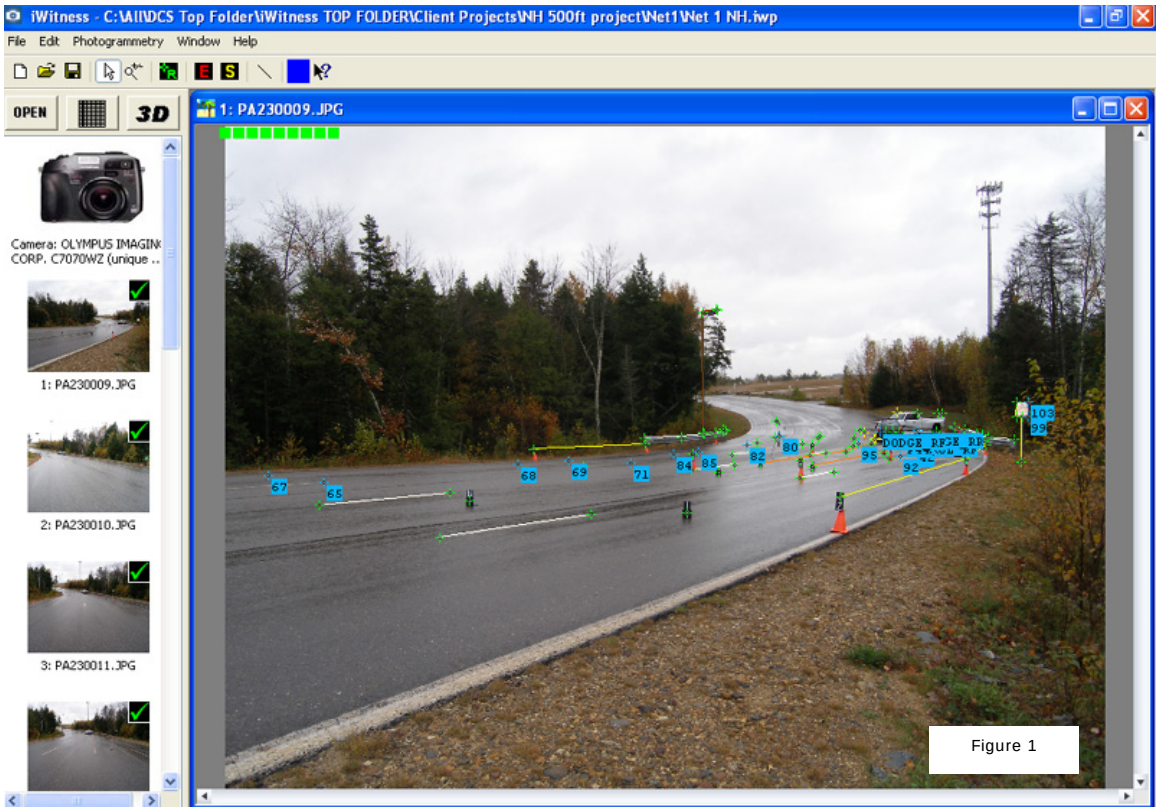
iWitness maps traffic accident scenes over distances of several hundred feet

Background:
In October 2005, the New Hampshire State Patrol (NHSP) teamed with DeChant Consulting Services - DCS Inc to conduct a photogrammetric survey of a staged traffic accident event on a section of a five-lane access road at the New Hampshire International Speedway (NHIS). The photogrammetric processing was performed using the *iWitness* software system - (www.iwitnessphoto.com).

This survey was carried out as a component of a broader DCS training program for the Traffic Accident Reconstruction Unit (TAR) of the NHSP, who are implementing iWitness on a statewide basis for image-based mapping of fatal traffic accidents and in support of other law enforcement investigations.

The Survey:
The staged accident scene was over 500' (152m) long. Troopers from the NHSP staged three vehicles where simulated road markings (i.e. tire yaw and skid marks), were mapped on the roadway, including all road geometry. The roadway was curved, with significant changes in gradient, thus presenting a good example of the image-based mapping of complex three-dimensional (3D) geometry over long distances. Signage, a streetlight, two shoulder barriers, centerline paint marks, paint line road edges and vehicle positions were all imaged, and later mapped in iWitness. Shown in Figure 1 is the layout of the accident scene, though note that the photogrammetric markers cover only a portion of the full extent of the section of roadway. These are moved and reused as the photography progresses from one end to the other.

