Stephanie Masakowski,[1] *M.F.S.; Bruce Enz,*[1] *B.A.,*
James E. Cothern;[1] *and Walter F. Rowe,*[2] *Ph.D.*

Fiber-Plastic Fusions in Traffic Accident Reconstruction

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ABSTRACT: This paper discusses four traffic accident investigations in which fabric impressions in thermoplastic materials or hairs and fibers found embedded in upholstery or interior decorative components played important roles in the reconstruction of the accidents.

KEYWORDS: forensic science, accidents, collision research, fibers, plastics, trace evidence

In recent years, automotive manufacturers have increased their use of plastics in a variety of interior and exterior applications. Typical reasons for the increasing use of plastics include reduction in the costs of manufacture, reduction in vehicle weight (with concomittant reduction in fuel consumption), greater flexibility in design, and reduction in corrosion. *Thermoplastics* used in automative construction include polyvinylchloride, acrylonitrile-butadienestyrene (ABS), polypropylene, ethylene-propylene terpolymer, polyethylene, polyamide, polyoxymethylene, polymethylmethacrylate, and polystyrene. Polyurethane is the most commonly used *thermoset* plastic [*1*].

Traffic accident investigators have long recognized the value of contact traces involving exterior plastic materials in the solution of hit-and-run accidents. Automotive paint layers behave like other plastics when subjected to impact forces: they may crack or smear. When two vehicles collide paint may be exchanged between the vehicles involved; likewise, if a vehicle strikes a stationary object, paint may be exchanged between the object and the vehicle. If a pedestrian is struck by a vehicle, his clothing may retain paint chips or smears from the vehicle [*2*]. The vehicle's paint work may bear a patterned impression of the pedestrian's clothing; it may also have textile fibers embedded in it [*2,3*].

In a traffic accident, contact traces may also be exchanged between the interior surfaces of a vehicle and its occupants. High-speed impacts may result in hairs or textile fibers being embedded in the thermoplastic surfaces such as roofs, window pillar covers, or dashboards. Pabst [*4*] has coined the term "textile-plastic fusing marks" to describe this phenomenon. We will refer to such marks in this article simply as "fiber-plastic fusions" (FPFs), because

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[1]Director of collision forensics, technical analyst, and vice president, respectively, The Institute for Safety Analysis, Rockville, MD.

[2]Associate professor, Department of Forensic Sciences, The George Washington University, Washington, DC.

hairs as well as textile fibers may be found embedded in interior plastic surfaces. In addition to showing that a high-speed impact occurred between vehicle occupants and plastic surfaces, FPFs may also show threads of smeared plastic that indicate the direction of the impact that produced them. Such threads may help determine the trajectories of the vehicle's occupants during the collision. Although the focus of this article will be on the embedded fibers and threads of smeared plastic in FPFs, traces of plastic may also be transferred to clothing by high-speed impacts. Pabst [5] has described a simple microscopic method for identifying transferred thermoplastics, using transmitted light, polarized light, and dark field microscopy.

FPFs may help resolve issues in litigation arising from a traffic accident, including the following:

(1) the seating arrangements of the occupants of the automobile at the moment of impact;
(2) the trajectories of occupants during the collision;
(3) the agents that caused injuries suffered by the automobile's occupants; and
(4) the alleged failure of vehicle components, particularly passenger restraint devices.

The seating arrangements of a vehicle's occupants may be an issue if a driver attempts to evade responsibility for an accident by claiming that someone else was driving. Seating arrangements and trajectories of vehicle occupants may not be determinable through testimonial evidence. Some occupants may not be available as witnesses as a result of death or serious injury. Memories of the accident may be lost because of the violence of the event [6]. Furthermore, in many instances, witnesses testifying to such matters have a financial interest in the outcome of litigation.

This paper describes the use of FPFs in the reconstruction of several traffic accidents. The cases have been chosen to illustrate the wealth of information that can be gleaned from FPFs.

