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 Construction Accidents

Reconstruction of Construction Accidents

Using 3D Computer Simulations and Analytical techniques to accurately reconstruct and illustrate an event.

The Challenge

How to develop an accurate reconstruction of a construction workplace injury when the scene has been completely changed.

The Solution

Reconstruction of accidents that occurred during construction of a project present a unique challenge. By their very nature, construction sites change dramatically over time.

Using 3D laser scanning, and laser-assisted photogrammetry with a proprietary analytical software system, PSI can accurately build a computer generated working model of the scene as it actually appeared during the accident.

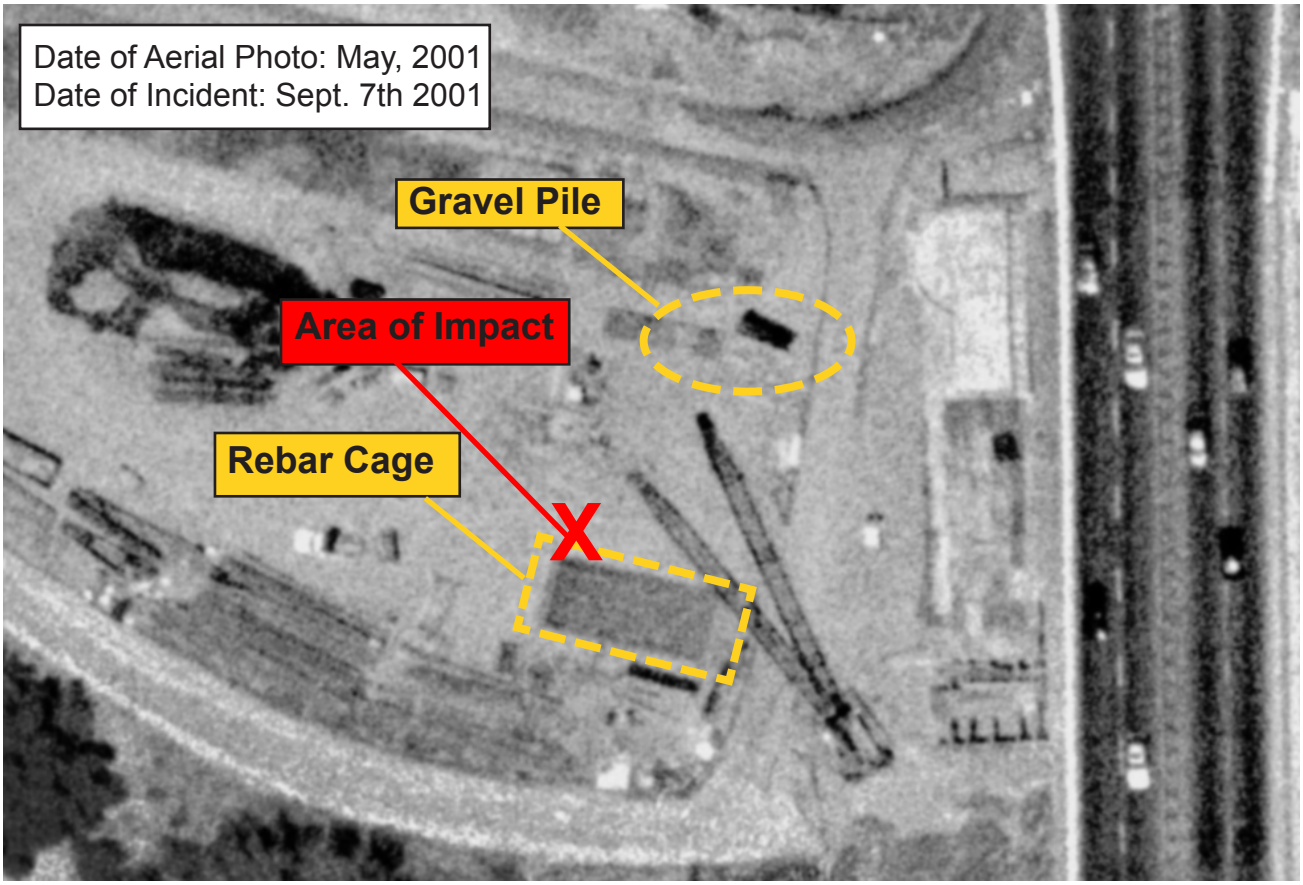
PSI Case Example

Scenario

A construction worker is preparing a large re-bar cage to be lifted into place. Behind the worker a front loader operator is moving a large pile of aggregate from one place to another. The operator backs up the front loader crushing the construction worker. The several witnesses to the accident offered conflicting testimony.