Figure 1: *Network 1 section of roadway showing the DCS Reference Point Markers (RPM's), two of three vehicle final rest positions, and photo-grammetric natural feature marking.*



The camera used for the mapping was a 7.1-mega pixel Olympus C-7070 consumer-grade digital camera. This camera yielded 3D positioning accuracy of measured features to better than 0.1' over the full 500'-long array object points of interest. The camera was previously metrically calibrated via a fully automatic calibration process available in iWitness.

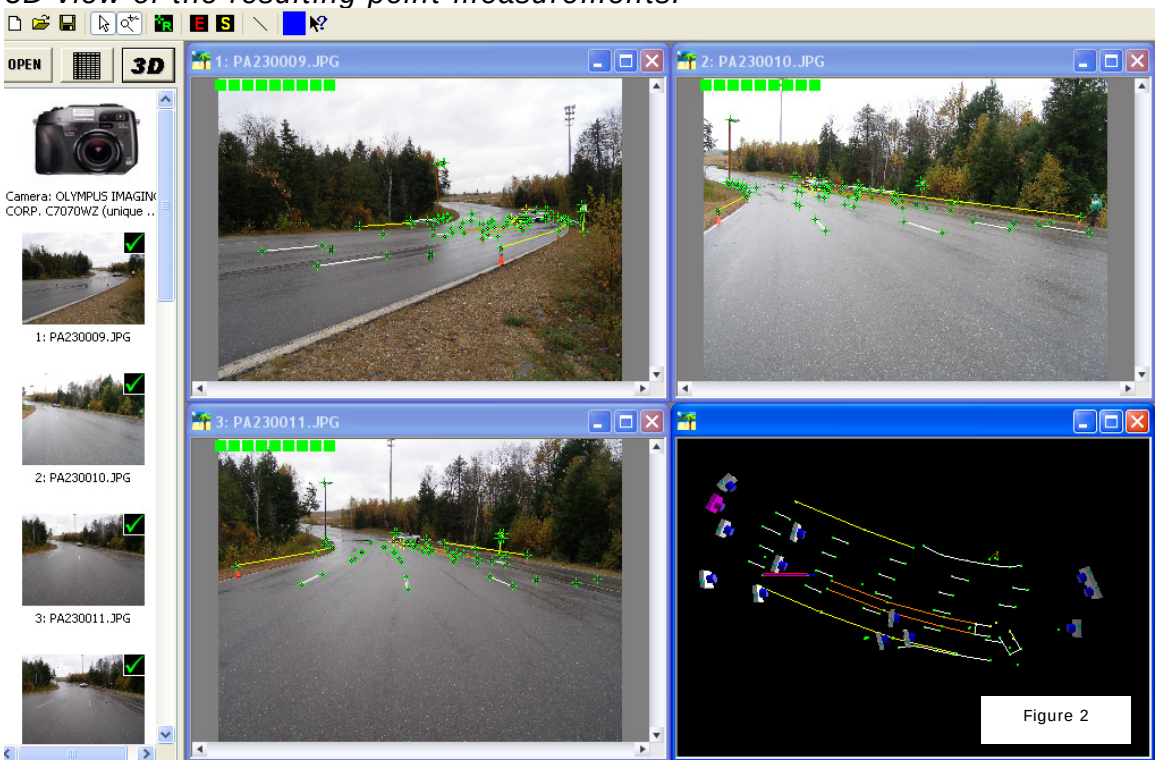
The purpose of measuring this scene was to test the capabilities of photogrammetric 'network stitching' available within the iWitness software system. For the sake of brevity, only the 3D transformation to control method available in iWitness will be discussed in this report. The 3D control points used in this project were intentionally not 'pre-planned', and were later determined for use after the test scene was imaged. Six photogrammetric scaling distances were obtained, and approximately 40 digital images were acquired. Scaling distances were used in all three networks, however this was not a requirement of iWitness, but rather a means to ensure some additional 'check distances' were present in order to verify the project accuracy.

The survey was split into 3 overlapping networks of images, each network covering approximately 175' (53m). The scene was entirely imaged in less than an hour, which included the time necessary to place the RPM's (markers) in the desired locations. On the day of the photogrammetric survey, it was rainy and cold at the NHIS track. The miserable weather conditions were actually ideal for illustrating the capabilities of iWitness and the digital camera for incident scene 3D mapping in inclement weather.

