FROM CRASH TO COURTROOM: COLLISION RECONSTRUCTION FOR LAWYERS AND LAW ENFORCEMENT

JOHN B. KWASNOSKI

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"EVERY prosecuting attorney should have this on his shelf, just to make sure the police reconstructionist has everything in order, OR to see if the defense's "hired gun" is actually obeying the laws of physics!"

John Daily, President
Jackson Hole Scientific Investigations, Inc.
Retired Wyoming Highway Patrol Sheriff
Reconstructionist and nationally known author.

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"What a phenomenal book! John once again is able to take even the most difficult aspects of collision reconstruction and put it into meaningful prose. Combined with real world examples that show actual mistakes, and explanations of how and why the mistakes occurred, make this text a **must have** for every police reconstructionist and prosecutor."

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"*From Crash to Courtroom* is the most user-friendly reference on a technical subject I have ever seen.

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"Mr. Kwasnoski is adept at identifying the practical aspects of accident reconstruction and the necessary leg work to build a strong case in court."

Debra M. Walsh
Former Deputy County Attorney
Rockingham County, NH

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"I have had the opportunity to work on many cases with John Kwasnoski, both as a prosecutor and as a plaintiff's attorney. I know of no one who has more expertise and ability to present theory and practical application of accident reconstruction principles so that it is completely understandable to the layman."

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"Thanks to this book, the science of crash reconstruction finally makes sense and the prosecutor or law enforcement officer who reads and relies upon it will surely be more effective in not only explaining crash reconstruction evidence in court, but also assuring its reliability before even entering the courtroom."

Kim Fogarty, Traffic Safety Resource Prosecutor
Massachusetts District Attorneys Association
Author of *Massachusetts Prosecutors OUI Manual*

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"Whether practicing civil or criminal law, Kwasnoski addresses and answers the most frequently asked questions that attorneys have after receiving an accident reconstruction expert's report."

Robert Gottlieb, Esq., Nationally recognized criminal defense attorney and news law commentator

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PREFACE

This book has evolved through my review of hundreds of collision reconstruction reports, including some in which the principles of physics had been misapplied, misunderstood, or misinterpreted. What has troubled me is the misuse of scientific methodologies by those who either do not fully understand the basis for a particular method, or who would take liberties with the scientific method unknowingly.

I have experienced only a small number of what I would call intentional abuses of the science, and those have been rather obvious, and easily exposed. Being trained to perform mathematical calculations by inserting numbers into algebraic or trigonometric equations without the understanding of the derivations, limitations, and restrictions on those equations can produce a conclusion that is incorrect. In many instances these errors resulted in an effect that was merely monetary, while in other cases personal liberties were affected.

The attorney who receives a collision reconstruction report is in some respects at the mercy of the writer, unless the attorney can ask the incisive questions that expose potential vulnerability in the report. What has been striking in many of these cases is the inability of the attorney(s) to discern the potential problems in expert reports, and in some cases to accept their own expert's faulty opinions without any caution.

The sense of being overwhelmed by technical jargon and mathematical calculations may result in the attorney's acceptance of the expert's opinions. Unable to ask the incisive questions needed to expose an expert's vulnerability the attorney is ill-equipped to challenge the expert in a pro-active manner. An objective of each chapter in this book is to help the attorney develop an eye for the "red flags" that appear in expert reports.

While it may not be possible to educate the attorney to a level of understanding equivalent to that of the expert in a case, it is my goal in this text to help attorneys more closely scrutinize expert reports and to subsequently pose challenging questions for both their own and adverse collision reconstruction experts.

In each section of the book I have included some foundation of the science involved, along with references to the literature that supports the science. This is only done to the extent that it will help the attorney understand the terms of art or vocabulary that will be needed to communicate with experts. My hope is that by seeing some of the errors from actual reports that are the basis for this book, attorneys will begin to think in a more cause-and-effect manner, and to develop some of the logic patterns that may be different from those employed in dealing with legal problems. There are certain areas of expert opinion that may not withstand the test of common sense, but the attorney must have the confidence to challenge those assertions —a confidence that must be grounded in a true understanding of the scientific principle upon which the opinion is based.

