BICYCLE COLLISION INVESTIGATION

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TABLE OF CONTENTS

1 – INTRODUCTION

With proper training and good technique, cycling is one of the safest modes of transportation and one of the most rewarding forms of exercise. When recklessness and inattentiveness occur, death and serious injury are common for cyclists. Between 700 and 800 cyclists are killed each year in traffic collisions throughout the United States. Although fatalities of pedestrians and motorists outnumber those of cyclists each year, they occur often enough to warrant greater attention. This text is the only book solely about bicycle collision investigation and is geared specifically to law enforcement officers, risk managers, attorneys, and collision reconstructionists.

If the investigator has the right tools, the process of investigation a bicycle collision can be simplified and the results can be more thorough. One of the most important analytical tools is an organized framework. Perhaps one of the best frameworks available is the nine-cell matrix (Figure 1). The nine-cell matrix is an analytical tool to help the investigator quickly classify a large amount of information. This book is organized with the nine-cell matrix in mind, with the next three chapters of the book organized by environmental, vehicle, and human factors. These factors comprise one axis of the nine-cell matrix. The other axis of this three-by-three table is the time component, which

Unlike with the station line and coordinate techniques, the investigator does not have to contend with making perpendicular measurements (Figure 4). As long as obtuse angles generally are avoided, the investigator can take accurate measurements with a steel tape. This technique is recommended for serious injury and fatal collisions.

Sideshot

This technique requires the use of sophisticated instruments such as a total station or a transit with a stadia rod or an electronic distance measuring device (EDM). By setting up the instrument and backsight in known locations, evidence points can be collected by taking sideshots (or foresight). The instrument determines the horizontal and vertical angles, and the rod-person provides the location for the instrument to measure the distance. Given these three sources of data (two angles and one distance), the instrument or data collector then can calculate the three-dimensional coordinates for the evidence points (Figure 5).

This equipment is fairly simple to use once the operator has had sufficient formal training and experience in set-up and operation techniques. With the notable exception of high-end robotic total stations, two people are usually necessary for operating the device. As long as the device remains level throughout the evidence collection process, and the rod-person keeps vertical control,

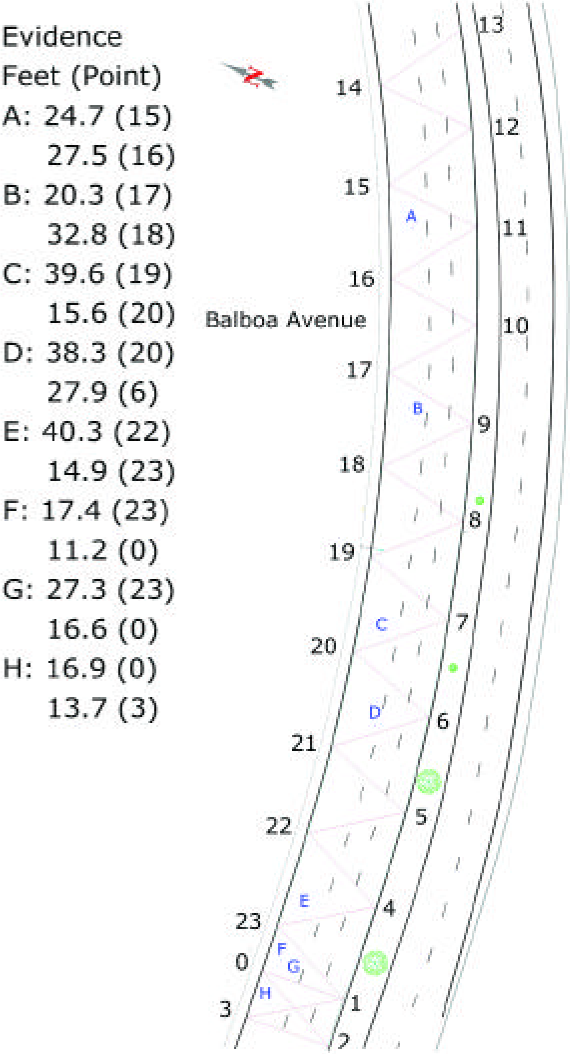

Figure 4. Documenting physical evidence with the triangulation technique and reference points (scale 1:1150).

