

Vehicle Crush Analysis with Laser Scanner

The Challenge

In the analysis of vehicle accidents, one of the most important sources of insight is the physical evidence left behind in the form of vehicle deformation, often referred to as “crush”. The amount and location of the damage to the vehicles exterior and interior provide the reconstruction expert with detailed data regarding the energy expended in the collision. This in turn can be used to calculate speeds at impact. When combined with braking evidence, critical data such as speed and location at onset of braking and when a hazard was first recognized can be determined.

The challenge in using this rich source of information is in how to measure the crush. Vehicles that have been involved in high speed impacts often have an irregular damage pattern due to the differential force applied during the impact and varying stiffness values of the affected parts of the vehicle. This issue is further compounded by the need for crush measurements at multiple locations and potentially multiple heights on the vehicle. As with all analysis techniques that rely on known factors and equations, error in the input measurements result in errors in the conclusions.

At PSI, we believe in minimizing error at each step of analysis –

Measurement, not Conjecture.

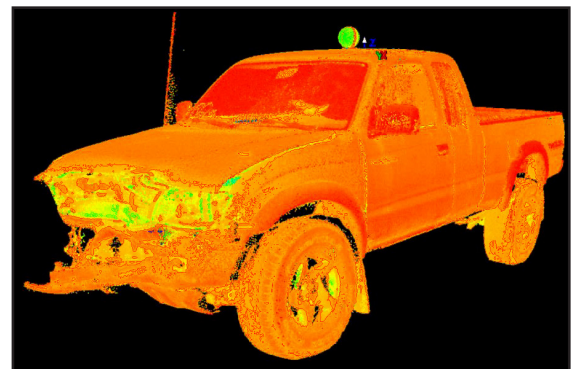


The Solution

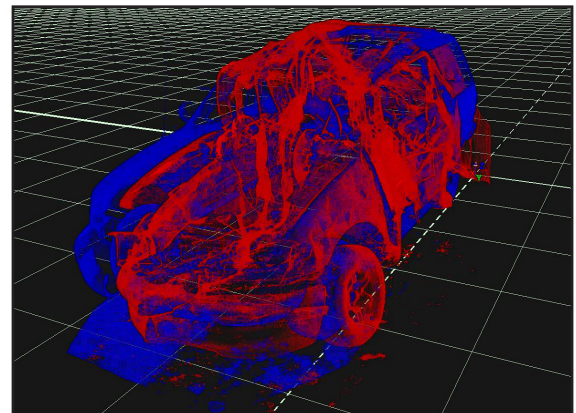
Typically, crush measurements were made by hand, using legacy tools such as plumb bobs and a series of rulers. Recently, pre-made jigs have been developed to assist the expert in the collection of this data. Although these methods can provide valuable data, it is tedious, prone to errors and is a “one-time” method – if additional data is desired at a later date, the analysis and vehicle inspection must be done again. Additionally, if the case makes it to trial, the presentation of this data before the jury lacks visual appeal and may seem outdated to a juror who has been raised on a steady diet of **CSI** and **48 Hours**.



PSI has developed an updated technique for capturing the data necessary to perform this pivotal analysis – Laser Scan Vehicle Documentation. Using our in-house 3D Laser Scanning system, PSI’s engineers can comprehensively document the vehicle’s exterior and interior using a laser accurate to within millimeters. A typical vehicle laser scan consists of 5 to 10 million individual measurements, each one performed automatically and bypassing the potential of human error. The density of this data results in a virtually solid, 3D model of every detail of the vehicle that is scanned, providing the ultimate accuracy and minimizing the error component at the most foundational step.



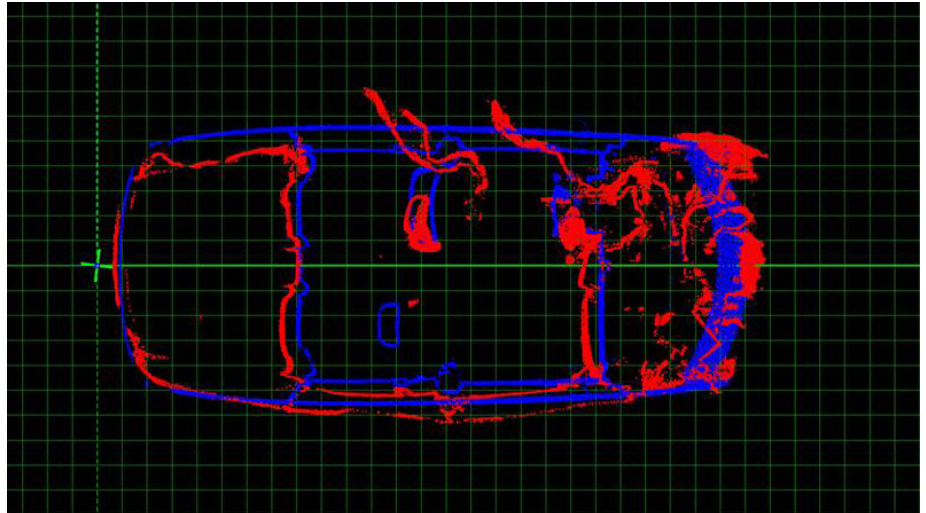
PSI’s method allows for simultaneous scanning of both the incident vehicle and an exemplar vehicle – an important step as the comparison of pre- and post-impact vehicles is what provides the necessary input for the analysis. Performing these steps at the same time is more efficient (cost effective) and allows for a side by side visual inspection to assure the exemplar vehicle is sufficiently similar and without unrelated damage that would confound the comparisons.



