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HYDROCARBON PROCESSING®

Laser-scanning technology improves plant quality, safety and training

Costs can be reduced due to 75% fewer field trips as well as 50% fewer fit-up welds and field changes

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With budgets being cut and schedules becoming increasingly more rigid, to curtail costs, project managers and engineers are facing harsh demands on how to revamp facilities as accurately, quickly and cost-effectively as possible. Safety and training issues are also at the forefront of many facility owners' minds. How to quickly and cost-effectively train facility employees has become yet another issue to deal with.

Having to work training around scheduled outages, or practice emergency plans during "off" times has often delayed training certifications or compromised stringent safety guidelines. Using existing plans to formulate emergency strategies or to base designs from has typically been a major source of project defect because often there is little or no as-built (or "existing condition") documentation. Furthermore, the as-built documentation that does exist can be out-of-date or of questionable integrity.

Foggy data. Inaccurate or non-existent as-built documentation can cause many issues during revamps. These include:

- The necessity for more personnel in the plant
- Extended design time
- Clashes between new equipment and/or piping and existing piping and equipment and field routing of pipe (contributing to additional inaccurate as-built documentation).

The cost in time and money accrues in the form of field changes, missed schedules, project delays, construction rework, hot work and lost production.

Using 3D laser scanning is one of the most powerful and increasingly preferred methods of gathering dimensional information for project design. Over the past several years, this technology has gained wide acceptance in the process industries, providing a faster, more complete and more accurate alternative to traditional data collection techniques. The primary reasons for its adoption have been the significant and tangible benefits, such as reduced costs, improved schedules, increased quality and enhanced safety.

However, the adoption of laser data has been hindered since, until recently, it could only be displayed as "point clouds." By definition, a point cloud is a group of point measurements representing the visible surface of the object that has been scanned. To work with a point cloud, multiple laser scans, from many different directions must be overlapped and integrated together.

The "scan-centric" architecture of point clouds requires user knowledge of which laser scans "saw" the area of interest. This negatively impacts usability as the user may miss critical information by not loading a laser scan. Additionally, the multiple overlapping views of the facility are often difficult to interact with and navigate. Point clouds have a "foggy", undefined appearance

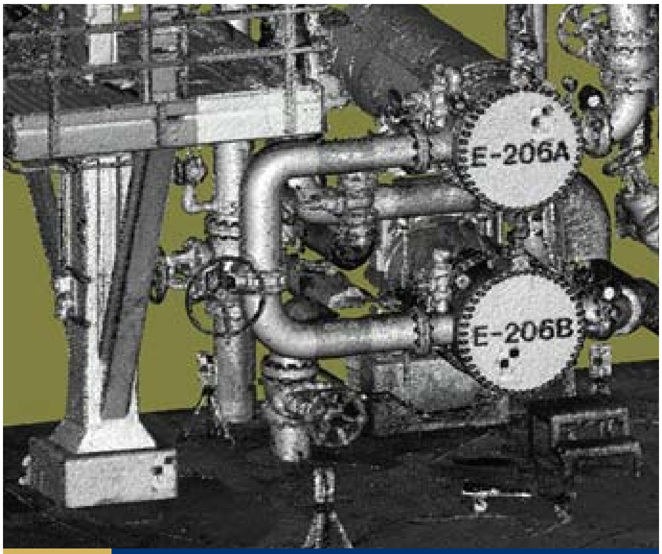

FIG. 1 Actual laser model of a facility, not a "point cloud" or photograph overlay.

FIG. 2 Integrate laser models and a CAD model directly in design software.

due to the redundant points and the spaces between the points within the individual scans. Colorizing the data to show depth is almost required since the point cloud is transparent, but can make it even more difficult to interpret because it looks even less like the facility. This "cloud-like" view can make it more difficult to visualize or understand the facility and more tedious to use the data, thus making it more likely that important design details are missed.

User friendly technology. An alternative to point cloud technology is the laser model. Laser models integrate all laser scan data to provide detailed, high-definition, solid volumetric "models" of a facility. To work with laser models, a user simply selects the desired facility area to be viewed. Since the laser scan data is integrated, the user need not manually select the laser scans to be loaded, nor worry about missing critical facility information from not selecting a laser scan. The "facility-centric" approach of laser models makes the data much more usable as all captured information is automatically displayed in a single view of the facility for easier interaction and navigation.

Laser models look like the facility. They are three-dimensional, solid, visually clear and include very fine details (Fig. 1). The need for depth colorization is eliminated as laser models are physically solid, making depth perception easier and more "natural." Additionally, laser models may be accessed directly or within various design software in true 3D (not as a background image) and may be significantly zoomed into while maintaining their solidity and high definition.

The visual clarity of laser models not only makes them more intuitive and helps drive design efficiency, but also offers clear advantages for engineering and construction analyses. For example, laser models have been used to certify tie point locations, ensure clash-free designs, verify fabricated items and visualize construction. They are also ideal for "virtual" site visits due to their high resolution (Fig. 2).

With the use of laser models, project team members are able to extract the greatest value from the laser scanning investment by increasing usefulness of the technology throughout the design, engineering and construction process. It also enables proposed designs to be reviewed against existing conditions to identify clashes, interferences or construction issues earlier in the project life cycle, where they are much less costly to correct than during fabrication or construction. The digitized plant can also be used to certify 3D locations for tie points for piping or structural modifications, to perform constructability reviews such as construction sequencing or to create 2D drawings on demand, including equipment layouts, sections, piping and instrumentation diagrams and piping isometrics.

