PSI PRECISION SIMULATIONS

DOCUMENT, ANALYZE, VISUALIZE;
TURN JURORS INTO WITNESSES

115 S. Church Street • Grass Valley, CA 95945 • (877) 339-7378 • info@precisionsim.com • precisionsim.com

A Case Study: Reconstruction of a Power Line Wire Strike Event

115 S. Church Street • Grass Valley, CA 95945 • (877) 339-7378 • info@precisionsim.com • precisionsim.com

Reconstruction of a Power Line Wire Strike Event

PSI pioneered the use of laser scanning in forensic analysis and was the first firm in the US to get laser scan data admitted into evidence in 1999. Then and now, PSI has used the technology in innovative ways to pursue the truth through forensic engineering excellence.

3D Laser Scanning has been a valuable tool for accident scene documentation, reconstruction and visualization since the late 1990s. As with all technology, laser scanning has evolved to become a more effective tool and much easier to operate since its invention. Current laser scanners capture data and measurements in 360 degrees in a single pass with upwards of one million points per second.

The subject of this case study however, occurred long before the advent of these new scanners. Using a CYRA scanner that was built close to a decade and a half ago, PSI had to capture data using the available 40-degree by 40-degree window, which required ten passes to complete a circle and approximately fifty passes to generate a useful full field panoramic model. Even with the limitations of the now old technology, PSI was able to successfully reconstruct a nearly fatal electrical wire strike event with sufficient fidelity to be admitted at trial.

The Scenario

A television news van operator and a news reporter, (the plaintiff in this case) were late arrivals to cover a public service event put on by the local police department. Upon arrival, the news van carrying the reporter has limited options for parking next to the other previously assembled television crews. In an attempt to get closer to the event they were covering, the driver of the van knowingly parks on the sidewalk, directly below clearly visible powerlines. As the reporter inside the van makes last minute preparations so she could begin covering the event, the driver of the van walks around to the back of the vehicle and begins raising the transmission antenna, a telescoping pole with a transmitter on top weighing approximately 400 pounds. The operator testified that she looked up, saw the power lines and determined that the antenna could be safely raised adjacent to the lines without striking them. The operator stated she watched the antenna rise for about 10 feet of its eventual 44 foot extension and visually confirms that the antenna will rise safely, walking away from the still ascending antenna to perform other tasks.

Unfortunately for the reporter inside the van, the antenna does make contact with the power lines, electrifying the van and quickly causing a short circuit. A small explosion ensues, catching the hydraulic fluid of the antenna on fire, filling the electrified van with acrid smoke and fumes. In an effort to escape from the van, the reporter opens the door, places a foot on the ground while still holding onto the van, thus completing the circuit. She suffers massive injuries requiring multiple amputations as the current flowed through her into the ground.

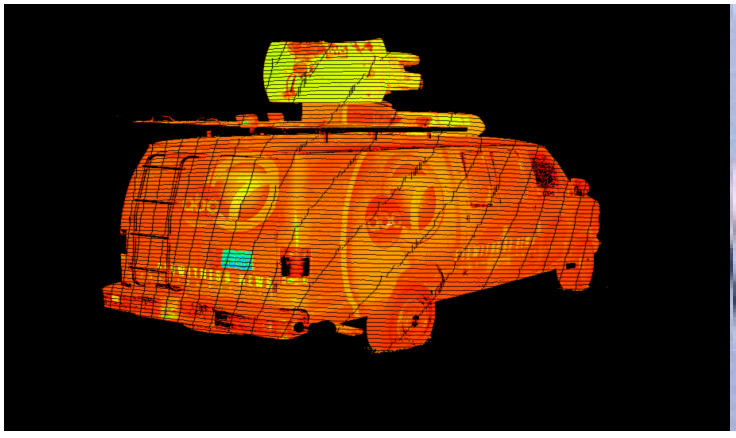
The Challenge

PSI was asked by the defense attorney to reconstruct the view the operator had of the power lines, with the intention of placing the viewer and trier of fact in in the operator's position and providing a simulation of the visual information that was available to the operator - warning against raising the antenna. In order to do this with sufficient fidelity for the court to allow the presentation of the animated reconstructed view to the jury, PSI had to reconstruct each aspect of the event and compare the results to the physical evidence, proving they were effectively the same.

In order to accomplish the reconstruction and validate the results, PSI needed to recreate each piece of the physical environment and evidence in 3D.

