Alf von Bremen[1]

The Comparison of Brake and Accelerator Pedals with Marks on Shoe Soles

REFERENCE: von Bremen, A., **"The Comparison of Brake and Accelerator Pedals with Marks on Shoe Soles,"** *Journal of Forensic Sciences,* JFSCA, Vol. 35, No. 1, Jan. 1990, pp. 14–24.

ABSTRACT: The driver of a motor vehicle that was involved in a collision may sometimes be identified by marks on shoe soles or pedals. Forceful contact of an automotive pedal with a shoe sole may leave characteristic features on either or both. An optical method was developed to compare these features that are illustrated with 15 photographs. Four cases are discussed in detail and conclusions are given.

KEYWORDS: forensic science, criminalistics, motor vehicle accidents, footwear, automotive pedals, comparisons, high contrast photography

A motor vehicle collision occurred involving a single vehicle. One of the two occupants was found in the back seat with head injuries and was unable to recall who was driving. The other occupant was ejected from the car and did not survive. There were no witnesses to the accident.

There are usually one or two questions among many other that the investigator wants the laboratory analyst to answer in such cases:

1. Who was driving at the time of the accident?
2. Which pedals was the driver operating at the moment of impact?

Answers to these questions are derived from Locard's Exchange Principle: When any two objects come into contact there is usually a transference of material from one object onto the other.

Petty [*1*] addressed the topic from the medical examiner's point of view in 1973. This paper describes and discusses the physical examination of shoe soles and automotive pedals in the laboratory. It also looks in detail at four cases and a range of conclusions.

The author accepted his first shoe and pedal case in 1972. A method for examining shoes and pedals has been developed based upon the examination of 94 cases in this laboratory between 1980 and 1988.

Procedures

The most frequently submitted items are the brake pedal pad, the accelerator pedal, and footwear. The footwear should include both shoes of all occupants of the vehicle. Items that should also be examined are the parking brake pedal, the clutch pedal pad, and patterned floor mats. However, not all of them are always available.

Received for publication 1 Dec. 1988; revised manuscript received 23 Feb. 1989; accepted for publication 28 Feb. 1989.

[1]Forensic analyst, The Centre of Forensic Sciences, Toronto, Ontario, Canada.

Automotive Pedals

Accelerator pedals are frequently manufactured from plastic and suspended from the car body by a metal arm. This unit is not as strongly built as the brake pedal and will show abuse more readily. In a collision, with a shoed foot resting on the accelerator pedal, it may break. The pedal should be examined for recent cracks that show the clean condition of the plastic on the fracture surface.

It should also be determined whether the metal pin holding the pedal to the metal arm is bent. The end of the arm may have been forced into the underside of the plastic pedal. Since the presence of damage to the accelerator unit can be significant to the examination, the pedal and arm should be removed from the vehicle and examined as a complete unit. Otherwise, unknown to the analyst, the investigator may have damaged it while removing it from the arm (Fig. 1).

The side of the accelerator pedal may also reveal damage (Fig. 2). Here the lower half of this pedal was forced forward by a shoed foot or some other object during the collision. When the pressure on the pedal was released after the collision the plastic pedal sprang back to take on its original shape, but the metal trim surrounding the pedal remained bent.

Frequently the accelerator pedal will have vertical ribs on its face and sometimes a herringbone pattern. Either of these may leave marks on shoe soles. The ribs are searched for marks such as glossy friction marks. Glossy marks are best revealed with a microscope spotlight placed next to the examiner's eyes. The marks in Fig. 3 were created when a patterned shoe sole under pressure slid off the pedal, and suggest unusual events such as a collision (compare to Fig. 4).

Other marks may also be present on the accelerator pedal such as soil or salt marks. They may be formed when a wet or soiled shoe sole comes in contact with a pedal. These marks also are examined with a spotlight placed at an oblique angle in conjunction with a 10-cm reading glass.