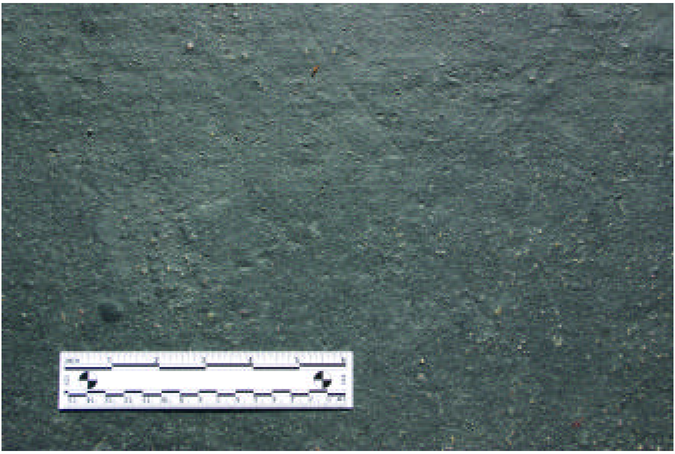

Figure 12. Slurry-seal asphaltic cement concrete.

“chip-seal”, which has a layer of asphaltic concrete underneath a rolled-in mixture of rock chips and a viscous asphaltic emulsion (Figure 13). Portland cement concrete roadways also vary in the size of the aggregate and the roughness of the finished surface (Figures 14 to 16). Until traffic removes them, the “fines” visible in Figure 15 may initially reduce the potential drag factor.

Although many bicycle collisions occur on Portland cement concrete sidewalks, the main type of roadway surface where bicycle-vehicle collisions occur is asphaltic cement concrete. Because roadway surfaces wear unevenly, the investigator should photograph the actual surface

Pre-collision Environmental Factors: Dry sand-and-seal asphalt cement concrete roadway in good condition, cloudy visibility, possible view obstructions, dark-no street-lights, roadway striping	**Collision Environmental Factors:** No bicycle tire scrub marks, no motor vehicle skid marks, no bicycle rim and axle scrapes, no motor vehicle headlamp debris, but some cyclist's belongings	**Post-collision Environmental Factors:** No motor vehicle skid marks, cyclist's clothing and food debris, scrapes on bicycle from tumbling and sliding on roadway
Pre-collision Vehicle Factors	Collision Vehicle Factors	Post-collision Vehicle Factors
Pre-collision Human Factors	Collision Human Factors	Post-collision Human Factors

Figure 25. A nine-cell matrix accounting for some of the environmental factors identified in a nighttime collision between a bicycle and a motor vehicle (see Chapter 7).

Figure 28. The *Cyclo-cross* usually is equipped with slightly-knobby and narrow 700mm wheels, multiple-speed gears, and drop handlebars. Cantilever brakes (lower right) are the most common, but some have disc brakes (lower left). Although similar in appearance to a *Road/Race* bicycle, the *Cyclo-cross* differs in that the fork is usually straight, rather than curved, and the frame is a size or two smaller to ease dismounting. The fork, brakes, and stays are usually designed for optimum mud clearance. The titanium model above was designed with 73-degree seat and head tubes, which are common angles for this bicycle type.

Figure 40. The fracture in this steel alloy tube is about 1/8″ (3 mm) to the right of the weld, and is an acceptable fracture as a result of excessive force.

(see Figures 41 and 42). These weld and tube breaks can have catastrophic consequences to the rider, who is sometimes unaware of pre-existing stress fractures. If any type of weld or tube failure is suspected, the frame should be inspected by a reputable framebuilder.

