3D laser scanning helps Chevron revamp platform

Floyd H. Sanders
Chevron USA Production Co.
Lafayette, La.

Chevron USA Production Co. exceeded its project goals by deploying 3D laser scanning and modeling on a Gulf of Mexico platform upgrade project.

The technology reduced shut-in time by more than 40%, and capital savings more than paid for the deployment cost.

Retrofit and upgrade projects frequently contain more risk than green-field projects. For retrofit projects, both design and construction planning have the added challenge of having to take existing structures, piping, etc. into account.

These projects often encounter scope revision, hefty field rework, and schedule delays, all of which originate from not having accurate as-built information for design or construction planning.

EI 252 I platform

Chevron decided to move forward on a 70% capacity upgrade to the Eugene Island platform, EI 252 I (Fig. 1), a key processing facility owned and operated by the Chevron Gulf of Mexico Business Unit (GOMBU).

The platform receives production from 18 nearby platforms and handles oil-water processing in addition to serving as a well production platform. The engineering scope for this $2 million capital upgrade project included creating up-to-date, as-built documentation of the existing platform.

As with most of Chevron's projects, the as-built 2D CAD drawings were created by the project's engineering contractor (in this case Pegasus International, Lafayette, La.) using the traditional "measuring tape and clipboard" method.

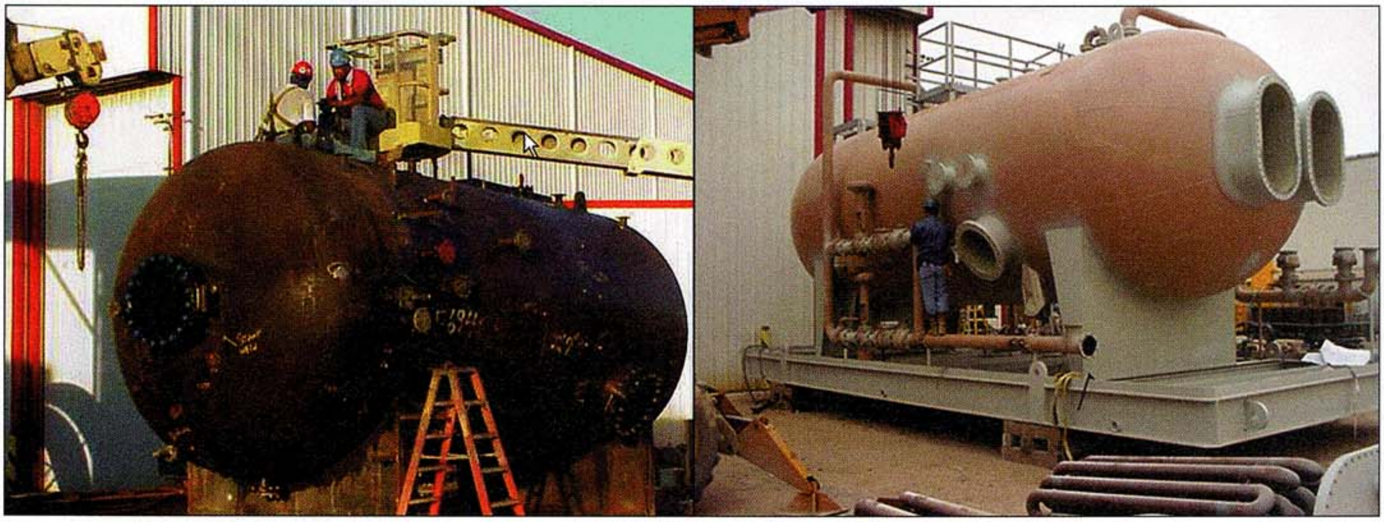
Chevron's EI 252 I platform, with a capacity to handle 20,000 bo/d, lies 83 miles offshore Louisiana (Fig. 1).

Chevron's experience with doing as-builts manually is that the resulting drawings are only accurate to within 1-3 in. The project's fabrication and construction plans, therefore, included a large number of field fit-up welds to account for the looseness in the as-built documentation.