Particularly, my intention in this book is to shed light on the nature of assumptions made by experts, which in many instances are an integral part of a collision reconstruction; the focus in each of these case studies is on the need to consider ranges when a specific numerical value cannot be determined. In this regard, the attorney should continuously ask the question, *"What do I know for certain?"* when reviewing an expert's report, as this can encourage a dialogue with the expert that strengthens the case.

The text is segmented into topical Chapters that address the most commonly used reconstruction methodologies, and each Chapter contains a technical foundation followed by examples of errors or “bloopers” found in expert reports. In each such “blooper” the technical issue is identified, followed by a comment to clarify the issue, and areas of inquiry for the attorney that can expose a potential problem in the technical expert report. In many of the case studies some indication of how the issue affected the case is included, but this was not possible in all the cases because of my own limited knowledge of how the case was resolved. Some of the case studies include cross examination attacks that would expose the error, and in every case there is a list of questions to help the attorney investigate further.

I have sought to have the text reviewed by attorneys with a wide range of experiences, and from that feedback have endeavored to make the text as user-friendly as possible. A preliminary perusal of the entire text would alert the attorney to the technical terms-of-art that are the vocabulary of any expert’s report. The attorney can then identify key concepts within a technical report—speed estimates from tire mark evidence, time-distance analyses, etc.—and consult the appropriate chapter for assistance.

Above all, it is my hope that this book can support attorneys in developing an ability to communicate that leads to better assessment of their own case, and the ability to critically dissect the report of an adverse expert. Time spent in consultation with the attorney’s own expert can be so much more productive and economical when the attorney and the expert can communicate on a technical level, and the attorney-expert relationship is strengthened by an informed dialogue. As an expert having had hundreds of meetings with attorneys, it is encouraging when an attorney is well prepared and capable of assimilating technical information. The advocacy process in motor vehicle collision cases includes scientific evidence, complicated mathematical manipulations of the evidence, and concepts and language that cannot be strange to the attorney who would successfully litigate this type of case. The idea that an expert can win a case by simply writing a report or by giving persuasive direct testimony should be tempered by the understanding that both sides will usually offer experts, and the ability to discern the actual differences between the two helps the attorney develop the proper focus for the litigation of the case. The ability to understand the reality of a given case can empower the attorney, and lead to the most favorable resolution of the case for the client.

I am grateful to Gerald Partridge, Deb Walsh, Bob Gottlieb, Ken Padowitz and John Daily who took valuable time from their schedules to review the manuscript and give their comments on making this book most useful. Their perspective has hopefully made the organization and format of this text one that will make it economical of time for the user. Their comments have reflected the reality that in some of their own cases they have been unable to adequately challenge or interpret the work of an expert, but instead may have accepted the expert's opinion without being able to scrutinize it more aggressively. I welcome communications from those of you who use this text and may have questions about specific technical issues in your own cases. I can be contacted by email at kwasnoski@aol.com or by phone at 413-589-0793.

FROM CRASH TO COURTROOM

EXCERPTS

2.5.11 Misinterpretation of Air Bag Nondeployment: Failure to Deploy Cited as Proof of Low Impact Speed

An intersection collision occurs in which the front of a 4x4 SUV collides with the passenger side of a car, causing the death of the passenger in the car. An issue in the case is whether or not the operator of the SUV stopped for a stop sign before entering the intersection. The collision configuration is shown in the photograph, which also shows that because of the height of the front bumper of the SUV it overrides the car.

Collision in which driver's air bag did not deploy.

In this collision the driver's side air bag did not deploy. In the criminal case, a defense expert opined that since the threshold triggering speed for the air bag was 15mph, the nondeployment was proof that the SUV's impact speed was less than 15mph. The expert cited a published piece of literature that stated, "Most auto manufacturers have chosen a range of 8-14mph frontal vehicle-to-barrier crashes for the deployment threshold." Furthermore, given this low impact speed the expert opined that it could not be proven whether or not the SUV had stopped prior to entering the intersection and colliding with the car.

