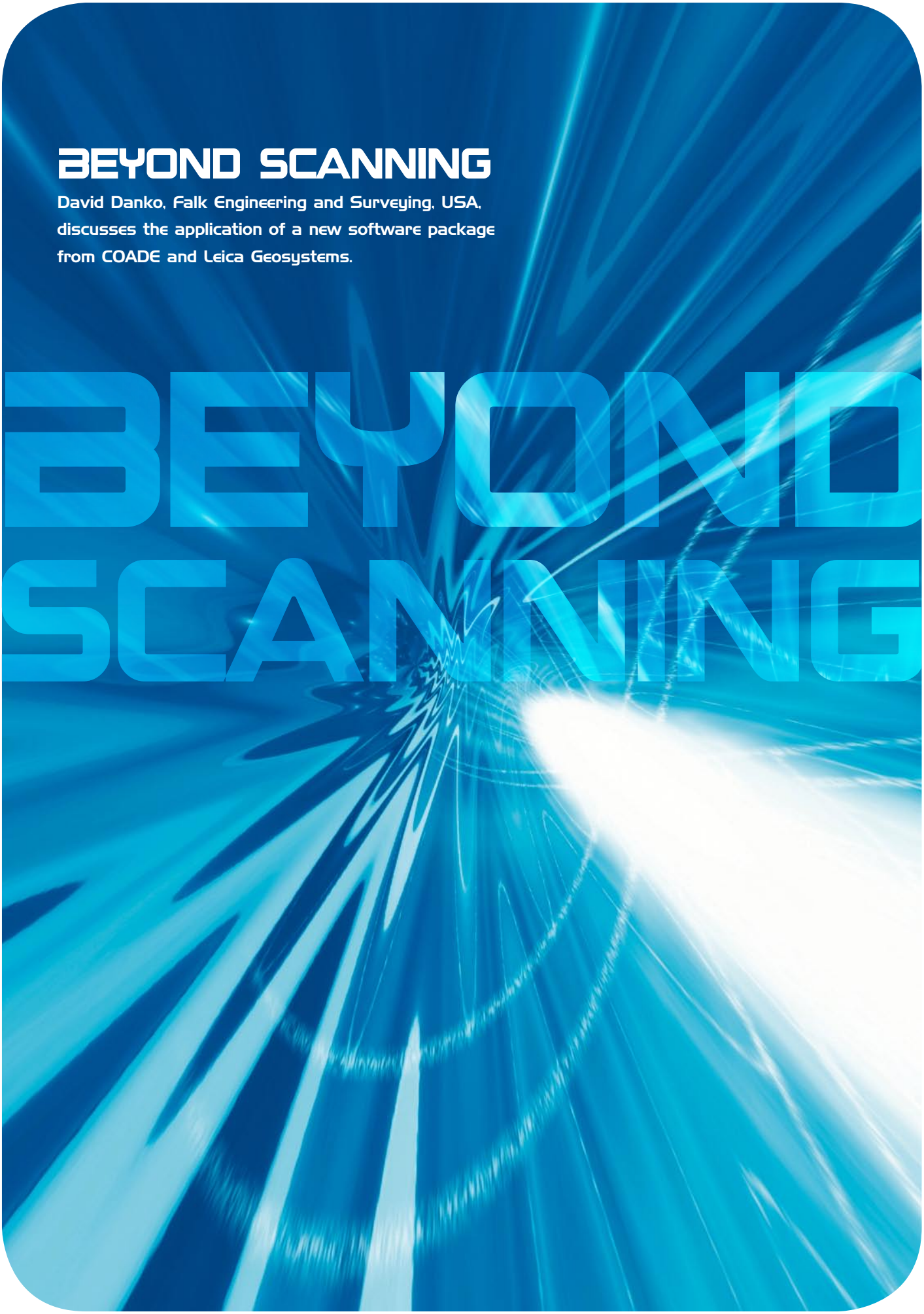
BEYOND SCANNING

David Danko, Falk Engineering and Surveying, USA,
discusses the application of a new software package from COADE and Leica Geosystems.