Laser scanning

The project was moving along steadily. Detailed mechanical design was virtually complete and fabrication of pipe spools had begun when a promising new technology was presented at a Chevron semi-

The tight fit and cramped environment added risks to the replacement of two of the larger vessels (Fig. 2).



The large size of the new vessels, shown under construction (separator in right photo, and electrostatic treater in left photo), complicated the upgrade (Fig. 3).

nar in January 2000.

The technology, Cyrax 3D laser scanning and modeling (Cyra Technologies Inc., Oakland, Calif.), was said to provide much better accuracy and completeness than traditional manual as-builts, yet at a comparable cost.

The technique uses a portable 3D laser-scanning device that quickly captures complete, accurate geometry of existing complex scenes, almost like a 3D digital camera but with accurate geometry included.

Cyra's PC software is then used to process the captured data (point clouds) into accurate CAD drawings and computer models.

At the seminar, it was learned that Chevron had used the technology during the last couple of years on more than 30 pilot and other projects, with apparently very good results.

Retrofit problems

The EI 252 I upgrade project had considerable financial risk exposure, more than most other retrofits.

First, it involved a platform shut-in. With a large portion of the profit center's revenue flowing through this platform, it was critical to remain within the planned 72-hr shut-in.

Secondly, the upgrade involved replacing two existing vessels with two larger vessels in an area already cramped with equipment, piping, and structures (Figs. 2 and 3). Because of this tight fit and cramped environment, there was the added risk of encountering unplanned interferences during construction.

Operating problems had also plagued this platform, so that any glitches in the upgrade design that did not account for proper maintenance access posed another risk.

In view of these risks, Chevron decided to look at deploying the 3D laser scan on the project. The thinking was that having highly accurate as-built information to check the detailed engineering designs would significantly reduce the project risks.

The hope was that spools could be prefabricated onshore to the exact dimensions needed, thereby minimizing the time required for field fit-up welds and also eliminating unplanned interferences.

Deployment of the Cyrax technology was put on fast track after the feasibility and costs were checked. The deployment cost estimate came in at less $50,000.

The upgrade project had a 10% contingency, $200,000, for rework, etc., so that this additional work could be paid from this contingency budget.

Specific project goals were to:

- Use Cyrax as-builts to check against in-process retrofit designs.
- Meet or beat scheduled platform shut-in of 72 hr.
- Keep rework time and cost to a minimum.
- Eliminate interferences and conflicts, including path conflicts during installation.
- Improve conceptual design for better maintenance access.
- Establish more than 24 tie-point locations to 0.25-in. accuracy.
- Quantify the costs-benefits of the technology for future project references

Project logistics, costs

The project used scanning equipment rented from a Cyra dealer, 3D-LaserTech, Houston. This dealer coordinated the personnel for the fieldwork, and office processing of the scan data, which included support from ConneXsys, Richmond, Calif., an engineering company experienced with Cyrax projects.

A helicopter transported the equipment and personnel to the platform. The three-person team included two for the setting up, moving, and operating the equipment, and a surveyor to capture specific target points for linking the laser scans together.

In addition to the project area, the team also scanned other platform areas to support possible future changes.

A typical scan takes about 10-15 min. Placing the scanner in different locations around the area of interest allowed multiple scans to be stitched or registered together, creating a single, complete 3D representation of the area.

The scanning team was on the platform for 4 days, because changes in scope reduced the scan to critical areas. The team also had to deal with periodic, excessive platform vibration. The 3D laser scans affected by excessive platform vibration were easy to identify by viewing the data graphically in real-time, after which the areas were rescanned.

For this project, estimated deployment

A comparison of images shows the shrink-wrap laser scan on the left, a digital photo in the middle, and the laser scan on the right (Fig. 4).

costs of the Cyrax technology were:

- 10% - Travel, shipping.
- 30% - Field labor (including travel time to and from platform).
- 40% - Data processing labor.
- 10% - Equipment rental.
- 10% - Scanning project contingency.