The brake pedal is usually manufactured from a metal plate that is welded to a strong metal arm and is designed to withstand extreme pressures. The author has not yet seen a broken brake pedal. The pedal has a rubber pad that must be removed carefully so that any surface marks will not be lost. The pad's face will usually have a textured pattern of either horizontal or vertical ribs. Some pads may have ribs that have been broken off from forceful or frequent contact with shoe soles, giving the pad an individual surface

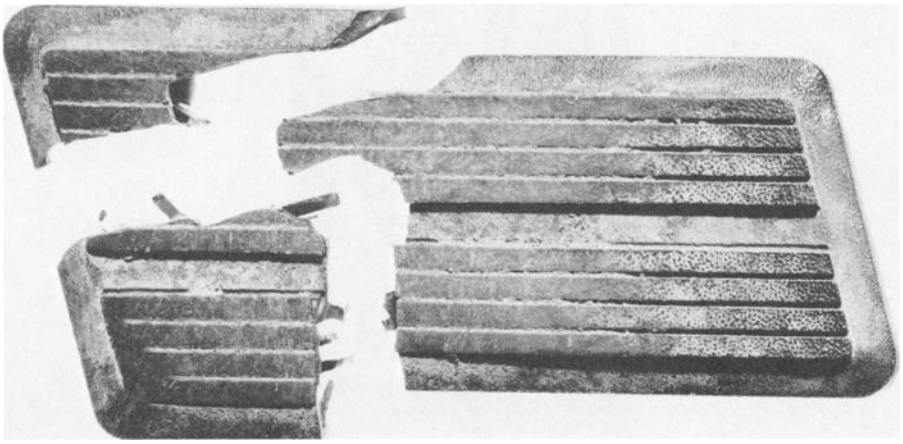

FIG. 1—*The accelerator pedal was broken during removal from the car after the accident.*

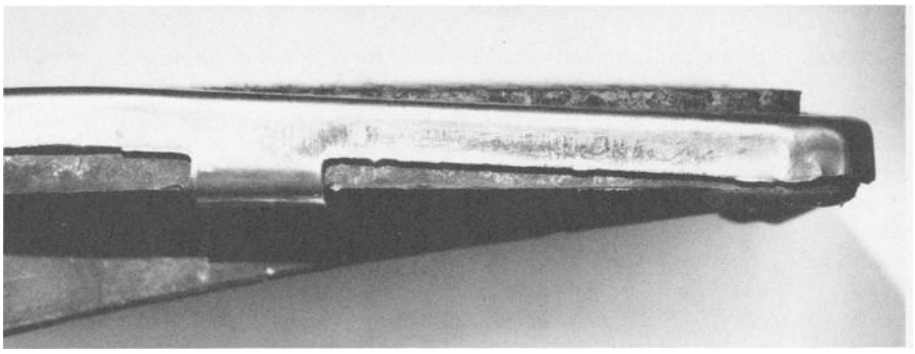

FIG. 2—*The side view of an accelerator pedal with metal trim that is not parallel with the pedal's top surface (magnification ×1.8).*

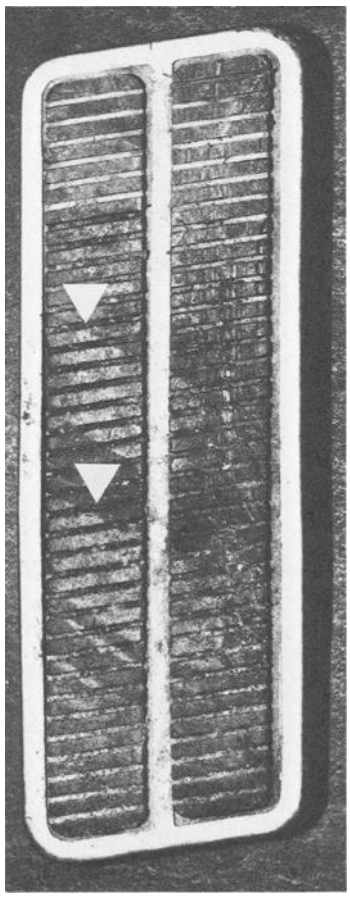

FIG. 3—*Two parallel friction marks on an accelerator pedal revealed by a microscope light.*

(Fig. 5). All brake pads are examined for friction marks and soil marks forming a pattern (Fig. 6). The microscope spotlight and reading glass are used again.