Many photos were taken after the accident. However, the construction site has been significantly changed. The photos may not be useful if there are no remaining reference points at the original scene. The front loader is available and an aerial photo of the construction site taken four months before the accident is also available. The construction worker was seriously injured but is alive, and the front loader operator is available for deposition.

Incident Site Overview



Questions

The attorney for the defense needed to know:

1. Could the operator of the front loader see the construction worker as he backed up?
2. Could the construction worker see or hear the front loader backing up?
3. Who was at fault? Was there shared responsibility?

Visual Comparison Between Front Loader and Construction Worker

Front Loader	Construction Worker
Height: 14.7'	*Height: 5'9"*
Weight: 20 Tons	*Weight: 200lbs*
Bright Yellow	*Green Helmet*
Warning Lights	*Dark Pants*
Reflective Marker	*NO ORANGE VEST*
Backup Alarm	

Reconstruction Needed

To determine what was available to be seen by the operator and the injured worker, the construction site had to be reconstructed as it existed when the accident occurred.

The true dimensions and location of the re-bar cage also had to be determined with sufficient foundation to be admissible.

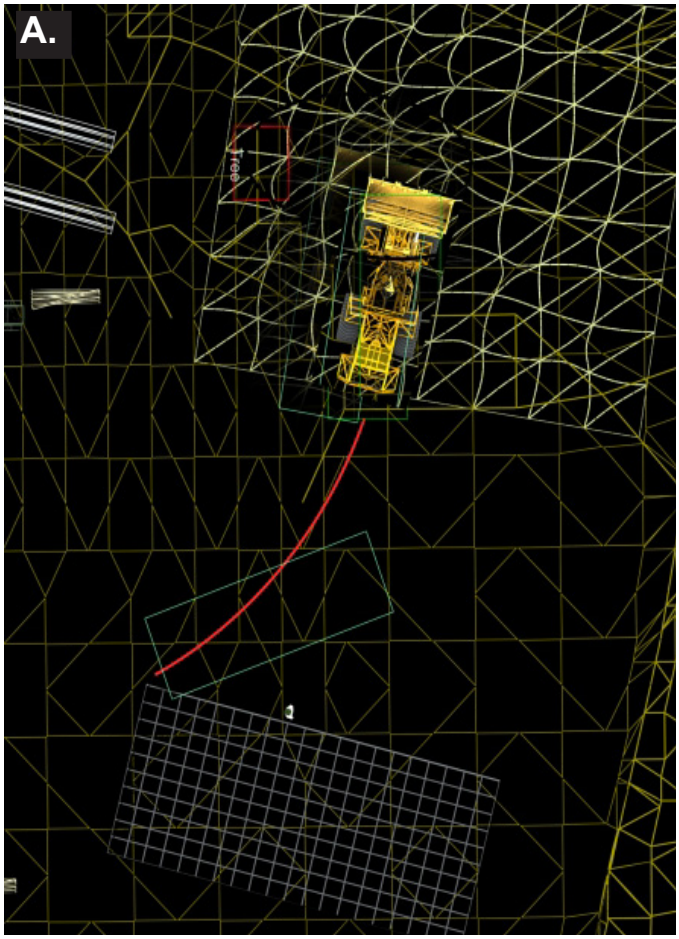
The 3D Working Model

PSI first laser scanned the construction site to develop an accurate working model of the current site including the adjacent houses. Forensics USA was able to obtain an aerial photograph which included the construction site four months before the accident occurred.

