LASER SCANNING FOR AN AS-BUILT STRUCTURE

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OVERVIEW

LIDAR (Light Detection and Ranging) Laser Scanning has become a staple throughout industries: from architecture, construction and engineering to crime scene and forensics. The laser scanner is among the very best tools for fast and accurate measurements with consideration to budgets, safety and time. These

scanners when used for the Oil and Gas Industry, will allow for complex 3-dimensional models to be created and used with virtual reality and extremely accurate drawings. This document will discuss the concerns of Engineers and Naval Architects, as well as Drilling Contractors and Oil Companies in how to make site surveys more efficient, safer and more budgetary conscious.

BACKGROUND

Traditionally, when a site survey is needed for vessel life extension, redesign, upgrade, reactivation or refurbishment, a 1 or 2-person Team must be deployed to capture, as accurately as possible, the information specific to the defined task(s) using measuring tapes, levels and other basic tools. The information gathered on site is then compared, offsite, to owner furnished drawings and manuals allowing decisions on how to accomplish the project requirements. This method does not consider additional issues such as safety, time loss and additional equipment that is needed to get a complete and full drawing of the space. Due to time constraints, Facility access considerations and project Schedule this method does not always gather additional ancillary information which at the time of the survey may be deemed unnecessary; yet, can and often, does become important later. With Laser Scanning, less manpower is needed with less equipment and offers more concern for safety. By using this method, hard to reach areas and wide-open spaces can accurately be measured yielding dimensions of surfaces, piping and cabling and equipment. By capturing multiple scans throughout a space or a vessel, a 3-dimensional model can be created to offered extended and complete detail. The use of a Laser Scanner allows the accurate capture of all visible features and details in a point cloud which can be used to construct a cad model and produce drawings containing the needed information for the defined task; and, if the scope of the task should change or expand the additional information is already available without additional field trips.

SAFETY

The factor most concerning to all parties involved in the Oil and Gas Industry is personnel safety. Whether it be the rig hands onboard, or a visitor, safety is key. Yet, this is most of the time at an additional cost. In traditional site surveys this translates into additional manpower, thus sending cost upwards. When a surveyor is on site and must take a space offline, this is usually at the consequence of having a rig hand facilitate overwatch to ensure visitor safety, especially if the visitor must become elevated to take measurements. The laser scanner eliminates much of this through its all-seeing lens/mirror. In this paper, the FARO Focus S150 Terrestrial Laser Scanner was used for data capture. Also, being that the scanner sits or is suspended from a tripod, it can be sent into hazard conditions with little concern to life safety, as it can be remotely operated.

Figure 1: FARO Focus S150
(Spec Sheet Attached)

Figure 2: FARO S150 Deployed on LNG Vessel
(Inverted and down opening)

TIME

When tasked with a site survey, downtime is a major cause of concern, as typical working areas must be taken offline for team members to perform the task, or the team members must wait for an opportunity to work the project. A traditional survey requires more expensive field time due to the requirements that the surveyor must be more sensitive to the facility operations due to the time required within the space. In spaces that are single level and open, a surveyor can quickly move through the space with ease; however, in spaces that are multi-level and/or have very high ceilings, require additional time, because Structure, piping and wiring can be out of reach. This issue then brings the added resource of ladders, scaffolding or a lift with fall PPE required; and, the added time to build, move and reset the equipment around a space. Downtime will become an issue at this point increasing the time required to complete the survey. Laser scanning from its individual scan positions, although line-of-sight, captures millions of points in minutes offering greater detail and accuracy. This is not limited to only what a surveyor might draw out, rather all that is within the sight of the laser scanner. With a more complete and accurate point-cloud model comprised of multiple facility scans (the combination of all points captured within each area scanned in the facility), human-error is minimized because of the capturing of additional data; therefore, if something is missed or additional information is needed after once the surveyor has left the facility, the model stands alone allowing for additional measurements and imagery to be extracted at any time, offsite – with no additional facility time required.

ACCURACY

As stated in Safety and Time, Accuracy assists in those aspects, as well as in Budgets. It is the proverbial glue that holds it all together. Within a single scan position, accuracy is +/- 1-2mm at 30m. This number continues to get tighter and tighter as more scans are added, in the immediate area, further reducing standard deviation. This is in larger part to several factors that are built into the FARO Focus S150 – GPS location, photographic overlay and target spheres or April Tags.

Figure 3: FARO Focus S150 with Target Spheres

These white spheres offer a consistent point of recognition and are coated with a special paint that allows for accurate reflection of the laser back to the Laser Scanner. The sphere being a fixed sized, 200mm, this further tightens accuracy for overall measurements and dimensions throughout the point-cloud and 3D model.