The accident scene itself

The actual news van used in the event. The van was stored near the event but could not be brought to the scene



As the actual van was irreparably damaged, an exemplar was used for portions of the analysis. This exemplar needed to be proven to be an exact replica of the actual van.

The actual antenna and transmission dish that showed visual evidence of the wire contact location and resultant burning.

The position and rotation within the scene of the van. As the van had both 3-axis of location (xyz) and 3 axis of rotation (xyz) due to being parked on an uneven surface, the precise location of the van within the scene was critical.

After creating these 3D models and assembling them in the proper relative locations, a “validation” check was required to visually prove the results matched the physical evidence precisely.

Photo of Incident Scene and Van

The Solution

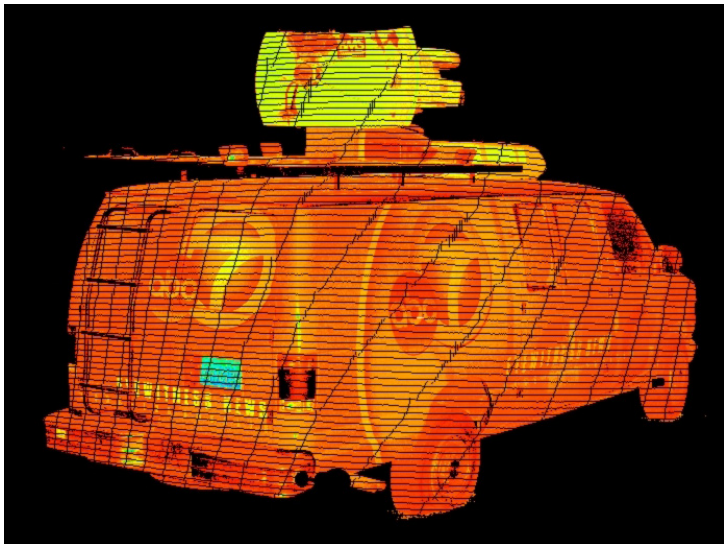
PSI used the new technology of 3D Laser Scanning to document the scene, for two particular reasons. The first is the typical reason – to create the most accurate 3D representation of the true environment as possible, in order to perform accurate reconstruction in the computer. The second, given the obvious danger of bringing a van to the actual scene and raising the antenna, the reconstruction could not occur on site. In addition, the power lines themselves were a critical aspect of the scene and could not be safely measured with any method that required we get near the lines or have direct contact with them. Once the laser scan was completed, PSI’s animators set about creating an accurate and visually realistic 3D model of the scene.

Photo of Scene

3D Model of Scene

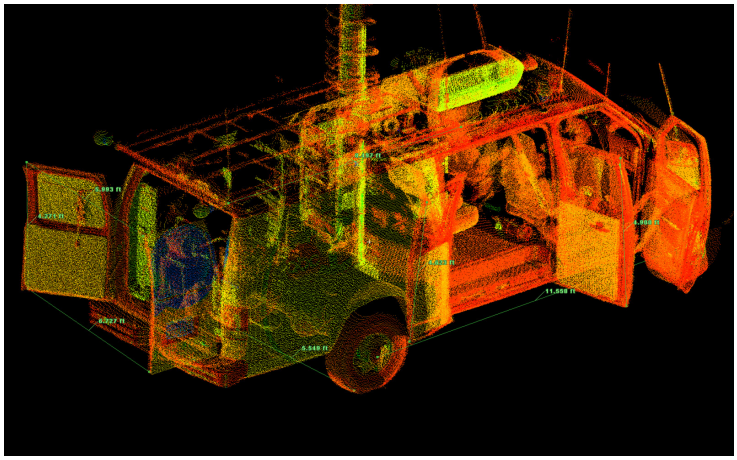
The next step was to document the damaged van involved in the event.

This vehicle was laser scanned for dimensions of the vehicle itself, as the telescoping antenna boom was no longer operational and could not be raised to scan it in its extended position.