Measurement Analysis:
Three network sub-folders named Net 1, Net 2, Net 3 were created and the applicable images were organized for measurement. Each network was started using two images with strong angles of convergence, and then additional images were referenced in iWitness to produce the 3D object points. iWitness automatically labels the third and subsequent 3D point locations and the user simply pushes a button on the keyboard, and is 'driven to' the location to either mark the target with the cursor or, optionally, invoke the automatic target centroiding capabilities for measurement of target dots (i.e. DCS photogrammetric RPM markers in this case). The image marking process is highly automated and fast to accomplish. The 3D object points are generated in a completely transparent manner for the user.

iWitness is the only close-range photogrammetric software program that allows such automation and fully automatic on-line photogrammetric bundle triangulation. Shown in Figure 2 is the user interface for iWitness.

Figure 2: *iWitness user interface showing three referenced images and the 3D view of the resulting point measurements.*



The control points that were eventually used were a combination of natural features (points on the vehicles), and some DCS photogrammetric RPM markers: www.photomeasure.com/rpms.html. iWitness accurately "stitches" its combined photogrammetric networks with an easy-to-use interface to link the independent coordinate systems into one common 3D coordinate system that allows coordinate export to CAD. In this survey/test example, the CAD diagramming program used with iWitness was the Crash Zone by The CAD Zone Inc. A quantity of two hundred and sixty one 3D object points were

generated from the images measured in iWitness. Point offsetting in the Z-Axis was also used in iWitness, so that all points measured were representative of the road surface geometry, and vehicle heights accounted for the changing gradient of the road. Point offsetting in iWitness was designed specifically for accident reconstruction mapping, so that all coordinates can easily be projected to accurately represent the 3D geometry in CAD views. It took approximately 3 hours to conduct the computer analytics in iWitness to generate the 261 feature point positions ready for immediate use in Crash Zone. Shown in Figure 3 is one of the final plots from Crash Zone and a screen capture from iWitness of Network 1.

Figure 3: Example plot of object points and feature attributes produced from the iWitness measurements illustrated in Crash Zone (CAD diagramming software).