The global hydrocarbon processing market has seen many challenges, including shrinking supplies, increased demand and heightened environmental concern. In recent years, things have become even more difficult as the double whammy of high oil prices and high demand have simultaneously confronted shrinking regional and global capacity and reduced contracting fabrication capabilities.

With the long term rate of return to produce these refined products hovering below 5%, an investment of US$ 1.5 - 4 billion required to complete a facility and hundreds of governmental permits needed to even begin, it is not surprising that these facilities do not rate highly for new capital expenditures.

The situation in the US is a sobering example. The last US refinery, built in Garyville, Louisiana, came onstream in 1976, over 30 years ago. At that time, gasoline consumption in the US was averaging 6.98 million bpd (petroleum equivalent). Today, gasoline consumption has reached 9.16 million bpd and it is still growing. 90% of gasoline consumed still comes these same US refineries (Source: Energy Information Administration).

Current market conditions have meant that many of the world's refineries are constantly in a state of flux. This activity is in the form of updates, modifications and expansions that are needed to accommodate the ever increasing demand and the need for cleaner burning products and lower environmental impact. Although refinery updates and modifications seem to be the only viable option, one thing is certain: these changes have to be turned around as safely and quickly as possible to minimise lost production or prevent unscheduled shutdowns.

For owner/operators of these existing facilities to have modifications performed as efficiently as possible they must:

- Gather the most accurate and up to date as-built information.
- Produce the most accurate designs to that as-built information.
- Procure and deliver accurate materials for construction.
- Prefabricate as much of the design as possible offsite.
- Deliver and install the design with minimum onsite work.

Gathering information

Typically, as-built work is done the way it was a hundred years ago when the first refinery was due for its first update. A pair of designers would go onsite armed with tape measures, plumb bobs, pens and pad and, by hand, measure the area to be modified. Have things changed? To some extent, they have. The tape measure is still used, but it is augmented by handheld laser measuring devices that deliver ultra accurate linear