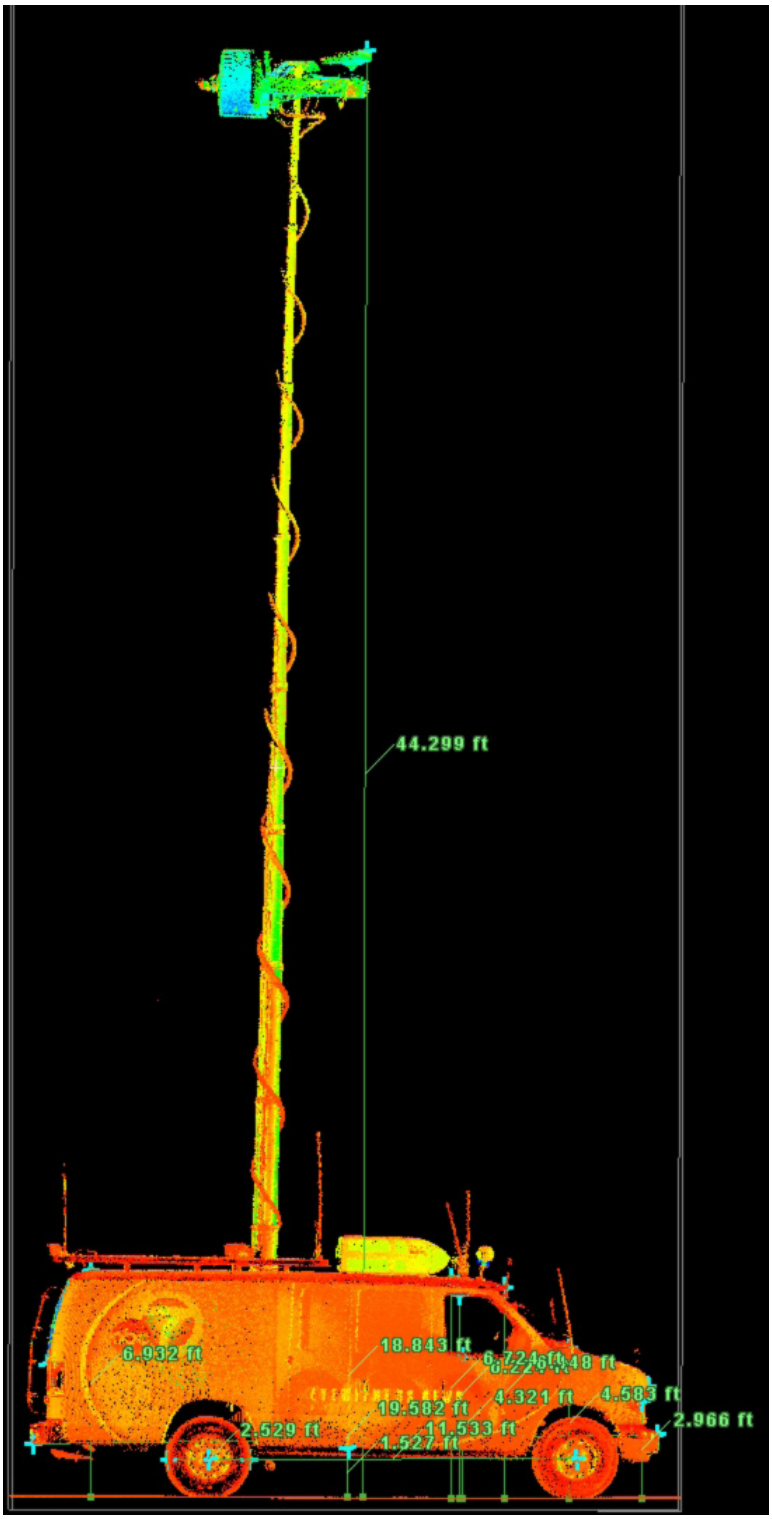


Laser Scan of Van

In order to document the extended telescopic antenna, an exemplar vehicle with a functional boom was used. We extended the antenna to its full height and laser scanned it in this configuration. In addition, since the exemplar van had an intact interior, it was laser scanned as well.

