CASE STUDY

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Figure 1. Point cloud data of an under construction seven-story building with a 100-foot by 250-foot footprint that collapsed when it had been built up to five stories.

Laser Scanning Brings New Asset to Accident Investigations

by Brad Longstreet

Laser Scanning technology is revolutionizing many aspects of surveying and applied measurement, but it's been especially game changing in forensics and accident investigation. The main strengths of scanning — speed, safety, accuracy, comprehensiveness, and the ability to return to the same data set and make new observations — serve forensic engineers especially well. Money is also a factor: when so much is riding on a court case, the extra costs associated with adopting new technology don't seem so overwhelming.

Companies that have been doing forensic work for years are finding that laser scanning enables them to complete investigations faster, and more thoroughly. And, as the popularity of laser scanning continues to grow in the field of forensics, service providers who originally acquired scanners to complete traditional surveys and inspections are carving their own niche in the industry. Regardless of forensics expertise, veterans and rookies of this specialized field are discovering that just having access to a scanner positions them ahead of the competition when bidding for new jobs.

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Thomas Long,
Manager of Field Services,
Packer Engineering

Packer Engineering

"You name it, we get into it," said Thomas Long, Manager of Field Services for Packer Engineering, Inc., a multi-discipline consulting firm with a strong presence in accident reconstruction of all kinds, including fires and explosions; mechanical, engineering, electrical, and structural failures; aerospace accidents; and automotive accidents. "We were one of the first consultants in the country to get into private sector accident investigation, and we're very competitive. If there is any way to do this work faster, easier, or better: we're interested."

One way Packer chose to remain competitive is to use two FARO Laser Scanners. Long said the advantages of scanning for accident reconstruction are undeniable. (figure 2)

"Consider a refinery explosion, for example. In an explosion environment there are thousands of artifacts, from the size of a quarter up to the size of a car. Since we're always looking at the amount of energy involved when trying to determine cause and origin, the pattern of debris dispersion is important so we have to map all those thousands of artifacts. Most investigators will use total stations to record the position of a fragment and record some notes about it. But that means they're selecting the larger objects and the ones they think are the most important — and it's hard to know what's important on the day of the survey. With a scanner, not only do you get everything, but you also have a 3D image of it so you can check the orientation, identify it, and take measurements as needed.

Figure 2. Performing a laser scan of a crashed vehicle.

You don't have to be selective!"

But at the same time, Long said that the scanner hasn't really changed the way he does forensic surveying, just augmented it: "Really, a scanner is like a total station on steroids, and we've been using total stations since 1991. It's just another tool in the toolbox, but it's a nice one."

Packer Engineering has produced most deliverable types, including virtual reproductions and models suitable for import into finite element analysis software. Long explains that the scan data they capture is most often converted to 3D polylines and exported for use in a CAD program. (figure 3)

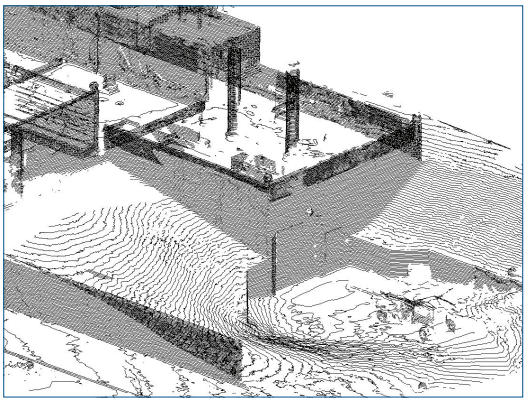

Figure 3. Point cloud data obtained from laser scanning a site is converted to 3D polylines and exported into CAD.

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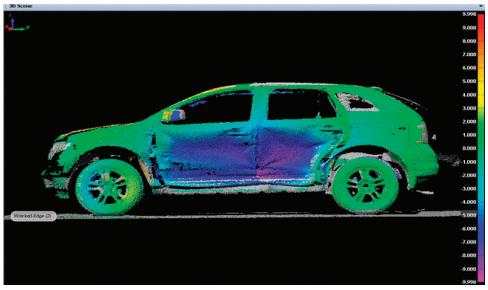

Figure 4. A color map of this vehicle depicts all of the detail and contor variations.

