impressions), pour it into the impression in the same way as plaster. *Do not* pour the wax rapidly as in snow but allow it to flow slowly. Rapid pouring will cause impression damage.

Because the wax is poured slowly, it must be quite hot to prevent hardening before the surface is completely covered. However, it should not be too hot or it will evaporate the water barrier and the cast will be difficult if not impossible to clean. A little experimenting will soon tell whether or not the wax is too hot or too cold.

Once the cast is approximately one-half inch thick allow it to stand until cool. This takes from 15 to 20 minutes depending on external temperatures. After 10 to 15 minutes on a warm day, hardening can be accelerated by pouring cold water on top of the cast.

Removal of wax cast

Remove the cast by lifting the cardboard retainer wall. The wax will adhere to the side of the cardboard, which will hold the wax in place during transportation.

Cleaning

Wax is not as hard as plaster and will score easily if rubbed hard. If the impression was thoroughly dampened, the dirt will wash away from the cast fairly easily. Stubborn particles of dirt and sand can be removed with a camel hair brush that has been cut back so that the bristles are approximately a quarter of an inch long. Washing of the cast *must* be done in water about 20° Celsius. If the water is too cold the cast will become hard and the dirt will stick to it. Hot water will soften the cast and may in fact melt it. On impressions made in wet clay you will find very little cleaning necessary. (See Figure 24-2.)

A wax cast made from an impression in dirt will have soil adhering to the cast and will require cleaning. Impressions in dry sand can be cast with wax however wetting it well without causing some destruction will be difficult. Large water droplets from the sprayer will break down the sand when they hit the impression. This can be overcome by first spraying the impression with a cheap lacquer hair spray or an aerosol atomizer with a water attachment which sprays water much more finely than a hand sprayer. It takes a considerable amount of water to soak a dry sand impression and this procedure is suggested only when no other methods are available.

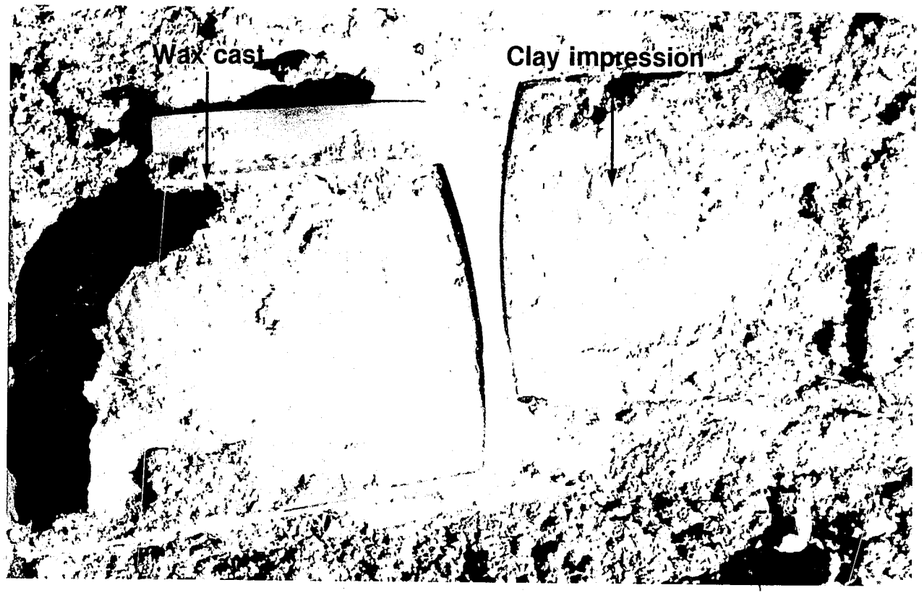


FIGURE 24-2: Wax cast made in damp clay — little cleaning required.

Enhancing wax casts

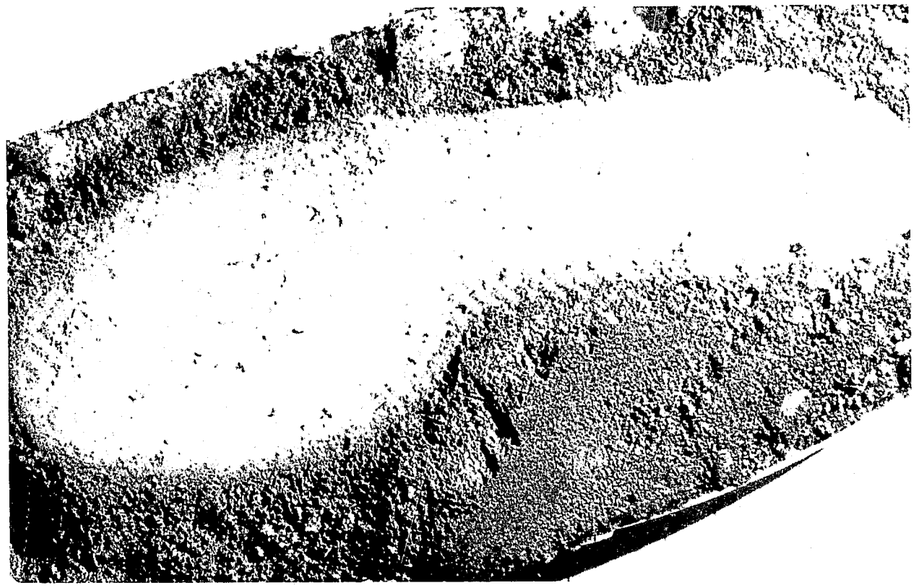
The wax cast can be enhanced in the same manner as the dental stone cast: first, by photography and oblique lighting; second, by dusting the wax with black fingerprint powder. This may cause some characteristics to become more easily visible and to photograph better. (See Figure 25-2.)

Wax is translucent. Strong back lighting may enhance certain detail not readily visible with front lighting. Pick middle range colours for your cast. Yellow, orange and green are better than black, purple or white. Very dark colours do not permit back lighting and white is difficult to photograph.

Wax of course cannot be used on any impressions which are covered by water or have droplets of water on their surface.

Other casting methods

In recent years other casting materials have become popular. The development of silicone rubber has caused many investigators to try these materials for casting shoe and tire marks. Under good soil conditions these materials render excellent results. If you want to use silicone, a release agent should be applied to the impression. There are silicone release agents available. For dirt or sand however, talcum powder works very well. Figure 26-2 illustrates three examples cast in light sandy soil. A - had no release agent, B - was sprayed with a silicone release agent, and C with a talc release agent. The advantage of using silicone over plaster or wax is the fact that not much equipment is needed in your kit. Furthermore the rubber cast is pliable and will not break if dropped.



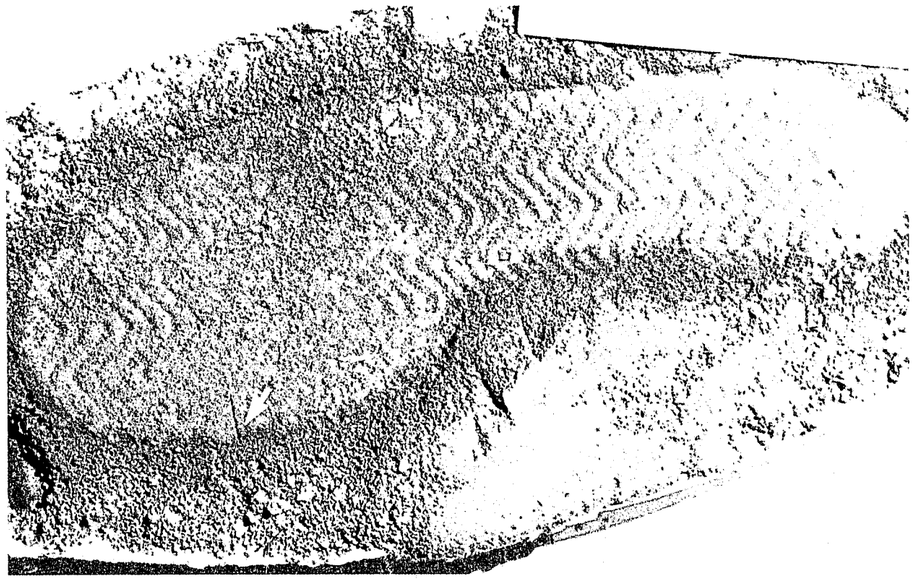
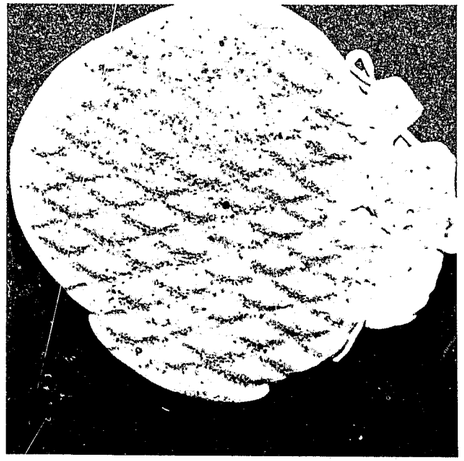
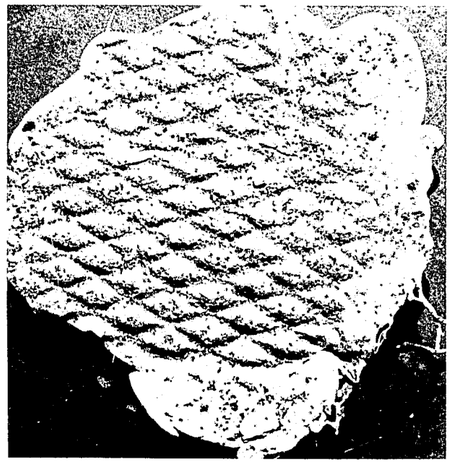


FIGURE 25-2: Wax cast improved after dusting with black fingerprint powder.

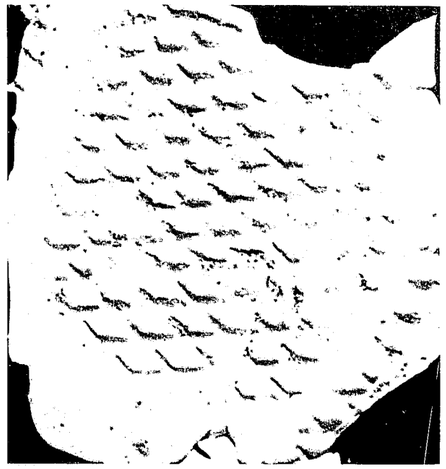
FIGURE 26-2: **Silicone rubber casts**



A
No release agent applied to impression.



B
Silicone release agent applied.



C
Talcum powder applied as release agent.

Disadvantages:

1-Cost: A full size shoe impression could cost from four to six dollars, compared with pennies for dental stone.

2-Setting Time in Cooler Temp:

Setting time gets longer as the temperature drops below 20°C. Below 0°C it can take hours for the cast to set.

Summary

From numerous tests conducted with three-dimensional impressions I am satisfied many of them at crime scenes will provide considerable detail. I do not believe you can determine the value of these impressions at the scene. Their significance will only be known when compared to a suspect's shoe.

Evidence must first be recovered before it can serve a useful purpose. Recovery can be accomplished by photography, sketching, and casts.

The use of casts over the years has dwindled and very few investigators today are familiar with procedures involved in making them. They can be made from a number of available materials. The decision as to what material should be used will be influenced by type of soil, weather conditions and cost. The decision to cast can only be made through experience. Determining factors are: Can the impression be linked to the crime? How well is it recorded? and, What type of soil is the impression in?

The most reliable casting material for soil impressions is dental stone. It is very hard and sets within 15 minutes when potassium sulfate is used. The most reliable casting material for snow impressions is sulphur.

The ability to properly interpret detail on a cast can only be achieved by making a number of them under controlled conditions. This also serves to develop confidence in preparing a cast under different conditions.

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3. Kjell Carlsson and Andreas C. Maehly, "New Methods for Securing Impression of Shoes and Tyres on Different Surfaces", *International Criminal Police Review*, (Jun/July 1976), pp. 158-167.
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Chapter 3

Two-dimensional footwear impressions

The identification of footwear evidence is usually associated with two-dimensional impressions. These illustrate length and width only. Often they can be found on objects which the criminal touched or placed there. An example might be a piece of paper pulled from a desk drawer during an office ransacking, or a broken window at the point of entry. These impressions can also be found on the floor leading from the point of entry. Unlike three-dimensional impressions normally located outdoors, two-dimensional impressions are usually found indoors and often constitute a definite link between the culprit and the crime. The whole footwear tread does not have to be recorded in order to establish an identification. In many cases only a small portion of the shoe tread is required. (See Figure 1-3.)

Even when fingerprints are located at the point of entry, examination should also be conducted for footwear impressions. One cannot usually give evidence

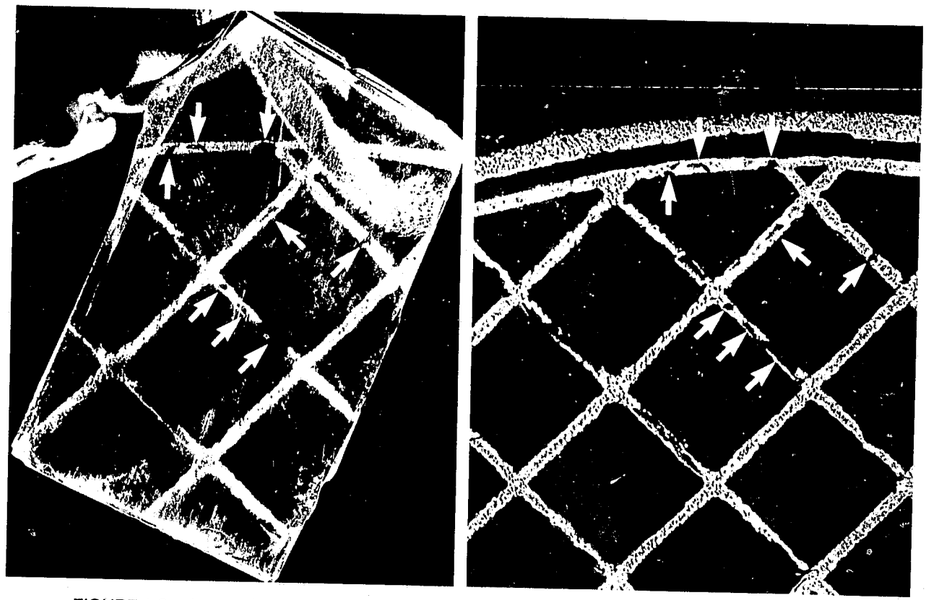


FIGURE 1-3: Impression on glass compared to test impression. (It is not necessary to have the entire shoe recorded for an identification.)

determining a fingerprint's age. The footwear impression's very location may permit you to say whether or not it was consistent with someone coming through the point of entry and was made either during or after the offence. This could be valuable in corroborating other evidence such as fingerprints even if positive identification of the footwear impression cannot be made. A common defense to fingerprint evidence located at the point of entry is "the accused merely happened by and looked in through the broken window". Footwear impressions located inside the building tend to refute that defense.

A shoeprint must first be found before it can be identified. A big problem in locating this evidence is the fact that investigators and the general public often destroy it before the identification officer arrives.

The remainder of this chapter deals with methods and techniques used for developing footwear impressions on two-dimensional surfaces most likely to be encountered during a crime scene examination.

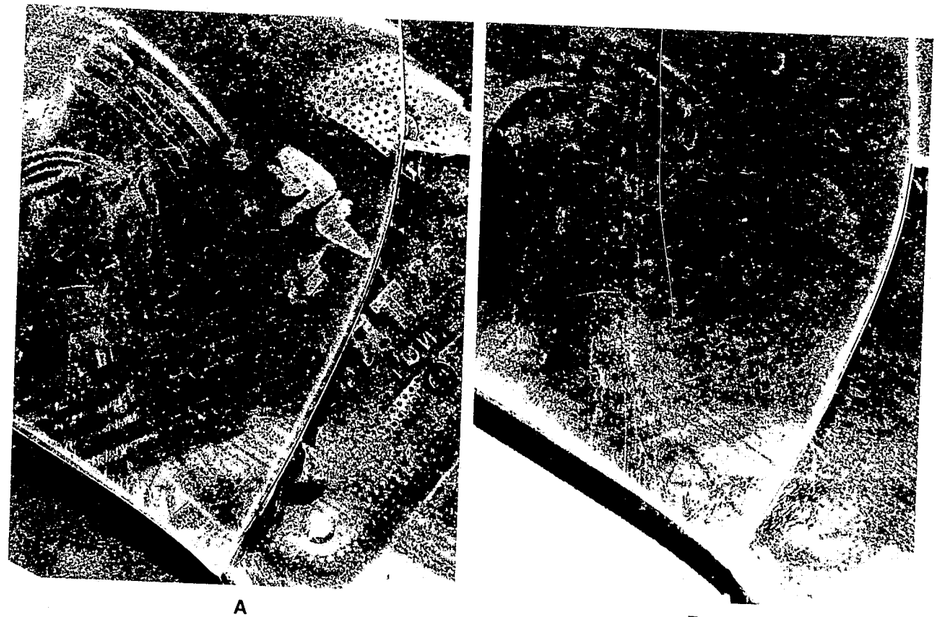
Glass surfaces

One of the more common surfaces footwear impressions are found on around the point of entry is glass. At many crime scenes entry is gained through a window at the side of a building or an area not used by the general public. Footwear evidence located here can prove very incriminating. Identification officers are sometimes reluctant to bother examining a front door or window entry point normally used by the general public because fingerprint evidence can be easily explained by the accused. However footwear evidence will probably be detected here and can place the culprit inside or at the crime scene during or after the offence.

Unfortunately, eager scenes-of-crime examiners attempting to locate fingerprint evidence may destroy impressions left on glass, especially during the drier season. Dust impressions on glass are simply brushed off when the examiner dusts for fingerprints. He may even see signs of a footprint and attempt to enhance it with fingerprint powder. The same problem exists when an impression is made on a piece of glass covered with a dirt or dust film. The shoe lifts the dirt away leaving a negative image. Both conditions record excellent detail but in many instances the impression is destroyed during examination. *Do not attempt to enhance dust impressions with fingerprint powder*. (See Figure 2-3.)

If an impression appears to have been made by dust or made by lifting existing dust away, it should be photographed, preferably at the office. Examining the glass for fingerprints can still be done later after it has been photographed. All glass should be carefully examined by holding it at an angle to the light before dusting. If conditions suggest the impression was made by a damp or wet boot it can be developed the same way you would a fingerprint. Visible impressions, as a general rule, should be photographed before any attempt to enhance them is made.

It is usually difficult to assign a particular value to a footwear impression until you compare it with the boot. Figure 3-3 is an impression on glass made from a wet boot. In your opinion, if you saw this impression at a crime scene, would you bother with it? Look at the lower portion of this impression once more and compare it with the boot that made it. I have marked out some areas of agreement that you may or may not have considered of any value. (See Figure 4-3.) Remember, it's just about



A B C

FIGURE 2-3: A) Dust impression on glass B) Same impression dusted with fingerprint brush C) Boot removed dirt creating an impression.

FIGURE 3-3: Damp heel impression on glass. Would you keep it?

impossible to walk in from outdoors across an area covered in broken glass and not leave some tell-tale shoe sign.

Floor surfaces

Once a culprit has gained entry the first thing he comes into contact with is the floor. This may be tile, linoleum, wood, concrete, dirt or carpet. Observe someone coming into a building. Compare the number of times their feet come into contact with the floor and the number of times they pick up or handle objects with their hands. I have conducted many experiments walking from outdoors, to indoors. During dry dusty conditions one can expect dustprints to be deposited on a floor for a distance of at least ten feet. In damp or wet periods good prints may be developed on tile floors for 100 to 150 feet, depending on how wet it is outdoors and whether or not all areas are tiled.

The problem with floor examination is the careless wanderings of police and spectators. The only solution is to properly educate police officers in the art of protecting the scene. A number of positive footwear identifications will soon have an investigator giving more consideration to footwear evidence.

Dark-coloured floors

The dust and dirt deposited on a dark-coloured floor is usually visible, requiring little or no development. Always photograph before attempting to dust

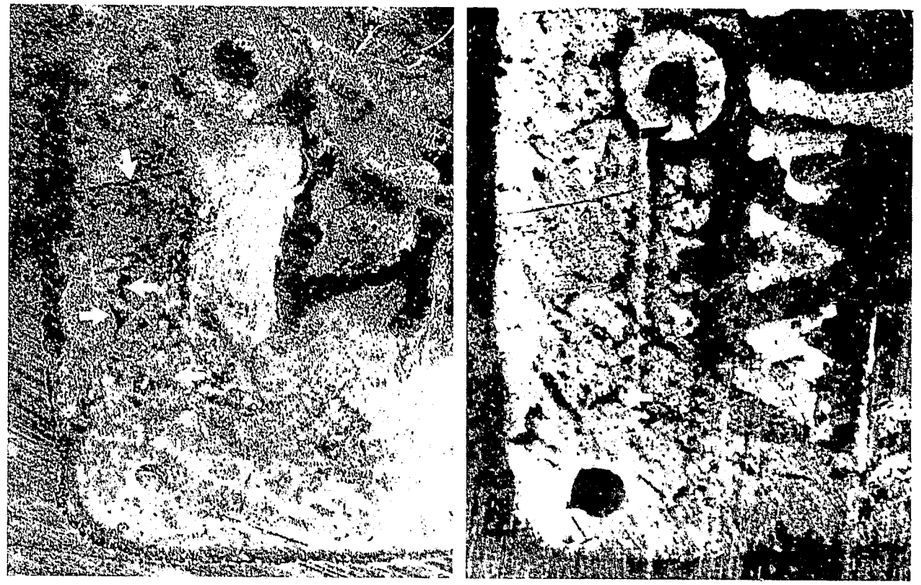


FIGURE 4-3: One area of figure 3-3 compared to suspect boot. Note areas of similarity.

with fingerprint powder. Like impressions on glass, dustprints made by a dry shoe will only be brushed away if dusted. An impression made by a wet shoe can be considerably enhanced with the use of fingerprint powder.

There is a technique involved in dusting impressions left behind by damp or wet shoes on a waxed surface. When water from the shoe surface comes in contact with the waxed surface, it removes the wax. The water also tends to form droplets on the floor after the shoe is lifted and a heavier concentration of moisture will be located near the centre of the pattern design. When weight is placed on the shoe it forces the water to the peripheral edges of the pattern. When the weight is removed the water returns to droplet form. After the impression is made and the water has evaporated the identification officer arrives to dust the area for footwear impressions. The area of heaviest water concentration absorbs the fingerprint powder. Unfortunately, this is an incomplete pattern often without sufficient detail for identification purposes. (See Figure 5-3.)

By breathing on the impression and applying warm moist air over the area, the wax surface of the floor softens. Re-dust the impression. The powder is now absorbed into the wax surface and the area containing the tread design remains clean. Vigorous brushing may be necessary to clean out the impression. You will probably see quite an improvement in the print. (See Figure 6-3).

Very little moisture from the shoe is needed to remove the wax. The white peripheral edges of Figure 6-3 are a far more accurate duplication of the sole or heel surface. If the suspect's footwear was wet upon entering the building, look for further impressions made as the footwear became drier.

Some floor surfaces absorb powder completely. This depends on flooring porosity, how often it is waxed or the type of wax used. In this situation the

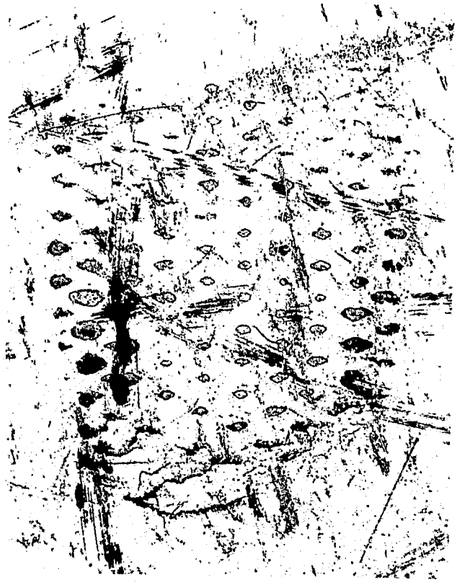


FIGURE 5-3: Impression developed on tile floor with black fingerprint powder.

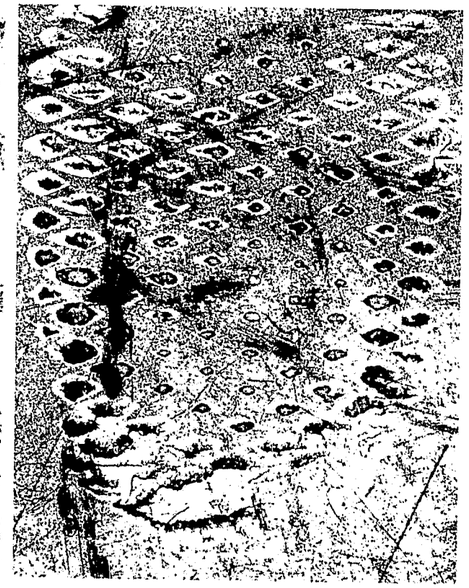


FIGURE 6-3: Same impression re-dusted after warm breath applied.

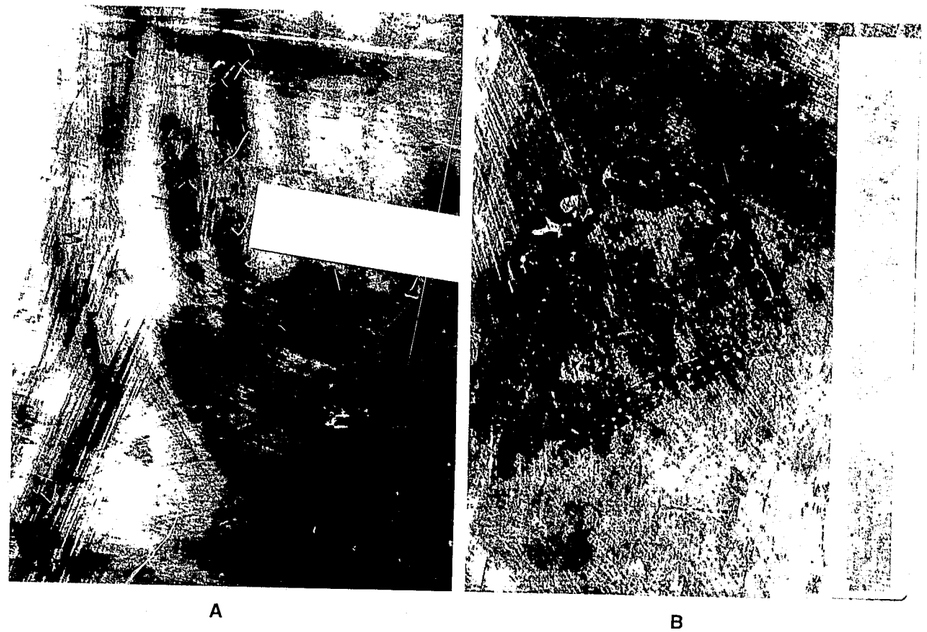
impression may still be developed. The technique may seem rather odd but by spraying the area with water and wiping across the impression with a soft cloth as though you were cleaning the floor, the print may become visible (See Figure 7-3). This method of course is a last resort as the print may be wiped away permanently.

The methods described may just make the difference between a footwear impression being suitable only for pattern design or one which could be used to identify a suspect.

Photographs of the impression should be taken with extreme care, ensuring the camera is parallel and level to the impression surface. A sturdy tripod is needed. A flashlight is probably the best way to determine the correct angle for the light source. A 4 x 5 press camera with a polaroid back can be a real advantage with difficult prints. Not only will you be assured the evidence is properly recorded but the investigator will also have a developed print right away. A scale ruler and data relating to your notes should be included. The proper scale length should be at least six inches or fifteen centimeters. Accurate measurements from the photograph itself can be taken with a set of calipers without enlarging to a full size print. Scales shorter in length make this more difficult and a greater chance of error exists when attempting to enlarge the impressions to original size. Any error on a one inch scale enlarged three or four times will be considerably exaggerated on a final print.

Light-coloured floor surface

Dust impressions on a light-coloured floor surface can only be seen by directing a strong light source obliquely over the floor in a darkened room. By obliquely in this case, I mean the light *must* be placed right on the floor. This type of



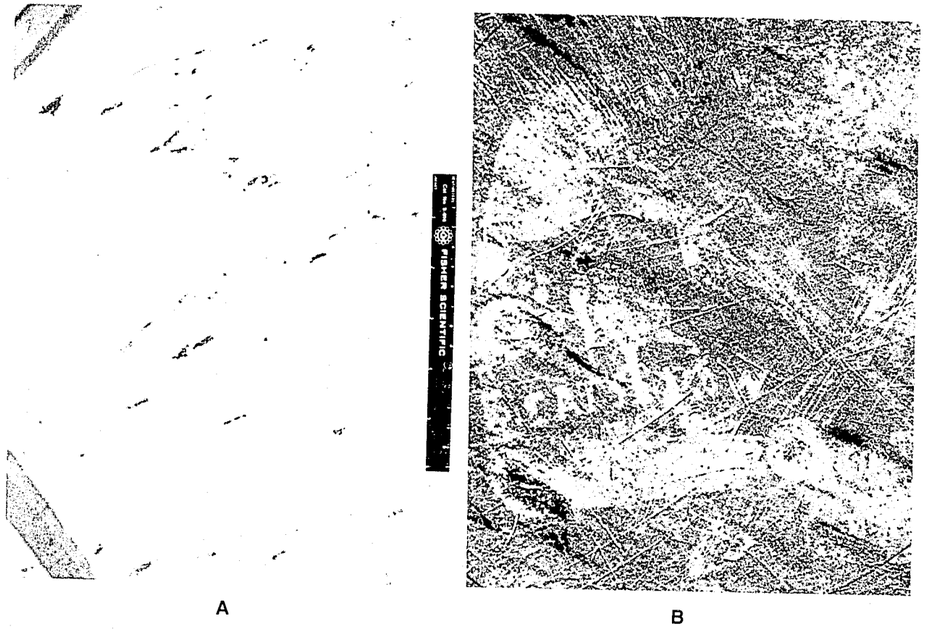
A B

FIGURE 7-3: A) Tile floor examined with black fingerprint powder. Powder absorbed by floor.
B) Impression becomes visible when wiped with damp cloth.

footwear evidence is completely latent and cannot be seen unless an intense beam of light is used. Dirt and dust picked up on a sidewalk or road is usually enough to deposit an identifiable print close to the point of entry. Conduct your own test using this procedure. You'll be surprised how well the detail is recorded. (See Figure 8-3.)

This form of impression can be improved by cleaning out excess dust with a compressed air can. These cans are used in photographic dark rooms for cleaning negatives.

Once the impression is located, the only sure way of reproducing it is by photography. Here again, polaroid film can be a lifesaver. The camera is set up on a tripod over the area after a ruler and data are placed close by and the camera is focused at the floor. Remember, the impression is usually invisible. Determine the best position for your flash unit with your light source. The flash resting on the floor is directed over the impression about two feet away. A few simple tests with the type of film you use will determine the aperture setting which should remain constant unless the floor colouring changes drastically. (For example — a white coloured floor photographed with tri-X-sheet film, ASA-325, aperture setting F32; polaroid type 52 film, ASA-400, aperture setting F32; Vericolor II type S, ASA-100, aperture setting F16. These may act as starting points. Once the impression has been photographed with polaroid film it can then be photographed again with



A B

FIGURE 8-3: A) Tile floor photographed using normal light. B) Same area re-photographed using flat lighting.

conventional film. NOTE: *If the flash unit is raised off the floor at all the impresssion will not be recorded*.

What may appear to be a fairly clean floor under normal light conditions will become quite dirty viewed with oblique lighting. In fact, you may have a difficult choice among many different kinds of impressions. Here you must use logic and intuition to determine which were made by the criminal. Did the impression lead to or away from the point of entry? Could similar shoe impressions be located around the point of entry outside? Is the shoe pattern inconsistent with the type of occupant? (Elderly people would not normally wear running shoes). These questions and others will help determine whether or not the impression should be recorded for evidence purposes.

Doors

Occasionally, the suspect's foot ar impression may be located on a kicked in door. These forms of impressions may also be recorded from dust off the shoe.

The culprit's foot may have slipped causing a double image, however it may still contain a fair amount of detail suitable for identification. Figure 9-3 illustrates a case where the culprits forced entry by kicking in a door. The impression was located on a piece of paper which was attached to it. Notice the double impression. In this case there was a size discrepancy as well, caused when the paper wrinkled from the kick. Even with the double impression and size difference an identification

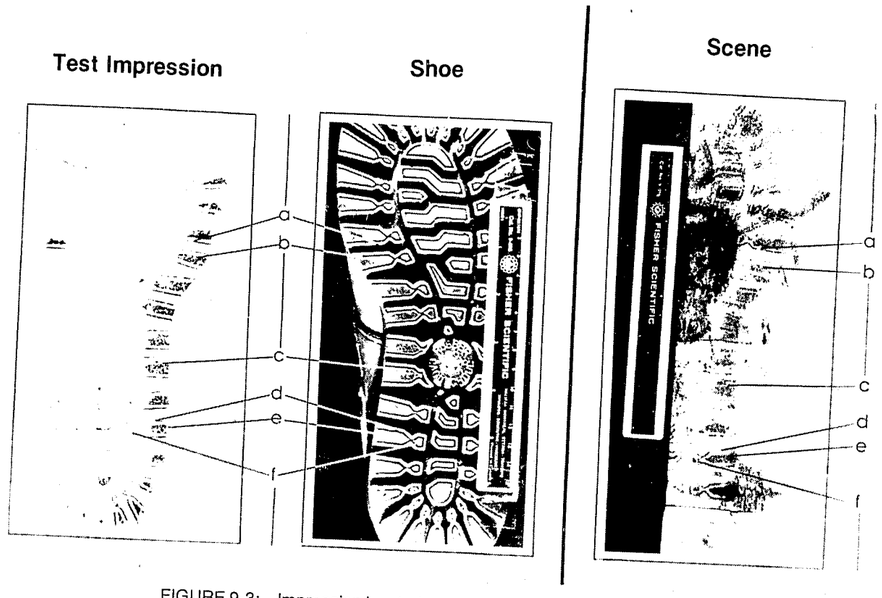


FIGURE 9-3: Impression located on paper attached to kicked-in door.

was still possible. In this particular case a different shoe impression is also visible suggesting to the investigators that more than one person is involved. Even if you cannot establish positive identification, an impression of this kind may be useful as corroborative evidence.

Dustprints cannot be enhanced with powders and probably will have to be photographed using the same flat oblique lighting as on a floor. The print can also be successfully lifted using either carbon paper or static electricity lifting techniques, which will be discussed later in this chapter. Should conditions or appearance of the impression suggest a wet or damp boot then develop the impression with fingerprint powder.

Impressions which have been developed with fingerprint powder can be lifted by a number of conventional methods:

1. Obtain photographic paper of contrasting colour. Dampen the surface until tacky. Lay it over the impression. Run a fingerprint roller over the entire surface to eliminate air bubbles. Remove the paper.
2. Treat and apply photographic film in the same manner as (1.).
3. Commercial footprint lifts are applied in the same way as fingerprint lifts.
4. Lay fingerprint tape in strips to cover entire impression. Procedure for applying the tape is the same as for fingerprints.
5. Adhesive shelf covering (commonly referred to as Mac-Tac) applied with fingerprint roller.
   CAUTION: Mac-Tac may stretch when being removed causing some distortion to the print.

Footwear impressions should always be lifted as a backup to photographs, not as a substitute.

Footwear impressions on paper

Footwear impressions are frequently found on paper. The criminal is generally sloppy about such things as office files or personal papers. These are often found strewn over the floor in break and enter offences, wilful damage, and so on. Careful examination usually reveals that the criminal inadvertently left his shoe imprint on some of them.

Most of these can be enhanced considerably by various techniques. Depending on weather conditions and geographic location, e.g. rural or urban areas, impressions may be visible requiring no development while others are completely latent. The majority of identification personnel in Canada examine paper exhibits for footwear impressions using a Magna Brush.* There are few exceptions.

After more than one hundred controlled experiments under many and varied conditions I am convinced evidence is being destroyed rather than being preserved for future court use.

Always be aware that paper on the floor may have been stepped on. There is a very good chance it bears an identifiable footwear impression. If you are doubtful about this try the following experiment. Step on a piece of paper. You are probably reading this at the office where there is tile flooring. If the bottoms of your shoes are dusty, a faint impression will be indicated. Shoes that are very clean as a result of walking on a carpet may show no visible signs except for some indentation or paper wrinkling. In both cases a good chance exists that evidence suitable for identification is present. The problem is how to develop this evidence without destroying it. After you have read this section on paper, see if you can develop the impression.

Photography

The first step is to photograph any visible impressions which show detail. This will usually mean taking the paper back to the office. I realize it is not always practical, especially in a busy photo section. However, photographic techniques can develop weak prints which usually require special films designed to develop contrast (such as C.P.O., C.P.P. or Kodalith). Other factors such as filtration, controlled lighting and sometimes special chemical developers also play a part. I do not intend to deal with photography in any great detail here as this is a subject on its own with which all scenes-of-crime examiners should be familiar. I do wish to point out, however, that many identification officers do not always make full use of their photographic knowledge. An advantage of working at the office is that you control all the conditions and can make use of reference material to solve problems as they occur. You seldom have control over filtration, controlled lighting and choice of filters at the scene.

*(Information obtained from a cross-Canada survey conducted by author.)

Lighting

Figure 10-3 depicts a piece of cardboard with a faint indication of an impression. Figure 11-3 is the same impression with a change in light direction. Sometimes, straight-on lighting will give best results. Sometimes oblique lighting may be required. Trial and error will prevail.