Issue:	*Is this interpretation of the threshold speed for air bag deployment correct?*

Comment: This interpretation is not correct. The threshold speed is stated for vehicle-to-barrier collisions, meaning that in a vehicle-to-vehicle collision a speed greater than 14mph might not trigger the deployment of the air bag since energy would be absorbed by both vehicles. In a vehicle-barrier collision an insignificant amount of energy is transferred to the barrier. Actually, the threshold does not represent a speed but represents a required change in speed of 15mph or more, and the 15mph threshold is therefore not equivalent to an actual or impact speed. A few examples will show this flaw in reasoning:

1. A vehicle is traveling at a speed of 65mph on the interstate and in making a lane change it strikes the rear of a vehicle in its lane. This causes the striking vehicle to slow by only 1-2 mph and does not trigger the air bag to deploy. Obviously, the change in speed is too small to trigger the bag, yet the actual vehicle speed is much greater than 15mph.
2. A vehicle traveling at 40mph strikes a soft barrier on a ramp exit

designed to absorb energy and gradually slow a vehicle that strikes the barrier. The vehicle comes to rest and changes speed by 40mph in the engagement with the barrier cushion, but in this collision the rate of deceleration is too low to trigger the deployment of the air bag. In this case the impact speed is greater than the 15mph threshold speed, but there is no deployment of the air bag.

3. A vehicle at 50mph strikes a pedestrian. The airbags do not deploy because the vehicle change in speed is too low.

Clearly, the 15mph threshold speed is not a solid indicator of actual impact speed of the vehicle. Also, the bag may not deploy because of a malfunction or defect in the bag or sensors. The bag may have been disabled prior to the collision. Or, there may be a significant lateral component to the collision forces which would not necessarily deploy the bag because the sensors are designed to sense primarily frontal impacts. Thus, for example, a car sliding sideways into a utility pole at a high speed would not necessarily cause the air bags to deploy. In summary, there can be a number of reasons why an air bag would not deploy that do not lead to a conclusion about the speed of the vehicle.

Issue resolution / impact: The prosecutor contacted the defense attorney in this case to inform her that the prosecution would be bringing a rebuttal witness to trial to explain the nature of the air bag deployment mechanisms, and to explain to the jury that the defense expert's opinion was faulty. In light of the horrific nature of the collision and the potential penalty for the defendant, the two sides were able to reach a negotiated conclusion to the case. The author advised the prosecutor that if this issue was made the focus of a good cross examination then the jury would clearly see that expert's opinion was faulty. By bringing in testimony about common examples of collisions in which the air bag would not necessarily deploy the jury could come to their own conclusion about the expert's opinion.

3.3.13 Published Charts of f Values
Measured drag factor value falls outside published ranges

A drag factor value of .83 is measured at a collision scene within one hour of the collision, and the value is subsequently utilized to determine the speed of one of the vehicles involved in the crash. An expert hired by the attorney representing the operator of the vehicle takes issue with the **f** value, and claims that it is too high based on published ranges for traveled road surfaces in widely accepted reconstruction texts. In particular the expert refers to texts by Fricke and Rivers in which published charts of drag factors for dry asphalt surfaces are .60 - .80 and .55 - .80, respectfully. [13] The expert refers to the specific heading on the Rivers chart, which reads, "Possible Coefficients of Friction for Roadway Surfaces" and opines that the value of .83 measured at the scene is not possible.

Issue:	*Can a measure value of the drag factor be correct if it falls outside the ranges published in reconstruction texts*?

Comment: There are many road surfaces that have higher drag factors than the values suggested as "typical" or "common" in published texts. These **f** values can readily be found in the literature, and a reconstructionist who asserts that there is such a rigid upper limit to the drag factor is not in agreement with the general field of study. The suggestion that the measured value is too high is usually accompanied by the disclaimer that the same expert cannot now rely on any one particular value, and therefore is unable to give an opinion as to the speed of a particular vehicle. The author's text suggests a range of **f** values, but also states that this range is not meant to limit the possible values that real

13 Fricke, *Traffic Accident Reconstruction*, Vol. 2, Northwestern University Traffic Institute**,** 1990; Rivers, *Traffic Accident Investigation*, IPTM, 1995, p. 371.

roads could have.[14] In fact, numerous roads that the author has himself measured have drag factor values above .80, especially in areas where high granite content is used in the composite road surface. Very simply, there is no arbitrary upper limit to the drag factor value a road could have—newer roads could exceed 1.00 in some cases.

Issue resolution / impact: In this case the issue was resolved during pre-trial discussions when published literature showing measurements outside the published range were produced. Both attorneys then understood that the published ranges were not absolute in any way, and the two sides settled the case before trial.