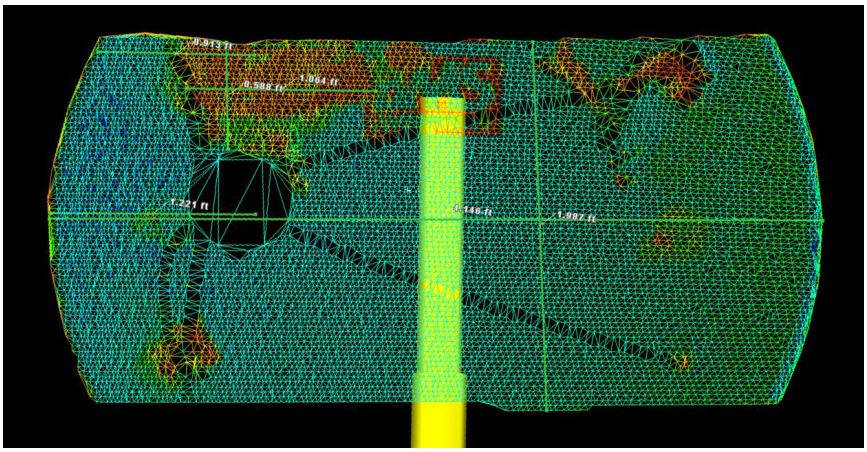


Laser Scan of Van with Interior



Laser Scan of Van with Telescoping Antenna

The actual antenna that contacted the wires was available for inspection. Alongside the electrical engineering expert, PSI laser scanned the antenna, paying particular attention to capturing the evidence of damage that illustrated where on the large antenna the wire contacted.



Laser Scan of Burned Antenna

From this three-part scan of the incident and exemplar vans, PSI's animators combined the data to create an accurate and realistic 3D model of the van in its incident condition.

3D Model of News Van

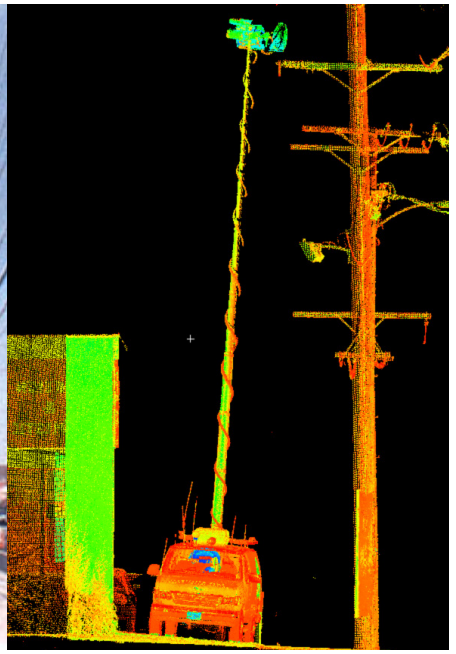
3D Model of News Van with Interior

With the 3D models completed, PSI moved to the task of positioning the van and antenna on the varied surface of the sidewalk as it was at the time of the incident. This step was critical as any errors here in the angle of the van on the uneven surface would be magnified when the antenna was raised over 40 feet above the ground. If the wire that was struck did not line up with the strike mark on the antenna dish itself, this would invalidate the reconstruction and ensure it would never be shown to the jury. Video footage and photos of the van in its incident location provided the foundational data for its event location.

3D Laser Assisted Photogrammetry

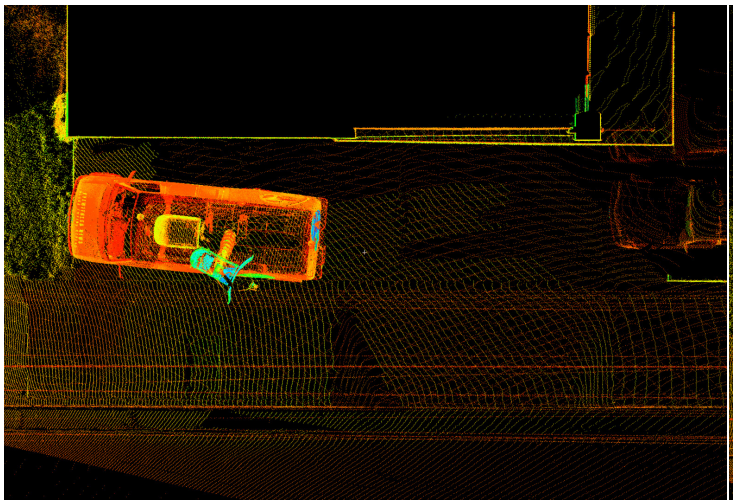
PSI then used a technique pioneered in our offices in 1999; “Laser-assisted Photogrammetry”. This process allows PSI to use photos of the event in conjunction with the thousands of measurements taken by the scanner (today this would be many millions) to replicate the camera location and field of view when the photo was originally taken. PSI then “viewed” the 3D scene from this same perspective, introduced the laser scan-derived 3D model of the van into the computer generated scene and moved it along the virtual sidewalk until it aligned with its location in the photos. When the process was completed, the location of the van was derived and a visual reference for the quality of the match is generated.