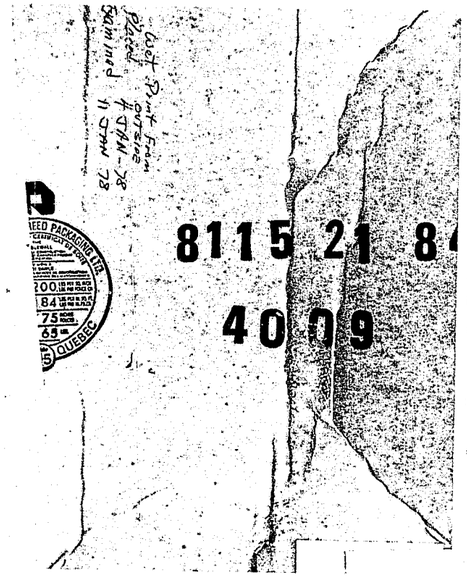


FIGURE 10-3: Cardboard showing faint footwear impression.

FIGURE 11-3: Same impression as figure 10-3 with a change of light direction.

Filters

I have often found that visual examination of fingerprints or footwear impressions on paper can be considerably enhanced when viewed through photographic filters. These tend to clean up the print and make questionable areas more discernible. Trial and error prevails here too. Refer to filter data books for the exposure correction when using filters on the camera.

Film

The use of proper film is very important for enhancing weak impressions. Evidence that has been photographed at the scene with a panchromatic film can be considerably improved by merely using a contrast film to make a second plate negative. Many identification sections find it not only impractical but dangerous to carry many types of specialized film in their scenes-of-crime camera kits. There have been numerous instances where, as a result of this practice, the whole scene was recorded on the wrong type of film.

When the exhibit cannot be taken to the office you should use a general purpose panchromatic film such as Plus-X or Tri-X. Use a flashlight to determine proper lighting angles. The film can be further enhanced in the darkroom by making a second plate negative and choosing the best contrast film for the particular problem you face. Figure 12-3 is such an example, where the investigator improved the original impression considerably using Contrast Process Pan Film.

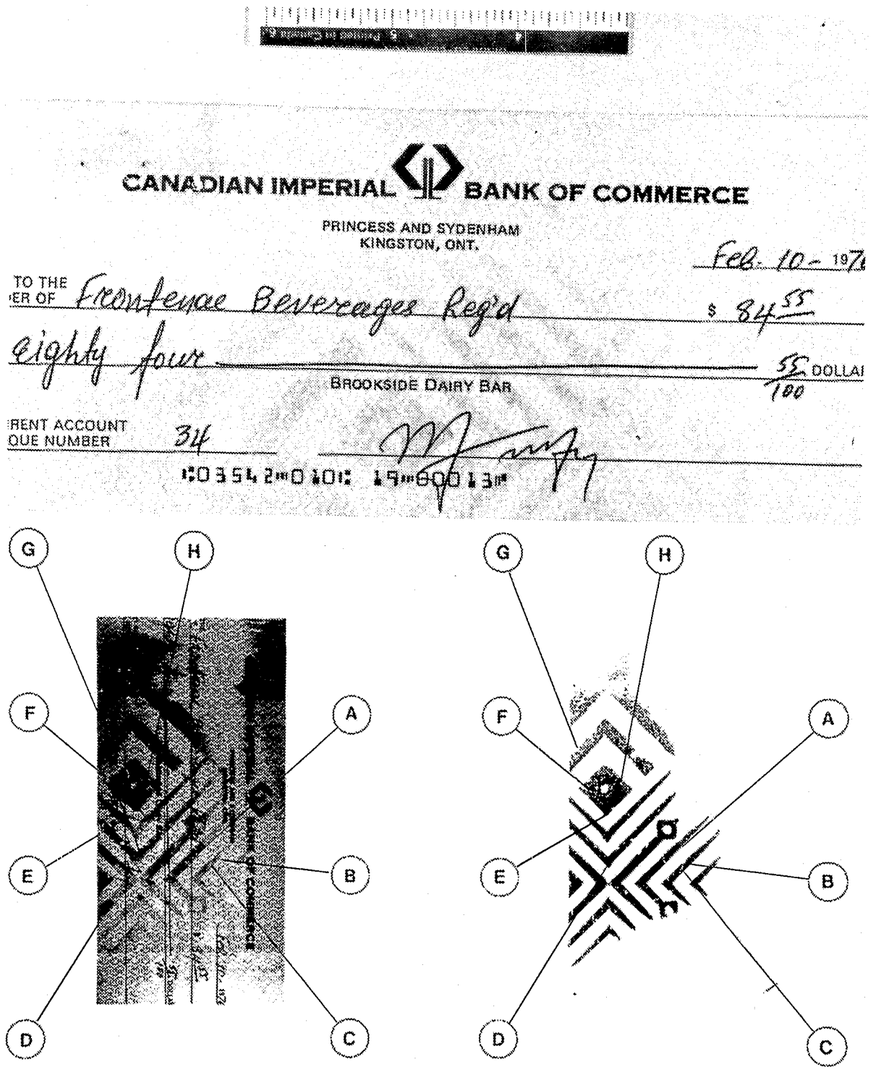


FIGURE 12-3: Impression located on cheque enhanced by using Contrast Process Pan Film.

Chemicals

Chemicals designed specifically for the particular film chosen should be used. Photographic data books can indicate proper chemicals to use should you wish to achieve specific results.

Carbon Paper Lift

The next step is unusual and unique. It should be used after visible impressions have been photographed, or with suspected impressions unsuitable for photography. Lay a piece of new black carbon paper over the suspected area, the carbon surface covering the impression. Next, place a pad of paper over the carbon paper. This prevents the carbon paper from slipping. Now, rub the pad of paper with a fingerprint roller or the edge of your hand in one direction. Remove the pad and the carbon paper from the exhibit and you should find a dust impression from the shoe recorded in excellent detail. In the event nothing appears on the carbon paper, **DO NOT THROW IT AWAY.** *Faint impressions should be examined using very flat oblique lighting in a darkened room*. Don't be surprised to find a print recorded in excellent detail.

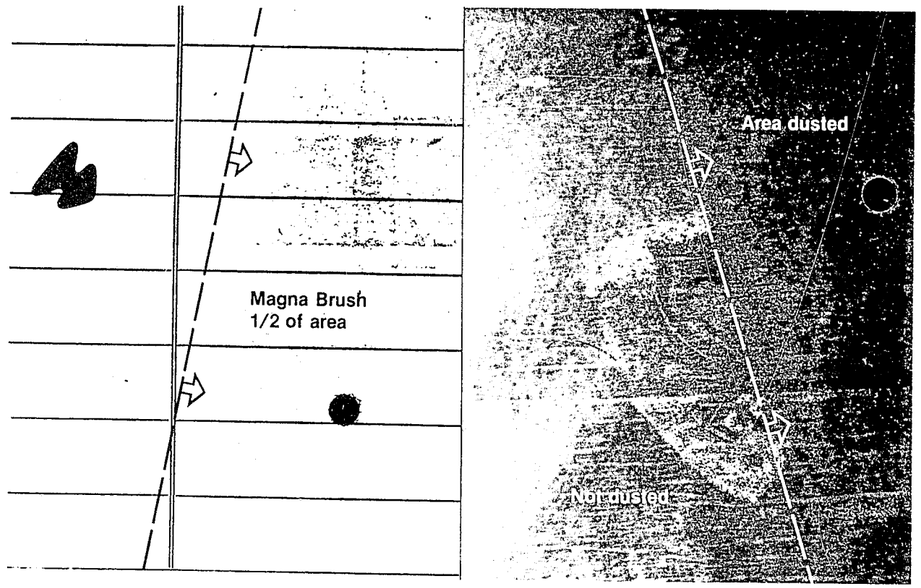
Light-coloured dust against the black carbon background gives good contrast. You will probably notice much more detail in the carbon lift than on the actual exhibit. There is no adhesive quality to carbon paper. Thus the original print is still on the paper. A second or even a third lift can be made with the second lift often superior to the first because all excess dust and debris has gone. Figure 13-3 illustrates an envelope where half of a suspected impression was dusted with a Magna Brush. Note the results. This method of lifting prints can also be applied to dust impressions on doors and counter tops and will occasionally work on a smooth floor surface. It should even be used as a first step on impressions made from a damp boot on paper. The problem with lifting dustprints from floors is that the floor surface usually has a coating of dust with the shoe impression printed over top. The background layer of dust along with the impression is lifted showing no separation between background and impression.

NOTE: *A carbon lift is like a rubber fingerprint lift. It creates a reversed or mirrored image. The lifted impression must be photographically reversed.*

Iodine fuming

Iodine fuming is a fingerprint developing method which works well on footwear evidence. Iodine does not preclude the use of other developing methods but should be used first for optimal results. The advantage of fuming, over fingerprint powders and chemical treatment, is that it does not cause minute detail destruction. Any organic materials or salt crystals deposited on the paper by the impression absorb the iodine fumes which change these areas to a brownish colour. Shoe soles will probably retain a fair amount of organic or salt wastes coming in from outdoors or from walking over a waxed floor.

Iodine fumes rapidly evaporate and the developed impression soon disappears. A method of fixing iodine prints is to apply soluble starch, shake the excess off and pass the exhibit through steam. Most papers and some types of cardboard



A B

FIGURE 13-3: A) One-half of envelope dusted with magna powder. B) Same envelope examined with carbon paper lift. Note: Dusted area bore no evidence.

contain considerable amounts of starch[1] used in sizing. These do not require more starch. Pass the area that has absorbed iodine fumes rapidly (approximately 1 second) through steam which will turn the impression a purplish colour. A marked improvement from the original iodine reaction will be noticed. In some cases the entire procedure of exposing the exhibit to iodine fumes and steaming the paper may have to be repeated three or four times before a satisfactory impression develops. The reaction to the steam will normally cause the impression to improve dramatically. This process will delay the disappearance of the impression for a number of days. Once the impression is enhanced, photograph it immediately. An impression exposed to the steam too long will disappear but it can be redeveloped. Some papers contain so much starch they take on an orange tinge when brought into contact with iodine fumes. Should this happen, allow any iodine excess to evaporate prior to applying steam, otherwise the entire paper will turn purplish. Figure 14-3 illustrates the results of Iodine and steam.

Impressions on materials without starch content can be made permanent using other recognized techniques. One problem. These techniques tend to prevent or reduce the effectiveness of other developing methods.

Fuming pipe

Toxic and corrosive iodine fumes require a glass constructed fuming pipe at

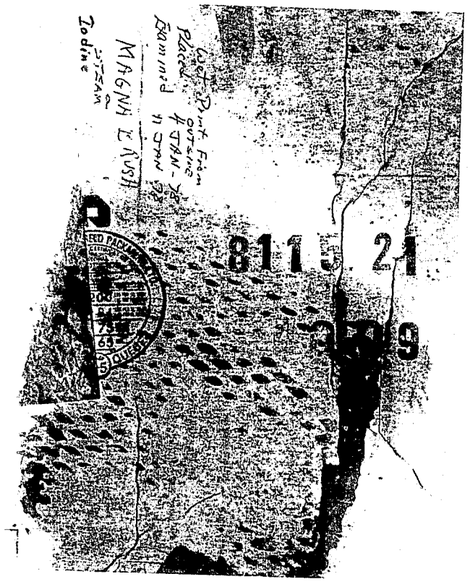


FIGURE 14-3: Same impression located in figure 11-3 examined with iodine fumes and steam.

the scene. The pipe is held in one hand and you blow into a tube connected to one end of it. The heat from your breath and your hand, which is wrapped around the pipe where the iodine crystals are situated, is sufficient to cause the crystals to produce vapour. Tne vapour then reacts with any organic or salt material on the object causing discolouration. The fuming pipe does work, but is difficult to operate at a crime scene and is easily broken. (See Figure 15-3.)

Fuming cabinet

An iodine fuming cabinet can be constructed of glass and wood. Similar results can also be obtained by placing the exhibit in a plastic bag thus entrapping fumes within. Iodine crystals are heated which transforms the crystals into vapour. More elaborate cabinets vent excess fumes to the outside. Glass walls allow the examiner to observe the exhibit being exposed to the fumes. (See Figure 16-3.)

Driodine crystals

A recent development in iodine fuming is a product called driodine. Developed in the U.S.A. by Herbert L. MacDonnell, driodine consists of small glass crystals impregnated with iodine. These crystals control the amount of iodine fumes allowed to escape. It is far less toxic than iodine crystals and can be used at the scene for preliminary testing on horizontal surfaces. Figure 17-3 illustrates driodine crystals.

FIGURE 15-3: Iodine fuming pipe.

FIGURE 16-3: Fuming cabinet window allows visual inspection.

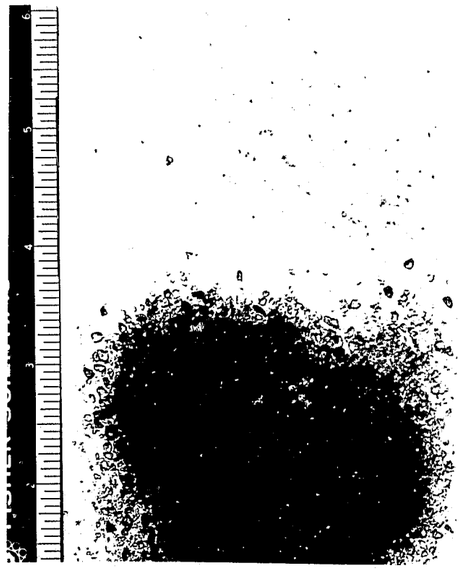


FIGURE 17-3: Examining paper with driodine at scene.

Iodine is rated a fairly toxic substance which should be handled with considerable care. The Handbook of Industrial Toxicology by E.R. Plunkett, 1966, Chemical Publication Incorporated, Page 216, states iodine will cause redness around the eyes and nose, headache, coughing, dizziness, shortness of breath and acne-like ruptures of the skin. Treatment for prolonged eye exposure is to irrigate with a 5 percent solution of sodium thiosulfate which should be administered at a local hospital. These effects can be avoided however, with proper ventilation and by leaving the area as soon as *any* discomfort is felt.

Magna Brush

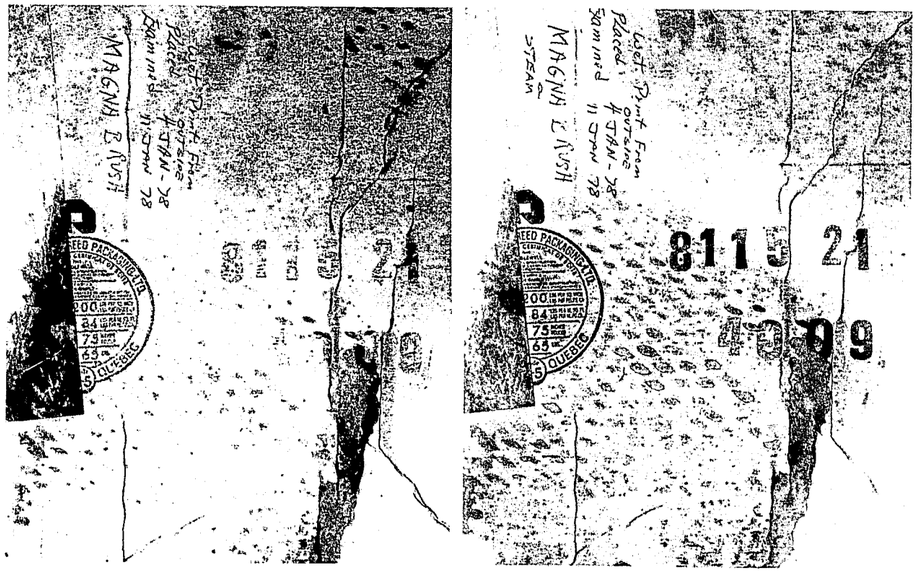
Magna Brush examination of paper for footwear impressions should follow iodine fuming. Iodine works after an exhibit has been dusted with powder, however, chances of contaminating the impression preventing successful fuming becomes greater.

The Magna Brush is a simple device developed by the same person who developed driodine. The brush, in reality, is a magnetic wand which picks up metallic based powder forming a brush like projection on the end of the wand. Exhibits such as paper can then be dusted without brush bristles touching the paper. This is important. A regular fingerprint brush tends to fill in and damage impressions on paper. The Magna Brush develops the print with very little filling in. (See Figure 18-3.)

FIGURE 18-3: Examining paper with Magna Brush and powder.

The print can be cleaned out by running an empty wand just above the surface of the impression. This removes any excess powder. If an impression on paper or cardboard is developed with an ordinary fingerprint brush using black fingerprint powder, it should then be redusted with the Magna Brush and jet black magna powder. Not only will a clearer print be obtained but also a much stronger impression.

Optimum results rely on two procedures when using this method. First, shake the jar before using the powder. Excess powder from previous examinations is usually picked up and returned to the jar. Over a period of time this excess powder becomes weak from repeated use. Shaking the jar ensures the powder is thoroughly mixed and remains active. Secondly, steam the paper just before dusting with magna powder; on weak impressions this will enhance the print. (See Figures 19-3.)



A B

FIGURE 19-3: A) Magna Brush only. B) Impression steamed and re-examined with Magna Brush. Note improvement in some areas.

Breathing heavily over the impression creates a similar effect. Steam, however, will usually do a better job especially on the large surface areas footwear impressions cover.

Impressions can also be developed when dust, wax, salt or moisture is not present on the bottom of the shoe. Most soles or heels will deposit a small amount of plasticizer which is part of the compound making up the bottoms. I conducted a number of tests on impressions made from both old and new shoes. Twenty-four

hours after the impressions were made, excellent results were obtained using a Magna Brush. All tests had a negative reaction to silver nitrate and iodine. Figure 20-3 demonstrates the reaction of new sole and heel material to magna powder.

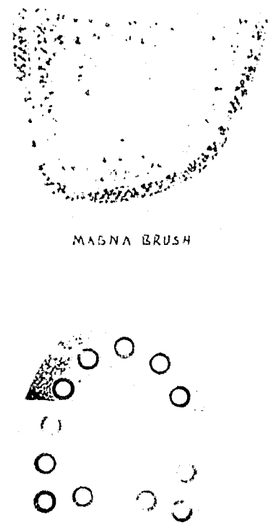


FIGURE 20-3: Magna powder adheres to oils and plasticizer from new shoe.

Normally a shoe will have a film of dirt or dust covering the bottom. Walking on a clean carpet or through water will remove this protective film. A good chance exists of developing the impression with a Magna Brush when this happens.

Silver nitrate

A very effective technique in developing footprints and the final phase for examining paper is the silver nitrate process. This process must be kept as a last resort. Once attempted, success cannot be obtained using the previously described procedures.

Silver nitrate solution reacts with salt crystals to form silver chloride. Silver chloride reacts to ultra-violet light and changes colour to reddish-brown or black. The silver nitrate is mixed in the same amount as for fingerprint examination: 5% solution, one ounce silver nitrate to 19 ounces of distilled water. Tap water can be used, but salt crystal presence in tap water will cause the background to darken.

Salt is abundant in this country from coast to coast. During the winter months tons of salt are spread on city streets and highways. (Even in areas where salt is seldom used on streets, salt still appears.) It may be present in minor amounts in part of the country near large salt water bodies or in areas where a heavy

concentration of salt appears in the soil. Industries may expel a certain amount of salt crystals as waste.

I had a series of tests conducted during the winter from coast to coast in nine different locations in Canada. Instructions to those conducting the test were that they had to go outside on a snow covered or wet street, walk back into the building then around the office briefly and step on some paper. The paper was later treated with silver nitrate. Results from all but one location were salt positive. One negative reaction was due to a misunderstanding of instructions. Tests were also conducted in the latter part of the summer when streets were wet with rain. Again, results were positive! I would suggest the use of silver nitrate year round on impressions made from damp or wet feet, as a final method of examination. An impression made from a damp shoe which reacts to iodine fumes should definitely be examined with silver nitrate. An iodine reaction is a good indication salt is present.

Silver nitrate must be carefully handled and you should wear good quality rubber gloves. Silver nitrate stains cannot be removed from clothes and will take some time to come off skin. Cover the counter top you are working on with absorbent paper several layers thick to prevent staining.

Silver nitrate can be applied to large objects (such as boxes) with cotton swabs. Smaller exhibits such as paper can be immersed in a large tray. Exhibits being treated do not require soaking in the silver nitrate solution but all areas must be coated. Any excess should be removed with blotting paper and the exhibit air dried in subdued light.

Exposing the exhibit to ultra-violet light develops the impression. This can be done a number of ways: sunlight, fluorescent lighting, ultra-violet light (sunlamp,

FIGURE 21-3: Results of treating with silver nitrate. Compare to figure 19-3.

special ultra-violet lamps) or chemicals. Slow development in a room with fluorescent lighting gives excellent results. Although slower than other methods, it tends to develop otherwise unobtainable impressions and you have some control over their development. These normally become visible within 24 hours. Figure 21-3 illustrates the same exhibit seen in Figures 11-3, 14-3 and 19-3 after being treated with silver nitrate.

In one survey, a police department in the Maritime Provinces submitted some papers which had been seized four months earlier, bearing faint footprint impressions. They were obviously made by damp shoes. I used silver nitrate to see if they could be enhanced. Not only were the impressions improved, but some areas were also developed which were not originally visible.

Silver nitrate can also be successfully used on bare smooth unpainted wood. Footwear impressions made from wet shoes are sometimes visible on this type of wood but these cannot be developed with powder because of wood porosity.

Static electricity lift

There are occasions when signs of footwear impressions are visible on surfaces such as rugs, or fabric on chairs, from the dust or dirt deposited by shoes. Due to the texture or colour of the material, these impressions are seldom recovered. Few crime scene examiners would expect to find much of value here in any event.

In 1970, a Japanese police officer developed a method of lifting footwear impressions from floor matting using vinyl plastic charged with a very high voltage.[2] The high static charge was obtained with electronic equipment along the lines of the high voltage section in a black and white T.V. set. The vinyl mat was made up of three parts:

1. Black vinyl plastic top.
2. Tinfoil centre, which was connected to the high voltage unit with a high voltage lead with Koronguard (TM) design. This special cable prevents internal and external cable arcing.
3. Black vinyl plastic bottom.

The three pieces when bound on the edges formed the static lifting mat.

To lift an impression, the mat is laid over the impression area. The high voltage unit is connected to the mat with the high voltage lead and the unit connected to a 110 A.C. outlet is turned on. When the high voltage rectifier has built up sufficient charge (approximately 15-20,000 volts in one minute) the unit is turned off. Before touching the mat, the high voltage is discharged by grounding the cable connecting terminal on the mat with a ground cable from the unit. Once discharged, the mat can be turned over. Any impressions lifted will contrast against the black vinyl plastic mat. Examination should be carried out in a dark or dimly lit room using a strong oblique light (see floor lighting procedures). Impressions are photographed immediately. Remember, like the carbon paper lift, impression laterality is reversed.

The principal behind this lifting technique is that the static charge on the mat attracts dust particles left from the shoe. Tests that I have conducted with a prototype of this unit demonstrates it works better than most would think. Large cuts from the shoe will sometimes be visible on tight weave carpeting such as the indoor-outdoor type frequently found in business premises. Pattern design which is

totally latent on the carpet becomes visible even on some short shag carpets. Exterior measurements of the shoes are often recorded quite accurately, because the shoe sinks into the carpet recording the entire sole and heel surface.

Earlier I discussed lifting dustprints from paper, doors, counter tops and floors with carbon paper. The advantage of carbon paper is availability. However, I have found the static mat will also lift impressions from these surfaces. In fact, the result in some cases is much better.

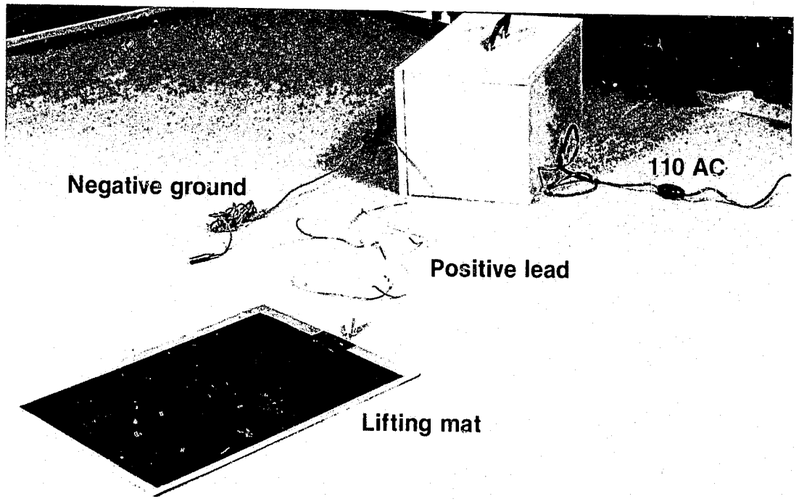
The ability of the static mat to lift footwear impressions increases when the power unit rests on the same surface as the area being examined. For example, when a paper exhibit is being examined on a table, the power unit should also sit on the table. Where this is not possible, such as a chair, connect the ground cord to the same surface the impression is on. Although not as good, it will improve the lifting ability of the mat.

The static mat can also be used to clean out excessive dust or dirt from impressions, especially on floor surfaces. The cleaned out impression should then be rephotographed.

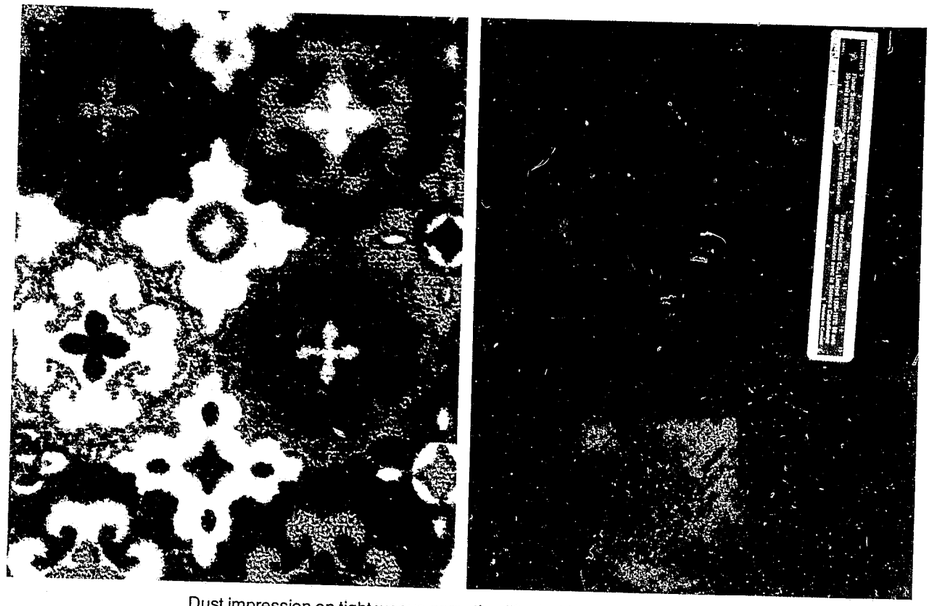
The static charge used to attract dust particles can be created without a high voltage power unit. Simply lay a single piece of black vinyl plastic over the suspected area then stroke the plastic in one direction with a piece of fur. The static charge created will lift impressions from similar surfaces as carbon paper. Dust impressions on carpeting or fabric surfaces can also be lifted, although not as well as with the power unit.

The advantage of the power unit is that larger areas can be covered with static electricity. Figure 22-3 illustrates the high voltage unit in operation and some results. *The high voltage created from a power unit can be dangerous. Caution should be exercised when using this equipment.*

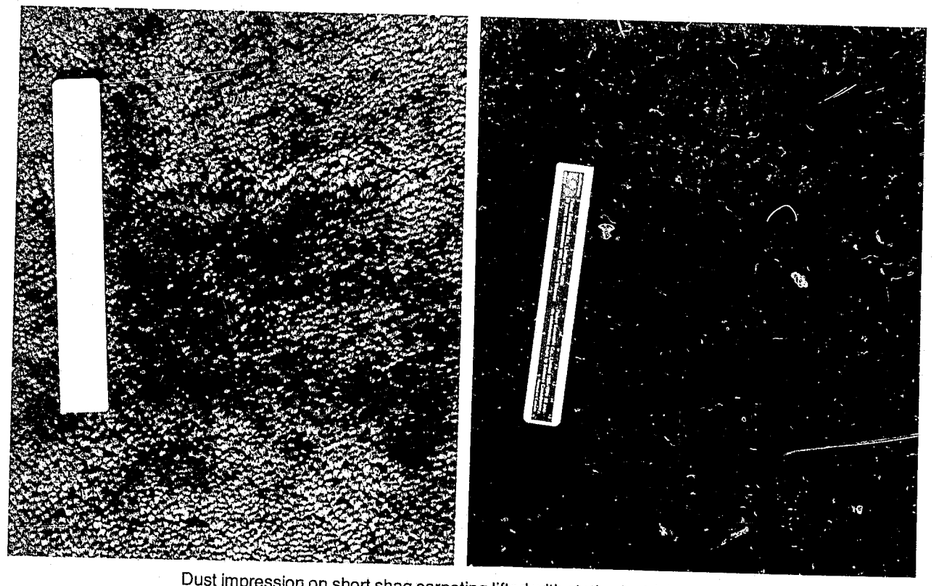
FIGURE 22-3: **Static electricity mat.**



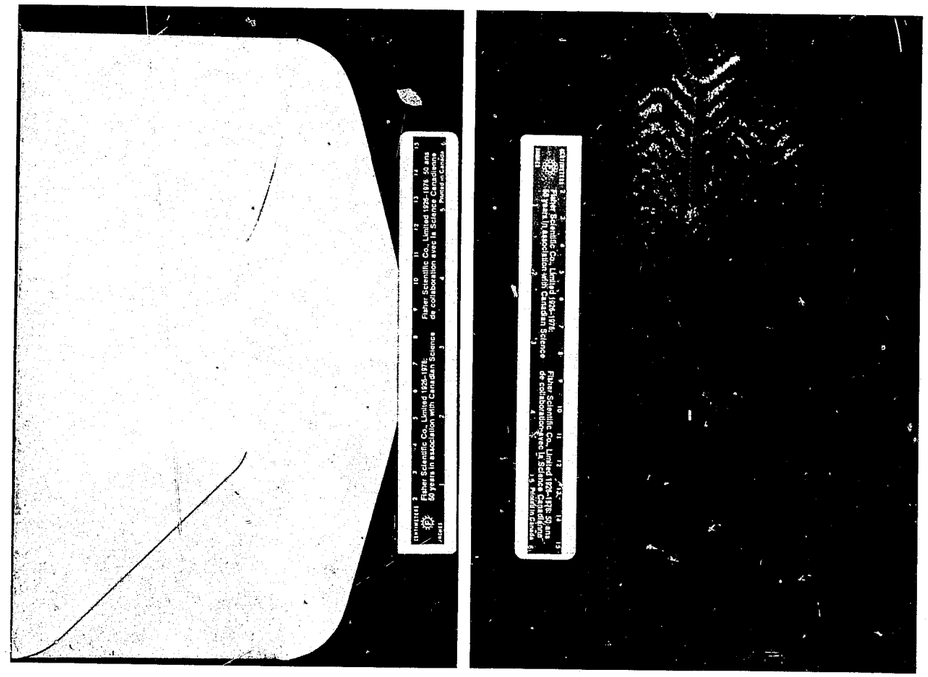
Power unit attached to AC outlet. Positive cable attached to mat connector. Negative cable used to discharge mat once power is turned off.



Dust impression on tight weave carpeting lifted with static electricity mat.



Dust impression on short shag carpeting lifted with static electricity mat.



Dust impression on envelope lifted with static electricity mat.

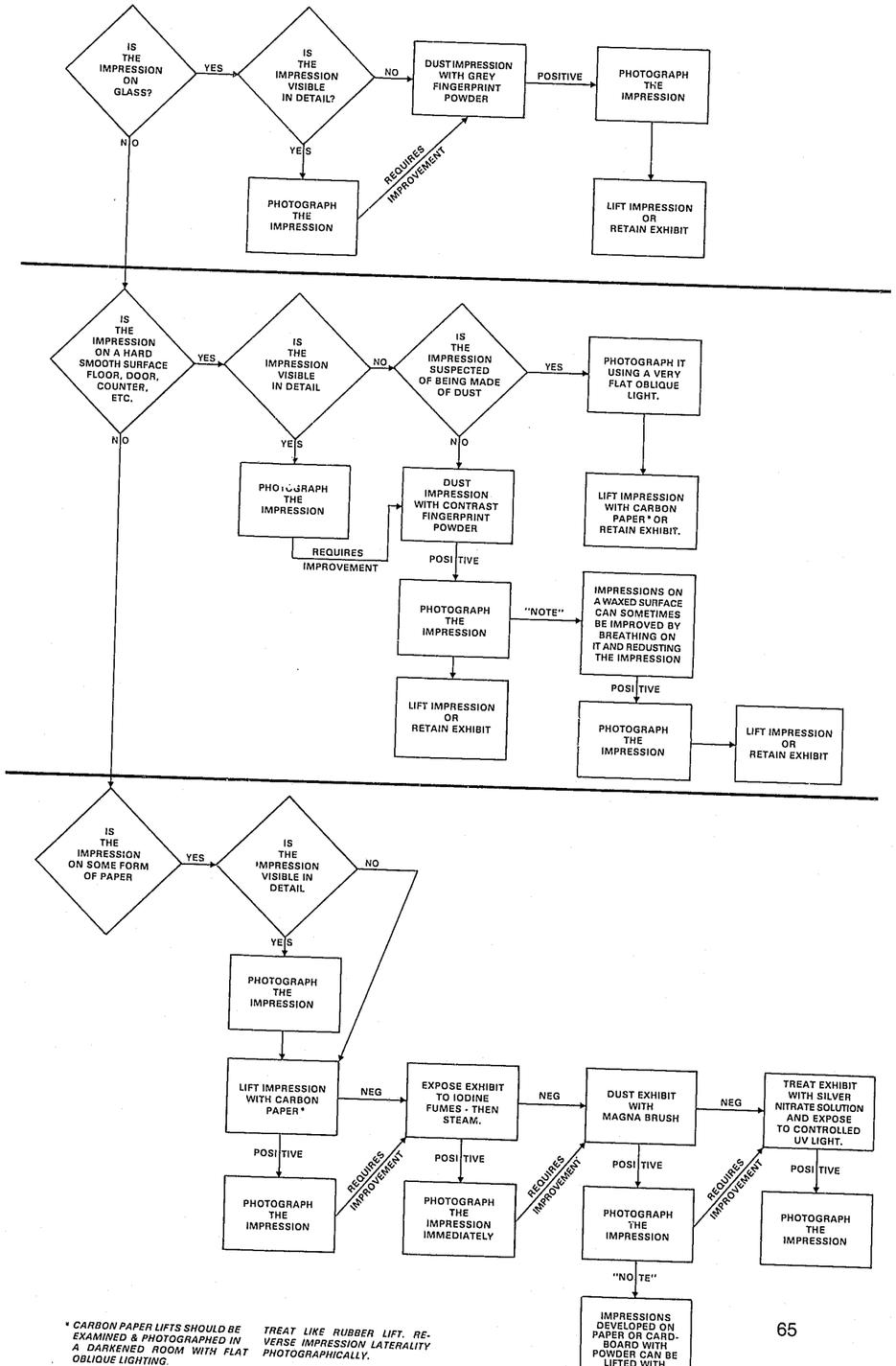
Summary

In this chapter I have discussed many methods of enhancing or developing impressions on two-dimensional surfaces. Dust can be photographed or lifted with either carbon paper or static electricity. Foreign materials such as waxes, oils and salts can be enhanced. Even the material from which the sole is made possesses certain residues that absorb fingerprint powder. Most impressions can be enhanced by one or more of the methods discussed: photography, iodine fuming, fingerprint powders, lifting methods or silver nitrate. The probability of a criminal not leaving some form of footwear evidence on two-dimensional surfaces is extremely remote. Our job is to use known methods in the best possible way and develop evidence to its fullest potential.

References

1. Andre A. Moenssens, *Fingerprint Techniques* (Philadelphia, 1971) p. 119.
2. National Police Agency Tokyo, "An Electrostatic Method for Lifting Footprints", *International Criminal Police Review*, (November, 1973) pp. 287-292.

RECOVERY OF TWO-DIMENSIONAL FOOTWEAR IMPRESSIONS



* *CARBON PAPER LIFTS SHOULD BE EXAMINED & PHOTOGRAPHED IN A DARKENED ROOM WITH FLAT OBLIQUE LIGHTING.*

Chapter 4

Manufacturing of soles and heels

Should you, as an identification officer, possess general knowledge about how shoe bottoms (soles and heels) are designed or constructed? Should every identification officer visit a factory where these are made? Are some new soles more unique or individual than others because of the way they are made? Would courts give more weight to your credentials if you possessed this general knowledge? Figure 1-4 and 2-4 illustrates two footwear impressions. A number of areas are marked out which could be considered accidental characteristics. Are they? Read this chapter and find out.

Obviously the cost of sending identification officers to factories would be prohibitive. The companies involved would soon tire of giving police officers continual tours.

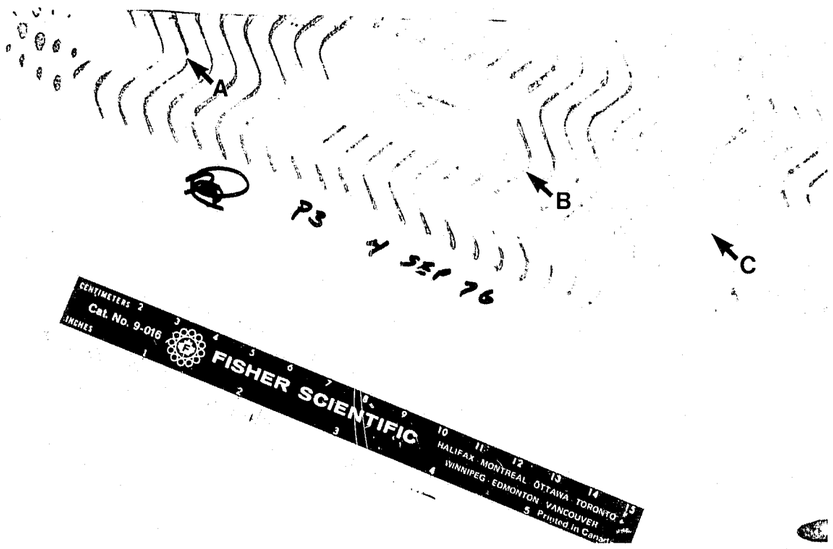


FIGURE 1-4: Marks A, B & C. Are these accidental characteristics?