Case 1

Often the patterns of textiles will be embossed on plastic surfaces by a high-speed impact. This case provides a good example of a textile pattern transferred to a plastic surface. In this case, a late model, mid-size, American passenger car collided with a pickup truck at an intersection. The vehicles were travelling in opposite directions. The left front of the car struck the left front of the pickup truck. The adult male driver of the car and the adult female passenger seated in the right front passenger seat were both wearing seatbelt shoulder harnesses of the standard three-point type. The driver was not hurt in the collision; however, the female passenger received severe maxillofacial injuries and multiple internal injuries from high-speed impact with the vehicle's dashboard. An examination of the passenger's seatbelt revealed that the seatbelt webbing had left an imprint of its weave pattern as it passed over the plastic retainer at high speed and that the resulting friction had melted the surface of the plastic retainer (Fig. 1). The pattern on the surface of the plastic retainer indicated that the seatbelt webbing had not been locked by the inertia system that is supposed to restrain the passenger; the seatbelt instead had rapidly "spooled out," permitting the passenger to hit the dashboard. Because of the tightness of the weave of the seatbelt webbing, no fibers were transferred from the seatbelt to the plastic retainer.

Case 2

This case involved a new, imported sports car. The driver swerved to avoid striking an animal in the roadway; the vehicle then hit a utility pole and overturned. The back of the driver's seat broke at some point in the crash sequence, the rear hatch opened, and the driver was ejected from the car during the rollover. The driver sustained a concussion, two frac-

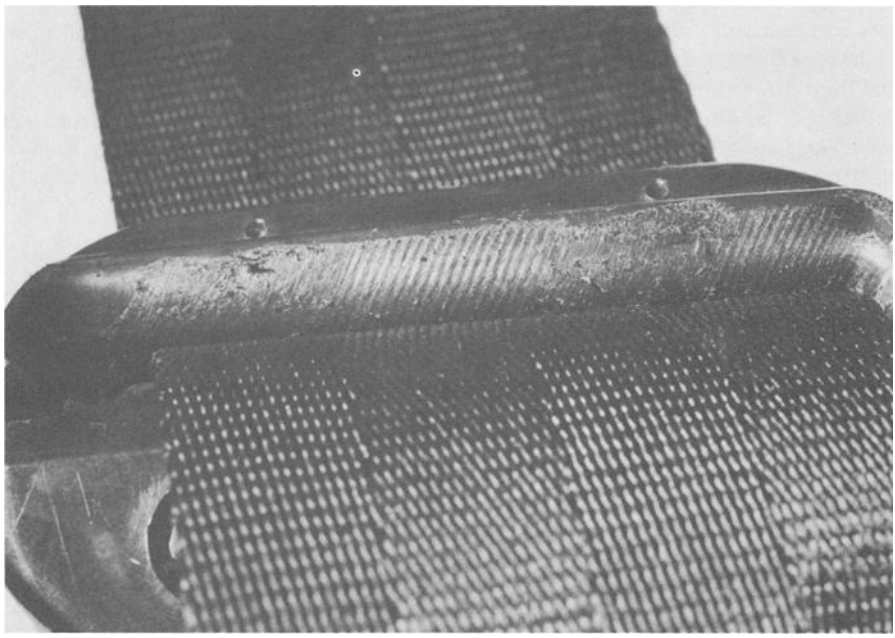

FIG. 1—*Plastic retainer from passenger restraint system showing fiber-plastic fusion resulting from "spooling" of the seat belt.*

