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Beyond mere scanning – intelligent laser technology

By Vornel Walker, Marketing Manager, COADE

Laser scanning provides a more efficient and accurate method of data to be used for modifications or expansions of existing infrastructure. CADWorx fieldPipe – distributed in Australia by Cortex Resources – allows the operator to leave site with an intelligent 3D model of associated works.

Typically, the as-built work process involves a pair of designers visiting site armed with tape measures, plumb bobs, pens and pad and, by hand, measuring the area to be modified.

This has changed to some extent over the years – the tape measure is still used, but it is augmented by hand-held laser measuring devices that deliver ultra-accurate linear results. However, the often dangerous task of climbing ladders and clambering over specially erected scaffolding to collect the information required has not changed.

Lasers provide a far more accurate method of gathering the as-built information, but accuracy can be improved if the operator is not required to clamber over equipment to obtain the required information to produce as-built drawings and models.

Laser scanners and trackers provide a way to overcome this, as collecting data through the use of these technologies provide extremely accurate information and reporting. The laser tracker also makes 3D measurements faster, providing up to 10,000 observations per second in the thousandth of an inch range for excellent statistical redundancy and repeatability.

Laser scanning 101

To produce an 'as-built' data model, a laser scanner is used to scan a specific area of a plant. This produces 'point clouds', which refers to millions of 3D data points that match the outlines of all the items in the area being scanned.

In order to complete this, a techni-

cal engineer arrives onsite and identifies the system to be modelled and a decision is made as to the co-ordinates to be used. These can be global co-ordinates or arbitrary co-ordinates derived from fixed objects in the plant.

Once the scanner is set up, the engineer starts scanning the areas of interest. After an area is captured, the equipment is moved to another location, and scanning continues. The process might take a few days or weeks, depending upon the size and complexity of the facility. The point cloud data set that is obtained from this activity should then be a faithful representation of the site and piping systems.

Interpretation of point cloud data

Once the scans are completed onsite, the engineer will take them back to the office where the designer will use them to produce either as-built 2D drawings or a 3D model of the scanned image – or both. For 2D drawings – steel, equipment and piping items are typically represented by lines, arcs, circles and so forth. If the scanned image is to be used for further design, a 3D model is generally required because items are represented by cylinders, tori, spheres and one-off blocks to make the design complete.

Creating a 3D plant model from the captured point cloud data is not an easy task because not all objects can be made clear from completed point cloud representations. Sometimes, portions may have been missed or the designer might need to resolve inconsistencies in the original

scanned data. Unfortunately, this usually requires a re-inspection of the site in order to verify what was represented by the point cluster data.

Typically, the 3D model that is produced is without intelligence, meaning it has no automated tools with which to create the deliverables needed for on-going construction. At best, its components are no more than 'place holders' in space.

Intelligent as-builts

Where accurate information about a finite number of lines and associate equipment or producing accurate deliverables for current construction needs is required, laser technology does not provide enough information.

To this end, in 2005, Leica Geosystems and COADE Engineering Software teamed up to develop a system that leverages what they call Direct-To-Model (DTM) Technology. As the name implies, this allows the engineer or designer to leave the site with a full-featured intelligent model and gives them the ability to create fabrication deliverables on-site – with no post-processing required.

The package the companies developed, CADWorx fieldPipe for Leica fieldPro, combines the intelligent piping design and modeling capabilities of COADE's CADWorx Plant Professional with the proven laser scanning technology of Leica's Leica fieldPipe for Leica field Pro. What makes the product unique is that, as points are picked, the piping model is created before the operator's eyes, automatically placing elbows and bends at each change of direction and trimming them if and when required.

When done, the designer has an intelligent 3D model from which deliverables such as fabrication isometrics and bills of materials can be created. The package even has bi-directional links to the industry's most widely used stress analysis package.

With the laser's point-and-shoot approach, the safety aspects have a two-sided benefit. First, the need for scaffolding for field measurements is virtually eliminated, saving time and providing a safer method of obtaining information.

A case study with Falk PLI Engineering & Surveying

Founded in 1995, Falk PLI Engineering

& Surveying is a closely held firm located in Portage, Indiana, USA, that specialises in land surveying, industrial measurement and civil engineering services for a diverse range of clients across the United States and beyond. The company's philosophy is to provide services that help clients improve their productivity and profitability. And, these services often include producing as-built drawings and models for existing refineries and other hydrocarbon processing installations.

Falk PLI's technical engineers and tradesmen operate a varied range of surveying equipment such as total stations, laser scanners and laser trackers. The support staff of skilled surveyors, engineers and designers analyse and report survey data in varied formats for the firm's clients, including 3D models, spreadsheets and traditional 2D and 3D drawings.