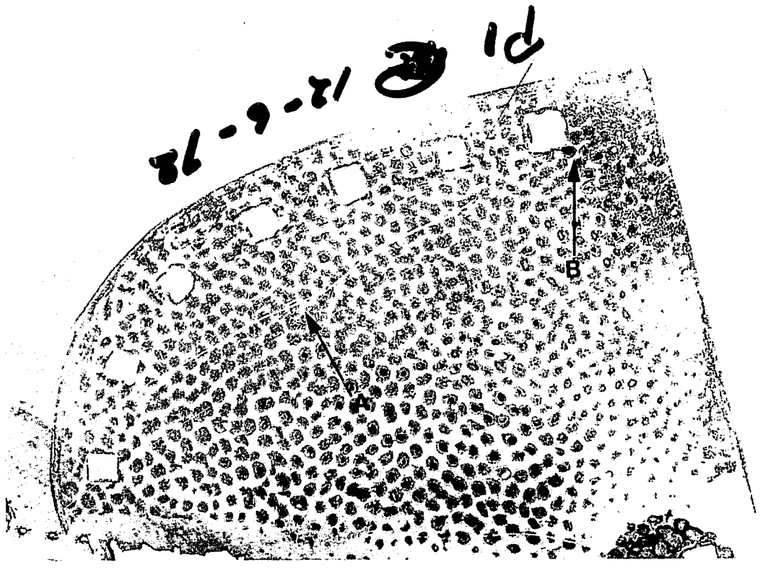


FIGURE 2-4: Marks A & B. Are these accidental characteristics?

To gain some understanding of how shoe bottoms are made I visited Bata Shoe Industries, American Biltrite (Canada) Ltd., Baron Rubber Company and Minor Company Limited; all are Canadian footwear manufacturers. These visits allowed me to observe the main techniques used in developing soles and heels. I also saw the manufacturing process for some molds.

Years ago, soles and heels had no pattern. They were constructed of leather with the shape of the bottom cut out by hand. Until the 1800's all shoes were made this way. In 1858 Liman Blake invented a machine designed to sew the soles of shoes to their uppers.[1] This invention was the beginning of shoe mechanization. In 1976 there were 165 shoe manufacturing companies in Canada producing just under 50 million pairs of shoes per year. Imports from countries like Taiwan, Korea, Italy and the U.S.A. exceeded Canadian production. The total number of pairs of shoes sold in Canada during 1976 was over 100 million, representing approximately 4.33 pairs per person. So diverse are shapes, patterns, colours and sizes that less than one percent of the yearly production of the average shoe factory is identical.[2] This difference, especially in sole and heel patterns, makes footwear identification a practical task. Could you imagine the problems we would face if every person's shoes had identical sole or heel patterns?

This chapter will deal with six different methods of sole and heel development:

1. Die-cut soles.
2. Calendered soles.
3. Compression molding.
4. Injection molding.
5. Slush molding.
6. Crepe rubber.

Most of these methods owe their development to the use of synthetic materials and excellent bonding cements.

Die-cutting

Die-cutting is the simplest and least expensive method used primarily for cutting out leather and natural crepe soles. Figure 3-4 depicts a die-cutting machine and a number of different sized dies. This particular machine is used for stamping out crepe rubber soles.

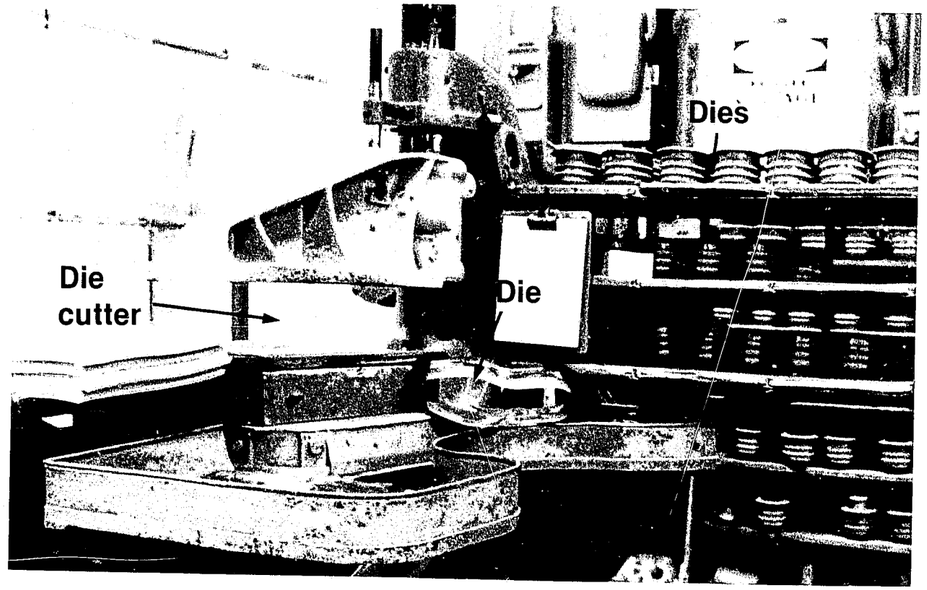


FIGURE 3-4: Die-cutting machine and various size dies.

Leather, when used as a bottoming material, is subjected to a series of buffing operations with fine sandpaper. Once a fine velvet smooth nap has been achieved, a series of stains and waxes are applied and it is polished to a high lustre.[3] Although strong and durable, leather rapidly changes through wear. A new pair of leather soled shoes will show a significant surface change immediately after they have been worn, unlike the more resilient rubber compounds.

Calendered soles

Calendered soling is a method of producing soles in Canada for rubber boots, rubber overshoes, leather top rubber workboots and snowmobile boots. It is also used in producing bottoms for some imported inexpensive canvas running shoes.

The compound from which the soles are made is first heated to 150 - 170°F on a warming mill illustrated in Figure 4-4. Flaws may be evident in the final product if

the proper compound temperature and viscosity is not attained. The compound may become too hard or soft which in turn will not accurately record the engraved pattern on the calender roller. (See Figure 5-4.) These flaws are common in this form of calendering.

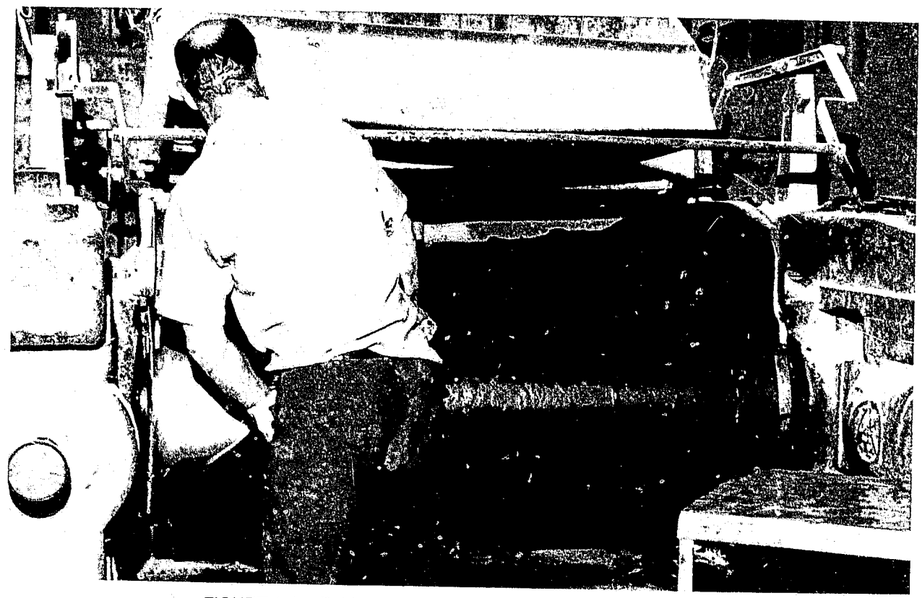


FIGURE 4-4: Rubber compound being warmed in warming mills.

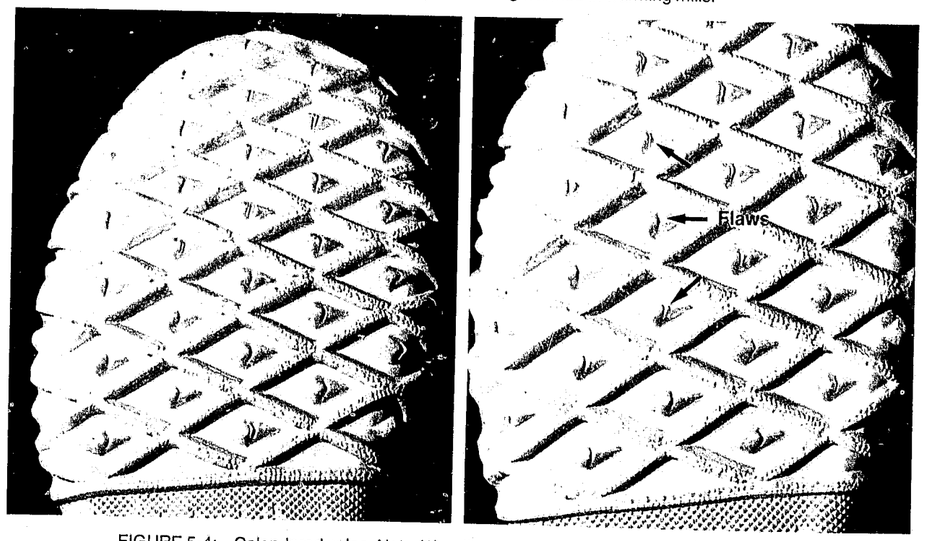
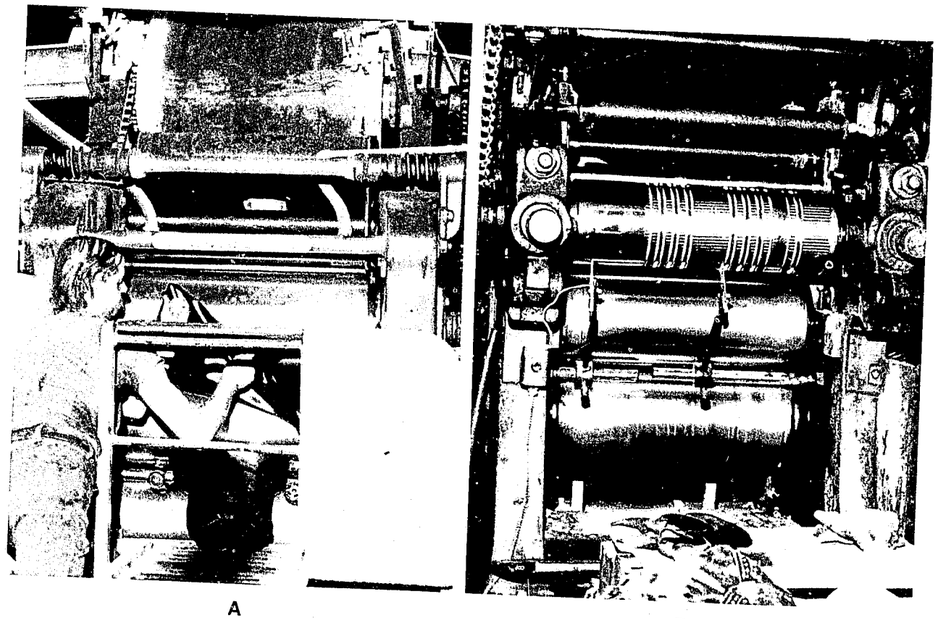


FIGURE 5-4: Calendered soles. Note (1) pattern changes at edge of soles and (2) flaws.

CONTINUED

1 OF 3



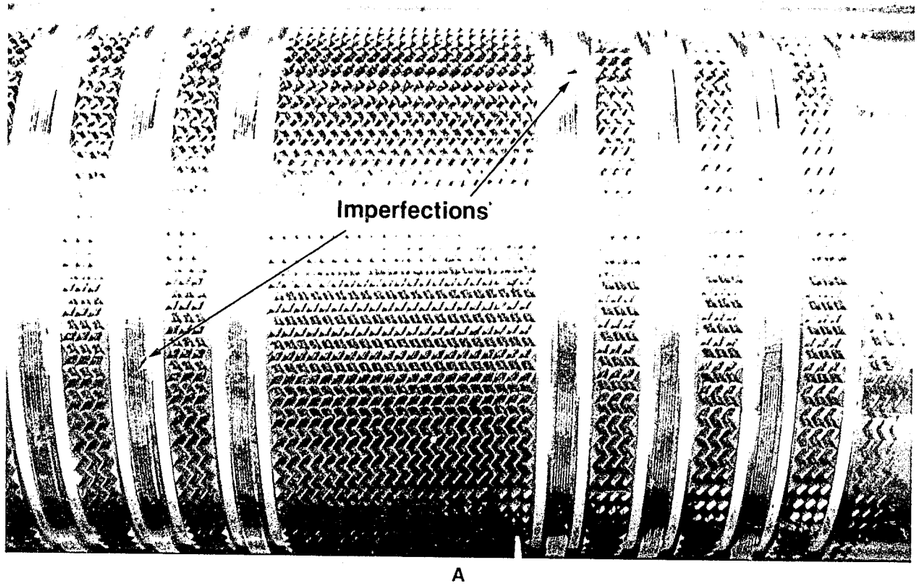
A B

Figure 6-4: Soling calender. A) Rubber compound being fed into calender. B) Final roller has engraved pattern.

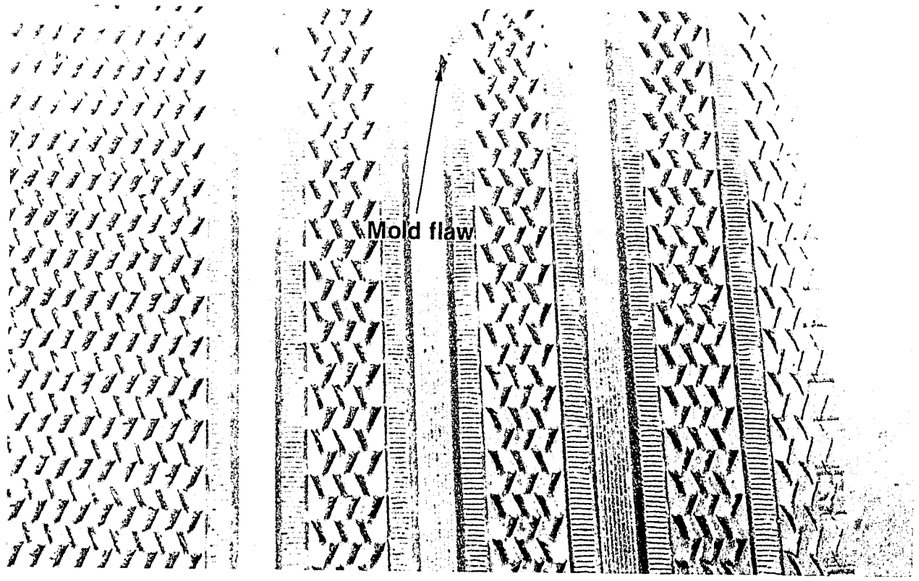
Once the compound is warmed up, it is fed into a machine called a "Soling Calender". This machine consists of a number of smooth rollers, usually 3 or 4, the last of which bears the engraved sole pattern. (See Figure 6-4.) It is subject to damage with use and this damage is passed on to the calendered stock. This is illustrated in Figure 7-4.

The calender stock is taken by conveyor belt to another area where it is cut to workable lengths approximately three by two feet. Once cut, it is stored on racks for a short time before being removed to another area where the bottoms are cut from the stock. The pattern on the compound from the time it is engraved until the soles are cut out, receives some distortion caused from handling. It has not yet been vulcanized and is still soft and pliable. A cutting machine cuts out the sole shapes. Figure 8-4 illustrates a "Wellman Outsole Cutter". A knife guided around a template cuts the rubber leaving a beveled edge. A beveled edge ensures a good join when the sole is attached to the uppers. *This edge also is an indicator to the footwear specialist that the sole was made by the calendering method*. (See Figure 9-4.)

A very important part of this process for the footwear specialist is the manner in which the soles are cut out. Strips of stock are manually manipulated through the cutter. *The possibility of an operator cutting two soles exactly duplicating the cut on the pattern design would be remote*. Figure 10-4 depicts two soles cut one after



A



B

FIGURE 7-4: A) Imperfections illustrated on calender. B) Imperfections reproduced on final stock material.

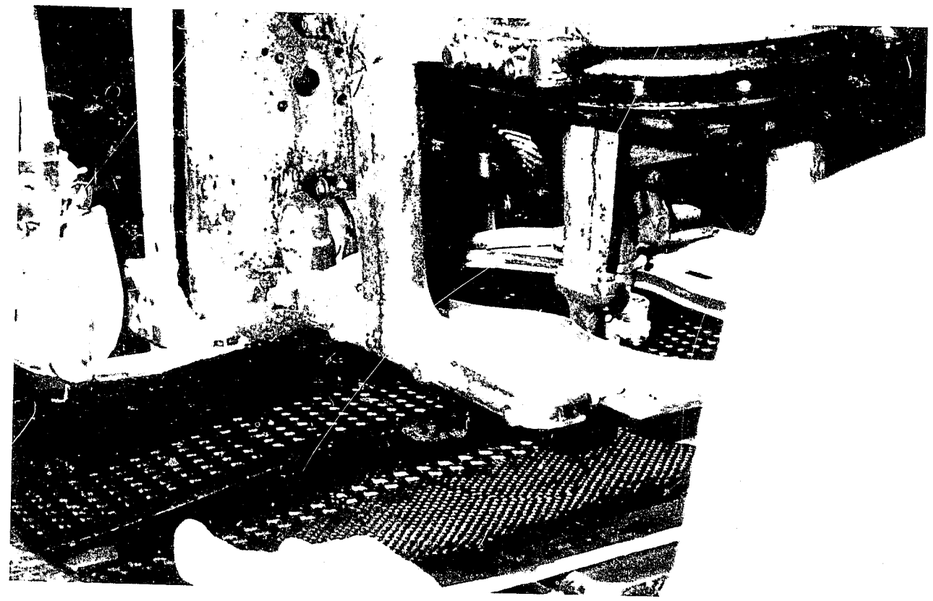


FIGURE 8-4: Manually operated, "Wellman outsole cutter".

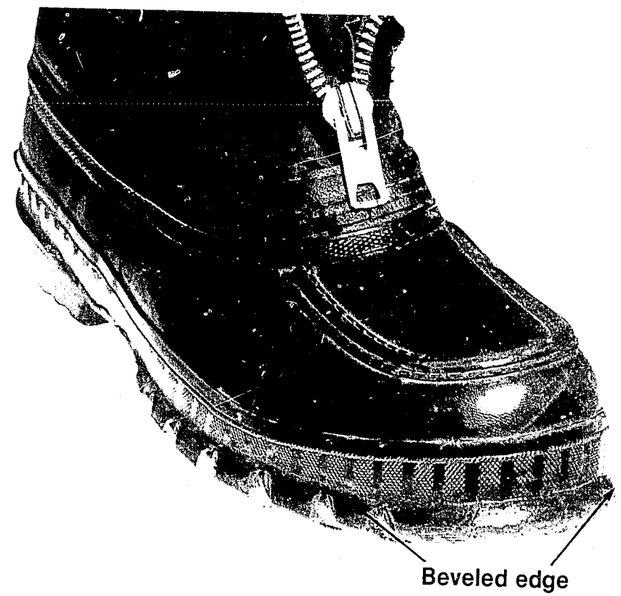


FIGURE 9-4: Bevelled edge indicates calender soling.

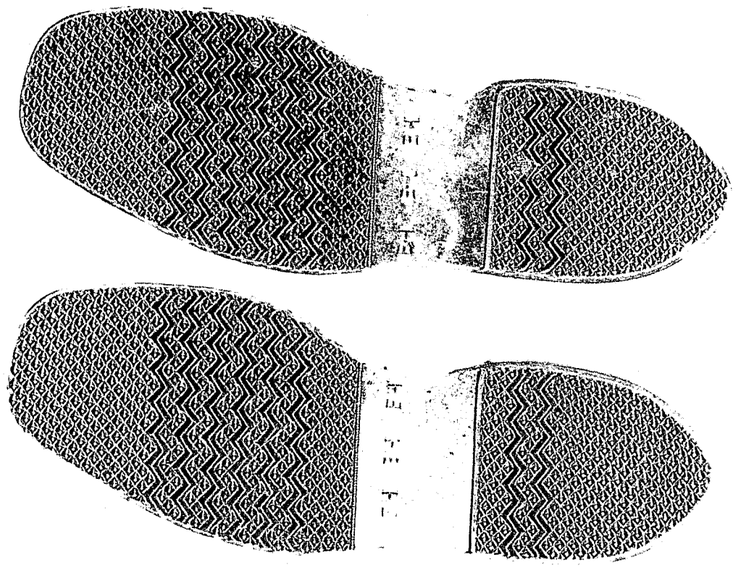


FIGURE 10-4: Two calendered soles cut in succession on "Wellman out-sole cutter". Note pattern differences on edge.

the other. Figure 5-4 depicts two separate soles of boots the same size. Note the obvious differences in the pattern at the edges. Research reported on page 88 lists in order some of the other reasons why this pattern design will vary from shoe to shoe.

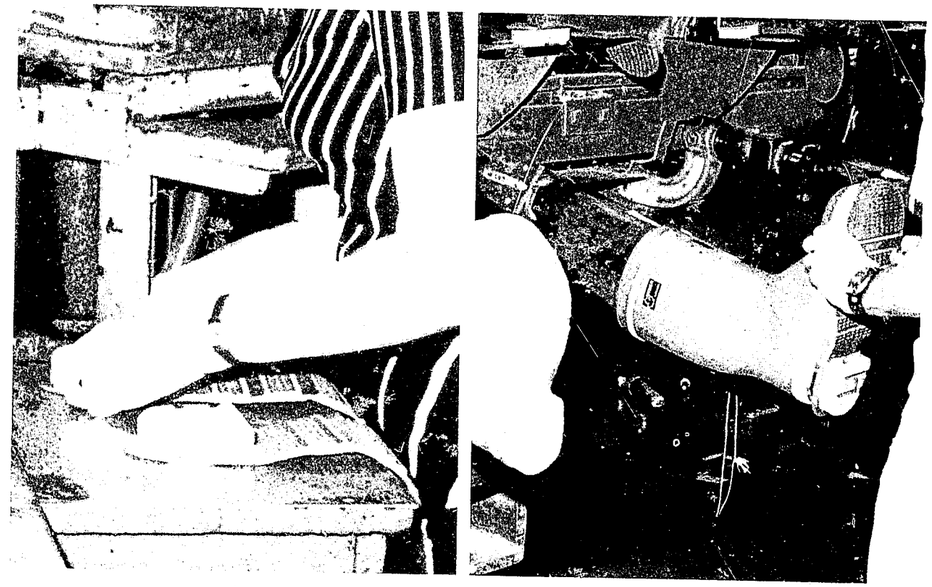
If you were to find a sizeable portion of the pattern at the scene (particularly out to the edge of the sole), and the fact that the suspect's shoe pattern completely agreed with the scenes-of-crime impression and were you to establish the sole was made by this method, your evidence would carry far more weight in a court of law than for any other sole pattern that had been made from an individual mold. The information which will help determine whether or not the sole was calendered is: the presence of a bevelled edge; the type of boot; and changes in sole pattern design at the edges of a number of boots of the same type and size.

The heels on some boots using calendered soles, such as rubber boots and snowmobile boots, are made by the compression molding method which is discussed next.

Although the pattern of these heels may be identical, their position in relation to the soles could be different and is a factor to consider when making a comparison.

The heels are attached to the sole by hand then both are manually placed on the boot. (See Figure 11-4.)

Up to this point, the sole stock is quite soft and pliable. If stretched, it remains so. Any blunt or sharp object dropped or rubbed across the material would make a permanent mark. After the boot, sole and heel are attached they are placed in a large vulcanizing chamber at a temperature of approximately 270°F. Temperature



A B

FIGURE 11-4: A) Heels attached manually to calendered sole. B) Calendered sole and heel attached to boot manually.

and pressure in this chamber activates the vulcanization or the cross linking of sulphur in the compound with the rubber, thereby increasing its physical properties such as strength, abrasion and elasticity. Within a couple of hours the material is vulcanized and can be handled without damage.

Earlier, I drew attention to the fact damage was evident in some of the calender rolls. Although the flaw is duplicated in the sole material, the possibility of it showing up in the exact area of the sole on a shoe is unlikely due to the random manner in which the soles are cut.

Compression molding

Compression molding is a common manufacturing method for producing soles and/or heels on workboots and shoes. Replacement heels and "gym" shoe bottoms are normally produced using this principle.

With this technique the compound is cut to a specific weight and size, referred to as a biscuit, which is placed into a mold illustrated in Figure 12-4. The mold is closed and loaded onto the platform of a hydraulic press. (Shown in Figure 13-4.) The biscuit is compressed under intense pressure at the same time the mold is heated. This allows the compound to become a positive replica of the mold. Because of the intense pressure and heat the final sole is accurately recorded. The heat activates curing agents in the rubber compound which causes it to vulcanize.

Sole molds come in pairs, each mold holding from one to six pairs according to size. Heel molds usually consist of twenty-five to thirty-six cavities for each size.

FIGURE 12-4: Biscuits placed into compression mold.

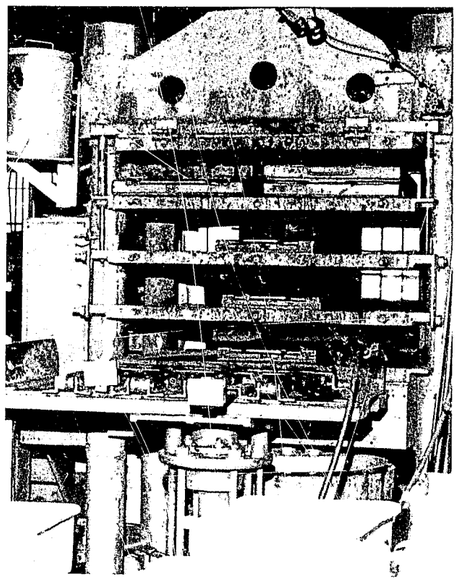


FIGURE 13-4: Compression molds placed on shelves on hydraulic press.

Heel molds with predetermined nail holes, contain small pins approximately half the depth of the mold cavity. The purpose of these pins is to establish nail hole positions. Before the biscuits are placed into the mold, small washers which prevent nails from being driven through the heel when attached to the shoe, are placed on top of the pins. These washers become embedded midway in the final heel. The shape of the pins and their position, will be duplicated on every heel and have no significance when establishing identification other than as a class characteristic. Any obvious deviation in the shape of the hole becomes significant as this would *normally* be caused by wear and tear. In fact, cuts are frequently located around these nail holes in worn shoes. Figure 14-4 depicts biscuits being placed into the heel cavities.

Molds are quite expensive. Most companies, therefore, have one mold per size, except for the more common sizes 8, to $10^1/_2$. These may require two to three molds to maintain production levels. Many soles and heels have numbers printed on the reverse or inner side which could determine mold and cavity origins. Shoe factories do not always make their soles and heels. They may purchase them from companies who specialize in this field. In these cases the company making the bottom material will sometimes include their name on the inside of the sole or heel. (See Figure 15-4.)

Injection molding

Injection molding is one of the more recent developments used in running shoe soles, flat bottom casuals, winter boots and shoes where the sole and heel

FIGURE 14-4: Heel biscuits placed on top of compression mold nail hole pins and washers. This mold produces 30 heels at one time.

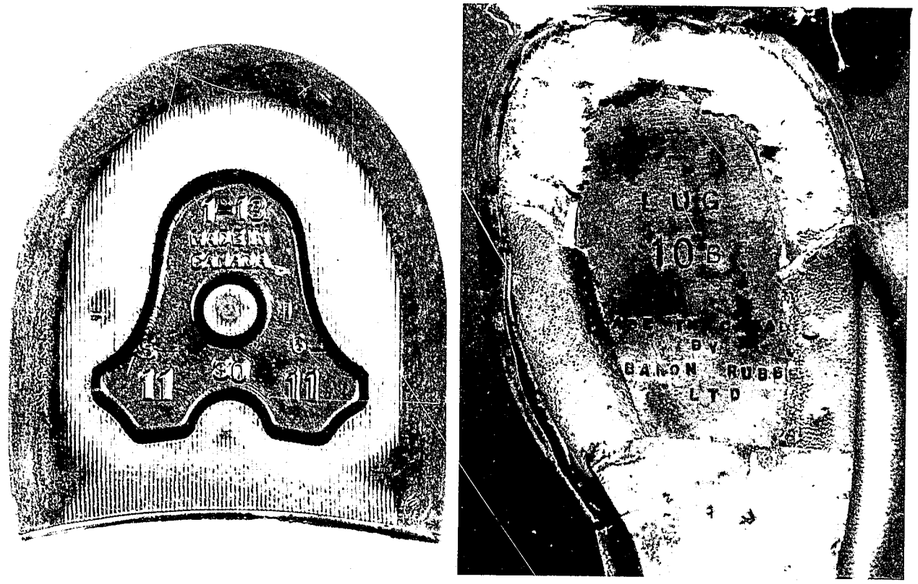


FIGURE 15-4: Sole and heel illustrating manufacturer's mold numbers, sizes and other information.

are of unified construction. This type can generally be detected by examining the edge of the sole or heel where there may be a mold design.

The compound in the form of small pellets, is stored in a hopper at the rear of the machine. Heated in a chamber (extruder) linking the hopper to the mold machine it is injected into the closed mold under controlled pressure upon reaching the correct temperature. Figure 16-4 depicts an injection mold machine. The mold cavity is cool. Through chemical additives in the thermoplastic compound the sole is rapidly set. It is removed by hand or in some machines ejected automatically. Figure 17-4 depicts the two parts that make up an injection mold. Figure 18-4 shows this machine with the molds open ready for sole ejection. Some types of injection machines form the bottom material right on the shoe, although this has no significance for identification purposes.

In the early part of this chapter, Figure 1-4 depicted three possible accidental characteristics in a running shoe impression. These marks were not accidental. Machines with automatic ejectors require some means of ensuring the sole will remain in that portion of the mold containing the ejectors. The machine illustrated in Figure 18-4 has ejectors in the lower portion of the mold. Should the sole stay in the top part it will not eject automatically. To overcome this problem small air jets in the opposite half of the mold allow air pressure to hold the sole in the lower cavity. Not all injection molds have automatic ejectors. Careful examination of the mold in Figure 19-4 illustrates these air holes. These type of holes caused the marks A, B and C in Figure 1-4. These might not show up in the same place were you to examine any sole of similar design and make. You would have to be sure the sole was from the same mold. You should look for this type of mark in newer shoes.

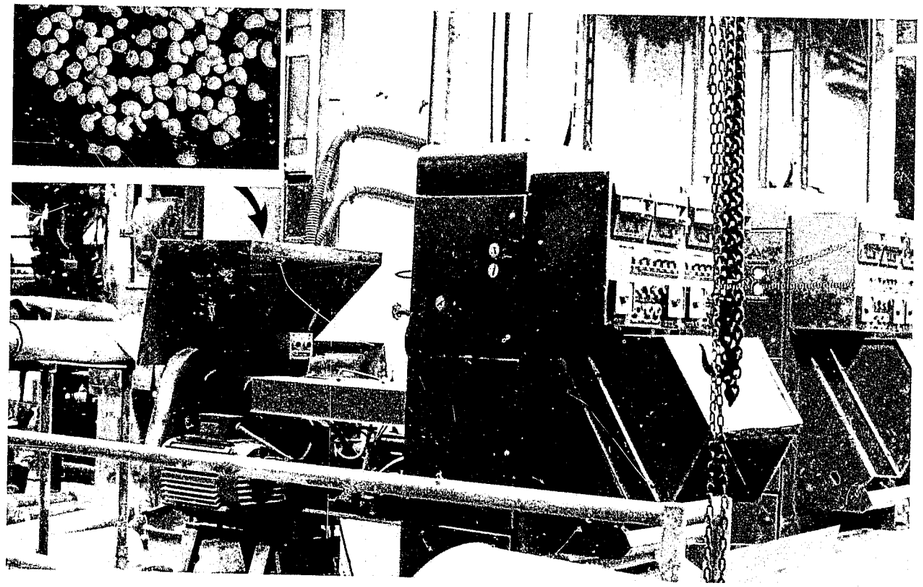


FIGURE 16-4: Injection mold machine. Insert shows thermoplastic pellets.

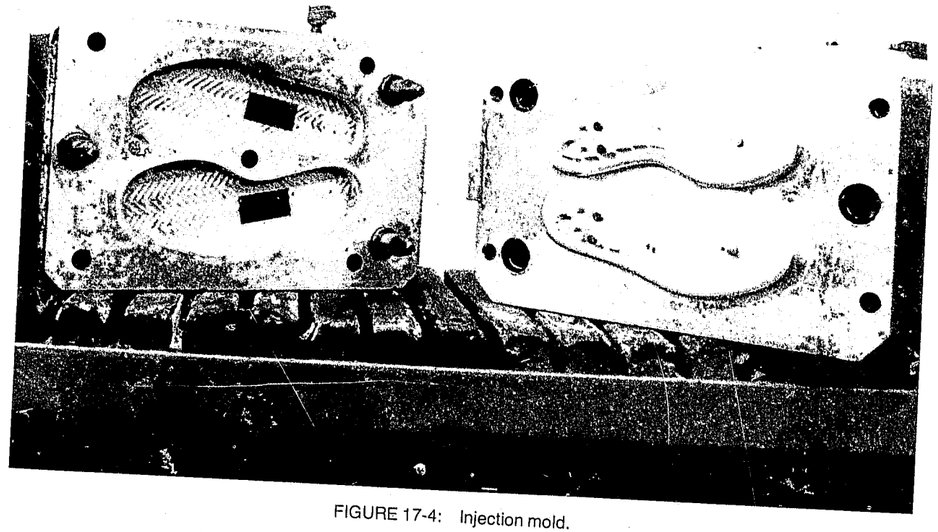


FIGURE 17-4: Injection mold.

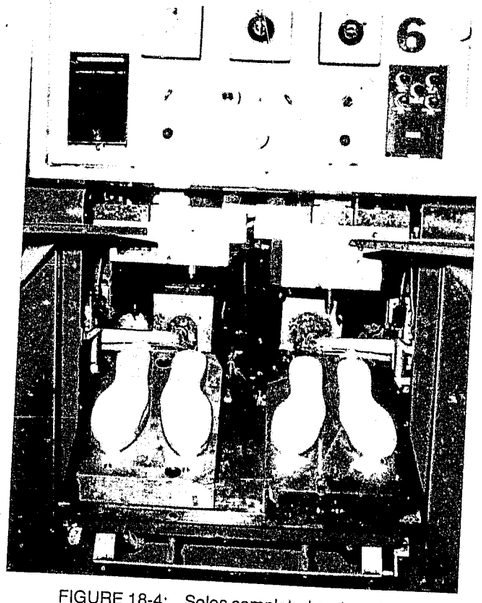


FIGURE 18-4: Soles completed and ready for automatic ejecting.

These marks could still be found in worn shoes even after considerable use, especially under the arch region where less foot pressure is exerted. Their incidence may vary but might total three or four to a complete pattern.

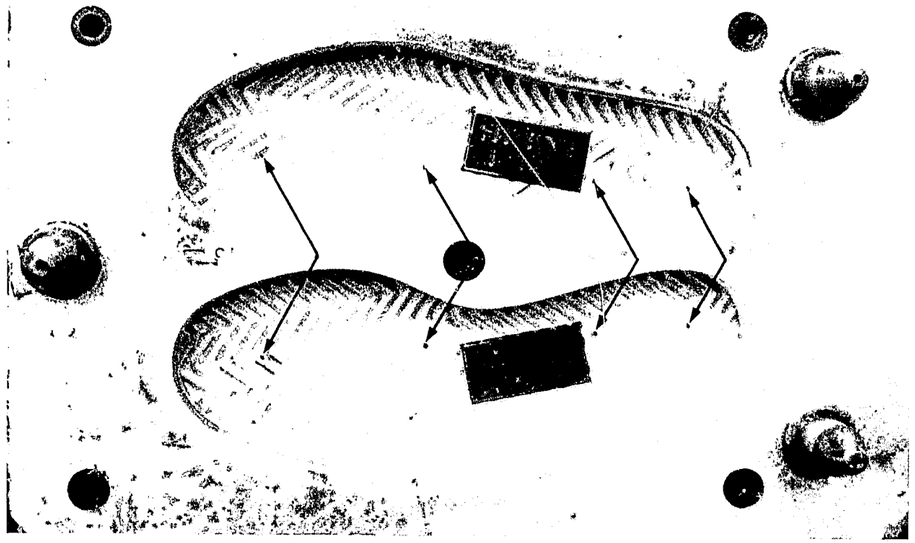


FIGURE 19-4: Small air jets located in top half of mold.

Figure 2-4 shown at the beginning of the chapter has two areas marked out A and B. A appears to be a long cut across the heel and B a nick out of a nail hole. These marks are not accidental and occurred during the manufacturing process.

When the molten material is injected into the mold cavity, it flows across it in a river delta like manner. As the cavity fills the cooling streams of compound flow together forming one mass. The long cut depicted is caused where two of these streams joined. Because temperature and pressure are constant, the marks occur in the same place everytime. This type of mark is only visible on smooth hard surfaced soles. It is not very deep and would disappear soon after the shoe is worn. Figure 20-4 shows the mold from which Figure 21-4 originated. There is no cut in the heel area. In the mold, an attempt was made to rectify the problem by putting small holes near the toe. These holes created marks on the toe area of the sole which could also be mistaken as accidental characteristics. The nick is merely the pattern around the imitation nail holes in the mold and is repeated on every heel. Figure 21-4 shows two heels taken from the above mold. Note the similar imperfections. All these flaws can be detected by examining other soles made from the same mold. When you find yourself with this kind of a problem, numbers printed on the inner surface of the sole can be useful. By contacting the company you may be able to obtain a sole from the same mold. This is not necessary for all identification cases but when dealing with fairly new shoes or characteristics in areas showing little wear, it could be helpful.