Checklist:

- ☑ Does the attorney have copies of the Fricke and Rivers charts?
- ☑ Can the attorney's own expert provide published research data that shows values above .80 as part of the raw data?
- ☑ One source of such information is the Wakefield publication, which has raw data values greater than .80 in the published paper.
- ☑ Has the adverse expert testified in previous cases in which his/her own accepted value exceeded .80?
- ☑ Can the attorney contact a local reconstructionist who could offer rebuttal testimony about such an assertion?
- ☑ Has a local police officer made measurements that would contradict the claim that .83 is beyond the realm of possibility?
- ☑ Would a hypothetical question using the published range of **f** values be helpful to the attorney?
- ☑ In deposition will the adverse expert cite the source of his/her conclusion that the measured value is unacceptable?
- ☑ If the expert mentions published sources as a basis for the opinion does the attorney follow up and get copies of those publications?
- ☑ Can a local highway engineer testify that drag factor values greater than .80 are possible?

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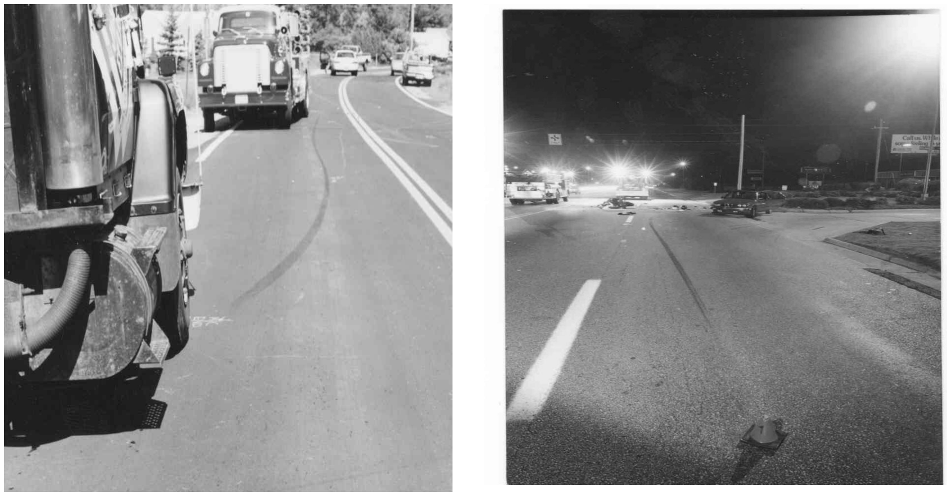
14 Kwasnoski, et al, *Investigation and Prosecution of DWI and Vehicular Homicide*, Lexis Law Publishing, 1998.



Rear-only skid mark from a motorcycle.

Using a model for the MC braking efficiency that ascribes 35% of the weight of the motorcycle to be on the rear tire, the reconstructionist calculates a speed from the skid mark to be:

$$S = \sqrt{30\ d\ f\ BE}$$
$$S = \sqrt{30\ (80)(.84)(.35)}$$
$$S = 26.5\text{ mph}$$

Issue:	*Is this speed estimate correct, specifically in the use of the 35% BE based on a general model for motorcycles?*

Comment: The skid was with only one wheel locked. The photograph shows a rear-only locked-wheel brake mark that includes the typical serpentine or S-shaped mark made by the locked rear tire. In addition to the tire mark, the rear tire often shows the skid patch caused by the intense heat built up during the locked wheel skidding. There are really two possible concerns in this case with the use of the 35% BE for the rear tire of the motorcycle. First, the 35% is a general model for motorcycles, and may not reflect the actual weight distribution of the particular bike involved in the collision. Second, the reconstructionist in this case did not take into consideration the weight shift when the braking occurred, which would shift weight forward onto the front tire and therefore reduce the braking efficiency of the rear tire. The BE would have to be determined for this dynamic condition, not just based on the static weight distribution of the motorcycle when it was standing stationary. A consideration of the weight shift would be based on the Daily equation, and might significantly affect the BE of the rear tire of the motorcycle in this case.[6] If a calculation of the weight shift in this case produced a reduction of the weight on the rear tire by 20%, and the actual static weight distribution on the rear tire was only 30%, the new BE for the rear tire would be only (.30)(.80) = .24. When used in the speed from skid marks calculation this new information would yield a speed estimate of:

$$S = \sqrt{30 \, d \, f \, BE}$$
$$S = \sqrt{30 \, (80)(.84)(.24)}$$
$$S = 21.9 \text{mph}$$