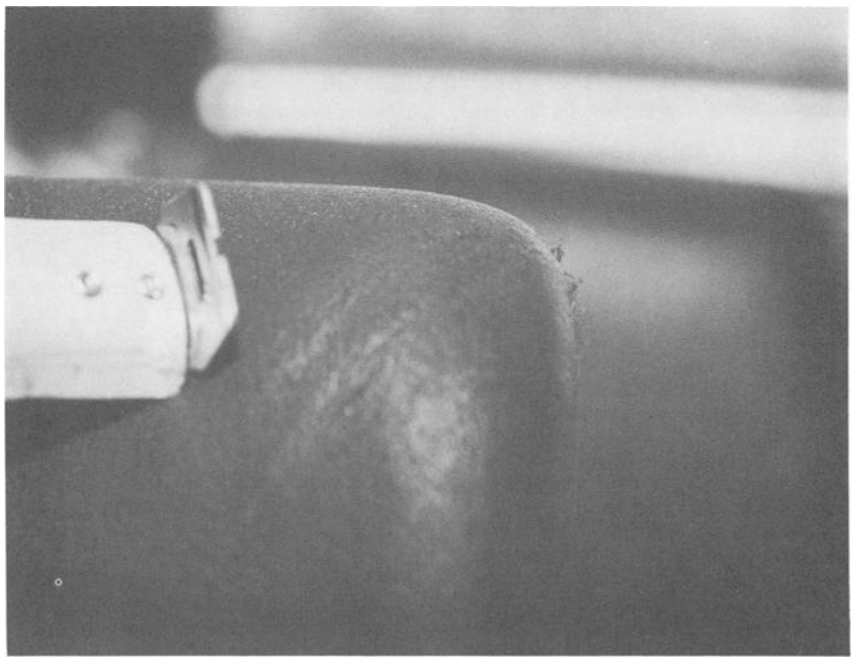

FIG. 2—*Fibers embedded in headrest of driver's seat.*

tured vertebrae, and damage to his aorta. The path of ejection was determined in part by fibers embedded in the plastic of the headrest of the driver's seat (Fig. 2). These fibers matched the fibers in the driver's coat. The threads of smeared plastic on the headrest indicated impact forces moving toward the rear of the vehicle. The presence of fibers in this location and the direction of the threads of smeared plastic indicated that the driver was ejected rearward through the open hatch. The damage to the driver's aorta may have resulted from his arching rearward over the seat.

Case 3

The driver (and sole occupant) of a two-door sedan was seriously injured when his car veered off an expressway and struck the concrete base of a light stanchion. The point of impact was on the left side of the vehicle, immediately in front of the A pillar (see Fig. 3 for the nomenclature of passenger car window pillars). The driver brought suit against the manufacturer of the car, alleging that the injuries he sustained (which included a basal skull fracture) were the result of the car's roof buckling down on his head. This buckling was alleged to be the result of a combination of three factors: (1) the impact immediately in front of the A pillar; (2) the long distance (approximately 120 cm [48 in.]) between the front and rear window pillars; and (3) the lack of a central window pillar. The defendant's expert witnesses, on the other hand, alleged that the plaintiff had suffered a "side ejection," that is, the impact had hurled him partly out of the side window, causing the plaintiff's head to strike the concrete base of the light stanchion.

An examination of the roof upholstery (the roof headliner) of the car revealed a FPF at a point directly over the driver's seat (Fig. 4). The fibers in this case proved to be human head hairs. These hairs were compared to head hairs of the plaintiff and were found to match those hairs in color, size, and distribution of pigment granules, configuration of medulla, and thickness of cuticle. Diameter and diameter variation were not compared because microscopic examination of the hairs from the roof headliner showed that their shafts were crushed, indicating a high-speed impact between the plaintiff's head and the vehicle's roof. The threads of smeared plastic further indicated that the plaintiff's head was moving forward relative to the roof when the FPF occurred. The FPF was consistent with the plaintiff's reconstruction of the accident, but not with that of the defendant.

Case 4

The final case involves a late model, imported car occupied by the driver and one front seat passenger, both adult males. The driver lost control of the vehicle in a curve and the vehicle overturned. Both the driver and the passenger were ejected from the vehicle. The