FIGURE 20-4: Mold used to produce heels illustrated in figure 21-4.

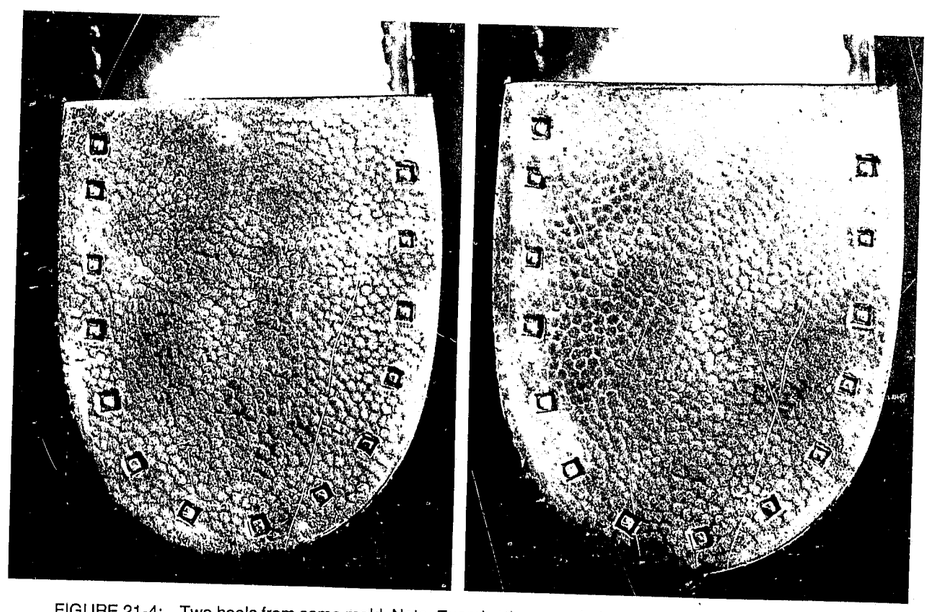
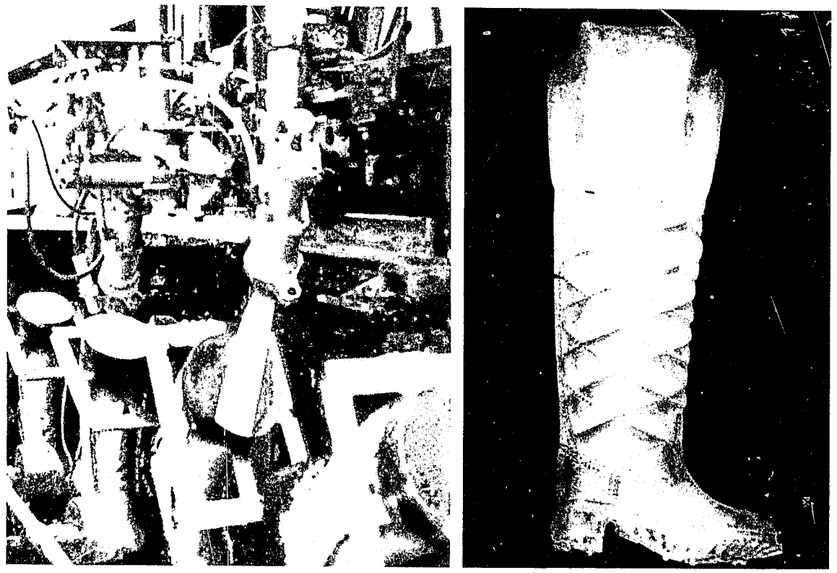


FIGURE 21-4: Two heels from same mold. Note: Examination revealed no signs of cut marks in the mold.

Slush molding

The monoplax or slush molding process is a recent development especially in women's and children's winter boots. The primary difference in this method is that the entire boot, uppers and bottoms are one molded unit.

In this form of shoe making, nickel hollow molds are attached to a continuous conveyor belt. The inside of the nickel mold bears the complete design of the boot which includes the sole and heel pattern. There are molds for each foot of every size with the possibility of more than one mold for the more common sizes. A synthetic material "plastisol" is poured into the hollow mold and passed through a heating chamber. The material next to the mold cures forming a solid skin. The excess material is then poured off. Extra plastisol is then added to the sole and heel to give that area extra thickness and strength. The molds are passed through a few more heating chambers then cooled. The plastisol is now in a solid cured state ready to be removed from the hollow mold. The final boot becomes an accurate positive replica of the mold. The possibility of damage to this form of mold is probably less than to those previously mentioned. Should any damage or flaws occur in the mold they will be duplicated and could be observed as mold flaws by examining a number of boots of the same size and design. There are no numbers identifying the individual mold except possibly the shoe size. Figure 22-4 illustrates the plastisol being poured into a mold. Also illustrated is a production mold from which a hollow nickel mold was made.



A B

FIGURE 22-4: Slush molding procedure. A) Plastisol injected into mold. B) Production mold used to make hollow nickel molds. (Photos courtesy Bata Industries Limited – Footwear Division.)

Quality control

In all the factories I visited, I observed quality control exercised to varying degrees. With the exception of the calendered soling, the methods I saw did not produce soles and heels with large cuts and abrasions. Soles or heels in this category were discarded.

Mold construction

Molds are very expensive and take considerable time to produce. Some cost in excess of $5,000 each. Obviously they do not become obsolete quickly and should they be damaged, are generally repaired rather than replaced.

While visiting The Baron Rubber Co. I had the opportunity to see how they made molds for the injection mold machine. The aluminium block from which the mold is constructed, was engraved using a "pantograph machine". This is illustrated in Figure 23-4. It operates along the same principles as a mechanical printer such as the Leroy Set used in drafting. The right side of the pantograph bears the pattern design or shape of the sole. The left side cuts the aluminum block. Engraving is done by the operator guiding the machine through the template. Templates can be interchanged to allow for combinations of patterns. Some of the fine engraving is later performed by hand.

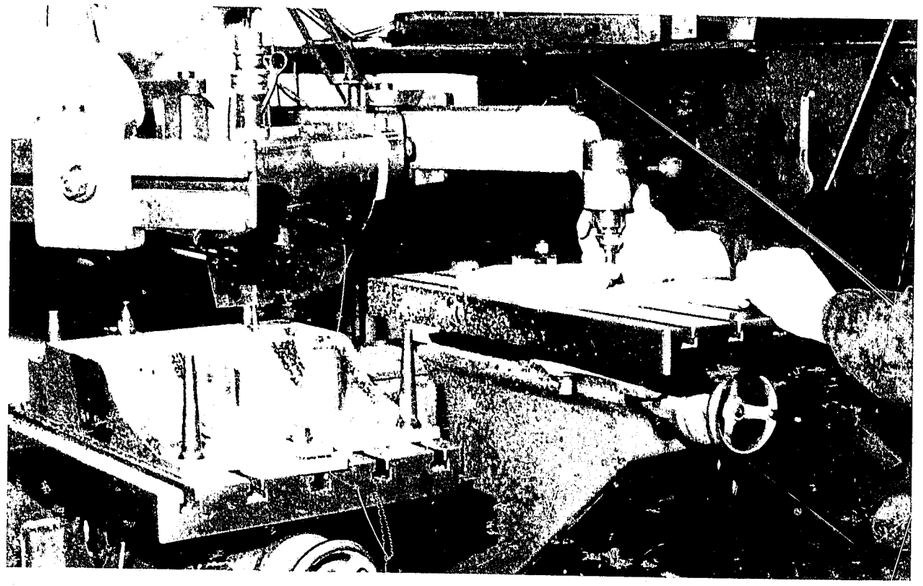


FIGURE 23-4: Molds being machined on pantograph machine.

Each mold cavity, including heel molds, is individually engraved. Therefore, each heel from a different mold cavity will show differences which may be obvious or difficult to detect; but they are there.

Crepe rubber

The word crepe is defined in Funk and Wagnalls, Standard College Dictionary as: "(1) A thick fabric of silk, cotton, wool, or synthetic fibre having a crinkled surface, (2) Black Crepe as used as a sign of mourning, as in an arm band: in this sense usually "Crepe", (3) crepe paper, (4) crepe rubber (derived from french — tissu) crepe crinkled "cloth", derived from latin (crispus) curled." Crepe rubber then is a crinkled, curled or pebbly surfaced rubber.

The use of crepe rubber as soling material is common today, normally used for casual shoes and winter boots. Crepe rubber manufacturing has a particular significance to footwear identification. Unlike other soles and heels the pattern is not created from a mold but occurs naturally during the processing stage.

The bulk of natural rubber is obtained from the "hevea brasiliensis" tree located in a 30° belt, 15° north and south of the equator. Most commercial rubber comes from rubber plantations, hence the term plantation rubber. There are two basic types of crepe used in shoe bottoms:

1. Natural plantation pale crepe rubber (sole crepe grades).
2. Remilled crepe rubber.

Plantation crepe rubber

The rubber latex derived from the hevea tree is diluted to an approximate 20 percent content. The latex is then coagulated by adding dilute formic or acetic acid after which it is formed into sheets. The treatment of the coagulum differs depending on the type and grade of rubber made. Coagulated rubber used for crepe soling purposes is passed through a series of milling machines. (A milling machine has a number of uses in a rubber factory and consists of two rollers side by side on a horizontal plane.) The rollers used in creping can either be smooth or grooved or in some cases a combination of both. The rollers turn towards each other at different speeds. The coagulated rubber sheets are passed through a series of eight or nine mills with rollers set progressively closer together so the final sheet of crepe is approximately 1mm thick. During the creping process, water jets remove any impurities from the rubber. The grooves on the mill do not form a pattern as such, rather they masticate the rubber to allow thorough washing. Crinkling or pebbling of the rubber is the natural reaction to the intense pressure when being passed through mill rollers while still cold. (This will be explained further under the heading *Remilled Crepe*.)

The rubber is dried after creping. Thin sheets of pale crepe are layered to desired thicknesses for soling purposes. The layered rubber is then naturally bonded together by passing under moderate pressure through another form of mill, called a sheeting mill. The degree of pebble is determined by the thickness of the individual crepe sheets. Soles can be made with smooth plantation crepe (Figure 24-4) or pebbly plantation crepe (Figure 25-4). The shape of the sole is manually and randomly cut from the crepe sole sheets with a die-cutter as shown in Figure 3-4.

Crepe not immediately made into soles is formed into large solid bales weighing up to 250 lbs. These are then shipped around the world to rubber factories.

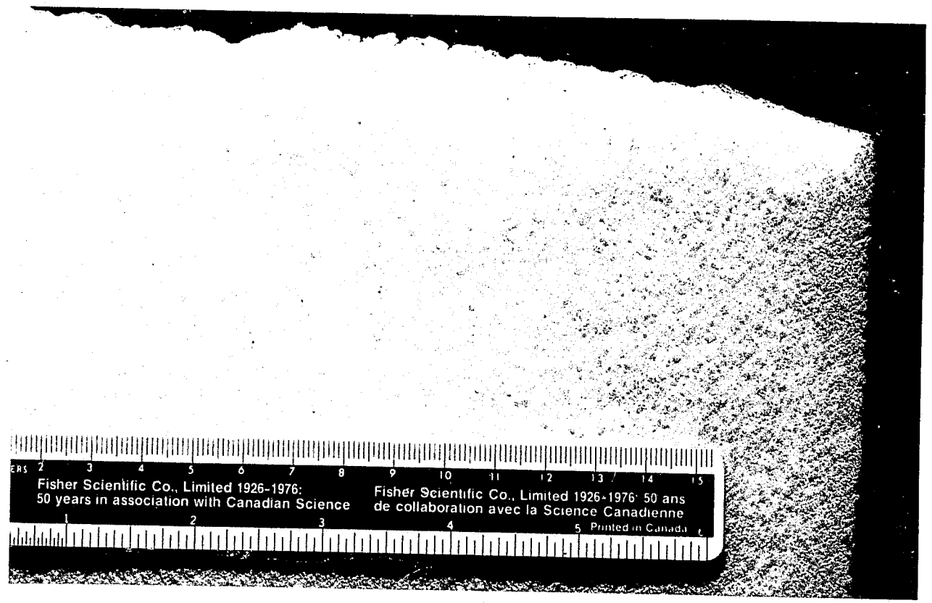


FIGURE 24-4: Smooth plantation crepe.

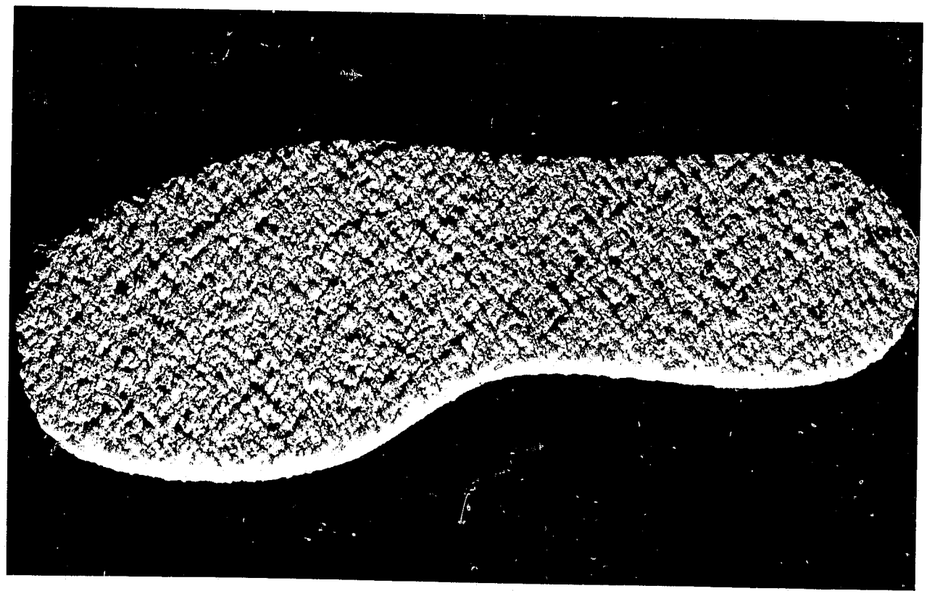


FIGURE 25-4: Pebbly plantation crepe.

Remilled crepe rubber

During my visit to Bata Industries, I observed procedures for remilling natural plantation crepe rubber from its baled form.

The baled crepe, after being chopped up into workable pieces, is passed through a mill consisting of two *smooth rollers*. The rollers are water cooled on the inside. This avoids heating through friction, which could cause the rubber to become gummy. Figure 26-4 illustrates a milling machine used to form remilled crepe rubber.

The rollers are initially set to form sheets of crepe approximately 1″ thick. Because only natural rubber is used (without fillers such as clay, cork, etc. found in other soling compounds) when it is released from the intense pressure of the milling rollers, it takes on a very rough texture. (See Figure 27-4.)

The rough rubber sheets are cut to a workable size, approximately five feet by twenty inches. These are once again passed through the mill with rollers now set approximately 1mm apart. This reduces the sheet thickness to approximately 2mm with a surface texture similar to that found on most crepe soles on the market today. (See Figure 28-4.)

The actual thickness of the final sole varies from company to company and is produced by layering the 2mm thick sheets of crepe. A natural bond will form when the layers are passed through a final sheeting mill under moderate pressure. The sole is then cut from the final sheet on a die-cutting machine. This cutting process is accomplished manually with the die randomly placed. Cutting waste is collected and recycled through the same process as used to remill the baled plantation crepe.

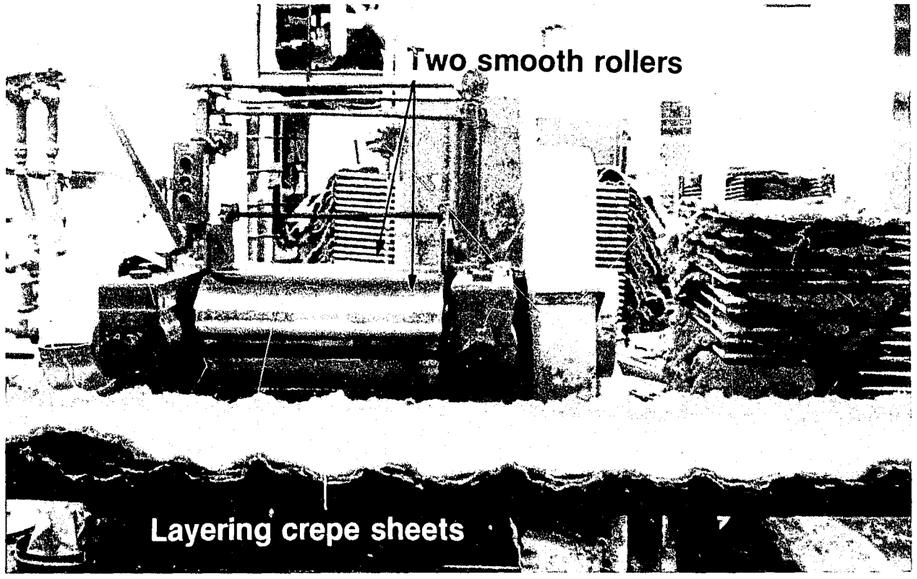


FIGURE 26-4: Milling machine used for "remilled" crepe rubber consists of two smooth rollers. Crepe rubber sheets in foreground are being layered to correct thickness.

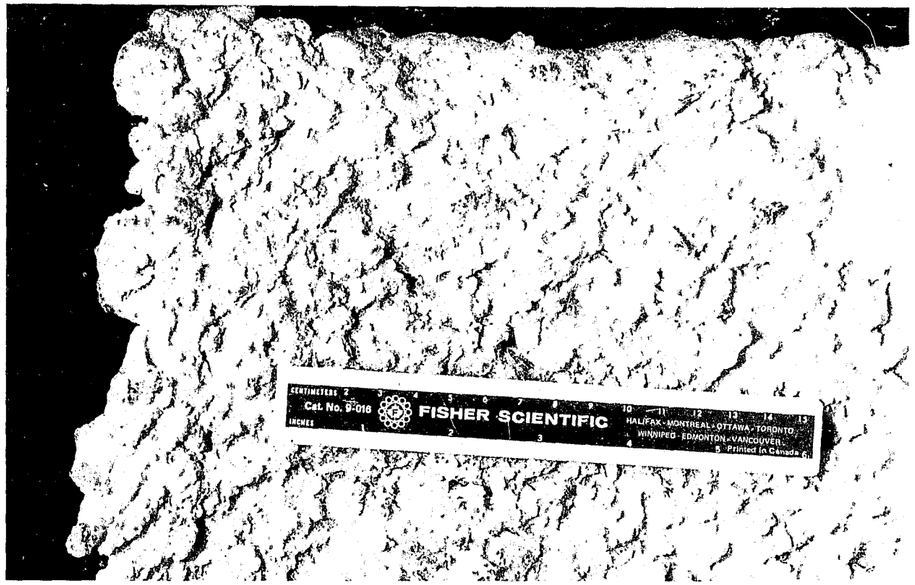


FIGURE 27-4: First pass of remilled crepe rubber through mill.

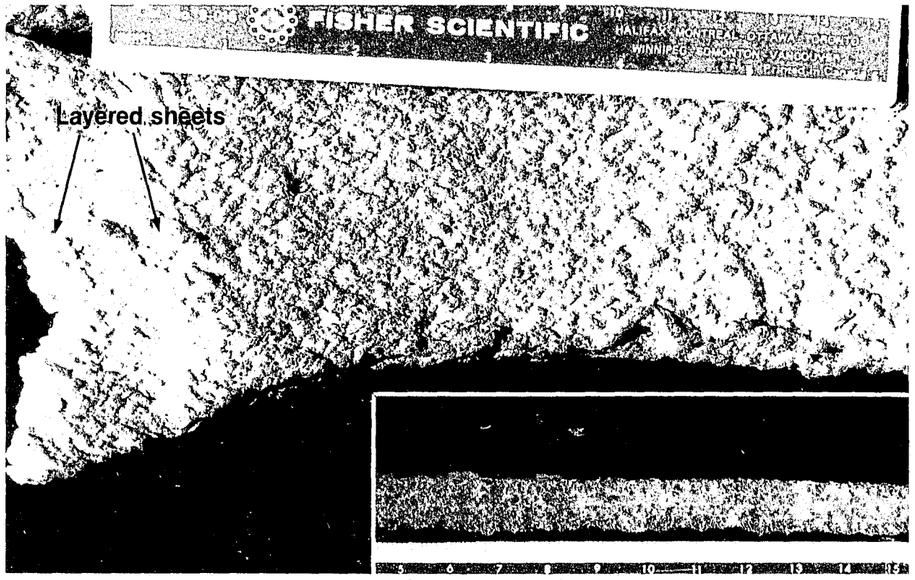


FIGURE 28-4: Final pass of remilled crepe rubber through mill. Insert illustrates layering effect.

In 1950, Charles W. Zmuda, laboratory technician for Dade County, CBI Lab, conducted a study of crepe soled shoes.[4] During his investigation, he reported examining nearly 200 such soles, over 100 consecutively cut soles and nearly 50 sole assemblies. No two crepe soles examined were found to be exactly alike. He listed the reasons for this chronologically:

1. Elements causing variability in the original crude rubber.
2. Variations in plastisizing and mixing before calendering.
3. Variations caused by irregular tension in conveyor removing sheets.
4. Nature of roll engraving.
5. Variable shrinkage after cutting.
6. Random handling and moving of cut sheet from storage to cutter.
7. Random nature of the sole cutting procedure and variations in assembling the sole with the mid sole.
8. Variations caused by vulcanizing.

Reviewing his conclusions, I feel his study dealt with ribbed crepe rubber seldom used today. The rib was in fact calendered. It would appear his examination dealt with the ribbed design and not the natural pebble caused from creping. The reasons given describe calendered soles rather than creping. His study actually verifies the fact calendered soles would unlikely repeat themselves.

Imitation crepe rubber is becoming popular in the shoe industry today. Some of these look quite realistic. Unfortunately, they are manufactured using an injection mold process with each sole from the same mold identical. Natural or remilled crepe rubber can often be verified by examining the sole edge. Layers of crepe used for determining thickness may be visible. Real crepe also has a softer more pliable texture than synthetic rubber, which can be quite easily detected. Finally, the reverse side of real crepe rubber will also show pebble whereas imitation crepe will be smooth or have large air spaces to reduce sole weight. In cases where you are not sure, simply remove the insole and check the reverse side of the outersole.

Do crepe soles differ from one another?

To determine the individuality of remilled and natural crepe rubber I conducted the following tests:

1. Test impressions from 29 new remilled crepe soles were examined. Each sole was compared to the remaining 28 totalling 812 comparisions. No two were found to be similar.
2. Test impressions from 16 worn soles, both remilled and plantation crepe, were recorded twice totalling 32 test impressions. The 16 individual shoe impressions were compared to the remaining 31 test impressions totalling 496 comparisons. No two test impressions from different shoes were found to be similar.

Initially it is difficult to examine a crepe sole impression as no structured design pattern exists. By viewing the impression and forming shapes or figures in a specific area such as faces, letters or numbers, identification becomes remarkably easy. Figure 29-4 shows a crepe rubber impression with an area which appears to me to be a wolf head. When asking someone else to see the identification they could be asked to form their own images as two individuals may not interpret them the same way.

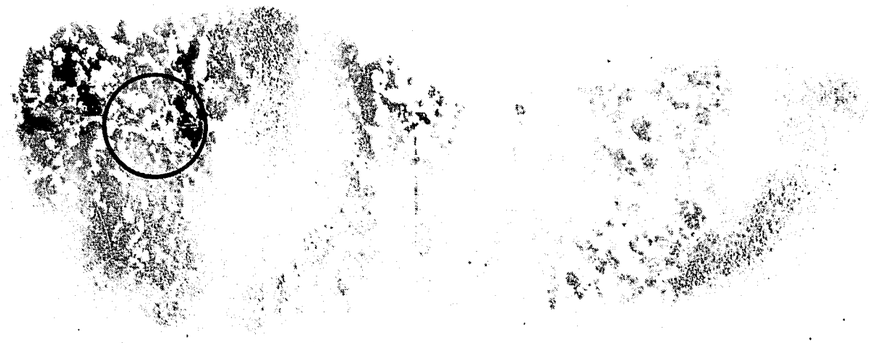


FIGURE 29-4: Examine areas of crepe rubber impressions. Circled area resembles image of wolf head.

During these tests an extensive surface area of each sole was compared to other soles. For example group "1" had a total of twenty-nine different areas of each sole compared to each other. Group "2" had a total of sixteen different areas compared.

The way crepe rubber soles are made and from the tests I conducted, I am satisified no two crepe soles even when new will be the same.

Conclusion

In this chapter an attempt has been made to give a basic overview about heel and sole manufacturing methods. False characteristic interpretation could lead to false identification. The investigator therefore must become aware of the consequences of possible incorrect interpretation of accidental characteristics which are in fact class characteristics. Confirming doubts can only lead to greater objectivity on the part of the examiner.

Evidence dealing with crepe soles or calendered soles is of more value to one who understands how they are made. Most shoe manufacturing companies are more than willing to assist the police when required. The name of the factory which made the shoe can usually be obtained from a shoe store selling that particular brand. There is a Canadian shoe manufacturers' association in Montreal, Quebec, which may also provide assistance.

References

1. Maribeth Cuccinelli, *The Art and Science of Footwear Evidence*, (Virginia, 1974), p. 2.
2. *ibid.* p. 3.
3. *ibid.* p. 47.
4. C.W. Zmuda, "Identification of Crepe-Sole Shoes", *Journal of Criminal Law* 44, (1953), pp. 374-378.

Chapter 5

Identification of footwear evidence

Talking in physical comparison terms, identification, particularly in footwear and tool mark evidence, is more than just identifying an object from common categories. Rather, it refers to a degree of individuality. Identification begins once evidence is collected and a suspect shoe is found. This chapter will deal with this individuality and how it is determined.

1. Which process or rules are followed to establish identification?
2. Can these rules be philosophically stated?
3. Who should conduct the examination?
4. What experience and knowledge level is paramount to form an opinion?
5. How does footwear identification compare with fingerprints and other physical evidence forms?
6. What are the minimum number of characteristics required to establish positive identification?

Identification process

Any identification method can be expressed under the headings ANALYSIS, COMPARISON AND EVALUATION,[1] which contracts to the acronym "ACE".

ANALYSIS — "An unknown item must be reduced to a matter of its properties or characteristics which may be directly observed or measured."

COMPARISON — "The properties or characteristics of the unknown are then compared to the known."

EVALUATION — "Similarities or dissimilarities in the properties or characteristics will each have a certain value for identification purposes. The significance of which will be determined through evaluation."

The objectivity of an examiner who follows this process remains beyond question. I should point out that many accidental characteristics in a footwear impression do not become apparent until the boot is examined.

The inexperienced examiner should always have his identification work re-examined and confirmed by a qualified person. Only a qualified examiner can testify in court. This is not to say the experienced technician should not seek assistance on difficult cases. Training and experience develops the necessary confidence in one's ability to form proper conclusions and express them in a court of law.

A method of examining footwear evidence known as the "overlay method" (placing the unknown impression over the known impression) has one weakness. The examiner may see non-existent characteristics on one of the impressions. This is particularly true with examinations that take hours or days before an opinion can be formed. Simple awareness of that fact can avoid error. In some cases the examiner may wish to have someone else view certain characteristics to ensure this problem does not exist.

Characteristics

There are two separate phases involved in an identification:

1. **CLASS CHARACTERISTICS** — In footwear these would be size, shape, style and pattern design. Predetermined nail holes and flaws in the mold repeated in every sole or heel in the same place are also considered class characteristics.
2. **ACCIDENTAL CHARACTERISTICS** — These are cuts, tears, wear marks and randomly placed nails and flaws acquired during or after manufacturing, but not reproduced on subsequent soles or heels manufactured.

All forms of physical comparison identification begins with the agreement of class characteristics. Accidental characteristics are used to establish individuality.

Philosophy of identification

A philosophy of identification has been thus expressed "...when any two items contain a combination of corresponding or similar and specific oriented characteristics of such number and significance to preclude the possibility of their occurrence by mere coincidence, and there are no unaccounted for differences, it may be concluded that they are the same, or their characteristics attribute to the same cause...."[2] This is a cumbersome statement as far as footwear is concerned. I would say: "FOOTWEAR IDENTIFICATION IS ESTABLISHED BY AGREEMENT OF CLASS CHARACTERISTICS AND ACCIDENTAL CHARACTERISTICS OF SUCH SIGNIFICANCE OR NUMBER THAT NO OTHER LOGICAL CONCLUSION CAN BE REACHED".

Because it would be impossible to examine every shoe of similar class characteristic in existence, findings become an expression of probability. The field of probability is an extremely complex world of statistical analysis. However, the philosophy of identification lends itself to the *law of compound probability*.*

The problem of applying the law of compound probability to the philosophy of identification is: what mathematical fraction can be attributed to each characteristic? Thousands of similar characteristics and similar shoes would have to be compared to develop the necessary statistical data. Unfortunately, accidental characteristics in a sole or heel are nondescript, except to say they may be categorized as minute, moderate or highly individual. Interpretation given to these nondescript characteristics is quite subjective and depends on an individual examiner's experience.

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*"The probability - P, of the simultaneous occurrence of independence A1, A2, A3...AN is given by the product of the separate probabilities."[3]
(P = P1 x P2 x P3...PN)

An *arbitrary* figure of 1:10 was assigned to the probability of accidental characteristics happening on a heel in exactly the same corresponding position.[4] Assuming 10 nicks and cuts were located, the probability of another shoe having identical characteristics stands at 1:10 billion. This is an arbitrary figure unfortunately, which attributes the same probable fraction to each characteristic.

Charles R. Kingston has said "...the subjective process of presenting evidence of this nature in court should proceed, unhampered by the injection of pseudo objective calculations. But we must also continue to develop objective data methods of analysis...."[5]

Richard H. Fox and Carl L. Cunningham in their Crime Scene Search and Physical Evidence Handbook stated: "...There are forms of physical evidence that do not lend themselves to statistical evaluation because we lack data that would support an estimate of their frequency in which a particular type of physical evidence might be encountered. For example, we do not know what the statistical probability would be of observing a particular configuration of a tool mark. The value of this type of evidence must, therefore, be estimated on the basis of experience alone. Even though statistical data is lacking, it is possible to relate particular observations of an event or items to experience and thus to form an opinion as to the value of the evidence...."[6]

I have conducted thousands of footwear impression examinations and compared hundreds of shoes under both controlled and field conditions. I feel their statements accurately put the whole area of probability concerning footwear identification into proper perspective.

Who is responsible for footwear evidence

The location and development of footwear evidence plays an important part in the identification process. Since this function is usually performed by the scene-of-crime officer in Canada, he normally conducts examinations for identification purposes. There is no question the officer feels responsible for this work. In one survey recently conducted 90 percent of identification officers felt they should examine footwear evidence and present it in court. In order to present this form of evidence in court training and experience is necessary.

Training and experience

In Canada, identification field training programs usually last two or three months. The syllabus covers basic photographic theory, fingerprint identification, physical comparison, and a number of other related subjects. Practical projects are also carried out, mainly designed to develop necessary technical skills to operate sophisticated equipment. During training, a considerable amount of time and emphasis is placed on fingerprint identification. Other forms of physical comparison such as footwear identification are merely introduced.

Following a basic two or three month training program the candidate is neither considered qualified to give fingerprint evidence nor other forms of physical comparison evidence. Most police departments require a further training period under the guidance of an experienced identification officer. The Royal Canadian Mounted Police require a minimum of one year understudy period or longer, depending on the candidate. The type of practical experience necessary to qualify as an expert in a court of law is gained during this time.

The average scenes-of-crime examiner might conduct 30 shoe impression examinations a year to known suspect shoes. This may result in three or four positive identifications. For most departments these figures are probably high. The reason this type of identification seldom surfaces is not because the criminal neglects to leave footwear evidence, rather, because training programs are geared more towards fingerprint location and identification. Scenes-of-crime officers from various police forces across Canada were surveyed and asked "have you ever made a positive identification of footwear evidence?" The results relating to years of experience are shown in Table I.

TABLE I

Years of Experience	1-4	5-9	10+
Identified Footwear Evidence	56%	78%	72%
Not Identified Footwear Evidence	44%	22%	28%
Percentage of Respondents	36%	36%	28%

Total Identification Officers Surveyed — 114

The table clearly indicates the more experienced an officer, the more likely he is to identify footwear evidence. In fact, the majority of those among the group with one to four years experience who had not made an identification had two years experience or less. Also note the number of respondents with over five years experience who had never identified footwear evidence!

The argument has been put forward that since most forms of identification are based on identical principles, experience gained in examining fingerprints is all that is required. Interpretation of accidental characteristics in footwear are far more complex than natural fingerprint characteristics. Does examining 30 or 40 shoes a year develop the kind of experience that is necessary in this field? Obviously analysis and evaluation of accidental characteristics in actual field evidence is extremely important. Whenever possible, a suspect's shoes should be subjected to comparison even when other conclusive evidence exists. The findings will always be of some value and will go a long way in developing practical experience. Unfortunately, scenes-of-crime experience in itself is not enough to carry out and accumulate hundreds of examinations necessary to meet "expert status". Only through controlled exercises, similar to those performed in fingerprint identification training, can adequate experience be gained. In the earlier stages of footwear specialist training, it is important to get positive reinforcement that opinions formed are correct. Only controlled exercises can accomplish this.

Footwear identification versus fingerprint identification

One major difference between footwear and fingerprint evidence is the manner in which the opinion is expressed. The footwear identification specialist

expresses a level of individualization. This may be a statement such as: The suspect shoe and the shoe which made the crime scene impression were the same; The possibility of another shoe having the same agreement of accidental and class characteristics is very remote; The suspect shoe or any other shoe with similar class characteristics could have made the crime scene impression; or, The suspect shoe did not make the crime scene impression. Here again, the individual examiner's experience will determine the value and weight the court places on the evidence.

The opinion expressed in fingerprint evidence is quite different, e.g., The scenes of crime impression was made by the suspect; There were insufficient characteristics to draw a positive conclusion; or, The fingerprints were not made by the suspect. I know of no fingerprint examiner who would state "the crime scene impression was in all probability made by the suspect." Fingerprints are considered the most reliable form of identification throughout a persons life. Today, in the field of identification they have attained a status of their own.

Footwear characteristics differ from fingerprint characteristics in three basic ways: (See Table II.)

TABLE II

Footwear	Fingerprints
1. Accidental characteristics may change dramatically and quickly through wear or pressure.	Characteristics are permanent and remain unchanged (except size and through injury) from the early stages of fetal development until after death.
2. Accidental characteristics are nondescriptive.	Characteristics can be described as ridge endings, bifurcations, lakes or islands.
3. Characteristics refer to an area.	Characteristics refer to a definite point.

Footwear identification vs toolmark and firearm identification

Footwear impressions occur under different circumstances than toolmarks or firearms. A footwear impression is usually a static impression similar to the fingerprint. The tool mark is normally engraved.*

Static impressions of footwear evidence reveal characteristics that can normally be compared under very low or sometimes no magnification whereas

*"...If a surface is brought in contact under pressure with another harder surface, the resultant effect upon the softer surface at any instant will depend on the relative hardness of the two surfaces, the character of the harder surface, the magnitude of the pressure and the relative motion of one surface with respect to the other...."[7]

most engraved impressions are examined by comparison microscope. Most tools and firearms carry an individual signature which is detectable either in the toolmark, bullet or casing engraving. The sole or heel produced from the same mold will also have an individual signature consisting of minute nicks or scratches. However, due to the surfaces upon which impressions are located and methods used to develop or enhance the evidence these signatures are not detectable in most cases. For this reason most soles and heels produced from the same mold should be considered identical until they have been worn producing a more distinct signature.

Minimum number of characteristics required for positive identification

A number of factors enter into the number of accidental characteristics required before a positive identification can be established, the most important of which are the examiner's experience, the impression's clarity and the uniqueness or significance of characteristics. Figure 1-5 (A & B) illustrates two examples of accidental characteristics from the crime scene impression and the suspect's shoe impression. Obviously (A) will have more significance than (B) when forming an opinion.

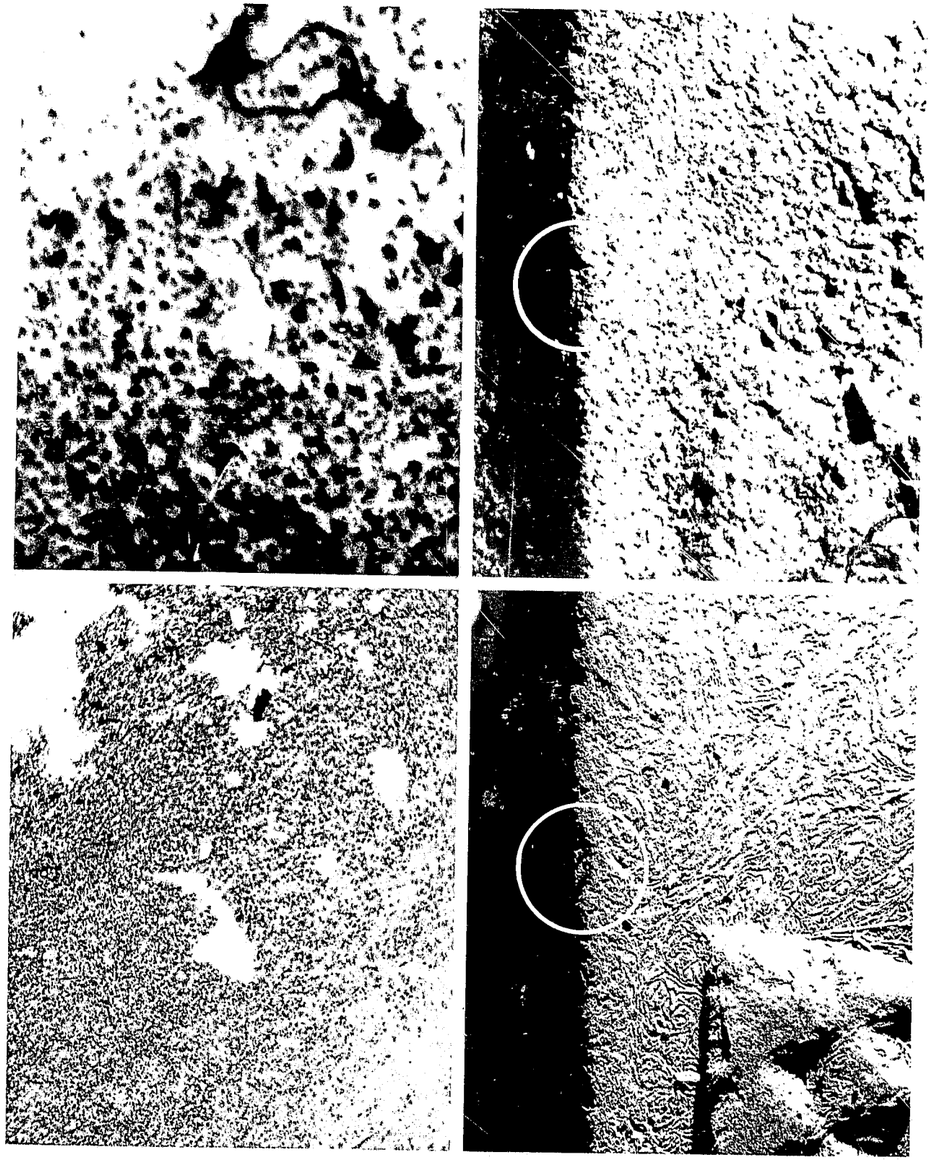
An opinion of fingerprint identification takes into consideration the world population of which the majority have 10 fingers. Fingerprints are then divided or classified into basic patterns. In Canada, 10 basic patterns exist. Footwear on the other hand is different. Many people in the world do not wear shoes. There are hundreds and possibly thousands of pattern designs on soles and heels. The number of people in the world with a central pocket loop fingerprint could be in the millions. The incidence of a person wearing a particular sole or heel pattern may only be in the thousands.