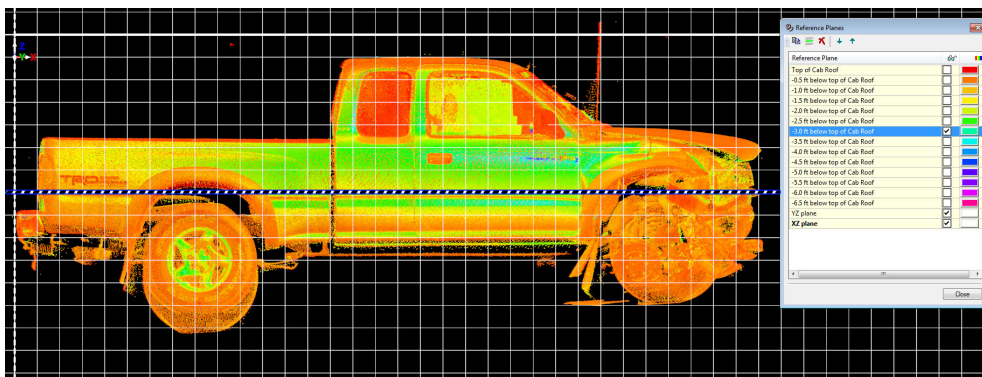
Crash Analysis

Due to the density of the laser data, the data itself provides an accurate 3D model of the vehicles, effectively providing a permanent database of the vehicles dimensions that can be accessed at any time without the need for additional visits. Because the data is in a computer based CAD format, the measurements that are typically taken by hand are now performed with the precision and accuracy afforded by the computer. Once in the computer, the exemplar and the incident vehicle are aligned to one another, allowing for the measurements for each to be taken at the exact same location, thereby minimizing error in the comparisons.

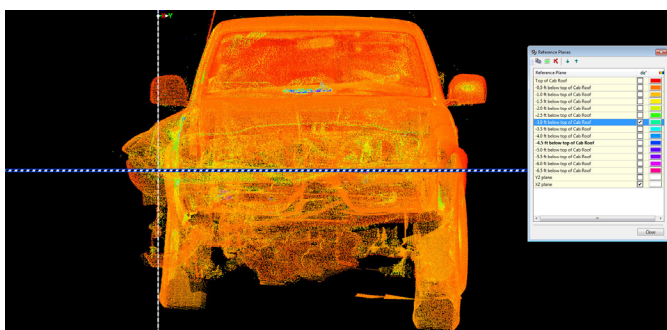
As the data forms a 3D model, it is visually intuitive, allowing for a clear-cut visual reference of the crush damage and the comparisons between the incident and exemplar. The data for the crush analysis can be taken at precisely specified locations. The vehicles are analyzed in slices, much as a CAT Scan or MRI in the medical field. This method allows the expert to precisely specify the locations for each slice.