It is apparent that correctly determining the dynamic BE for the motorcycle (including the weight shift phenomenon) can make a significant difference in the speed estimate. Many reconstructionists do not do this, and simply use a general model for the weight distribution for motorcycles that is described in training materials as:

Small motorcycles (less than 750 cc engines)	Front = 60% Rear = 40%
Large motorcycles (greater than 750 cc engines)	Front = 70% Rear = 30%

6 Daily, *Fundamentals of Traffic Accident Reconstruction*, Institute of Police Training and Management, 1988.

Other published literature, all models	Front = 65% Rear = 35%

The attorney should scrutinize such a general number when it is used. Although it may be close to the correct value by coincidence, the expert should do a more thorough analysis of the braking efficiency as part of a speed estimate, since the speed is often a critical issue in determining liability or culpability. There is really no need to use a published value in lieu of making an actual determination for the specific model motorcycle, so this should be something that demonstrates the completeness of the investigation/reconstruction.

Issue resolution / impact: In a recent motorcycle collision that the author worked on, the weight shift caused more than a 15% shift in weight onto the front tire of the motorcycle, and brake efficiency of the rear tire was reduced significantly as a result. Failure to take weight shift into consideration had produced a high speed estimate. When the error was found in the deposition of the defense expert the plaintiff's attorney was able to retain a rebuttal witness, and the case settled.

Checklist:

- ☑ Is the skid length accurately determined?
- ☑ Does the drag factor measurement apply to motorcycle tires?
- ☑ Has any correction been made, if necessary, to apply the **f** value measured at the scene to the motorcycle tires?
- ☑ Does the expert have the vehicle specifications for the motorcycle?
- ☑ Did the expert make measurements on the bike involved, such as the center of mass location of the bike (with the rider on the bike)?
- ☑ Does the manufacturer's literature describe the location of the center of mass of the bike?
- ☑ Has the expert reconciled the fact that the CM of the bike is not the same as the CM when the rider is on the bike?
- ☑ Does the expert acknowledge the weight shift phenomenon when the bike is braked hard?

5.4.1 Yaw After Impact
Impact forces cause loss of traction.

A car is traveling on the interstate and a vehicle coming up behind this car pulls out and starts to pass, but clips the left rear of the lead vehicles and causes it to go out of control. The lead vehicle starts to yaw and then leaves the pavement and rolls over, causing serious injury to the passenger. During the yaw the vehicle puts down a visible yaw mark that is measured by investigators. From the chord and middle ordinate of the yaw mark an expert opines about the estimated speed of the vehicle, which he claims to have calculated from the speed from yaw marks equation. Photos of the vehicle are shown below.

Rollover vehicle and rear-impact damage.

Issue:	*Is this a proper application of the speed from yaw marks equation?*

Comment: This is <u>not</u> a proper application of the equation since it violates the conditions under which the equation was derived—that there was a balance of the lateral forces acting on the vehicle, namely that the road friction could provide the needed centripetal force to keep the vehicle <u>on its intended curved path</u>. In this case the vehicle was not in a curved path prior to losing traction, and more importantly it was an external force (the impact of the following vehicle) that caused the loss of traction, not a lack of centripetal force.

Consider this situation: The vehicle in this case is struck on its left rear corner by the passing vehicle that is going 25mph faster than the lead vehicle, and compare that to the same situation with the passing vehicle being only 5mph faster than the lead vehicle. Although the lead vehicle's speed could be the same in both cases the resulting yaw would be different, and therefore the yaw marks would have different radii. It is obvious that using the different radii would give two different estimates of the lead vehicle's speed, although it was the severity of the impact that really caused the different yaw marks.

Do not use the speed from yaw marks equation **to analyze post-impact** yaw mark evidence when the yaw was caused by collision forces.

> Fricke [4]
> "Velocity estimates obtained using the speed equation should never be used to estimate after-collision velocities. The equations are based on balancing centrifugal and centripetal forces and not collision forces. Therefore, using these equations after a collision to establish velocity is totally inappropriate."