The population as far as footwear patterns are concerned becomes considerably "diluted" as compared to fingerprints. The chance of finding two ridge endings in agreement and in sequence in a fingerprint is common. Finding two accidental characteristics on a sole or heel that reoccur in the same place on a different shoe would be quite rare. I have only seen this happen on two occasions. One dealt with nail holes, which will be shown later, the other with two minute marks.

The number of characteristics required to establish positive footwear identification will normally be less than that for fingerprints, however, each case must be judged on its own merit.

The Standards Committee for The International Association for Identification attempted to establish a minimum number of fingerprint characteristics in 1973. They stated: "...The International Association for Identification, assembled in the 50th Annual Conference at Jackson, Wyoming this first day of August, 1973, based upon a *three year* study by a standardization committee, hereby states that no valid basis exists at this time for requiring that a predetermined minimum [of] friction ridge characteristics must be present in any two impressions in order to establish positive identification. The foregoing reference to friction characteristics applies equally to fingerprints, palm prints, toe prints and sole prints of the human body...."

My research and experience to date would indicate that a similar policy should also apply to the field of footwear identification.



A B

FIGURE 1-5: Accidental characteristic in A much more significant than B.

Research projects

In an attempt to understand footwear identification more fully, research was conducted to determine:

1. The possibility of accidental characteristics reoccurring in the same place on other shoes and the incidence of general wear being repeated.
2. The number of accidental characteristics required for identification purposes.
3. Duration of accidental characteristics.

Project No. 1 Accidental characteristic & wear evaluation

Subjects: Two controlled groups of police recruits. The purpose of this exercise was to gain experience in identifying footwear evidence under controlled conditions and to help determine:

A. The chance of accidental characteristics reoccurring on the same spot on other shoes.
B. The value of general wear.

Police recruits were chosen because:

1. Shoes worn by both groups were worn for the same time span. (Group A — two months, Group B — five months).
2. The geographical area in which the shoes were worn was confined to approximately four city blocks.
3. Only two heel patterns were involved.
4. Each group travelled in a military formation covering the same area often.
5. Subjects ranged in height from 5′8$^1/_2$″ to 6′3″.
6. Shoe sizes were evenly distributed between size 8 and size 10$^1/_2$.

Conditions would therefore favour the chance reproduction of accidental characteristics and wear on other shoes.

Two test footwear impressions were taken from each recruit's shoes. These were each given a code number for identity verification. 118 shoe impressions from group A and 76 shoe impressions from group B were involved. Tread design from group A differed from group B. Groups were separately compared.

One impression was drawn from group A or B. The code number was recorded then the impression was searched against the remaining impressions in its own group. Three accidental characteristics were chosen from each impression searched and an attempt was made to see if any of these three characteristics would be duplicated in the same position on other shoes. (The impression was searched against all impressions regardless of when an identification was made).

When a similar characteristic was located on another shoe (not its duplicate), it was rated for its degree in similarity and position. 1-5 points were alloted for similarity, 5 points were given if the characteristic was in the same spot, none if it was not. The combined score for location and similarity was recorded.

General wear was rated from 1-10. One point was deducted for every obvious discrepancy.

Examination for rating purposes was conducted using the overlay method. Once each shoe impression was searched, the accuracy of identification was

verified by comparing each code number located on the impression sheet to a master list to ensure the opinion formed was correct.

Approximately 10,000 examinations had been conducted upon completion of this research. These involved 97 separate shoes and 194 impressions. A total of 291 accidental characteristics were compared; 177 to group A and 114 to group B. From the data sheets maintained on each search I was able to analyze wear and accidental characteristic duplication.

Project No. 1 Conclusion

General wear duplication

The chances of *general wear* being accurately duplicated decreased in proportion to shoes being worn. (e.g. 74 percent of the shoes two months old had similar wear compared with 18 percent of five month old shoes.) Only one set of shoes worn for five months rated above seven. Figure 2-5 illustrates this wear agreement.

Identification of footwear should not be based on *general wear* alone. The value of wear, however, becomes more significant as the shoes become worn. (This exercise consisted of heel wear only.) We are often asked why a crime scene impression is not identical to a test impression. The answer would indicate differences in pressure, the suspect did not make the test impression, or, the surface condition upon which the shoe was imprinted was not identical with the one used in the test. During this exercise one and the same person made both impressions consecutively on the same surface. Under these ideal conditions, the individual making the duplicate never did make an identical impression. On a number of occasions the mate wear rating fell below seven. Obviously, identical

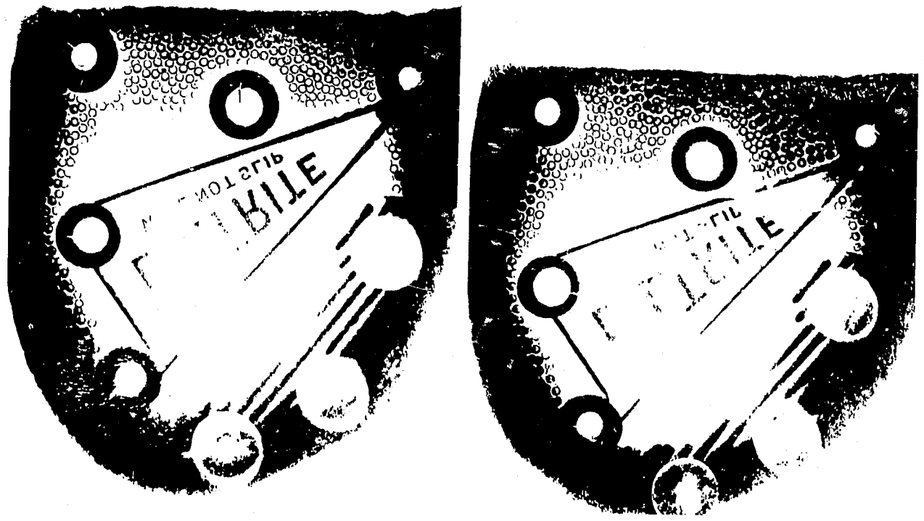


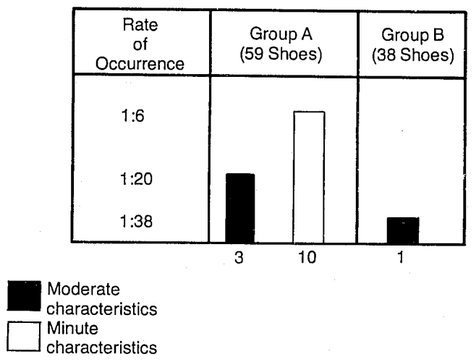
FIGURE 2-5: Similar wear agreement from two different shoes.

impressions will not be found. Minor disagreement of wear should not constitute a bar towards identification.

Accidental characteristic duplication

Statistics revealed a higher incidence of minute characteristics in shoes worn for two months; with none recorded on the five month shoes. Finding moderate or significant characteristics on newer shoes was difficult. Minute ones had to be used therefore. Table III illustrates the number of accidental characteristics in group A and B shoes showing some similarity in position to another characteristic. The vertical axis on the table represents the chance probability factor for both moderate and minute characteristics derived from this study. The horizontal axis shows the number of characteristics which were found to be in similar position to one another. Characteristics from the group A shoes could have been molded. Without a shoe to examine this fact remained unconfirmed. Accidental characteristics are easier to determine on well worn shoes.

TABLE III
Number of characteristics showing position similarity with another characteristic



Group B heels were placed on shoes by a shoemaker. There were no predetermined nail holes in the heels. The nails were therefore positioned manually and at random. A concentrated study regarding the possibility of random nail holes being placed in the same position on the shoes was not made. However a chance nail positioning similarity appeared to be greater than the chance reoccurrence of accidental characteristics. This is probably due to the fact that the same shoemaker placed the heels on the shoes and the nails would be positioned in approximately the same area of the heel. On seven separate occasions nail holes that were compared showed some agreement. Once, two nail holes were in the same area. Figure 3-5 illustrates the positioning of these two nail holes. I had no problem in determining identification by comparing 4 or 5 nail holes. However, one must realize scenes-of-crime impressions are not always recorded in their entirety and a fragment impression may only depict a couple such holes. Under these conditions other accidental characteristics would be required before drawing

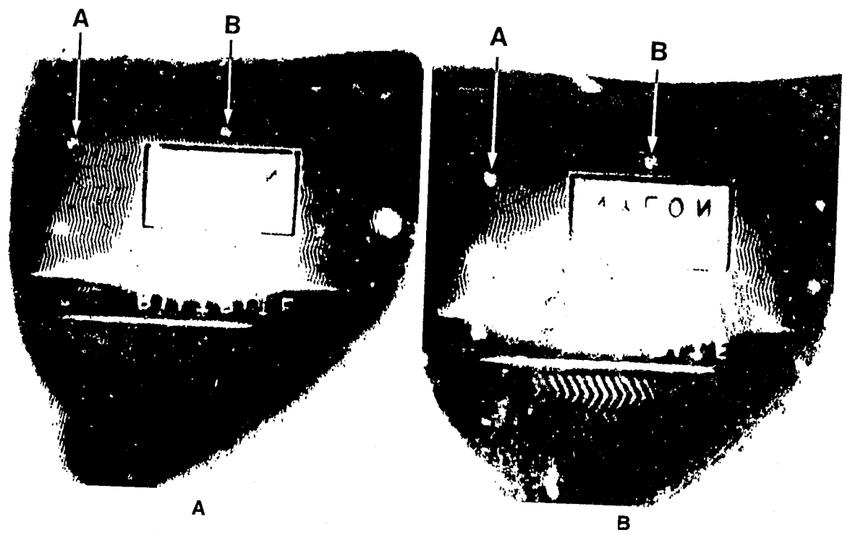


FIGURE 3-5: A and B. Two different heel impressions bearing similar nail holes.

any conclusions. Each characteristic must be weighed on its individual merits. Characteristic size is not necessarily the most important factor, but rather how individually shaped and how accurately they are recorded. Impressions revealing minute or poorly recorded characteristics with little individuality will require a greater number to be in agreement before positive identification can be established. Highly individual characteristics may only require a few for an opinion to be formed. The interpretation of what is highly individual as compared to minute, can only be made after considerable experience.

Project No. 2 Accidental characteristic and wear evaluation

In 1969 I conducted research similar to project No. 1. On that occasion sixty shoes were examined made up of four different heel patterns: 12 Holtite, 5 Biltrite, 39 Good Year and 4 Cat's Paw. Accidental characteristics were compared in all impressions regardless of pattern to see if chance characteristics would reoccur in the same position. The shoes in that exercise had been worn for approximately six months. The exact number of characteristics examined was not recorded. Although a minimum number of sixty were examined, a more accurate number would have been 120.

Project No. 2 Conclusion

Characteristics were not rated. Only general observations were recorded. One accidental characteristic was located in a similar position on a different shoe. Wear was also considered, with only two impressions found to be similar. I am unable to say whether the similar accidental characteristic was minute or significant. The shoes were well worn. The information from this exercise indicates a 1:60

chance of an accidental characteristic reoccurring in the same position on another shoe.

It should be stressed that both of these reasearch projects were controlled exercises where conditions favoured duplication of accidental characteristics and wear. These results would tend to favour the accused, as opposed to a random sampling taken from the street.

Discrepancies in the scenes-of-crime impression or suspect shoe

A problem encountered by the inexperienced examiner is the number of obvious discrepancies when comparing footwear impressions. What appears to be an accidental characteristic on the scenes-of-crime impression is not located on the suspect's shoe impression. In reverse, what is obviously an accidental characteristic on the shoe impression does not appear in the scenes-of-crime impression. These differences can be explained.

A shoe can have a fragment of glass, small rock or some other foreign object adhering to it when the impression is made. This material may leave some form of mark in the evidence. On the next step, the fragment could fall off with subsequent impressions showing no trace of its mark. Foreign material could be on the surface receiving the impression and be removed by the shoe giving the same effect.

An obvious characteristic in the shoe, not recorded in the impression, could be the result of a cut or abrasion formed in the sole or heel after the impression was made. Figure 4-5 is an example of what excessive pressure can do to a characteristic.

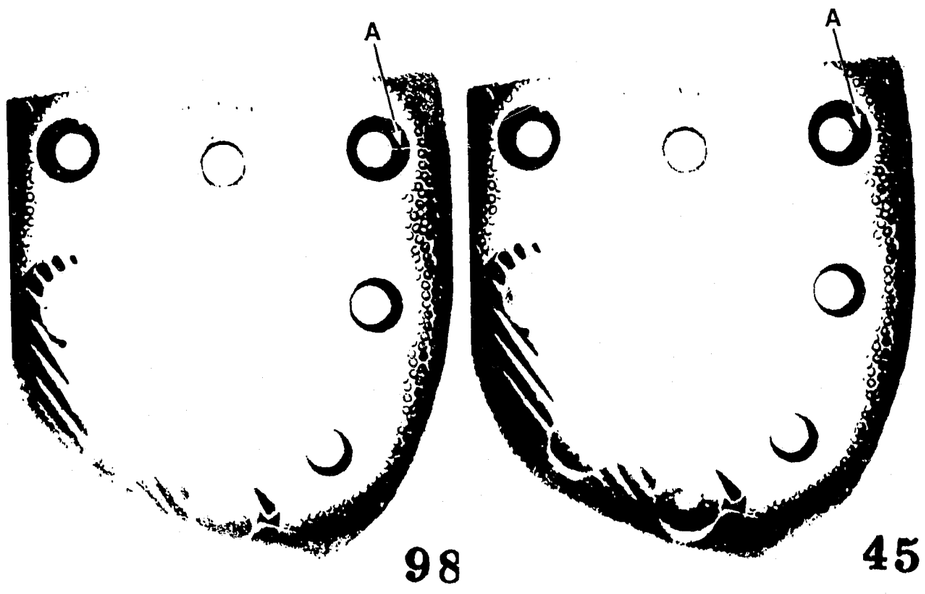


FIGURE 4-5: Accidental characteristic change caused from pressure.

Project No. 3 Accidental characteristic duration

Generally most examiners of footwear feel that if a suspect shoe is not obtained in a very short time, scenes-of-crime impressions will be of little value. There is no doubt the sooner the suspect shoe can be located the better the chances are for establishing an identification. But what constitutes a reasonable period?

At one time, shoe bottoms were mainly leather which rapidly showed signs of wear and tear. Todays modern synthetic materials and rubber compounds are more durable. In order to establish some idea of how long cuts and abrasions might last, tests were conducted with a new pair of Cat's Paw rubber compound heels. Impressions were made from both heels prior to use. Further impressions were taken, once on each of the first three days and at one week intervals thereafter for a total of sixty-eight days. Upon conclusion, thirty-six accidental characteristics were identified for use in this exercise. They were classifed according to the time they first appeared and then again upon their disappearance, Table IV illustrates the results.

TABLE IV
Duration of characteristics

Number of characteristics	Duration time
9 characteristics	1-3 days
1 characteristic	13 days
4 characteristics	18-20 days
3 characteristics	approximately 35 days
7 characteristics	approximately 48 days
6 characteristics	approximately 59 days
6 characteristics	65-68 days

Project No. 3 Conclusion

I was surprised to find a number of characteristics lasting for 59-68 days. This number represents 33 percent of the characteristics examined. There were also quite a few characteristics that lasted only a very short time. I think this exercise adequately points out that footwear evidence should not be discarded after a couple of weeks. Possibilities do exist for an identification to be made much later. Figure 5-5 is an illustration of an identification made more than 21 days after an offence. The boots in this case were constantly worn until the suspect's arrest.

Illustrations 6-5, A to G consist of scene and test impressions relating to actual cases submitted by identification officers across Canada. You will note, there are no markings on the impressions. Make your own observations and findings, based on the process of identification (analysis, comparison and evaluation). When you have completed this section, check Appendix II at the back of the book and see if your findings agree with the person who actually did the work (a low power magnifying glass may be useful).

NOTE: When viewing Appendix II, remember, the examiner in each case had actual exhibits to work with.

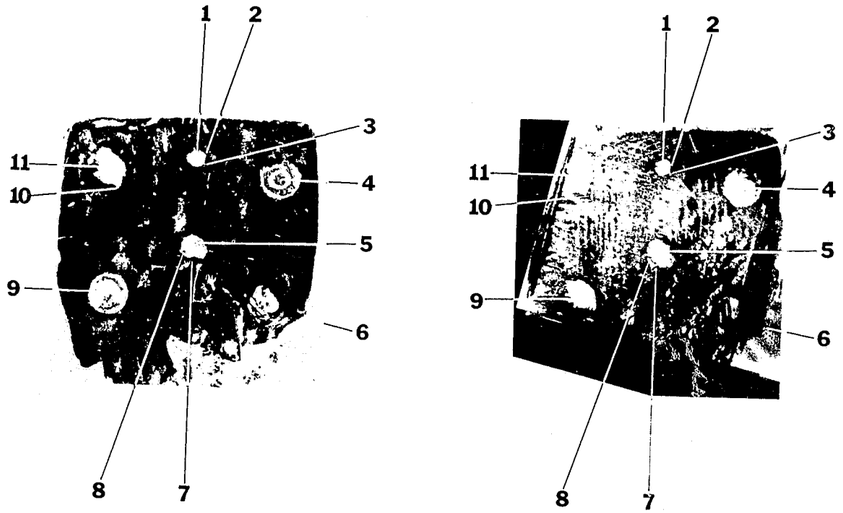
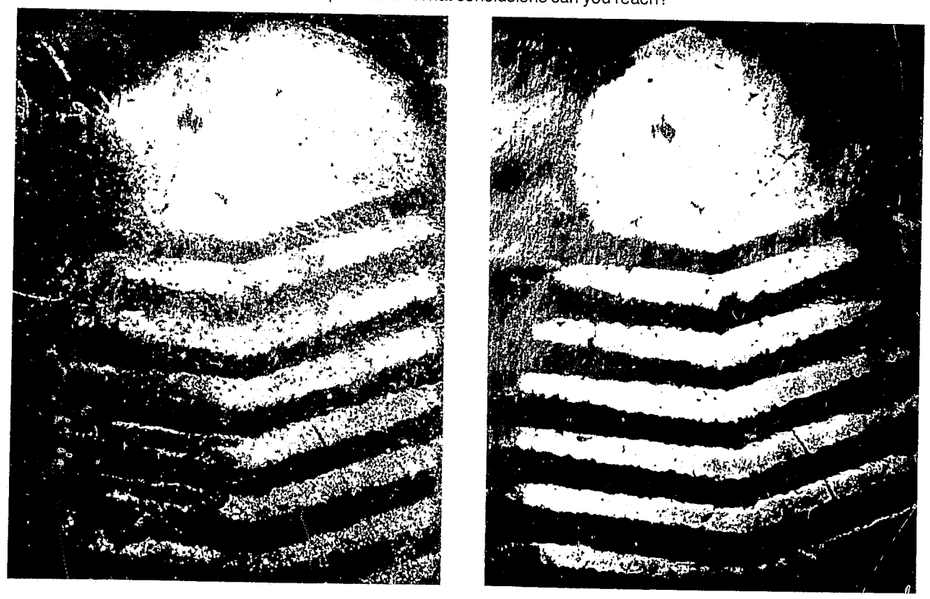
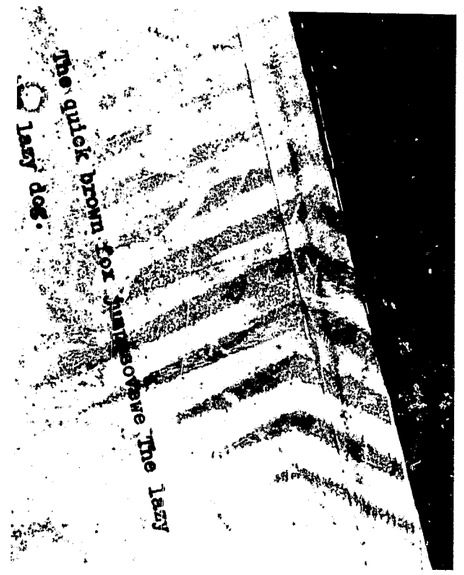


FIGURE 5-5: Footwear identification chart. Boot located 21 days after offence. Boots worn constantly.

FIGURE 6-5: **A to G** Examine these impressions. What conclusions can you reach?



A



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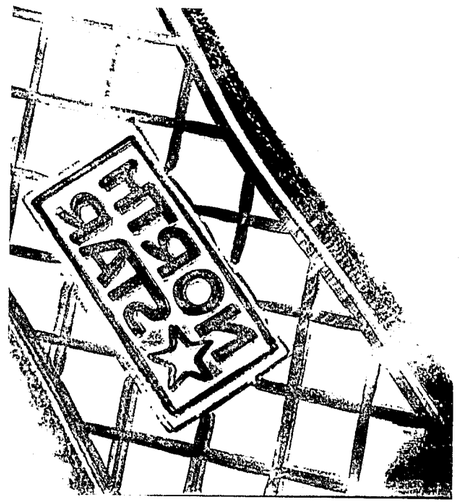
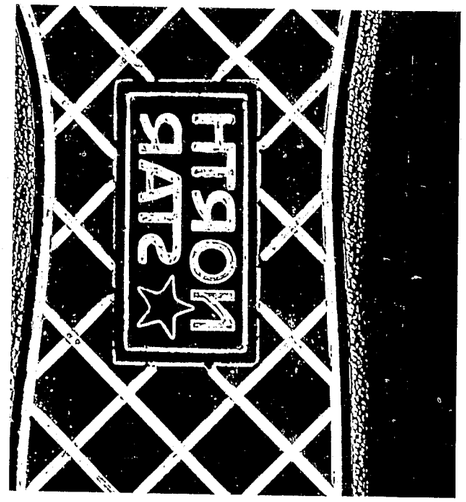
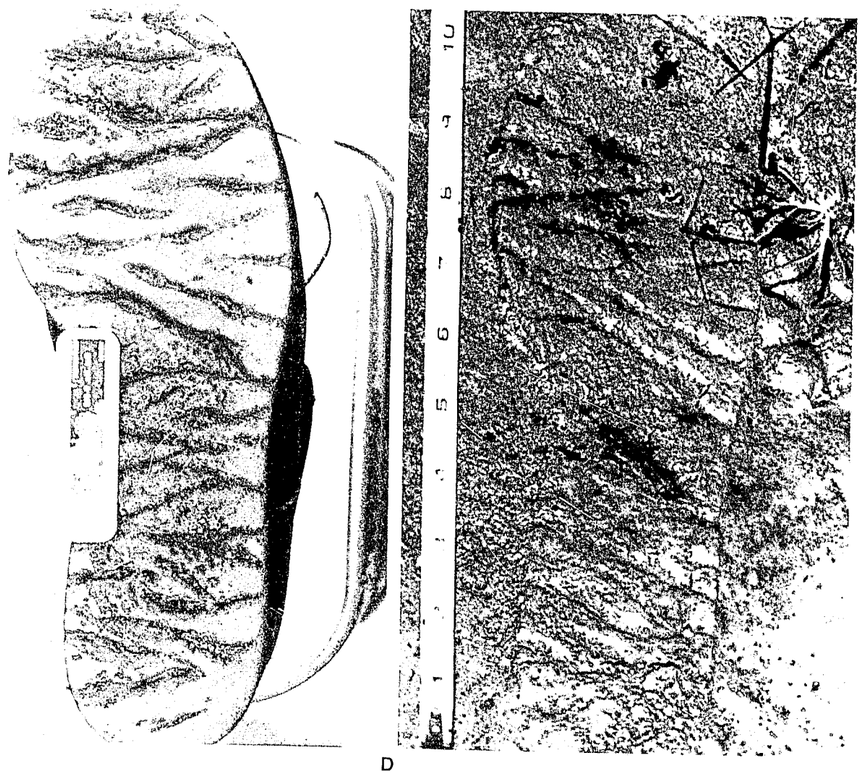




C



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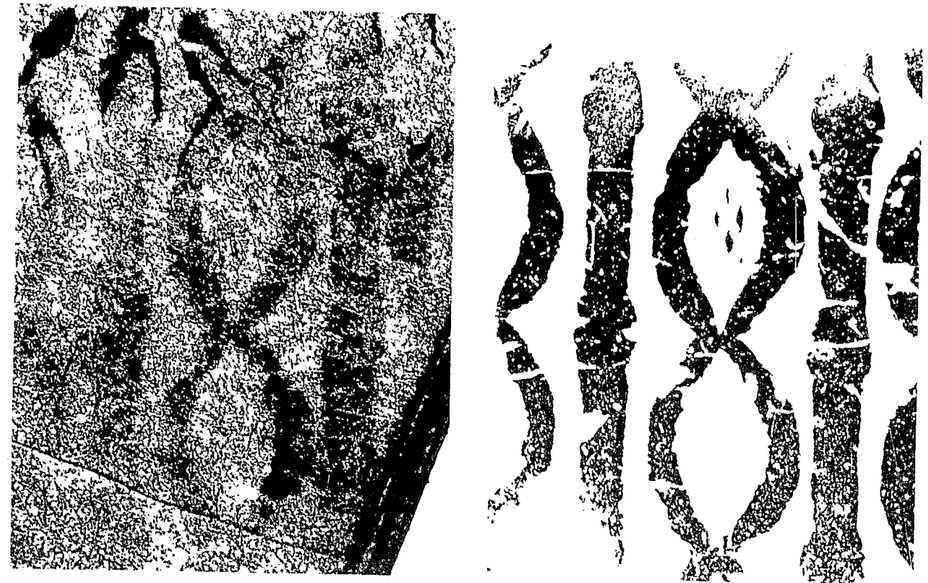

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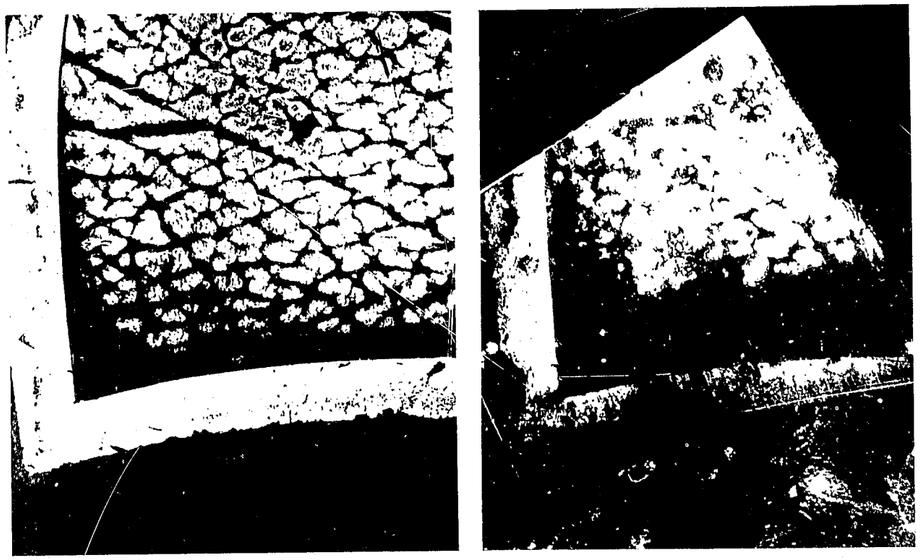
F



G

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Chapter 6

Footwear impressions — An investigational aid

Shoe impressions can help the investigator in a number of ways other than establishing *positive* identification. They can determine a minimum number of individuals involved, their sex, the direction to and from the scene, approximate height, age and sobriety. On occasion they have led directly to the culprit, pointed the way to stolen goods and have even served to eliminate a suspect.

Minimum number of suspects

A crime scene that has been properly protected from curiosity seekers and witnesses can provide fairly reliable figures on a minimum number of suspects. One method is to record the number of different suspect shoe patterns at the point of entry or on objects stepped on inside. Measurements of similar patterns may also establish more than one person, e.g. one complete impression measuring eight inches long and another twelve inches long would tend to suggest two individuals. The information obtained should not be construed as definite but more as an investigational aid.

Sex of offender

Usually, women have smaller feet with narrower shoes and slimmer heels than men. Shapes and styles may also determine the offender's sex.

Age of offender

A small shoe impression would normally suggest the suspect is a juvenile. The only problem with this deduction is that different styles vary in length. A man's high heel shoe impression measuring $10^{3}/_{4}$" long for example, will probably be between size 8 and 9. A workboot of same length could fall between sizes $4^{1}/_{2}$ and $6^{1}/_{2}$. A boy's shoe size is between $2^{1}/_{2}$ and 6. A man's shoe size is generally between size 6 and 12. The workboot impression therefore, was probably made by a juvenile and the high heel boot by an adult. This type of information may not be one hundred percent reliable. However, as long as the investigator is aware of this it can still be helpful.

I recall one case where a school was broken into and wilful damage was committed. I was able to tell investigators a minimum of seven culprits were

involved, three of whom were girls. All appeared to be juveniles. With this information, along with photographs of shoe patterns they quickly established the names of a group of young people who later admitted to the offence.

Height of the offender

Can shoe impressions indicate the approximate height of suspects? First the scene measurements must be converted to a shoe size. Some criminology authors writing about crime scenes feel estimating size from shoe impressions is too unreliable. Two-dimensional impressions are seldom recorded in their entirety. In a three-dimensional impression a number of variables must be considered such as expansion in mud or snow when the pressure of the shoe forces the snow or mud away. The toe of the shoe may slip back toward the heel in mud, snow, soft earth and sand, which can shorten the overall length of the impression. This shortening effect can often be observed in sand or snow piled up in the toe area or in mud when slip marks on the impression edges are evident. Figure 1-6 illustrates how snow in the toe has been pushed back, indicating a probable false measurement. In this particular case, the length of the impression in the photograph is one inch shorter than the actual boot. This difference could be crucial in estimating accurate shoe size.

Mud and wet prints may shrink as they dry, while snow impressions become larger as they melt.

FIGURE 1-6: Impression could reveal incorrect size because of snow pile-up in toe. Actual length of boot: 12½"; measured length from impression: 11 5/16".

Use of the scale ruler

A ruler at least six inches in length should be included with the photographed impression. The positioning of this ruler in a three-dimensional impression is very important. In one survey I conducted, crime scene examiners submitted copies of photographs taken at the scene. Thirty percent of the photographs submitted did not include a scale ruler. Among photographs that did include some form of scale, it was often in the wrong place. *The scale must be at the same level as the lower portion of the impression*. In a number of tests conducted in snow the difference in measurements of the impression using a ruler at the proper level as opposed to one set on top of the snow ranged from 1/8 to 9/16 of an inch depending on the depth of the impression. Obviously this discrepancy not only creates a problem in trying to reproduce the photograph to a known size but could also give the investigator misleading information as far as shoe size is concerned.

Problems in obtaining accurate measurements exist. These explain why many impressions are not the same length as the suspect boot even when agreement of accidental characteristics determine positive identification. These differences can be explained and do not necessarily prevent identification. The only way to recognize the problem is to conduct controlled tests under different surface conditions with a known shoe. Those which are and are not accurate will soon become evident.

Figures 2-6 and 3-6 show impressions in sand. Using calipers measure the impression from the point you think represents the shoe length and obtain a measurement from the ruler. Compare your measurements to the actual length of the boot. *(See footnote on page 113.) Even with shrinkage, expansion and slipping problems, numerous prints are well recorded. These should not be ignored.

Reasonably accurate shoe sizes can be obtained in two ways:

1. By comparing measurements of shoes that appear to have left an accurate impression to shoes of the same type at local shoe stores. A size is determined from the shoe that comes closest to the scene measurement.
2. Some soles have the size imprinted on them. Occasionally this is also recorded in the receiving medium.

The extremities of six hundred shoes of different common shoe styles were measured in an attempt to form a reference table. Usually the imprinted size of the shoe is not left at the scene and it is often difficult to locate and compare similar shoe styles. Approximate size of the shoe from measurements taken at the scene can be obtained from Table V for types of shoes shown.

NOTE: (If you use Table V and VI together the approximate size will be very general but should be helpful in determining small, medium, or large suspects. By knowing the actual shoe size the estimate becomes more accurate!)

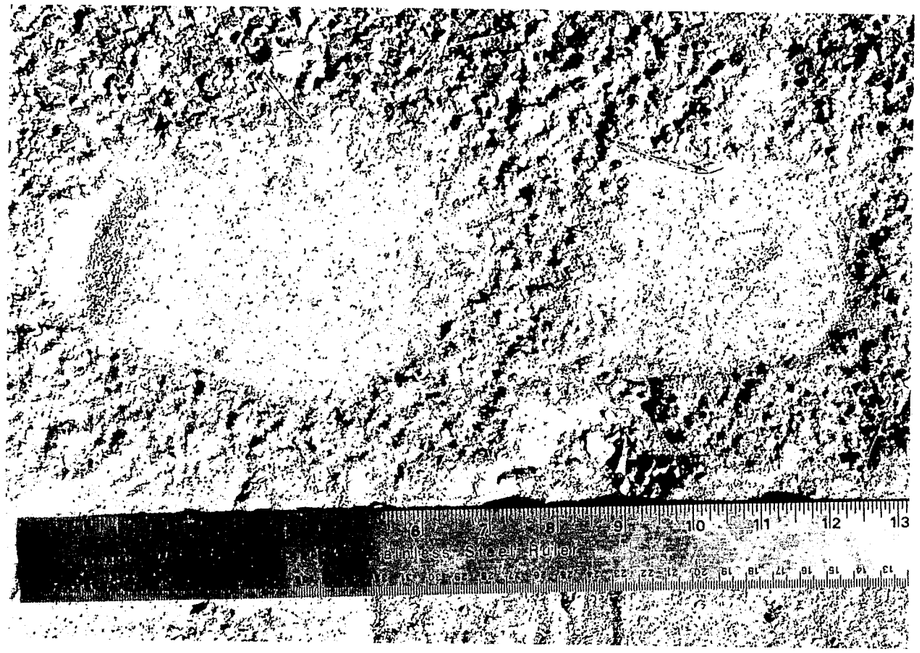

FIGURE 2-6: Impression in sand.

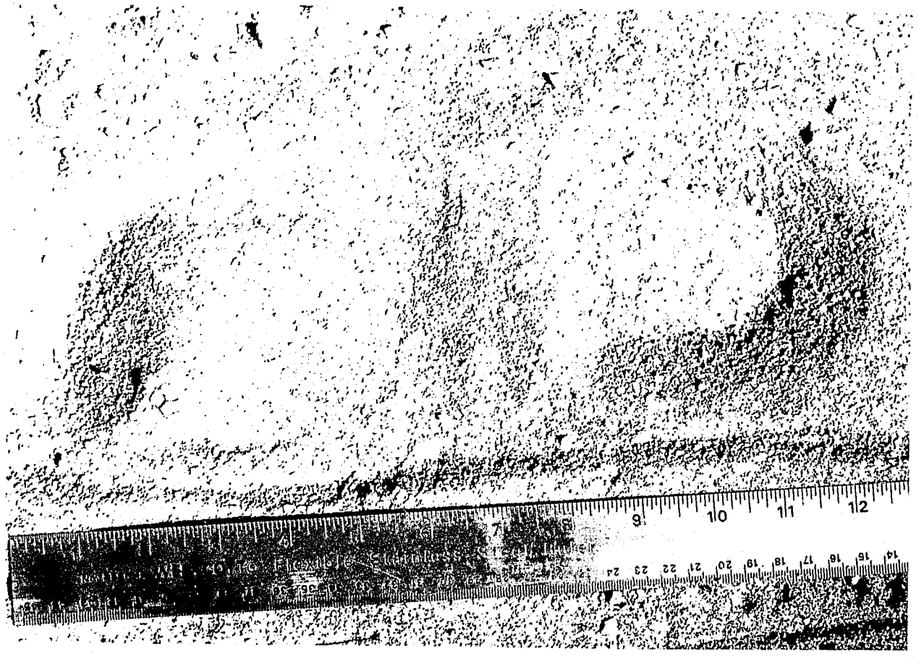

FIGURE 3-6: Impression in sand.

Assuming a fairly accurate shoe size has been obtained, what value is it to you? For example, if I were to say the suspects shoe size was eleven, what can you tell the investigator? On what information is your answer based? To begin with is there any correlation between shoe size and height?

I conducted a survey of 1,800 male adults of varying height. (The results are shown in Table VI.) The subjects in this survey were male employees in the RCMP. Because height restrictions existed at that time within the Force, the survey was extended to include some male employees of the Canadian Armed Forces. The table clearly illustrates the suspect's exact height cannot be established. Approximate height however, can. A size 11 would suggest a better than 80 percent chance the culprit would be 5′10″ - 6′2″. A size 9 would mean a better than 80 percent chance the offender was between 5′7″ - 5′11″. This type of information will at least give the investigator something with which to work.