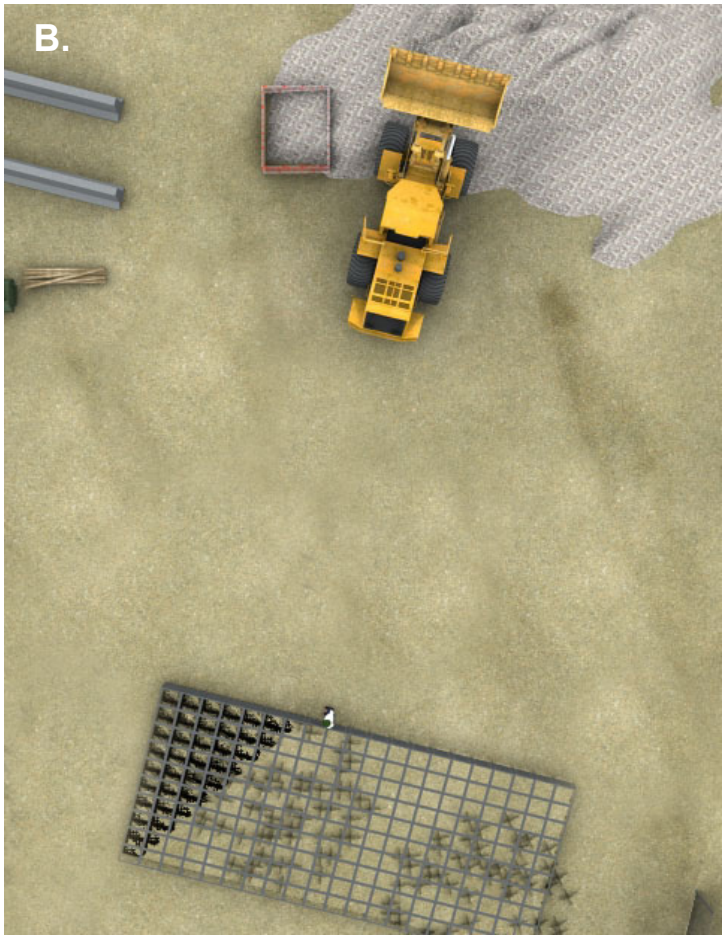
Using photogrammetry and proprietary software, PSI was able to determine the dimensions and location of the re-bar cage and the gravel pit, and place them into the working model.

PSI laser scanned the front loader, created an accurate 3D model and placed it into the working model. The front loader operator was laser scanned sitting in the front loader, which provided the correct eye position for the working model.

The path the injured worker walked just before he was crushed was described by eyewitnesses and placed in the working model as well.



A = Computer generated 3D "wire frame" of incident site.



B = Shaded and textured 3D model of incident site.

The Tools

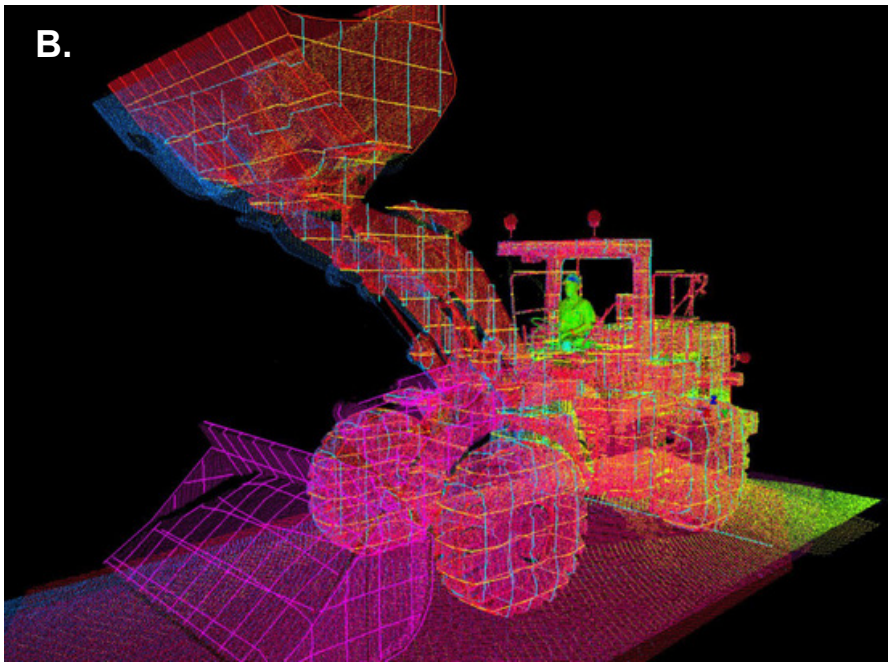
3D Laser Scanner

A 3D laser scanner is an advanced type of survey instrument that is used to remotely measure surface geometry of sites and structures with extraordinary completeness, accuracy and speed.