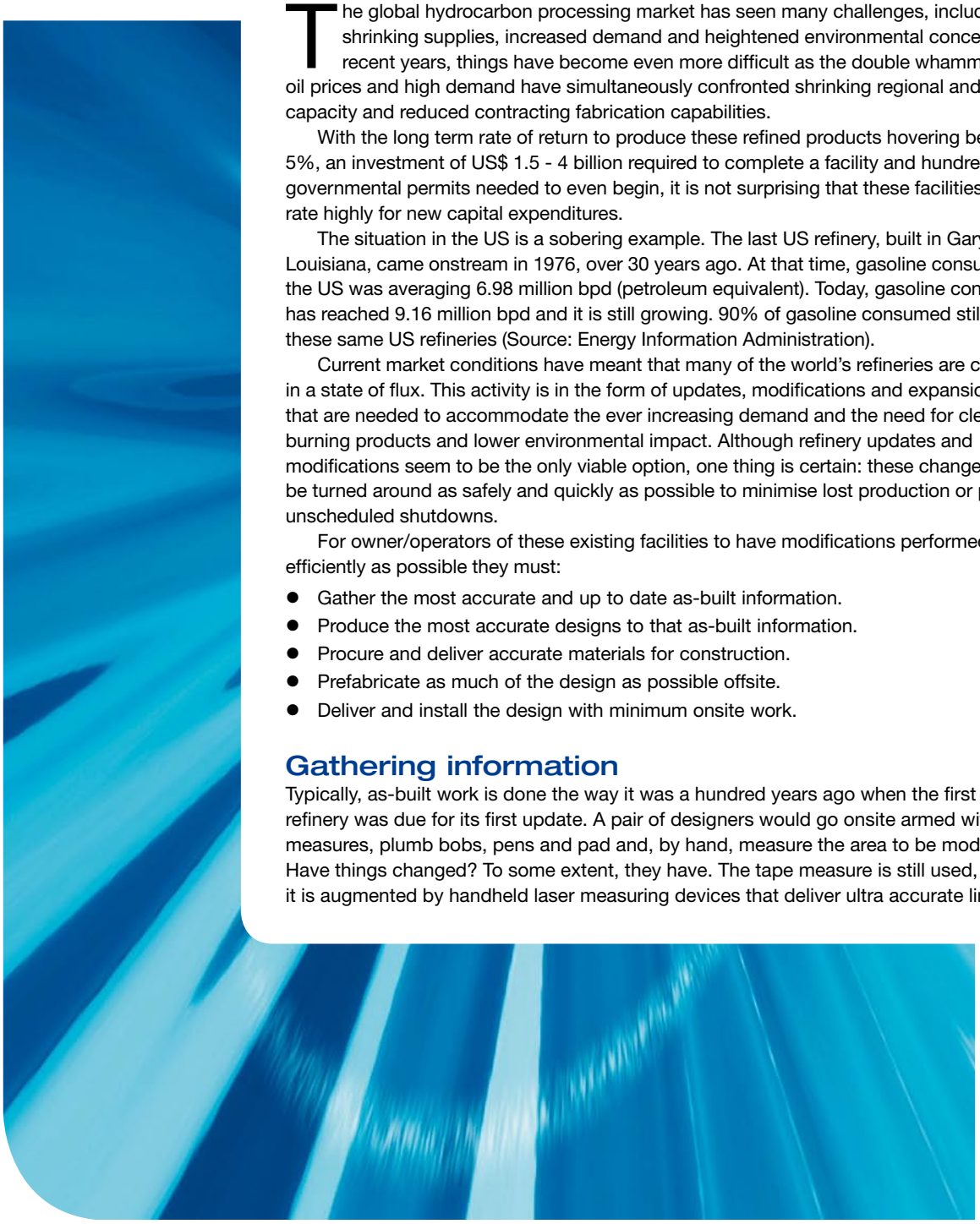


Figure 1. CADWorx fieldPipe in operation with the tripod mounted Leica Total Station and Leica fieldGear.

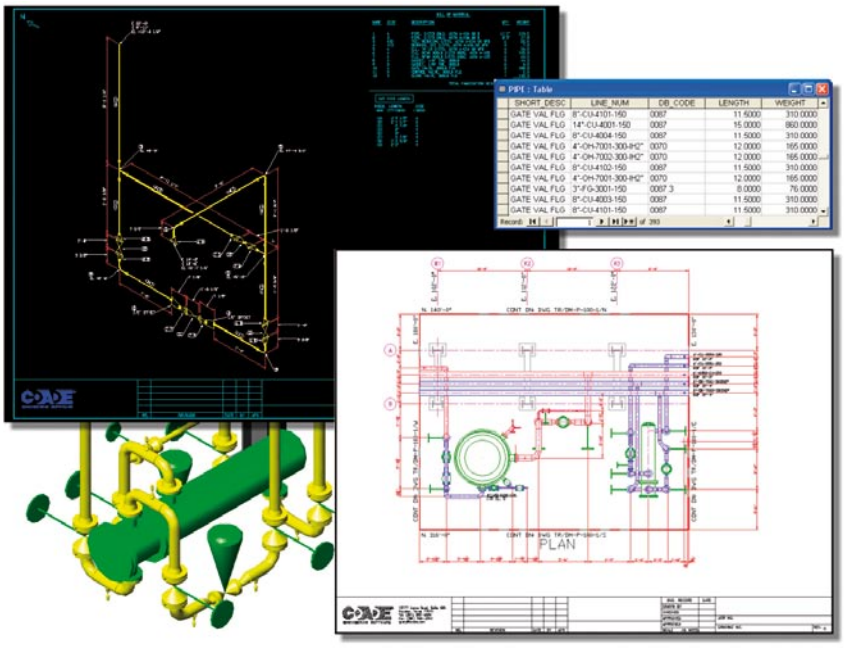


Figure 2. With CADWorx fieldPipe the operator can produce a wide range of deliverables, including 3D models, fabrication isometrics, bills of material and layout drawings, without leaving the job site.

results. What has not changed is the often dangerous task of climbing ladders and clambering over specially erected scaffolding to collect the information required.