Table VI also illustrates the percentage of adult males surveyed who wore a particular size shoe.

Walking patterns

A series of shoe impressions left by a culprit is commonly referred to as a walking pattern or walking picture. Various texts refer to this walking pattern as being highly individual. Foot angles can be very characteristic,[1] and are of great value to the investigator.[2]

I have very seldom made much use of a walking pattern even though much of my work has been in rural areas where they are often located. Occasionally I may have suspected the culprit to be intoxicated by the staggering effect observed or I may have determined the suspect was running by the length of his stride and even followed the walking pattern to the accused's home. I have never bothered to record the measurements and angles necessary to properly record a walking pattern at a crime scene.

In order to ascertain whether or not a walking pattern could be of any value to an investigator and whether or not a walking pattern is unique to an individual, I conducted a study on 60 people.

Subjects were made to walk in a normal fashion on long strips of paper. (Instructions were given to walk as though they were walking down the street.) This controlled group ranged in height from 5′8″ - 6′3$^{1}/_{2}$″. Walking patterns were then examined, recording stride, distance between heels and the angle the heel presented to an imaginary walking line. Figure 4-6 illustrates the typical measurement and angles used to record a walking pattern.

The direction line indicating the person's travel direction is imaginary. Stride is recorded from the rear of one heel to the rear of the next. Distance between heels is taken by relating the inside of the heels to the directional line and combining the measurements of the first and second step. Foot angle is created by drawing a line through the middle of the toe and heel and extending it to the direction line.

Diagrams in texts used to illustrate a walking pattern often leave the reader with the impression that measurements are easily taken. Under ideal conditions I

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*The boot is 12$^{1}/_{4}$″ long. Figure 2-6 indicates some slipping in the toe area. Figure 3-6 was made in soft sand. The sand has fallen into the sole and heel making the impression appear smaller.

TABLE V
SHOE SIZE CALCULATION

WELTED BOOTS NORMAL HEEL — SHOE SIZE

	5	5½	6	6½	7	7	7½	8	8	8½	9	9½	10	10½	10½	11	11½	12	12½	13	13	13½	14	14	14½
	3½	4	4½	5	5½	5½	6	6½	6½	7	7½	8	8½	9	9	9½	10	10½	11	11½	11½	12	12½	12½	13

WORK BOOTS & SNOW BOOTS — SHOE SIZE

5	5	5½	6	6	6½	6½	7	7½	7½	8	8½	9	9	9½	9½	10	10	10½	10½	11	11½	11½	12	12½	12½	13
3	3	3½	4	4	4½	4½	5	5½	5½	6	6½	7	7	7½	7½	8	8	8½	8½	9	9½	9½	10	10½	10½	11

COWBOY BOOTS — SHOE SIZE

6	6	6½	7	7½	7½	8	8½	9	9	9½	10	10½	10½	11	11½	12	12	12½	13	13½	13½	14			
4	4	4½	5	5½	5½	6	6½	7	7	7½	8	8½	8½	9	9½	10	10	10½	11	11½	11½	12			

RUNNING SHOES & FLAT BOTTOM CASUALS — SHOE SIZE

6	6½	6½	7	7½	8	8	8½	9	9	9½	10	10½	10½	11	11	11½	12	12½	13	13	13½				
4½	5	5	5½	6	6½	6½	7	7½	7½	8	8½	9	9	9½	9½	10	10½	11	11½	11½	12				

9¾	9⅞	10	10⅛	10¼	10⅜	10½	10⅝	10¾	10⅞	11	11⅛	11¼	11⅜	11½	11⅝	11¾	11⅞	12	12⅛	12¼	12⅜	12½	12⅝	12¾	12⅞	13	13⅛	13¼	13⅜	13½

IMPRESSION MEASUREMENT (IN INCHES)

TABLE VI
HEIGHT CALCULATION

APPROXIMATE HEIGHT (80% OR BETTER)

4'11	5'	5'1	5'2	5'3	5'4	5'5	5'6	5'6	5'7	5'8	5'9	5'10	5'10	5'11	6'	6'1	6'2	6'2	6'3	6'4	6'5	6'5	6'6	6'6
4'8	4'9	4'9	4'10	4'11	5'	5'1	5'2	5'2	5'3	5'4	5'5	5'6	5'6	5'7	5'8	5'9	5'10	5'10	5'11	6'	6'1	6'1	6'2	6'2
2	**2½**	**3**	**3½**	**4**	**4½**	**5**	**5½**	**6**	**6½**	**7**	**7½**	**8**	**8½**	**9**	**9½**	**10**	**10½**	**11**	**11½**	**12**	**12½**	**13**	**13½**	**14**

SHOE SIZE

APPROXIMATE % OF MALE ADULTS

1%	1%	3%	3%	11%	11%	15%	15%	14%	11%	7%	2%	3%	1%	1%

found this to be quite difficult. Measuring numerous patterns to see how the foot angles of different people related became a problem. A slight change in the directional line alters foot angles. The line drawn through the foot is also important. Any deviation will cause considerable angle change.

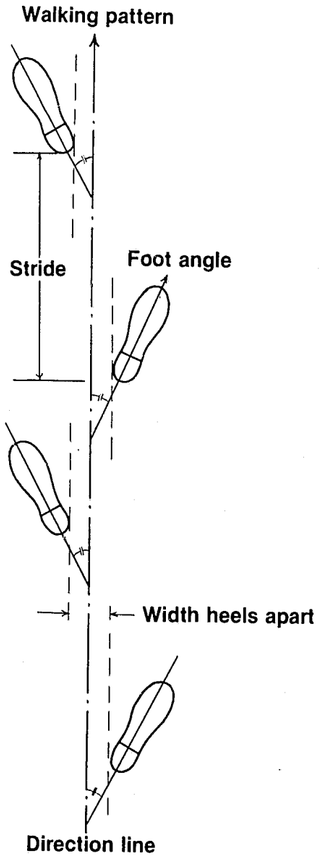


FIGURE 4-6: Typical measurements and angles used to record walking pattern.

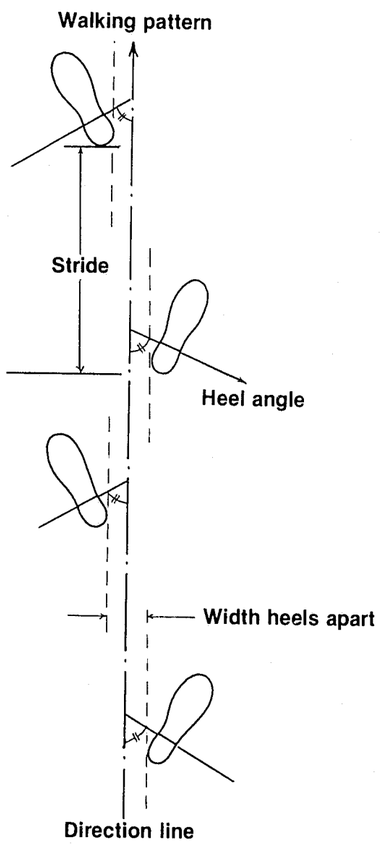


FIGURE 5-6: Method used by author to record walking pattern for this research.

I followed these general rules to be as consistent as possible.

1. The first and last step on the paper was disregarded. I felt accuracy of the walking pattern would be questioned due to starting and stopping.
2. The direction line was made with a chalked string along the inside of the right heels. Since heels do not always fall in a direct line with one another, each alternate right heel was disregarded.

3. The foot angle was made by placing a straight edge along the front edge of the heel, bisecting the directional line. I chose to do this because this is usually the only well defined reference area recorded at a crime scene and would be consistently more accurate than drawing a line through the mid toe and heel. The extension of the heel to the direction line is shorter, leaving less room for error.
4. Stride was determined by measuring the distance between five complete steps and calculating the average. Figure 5-6 illustrates the manner in which the walking pattern was measured.

During the course of this exercise 390 footsteps were measured. It soon became apparent in a series of steps of one individual that stride, heel distances apart and heel angles were not consistent.

I would like to emphasize again, these walking patterns were a controlled exercise taken under ideal conditions. Errors recorded here would be minimal compared to actual cases.

Stride

Can some idea of height be determined from a person's stride? Table VII clearly shows a person's stride has no direct relation to his height. Obviously a small child would not have a 28 inch stride when walking. But it is safe to say stride should not be used to judge height. The majority of stride length for this group of individuals measured between $27^1/_2$ - $33^1/_2$ inches.

Walking patterns were also taken from a small group of women (15), whose height ranged between $5'4^1/_2''$ - $5'6''$. Generally speaking their strides were shorter than those of the men.

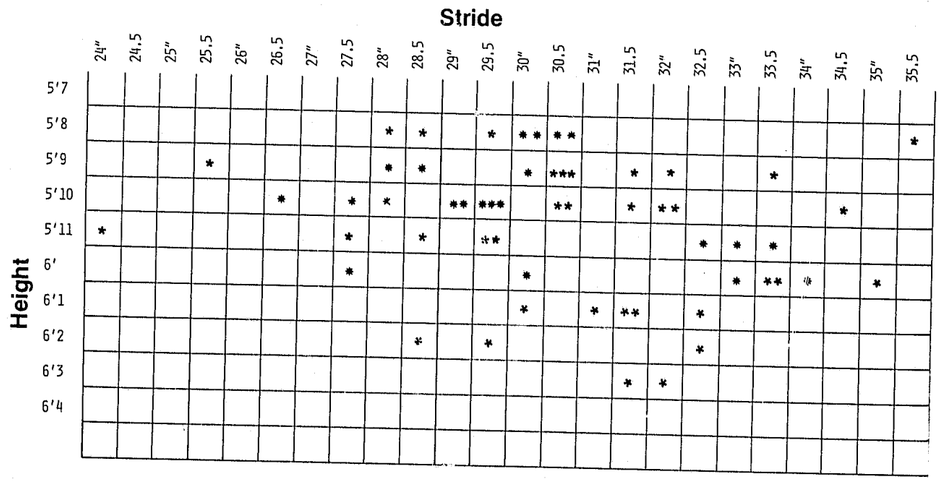
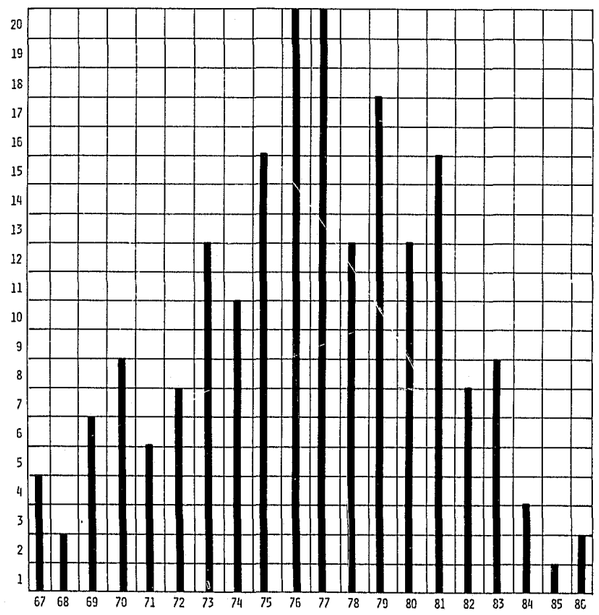
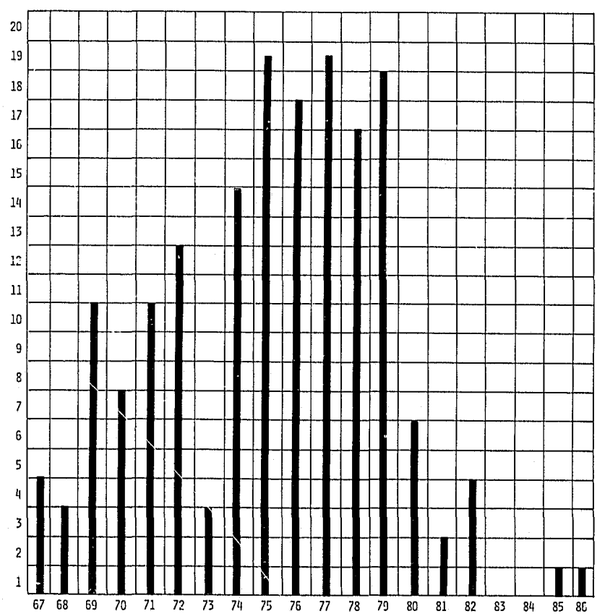


TABLE VII: Stride to height relationship.

Number of heels



Left foot



Right foot

TABLE VIII: Heel Angle — Left & Right Foot.

The inside leg length of both controlled groups was recorded and clearly indicates a relationship to height. Women in the group, it appears, tend to have longer legs in relation to their size but take shorter steps. I should add, the group of women was too small to draw any definite conclusion.

Heel angles

A total of six heel angles from each person was recorded. Five individuals had their walking patterns recorded twice, which gave a grand total of 390 angles in all. Table VIII shows the number of times each heel angle was recorded. The more common angles for the left foot are 73° - 81°. The right foot is 69° - 79°. The difference between the left and right foot angles of an individual varied from 0° - 20°, the norm was 0° - 4°. Of approximately 90 angles measured in women, the norm lay between 78° - 81°, which is quite close to that of the men.

Heel distance apart

The distance between heels when walking measured from - 1″ to + 5″, with the norm running between $^1/_4$″ - 1$^1/_2$″.

In an attempt to associate height with all the above conditions, no correlation except leg length was indicated. Of course leg length could not be detected through normal crime scene examination and thus serves no purpose.

Five individuals had their walking patterns recorded twice, with an approximate 15 minute time span between each walk. The second pattern simulated one taken from the suspect; the first being the actual crime scene pattern.

Would these two patterns be similar and what value would they serve? The measurements are shown below for each individual.

PERSON #1

	1st Walking Pattern			2nd Walking Pattern	
A	Average Stride	30.2″	A	Average Stride	29.6″
B	Heels Apart	1 $^1/_8$″	B	Heels Apart	2 $^3/_8$″
C	Angle Left Foot	77°	C	Angle Left Foot	75°
D	Angle Right Foot	69°	D	Angle Right Foot	81°
A	Average Stride	30.2″	A	Average Stride	29.6″
B	Heels Apart	1 $^3/_8$″	B	Heels Apart	- $^3/_4$″
C	Angle Left Foot	79°	C	Angle Left Foot	74°
D	Angle Right Foot	74°	D	Angle Right Foot	73°
A	Average Stride	30.2″	A	Average Stride	29.6″
B	Heels Apart	3″	B	Heels Apart	- $^3/_8$″
C	Angle Left Foot	74°	C	Left Foot Angle	75°
D	Angle Right Foot	74°	D	Right Foot Angle	76°

AVERAGES 1		Difference	AVERAGES 2	
Avg. Stride	30.2″	.6″	Avg. Stride	29.6″
Heels Apart	1.8″	1.3″	Heels Apart	.5″
L.F. Angle	77°	2°	L.F. Angle	75°
R.F. Angle	72°	3°	R.F. Angle	75°

PERSON #2

	1st Walking Pattern			2nd Walking Pattern	
A	Average Stride	30.2″	A	Average Stride	29.8″
B	Heels Apart	1″	B	Heels Apart	1 1/2″
C	L.F. Angle	73°	C	L.F. Angle	75°
D	R.F. Angle	77°	D	R.F. Angle	73°
A	Average Stride	30.4″	A	Average Stride	29.8″
B	Heels Apart	2 1/8″	B	Heels Apart	1 1/8″
C	L.F. Angle	72°	C	L.F. Angle	77°
D	R.F. Angle	75°	D	R.F. Angle	75°
A	Average Stride	30.4″	A	Average Stride	29.8″
B	Heels Apart	1/4″	B	Heels Apart	1 7/8″
C	L.F. Angle	76°	C	L.F. Angle	75°
D	R.F. Angle	74°	D	R.F. Angle	79°

AVERAGES 1		Difference	AVERAGES 2	
Avg. Stride	30.4″	.6″	Avg. Stride	29.8″
Heels Apart	1″	.5″	Heels Apart	1.5″
L.F. Angle	74°	2°	L.F. Angle	76°
R.F. Angle	75°	1°	R.F. Angle	76°

PERSON #3

	1st Walking Pattern			2nd Walking Pattern	
A	Average Stride	33.8″	A	Average Stride	30.2″
B	Heels Apart	1 1/4″	B	Heels Apart	- 1/4″
C	L.F. Angle	72°	C	L.F. Angle	70°
D	R.F. Angle	75°	D	R.F. Angle	65°
A	Average Stride	33.8″	A	Average Stride	30.2″
B	Heels Apart	7/8″	B	Heels Apart	1/4″
C	L.F. Angle	73°	C	L.F. Angle	71°
D	R.F. Angle	72°	D	R.F. Angle	71°
A	Average Stride	33.8″	A	Average Stride	30.2″
B	Heels Apart	5/8″	B	Heels Apart	0″
C	L.F. Angle	73°	C	L.F. Angle	69°
D	R.F. Angle	73°	D	R.F. Angle	71°

AVERAGES 1		Difference	AVERAGES 2	
Avg. Stride	33.1″	3.6″	Avg. Stride	30.2″
Heels Apart	1″	1″	Heels Apart	0″
L.F. Angle	73°	3°	L.F. Angle	70°
R.F. Angle	73°	4°	R.F. Angle	69°

PERSON #4

	1st Walking Pattern			2nd Walking Pattern	
A	Average Stride	28.4″	A	Average Stride	28.6″
B	Heels Apart	3 1/4″	B	Heels Apart	2″
C	L.F. Angle	80°	C	L.F. Angle	82°
D	R.F. Angle	79°	D	R.F. Angle	79°
A	Average Stride	28.4″	A	Average Stride	28.6″
B	Heels Apart	3/4″	B	Heels Apart	1/2″
C	L.F. Angle	79°	C	L.F. Angle	83°
D	R.F. Angle	77°	D	R.F. Angle	78°
A	Average Stride	28.4″	A	Average Stride	28.6″
B	Heels Apart	1″	B	Heels Apart	1/8″
C	L.F. Angle	81°	C	L.F. Angle	81°
D	R.F. Angle	77°	D	R.F. Angle	75°

AVERAGES 1		Difference	AVERAGES 2	
Avg. Stride	28.4″	.2″	Avg. Stride	28.6″
Heels Apart	1.6″	.4″	Heels Apart	1.2″
L.F. Angle	80°	2°	L.F. Angle	82°
R.F. Angle	78°	1°	R.F. Angle	77°

PERSON #5

	1st Walking Pattern			2nd Walking Pattern	
A	Average Stride	31.6″	A	Average Stride	31.6″
B	Heels Apart	4 1/8″	B	Heels Apart	2″
C	L.F. Angle	77°	C	L.F. Angle	77°
D	R.F. Angle	76°	D	R.F. Angle	77°
A	Average Stride	31.6″	A	Average Stride	31.6″
B	Heels Apart	1 3/4″	B	Heels Apart	2 5/8″
C	L.F. Angle	77°	C	L.F. Angle	79°
D	R.F. Angle	76°	D	R.F. Angle	75°
A	Average Stride	31.6″	A	Average Stride	31.6″
B	Heels Apart	3″	B	Heels Apart	3/8″
C	L.F. Angle	77°	C	L.F. Angle	80°
D	R.F. Angle	77°	D	R.F. Angle	79°

AVERAGES 1		Difference	AVERAGES 2	
Avg. Stride	31.6″	0″	Avg. Stride	31.6″
Heels Apart	2.9″	1.3″	Heels Apart	1.6″
L.F. Angle	77°	2°	L.F. Angle	79°
R.F. Angle	76°	1°	R.F. Angle	77°

A walking pattern can determine whether or not the individual was walking, running or drunk. A stride exceeding 35 inches would probably indicate the person was running. Unfortunately an individual's foot angles and measurements change constantly when walking. In five individuals who duplicated their patterns a *maximum* average difference of 3.5 inches for stride, 1.3 inches for heels spaced apart and 4° for foot angle is revealed between both recorded patterns. Measuring a crime scene walking pattern with the same degree of accuracy performed in these tests would be extremely difficult. In reality only a pattern deviating considerably from the established norm could conceivably be of any value to the investigator.

A number of ways exist to measure a walking pattern. The use of a base line and offset measurements to plot the feet would probably be the simplest. This procedure would be similar to recording an accident scene. Offset measurements should be kept to a minimum distance for the sake of accuracy. A walking pattern could then be drawn to scale at the office and scale photographs of the shoe impressions placed in the diagram. Measurements and angles could also be obtained at the scene using string, rulers and a protractor.

In conclusion, not too much emphasis should be placed on walking patterns considering their overall value obtained and the difficulties involved in recording them.

Link between crime scenes

Footwear impressions can also help to establish a link from one crime scene to another. Criminals occasionally commit more than one crime in an evening. The culprit's shoes may leave a track to the second offence. Finding similar shoe patterns there, although not conclusive, might also assist the investigator in linking both offences.

Foreign material

The use of foreign material found adhering to the suspect boot is usually overlooked as an investigational aid. Control samples from a crime scene will have to be gathered for laboratory comparison. This type of evidence would in all probability be used when suspect boots are seized prior to a crime scene examination. In more serious crimes, surface control samples should be taken for possible future use. Control samples should also be taken when shoe impressions are found in blood, fire extinguisher propellant, oil, flour, or other unusual mediums. (Samples of broken window glass located at the point of entry should also be taken.) Any form of material adhering to suspect boots should be placed in a plastic bag or glass jar and forwarded to the crime detection laboratory along with control samples. If not required for identification purposes, the complete boot should be placed in a plastic bag and forwarded to the laboratory.

The RCMP Crime Detection Laboratory Manual recommends control samples be gathered from the impression and at ten, fifty and one hundred foot intervals. Each sample should be accurately related to the crime scene impression by photography and measurements.

Foreign material in itself will seldom if ever become sufficient evidence to establish a conviction, but could serve in corroborating other evidence.

Hot-list collection

The idea of developing a hot-list collection of footwear impressions from known active criminals on a regional basis should not be overlooked. Accidental characteristics can last for some time. This type of collection could be useful.

A footprint collection could be developed by taking footwear impressions of known criminals as the opportunity arises. The recorded impression could be filed by pattern design and/or size for future searching purposes. A collection would have to be updated on a continual basis. Impressions over six months old should be removed. A footwear collection is just another possibility for furthering footwear evidence.

Sole/heel and shoe design collection

In conjuction to a hot-list, a book illustrating sole surfaces and shoe design could also be developed. I know of some departments that make excellent use of this type of book. When an impression is located at the scene the book is checked to locate a similar impression showing the style(s) of shoe bearing that sole. This gives the investigator something to look for when conducting his investigation.

A book of this type would be nearly impossible to develop from a central location, because of constant change in designs and the large number of designs nation wide. However, it does work on a local level especially in smaller more isolated communities.

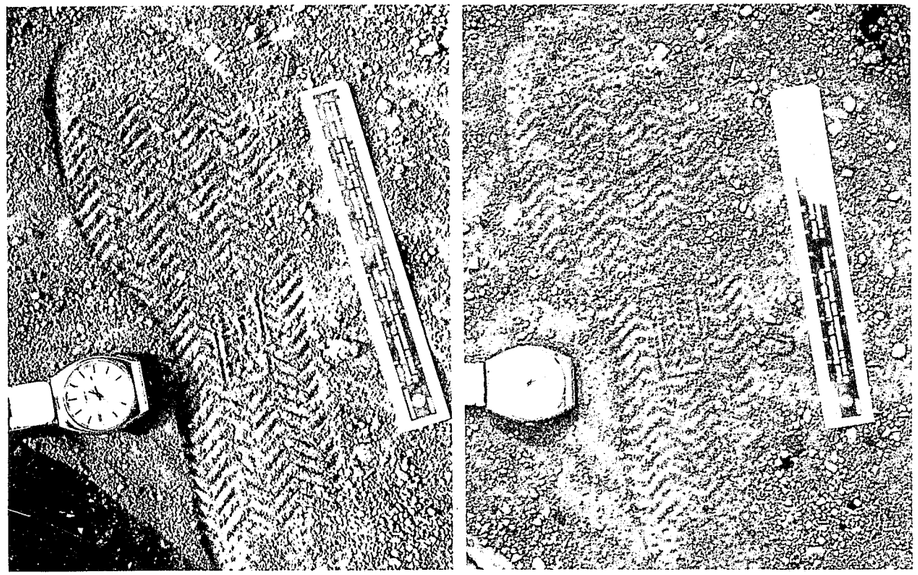
The collection can be developed by visiting local shoe stores and/or photographing the shoes of suspects when they are arrested. The shoes are set up so one illustrates the shoe style while the other depicts the sole and heel design. A comprehensive collection can be gathered locally in a relatively short time.

Age of footwear impressions

Can the age of a footwear impression be determined with any accuracy?

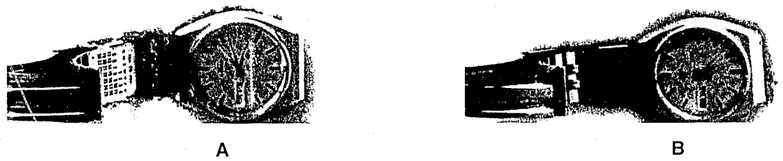
As far as the two-dimensional impression is concerned the same type of answer that holds true for fingerprints applies. However, if it can be established that no prior impression existed on the exhibit before the offence an approximate age can be established. For example: "The paper was in a drawer prior to the offence and bore no shoe prints"; "There was no glass bearing the footwear impression on the floor when I left last night"; or, "The floor was washed yesterday."

The age of three-dimensional impressions can be established by recording weather conditions over a 24 hour period prior to the offence. Rain will destroy most impressions except those located under water. Hard packed mud impressions will withstand a certain amount of rain although most impressions will deteriorate within an hour. Fresh snow will obviously cover any existing impressions establishing a time frame for those that are visible. Wind will cause rapid destruction of impressions in soil or snow. The sun's rays or the heat of day will cause any moisture, whether it be in snow or soil, to evaporate rapidly causing a break down.



A B

FIGURE 6-6: A) Impression recorded immediately. B) Impression recorded 3 hours later. Note different appearance.



A B

F!GURE 7-6: A) Impression recorded immediately. B) Impression recorded 3 hours later. Note difference.

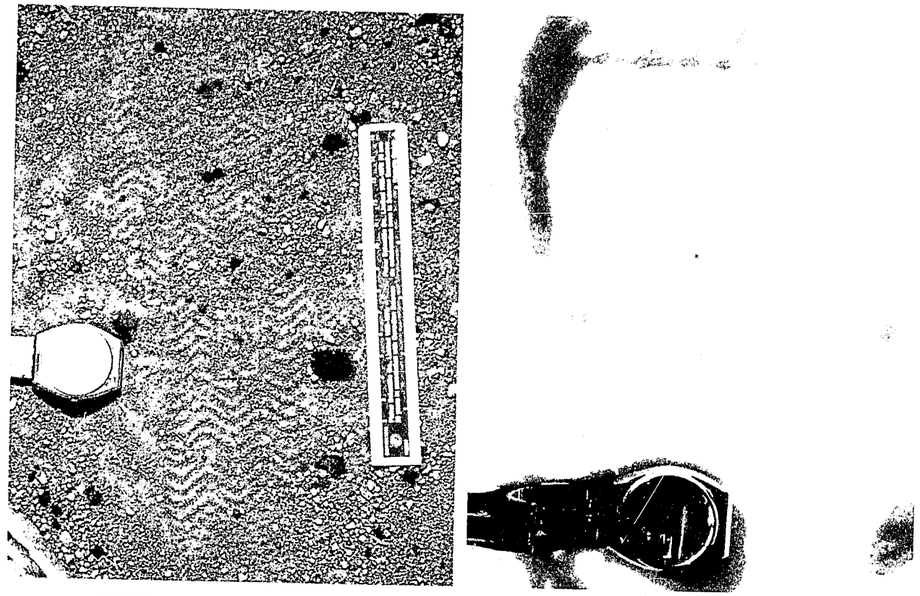


FIGURE 8-6: Impressions recorded after 24 hours. Note difference in appearance from originals.

When an impression is originally made the pattern formation appears crisp and sharp. Figure 6-6 illustrates two impressions in sandy soil during hot humid weather conditions. Figure 7-6 depicts two impressions in snow with the temperature just below 0° Celsius. The second impression of each set was taken approximately three hours later. As you can see both reveal rapid break down in clarity and detail. Figure 8-6 shows both sets 24 hours after the original. The impressions have become rounded and present a blunt appearance, lacking definition.

Age determination within minutes or hours will normally be impossible. With a little experience however the age of three-dimensional impressions can usually be established to within a 24 hour period. A number of impressions in different stages of "evolution" under various ground conditions should be recorded as standards of comparison.

References

1. H. Soderman and John J. O'Connel, *Modern Criminal Investigation*, (New York, 1962), p. 157.
2. Arne Sevensson and Otto Wendel, *Techniques of Crime Scene Investigation* (New York, 1965), p. 72.

Chapter 7

The suspect's shoe

Two major requirements exist in a footwear comparison. First, the recovery of the scenes-of-crime impression; second, a suspect's shoe. This chapter will discuss the following aspects of the suspect's shoe:

1. What methods or authorities exist for obtaining shoes for court purposes? (e.g., Voluntary relinquishment and search and seizure.)
2. What protection does the police officer have from criminal or civil liability?
3. What are the different methods of obtaining test impressions from shoes?

Voluntary relinquishment

The easiest and by far the simplest method of obtaining shoes is to have the suspect volunteer them. In most cases he will do just that. The accused should sign some form of written agreement authorizing the police to retain the shoes for investigative purposes to protect the person taking possession of them.

Authority for search and seizure

Every police officer should be familiar with the powers vested in him during the performance of his duties. Unfortunately they are complex and often not clearly stated. The authorities most likely relating to footwear identification are: search, seizure and arrest. Due to the legal complexities of these powers they can only be dealt with in very broad terms.

Seldom does the footwear specialist actually seize the suspect's shoes. This is normally a job for the investigator. Sometimes however the specialist has to make an actual seizure. An identification officer may find himself at the accused's house during the course of his work. The investigator may have returned the accused to the crime scene while examination is in progress. The accused may be brought into the police office for photographing and fingerprinting. The identification officer should be familiar with his powers of arrest, search and seizure, as he may be involved in arresting the suspect.

Seizure without warrant

The suspect may refuse to volunteer his shoes. When this occurs what authority, if any, does the police officer have in obtaining them? Can they be

forceably removed? In a Canadian court decision *Gottschalk* v *Hutton*[1] it was stated:

"...it is undoubted law (5 *corpus* juristit. Arrest page 434) that after making an arrest an officer has the right to search the person, removing his clothing, if necessary and take from his person, and hold for the disposition of the trial court, any property which he in good faith believes to be connected with the offence charged, that it may be used as evidence against him, or that may give a clue to the commission of the crime or the identification of the criminal, or any weapon or implement that might enable the prisoner to commit an act of violence or effect his escape...."

In a recent civil action arising out of the search warrant process *Reynan* v *Antonenko et al*[2] the court acknowledged the existence of this general power of common law to search a person under arrest as stated in *Gottschalk* v *Hutton.*

The main points of this common law power of search and seizure are:

1. A valid arrest must take place.
2. The officer then has a right to remove clothing if necessary.
3. He can remove and hold for disposition any property he in good faith believes to be connected to the offence charged.
4. He can remove and hold for disposition any property that may give a clue to the commission of the crime or identification of the criminal.
5. He can remove any weapon or implement that might enable an act of violence or effect an escape.

The areas that pertain specifically to the footwear specialist are (1) and (4).

The right to search and seize without warrant goes beyond the person being arrested. It is generally accepted this right includes the property within the person's immediate control, no doubt to prevent escape or destruction of evidence. There must be some bona fide belief that evidence or a weapon will be found.

The power to search an individual as an *incidence* to a valid arrest is not laid out in the Criminal Code of Canada. It derives from Common Law, which is applicable by way of Section 7 of the Criminal Code. With the exception of special statutes, e.g., some provincial liquor acts, The Narcotic Control Act, Customs & Excise Act, there is no right to search a suspect except as an incidence to arrest.

The first criteria of this Common Law power is that a valid arrest must be made. Section 450(1) of the Criminal Code states:

"(1) a peace officer may arrest without warrant
  (a) a person who has committed an indictable offence or who, on reasonable and probable grounds, he believes has committed or is about to commit an indictable offence,
  (b) a person who he finds committing a criminal offence...."[3]

Section 450(2)(a)(b)(c) lists certain offences where a peace officer shall not arrest without warrant. However, it should be noted section 450(2)(d)(ii) permits the arrest to secure or preserve evidence of or relating to the offence (e.g., the suspect's footwear). In order for the officer to remove and hold the suspect's shoes for disposition, the arresting officer must in good faith believe it will give a clue to the identification of the criminal.

Seizure by warrant

The shoes that made the crime scene impression may not be on the accused when arrested. They may be in his residence or some other known place. In order to lawfully obtain them, a search warrant under Section 443 of the Criminal Code is required. The relevant provisions of this section are:

"(a) a justice who is satisfied by information upon oath in Form 1 that there is reasonable ground to believe that there is in a building, receptacle or place...
(b) anything that there is reasonable ground to believe will afford evidence with respect to the commission of an offence against this act...
may at any time issue a warrant under his hand authorizing a person named therein or a peace officer to search the building, receptacle or place for any such thing, and seize and carry it before the justice who issued the warrant or some other justice for the same territorial division to be dealt with by him according to law...."[4]

The important points here are:

1. The justice must be satisfied by information given under oath.
2. The person obtaining the warrant must state his reasonable grounds to believe the evidence will be located in the building, receptacle or place.
3. He must state his reasonable grounds to believe the object will afford evidence to the commission of the offence.
4. The offence contravening the Criminal Code must be identified.
5. The seized evidence is to be brought before the justice who in turn will normally order it held by the police.

In preparing the warrant a description should be included of the shoe sole or heel pattern. This description should be explicit enough that another individual could identify the object. If a photograph of the shoe impression is available, attach it to the warrant.

In the event the building, receptacle or place is in another territorial division, refer to Sub-Sections 443 (2) and (4) of the Criminal Code. In this case the warrant must be endorsed.

Once the evidence has been seized, it cannot be detained for more than three months, unless trial proceedings have been initiated where the exhibit will be required or upon application prior to the three months for an extension for a specific period. In this case the justice must be satisfied it is warranted. These provisions are covered in Section 446 of the Criminal Code.

Exhibit continuity

Continuity of the exhibit is extremely important. Care should be exercised that the owner's name, date/time of seizure and the initials of the officer seizing the shoe be clearly marked on it. The footwear specialist should always ensure that his initials, the date and the time the exhibit was turned over to him are properly recorded as well. This is basic police procedure but is often overlooked. *Any continuity break could render the evidence useless*. The use of tags for recording this information is not recommended as they can come loose.

Liability

A problem could arise where force may have to be used to seize the footwear. Section 25 (1) of the Criminal Code states:

"everyone who is required or authorized by law to do anything in the administration or enforcement of the law (a) as a private person, (b) as a peace officer or a public officer, (c) in aid of a peace officer or public officer, or (d) by virtue of his office, is, if he acts on reasonable and probable grounds justified in doing what he is required or authorized and in using as much force as is necessary for that purpose."[5]

Basically, this section is a justifying section providing the necessary civil or criminal protection to officers exercising force providing it is done within the law. Occasionally, while examining a suspect's shoe, it has to be cut apart to determine mold numbers on the reverse side of the sole or heel or examine the foot depressions located inside. It is far from clear if Section 25 provides protection from liability under these circumstances as there is no apparent legislative authority (required or authorized by law). Should examination be reasonable and necessary, considering all the circumstances, the court would probably give a positive response, based on common law powers of securing evidence, to search, seize and investigate. One would be wise however to seek direction from the justice having jurisdiction of the case before destroying shoes. Another solution would be for the police department concerned to reimburse the accused the cost of the shoes.

A word of caution: Section 26 of the Criminal Code provides that if anyone authorized by law to use force uses excessive force, he may be held criminally responsible for his actions.

Investigative techniques

Shoes that are not on the supect's feet when seized can be a problem. How do we know they belong to him? They could in fact belong to someone else living or visiting at the same place. If you are returning to the accused's residence or some other place to seize the shoes and if it is reasonable, have him accompany you. The search may be conducted with permission or with a search warrant. If you see similar type shoes in the building, ask the suspect who they belong to. If you are at the place to arrest the suspect and he is not wearing shoes simply ask him to put on his shoes. If he puts on the right ones there is no problem. Should he put on another pair point out the ones you are interested in and ask him who they belong to.

In the event he refuses to admit ownership, identity will have to be established by the methods described in the following chapter. The investigator should make every effort to have an admission of ownership put in writing as well as the fact that the footwear was not recently worn by anyone else. A major defence in footwear evidence is "the suspect was not wearing the shoes at the time of the offence". I do not intend to deal with the taking of statements other than to say make sure it is voluntary and preferably that he has been given the official police warning. An admissible statement admitting ownership will eliminate many hours of hard work.

Summary

In review then, shoes can be obtained in three different ways:

1. Volunteered by the suspect.
2. Seized from the suspect or his immediate surrounding as an incidence to his arrest.
3. By way of search warrant, when there is no arrest or the shoes are not on the suspect.

The shoes must be properly identified to the suspect with the date and initials of all persons who have had them in their possession since they were seized

clearly marked to establish continuity. The use of force to seize shoes by way of warrant or arrest is covered in Section 25(1) of the Criminal Code of Canada.

Test impressions

Once the shoes have been obtained, the best way to take test impressions for comparison purposes must be determined.

Two-dimensional impressions

The two-dimensional scenes-of-crime impression is a reverse positive image of the shoe. Comparing the crime scene impression directly to the shoe would be extremely difficult. Not only will accidental characteristics be reversed, many minute marks which might be recorded will not be visible. The test impression provides a medium which may be compared against the scenes-of-crime impression and also used in chart form to illustrate findings.

Every effort should be made to obtain an impression which closely resembles the scenes-of-crime impression. This can usually be accomplished by:

1. Taking a number of test impressions.
2. Having someone with a similar size foot wear the shoe to make the test.
3. Duplicate the way the scenes-of-crime impression was made.