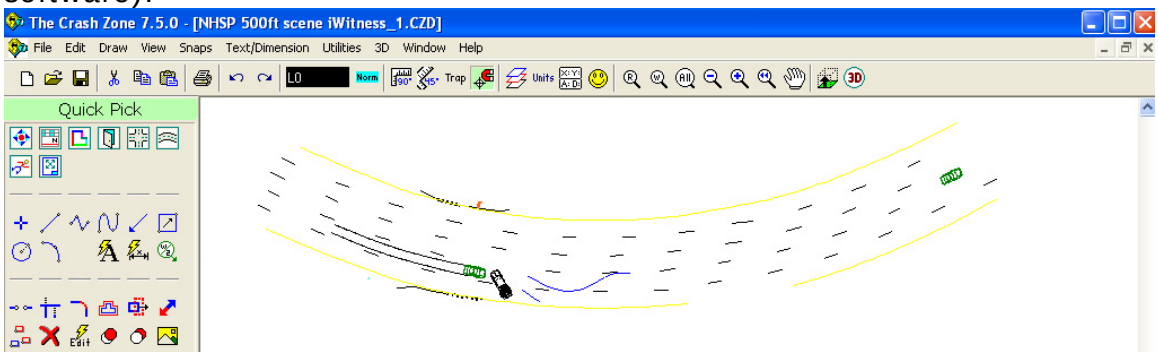
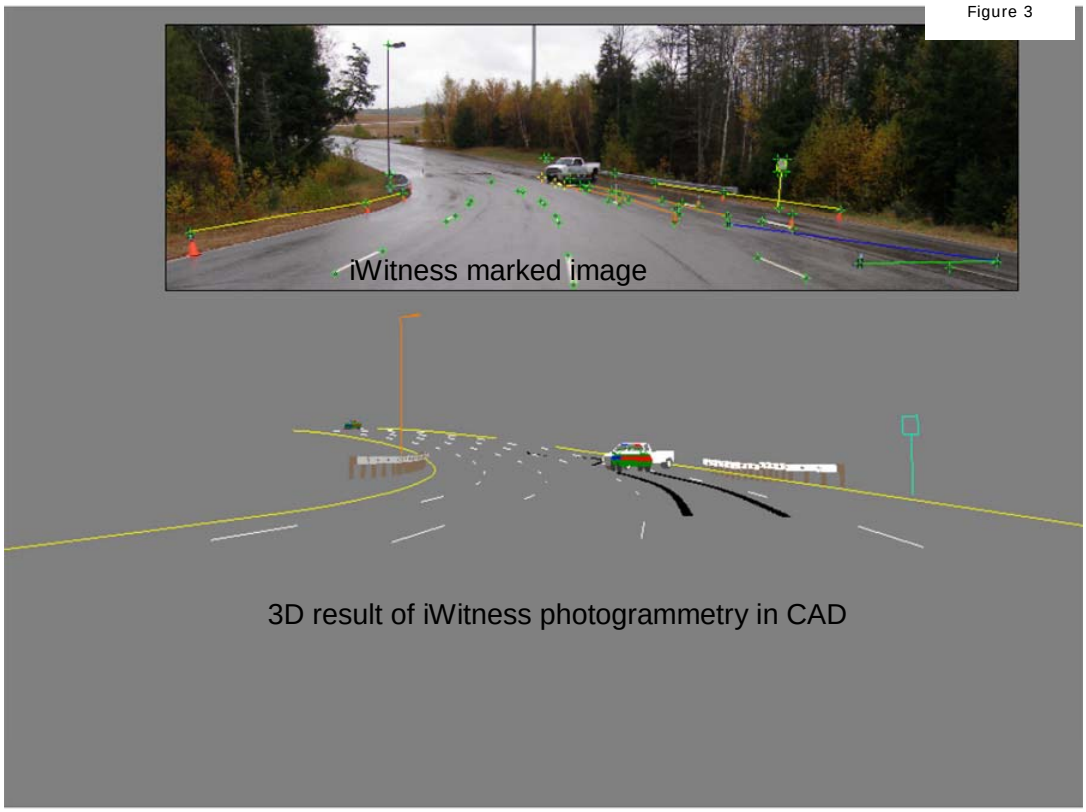
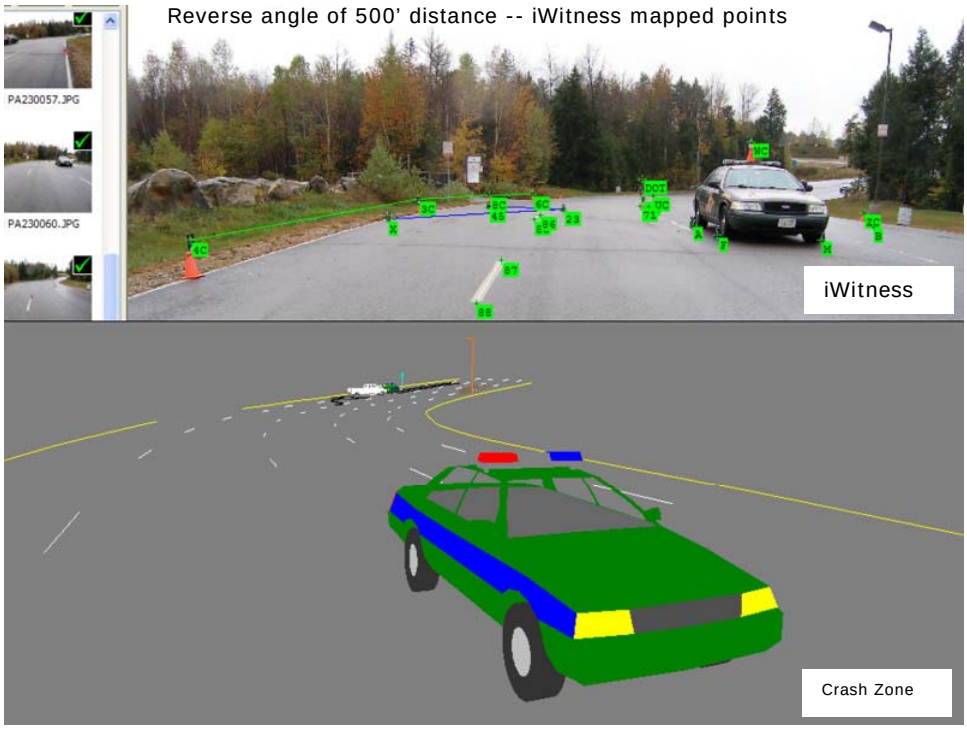


Figure 3





Conclusion:

The 3D mapping of traffic accident scenes which span several hundred feet via photogrammetry has traditionally been viewed as difficult. Yet this application has clearly illustrated the flexibility, accuracy and robustness of iWitness for accomplishing such distances and geometry in the accident reconstruction measurement and mapping task. The ability to stitch together sub-networks of points via a 3D coordinate transformation process allows long scenes to be mapped accurately from shorter, more manageable overlapping networks of images.