"It's been the easiest way to process data," Long said. "You can see cross sections, extrude portions, apply surfaces, etc." Scanning contributes to a variety of forensic projects at Packer. It has been used in three crane collapses, for example, and is also useful at smaller scales. Long said that scanning is extremely good for analyzing vehicle deformations.

"The old fashioned way to map deformation, or crush, is to take 12-24 measurements along the crush and then use those in engineering calculations. But with a scanner I can take an infinite number of measurements and use whichever ones I want. Take that a step further: in a rollover, the roof might shift slightly in a way that's hard to analyze. But with scanning I can compare the point cloud of the subject vehicle to the point cloud of an exemplar vehicle and see exactly where the deformation is." (figure 4)

Buying the scanners has been good for business, said Long, because, "Anytime you have a new tool, especially one as hot as scanning, the buzz spreads like wildfire and opens new doors, which is an advantage in this business — it's nice to be at the head of the pack!"

While listening to Long talk about scanning, one senses that the business advantages are insignificant compared to the new ways to do work that have opened up since its arrival. For this firm, it's been possible, even with decades of experience in forensic measurement, to not only learn new tricks, but whole new ways of doing work.

Arnold & O'Sheridan

Arnold & O'Sheridan is a multi-discipline consulting and engineering firm based in the Midwest that acquired a FARO laser scanner. According to Ron Luskin, their Director of Business Development and Marketing, it was a deliberate purchase of new technology.

"I'd been watching scanners in trade publications and realized there would be a demand, so we made a strategic decision to deliberately adopt the technology early," Luskin said. "I think we're still in the discovery and exploration phase, and we're educating potential clients. There's been a learning curve for the marketplace and for us."

Unlike Gilbert Engineering (see below), which acquired a scanner to help with the volume of forensic scanning they were already doing, Arnold & O'Sheridan acquired a scanner to help with more conventional work — and ended up getting a forensic job because they had a scanner. "The scanner was the reason they called," explains Survey Manager Frank Thousand.

The project in question was an under construction seven-story building with a 100-foot by 250-foot footprint that collapsed when it had been built up to five stories (figure 5). Two workers died. Two years after the collapse, project stakeholders were looking for a way to get construction restarted, and all parties agreed that a thorough building assessment, with scanned data, was a good start. The resulting deliverables would be distributed to all parties.

Figure 5. Under construction seven-story building with a 100-foot by 250-foot footprint that collapsed when it had been built up to five stories.

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At least two agendas would be served by Arnold & O'Sheridan's data: forensically, the point cloud would be equally accessible to all and would be used to assign or deflect responsibility for the catastrophe; and for construction purposes, the data could determine which areas of the building were safe to work in, which could be retained, and which needed to be demolished. It was a tall order, and required a great deal of planning.

"The owners were looking to get the building cleaned up and back under construction," said Thousand, "so we needed evidence that would be agreeable to all sides. We also needed all sorts of information about the building — did it follow plans, were walls out of alignment, what areas might have been compromised during the collapse, etc. Our approach was to use scanning, total stations, and other technology to make a tight, verified model."

Figure 6. Photo of the collapsed building under construction.

Figure 7. Scan data of the collapsed building under construction.

The control scheme began with a conventional total station network run across the street from, and completely around, the building. Total stations were also used to extend the network into the building, and up to each floor as work progressed.

"We had about seven points per floor, plus three or four points on each face of the building," explained Thousand. "So, more than 50 control points just in the building — we felt we needed this many because we would be gathering everything, and looking at everything as well, like the plumb of walls, for example."

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>
> *Ron Luskin, Director of Business Development and Marketing, Arnold & O'Sheridan*

Each floor took many scans to complete. These were registered conventionally, but the abundance of identifiable control points meant that crews could perform preliminary checks on site, then bring data back to the office for processing. Thousand said that FARO software was used for "…everything from importing the points, to looking at point clouds, and then transferring into AutoCAD®."

Deliverables for the job were relatively simple: just 3D plans and elevations, but not a full model yet. But as Luskin said, "Having the point cloud is like a photographer who keeps the negative — we can always go back for new measurements and details, or to create different displays." A date-stamped log of all work was kept for legal reasons, but the firm hasn't been asked to produce it.