Often before the test resembles the evidence many impressions using a variety of methods will have to be made. Too much ink, powder or pressure may cause characteristics to appear differently or to disappear altogether. The person making the test impression should always place a plastic bag over his foot before putting on the shoe. This is necessary to prevent any hair or fibre contamination from falling inside the shoe (which will be discussed later) and will also act as a measure of hygiene. If the culprit jumped off a chair or counter when making the crime scene impression, then some tests should be made duplicating the jump. When an impression is found on a small portion of glass some tests should be made on a similar piece, either as a receiving surface or under the receiving surface. Close duplication of the scenes-of-crime impression will often be the deciding factor for establishing an identification.

There are a number of ways to make a test impression. Where one method might work well on one case another may have to be used on the next. The footwear specialists should be familiar with these different techniques.

1. *Talcum powder — carbon paper — fingerprint powder*

A) An old and reliable method which records details very accurately giving good contrast between the impression and background uses talcum powder and carbon paper[6]. Talcum powder is spread over a surface such as a large sheet of blotting paper or newspaper. The talc is then shaken off the paper leaving a very fine hardly visible coating. A sheet of carbon paper is placed on a few sheets of newspaper which have been placed on the floor to prevent particles off the floor recording false details. By walking across the talc coated paper then onto the carbon paper, a test impression recording minute detail is visible.

NOTE: Grey fingerprint powder can be substituted for the talc.

B) Another version of the above method is to dust the shoe bottom with a fine coat of chemist's or analytical grey fingerprint powder then to step on a piece of carbon paper supported by a few sheets of newspaper or blotting paper. Results will be similar. As a receiving surface carbon paper does present one problem. It may develop crease marks or wrinkles.

2. *Fingerprint powder — plastic — glass — talc powder*

An excellent and possibly the most consistently accurate method is to record the test impression on clear plastic or glass. This procedure is similar to method number 1(B), except that glass does not require paper support. Plastic will require some protective base to prevent dirt from causing false detail. The advantage of glass or plastic over carbon is that creases will not form and the impression can be made either black or white through photography depending on the background and lighting procedures. A black background will show white powder in its natural state. Using a backlight (impression lit from the rear) and a white background the white powder will appear black. This form of test impression is very fragile and should be photographed immediately.

3. *Fingerprint lifting tape — fingerprint powder — rubber lifters*

A further method: Dust the shoe bottom with the desired colour of fingerprint powder and lift the impression with fingerprint tape. In this procedure apply the tape by hand or roller. In order to maintain proper laterality and not obtain a mirror image place the lifted impression on a clear acetate sheet and view it from the reverse side. This method is impractical for full size shoe impressions but may be useful when trying to record a specific area. Full size impressions would require more than one piece of tape to record the entire shoe bottom causing unsatisfactory joint marks. Contrasting coloured rubber lifts can also be used as a receiving medium. The use of these lifts will eliminate laterality problems however several tests may be required to obtain a good impression and rubber lifts are expensive.

4. *Fingerprint ink and paper*

A shoe which has had fingerprint ink applied to the bottom with a roller will make a good contrasting impression on white bond paper. After applying a thin coating of fingerprint ink to the shoe bottom the impression is made as in number 1. Fingerprint ink may cause very minute characteristics to become filled in and thus not register clearly.

5. *Margarine and Magna Brush*

In recent years another method has been developed which has proved quite successful. Sometimes referred to as the "Margarine Method"[7], a minute amount of margarine is rubbed into the palm of the hand and then against the entire bottom of the shoe. A test impression is obtained by wearing the shoe and stepping on a piece of glass, good quality white bond paper or clear plastic supported by newspaper. The receiving medium is then dusted with a Magna Brush developing a very clear and accurate image of the shoe bottom. The initial experiments with this method used a variety of greasy substances, e.g., vaseline, butter, shortening, oils; however, margarine proved to be superior.

Figure 1-7 illustrates some of the methods described.

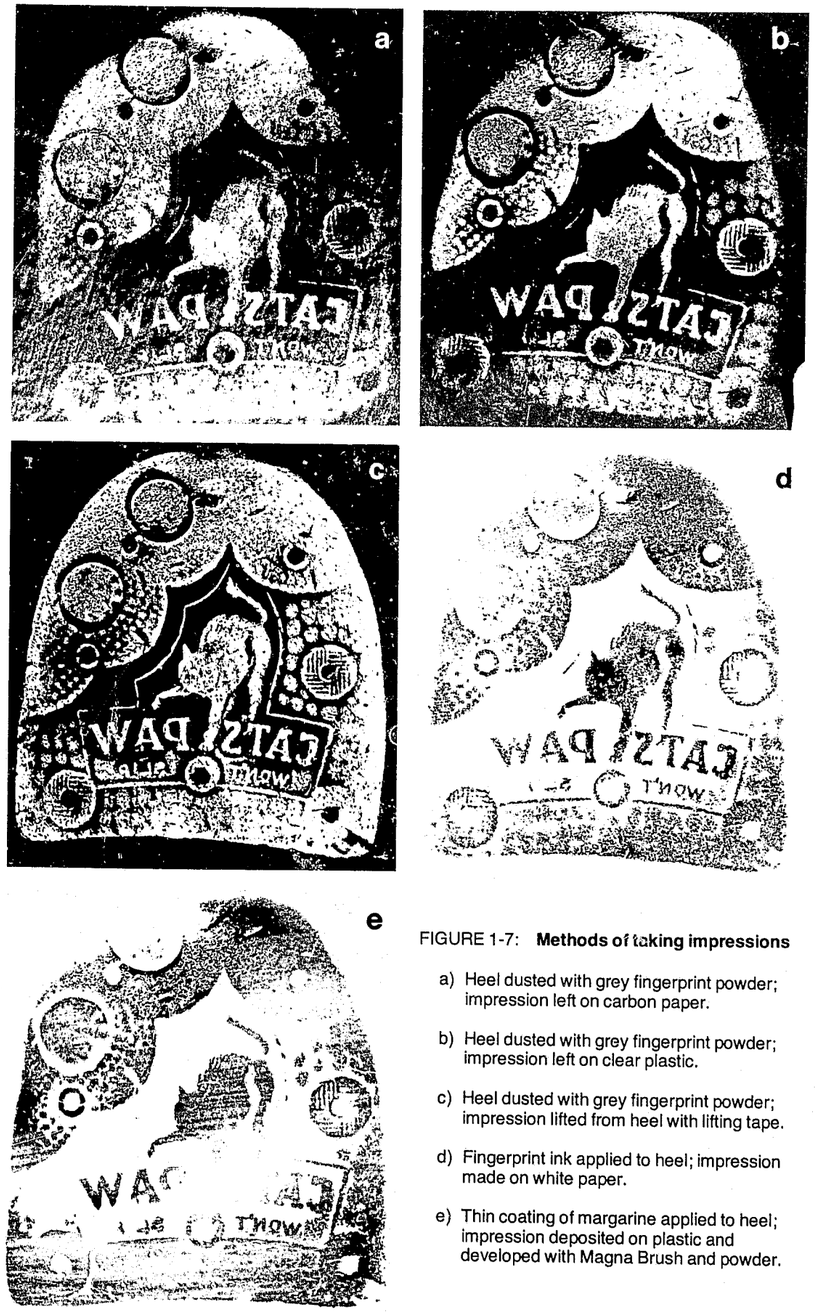


FIGURE 1-7: **Methods of taking impressions**

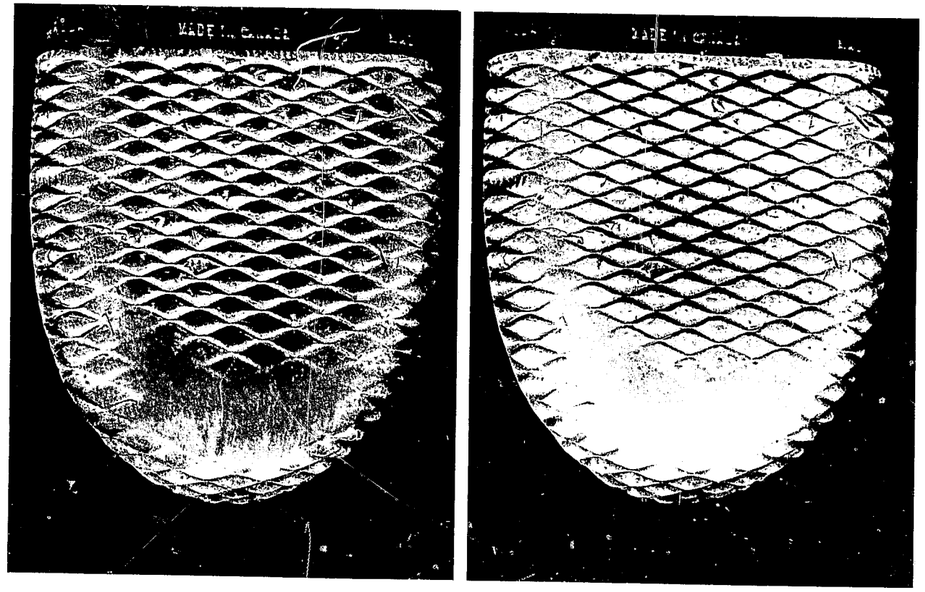
a) Heel dusted with grey fingerprint powder; impression left on carbon paper.

b) Heel dusted with grey fingerprint powder; impression left on clear plastic.

c) Heel dusted with grey fingerprint powder; impression lifted from heel with lifting tape.

d) Fingerprint ink applied to heel; impression made on white paper.

e) Thin coating of margarine applied to heel; impression deposited on plastic and developed with Magna Brush and powder.



A B

FIGURE 2-7: Cast impressions compared directly to boot. A) Boot in cleaned condition. B) Boot dusted with white fingerprint powder to accentuate minute cuts and abrasions.

Three-dimensional impressions

Three-dimensional comparisons create yet another problem. If a scenes-of-crime impression has been cast it will be directly compared to the shoe. Photographs of the shoe used for illustration or comparison purposes may be distorted because the bottom of a worn shoe develops a curve in the sole area. By inserting a shoe tree, the bottom can be straightened out and distortion eliminated. One photograph should be taken, depicting the shoe bottom in its natural, clean state. A second photograph should be taken after the bottom has been dusted with a contrasting fingerprint powder. This procedure will cause minute characteristics to become visible regardless of lighting angles. (See Figure 2-7.)

Where a cast has not been made a negative impression of the shoe bottom will have to be obtained using plasticine or spreading flour or dental plaster in a tray. Recreating a three-dimensional impression in snow or dirt is not recommended because the medium is too coarse to accurately record all the characteristics. A drawback in using flour or dental plaster powder is that the test impression is too fragile. Photographs would immediately have to be taken. Plasticine on the other hand is more stable. A negative cast of the shoe could also be made using silicone rubber. This would be fairly expensive. The advantage of course is its stability, permanency, accuracy and easy removal from the shoe.

Three-dimensional test impressions should always be lit from a similar angle and direction as the scenes-of-crime impression when photographed. If this is

overlooked, a "raised indented" illusion as discussed in Chapter 2 may occur making it difficult to examine both impressions at once.

Summary

When it comes time to establish identity, accurate test impressions can be as important as the scenes-of-crime impression. Two-dimensional test impressions can be recorded in a number of ways:

1. Fingerprint powder, carbon paper.
2. Fingerprint powder, plastic/glass.
3. Fingerprint powder, fingerprint lifts (rubber or plastic).
4. Fingerprint ink, bond paper.
5. Magna Brush, margarine, bond paper, plastic or glass.

The method chosen depends on the circumstances and will normally require more than one test to accurately duplicate the scenes-of-crime impression. As a rule the impression will be more accurately recorded if the shoe is worn by someone with a similar foot size.

Casts of three-dimensional impressions are usually directly compared to the shoe bottom. When photographs *only* have been taken, a negative image of the shoe bottom in some molding surface should be prepared. Silicone rubber, although expensive, is very accurate and stable. Plasticine, flour or dental plaster can also be used. The point to remember when photographing is to light the test impression in a similar manner as the scenes-of-crime impression to prevent illusion problems.

References

1. *Gottschalk* v *Hutton* (1921), 36 C.C.C. 198 (Alta, S.C., App. Div.) at pp. 301-302.
2. *Reynan* v *Antonenko* et al (1975) 20 C.C.C. (2nd) 342 (Alta. S.C.T. Div.).
3. *Criminal Code*, R.S.C. 1970, C.C. 34.
4. *ibid*.
5. *ibid*.
6. John R. Abbott, *Footwear Evidence*, (Illinois, 1964), p. 163.
7. G. Lafrance, "Reproduction of Impressions", *RCMP Gazette*, Vol. 38, No. 1, pp. 12-13.

Chapter 8

Identifying a suspect to an unknown shoe

Identifying a foot to a particular shoe is a problem not often encountered. In fact I have only heard of this happening on a few occasions. An article titled "Convicted By His Shoes" by J.C. Hofstede published in the RCMP Gazette, February 1965,[1] refers to a case in 1962 in Leiden, Holland. The criminal was convicted of safe- breaking primarily on evidence linking his feet to a pair of shoes. After committing the offence the culprit discarded a number of articles later recovered by the police. Among the articles was clothing and a pair of shoes he had worn. The police were able to link the clothes to a suspect but required more positive evidence for court.

Three orthopaedic specialists, one of which was a shoemaker, were able to provide the positive evidence needed. In court, all three specialists were able to conclude the shoes had been worn by the suspect. These findings were based on the premise that *no two persons have identical feet*. Their examination included comparing the wear marks located inside the found shoe to similar marks located inside a shoe taken from the accused. Impressions of the suspect's feet were also compared.

In another reported case "Donald and William Kett", RCMP Gazette, Volume 11, Number 11 (1949), two brothers had committed a number of break and enter offences. Footwear impressions were located which were later identified as coming from a pair of shoes seized by the police from William. Ample evidence was available to convict Donald who was sentenced to imprisonment. William, seeing his brother was going to go to jail anyway, gave evidence at his own trial stating he had borrowed the shoes from his brother the day after the offence and the shoes were in fact Donald's. Donald also gave evidence corroborating this.

Both brothers feet were recorded using photographs, ink impressions and casts, which were then compared to the wear marks inside the shoes. Donald's toe positions differed considerably from William's. The footwear specialist examining the shoes was able to demonstrate they did not belong to Donald and in fact agreed with William's feet.

I published a letter in the Journal of American Podiatry requesting any podiatrist who had conducted a forensic examination of feet and shoes to contact me. One of the replies I received was from Dr. N. Gunn of Weston, Ontario who had helped the Ontario Provincial Forensic Pathologist on two separate occasions. Both cases dealt with bodies which the police were trying to identify. Other identification means such as fingerprints and forensic odontology proved fruitless. The police had an idea who these deceased persons were, but required further proof. The identifications were made by comparing the unknown feet to wear marks located inside shoes retrieved from their homes.

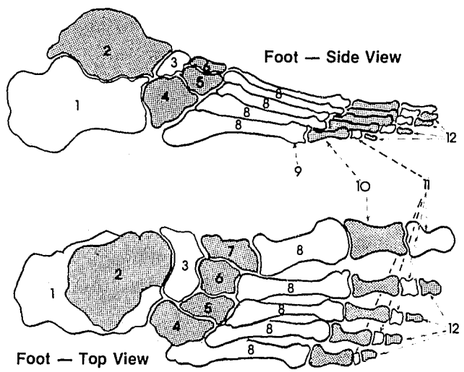
Although this aspect of footwear identification is uncommon there are probably many instances in which it could be used if the specialist knew what to do with the evidence. I could foresee this form of identification being of value when conventional methods were unsuccessful, for example, in plane crashes when unattached limbs are sometimes found. More than once I have located a suspect's old shoes inside a store where shoes are sold when he exchanged them for new ones.

Who is a foot specialist

Podiatry deals with the care of the human foot while orthopaedics is a branch of surgery dealing with deformities and bone disease. A podiatrist or orthopaedic surgeon is a specialist who has the type of background training to properly interpret the marks inside the shoe and present this form of evidence in court.

A footwear specialist could perform some of the preliminary work. He could assist with any photographic requirements which will be discussed later. He could also make casts from the shoes and conduct any preliminary examinations since podiatrists and orthopaedic surgeons may not always be readily available especially in rural areas. He may in fact be able to eliminate the suspect. An example would be a case where two or three persons are placed in cells and the shoes are removed and not properly identified. Then once footwear evidence gains importance no one admits ownership. The footwear specialist can then demonstrate how wear marks in the shoe agree only with one of the suspects, eliminating the others.

There are a number of bones in the human foot which play an important role in leaving wear marks. Figure 1-8 is a diagram identifying these.



1. Os calcis
2. Tallus
3. Scaphoid
4. Cuboid
5. Internal cuneiform
6. Middle cuneiform
7. External cuneiform
8. Metatarsals
9. Metatarsal heads
10. First phalanges
11. Second phalanges
12. Third phalanges

FIGURE 1-8: Bones of human foot.

I indicated earlier that orthopaedic specialists have often stated that no two people have identical feet. Dr. Gunn stated there is no such thing as a "pair" of feet. These statements are no doubt true. However, they are based on a number of features of the foot, all of which may not be detectable in the shoe. Figure 2-8 is a good example of what you may find on the insole of a shoe. The position of the toes and the area where the sole rests is of special significance.

Foot uniqueness

I conducted a study of the right foot on 90 people comparing:

1. Toe position.
2. Length.
3. Width.
4. Angle of great toe against medial (inner) side of the foot.
5. Longest toe.

The shoe insole generally bears the imprint of these five factors. After comparing all 90 feet using foot width and length and toe positions *only*, no two were found to be identical. Figure 3-8 depicts two similar but easily distinguishable feet. One must remember of course the only visible feature detectable in a shoe is the shadow of the foot. This shadow will not depict the detail or be as exact as an actual foot. I also believe duplication in the above three areas would probably reoccur on a world population basis.

FIGURE 2-8: Insole of shoe depicting image of foot.

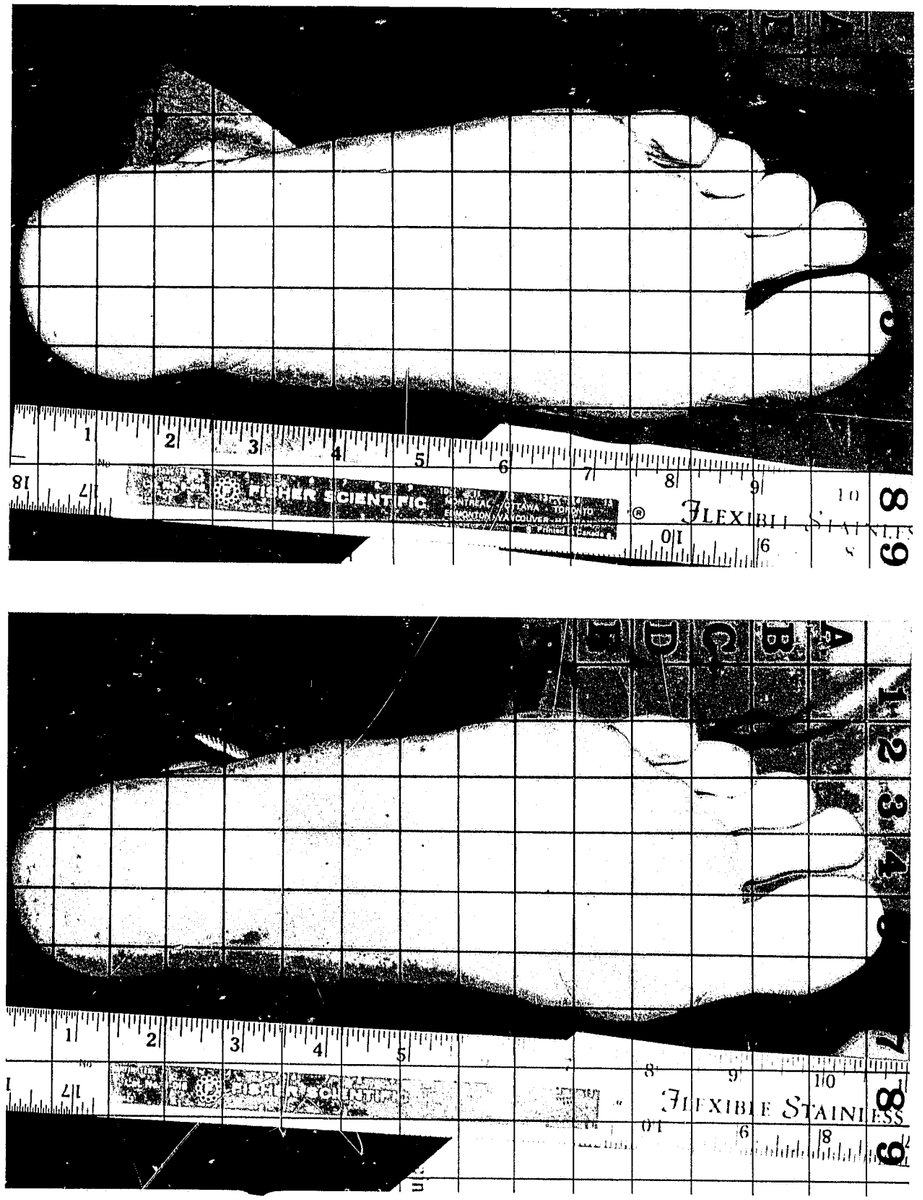
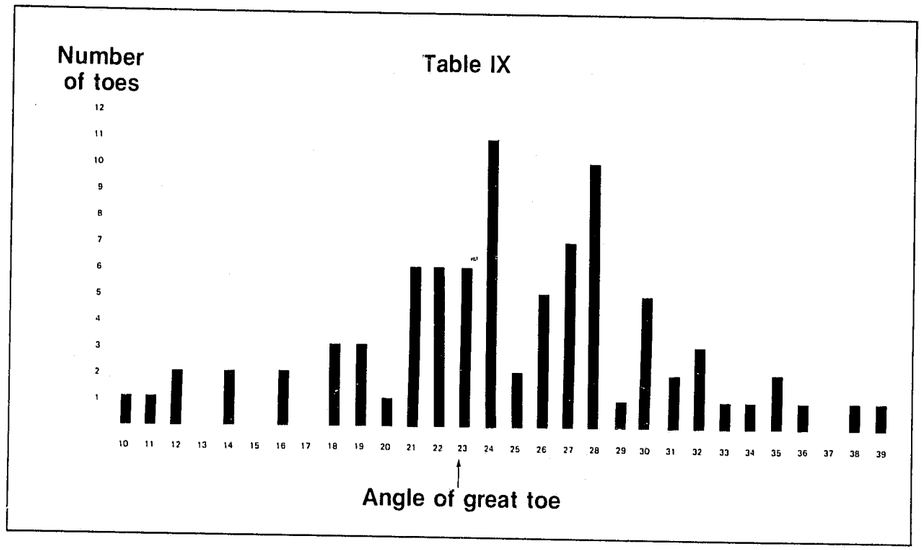


FIGURE 3-8: Two similar but easily distinguishable feet.



For this survey the angle of the great toe was taken from a line drawn along the medial (inner) side of the foot. Most common angles ranged from 21° to 30°. Table IX shows the angle distribution.

The longest toe was determined by placing a compass at the back of the heel and scribing an arc across the toe ends. Table X reveals the results.

TABLE X

Longest Toe	Percentage	Ratio
Great Toe	84.4%	1:1.2
Second Toe	9%	1:11
Great Toe and Second Toe Equal	8%	1:12.5

Foot disorders

In 1947 the Canadian Army published the results of an extensive foot survey carried out by Colonel R.I. Harris, M.C. R.C.A.M.C. and Major T. Beath, R.C.A.M.C. The major value of this survey to the footwear specialist is that it constituted a random survey of Canadian Army applicants consisting of a good cross section of men aged 18 to 35. The total number examined: 3,619. This extensive research revealed 41.4 percent had no foot defects, while 58.6 percent had some foot disorder. Many of these disorders would cause pressure or wear marks inside the shoe which would be valuable when attempting to identify a foot to a shoe. Table XI indicates the type of disorders and the percentage of times they were observed in this study. A brief description of the disorders and their possible effects on the shoe follows.

TABLE XI

Foot disorders

Disorders	% of population
Flat Feet	22.5
Pes Cavus	11.8
Skin Lesions	10.8
Scaphoid Defect	4.9
Hallux Rigidus	3.7
Hallux Valgus	2.2
Exostosis	1.2
Hammer Toe	.6
Total surveyed	3,619

1. **Flat Feet**: (22.5%) Abnormal flatness of the arch. In varying degrees of severity this condition is detectable in the shoe insole by signs of broader wear marks between the sole and heel.
2. **Pes Cavus**: (11.8%) The heel and metatarsal bones meet at a greater than normal angle causing a high instep. The high instep will normally cause greater pressure on the metatarsal heads which will be revealed in the sole of the shoe. The toes may also rest in a clawing position showing little wear on the insole where toes normally rest. This clawing effect could also be recorded on the uppers of the shoe in the toe cap area.
3. **Skin Lesions**: (10.8%) A skin lesion is any injury or wound. The four lesions that may be recorded in the shoe are listed below. The percentage of occurrence in the surveyed group is also shown.
   a. **Callous**: (2.4%) A thickening and hardening of the skin caused when excessive pressure is placed on an area of the foot. This will cause excessive depression or wear in the shoe.
   b. **Corn**: (2%) Soft or hard horny protusion of the skin caused from ill fitting shoes. Could produce excessive wear marks on the inside of the shoe.
   c. **Wart**: (.7%) Benign tumor of the skin, nourished externally. May cause wear marks on the inside of the shoe.
   d. **Excessive Sweat**: (3.6%) May show excessive staining on the inside of the shoe.
4. **Scaphoid Defects**: (4.9%) Abnormality of the scaphoid bone on the inner side of the foot (see foot diagram). This disorder normally shows a pronounced scaphoid bone which could cause excessive rubbing on the inside of the shoe near the medial ankle. It could also result in a rolling of the foot to the inner side causing the heel to show external wear on the inner edge. (The majority of people wear their shoe heels on the outer edge.)
5. **Hallux Rigidus**: (3.7%) The great toe remains rigid. May cause excessive wear on inside of shoe.

6. **Hallux Valgus**: (2.2%) Great toe bent away from the foot. Can be determined by the abnormal toe angle measured to the medial side of the foot.
7. **Exostosis**: (l.2%) Any bony growth could cause wear marks on the inside of the shoe adjacent to the growth.
8. **Hammer Toe**: (.6%) The first phalange adjacent to the metatarsal head rises and the second and third phalanges fall. May cause excessive wear on the inside toe cap of the shoe. Because the toe could rest on top of the adjacent toes, there may be no sign of a toe on the insole. Should the toe rest below the other toes, excessive wear would be evident.

Podiatrists have indicated to me that wear marks of the metatarsal heads (see Figure 1-8) would be significant in their examination inside the shoe. Harris and Beath reported 86 percent of the 3,619 men examined showed no excessive weight on the metatarsal heads. A total of 14 percent did on one or more heads. A breakdown of these is shown in Table XII.

TABLE XII

Excessive weight

Metatarsal head	Percentage
2nd	2.5%
2nd and 3rd together	1.7%
2nd and 4th, 2nd and 5th or 1st but not 2nd alone	.2%
1st, 3rd, 4th and 5th	5.0%
Other combinations	5.0%

Finally, sock fibres, leg and pubic hair are frequently left inside the shoe. People who own dogs and cats will most likely have animal hair present as well. This evidence can be of value when determining ownership of the shoe and should not be overlooked. Fibres and hair visible inside the shoe should be removed as the first stage of examination. If a cast is taken of the inside of a shoe the hair etc. will be found adhering to the edge of the cast.

The shoe

The unidentified shoe and one taken from the suspect should be examined in the following manner:

1. Exterior photos showing general condition: creases and wear marks.
2. Plaster cast of the inside of the shoe with laces tightened in normal position. The bottom of the shoe should be flat to prevent any distortion of the cast. Some release agent should be applied to the inside of the shoe such as a microscopic coating of light oil to prevent the salt in the leather from deteriorating the plaster. This will also allow the plaster cast to be easily removed. Allow at least two hours for the plaster to harden before attempting to remove. Shoe uppers will have to be cut with a sharp scalpel. Cutting should cause as little destruction as possible to the toe area. The cast will give a somewhat *exaggerated* positive image of the bottom of the foot in areas of excessive pressure. (See Figure 4-8.)

FIGURE 4-8: Two separate casts from two left shoes of same person. Note excessive pressure of metatarsal head repeated in both casts in same position.

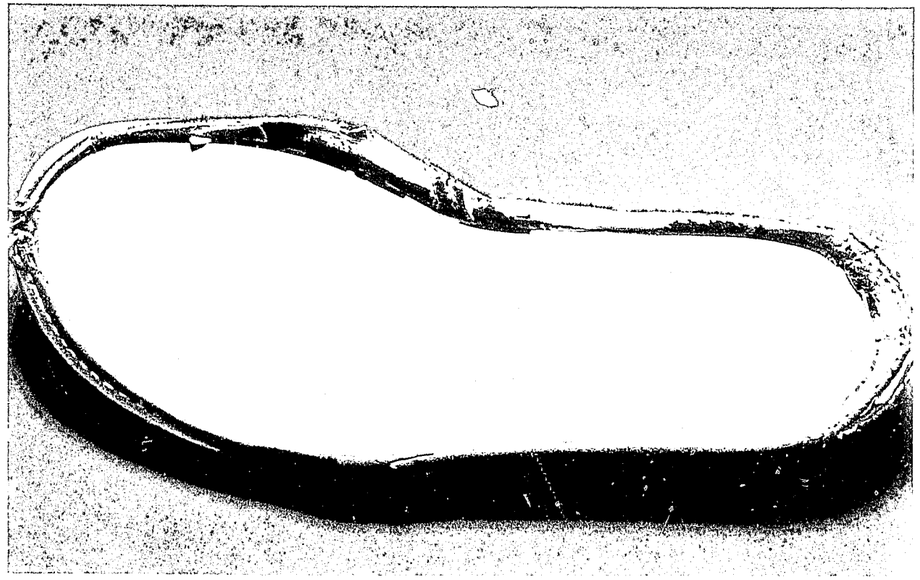
3. Photograph the inside of the shoe after casting. (Remove excess plaster first.) The sole should be flat to eliminate distortion. Include a scale ruler in the photograph to enable 1:1 enlargements.
4. Weak impressions can at times be enhanced by lighting the insole with ultraviolet light. When good results are obtained, ultraviolet photographs should be taken. The type of material used for the insole and the amount of sweat in the leather will determine the reaction to ultraviolet light. (See Figure 5-8.)
5. Any abnormal wear marks registered on the shoe upper (especially the toe area) should also be photographed.

Suspect's foot

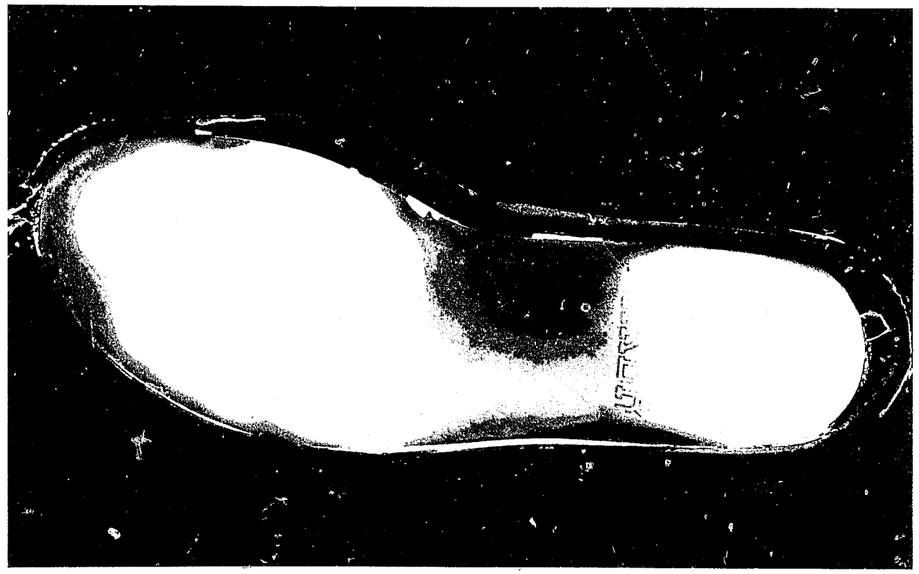
1. The foot should be examined in a weight-bearing position. Photograph the sides, front and rear, straight down and from the bottom up. The rear shot should include the achilles tendon which runs from the calf of the leg to the heel bone, as it has some effect on proper foot positioning.
2. Any foot cast should be made by a foot specialist.
3. Foot specialists use specially treated paper to record excessive weight-bearing areas.

Summary

The comparison of a foot to a particular shoe for identification purposes is obviously a field requiring the assistance of a qualified foot specialist.



A



B

FIGURE 5-8: Two photographs. A) Normal lighting. B) Ultra violet lighting. Image of foot becomes apparent.

The identification officer plays a role in this field and should have some basic knowledge about it, as he will decide whether or not this phase of identification is necessary.

The identification officer may be able to conduct the initial examination and eliminate the suspect in many cases. Foot length and width, position of toes, angle of great toe, pressure of any excessive wear marks caused from various foot disorders, position of metatarsal heads, general wear and creases of the shoe uppers, all play a part in establishing positive identification.

Toe positions may change when confined to the inside of a shoe, therefore every effort should be made to obtain a pair of shoes known to belong to the accused. At this stage of an investigation there should be sufficient evidence to warrant an arrest. The shoes he is wearing can then be seized as an "incident to arrest" and used for examination purposes.

The provisions of The Identification of Criminals Act would allow photographs and measurements of the feet to be taken. I do not know of any existing authority for taking casts of the suspect's foot. Should this be required, I would recommend the accused be asked to submit to the cast voluntarily.

No doubt a number of areas exist where this type of evidence could be useful. However, only by being aware of what can be accomplished, and by whom, can this be used to full advantage.

References

1. J.C. Hofstede, "Convicted by His Shoes", *RCMP Gazette*, Vol. 27, No. 2, (1965) pp. 6-11.

Chapter 9

The footwear specialist in court

The identification officer's opinion presented in court ends his involvement in a particular case. A jury and/or judge will very quickly determine the outcome of his efforts in locating, examining and analyzing footwear evidence. The manner in which he presents himself and the way he responds to cross-examination, will undoubtly determine whether or not his evidence can be given and the weight or value attributed to it by the court.

Footwear evidence is considered opinion evidence. Generally speaking witnesses are only permitted to give direct evidence, e.g., what they saw, did, or in some cases, heard. In Canada it is generally accepted one must be ruled an "expert" by the court before an opinion can be expressed. We often hear the word expert used in the sense of a professional quality. i.e., "He is a footwear expert". The truth of the matter is, the word expert is a term used by the court to classify a particular witness. The role of the expert witness is not to determine guilt or innocence, but rather to assist the court in determining what weight is to be placed on technical evidence entered which without assistance could not be interpreted properly. The court is not bound by the witness' opinion but will form its own conclusion based on the totality of the evidence entered, the witness' background and the way he presents himself.

Canadian courts state that a witness requires special or peculiar knowledge about the subject being discussed in court to be accorded the special status of an "expert". It does not matter whether such knowledge has been acquired through formal training or by other means. The rules governing "who is an expert" are not written in statutes but have developed from past court decisions (case law). In one court ruling the judge stated:

> "...One who is an old hunter, and has thus had much experience in the use of firearms, may be as well qualified to testify as to the appearance which a gun recently fired would present, as a highly educated and skilled gunsmith...."[1]

Footwear evidence is circumstantial. In order for a conviction to be obtained on that evidence alone the courts are governed by *Hodge's Case.*[2] In essence, the judge stated that circumstantial evidence must not only be consistent with the fact the accused committed the crime but that the facts were inconsistent with any other rational conclusion. The Supreme Court of Canada in *Maclean v R.*[3] recognizes Hodge's rule on circumstantial evidence as proper direction for Canadian courts. This ruling does not change the necessity that proof of guilt in a criminal case must be established beyond a reasonable doubt. Footwear evidence alone will seldom convict the accused but will often corroborate other direct or circumstantial evidence.

Qualifications

The trial judge must first be convinced that the witness does possess special or peculiar knowledge in his field. The following list represents some of the qualifications a footwear specialist should present in court:

1. Basic training in footwear identification.
2. Follow-up training under guidance of qualified personnel.
3. Study of recognized literature on the subject.
4. Approximate number of controlled and scenes-of-crime examinations conducted to date.
5. Knowledge about techniques of developing and recording evidence.
6. Knowledge and experience on the procedure of footwear identification.
7. Understanding procedures in manufacturing soles and heels.
8. Length of time employed as a specialist.
9. Membership in relevant recognized professional societies.
10. Articles published.
11. Additional on the job training, e.g., advanced training courses, seminars, workshops and self initiated research.
12. The number of courts and jurisdictions in which he has presented evidence (some courts are not interested in this point).

When presenting qualifications the witness must be careful to be thorough. The witness should not exaggerate his expertise. To this end some record of the number of examinations conducted, books and articles read or published, training courses attended, court levels at which testimony was given, should be maintained.

Once qualifications are tendered they may be subject to rigorous cross-examination. The witness who is unable to respond adequately to this cross-examination or who expresses his qualifications poorly may find he is refused expert status. This in turn will prevent his evidence from being tendered. *The importance of presenting proper qualifications cannot be overstressed.* Once the witness has been denied the chance to testify as an expert, it is too late to enter further qualifications. Too often unfortunately, defence counsel does not properly challenge the witness' qualifications. This could lead to poorly trained personnel presenting evidence. Good thorough cross-examination should be viewed in a positive manner as it keeps the witness alert and up-to-date.

The court's designation of an "expert witness" holds only for that specific case. Everytime the footwear specialist appears in court he must be requalified as an expert.

Defence counsel may state he accepts the witness as an expert thereby eliminating the need for qualifications to be entered. In a jury trial this is sometimes a deliberate attempt on the part of the defence to prevent the jury from hearing the witness' background. A jury not realizing the extent of the witness' training may place less weight on his evidence. It also prevents his qualifications from being placed on record. An appeal court may also lend less weight to the expert's evidence or even disregard it totally, if no record of his qualifications exists. Crown Counsel should as a rule insist on having the witness' qualifications given for the record.