Actual man-hours expended by contractors on the scanning project were within 10% of predeployment estimates, including contingency.

Project workflow

After completion of the scanning, the next step accurately registered the scans together. This involved using survey targets as well as geometry, such as piping and large columns, common to multiple scans.

The Cyra software shrink-wrapped all 17 scans to create colorful, detailed images of the area. This one-click process required only seconds for each scan. Fig. 4 compares the shrink-wrap, digital photo, and laser scan images.

Chevron personnel and contractors used these images to identify each tie-point for which an exact location was needed. Once the tie-point areas were selected, appropriate portions of the scans were processed into CAD objects and a table of tie-point locations was provided to the project design team.

The next step converted the registered scans into a base 3D model of the existing structure. New equipment skids also were modeled within Cyra's software (based on their fabrication drawings) and inserted into the 3D computer model of the existing structure (Fig. 5). The final 3D model then was used to create 2D as-built drawings in AutoCAD, part of the final deliverables.

As-built comparisons

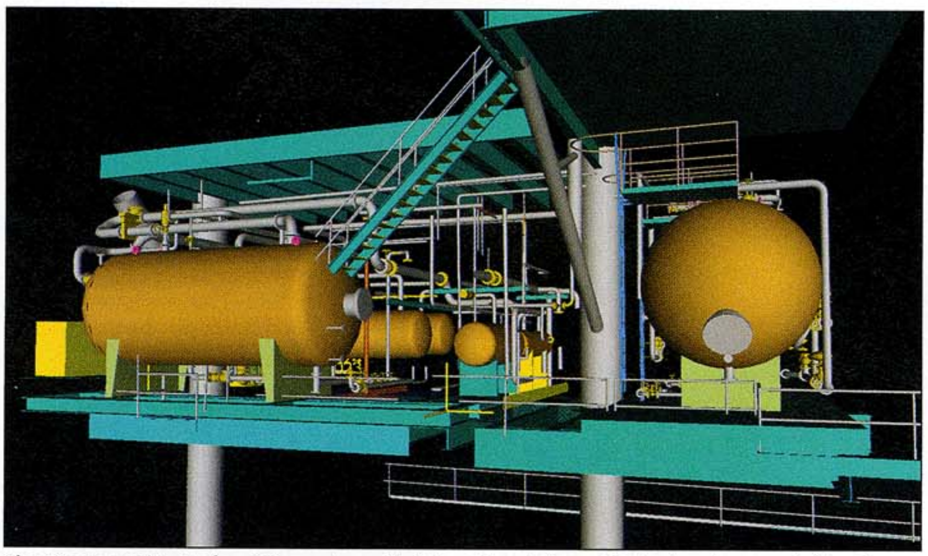
The project team discovered numerous differences in geometry when comparing the Cyrax as-builts against those previously created manually. One difference was that decks are not always square as assumed in drawings.

The team decided to go with the Cyrax as-builts and this had several consequences.

First, some tie-in spools, which had already been welded, were corrected in the shop prior to shipping offshore. Then checks on the remaining design uncovered interference fits of the larger vessels with existing piping that would have been missed until the vessel's field installation. This prompted several design modifications. The remaining spools were fabricated based on the corrected designs and the Cyrax tie-point locations.

The 3D model also helped in assessing the best lift path for the treater. The 3D visualization uncovered a potential conflict in the original planned path, requiring installation plans to be changed.

Finally, the 3D model permitted a 3D walkthrough of the area around vessels and associated piping for operations review and input to the proposed design. This made for a better layout for operations and maintenance.



The 3D scan provided data for a 3D computer model of the existing platform with the planned new vessels (Fig. 5).

Benefits

In the end, one never really knows if the as-builts and the retrofit designs are good until after the installation, which for this project was in August 2000.

For the EI 252 I upgrade installation, virtually everything fit the first time.

The installation went smoothly. It had:

- Eliminated 40-50 field welds, about 7 days' worth of construction on the platform (part of which was during the shut-in period), a $105,000 savings.

