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# 3D Laser Scanning for the Marine Industry

By Daryl Johnson

***FARO 3D laser scanning allows the Chief Engineer or Project Manager to work in detail with 3D model shots of machinery spaces with increased accuracy and reduced costs.***

The time to install a Ballast Water Treatment (BWT) System or maybe an Exhaust Gas Scrubber is rapidly approaching. Or, perhaps, you are an inland vessel operator watching the subchapter M drama with great interest. In all of these cases, most vessels have limited space in which to install these items. That said; as the regulatory uncertainty with regard to the impending regulations dissolves, the high cost of installing these systems will not go away – unless, of course, emerging technologies can ease that pain somewhat. Fortunately, and just ahead of the regulatory enforcement, comes FARO's new 3D Laser Scanning system.

Even without new environmental requirements, the marine Industry is in great need of applying emerging technologies like 3D Laser Scanning to a myriad of new tasks. Tens of thousands of aging vessels will soon need equipment retrofits, most of which involves navigating narrow, tight, and limited space areas. Even for those owners who have archives of original drawings, those general arrangement depictions may not accurately reflect the current situation on a given vessel, especially one which has been around for a while and seen its share of repair yard insertions. Hence, equipment retrofit is typically extensive, costly, time consuming, and fraught with measurement errors. It doesn't have to be that way.

### Old School

The typical approach when performing ship checks is to bring designers and/or engineers on board where, using tape measures, they record measurements of the existing systems and spaces. These measurements are then used in developing scope and construction documents. However, the uncertainty of the measurements requires allowances be included to account for discrepancies between the measurements and reality. These allowances can be expensive and/or prevent the installation of new equipment in a certain location because the space was considered too small, when in fact there was adequate clearance. Or, conversely, maybe not enough at the time of installation.

### 3D Laser Scanning

A better approach involves scanning ship spaces with a 3D laser scanner to create a very detailed and accurate 3D point cloud model. Today's high speed laser scanners are quite suitable for this purpose as they can take tens of millions of measurements in just a few minutes. Scans are taken from various positions in order to provide sufficient coverage around equipment. The scans are then registered together to bring them all into the same coordinate system. Done properly, with the latest FARO Focus3D scanner, the laser scan data can be accurate to within 3 mm over 10 meter distances.

### Benefits of using 3D laser scanning:

- Laser scanning can often be done while the ship is in operation.
- Vibration is one of the few limitations.
- Measurements: more comprehensive and precise compared to hand measurements.
- Reduces or eliminates the need for follow-up site visits.
- Design work can be carried out in office & within the created 3D Point Cloud Model.
- Data allows larger portion of new or replacement pipe spools to be pre-fabricated in shop @ lower cost.
- Data increases number of bolt-up tie-ins & reduces field welds, reducing shipyard costs & downtime.

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With all these benefits, the use of 3D Laser Scanning, despite its availability, nevertheless has not become a mainstream practice in ship repair and retrofit operations. The reasons why come down to three main issues. These include cost of hardware, capability and difficulty of use, computing power limitations and inconsistent workflow and software solutions. Fortunately, most of these issues have been addressed, as depicted below:

### 1. Hardware Cost and Difficulty of Use

Until recently, laser scanning equipment was cumbersome (multiple components with total weight over 150 lbs) expensive (\$150,000+), requiring highly skilled crews to operate. With the recent offerings from FARO, however, the new Focus3D scanners weigh in at just 12 pounds, at about one-third the cost and are similar in operation to a high end digital camera. The new scanners can, with one person, take significantly better measurements in one day than a ‘ship check’ team can accomplish in a week’s time. More significant, perhaps, is that every vessel can perhaps justify having a scanner on board, allowing the Chief Engineer or Project Manager to direct work in detail within 3D model shots of his machinery spaces. With this approach, the cost required to obtain accurate measurements has been greatly reduced – and can be accomplished from far out to sea, well in advance of the repair procedure.

### 2. Computing Power Limitations

Another barrier to wide acceptance of 3D Laser Scanning was the huge data sets that bog down computers and made it difficult for managers to visualize their projects in the 3D Point Cloud. Autodesk ReCap and Bentley Pointools among others have and are making great strides to overcome this barrier.

### 3. Difficult Workflow and Software Solutions

The next limiting factor is the work flow and software that allows CAD Designers to work directly in the 3D Laser Scan Point Cloud model and apply statistically valid algorithms to the point cloud data for feature extraction of system components such as piping, structure, and more. The software available on the market to meet this need has grown considerably over the last few years and is available from such companies as Kubit, Innovmetric, Edgewise and Kohera3D – just to name a few.

### “We Haven’t the Money, So We’ve Got to Think”

It was Ernest Lord Rutherford who is credited with saying, “We haven’t the money, so we’ve got to think.” A renowned Physicist, Rutherford proved time and time again that thinking saves money, but what drove him was his love of solving problems in more efficient and cost effective ways. The new 3D laser scanning technology is the perfect fit for this way of thinking.

In 2007, Summit Engineering and Design, LLC moved to FARO scanners and at the same time, began to develop software solutions so CAD designers could work directly in the Point Cloud model. Summit had learned the hard way that the further away from the Point Cloud the designer was removed, the more likely simple, yet costly design mistakes would be made. Data sets were needed that (a.) AutoCAD could handle, (b.) would allow clients to direct their project scope, and (c.) allow all to see the progress of the design efforts. Ultimately, this led to the ability to isolate (or classify or segment) the point cloud model into individual layers where they could be worked with in AutoCAD and visualized in Navisworks.

By loading high resolution “corridors” or volume boxes of specific areas within the point cloud model, this provided designers with the detail they needed to “thread the needle” on tight pipe routings while at the same time maintaining reasonable stability and performance speeds of the CAD system. In other words, the perfect tool for that tight ballast water treatment retrofit.

But even with all these options, designers were still tracing and eyeballing the new design over the scan data. In response, Summit developed statistically valid feature extraction algorithms to give the designers “Basic Modeled Parts” which included such things as cylinder fits, pipe centerlines, face of flange and top of steel locations. These Basic Modeled Parts provided “snap-to-points” in AutoCAD. In addition to these Basic Modeled Parts, it was discovered that loading high resolution “corridors” or volume boxes of specific areas within the point cloud model also provided designers with the detail they needed, while at the same time maintaining reasonable stability and performance speeds of the CAD system.

### Design & Retrofit – The Way Forward

Although it is possible to continue using the “brute force” methods of the past, 3D Laser Scanning has emerged as a valuable and accessible technology that will continue to make measurable strides in the shipyard industry, and beyond. But, if you’ve got all the time and money in the world, and you don’t like to think too much, then continue on as before.

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