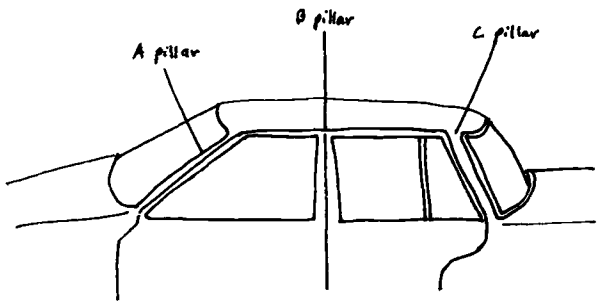

FIG. 3—*Nomenclature of passenger car window pillars.*

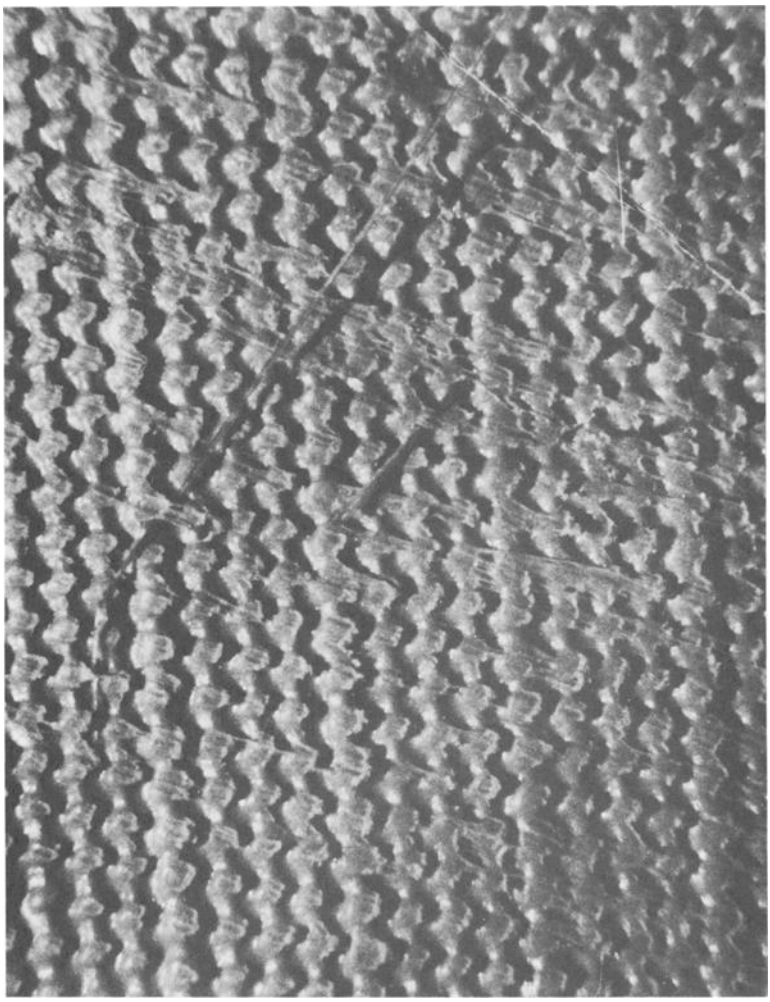

FIG. 4—*Human head hair embedded in roof headliner. The threads of smeared plastic point toward the front of the vehicle.*

driver sustained head and chest injuries, as well as a fractured C-6 vertebrae and pelvis. The passenger sustained minor injuries. The driver brought suit against the manufacturer of the vehicle, alleging that his ejection from the car was due to its faulty design. An examination of the car showed FPFs on the glove box cover and on the right A pillar cover. The FPFs on the A pillar cover (Fig. 5) proved to be highly interesting: one was a large smeared area near the upper screw hole (Fig. 6) in which there were a number of red fibers embedded; the other was a patterned abrasion covering approximately 14 cm (5½ in.) (Fig. 7) in which there were a number of blue and white fibers. One of the red fibers from the upper FPF is shown in situ in Fig. 8. Microscopic examination of the red fibers showed them to be acrylic fibers having a dogbone cross section; the same type of fibers was found in the FPF on the glove box cover. The blue and white fibers from the patterned abrasion were unmercerized cotton. The presence of two different types of fibers in the FPFs indicates impacts involving two different garments, such as a shirt containing the red arcylic fibers and corduroy trousers containing blue and white cotton fibers.