Unlike traditional surveying tools that are used to record certain, selected points within a scene, a 3D laser scanner automatically blankets the scene with millions of closely spaced point measurements.

A typical scan may take 5 to 20 minutes; scans are usually done from several different vantage points in order to capture geometry for the entire scene or structure.

The front loader operator was laser scanned sitting in the front loader, which provided the correct eye position for the working model



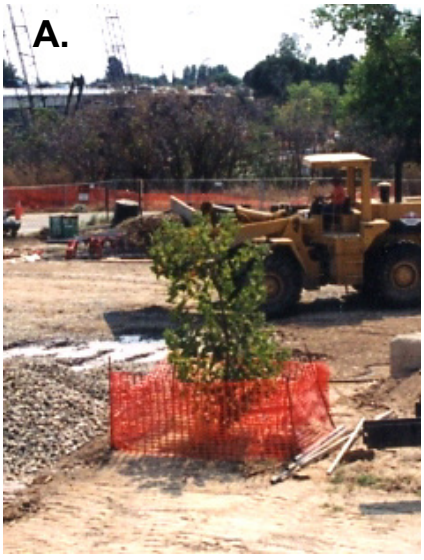
A =Subject Front Loader Positioned for Laser Scan

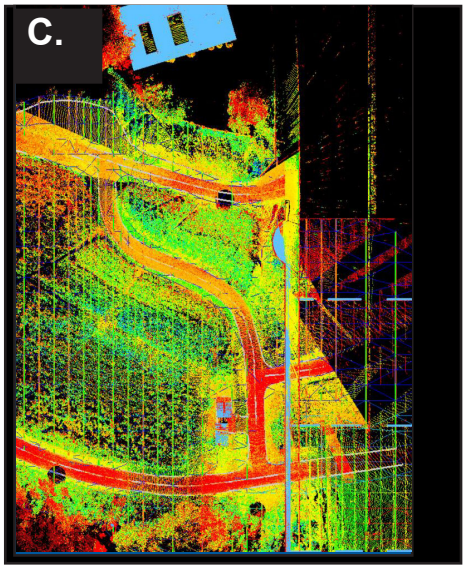
B =Laser Scan Data 'Point Cloud"

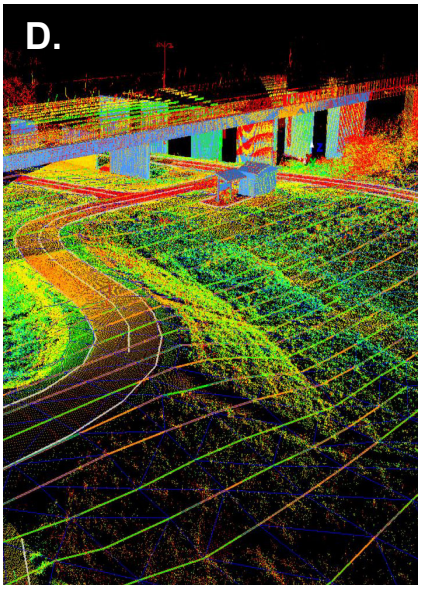
C =3-D Computer Model Created From Laser Scan Data

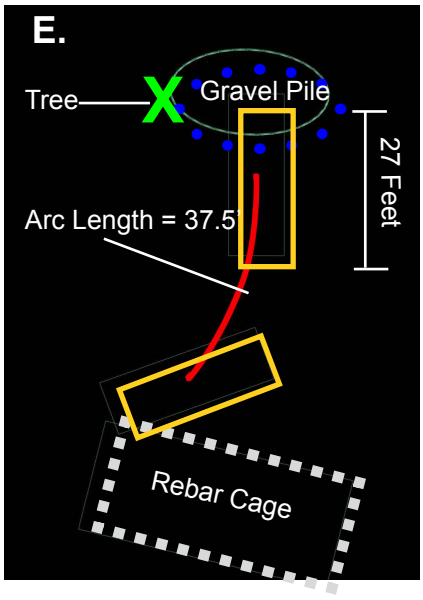
Laser Assisted Photogrammetry

PSI obtained an aerial photo of the site taken months before the accident. Using this information, combined with photos taken on the day of the accident, PSI was able to reconstruct (using photogrammetry) the site as it existed the day of the accident and place this into the computer based working model.