Briefing with Crown Counsel

The footwear specialist should make a point of meeting with the Crown Attorney a few weeks prior to giving evidence. Counsel should be briefed on the type of examination conducted at the scene, the conclusions he is prepared to present, any exhibits that will be submitted and any weaknesses in his evidence (i.e., age of print, placement of accused in shoes, break in trail continuity leading to a compared impression). The Crown Attorney might not have had the chance to qualify a footwear specialist in the past. A briefing will allow him to become familiar with the witness' background. It will also provide the Crown with an opportunity to recognize any areas of weakness the specialist may have.

Court brief

A court brief laying out the witness' qualifications in detailed question and answer form, his present duties, action taken in relation to the crime, exhibits to be tendered, illustrations to be used and the opinions to be expressed, should be available to counsel before the court sits. This will ensure that Crown Counsel has all the information available. Due to their busy schedule, many crown attorneys cannot always devote the time for preparing this information in advance. The brief also assists in this information being entered in orderly fashion, e.g., qualifications, exhibits, charts, opinions, photographs, etc.

Presenting evidence

Due to the nature of his work the Canadian identification officer gains considerable experience as a witness in criminal proceedings. There is no need to go into the basics of a good witness except to say demeanor (alluding to dress, speech and attitude) must be appropriate. The court's assessment of the specialist begins the moment he enters the room.

The one area where many expert witnesses tend to be weak is with the use of technical jargon. This should be avoided! Speak in simple, clear, language. Develop a rapport with the court and establish an honest, sincere and unbiased attitude. Do not be afraid to admit facts that may be beneficial to the accused. Do not hedge on answers. Do not be afraid to say "I don't know". When objections are raised from either the defense or the crown, stop speaking until the judge has had time to rule on the objection.

The use of notes in court

In Chapter 1, emphasis was placed on accurate, detailed notes. The value of these notes becomes evident during the trial. No one can be expected to remember details for months on end. Notes not only refresh memory prior to giving evidence but can be used during the trial provided the judge grants permission. The judge must first determine their accuracy. Obviously notes made days after an examination would not be as accurate as those taken during the investigation itself. The judge will also want to establish who prepared them. Normally the witness cannot read the contents of the notes aloud other than for specific

measurements, numbers or observations too detailed to be left to memory. Notes should always be prepared bearing in mind they can be viewed by defence counsel with cross-examination developed around them.

Defence attorney

The defence attorney's role rests on the assumption the accused is innocent until proven otherwise. He ensures his client receives a fair trial. He assumes nothing. His first attack upon the footwear specialist will be directed towards his witness' qualifications. If he is successful in demonstrating that the specialist lacks proper credentials the evidence will not be heard.

Assuming the witness is accepted as an expert in footwear identification the defence attorney will then attempt to discredit or weaken evidence by:

- establishing the chain of exhibit continuity was broken.
- determining whether methods used to process the evidence was recognized by other experts.
- trapping the expert into giving opinions beyond his field then causing the witness to retract statements.
- getting the witness to commit himself to statements contrary to those of other recognized specialists.
- establishing the witness has not kept up with modern techniques.
- having the witness admit his opinion is overstated.
- causing the witness to lose his temper.
- repeating the witness' statements but twisting them around to confuse or mislead.
- the use of long silent pauses so that the witness volunteers more information.

To avoid these tactics, the witness should:

- follow proper procedure in the handling, storage and marking of exhibits.
- keep abreast of new methods and techniques through reading, courses and seminars.
- never overstate and if anything understate findings.
- keep calm and be polite.
- ask for questions to be repeated if not clearly understood.
- correct any misquotes defense counsel makes.
- be firm and straight forward.
- answer questions then keep quiet.
- be well prepared before coming to court.
- be objective.

Objectivity

Objectivity is one of the most important impressions the expert should leave with the court. The footwear specialist as an identification officer is in a very difficult position in this respect. Unlike many other expert witnesses such as doctors or forensic laboratory personnel he is usually directly involved in the primary investigation, often with the victim, witnesses and the accused. Normally he has complete knowledge of the total investigation including evidence and statements

given. Even the fact that he may have been called out late at night could have an influence on his objectivity. The possibility of the witness becoming biased must be continually guarded against. He should occasionally attend court as a spectator to hear how detrimental a biased police witness can be. Only through self-evaluation and constant awareness of this problem can he reduce or eliminate a biased attitude. For example, he should be aware of this potential bias when the investigator comes to him with a suspect's boots saying "There is no question this is the guy but he won't say a thing". This type of influence places some question on one's objectivity. He owes it to himself and the court to do his best under the circumstances.

Use of charts in court

Using a chart can be helpful to demonstrate to a judge or jury how an opinion was formed. Not only does it assist them in understanding the complexities of a footwear identification but in many cases adds weight to the expert's opinion. Always emphasize the chart is merely there to help the court and the identification was actually formed from exhibits. A second advantage: you cannot come to court after making a chart and be unprepared.

There are a number of methods used to illustrate an opinion in the course of presenting footwear evidence. By far the majority of charts presented depict the known impression (taken from the accused) on one side and the unknown

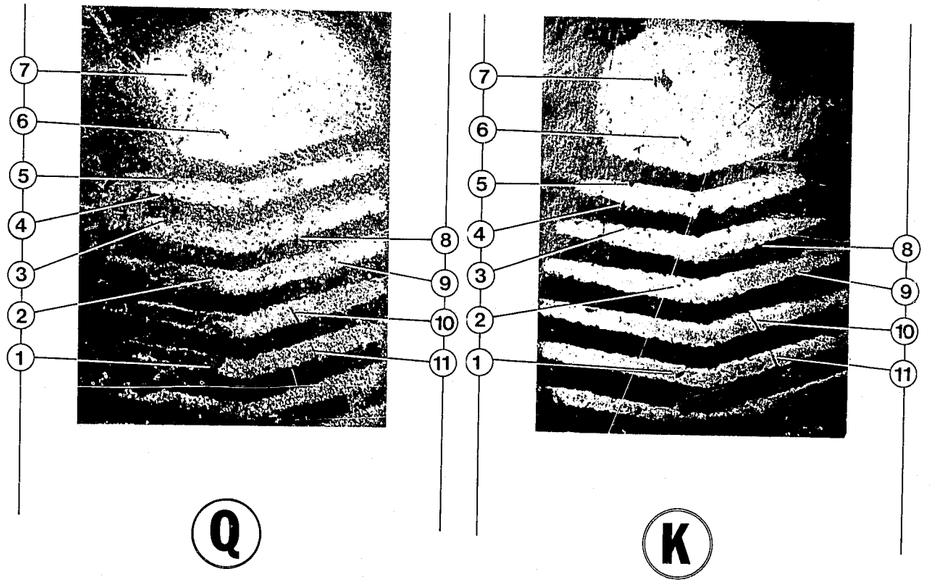


FIGURE 1-9: Typical footwear illustration chart.

impression (located at the crime scene) on the opposite side. Accidental characteristics are illustrated by drawing lines to each characteristic and consecutively numbering them. Figure 1-9 is a typical chart illustrating a footwear identification.

The only flaw with this method is its similarity to a fingerprint chart. The court may become confused and expect characteristics of similar number to a fingerprint chart to be in agreement. There are differences between the two forms of evidence which could conceivably leave footwear evidence with fewer areas in agreement as I explained in chapter 5.

One solution is to use letters instead of numbers. In this way a definite distinction between footwear and fingerprints exists.

Further, I feel a good photograph of the heel or sole from the shoe should be included in the chart. Although the shoe will normally be presented as an exhibit an explanation and illustration of accidental characteristics can be made easier with this photograph. Figure 2-9 is a sample of this method.

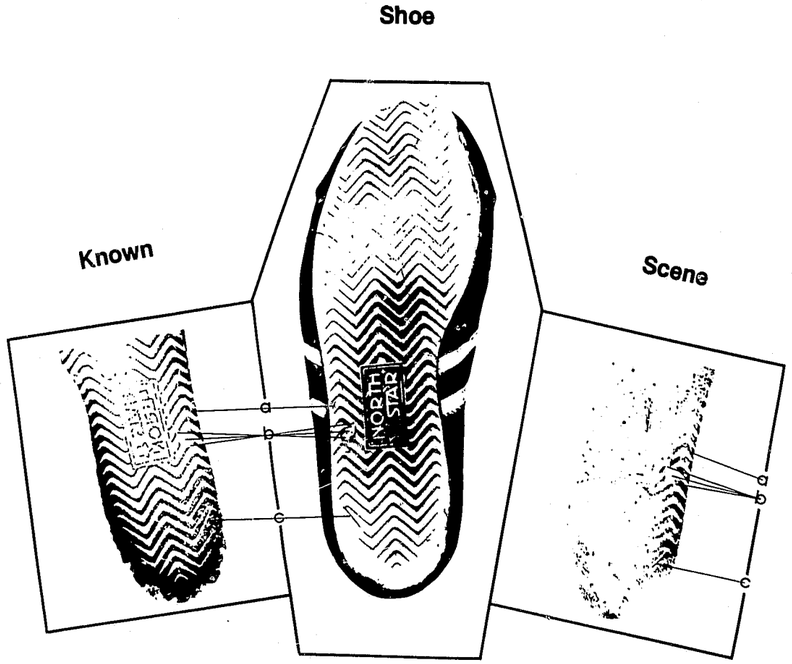


FIGURE 2-9: Footwear illustration showing:

1. Characteristics represented by letters.
2. Scenes-of-crime impression.
3. Known test impression.
4. Shoe.

In the past I have referred to the *overlay method* for examining an impression. This can also be used to illustrate an identification. The scenes-of-crime impression is placed over the known impression and similiarities are then demonstrated by placing a clear sheet of acetate over the unknown impression and lettering the characteristics with letraset in a contrasting colour. The coinciding characteristics can be clearly seen by moving the unknown impression up and down. This method should not be used if any distortion is present. Translate film (photographic paper with a transparent base) or large sheets of graphic arts film are normally used instead of photographic paper.This permits similarities between the known and unknown to be simultaneously seen. The overlay method is not recommended in jury trials because the jurors, lawyers and judge cannot all see the illustration at once. Figure 3-9 shows an overlay example.

The grid system lends itself well to footwear identification. A grid consisting of 1/4" squares, letters across the top and numbers down the side is prepared on an 8 x 10 sheet of bond paper. A 4 x 5 line negative (Kodalith film) is prepared from this master. The basic idea of the grid system is like map reading. Cross-reference points on the chart locate a definite area. The trick of course is to have the grid set up on both known and unknown impressions so each will have their accidental characteristics correspond to the same coordinates.

There are two basic ways.

1. ***Grid incorporated in photographic impression.***
   a. Expose a number of pieces of photographic paper to the grid negative at the desired grid size. Store paper in a light-tight box.

FIGURE 3-9: Overlay of crime scene impression placed over test impression. Transparent film or photographic paper used to record impressions.

CONTINUED

2 OF 3

b. Project the image of the scenes-of-crime impression to the desired size on the reverse of a piece of photographic paper. Trace three or four definite characteristics or reference points with a pencil on the paper and set the paper aside.
c. Without changing the image size, print a number of enlargements on the paper with the pre-exposed grid.
d. Insert the negative of the known impression and project it onto the blank paper with the reference points. Adjust the paper easel so that the reference points on the paper agree with those being projected.
e. Print a number of enlargements of the known impression on the paper with the pre-exposed grid.

The enlargements of both negatives will now have a grid design that coincides with accidental characteristics or reference points. With these photographs mounted side by side, we now have a chart. (Note — lining up reference points is also recommended when enlarging fingerprints for fingerprint charts.)

2. *Grid overlay.*

The grid system can also be used by incorporating the grid on large sheets of film 8 x 10 or 11 x 14. Place a sheet over each impression and adjust them so the accidental characteristics correspond to each grid.

Figure 4-9 illustrates #1 grid method. The use of a grid has three definite advantages:

1. It is completely different from a fingerprint chart and removes any suggestion of point numbers.
2. Any person viewing the chart can quite quickly locate agreement areas.
3. Chart preparation is very rapid.*

In some cases, enlargements of particular characteristics unique or difficult to see can be isolated on the side of the complete impression. See Figure 5-9. Figure 6-9 has pertinent information relating to the evidence placed right on the chart.

The manner in which a chart is prepared is one's own. The decision will largely be influenced by the number of people who are going to view it or any difficulties such as distortion that may be present. When preparing a chart the fact that the evidence is being transcribed is of prime concern. The chart should therefore have some method of identifying agreement areas for the record.

These are only some methods of demonstrating evidence in court. Neatness and accuracy in one's work can not be overstressed. The evidence will often be judged by the quality of the illustrations. There can be nothing worse than conducting a thorough examination of the scene, identifying footwear impressions, then presenting an illustration which does not accurately or neatly portray the evidence.

References

1. *Rice v Sockett* (1912), 270 L.R. 410, 8 DLR, 84 (C.A.).
2. *Hodge's Case* (1838), 2 Lewin 227, 168 E.R. 1136.
3. *Maclean v R.* (1933), 61 C.C.C. 7, (S.C.C.).

*Usually in three-dimensional impressions there is some distortion as mentioned in Chapter 2. Under these circumstances a grid system will not work.

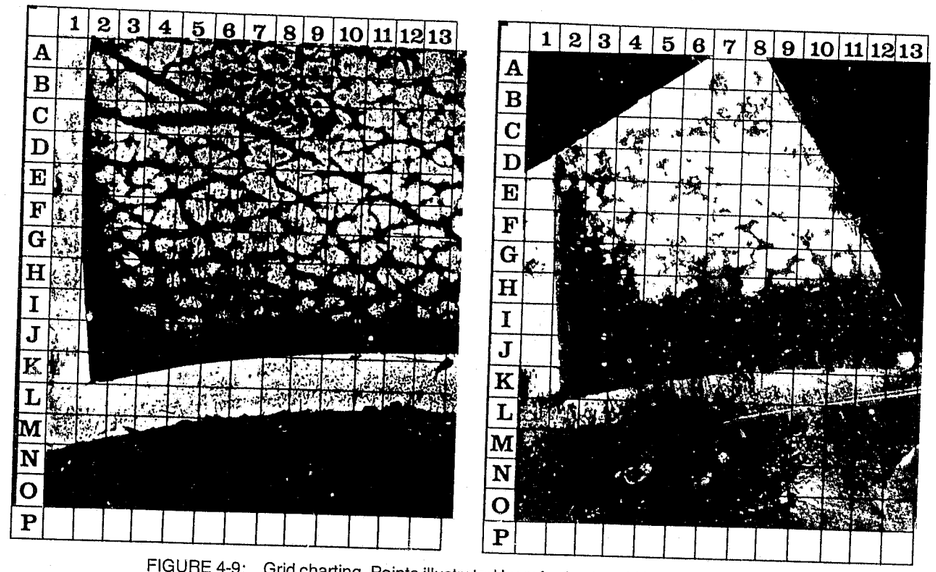


FIGURE 4-9: Grid charting. Points illustrated by referring to grid letter and number.

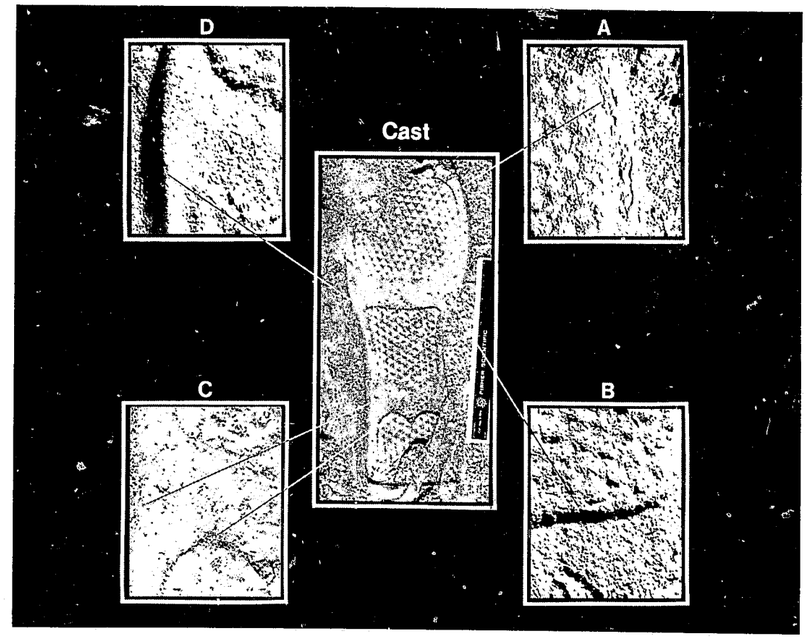


FIGURE 5-9: Charting technique isolates individual characteristics.

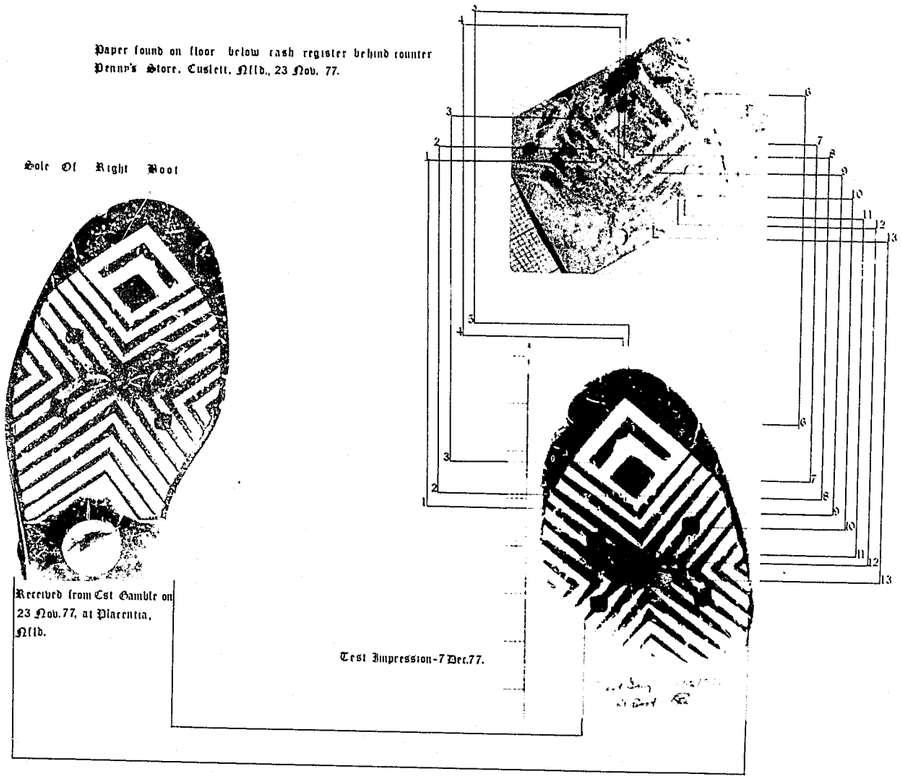


FIGURE 6-9: Illustration depicts shoe, test impression and scenes of crime impression with pertinent information regarding seizure of exhibit recorded on chart.

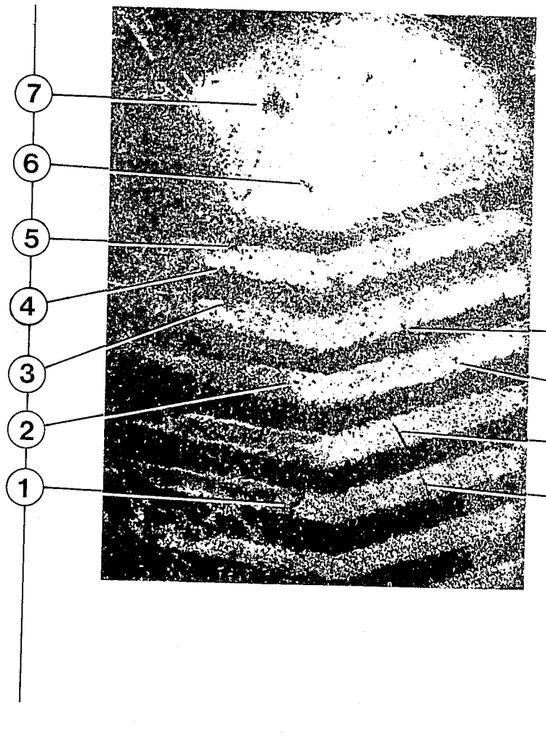
Appendix I

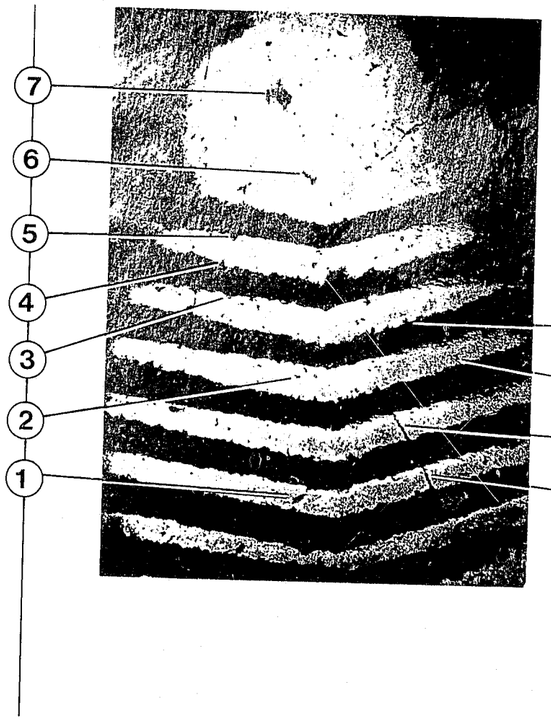
Footwear impression cast kit

SOIL CAST

Equipment Item No. and material		Purpose	Supplier
1	Dental Stone	Cast Material	Dental Depot Canada Ltd. or Any Dental Supply House 25lb Box
2	64 oz Juice Container or Plastic Mixing Bowl	Mixing Container	Dry Goods Store
3	6 lb Plastic Bags	Mixing Container Liner (Easy Cleaning)	Dry Goods Store
4	1/2 Gallon Plastic Bottle	Water Container	Discard Chemical Bottle or Drug Store
5	Potasium Sulfate	Accelerate Dental Stone Hardening	Canadian Laboratory Supply Co. Ltd. (Can Lab) Dental Supply House
6	125 ML Scoop (Approx. Size)	Transfer Dental Stone to Mix Container	Dry Goods Store
7	4" Putty Spatula	Direct Plaster Into Impression	Hardware Store
8	Stirring Rod Preferably Plastic	Mix Plaster	Photographic Store
9	Ear Syringe-Baby Oil-Q Tips Tweezers	Remove Debris From Impression	Drug Store
10	Baby Talc	Release Agent	Drug Store
11	Devilbiss Atomizer #119	Apply Release Agent	Devilbiss Canada Ltd. Box 3000 Barrie, Ontario L4M 4V6 Phone 705-728-5501
12	Deflector Card	Direct Release Agent or Soil Strengthener	Light Cardboard (Mounting Board)
13	Water Sprayer	Moisten Drying out Soil Impressions	Flower or Garden Shop

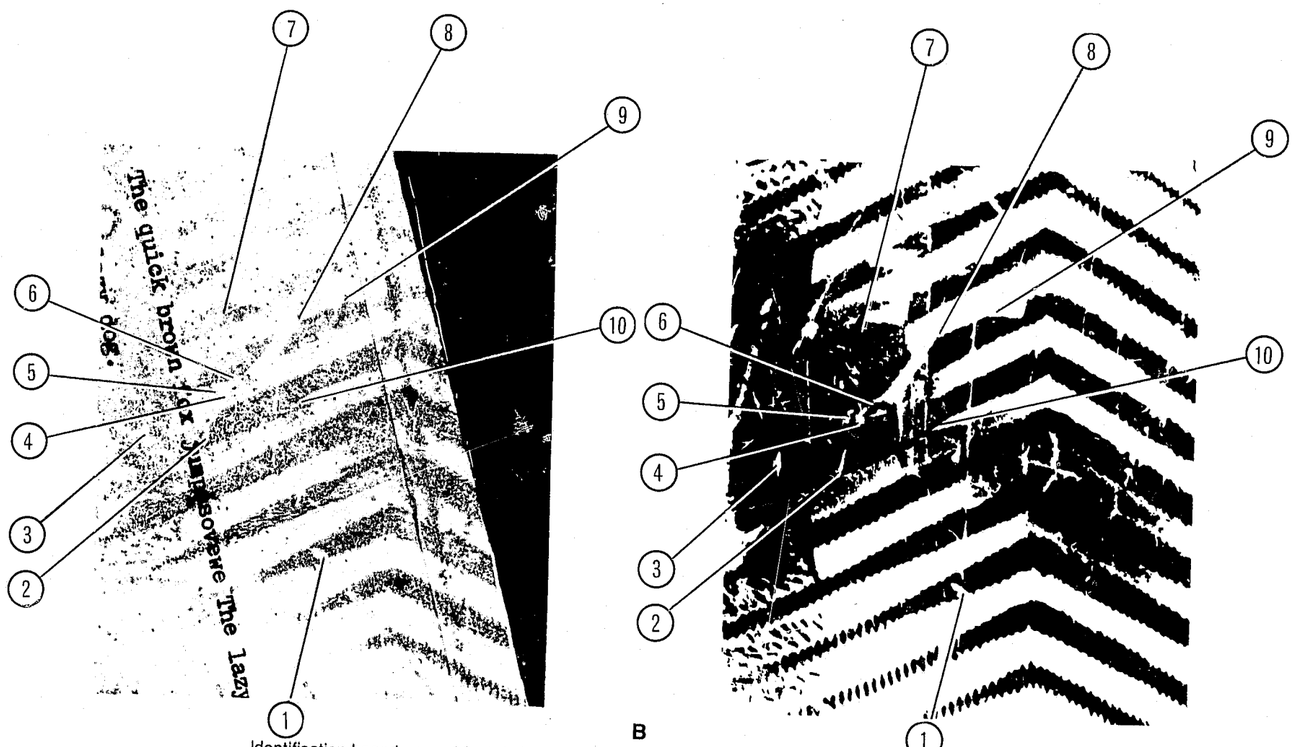
Equipment Item No.	and material	Purpose	Supplier
14	Paper Clips Cardboard Strips 2″ x 18″	Retainer Wall Around Impression	Mounting Board cut into Strips
15	White Shelac-Alcohol	Strengthen Fragile Prints $^{2}/_{3}$ Alcohol-$^{1}/_{3}$ Shelac	Hardware Store
16	Aerosol Spray Can with holding well	Apply Alcohol — Shelac Mixture	Canadian Tire etc. Lab Supply House e.g. Fisher Scientific Can. Lab.
SNOW CAST			
17	"Prill" Sulphur	Cast Material	Cornwall Chemicals Ltd. Toronto Attn: Mr. Blais (416) 226-7651 or Petrogas Processing Balzac, Alta. Phone (403) 274-3356 Attn: Mr. Kangus
18	2-Quart Metal Pot	Mixing Container	Hardware Store
19	Camping Stove (with Wind Deflector)	Melt Sulphur 113°c	Camping Outlet or Hardware
20	Screwdriver 9-10″ Long	Mixing Rod	Hardware
21	Box Wooden Matches	Ignite Camp Stove	Dry Goods Store
22	Compressed Air Cans (2) L.C. "Dust Off"	Clean out snow impressions	Lab Supply House Can Lab Canadian Laboratories Ltd. Fisher Scientific





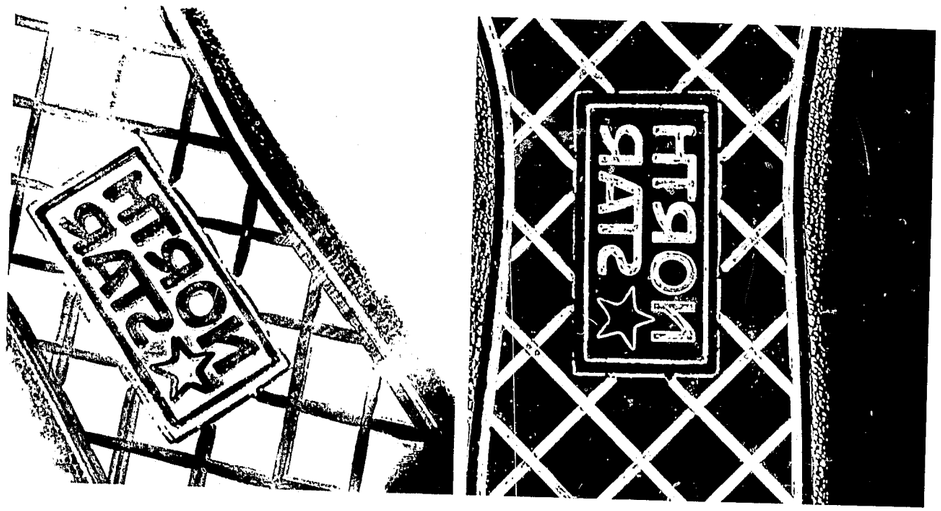
A

Identification based on accidental characteristics. Various cuts and abrasions illustrated by a series of numbers using typical charting procedure.



B

Identification based on accidental characteristics. Various cuts and abrasions illustrated by a series of numbers using typical charting procedure.

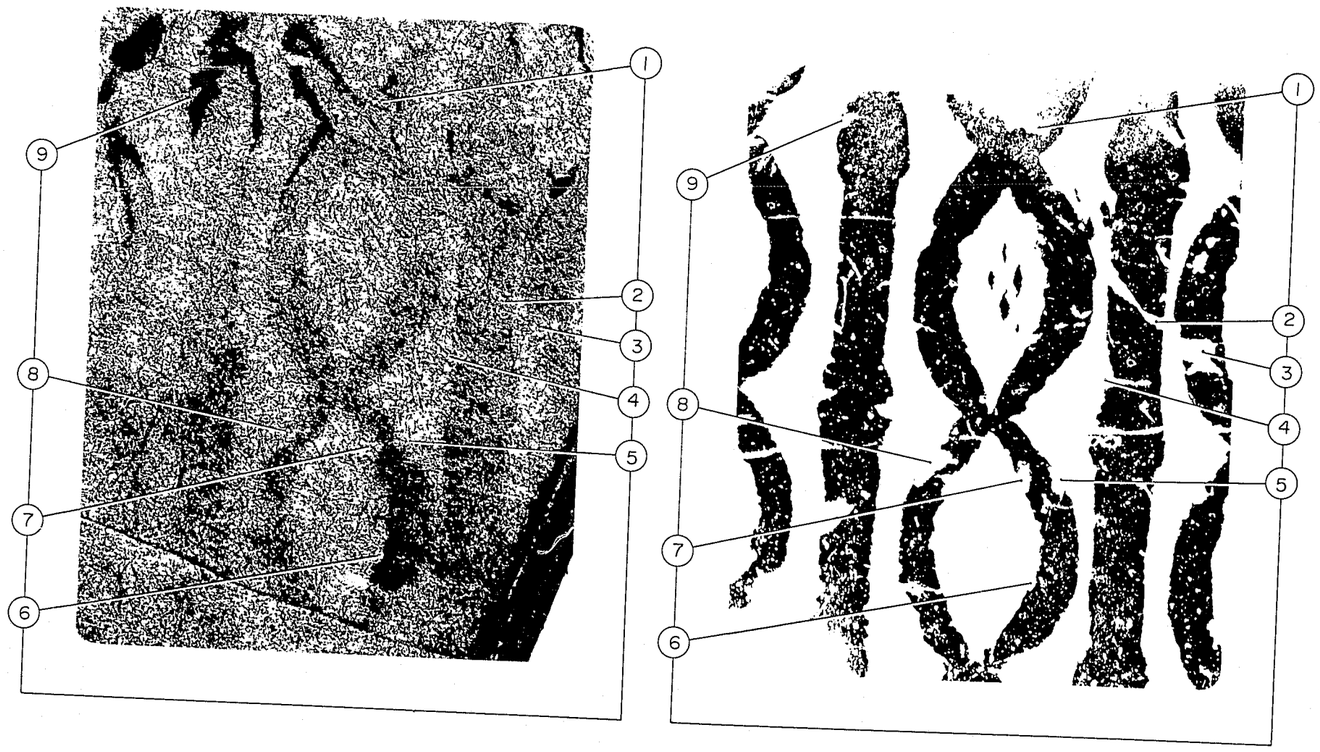


C

Not an identification. All markings located around name plate area were molded.

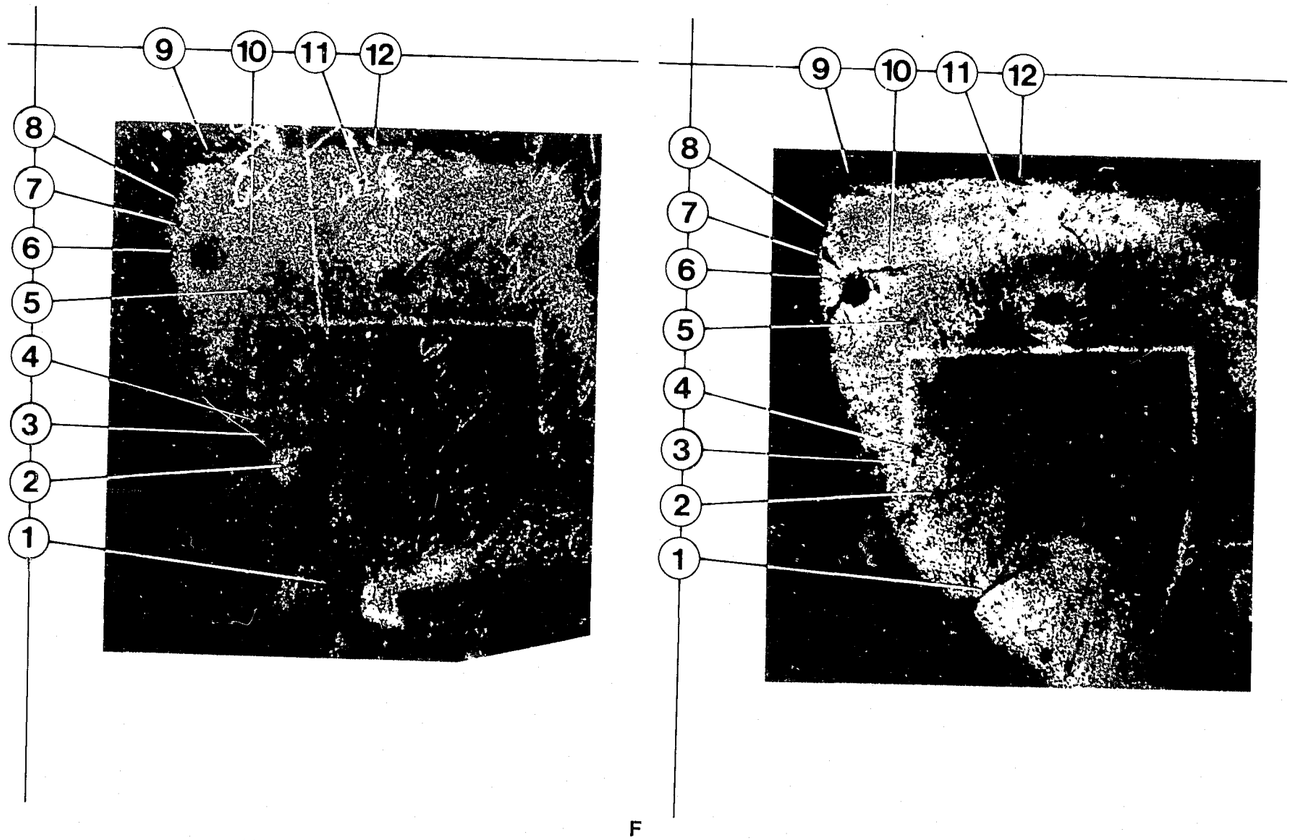
D

Not an identification. Marks on sole surface were molded during construction of sole. Similar marks would be found on any sole from the same mold.



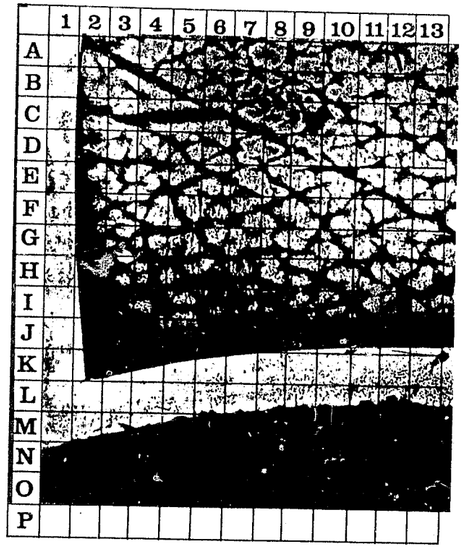
E

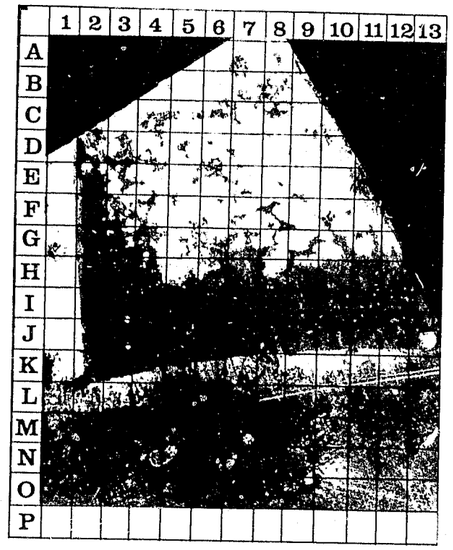
Identification based on accidental characteristics. Various cuts and abrasions illustrated by a series of numbers using typical charting procedure.



F

Identification based on accidental characteristics. Various cuts and abrasions illustrated by a series of numbers using typical charting procedure.





G

Identification based on accidental characteristics located along the peripheral edge of the heel's lower and left side; markings in centre area of heel were molded not accidental; some characteristics used to illustrate identification located in grid J12, J10 and 11, top right corner of K8, top of K2, top portion of K10.

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