Finally, maintenance and operations teams can also use the digitized plant as an intuitive visual entry point for information such as operations best practices, safety procedures, replacements parts and other information that may be available, but is typically "scattered" across a network. Obtaining this information by clicking on a piece of equipment in the digitized model makes it more accessible and thus more likely to be applied. By using the laser models, evacuation plans, emergency readiness plans and site visualizations for training purposes can be developed and simulated without sending teams into the facility. Often these areas are densely populated or in elevated areas, or the plant cannot be powered down, making simulations and rehearsals of emergency readiness plans or training on designated areas very difficult. Laser models help eliminate these concerns.

Laser models offer many clear advantages over older point cloud technology. These advantages include facility-centric access to the laser scan data, reduced file sizes and visual clarity. Laser models enable companies to extract the greatest value from their investment in laser scanning by helping ensure that project defects are identified and eliminated before they result in construction clashes, unnecessary field welds and rework. The difference is clear. The following case study further illustrates this point.

REAL-WORLD CASE STUDY

A large refining company located in southeast Texas was preparing for a major shutdown of its gasoline-producing fluid catalytic cracking unit. During this shutdown, large sections of the catalyst lines would need to be replaced. It would be crucial for these lines to fit flawlessly, within the shutdown times and installed by as few crew members as possible.

Challenge. Although the facility had been documented a few years previously to digitize the area so the design engineers could plan the replacements, the project still faced many challenges. First, the facility turnaround team needed to plot the cut lines with the existing lines so that the new piping sections could be placed and welded during the shutdown with absolutely no rework. The project also had a very tight budget with no room for overage. Finally, this facility prided itself on a commitment to maintaining a high level of safety, security and environmental consciousness. Safety was a major concern.

Solution. Because of the rigid time and budget constraints, the project team decided to use laser scanning. According to one of the owner/operator's project managers, "We started looking at how large the area was to document, how dense the area and how many people it would take to gather all of this information and decided to contact a laser scanning service provider. The clarity of the data and the precision of the laser models enabled us to fit the piping perfectly the first time."

Results. Through the use of as-built laser documentation, the project was completed with virtually zero field rework. The schedule was optimized due to fewer man-hours being required in engineering and the replacement of new piping within the scheduled outage time.

The documentation allowed the pre-fabricated catalyst lines to be fitted and welded without incident, definitely helping to meet the hard deadline. The advantages were also apparent in the accuracy of the line fit-up, improved design verification, and less physical survey time, along with fewer personnel required and improved safety exposure by the project team. All these factors contributed to a lower project cost.

Overall, design and construction goals were met in record time. The various benefits can be summarized by category:

Reduced cost. The number of man-hours decreased as the project was completed in reduced time with essentially no rework. Laser models of the facility were used to verify design, and to and visualize the replacement of the prefabricated catalyst pieces, all safely offsite.

Optimized schedule. Use of the technology significantly reduced the time required for creating, validating and marking up existing drawings by ensuring that the drawings issued to construction matched what is actually in the facility (Fig. 3). Using a 3D model allowed project team members to electronically transfer the design to multiple engineering, design and field crew members for around-the-clock design progress to comply with a rigid schedule.

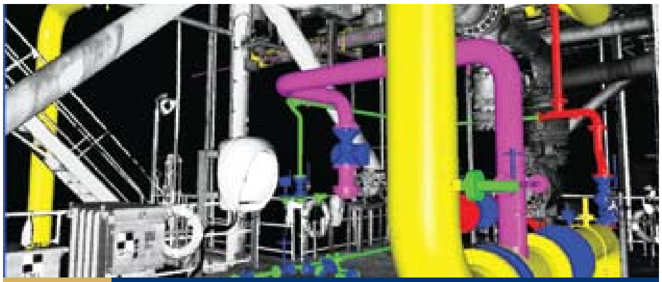

FIG. 3 CAD model "back projected" into a laser image of a facility.

Increased quality. Prefabricated pieces can better fit into the existing facility. Rework from cutting and refitting was significantly reduced, helping to ensure a clash-free design. Operations was given the ability to participate in virtual 3D reviews of the new facilities for operability and maintainability.

Improved safety. The laser scanning technology minimized the need to place workers inside a hazardous, congested work area. Using a 3D model of the facility allowed the project team to map out the route for quickly accessing the area to replace and for providing a safe path to exit the facility.

Outlook. By digitizing the facility and creating a laser model, the project team is typically able to reduce rework by 85%—measuring individual events and not a percentage of the total installed cost. Typically, the technology can reduce costs from 75% fewer field trips, 50% fewer fit-up welds and field changes, and less maintenance.

Data collection time can be reduced by 80%, revamp time can be shortened by one day from better construction planning, and design time can be decreased by 30% from better information. Quality is increased due to 80% lower rework rates, 10% more prefabrication and better pipe-routing plans.

Most importantly, improved safety results from the need for 50% fewer people in the field and 75% less scaffolding. Better safety plans and improved training capabilities can make certifications easier to obtain. **HP**

Eric Hoffman is the president and CEO of Quantapoint, Inc. He is a pioneer in 3D laser scanning. Over his more than 22 years in the field, Mr. Hoffman has generated several patents, including a patent for 360° laser scanning. He holds an MS degree in electrical and computer engineering as well as a BS degree in mechanical engineering from Carnegie Mellon University.