Photo from Incident Scene

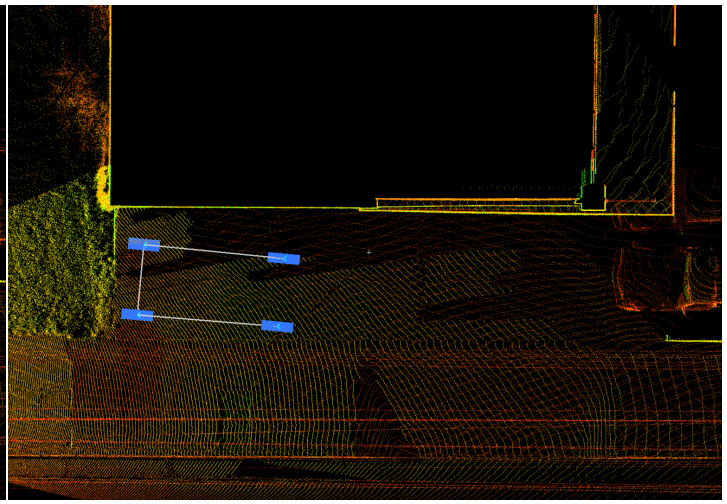


3D Laser Scan with Van Added

Given the angle of the van parked on the uneven sidewalk, and therefore the angle at which the antenna would be raised, and the 400 pound weight of the transmission dish, it was unknown if the telescopic pole would bend when raised to full height at this angle. In order to maintain the required fidelity, this also needed to be tested and documented. Once PSI had accurately positioned the 3D van on the 3D sidewalk, PSI extracted the relative heights of each van tire as parked and rotated on the uneven sidewalk surface.



Top Down Perspective of Laser Scan with Van Added



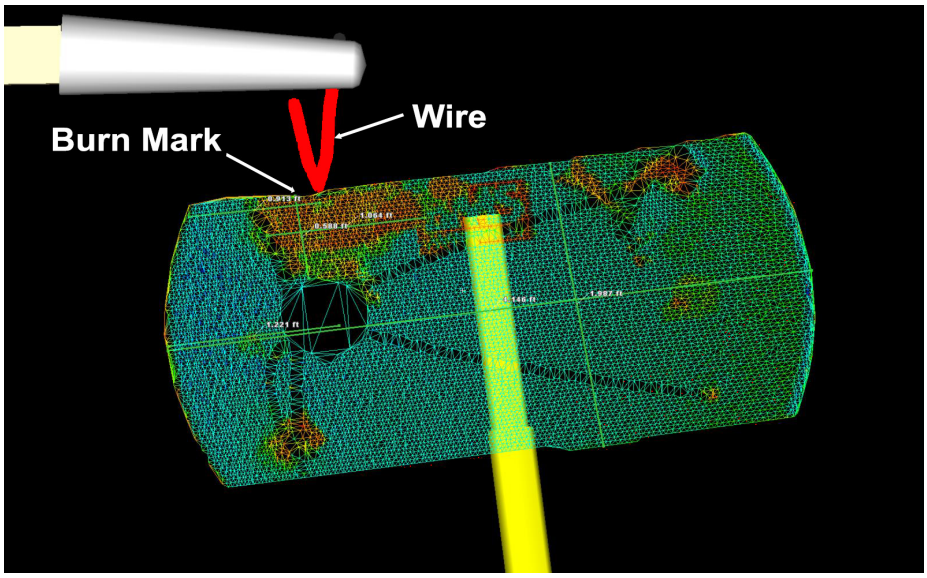
Top Down Perspective of Laser Scan withTire Location Added

We realized that if we could park the exemplar van offsite such that the four tire contact patches were at the same relative height as the incident van's, then we could raise the antenna and scan it a second time on this angled slope and compare the data when it was raised on flat ground. Any difference in the two would be "bend" in the telescoping pole sections as they were raised and carrying the full weight of the antenna. This difference would be an unaccounted error if not measured, again resulting in a lack of fidelity of the final reconstruction. After performing the analysis, it was determined that there was an additional 1.2 feet of lateral bend in the telescopic pole that the antenna was mounted on - in the direction of the power lines. This bend was in addition to the lateral translation of the dish imparted by the angle of the van as the antennae was raised.