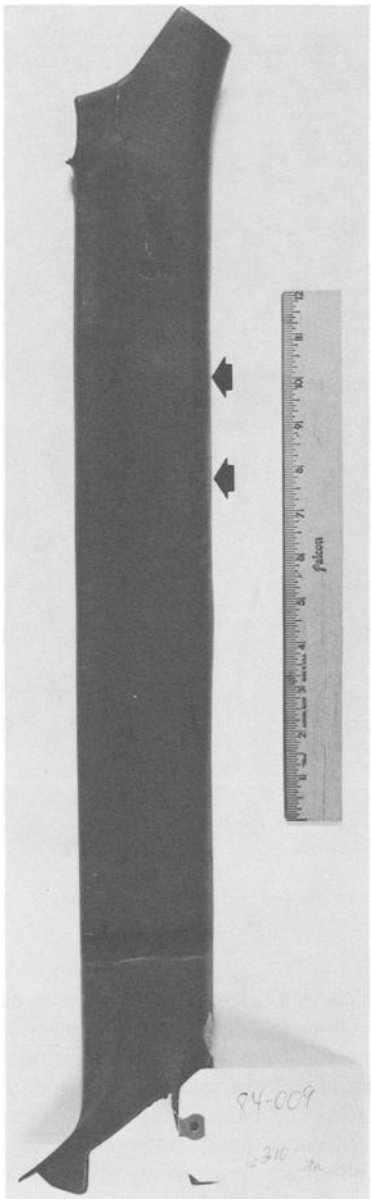

FIG. 5—*Passenger car* A *pillar cover showing locations of fiber-plastic fusions* (arrows).

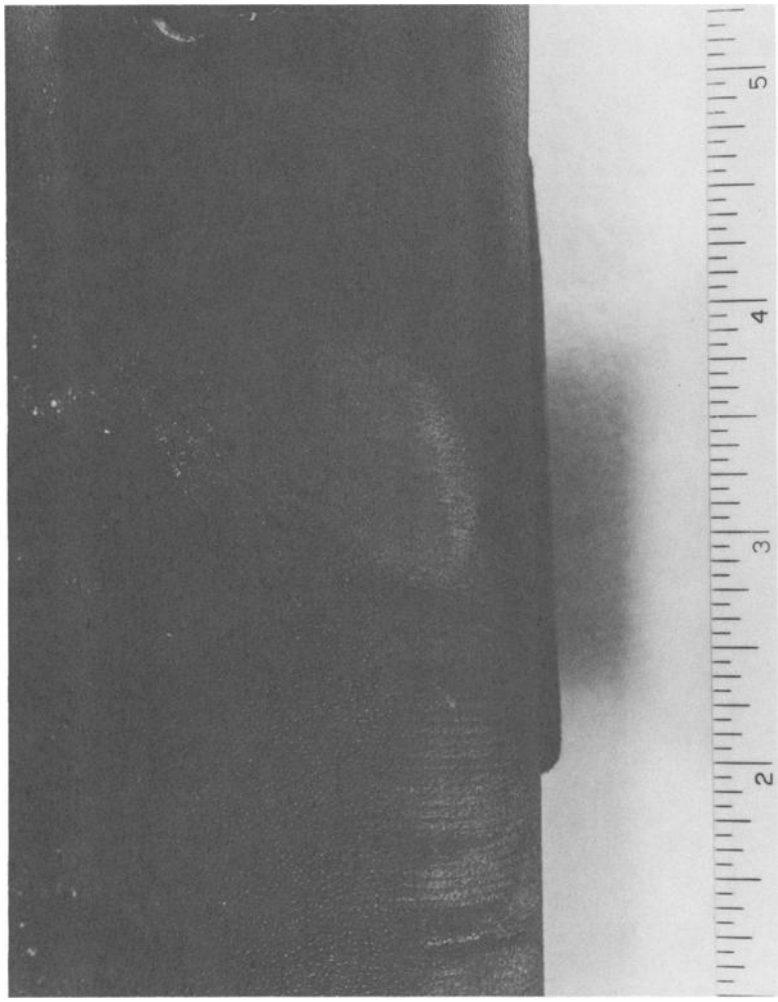

FIG. 6—*Upper fiber-plastic fusion on* A *pillar shown in Fig. 5.*

The plaintiff's clothing was removed at the hospital at which his injuries were treated and subsequently disposed of. The passenger was wearing a shirt and trousers at the time of the accident; he was able to provide investigators with the shirt that he was wearing at the time of the accident. This was a twill-weave, long-sleeved shirt composed of reddish-orange, black, and light-brown unmercerized cotton yarns. It could not have caused the patterned abrasion or the abrasion containing the red acrylic fibers. Consequently, the investigators concluded that the driver of the car had been ejected through the righthand passenger window.

Summary

The four cases discussed above illustrate the varied features of fiber-plastic fusions (FPFs) caused by impacts between the occupants of an automobile and thermoplastic materials within the passenger compartment in the course of a traffic accident.