- Reduced shut-in time by 32 hr, 40 hr actual compared to 72 hr planned, a $500,000 gross revenue gain.
- Avoided three field trips to capture additional geometry, a $15,000 savings.
- Required very little rework.
- Experienced no interferences among vessels and piping.
- Reduced project risk
- Generated cost savings significantly exceeding the Cyrax deployment cost.

The new Cyrax 2500 scanner is 40% smaller and lighter than the Cyrax 2400 scanner used on the EI 252 I project (Fig. 6).

The total revenue gain from the shortened shut-in was worth about $850,000; however, this savings included gains from other than the 3D scan technology, which is estimated to have saved about $500,000.

The entire project came in 5% under budget, even considering the deployment expense allocated to using the 3D scan after most of the detail engineering work had been done.

Front-end savings

As explained previously, the decision to deploy 3D scanning was made late in the upgrade project. This essentially caused the engineering work to be done twice.

If the 3D scan had been used from the beginning of the project, additional savings could have been realized as follows:

- Reduced engineering cost (actual cost $170,000—8.6% of project) with a potential cost reduction of $25,000-$45,000.
- Reduced fabrication cost (actual cost $680,000 for decks, skids, pipe spools, and vessels or 34.4% of project) with estimated cost reduction of about $50,000 in bidding with firm specifications.
- Further reduced field trips to gather data. Trip cost about $4,000-6,000/trip based on two people/2 days.

In total, the project could have saved another $100,000 if 3D scan had been deployed at the beginning.

Additional opportunities

A common problem with collecting data manually for as-built dimensions is that if the project scope changes or new ideas emerge, the design team often has to go back on site to capture additional data. This actually happened on the EI 252 I upgrade project, but in this case a return to the platform was not required because of the 3D scan data.

The project changes included adding a bypass for future intermediate pressure compression, and a decision to use an existing meter run on the deck rather than procure a new meter run. In both cases, the geometry of interest was captured by the 3D scans and no additional field trips were needed.

One of the workflow steps of the project was the creation of a 3D computer model of the new vessels and their associated piping. This model was incorporated into the overall as-built model. Note that in the future, the owner-operator could arrange to scan the actual fabricated vessels and skids in the fabrication yard as a further quality-assurance step.

Following the success of this project, Chevron authorized two other platforms to be scanned. This work was done by Atkins Benham, Minneapolis, Minn. One platform was for Chevron USA Production CO. (GOMBU) and the other for Chevron Overseas Petroleum Inc. (COPI), which will install the platform off West Africa.

These platforms had just been built and were still at the fabrication yard. The scanning was done in anticipation that accurate as-built geometry would at some point be needed and it was cheaper to do it while the platforms were onshore.

Chevron has earmarked additional Gulf of Mexico retrofit projects to use the technology in 2001.

Looking forward

Chevron wants to support engineering firms to develop the ability to scan and model future designs. It has already started this process with key contractors.

In addition, it also wants more hands-on experience in its own workforce, so that it can take maximum advantage of the 3D models for design reviews, operations and maintenance reviews, etc.

On the EI 252 I project, Chevron owned one software set that was used to review the 3D as-built model.

After the project, it was recommended that future pilot studies benchmark the technology and its cost effectiveness in other applications and that for the greatest benefits, the technology should be deployed at the start of the project.

Chevron has made specific recommendations to Cyra for enhancements in hardware and software that will further reduce project costs and schedules and allow the technology to be deployed on a wider range of projects.

Since this project, Cyra has introduced its next generation Cyrax 2500 scanner (Fig. 6) and Cyclone software, which address some of these recommendations. ✦

The author

Floyd H. Sanders is a senior facility engineer for Chevron USA Production Co.'s western-shelf profit center, Lafayette, La. He is a project manager for both onshore and offshore facility projects. Before joining Chevron, he worked for Sun Pipeline Co. Sanders has a BS in mechanical engineering from Lamar University, Beaument, Tex.