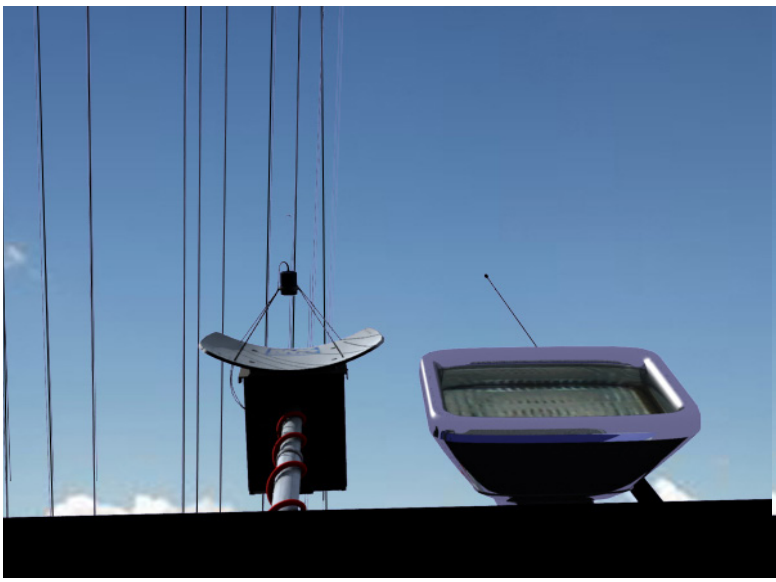
With this detail in place, PSI was ready to perform the final validation check. The 3D model of the van with the extended and bent telescopic pole and antenna was placed into the 3D model of the scene at the previously derived location on the sidewalk. We then zoomed into the area in the virtual accident scene where the dish and power lines were focused to see whether the antenna struck a wire; whether it struck the correct wire in the set, and whether this specific wire made contact with the antenna in the place determined to be the contact point by the electrical engineering expert. Three years after the fact, without benefit of having the van and the scene together in the "real world" at any point during the analysis, PSI's 3D reconstruction based upon then revolutionary 3D laser scanning and laser-assisted photogrammetry was shown to be accurate within an inch!

Photo with Elevated Wheels and Laser Scan Showing Antenna Bend

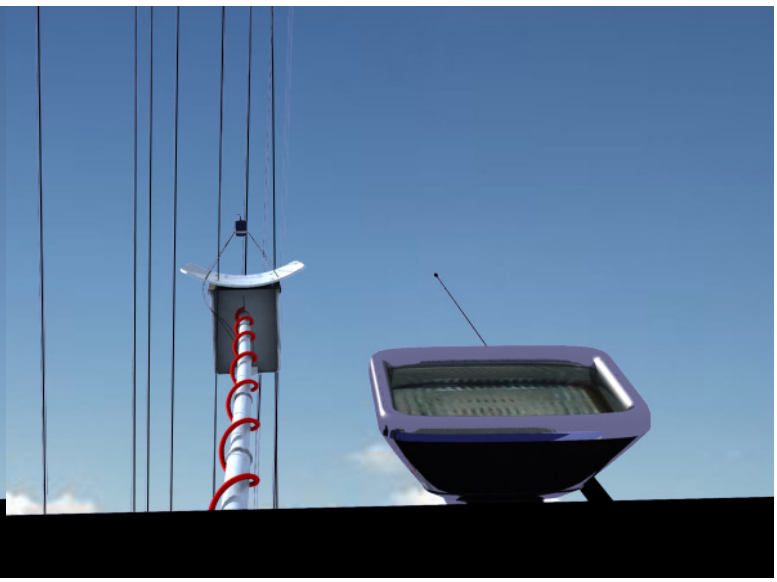
After PSI had a validated 3D reconstruction, the final task was to place the viewer in the antenna operator's location in the scene. We then animated the view of the operator looking up to watch the antenna rise from its initial location, up to the 10 feet of extension the operator stated she viewed and decided that it was safe before leaving the antenna to continue rising unattended. This view provided the visual evidence available to the operator at the time of the incident. It allowed the viewer to make their own determination if the decision to raise the antenna below known overhead power lines and further to leave it unattended as it continued to rise towards those lines, was reasonable or foreseeably likely to result in catastrophe.



Laser Scan Data Showing Wire and Burn Mark Alignment on Antenna Showing Less than One Inch of Deviation