Lasers: scanners and trackers

As mentioned, compared to manual methods of measuring, lasers provide a far more accurate way to gather information. How could this laser method be further improved? The best way would be to maintain the laser's accuracy while not requiring the person onsite to clamber over equipment to get the required information to produce as-built drawings and models.

This is where laser scanners and trackers really win out. Data collected 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 within 1/1000th in. for excellent statistical redundancy and repeatability.

So, what are the deliverables and how can they be used? For those not familiar with laser scanning technology, it is worth outlining the steps required for a typical project. To produce an 'as-built' data model, a laser scanner is used to scan a specific area of a plant. This produces what are known as 'point clouds', millions of 3D data points that match the outlines of all the items in the area being scanned.

The first task is project setup. Once the technical engineer arrives onsite and identifies the system to be modelled, a decision is made as to the coordinates to be used. These can be global coordinates or arbitrary coordinates 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 final result is a point cloud data set that is a faithful representation of the site and piping systems.

Interpretation of point cloud data

Once the scans are done on site, the engineer takes them back to the office where the designer uses 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. For 3D, those same items are represented by cylinders, tori, spheres and one off blocks to make the design complete and, if the scanned image is to be used for further design, a 3D model is generally required.

Creating 3D plant models from the captured point cloud data is not an easy task because, as faithful as point cloud data sets are, not all things 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 sending someone back to re-inspect the site in order to verify that what was represented by a point cluster is what exists.

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

A better way

While laser technology is good for the collection of large amounts of point cloud data, some needs are still not met. One need is for those situations where accurate information about a finite number of lines and associate equipment is required. Another is producing accurate deliverables for current construction needs and/or for subsequent site additions and modifications.

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 onsite, with no post processing required.

The package developed, CADWorx fieldPipe for Leica fieldPro, combines the intelligent piping design and modelling 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 being created before the user'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 bidirectional links to the industry's most widely used stress analysis package.

Applications in the real world

Founded in 1995, Falk PLI Engineering & Surveying is a closely held firm located in Portage, Indiana, that specialises in land surveying, industrial measurement and civil engineering services for a diverse range of clients across the US 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 analyses and reports the 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% of its projects. Falk PLI has a broad work experience. Civil projects include bridges, roadways, commercial properties and historical renovation projects. 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. The long roster of clients includes such names as Diamond Offshore, Western Refining, Global Santa Fe and BP, US Steel, Mittal Steel and Nucor Steel.

One of the first projects on which Falk PLI used the new CADWorx fieldPipe 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 vapour 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.

As mentioned earlier, prior to this new package, the engineer would do the scanning onsite and bring the data back to the office. The designer would then create a 3D model from the point cloud information.

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 there was a learning curve at first. When the designer left the site, the model was complete.

Falk PLI completed 3D drawings using CADWorx fieldPipe software and compared them with the piping arrangement created earlier from the point cloud data. 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 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. The designer can check the pipe before it leaves the shop for installation.

Conclusion

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 ensures that, when the designer or engineer surveys onsite, he actually sees the piping system being built. So when the designer leaves, he knows he has a complete and accurate 3D model of what was just surveyed. Falk PLI designers and engineers also appreciated the bidirectional links with COADE's CAESAR II program for pipe stress analysis.

CADWorx fieldPipe was developed by people familiar with piping design and how designers and engineers work in the field. 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 he has everything before leaving the job site and that all of it is accurate.

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. This removes 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. With CADWorx fieldPipe, pipe runs develop as the installation is being surveyed onsite.