The clutch pedal, the emergency brake pedal, and textured floor mats should also be examined. The clutch pedal pad is frequently of the same size and design as the brake pedal pad and one could be mistaken for the other. However, the clutch pad is usually worn on the left side, whereas the brake pad is usually worn down on the right side. Soil and dirt deposits are possibly heavier on the top edge and lower portion of both pedals.

Shoe Soles

The various types of shoe soles that are manufactured have been described. Cassidy [2] describes six different methods of sole construction. This paper concentrates only on recent marks found on shoe soles.

Light-colored synthetic soles show dark friction marks readily (Fig. 7). Faint marks are best seen when viewed at an oblique angle to reduce visually their size and optically "compress" them. Dark marks on dark soles are more difficult to see and compare. High-contrast photographs are made in some instances. Tests should be done to determine

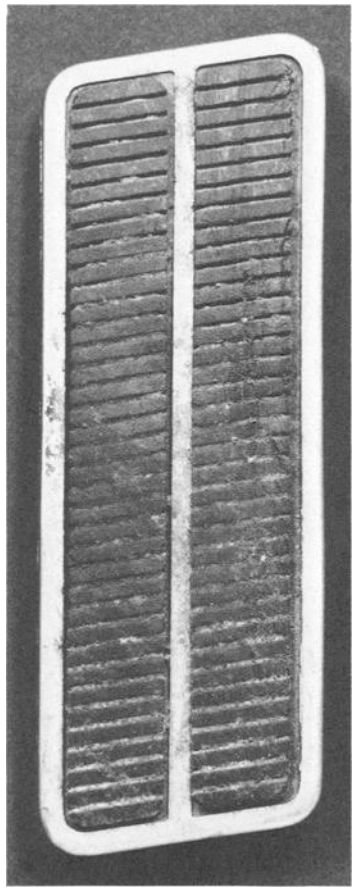

FIG. 4—*The same pedal as in Fig. 3 seen with room light.*

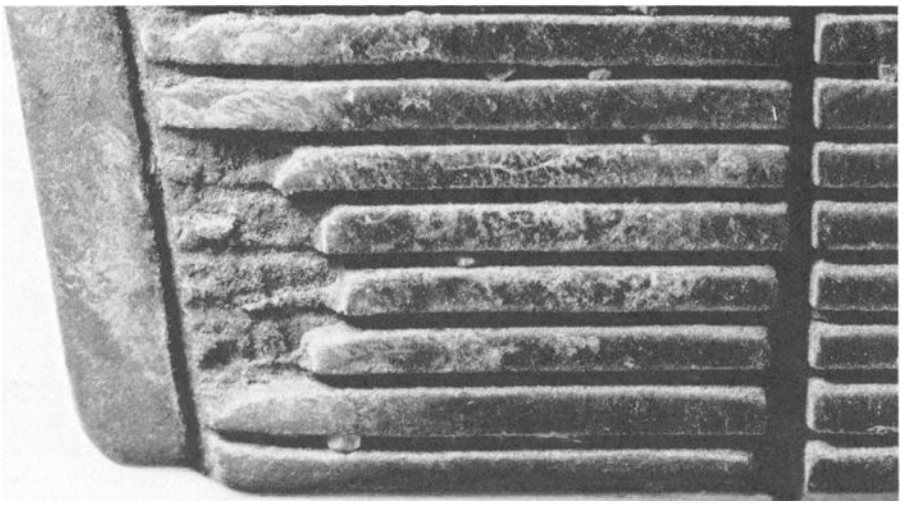

FIG. 5—*A sequence of broken ribs gives individuality to a pad surface.*

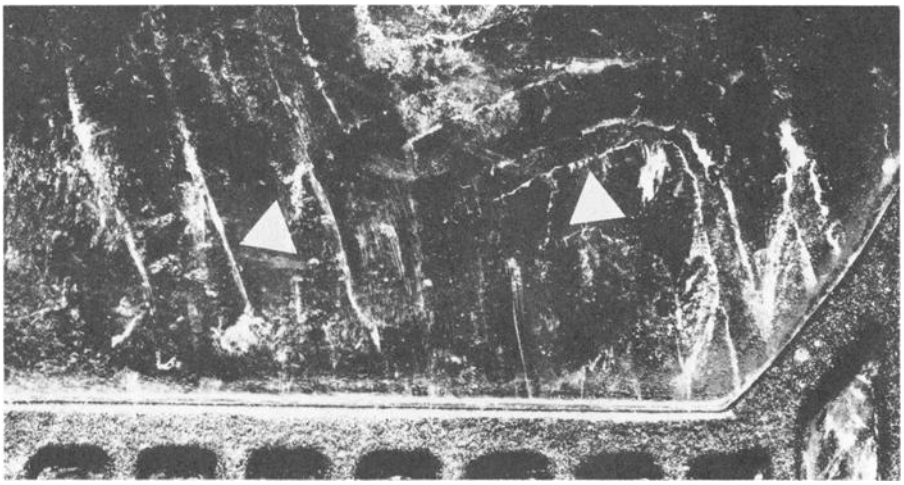

FIG. 6—*Light-colored soil marks on the upper half of a brake pad (magnification ×3).*

whether routine contact between a shoe and a pedal will leave friction marks similar to the one in question.

Leather soles are checked for indentations caused by ribs on pads. A microscope spotlight is used at an oblique angle. Leather soles may also pick up what appears to be a metallic sheen from metal trim surrounding a pedal (Fig. 8). This can be seen with diffused side lighting. Soles with a pattern of raised circles, rectangles, herringbone, and so forth are usually examined for any kind of recent damage. Soil marks are frequently found on shoe soles. If the marks are spaced at regular intervals or have abstract shapes, they may be related to a pedal.