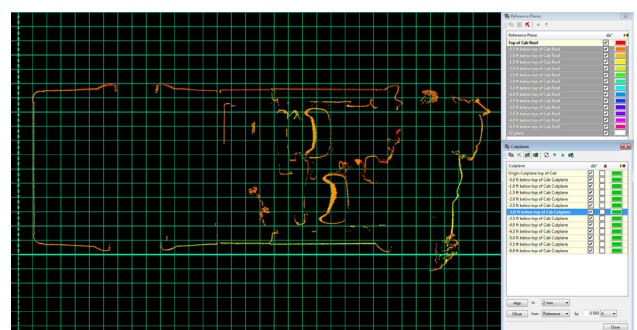
Exemplar & Incident Vehicle Aligned



Lateral 2D Slice Location



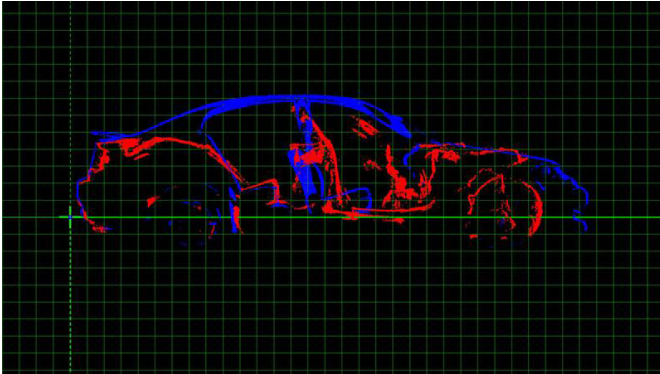
Longitudinal 2D Slice Location



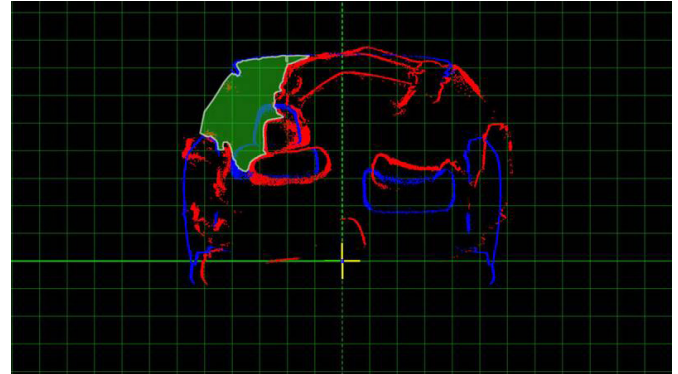
Resultant 2D Slice Cross-Section

The Data

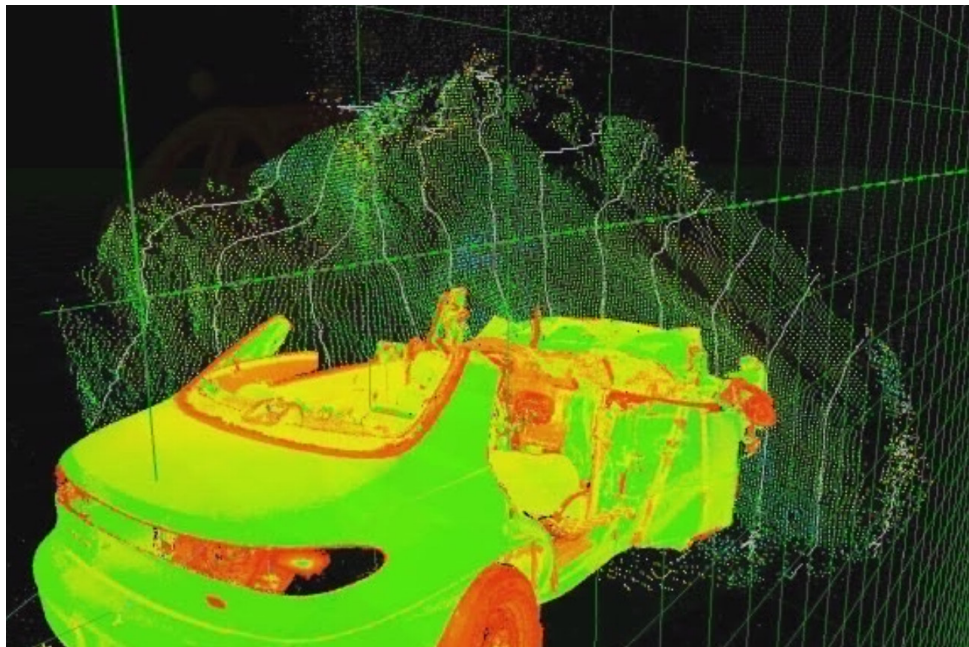
As the 2D slices come from a 3D model, the entire vehicle profile or plan is provided, as opposed to just data for individual points. If a specific point is desired for comparison, the 2D slices can be reduced to allow for this type of analysis. Any plane of reference can be analyzed and visualized for the jury – Lateral, Vertical, Longitudinal or even a Complex plane.



Lateral Cross-Section Comparison



Longitudinal Cross-Section Comparison



Complex Plane Cross-Section; Vehicle Impact with Rock Face

Crush Analysis benefits greatly from the use of today's advanced tools. The addition of 3D Laser Scanning provides:

- Higher level of accuracy
- More powerful and insightful analysis
- Compelling visual presentation before the jury