From 3D Animation; Operator's Point of View Antenna Rising



From 3D Animation; Operator's Point of View Antenna Touching Power Line

Gallery

Photo of Actual Wire Strike Explosion

Photo of Actual Wire Strike Explosion

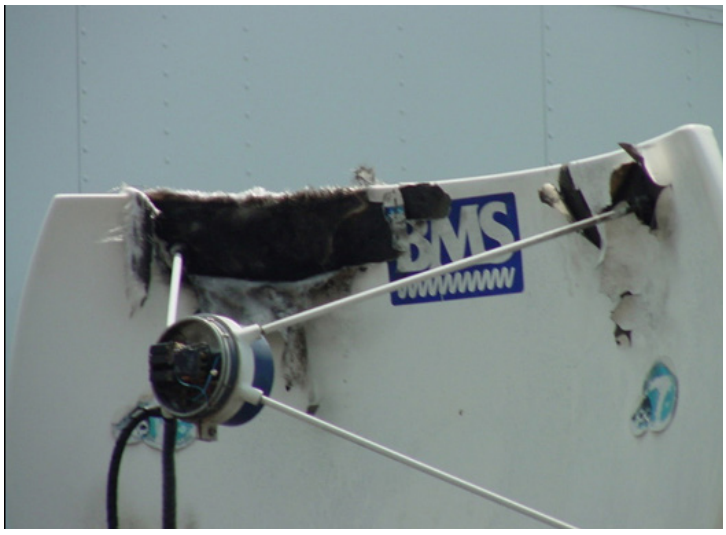
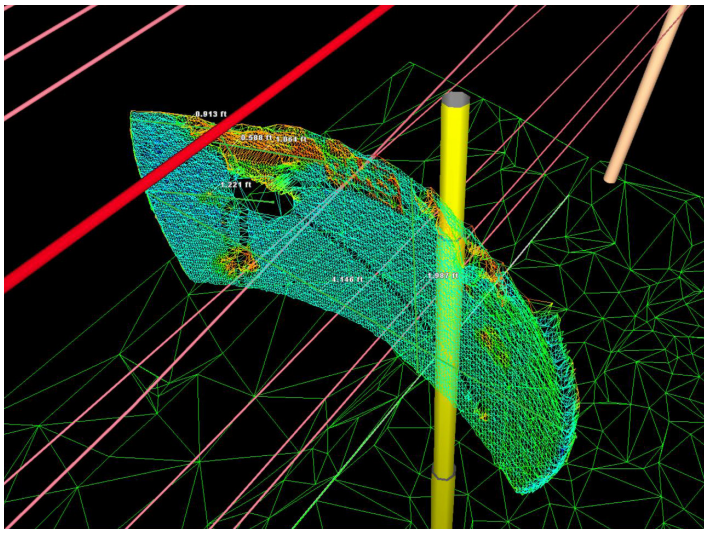
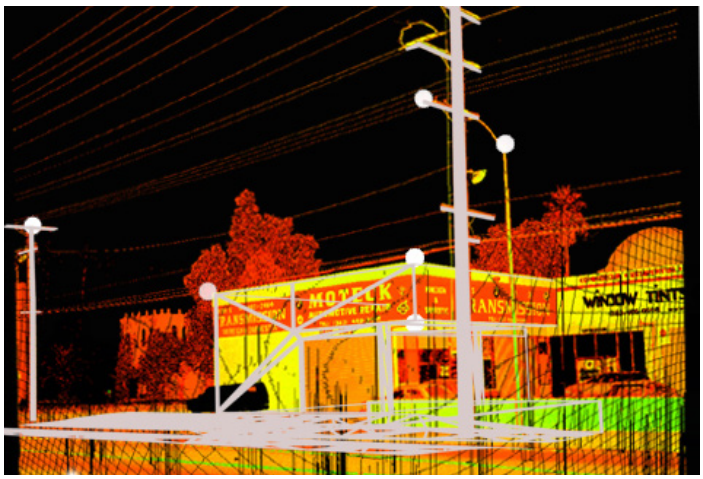