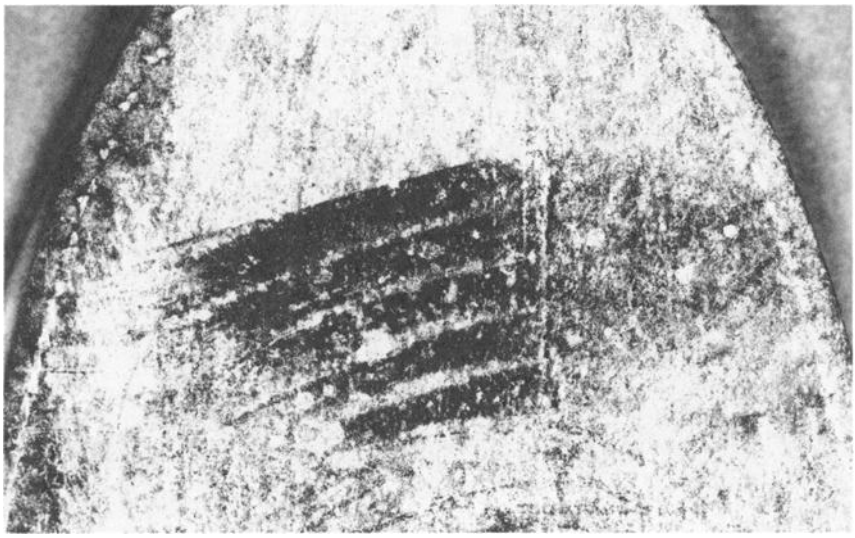

FIG. 7—*Black friction marks on a smooth sole.*

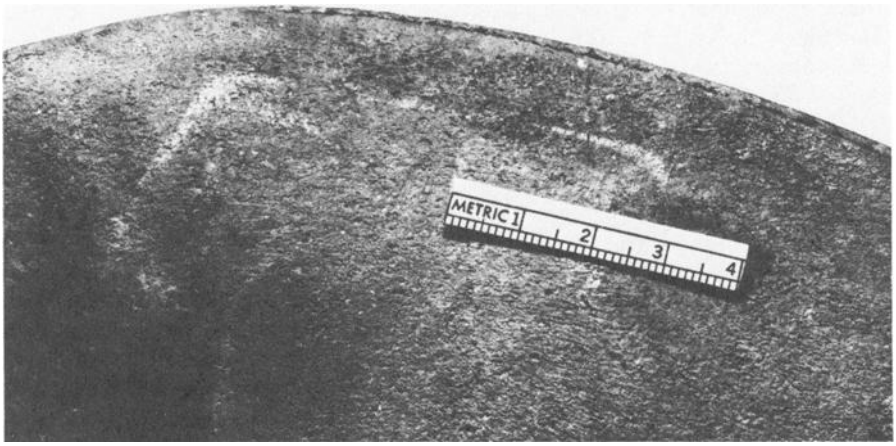

FIG. 8—*The metallic imprint on the right side of a leather sole originated from a brake pedal. The toe is at the right of the photograph.*

Recording the Features

A fluorescent ring light with a built-in magnifier (Luxo Lamp, Ltd.) is frequently used as a light source. A microscope spotlight is used to reveal glossy friction marks on pedals and indentations on shoe soles. The photographs are taken with a 4-by-5-in. view camera and a 6-in. (15-cm) lens. Exposures are calculated with a Sinar-Six meter. Some items are photographed on Plus-X. Other subjects requiring an increase in contrast are photographed on Tech-Pan. The negatives are then enlarged on photographic paper, Grades 2 to 5.

Black-and-white transparencies are made occasionally so that the characteristics of the items can be superimposed. In some instances, a Xerox® transparency of the sole is made to be used with a black-and-white negative (1:1) of the pedal. In other instances, an inked impression of the pedal is made on clear acetate and superimposed over a Xerox print of a sole or directly on the sole. The goal is to create sufficient contrast between the two items to reveal any similarities or differences.

Discussion of Four Cases

Case 1

The accelerator pedal had three groups of vertical ribs with two spaces separating them (Fig. 9). The shoe sole had two groups of recently made black friction marks and a third somewhat fainter group. There was correspondence of size and spacing between the marks and the ribs. The toe-to-heel direction of the marks corresponded with the direction of the ribs on the accelerator pedal. The intensity of the marks suggested that they were made with force rather than during routine contact.

The accelerator pedal had a recent fracture indicating forceful contact. The fracture was located on the right side and corresponded in location with the darker friction marks on the sole. These two observations are an indication of where most of the pressure was applied. Further, some of the herringbone pattern on the surface of the pedal was forcefully abraded recently. The pedals' patina was removed revealing a new plastic surface. This was best seen with a stereo microscope.

Taken all together, these findings suggested that these significant features are interrelated and were shaped during a collision. The conclusion then was based on these relationships and whether the other pedals and other shoes could be eliminated. The brake pad and the floor mats were not submitted. Therefore the conclusions read: "The