With the facts as they stand, there are inevitable adverse conditions that can come up and cause some small obstacles: equipment vibration, lighting, vessel movement and reflective surfaces, to name the more common conditions. Equipment vibration under normal operations is typically dealt with by using vibration isolation pads while light, like a common camera, is dealt with by exposure settings. Vessel movement is dealt with by scanner sensors, built-in – inclinometer, compass, altimeter – to compensate for movements. Reflective surfaces can be dealt with by increasing the "quality" or the number times the scanner verifies a single point and eliminates those it cannot average out for verification.

BUDGET

Budgetary concerns are always a large issue when planning a project. However, if Safety, Time and Accuracy can be mitigated and controlled, then budgets can and do fall in place. The Laser Scanner acts as the second person on a 2-person Team allowing for a controlled project that requires less safety efforts, less time offline and more accurate findings.

PROJECT/CASE STUDY

Company X, and LNG Vessel, requested Laser Scanner capture of their Water Heating Systems for a Glycol Conversion onboard their vessel. Scans were required of the affected area which included the current booster pump room, Ballast tanks containing piping and the cofferdam for piping hull penetration locations. The original shipyard design drawings were available but were not completely as built.

A 1-person Team was deployed and captured all spaces, approximately 60 scan positions, in 3 days. The vessel was in the Shipyard and all areas/spaces were

properly vented and secured. Scan positions were a combination of well-lit areas, as well as areas in complete darkness.

Figure 4: Well-Lit Area of LNG Scan

Figure 5: Transition from Well-Lit to Complete Darkness

Upon completion of the Laser Scanning and subsequent Point-Cloud creation, the model had a mean point error of 2.2mm with maximum point error of 5.5mm (see table below).

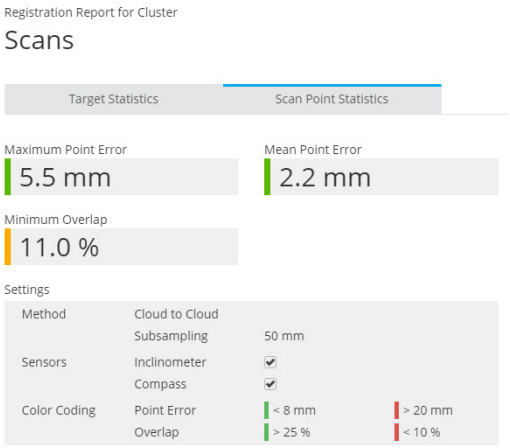

Figure 6: Margin of Error Table

This translated to the fact that once the 3D model was measured, there were several instances where the shipyard drawings were found to be off by as much as 150mm structurally. Had the Laser Scanning Site Survey not been conducted, there would have been issues installing the piping systems and additional materials would have been ordered.

Project/Case Study Facts:

Traditional Site Survey	**Laser Scanning Site Survey**
5-7 Days	3 Days
1 Person Survey Team	1 Person Laser Scanning Survey Team
Lift	None
2 Additional Personnel (Each Day)	None

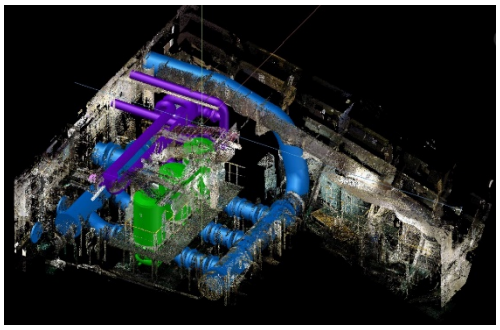

Figure 7: New Piping added After Point-Cloud Completion

Figure 8: HDR Imagery of Scan Area; Multiple Scan Locations

CONCLUSION

Laser Scanning for the Oil and Gas Industry is a technology that can reduce safety concerns, reduce time required to perform a survey while increasing the amount of quality accurate information gathered in the form of versatile data that can be used repeatedly for multiple task or in the event a task must expand beyond its original scope, and accessed from any location. Laser Scanning has perhaps one of its greatest features in being able to reduce the bottom line on a project for Engineers, Navel Architects, Designers, Drilling Contractors and Oil and Gas Companies. It is the technology of today, tomorrow and for the foreseeable future. Laser Scanning, as a tool, will reduce the cost of projects by increasing the accuracy of the engineering work, reducing time required to perform the survey and eliminating additional field trips and decreasing installation time through better design drawings; while increasing the amount of good available information to Naval Architects and Engineers for planning the project from beginning to end.

References:

All data, information and cross-referencing were created, generated and verified from Zentech Projects over our 40+ years of projects in the Offshore Marine Industry. Cost comparisons were verified from recent Laser/Non-Laser Projects. Safety comparisons were verified on what is needed by our teams to conduct a safe and responsible site capture. Time comparisons were verified by Laser/Non-Laser Projects.