**The Standard for Measuring Crush for an Automobile Accident Impact**
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There are standard methods for measuring crush that have achieved general acceptance in the accident reconstruction scientific community. Defense engineers commonly estimate crush solely by looking at photographs of the vehicles involved in a collision. They also sometimes use an "upper bound method" whereby they allegedly determine the maximum possible crush that could occur based on examination of exemplar vehicles, and then estimate the crush within these boundaries. These are not accepted methods for accurately measuring crush and should be challenged as unreliable and invalid.

Northwestern University, the college where most engineers have received their training in accident reconstruction, published a textbook entitled *Traffic Crash Reconstruction* by Lynn B. Fricke. (Fricke, Lynn B.: Traffic Crash Reconstruction, Northwestern University Center for Public Safety, Evanston, IL, 2nd Ed., 2010). This text addresses calculation of Delta V based on crush measurements. It states: "Damage in general is difficult to measure. The difficulty arises with shifting body parts, bowing of the vehicle (Exhibit 36), deep and shallow damage areas, mushrooming (Exhibit 37), and many other difficult-to-access irregularities. Measuring protocols have been suggested for properly measuring difficult or irregular damage profiles. (10)" There is no mention anywhere in the textbook about a protocol for measuring crush from photographs alone or an "upper bound analysis method."

Reference number 10 is to a 28 page study entitled "Measuring Protocol for Quantifying Vehicle Damage from an Energy Basis Point of View," Tumbas, N. and Smith, R., SAE 880072, 1988. This study exclusively addresses physical measurements of crush and never mentions measurements from photographs. Therefore, the standard mandated by the Fricke textbook is physical measurement of crush.

Texas A&M University is also considered a leading institution in the field of collision reconstruction. In 1999, the University published a textbook entitled "Collision Reconstruction for the Medical Practitioner." Section 4 is entitled "Reconstruction of Low Speed Collisions – Practical Applications." The text states: "Typically, objective evidence from an actual accident includes vehicle photographs, vehicle damage appraisals, and first-hand vehicle inspections." Also: "Rather than relying simply on a dollar amount from the damage appraisal, which represents an estimate for the anticipated repairs, the reconstructionist evaluating damage must carefully review the parts listed to be repaired or replaced. The notion that a comparison can be made between the cost to repair a vehicle and Delta V is dangerous indeed." There is no mention anywhere in the textbook about a protocol for measuring crush from photographs alone or an "upper bound analysis method." Szabo, T. and W.R. Haight: Course Text Book for *Collision Reconstruction for the Medical Practitioner*, Texas A&M University, 1999.

In June, 2012, a search was performed of the webpage www.sae.org for studies with the terms "crush measurement." Here is the most relevant study that was found:

Douglas R. Brown, John F. Wiechel, and Rickey L. Stansifer, Dennis A. Guenther: "Practical Application of Vehicle Speed Determination from Crush Measurements,"

SAE 870498, 1987: "The use of vehicle damage measurements has proven to be an effective technique in the determination of impact energy and pre-collision speeds. However, as with an analytical technique, the quality of the speed estimate is highly dependent on the accuracy of the measurements. This relationship suggests a need to employ intricate and exacting measurement schemes to obtain useable data. This approach is often difficult to implement in a routine accident investigation where a tape measure may be the only available measuring device. In the current study, vehicle damage resulting from collisions with a known speed is measured with techniques of increasing sophistication and the results are compared." "Conclusions: The results of this study indicate that the different methods of measuring crush (plastic, tape, plywood and string) are all similar in accuracy . . ."

The reliability of measurements of crush from photographs has been tested in a study. This study was published by the Society of Automotive Engineers (SAE) of which almost all defense engineers are members and entitled "Evaluating the Uncertainty in Various Measurement Tasks Common to Accident Reconstruction." (SAE 2002-01-0546) In the section on "Measuring Vehicle Crush," the researchers reported the findings of an experiment performed with 17 accident reconstructionists. When the reconstructionists were asked to evaluate crush damage from photographs, the results were an average estimated crush of 13.6 inches with a standard deviation of 4.2 inches (review of one photo), and an average estimated crush of 13.1 inches with a standard deviation of 3.3 inches (review of two photos). The wide variation in measurements between reconstructionists proved it is impossible to accurately assess the exact amount of crush from photographs.

The only exception for photographs is when specialized cameras, multiple specific photographs and special computer software is used. This technique is then called "Photogrammetry" and the results have been proven valid. A 2010 study entitled "The Accuracy of Photogrammetry vs. Hands-on Measurement Techniques used in Accident Reconstruction" (SAE 2010-01-0065) states: "Photogrammetry involves the use of multiple two dimensional photographs to create a three-dimensional representation of an object." The data is then analyzed by a software program such as *PhotoModeler*™ to derive a figure for crush which is then converted into g forces and Delta V. The study discusses other software programs and their widespread use to assure accuracy.

*PhotoModeler*™ is so main stream that it has been adopted for use by the Arizona Department of Public to reconstruct crash scenes. Engineers are well capable of purchasing this system so that their crush measurements would be accurate. Instead, they use a method that is unscientific which allows them to report whatever level of forces they want. They simply eyeball photographs and guess at the amount of damage. Here is the webpage for *PhotoModeler*™ so that all parties can see that this is the proper technology for 2013 to accurately measure crush from photographs: http://www.photomodeler.com/ Photogrammetry was specifically developed because it is generally accepted that eyeballing photographs cannot result in accurate measurements for crush damage.

This is not new technology. An SAE study from 2004 was entitled "Determination and Verification of Equivalent Barrier Speeds (EBS) Using PhotoModeler as a Measurement Tool." (SAE 2004-01-1208) This study documented the validity of *PhotoModeler*™ years' ago as

compared to engineers' method of guessing at the amount of crush from eyeballing pictures.

The inescapable conclusion is that the only way to accurately measure crush following an impact is to perform a physical inspection of the vehicle, not to solely evaluate photographs. Any Delta V calculation based on crush measurements from photographs must not be allowed in Arizona courtrooms since it essentially junk science. Because of these facts, in May, 2012, Joseph D. Peles, PhD was the expert in a case where the jury determined the plaintiff was injured in spite of his testimony based on crush damage measurements from photographs and awarded $70,000 in damage, see *Shamrock v. State Farm*, 02/23/12, AZ Sup Pima No. C20091753. In June, 2012, after an 8 hour Daubert hearing, Dr. Peles was almost completely excluded from testifying at trial because his crush measurements were based on photographs, see *Ramirez v. Boode De La Hoya*, 06/01/12, AZ Sup Yuma No. S-1400-CV-201000121. A transcript is available for Ramirez case upon request to Dr. Immerman.

(*Note: Full text copies of all referenced expert reports and studies are available from Dr. Immerman at 602-368-9496 or aimmerman1@cox.net. Since 1997, Dr. Immerman has defense engineers in more than 700 cases, has testified in 71 Arizona Superior Court trials, been qualified more than 65 times as an expert in accident reconstruction and clinical biomechanics by Arizona judges, had his deposition taken 50 times and testified in 20 arbitrations. He has been licensed as a chiropractor in Arizona since 1980 and is a post-graduate faculty instructor in the Clinical Biomechanics of Whiplash Injuries at the Parker University of Health Sciences. Full CV available on request.)*