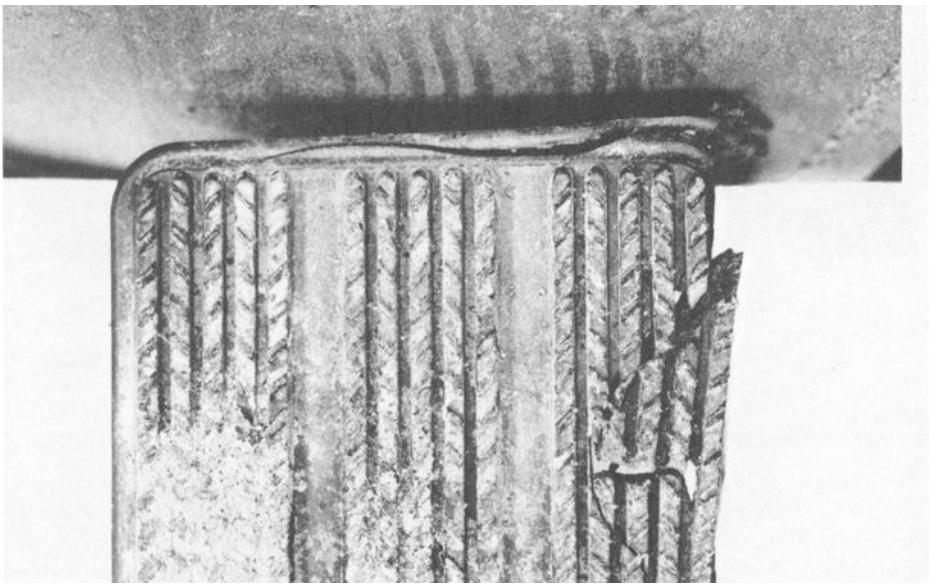

FIG. 9—*Marks on a shoe sole correspond with the ribs on the accelerator pedal (magnification 2×).*

marks on the sole of the right boot were probably made by the accelerator pedal during the collision." However, had it been possible to eliminate the brake pad and the floor mats the conclusion might have read: "The marks on the sole of the right boot were made by the accelerator pedal during the collision."

Case 2

Another case involved two possible drivers in one car. A friction mark deemed to be recent (Fig. 10) was found on the brake pedal pad. It was recent because it was glossy and lacked any deposits on top of the glossy surface. The mark measured approximately 14 mm wide.

The soles of running shoes from Suspect A had a tread pattern of four-sided shapes of various sizes. Some of them were square, others were approximately parallelograms. One parallelogram on the left shoe measured approximately 14 mm wide. Its width corresponded with the width of the friction mark on the brake pad. A corner of this parallelogram was torn off. The sharp edges and clean surface of the broken area indicated that the damage was recently made (Fig. 11). This suggested that the edge of the parallelogram got caught by one of the ribs on the pedal and was then forced forward. Also, the parallelogram was located below the ball of the foot where one would expect most of the pressure on the pedal to be applied. The location of a friction mark on the brake pad was consistent with the operators driving habits. The mark was to the left of the center of the pedal suggesting a "two-footed driver."

Eliminating Suspect B further strengthened the conclusion. His running shoes had a pattern of rings, each having a diameter of 17 mm, 3 mm larger than the damaged parallelogram on the first pair of shoes (Fig. 12). The soles had no recent marks or any indication of forceful contact with any of the pedals.

The conclusion was "The sole of the left shoe of Suspect A was probably in contact with the brake pedal during the accident."

Case 3

This case involved a collision between a tractor trailer and a construction crane at an intersection. The driver of the crane was wearing rubber overboots over workboots. His left boot had a recent tear starting at the sole and extending up past the ankle (Fig. 13).