Sometimes frame and component cracks are not immediately obvious, and are only discovered during regular maintenance or part replacement. Figure 43 depicts a crack in the chain stay of an aluminum road bicycle frame. Because high-end

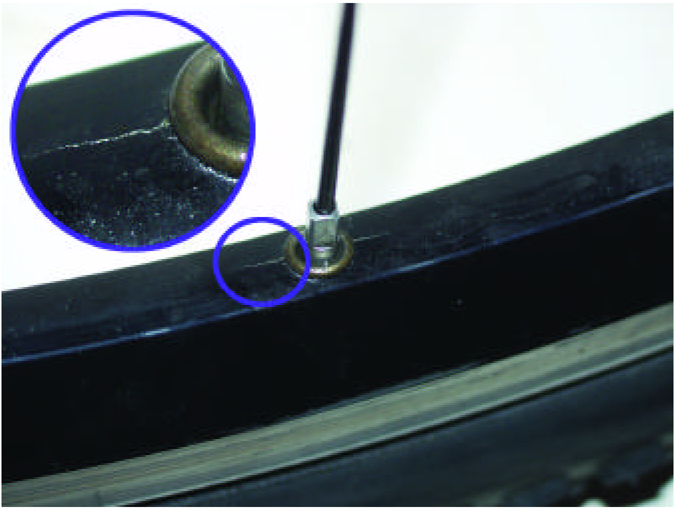

Figure 54. Cracked rim as a result of excessive spoke tension. Although not impossible to occur at the front wheel, this event is most common on the right (drive) side spokes of the rear wheel, because of the rear hub's rotational force transmitting from the spokes to the rim.

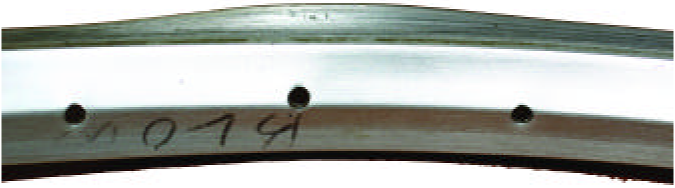

Figure 55. Blown out aluminum rim as a result of careless overinflation, and could have been catastrophic.

Figure 74. The upper image depicts a bicycle pedal imprint on the front bumper cover of a minivan involved in a right-angle collision, while the lower image depicts an head/shoulder imprint at the top of the windshield and leading edge of the roof. From the driver's view, the bicycle was traveling from left to right. The location of the damage in the lower image is further inboard from the driver's side than the location of the damage in the upper photo, indicating that the bicycle was moving at the time of impact.

especially to narrow ones. Because many collisions between cyclists and motorists occur at the right side of the vehicle, the right "A" pillar may obstruct the motorist's view of the cyclist. If the investigator suspects that such an obstruction, then he or she should position a camera at the motorist's eye height and take photographs of the "A" pillar from within the vehicle. Note the position of the driver's seat in the track. Also note any potential obstructions within the vehicle, such as a dirty windshield or fuzzy dice. This is also an appropriate time to inspect potential distractions as cell phones, food, maps or paperwork.

Injuries

Cyclist injury patterns are often similar to those of pedestrians. Because the cyclist has little or no crash protection from the bicycle, the type and severity of injuries is usually a function of momentum. This positive correlation simply suggests that the greater the momentum, the more severe the injury. Perhaps the most serious injuries to cyclists occur at the head, usually a result of direct contact with the windshield, hood, or roadway. A head and shoulder strike to the windshield of a motor vehicle traveling with a closing velocity in excess of 40 miles per hour (64 kilometers per hour) often results in fatal injury, even if the rider was wearing a helmet. However, even in low speed collisions a helmet-wearing cyclist can sustain fatal injury from ground contact.

Figure 82. Side mirror view of bicyclist. Distances from right mirror: 100 feet (30.5 meters), 75 feet (22.9 meters), 50 feet (15.2 meters), and 25 feet (7.6 meters). Images courtesy of Harris Visibility Studies.

When the lateral acceleration factor and path radius are known, the formula for determining velocity is:

$$V = \frac{15\sqrt{Ra}}{22} = \frac{15\sqrt{Rf_L 32.174}}{22}$$

> (where “a” is acceleration in feet per second per second, “f_L” is lateral acceleration factor, “R” is radius of the path in feet, and “V” is velocity in miles per hour).

For example, a cyclist turns right at an intersection that has a raised Portland cement concrete sidewalk with a radius of 25 feet (7.6 meters). At this curve the minimum turning radius is about 27 feet (8.2 meters). Using the above equations, the bicycle’s speed is 10.4 miles per hour (16.7 kilometers per hour) at a lean angle of 15 degrees. At a lean angle of 20 degrees, the speed is 12.1 miles per hour (19.5 miles per hour) (Figure 89).