Falk PLI was an early adopter of laser technology, and today, the firm is using the precision capabilities of laser equipment on about 90 per cent of its projects. The company is involved in a broad range of work. Industrial projects include the steel, petrochemical and offshore oil industries for projects such as blast furnaces, casters, duct work, equipment alignment, crane rails, fabricated piping, equipment verification, clash detection, pipe routing and design.

At least 50 per cent faster

One of the first projects on which Falk PLI used the new package was to verify fabricated piping spools. The spools were designed using CADWorx from scan data previously captured with a Leica 4500 scanner. The purpose of this project was to replace the overhead vapor piping on a pressure column, upgrading the material content from carbon steel to an alloy. With the extra work in preparing, purging, welding and testing required in fabricating and installing alloy pipe, the goal was to eliminate or at least reduce any potential for rework.

Falk PLI had a two-person field team using a Leica 1103 TCR total station linked to a laptop computer installed with the CADWorx fieldPipe software. Surveying the first eight spools took around three hours. Although a seasoned surveyor, the person performing the survey did not have any training and had little experience with the software, so

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- Collision detection
- Specification driven pipe modeling
- Automatic isometrics
- Links to stress analysis
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there was a learning curve at first. “That’s why it took him three hours that first time,” said Falk Laser Scanning Project Manager David Danko. “We soon learned it was taking about 15 minutes per spool with this new package.”

When the designer left the site, the model was complete. “We saved approximately six to eight hours just for one spool piece – a full workday,” Mr Danko reported. “That’s less than 50 per cent of the time it would normally take.”

Falk PLI completed 3D drawings using CADWorx fieldPipe software and compared them with the piping arrangement created earlier from the point cloud data. “We saw that the piping would fit as fabricated,” Mr Danko said. “So we totally eliminated the need for any rework prior to even trying to install anything.” The engineers and designers not only saved time, they also ensured a correct fit prior to installation, eliminating the added cost, time and frustrations of rework.

This case study demonstrates that, in addition to using it for piping that is going to be replaced ‘as is’, the package can also be used for checking as-built piping spools or other items in a fabrication shop. “If a piece goes out and it doesn’t fit, it costs our clients money all the way down the line,” explained Mr Danko. Because the designer can check the pipe before it leaves the shop for installation it’s “a big time savings, so it’s a win-win for both the clients and their fabricators,” he added.

Intelligence a big plus

There is a vast amount of work that goes into producing piping models using laser scanning equipment, yet what was being produced before was not intelligent. CADWorx fieldPipe allows the designer or engineer to see the piping system being built as surveying is completed onsite. And, this model is intelligent. “Everything is in it and all the components are identifiable, such as pipes, elbows, valves, etc,” said Mr Danko in describing the system’s intelligence. “Our designer can click on an item and get all the information about that item.”

Easy start up

CADWorx fieldPipe was developed by people familiar with piping design and how designers and engineers work in the field. The first time Mr Danko used the system himself, he reported that it took a half hour to go through his notes. Then, he set up the instrument and started shooting points. “We could tell that the developers of this package knew the way we survey pipelines, flanges, and so forth, because it was easy to set up and use. Once I started doing it, it felt natural and intuitive and was easy to use, so it just made sense to me right from the start.”

The accuracy of the new package comes from the laser-based surveying techniques it uses. Because the model is being produced live during the scanning,

the designer can check the drawing and be sure that all the relevant information has been accurately obtained before leaving the job site. “With this new package, the designer doesn’t get back to the office and notice that he forgot to shoot a flange or some other element,” said Mr Danko.

With laser’s point-and-shoot approach, the safety aspects have a two-sided benefit. First, the need for scaffolding for field measurements is virtually eliminated. “Also, you don’t put people at risk in erecting or breaking down the scaffolding,” added Danko. This eliminates the need for someone to climb scaffolding, ladders, elevated walkways and other challenging locations. The bottom line is that this saves time and money and improves safety.

The added value of having the piping, ductwork or structural steel fit easily the first time is possibly the greatest benefit to the typical project. The project schedule is shortened and field fits and rework are decreased or eliminated. “But, the biggest savings comes from the improved safety of only having to rig and lift each piece only once because it will fit the first time,” Danko declared.

“There is nothing else on the market like it,” said Mr Danko. “One of the best things for us was that clients were impressed with the drawings that we produced and gave back to them as a deliverable. That’s great for our clients, and that’s what matters most.”

Cortex Resources distributes COADE products including CADWorx fieldPip. For more information visit www.cortex.com.au