4 Fricke, *Traffic Accident Reconstruction*, Northwestern Traffic Institute, p. 72 – 31.

Issue resolution / impact:

This case example came from a participant at a seminar that the author was doing for a prosecutor group. One of the assistant District Attorneys asked the author about this case during a break, and he was immediately told that there could be a problem with the reconstruction of the crash because of the yaw equation being used in this situation. When the prosecutor sent the report to the author, it indicated that the reconstructionist acknowledged the collision, and even said that it could be the cause of the yawing motion. This was brought to the attention of the prosecutor and the issue was resolved in a supplemental report prepared by the officer to disclose this error. Gone unchecked, this could have been the basis for a prosecution verdict that would have been built on faulty reconstruction testimony.

Checklist:

- ☑ Did the yaw occur after impact or any other type of external force acted on the vehicle?
- ☑ If the external force was an impact is there documentation of that contact—damage photographs, observations by an investigator, etc.?
- ☑ If the vehicle is available, can those photos still be taken?
- ☑ Can the attorney show that damage was not done during transportation or storage of the vehicle?
- ☑ Is there any paint transfer, tire rub-off, or other evidence that would confirm the impact that caused the yawing motion?
- ☑ Does the attorney have a literature reference that the opposing expert will acknowledge, or to use at deposition or trial?
- ☑ Can the attorney's own expert explain why this is a misuse of the equation in simple, easy to understand language?
- ☑ Is there a need for a credible rebuttal witness in this case?
- ☑ Has either expert testified about this situation previously?
- ☑ Has either expert written anything that would acknowledge this to be an improper application of the yaw equation?

6.4.1 Accuracy of Airborne Speed Estimate: Sensitivity to Field Data

A vehicle goes out of control, leaves the paved road surface and vaults off the edge of the road, travels through the air and strikes the ground. Careful measurements by police investigators reveal that the car landed a horizontal distance of 60 ft from the launch point, and the landing point was 2 ft below the launch point. A measurement of the point where the car went airborne indicates a slope at the launch point of 3^o (slope = m = tan 3^o = 0.0524) measured up from the horizontal. The analysis of the airborne motion was done using an accepted airborne motion equation:

$$S = 2.73\, d / \sqrt{(h + d\, m)} \qquad \text{with } d = 60 \text{ ft, } h = 2 \text{ ft, } m = .0524$$

and yielded a speed of 72.2mph at launch.[2] The police report stated, "The speed of the vehicle at the point where the vehicle became airborne was determined to be 72.2mph."

Issue:	*How sensitive is the estimate of speed to the accuracy of the launch angle determination?*

Comment: Since this equation, and the other airborne equations as well, contains a trigonometric function the equation may be very sensitive to the

2 John Daily, *Fundamentals of Traffic Accident Reconstruction*, IPTM, 1988.

launch angle used in the calculations when the angle is small.[3] Realistically, the reconstructionist should include a sensitivity analysis (in which different launch angles are used to observe changes in the calculated speed) as part of the airborne calculation to reflect this dependence on the measurements at the scene. In many cases the unevenness (apparent in both changing grade and superelevation) of the roadside and the angular nature of the vehicle's exit path from the roadway may create significant uncertainty in the determination of the exact launch angle, even if the most careful measurement is made. Where exactly did the vehicle go airborne, and what was the orientation of the vehicle when it left the ground?

For the example above, the uncertainty in the speed estimate can be appreciated by calculating the speed for launch angles only a few degrees different from the measured value, as shown in the table below.

Launch Angle	Estimated Launch Speed
1 °	93.7mph
2 °	80.8mph
3 °	**72.2mph**
4 °	65.8mph
5 °	60.8mph

The measurement of the launch angle in this type of case may be the focus of attack, and the sensitivity analysis should be a part of the calculations if the nature of the roadside is such that a significant uncertainty could exist. The attorney should insist that his/her own expert makes such a sensitivity analysis so as not to be caught by surprise at trial or during a deposition with a hypothetical that could change the liability assessment in the case.

3 Kwasnoski, *Crash Reconstruction Basics for Prosecutors*, APRIL, 2003. This publication can be downloaded online (free of charge) by visiting www.ndaa-apri.org.

