Ralph's Accident Reconstruction Newsletter: Volume 11, Number 4—Summer 2012

As I've written before, the visual environment of a pedestrian traveling at night is vastly different from the visual environment of the driver of a car or truck traveling at night at the same location. In general, the eyes of the pedestrian will have adapted to much lower light levels than the eyes of the driver, since the driver will have been seeing the roadway and other objects as illuminated by his headlights, plus the instruments and many other interior components are sources of luminance. To differentiate, illuminance is the amount of light striking an object and is not dependent on the source; i.e., the sun provides illuminance, but so do the lamps in a room. Luminance is light that is reflected because of some source of illuminance or light which passes through a transparent or translucent object from some source of illuminance. In other words, we don't see illuminance, we see luminance. And we only see because of the luminance; in an environment totally devoid of luminance, we cannot see anything. Light from headlights is illuminance if it is lighting the road ahead for the driver of the vehicle; that same light is luminance to someone standing in front of the vehicle and observing the light emitted from the headlamps (and any other sources of light at the front of the vehicle). When we see light from brake lights on the vehicle ahead of us, we are seeing the luminance produced when the illumination from the bulb passes through the red lens. When we see light reflected from a license plate or other reflective object, we are seeing the luminance produced by some external source of light, like headlights, reflected back to our eyes. Light is a very complex phenomenon; there is a large collection of very technical terms involved in characterizing and measuring light. All we have to deal with in this context, however, is the differentiation between luminance and illumination/illuminance.

Getting back to our night-time pedestrian, he has (almost always) been walking without benefit of a portable source of illumination, and his eyes have adapted to allow him to see reasonably well in very low light. So when the lights of an approaching motor vehicle provide additional illumination, he believes that he is as visible to the driver of that vehicle as his own features are to himself. For the driver of that motor vehicle, however, his eyes are accustomed to seeing with a much higher level of luminance, due primarily to the use of headlights, so he usually won't see a pedestrian who is a significant distance away, particularly if that pedestrian is off to one side or the other. Plus, low-beam headlights in the United States are biased toward the right, further delaying the driver's ability to see a pedestrian to the left of his vehicle, who may be in the process of walking in front of him, believing that the driver of the motor vehicle can see his features as well as he can see his own. But perception of the location and path of the pedestrian by the driver of the motor vehicle may only occur in as little as 80 feet away, and possibly no more than 120 feet away. At 45 mph, a vehicle covers 66 feet every second; in the "classic" perception-reaction time (PRT) of 1.5 seconds, he will travel 99 feet. If the luminance from the pedestrian did not allow the driver to see that pedestrian until he was 80 feet away, that driver will not have time to take any effective evasive action to avoid striking the pedestrian. To bring his vehicle to a complete stop after application of brakes will take at least 85 more feet, meaning that he will have covered 184 or more feet from the instant the hazard became perceptible until he can bring his vehicle to a complete stop. The pedestrian who was first observed 120 feet away will be struck at a speed near 39 mph, often receiving fatal injuries, if hard braking begins after 99 feet of travel of the motor vehicle originally traveling at a speed of 45 mph.

Several other factors are involved. We see both by contrast and luminance. Even in a brightly lit room, finding a white dot on a white wall can be very difficult, but finding a black dot on a white wall can occur very quickly and easily at very low levels of illumination. Many pedestrians do not wear clothes which contrast with the background, making perception of their presence difficult for night-time drivers. One more factor is that our peripheral vision is not good at perceiving motion at night, particularly when there is low contrast between the moving object and the background. That is why pedestrians should wear reflective items on their feet and lower arms—those parts of the body move the fastest in normal walking. The reflectance provides a source of greater luminance and contrast, and the motion is likely to draw a driver's attention to the source(s), probably alerting that driver to the presence and location of the pedestrian while he is still hundreds of feet away, in time for that driver to reduce speed or take some other effective action to avoid colliding with the pedestrian. Although there are few absolutes in life, most night-time pedestrian collisions are caused by the pedestrian's failure to understand the differences in the visual environments of pedestrians and drivers.

The picture above has nothing to do with accident reconstruction, but it comes from one of many annual races called 24 Hours of LeMons. This photo was taken at the race designated Southern Discomfort, held the weekend of March 8, 2012, at Carolina Motorsports Park. It's a really interesting concept. When this racing concept first began, you couldn't enter with a car you paid more than $500 for, although you could add safety equipment after you bought it. The spectators would throw lemons at the cars as they raced past. The winner of the race would get a $500 prize, in nickels. After the race was over, the spectators would vote on a car to be demolished, and it would be sledge-hammered to oblivion. I don't know how much of those original practices remain, but the $500 purchase limit is still in place. These races have grown in popularity, now being held many times a year at different locations around the country. To actually participate in one of these races involves a crew of four or five or more people, each with an investment that would typically range from $2000 to $3000—peanuts compared to what it costs to go racing professionally, and not a lot of money for a lot of fun, if you're a motor head. I hope to be able to participate in at least one of those races before too long, but I have to find at least four other people whose sense of humor is as abnormal as mine. ☺ If you want more information, the Web site is www.24hoursoflemons.com.

In crash reconstruction, application of conservation of momentum principles will usually provide accurate analysis of the impact speed of each vehicle if there was a significant angle between their velocity vectors when they first made contact. In a collision where both vehicles are moving in a parallel fashion (either toward each other or in the same direction), momentum principles can't tell us the speed of either vehicle unless the speed of one is known or can be determined or demonstrated by some other method. In such situations, conservation of energy principles will often provide accurate analysis, if crush coefficients specific to the damaged surface of at least one of the vehicles are available. Most crush coefficients, however, are calculated from staged collisions with fixed barriers at speeds (usually) no more than 40 mph for frontal collisions and from staged collisions by a moveable, (usually) deformable barrier at moving-barrier speeds of 30 mph to 40 mph for side collisions. Staged, instrumented, side-impact testing always occurs between the axles; for a real-world side impact which includes one wheel or the other, the side-crush coefficients determined by staged collisions do not apply, because the wheels are much stiffer to broadside impacts than body components. Where there are accurate crush coefficients available for one vehicle but not for the other, but there are crush measurements for both, the effective crush coefficients for the struck surface of the vehicle for which no coefficients were available can be calculated (but they are valid for that collision only). There are some significant caveats, however. Limited studies have demonstrated that crush coefficients for very high values of delta-v (i.e., 50 mph or more) are usually not the same as crush coefficients calculated based on barrier crashes at lower speeds (in the 30 to 40 mph range). Also, frontal offset collisions occur frequently, where some portion of the front of one car (half or less) collides with a similar portion of the front of another car; an example would be a 30 percent overlap of the right front sections of each vehicle. Crush coefficients calculated for full-frontal collisions of those vehicles would generally not be applicable. There is limited data concerning staged, partial-front-overlap collisions. For many of these situations, data in the airbag control module of either or both vehicles might be the only accurate, reliable means of determining the impact speeds (and pre-impact speeds) of the involved vehicles.

Ralph Cunningham, Inc.
Accident Reconstruction
www.RalphCunningham.net

Collision Analysis

On-road/Off-road

Pedestrian/Bicyclist

Motorcycle Collisions

Bosch Crash Data Retrieval

Lamp Filament Evaluations

Conspicuity Evaluations

Tire Failure Evaluations

Brake/Steering Evaluations

Seat Belts/Airbags

1804 Thornhill Pass, SE
Conyers, GA 30013
770.918.0973
Fax: 770.918.8076

Ralph Cunningham, Inc.
1804 Thornhill Pass, SE
Conyers, GA 30013