A = Photo of Tree at Day of Incident

B = Aerial Photo of Same Tree a Month Before Incident

C = Laser Scan Point Cloud of Incident Site - Top Down View

D = Laser Scan Point Cloud of Incident Site - Ground View

E = CAD Data Derived from Photogrammetry Based on Position of Tree in Aerial Photograph (see B)

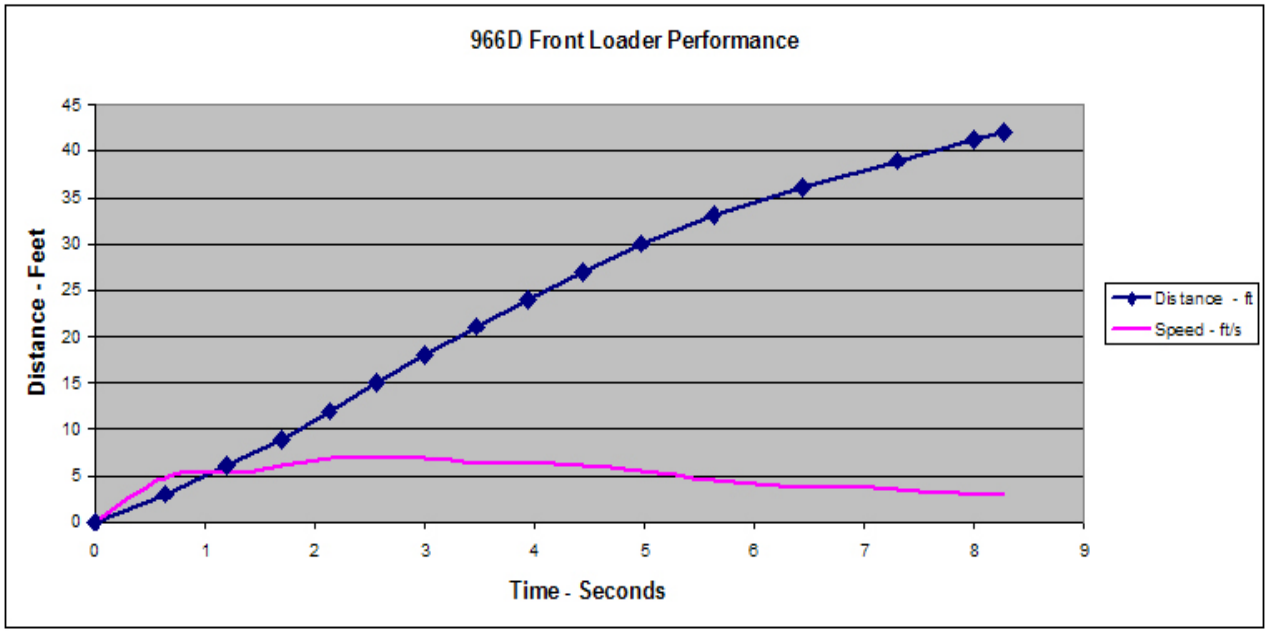
Using the Data

Using the accurate data derived from the 3D laser coupled with advanced least-squares algorithms and the detail available in a photograph, important features from a photograph (see Box B) (even those now missing from the physical scene) can be placed within a computer-generated working model of a crime accident or fire scene. The accuracy of the measurements available from laser-assisted photogrammetry provide not only the necessary foundation for a valid reconstruction, but also a very realistic, detailed and compelling animation of the fire, crime or accident scene.

Off-Site Reconstruction

Once the placement of the important objects had been determined with photogrammetry, an exemplar site was created in an open field, with each object placed in the correct position. This allowed the expert and PSI to visualize the accident site, giving everyone involved their first view of the scene as it was at the time of the accident.