Issue resolution / impact:

It is vital that the attorney question his/her own expert about sensitivity calculations when the airborne equations are used, as this can be fertile ground for hypothetical inquiries during a cross examination. If the attorney's expert has not done such an analysis it should be demanded by the attorney so the value of the expert's speed opinion is put into perspective. In the first case in which the author consulted on this issue, the adverse expert was forced to change his speed testimony from a very convincing 54mph to a range of 22-103 mph upon cross examination. Needless to say, the standard "to some degree of scientific certainty" became an important phrase in this trial, and one that ultimately persuaded the jurors not to accept the expert's opinion of 54mph.

Checklist:

- ☑ How was the slope or angle at the launch point measured?
- ☑ Where exactly was the slope or launch angle measured?
- ☑ Does the attorney understand the sensitivity of the calculation?
- ☑ Has the expert done a sensitivity analysis over a reasonable range of slope or angle values?
- ☑ If the adverse expert has not done a sensitivity analysis in a report, was one done and not included?
- ☑ Have the expert's work papers or calculations been obtained through discovery—the attorney's own expert may find useful information in the raw worksheets?
- ☑ If these worksheets were asked for in discovery did the attorney follow up and get them?
- ☑ Is it necessary for the Court to intervene in obtaining these worksheets and calculations?
- ☑ If the expert did not do such a sensitivity calculation is this a point of attack on his/her testimony at trial?
- ☑ Can a useful hypothetical be developed for the adverse expert?
- ☑ Does the attorney have published literature that affirms the sensitivity of the calculation to the slope or launch angle used in the airborne equations?

7.3.3 Identifying the Assumptions

One of the most critical skills an attorney can develop is to be able to identify **assumptions** used by an expert in arriving at his/her opinion. This may be most true in MV reconstruction cases, where an assumption of a value is necessary to continue a calculation that would otherwise be terminated by a lack of direct evidence or measurements. An example of a written report in the case of a pedestrian fatality is given below.

> "The point of impact where the vehicle struck the pedestrian was 12.5 ft from the North curb edge. The pedestrian walked Southbound 12.5 ft to the point of impact (POI). Using a walking speed of 5 ft/sec the pedestrian was visible to the defendant for 2.5 seconds prior to the collision. Skid marks from the Westbound defendant's vehicle started 17 ft prior to the POI, and the total skid mark to the stopped position of the car yielded a speed estimate of 40mph for the defendant's vehicle. The drag factor for the road was measured to be .80. Using the accepted perception-reaction time (PRT) of 1.5 sec it was determined that the defendant's vehicle moved 88.2 ft during the PRT, which placed it 105.2 ft from the pedestrian when the defendant actually perceived the pedestrian.
>
> If the defendant had been operating at 30mph the total stopping distance would have been 103.5 ft; he could have stopped his vehicle before reaching the pedestrian."

Issue:	*What are the assumptions in this expert report?*

Comment: The assumptions include:

- the POI is an exact point
- the pedestrian started walking at the curb edge

- the pedestrian walked at a constant speed of 5 ft/sec
- the path of the pedestrian was a straight line perpendicular to the road, and therefore the walking distance of 12.5 ft was the same as the measurement from the curb to the POI
- the operator's PRT was 1.5 seconds

Any of these assumptions, if not consistent with eye witness observations, would be very vulnerable to attack, and especially the assignment of the 1.5 second PRT value. Extensive literature in the field of human factors suggests that a <u>range of PRT values should be used</u>, not one specific value for every person. A value often found in the literature for operator PRT is .75 seconds, and if that value were used here the calculation would be:

for a PRT = .75 sec
the reaction distance would be $X_r = 1.47(40)(.75) = 44$ ft

and the distance from the pedestrian in this case would be:
$d = 44 + 17 = 61$ ft

At 30mph the reaction distance would be:

$$X_r = 1.47(30)(.75) = 33 \text{ ft}$$

the braking distance would be:
$X_b = 37.5$ ft

so the total stopping distance would be:
$X_s = 33 + 37.5 = 70.5$ ft

With a PRT value of .75 seconds the car would be only 61 ft from the pedestrian, and the stopping distance required would be 70.5 ft—<u>*the collision would not be avoidable*</u>.

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