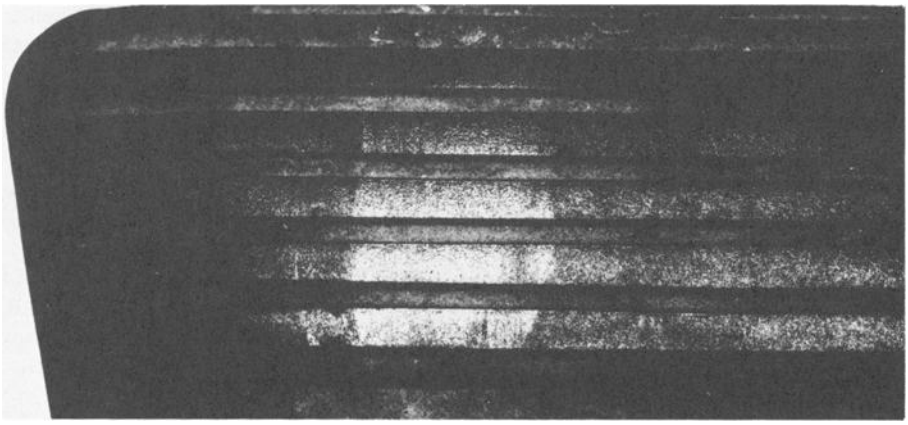

FIG. 10—*Friction mark on the left side of a brake pedal (magnification ×2).*

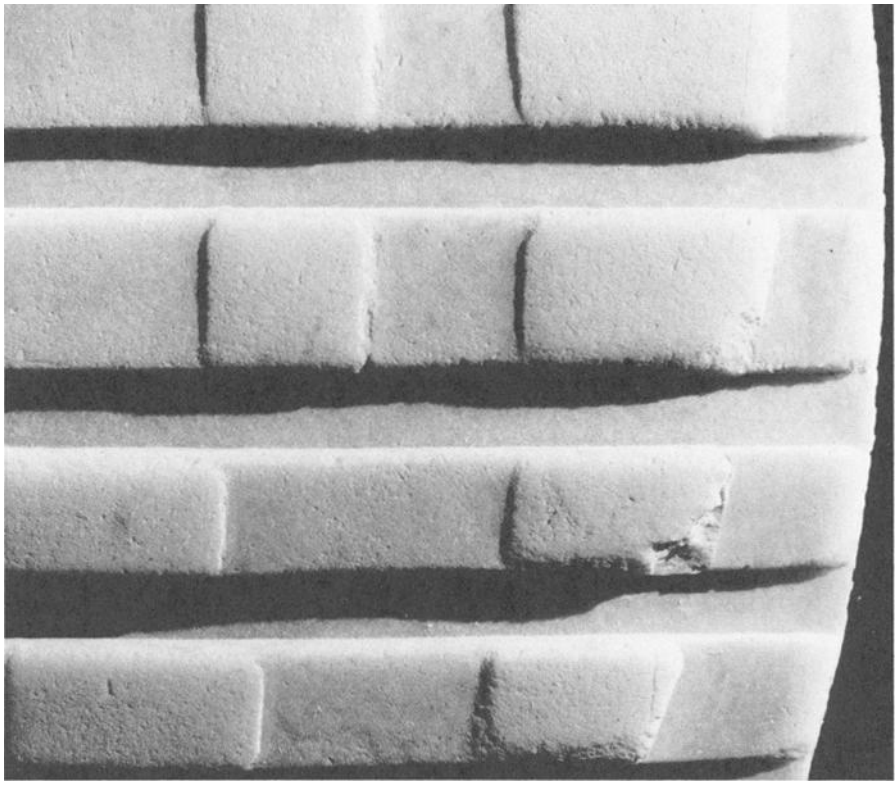

FIG. 11—*Recent damage to tread pattern on left shoe of Suspect A. Toe is at bottom of photograph (magnification ×2).*

The tear at the sole was in the shape of a right angle corresponding with the shape of two of three pedals. Both the clutch pedal and the brake pedal were of bare metal and without rubber pads. The clutch pedal plate had exceptional sharp edges all around.

It was not possible to relate the tear to a specific pedal, but since it was the left boot the conclusion was: "It is possible that the left overboot came in contact with the clutch pedal or the brake pedal during the accident." This suggested that the overboot slipped off one of the pedals while under pressure and the edge of a plate tore the boot.

Case 4

Light-colored marks (salt?) were found on the sole of the right boot (Fig. 14). They ran from side to side and little force if any was required to make them. Some of the marks were 10 mm apart.

The undamaged accelerator pedal had three ribs, the center one measured 10 mm wide (Fig. 15). These ribs ran in an up-and-down direction and at right angles to the marks on the soles. To make these marks the driver, the only occupant, would have to rotate his right leg and foot by 90°. This maneuver would be difficult to achieve in a mini truck (Suzuki).

The white marks on the soles were sharp and recent. The white deposits on the accelerator pedal were older, not as well defined, and did not run parallel with the ribs.