End-Over

Because of the potential severity of the end-over or pitch-over collision, and because it can occur in both solo and motor vehicle collisions, further discussion is warranted. The end-over is usually the result of one of more of the following four reasons: (1) hard front braking, (2) a frontal impact with an object that is more rigid than the front wheel, (3) a fallen front wheel (often from not securing the

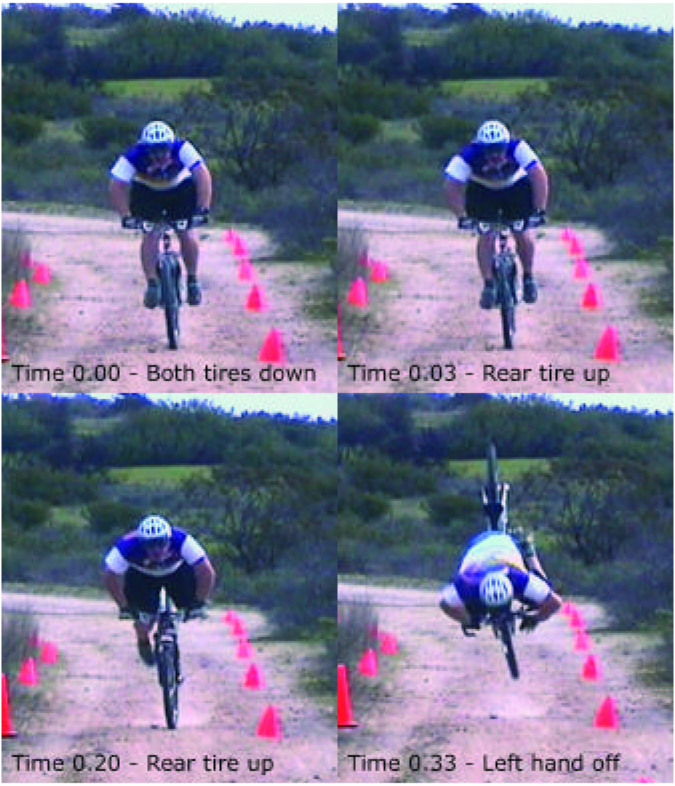

Figure 90. A mountain bicyclist traveling at about 22.5 miles per hour (36.2 kilometers per hour) applies only the front brake. Once the front wheel is nearly locked, the rear wheel starts to lift up. At about 0.20 seconds the rider really has no chance to recover. At about 0.33 seconds he releases the brake and prepares his right hand, and then his left hand for the landing. The cones are spaced in 25-foot (7.6-meter) intervals, the grade is about -2%, and the test surface is depicted in Figure 17 on page 32.

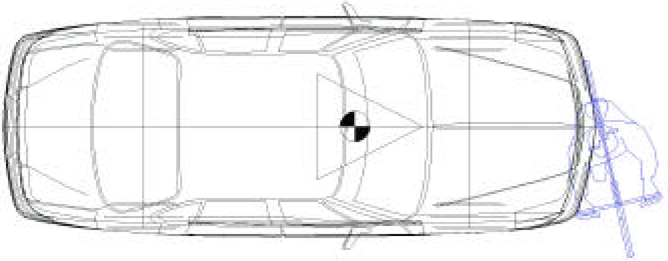

Figure 102. Impact alignment for the Brian Young collision.

the right of the license plate. This evidence gives the necessary information for alignment at maximum engagement. Initial contact may have occurred with the bicycle about one foot (30 cm) closer to the driver's side of the vehicle.

In reviewing the role of view obstructions, Brian Young should have been able to see oncoming headlights, even though his brother was on his right. Although the vehicle in lane number two may have been easier to see than the car in lane number one, both cyclists were probably aware of oncoming traffic. The "A" pillar obstruction for the driver is a less complicated matter. Given that the cyclists were stopped as the Pontiac approached, the motorist would have seen them through the windshield (not through the left door window) as the headlights illuminated the bicycles' reflectors. Oncoming headlights may have also backlit his view of the cyclists.

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10 – INDEX