The building collapse project is a good example of work that Arnold & O'Sheridan might have passed on without the scanner, as it would seem to defy even the most sophisticated total station.

"The scanning made it possible," said Thousand. "It would have taken a year to do this by other means."

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Luskin added: "We were able to do it in a few days, with no need for repeated trips. This in itself was an advantage, as otherwise the building might have sagged and changed while the survey was happening. This way, we're able to gather the data once and use it often."

And, in a partially collapsed building, safety was also a factor. Contractors were on hand to shore up sections as needed, but even so, the less time spent in a weakened structure, the better.

The client was happy, and the scanner has performed well on other difficult projects — including surveys of a food processing plant and a steam tunnel — that would have been too complex to capture adequately by other means. It may have been a deliberate early adoption, but so far Arnold & O'Sheridan's FARO scanner has proven to be a prudent purchase.

Gilbert Engineering

Micky Gilbert, founder of Gilbert Engineering, is no stranger to forensic work. Gilbert's company has been surveying and reconstructing accident scenes for more than 10 years.

"When an attorney needs an accident reconstruction," said Accident Research Specialist Doug Yanda, "we need accurate measurements. At scenes, we've been using total stations for the last few years to document critical points. At a rollover, this would be things like scratches, even shallow scratches, yaw marks, impact points and debris that police don't pick up."

Working with a total station was cumbersome, and required searching for small marks in the roadway and taking separate shots of each. Since Gilbert Engineering crews typically arrive on the scene 12-18 months after the actual accident, it is not always obvious which marks are important. Laser scanning has changed that.

"With the FARO laser scanner we have a huge advantage in the amount of data gathered and the time it takes to gather," Yanda said, "We can scan the whole scene in five or six setups, it will get all the gouges and any debris, and we'll have the character of the entire road."

Figure 8. Scanning with the FARO laser scanner

So scanning offers at least two significant advantages for this established company. First, scanning gathers everything, even shallow gouges, so scene specialists don't have to worry about missing anything during the scene survey. Essentially, they can "shoot first, ask questions later" by gathering all the info and examining it in detail later.

"We get more detail with the scanner," said Yanda, "Wheel gouges can be quite big — 12-18 inches long and a couple of inches deep — but we also gather scratches, which can be well preserved in some climates, like South Texas, and may be just a few millimeters deep."

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And, because the scanner works quickly, Gilbert Engineering doesn't have to decide which evidence is significant to gather at the scene — they just gather it all.

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Currently, the scanned data is used to generate 2D and 3D displays that attorneys use in and out of the courtroom, and Yanda said: "It hasn't come to trial yet, but we're working on views from above and flythroughs."

Scanning is particularly useful when vehicles roll into rough terrain: Yanda said, "We have some cases where the vehicle rolls off the roadway and into woods — it was really hard to get all the evidence with a total station. The scanner is much better." (figures 9 & 10)

Figure 9. Point cloud of damaged vehicle

Accident reconstruction is a thriving business for Gilbert Engineering. Yanda is on the road more or less constantly, surveying 10-15 scenes monthly. Work comes via referrals, and word of mouth. It helps that "Mickey is one of the foremost rollover

Figure 10. Point cloud of damaged vehicle, full view

experts anywhere," said Yanda, "There's only 10 or so in the country, and the big attorneys only use five or six of those — and we're one of them."

With that kind of reputation, and pressure, Gilbert Engineering can't afford to pass up technological advantages, and so far scanning has been a very big advantage.

Scanning is being adopted at a steady pace in most sectors of engineering, but in the area of forensic measurement it appears to be a near-revolutionary game changer. One big reason is that the sheer mass of data gathered, which is viewed as something of a handicap by many surveyors and engineers, is a nearly indispensable advantage for those trying to ferret out the reasons for a collapse, a rollover, an explosion or other catastrophe. And once you've had access to all the data you'll ever need, it's hard to go back — especially when your opponent in a courtroom may well have access to all that data as well. At a trial, the side with the best information is likely to win the day.

And the indisputable advantages of scanning, speed and accuracy, are also a big help in this high-stakes field. It seems that this new technology has already become an indispensable component of the forensic scientist's toolkit.

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