In addition to visualizing the scene, the exemplar site allowed PSI to perform tests on the performance capabilities of the front loader, in a functionally similar environment. Two video cameras were set up, along with a surveyed measurement grid, and the front loader was operated in the exemplar scene. Speed, acceleration and path of the front loader was recorded and analyzed frame-by-frame and then placed into the working model.



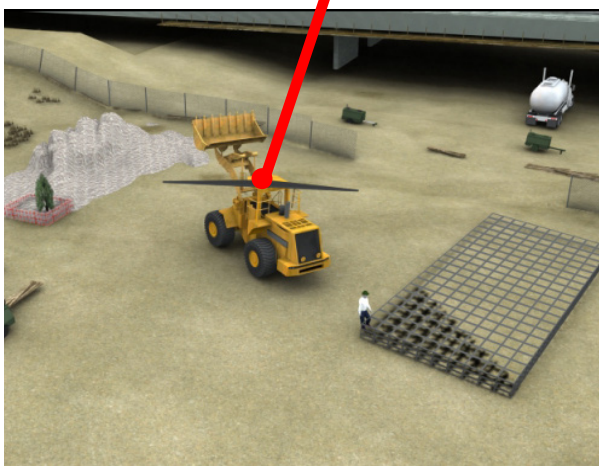
Visibility Analysis

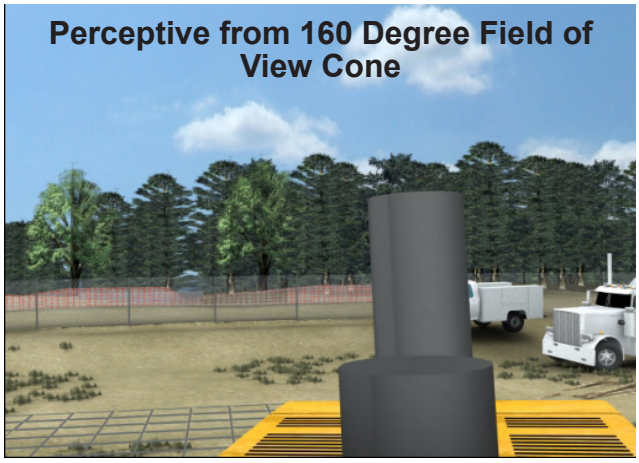
The speed, acceleration and path of the front loader as determined by the off-site reconstruction was placed into the working model. The animator and expert jointly developed an accurate “human head and eye jig” and applied the head turning movments as described in testimony. The result was an accurate, time-synchronized reconstruction of the front loader operators’ view. The expert-determined 160 degree field of view (FOV) was used to evaluate the operators viewpoint.

The working model could now be used to simulate what the front loader operator could actually see as he turned his head left and right whle he backed up the front-loader.

The final information needed was the location of the construction worker when the front loader backed-up. Based on eye witness testimony and the off-site reconstruction, the expert determined the construction worker’s path and speed (4.4 feet per second).