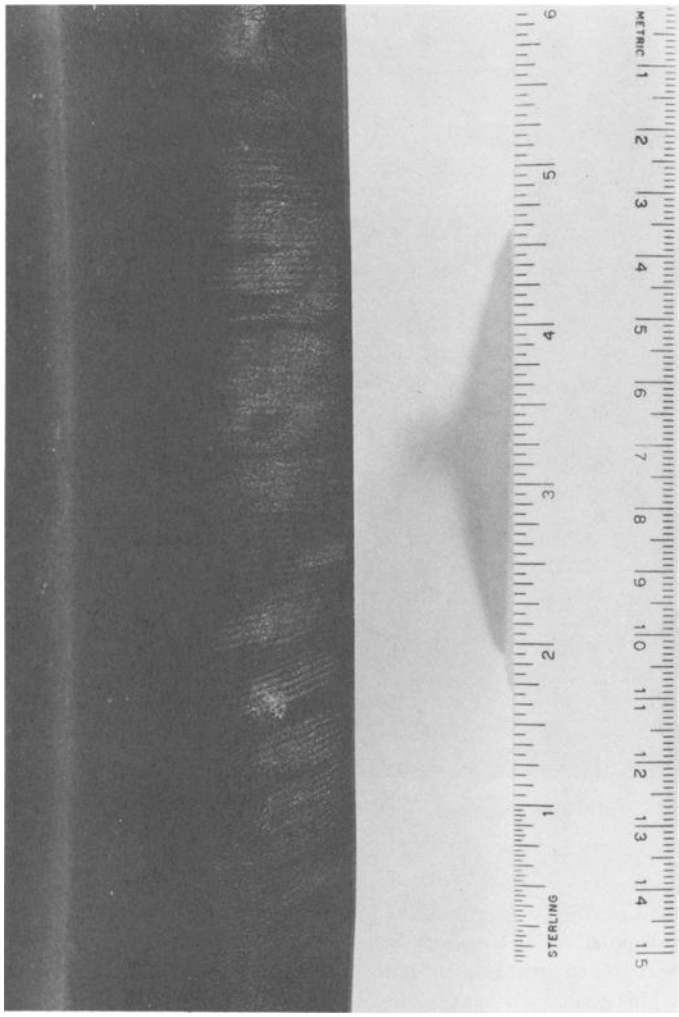

FIG. 7—*Patterned fiber-plastic fusion on* A *pillar shown in Fig. 5.*

FIG. 8—*Red acrylic fiber in situ in fiber-plastic fusion shown in Fig. 6.*

1. Patterned impressions may be produced on plastic surfaces that may be matched to the textile material that produced the FPF.
2. Embedded hairs and fibers may be associated with particular occupants of an automobile, showing where they were sitting in the vehicle and what surfaces they struck during the accident.

Acknowledgment

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References

[1] Seiffert, U. and Walzer, P., *The Future of Automotive Technology*, Frances Printer (Publishers), Dover, NH, 1984.
[2] Kirk, P., *Crime Investigation*, second ed., John Wiley and Sons, New York, 1974.
[3] Metter, D., "Clues in Pedestrian-Vehicle Collisions and Their Significance for Reconstruction of the Accident," *Zeitschrift fur Rechtsmedizin*, Vol. 91, No. 1, Sept. 1983, pp. 21-32.
[4] Pabst, H., "The Textile-Plastic Fusing Mark: Guidepost to the Car Collision Driver," paper presented at the Tenth Meeting of the International Association of Forensic Sciences, Oxford, 1984, sponsored by The Forensic Science Society, Harrogate, North Yorkshire, England.
[5] Pabst, H., "Microscopic Differentiation of Thermoplastics Demonstrated by the Microstructure of Different Black Plastics in the Interior of Passenger Automobiles," paper presented at the Tenth Meeting of The International Association of Forensic Sciences, Oxford, 1984, sponsored by The Forensic Science Society, Harrogate, North Yorkshire, England.
[6] Loftus, E. F., *Eyewitness Testimony*, Harvard University Press, Cambridge, MA, 1979.

Address requests for reprints or additional information to
Walter F. Rowe, Ph.D.
Department of Forensic Sciences
The George Washington University
Washington, DC 20052