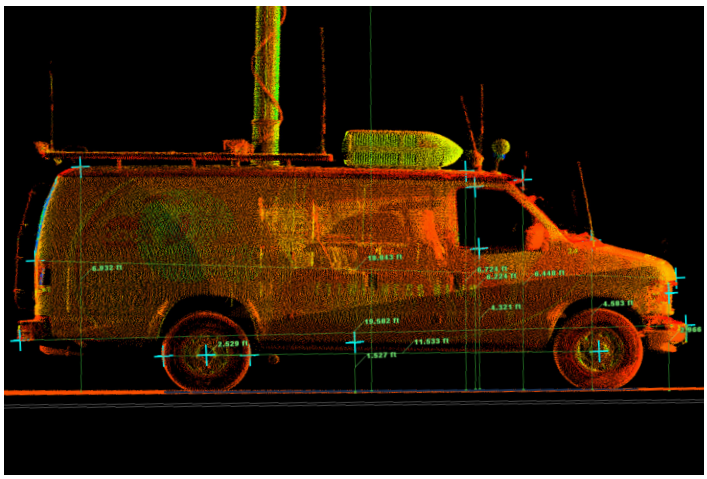
Photo of Burned Antenna



3D Laser Scan of Antenna and Power Line

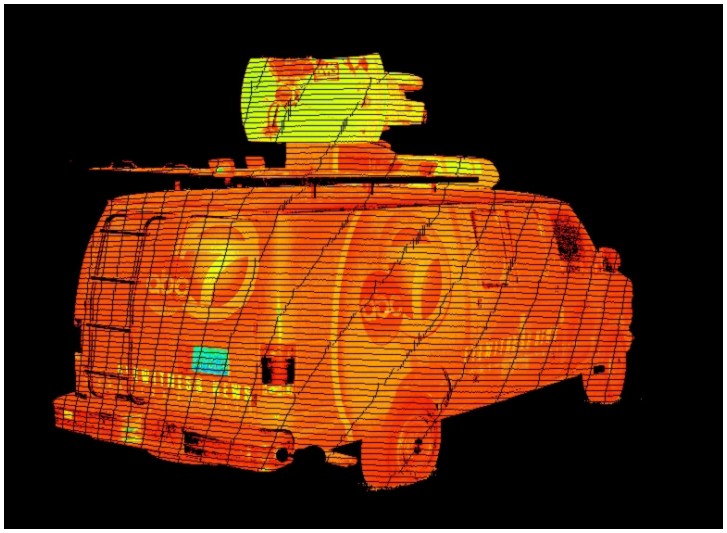


3D Laser Scan of Scene

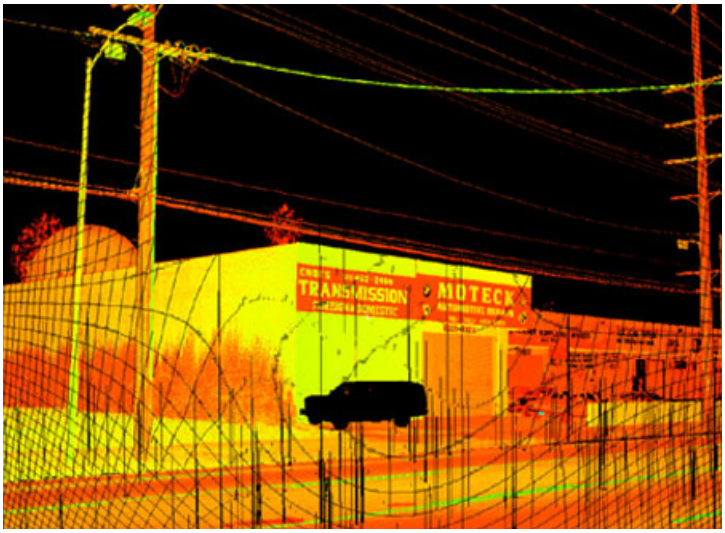


3D Laser Scan of Van with Measurements

Gallery

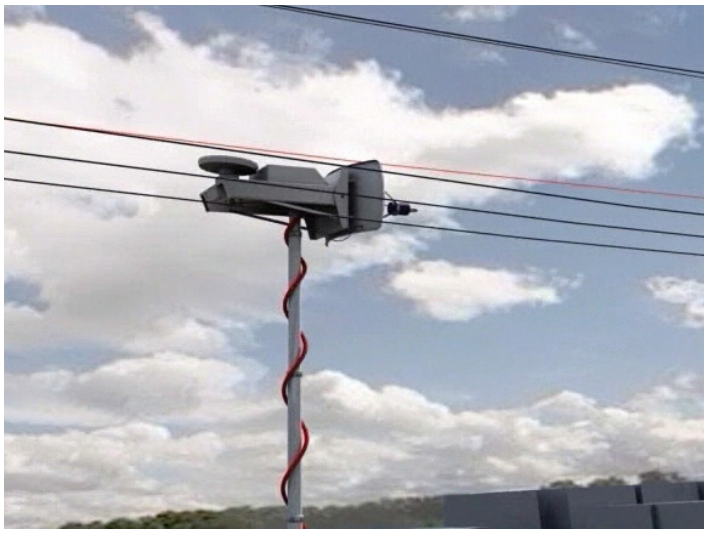


3D Laser Scan of Van



3D Laser Scan of Scene

3D Model of Scene with Van



3D Model of Antenna

Laser Scanner with Exemplar Van

3D Model of Van