160 Degree Field of View Cone

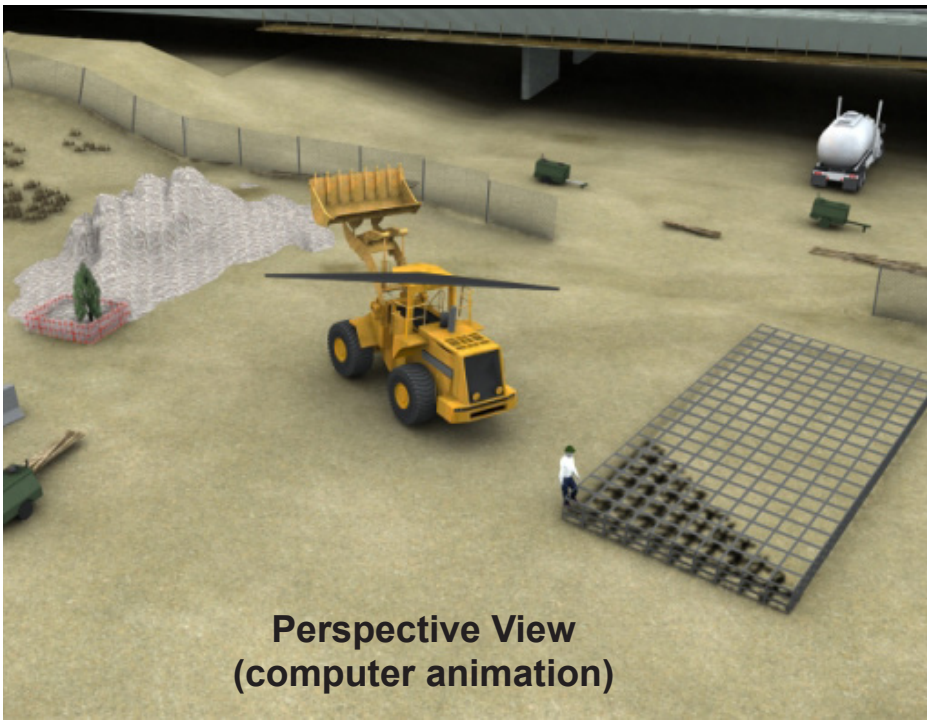




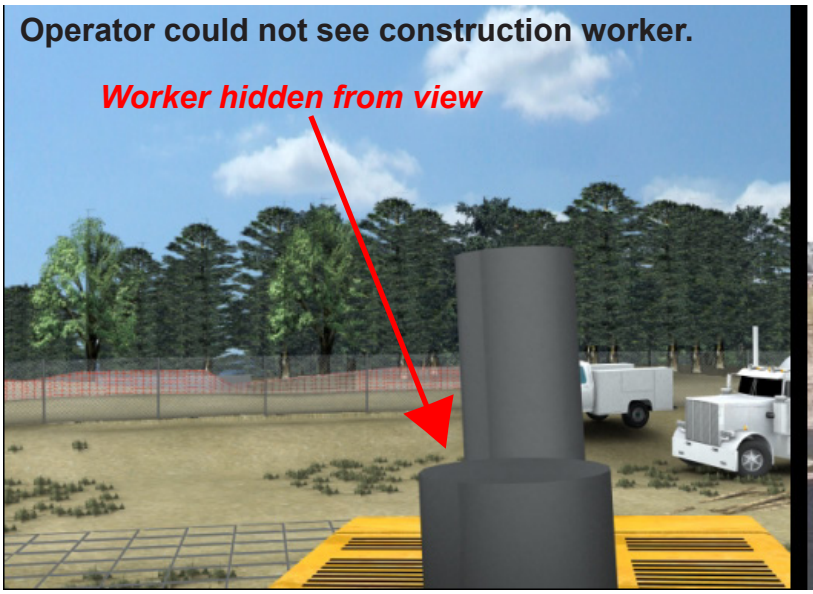
With the addition of the expert’s calculated walking speed for the construction worker of 4.4 ft/sec, the working model was complete and ready for analysis of the relative visibility conditions each participant was faced with.

Animation Analysis

2.8 SECONDS 10 FT



2.8 SECONDS 10 FT



Front Loader Operator's View
(computer animation)

Area of Impact View
(video footage)

The compelling animation of the front-end loader back up took eight (8) seconds and was accompanied by the loud sound of it's backup horn.

Conclusion

Once the working model was completed, the expert then used it to determine what the operator could see when he began to back-up the front-loader. Using 4.4 FPS as the walking speed of the construction worker the computer animation clearly showed that the operator could not see the construction worker at any time during the movment of the front loader. The stack located in the rear of the loader blocked his view.

The combination of the blocked view of the operator, combined with the construction worker's failure to react to the very large front loader's size and noise as it traveled toward him.

In mediation the plaintiff, who never admitted to any comparative negligence by way of Requests for Admissions, lowered their demand in excess of one third of their pre-mediation demand. In this case, the defendants saved in excess of $2.3 million dollars.

The working model provided the defense attorney a defensible position and two strong animations of the accident, for a cost substantially less than the cost of an actual simulation on site, even if such a simulation would have been possible.

Client Comment

"Very persuasive... breathes life into complex facts and demonstrates not only what happened, but just as important what did not or could not have happened."

-- Howard Churchill, Esq.
Dale, Braden & Hinchcliffe, Pleasant Hill, CA