C7 Analysis of Pedestrian Impacts and the Debris Field

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Attendees will be briefed on an objective method to assist in the esti- mation of the area of impact in pedestrian impact investigations. This pre- sentation will impact the forensic community and by demonstrating an objective, repeatable, and reliable mathematical tool for this application is appropriate.

Annually there are approximately 4,700 pedestrian fatalities, and another 70,000 pedestrian injuries in motor vehicle collisions.[1] In addition to vehicle speed and pedestrian visibility, typical reconstruction issues include determination of the point of impact. Using a case study as an example, it will be demonstrated how the method of least squares, an objective mathematical technique, can be used to estimate that area of impact from the debris field.

Overview of Event: In the early morning hours a 48-year-old male driver of a Jeep Wrangler left the roadway and passed through a barbed wire fence. The Jeep re-entered the roadway and traveled another mile or two before it became disabled on the shoulder of the divided highway.

According to ambulance personnel who passed the scene just before 2:00 a.m. the darkly clothed victim was attempting to flag down vehicles by standing on the shoulder ahead of his Jeep and waving what appeared to be a metal pipe in the air. Unfortunately, within about 10 minutes the pedestrian was struck and killed by a minivan.

Figure 1: Chrysler minivan

Figure 2: victim at point of rest

The minivan's driver told officers that he was traveling at 60 to 65 mph when the Jeep in the emergency lane without any lights on was observed. Both driver and front passenger described looking at the Jeep as the car passed, and when they looked back to the roadway a man in the lane was observed. The driver stated that there was no time to react before striking the pedestrian. Afterward the driver pulled to the side of the road and backed up towards the victim's point of rest.

Unfortunately, the investigating officers were unable to locate boot scuffs or other roadway evidence to confirm the victim's location on or off the roadway at the time of impact. However, a large debris field com- prising of broken glass, antennae ball, biological material, boots, and cane and stopper were diagramed.

Pedestrian Orientation and Visibility: The victim's right leg fracture, posterior right pelvis dislocation, left and right boot placement and posterior boot heel abrasion are all indicative that the pedestrian was essen- tially facing the minivan, but somewhat presenting his right side.

The driver admitted that just before striking the pedestrian, his attention was turned toward the Jeep on the

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side of the roadway. Thus, pedestrian visibility would not appear to be an issue in this case.

Vehicle Speed: Typical of pedestrian collisions that occur at highway speeds, the pedestrian's trajectory was a roof vault. It should be empha- sized that with fender and roof vaults, the vehicle is typically traveling faster than the pedestrian and therefore passes beneath or beside the victim during the collision sequence.

The body was airborne about 62 feet, and came to rest 78 feet past the first evidence of post-impact contact with the roadway. Using a 140 foot throw distance,, empirical data can be used to estimate pedestrian post-impact speed. Equations set forth by Barzeley[2], and Searle[3] yield estimates of 66 mph and 61 mph, respectively. This is relatively consistent with the driver's account of traveling 60 to 65 mph.

Pedestrian Point of Impact: Headlight glass, shoes and clothes are commonly used as indicators of the area of impact.[4, 5, 6, 7] While, it would certainly be tempting to subjectively place the point of impact at the cane's location, there is not an adequate explanation for the head light debris field or the location of the boots, nor would this be consistent with the eye- witness accounts, which all place the pedestrian forward of the Jeep.

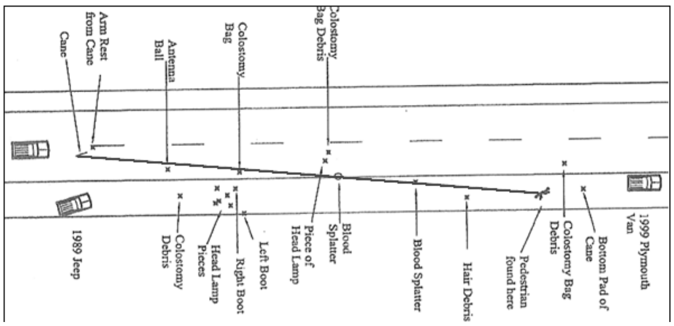

Figure 3, trajectory from cane to point of rest

The cane's point of rest can be explained as follows: direct contact with the mid portion of the cane while supported at the top would produce a high angular velocity of the cane. Release of the cane after it rotated past vertical provides a mechanism for the cane to be found upstream of the impact. In addition, the high angular velocity of the cane provides an explanation for the location of the cane's bottom stopper, which was found beyond the body.

Presumably, the representative line through the data field represents the best estimate of the pedestrian's trajectory, which can be used to indicate the area of impact. The "best fit" trajectory can be objectively obtained using the method of least squares, which treats each data point with equal significance. Unlike "eye-balling" this method is repeatable. Errors such as subjectively or inappropriately over-weighting some data points, like the cane's location, are eliminated.

In this case, the location of the jacket was excluded since it was likely carried to its point of rest by the minivan. The objects which had multiple points, such as the cane, an area of contact/splatter, and the pedestrian, were each replaced by a representative point. The diagram below depicts the resultant best fit line.

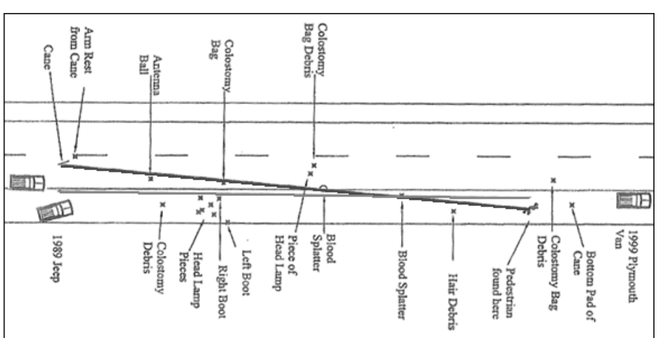

Figure 4, best fit trajectory

The above best fit pedestrian trajectory accounts for the fact that body impact with the pavement and point of rest, and both the victim's boots, the majority of the debris field from the minivan's right headlight were found within the emergency lane. Only the cane, colostomy bag and debris, one piece of headlight, and an antennae ball were found within the lane. Interestingly, the majority of the head light debris was found between left and right boots, as would be expected with the pedestrian facing the minivan's right head light.

Certainly, if it is assumed that the best fit represents the best estimate of the pedestrian's trajectory, then it must be concluded that the minivan most likely crossed the fog line and struck the pedestrian.

References

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Reconstruction, Pedestrian, Least-Squares