FIG. 12—*Left shoe sole of Suspect B. Toe is at bottom of photograph (magnification ×2).*

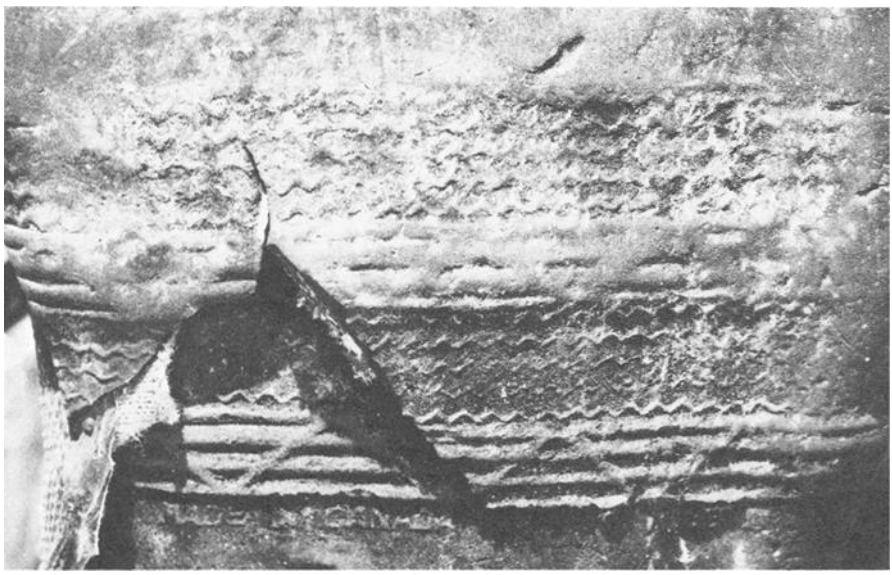

FIG. 13—*A right angle tear next to the instep on the sole of an overboot.*

FIG. 14—*White marks on sole of right boot.*

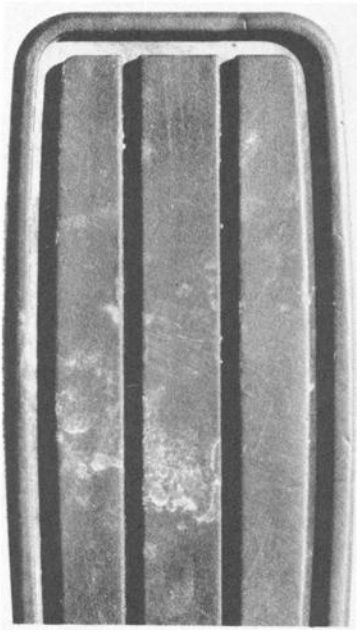

FIG. 15—*Accelerator pad in Case 4.*

The brake and clutch pedal pads had a pattern of solid circles, each with a diameter of 5 mm. The floor mats were not available. Therefore the conclusions stated: "The marks on the sole of the right boot were probably not made by any pedal pad in this vehicle." The marks were probably acquired after the accident.

Conclusions

A suspected driver of a vehicle may be identified after a collision by examination of shoe soles which may reveal friction marks or a recently damaged pattern. In turn, an automotive foot pedal may have been recently broken or its surface may have glossy friction marks. Features found on shoes and pedals that are due to forceful contact can be interrelated. Shoe soles with random features belonging to other suspect drivers can be eliminated.

Acknowledgment

The photograph in Fig. 7 was made by Lorne K. R. Blunt, The Centre of Forensic Sciences.

References

[*1*] Petty, C., Smith, R., and Hutson, T., "The Value of Shoe Sole Imprints in Automobile Crash Investigations," *Journal of Police Science and Administration,* Vol. 1, No. 1, 1973, pp. 1–10.
[*2*] Cassidy, M., "Footwear Identification," Royal Canadian Mounted Police, Ottawa, 1980.

Address reprints or additional information to
Alf von Bremen
The Centre of Forensic Sciences
25 Grosvenor St.,
Toronto, Ontario M7A 2G8 Canada