Brownfield Projects

Using Laser Scans for Offshore Platforms

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Complete information about as built plant status is critical for the EPC companies for revamps of old platforms. As compared to conventional methods of gathering the data, use of laser scanning technology in surveys results in generation of highly accurate data. This minimizes the overall cost by fast tracking on site data gathering without the necessity of plant shut downs. The authors have discussed various advantages of this technology for offshore platforms.

Laser scanning is a contact free survey method / technology in which laser are used to scan real objects or environment to collect data on its shape and its appearance. Especially in dangerous, complex and explosion protected environment (eg, offshore platforms) laser scanning technology offers considerable advantages over data gathering methods.

Key Advantages of Laser Scanning

- Laser scanning tools are explosion protected
- Fast data gathering
- No scaffolding / special access platforms required
- No shutdown of operations

The collected data, which are available from the scanner as a 'Point-Cloud', are used to construct three - dimensional models useful for a wide variety of applications.

IMPaC used applications of this technology are computer aided design, computer aided engineering, reverse engineering, quality control/inspection and documentation of technical installations.

Through laser scanning physical measurements of an object are transferred to a computer in an organized manner resulting in a collection of 3D scan data which actually is a scale model or 3D graphical rendering of the object. Once the scan data is available, all of the dimensions of the physical object can be taken, such as length, width, height, volume, feature size, feature location, surface area, etc.

Laser Scanning for as Built Plant Status Generation

For modification or revamp works of platforms engineers are faced either with obsolete data of the plant, e g 2D drawings or no data is available at all. As most of the EPC companies utilize 3D design software, 3D spatial models are the basic deliverables for good practice engineering project. Data gathering using conventional methods require a 'Key-in' exercise resulting in slow and inaccurate field data. Compared to conventional data gathering laser scanning technology can be used for surveys and generation of as-built documents of plants, achieving an accuracy of ±5 mm (±1 mm within a single

scan) for as built data for all visible items on the respective plant /site.

The Status of Plant Documentation can be described as follows

- Insufficient documents; either complete not available or available only in the hardcopy-format.
- Modifications carried out during the life cycle of the installation not documented properly.
- Deviations between the designed and the installed plant towards the end of the construction phase not documented.
- Long term changes in structures due to geological influence, like subsides and age related fatigue on structures not captured in the available drawings / 3D-model.

Disadvantages of Conventional as Built Data Gathering

- Restricted accessibility to plant-areas due to elevation, noise, heat, weather and contamination etc.
- Necessary scaffolding for conventional as-built data gathering.
- Data gathering activities may be related to shut down.
- High man-hour consumption for manual data gathering
- No validated data for necessary documentation of as-built for authority, security requirements etc.
- Long lead time for planning of plant revamps (ongoing / future engineering) and preparation of necessary documentation of entire plant prior to and after revamps.

Advantages of Laser Scanning include

- Cost minimization through
  - Fast track on site data gathering
  - No shut-down of operations necessary
  - Generally no scaffolding necessary
- High quality results & validated data
- Direct usage of the field data
- 3D visualization of current and future design
- Once the scanning has been performed, all geometrical data is available for engineering, hence no additional site visits are required.

From Plant to 3D model

- A number of scans are taken at different locations of the plant site using 3 D laser scanner. For combination of all scans a number of reference points will be fixed in the installation
- All scans are registered (merged) to generate a point cloud of the plant. The process of extrapolating all points to the shape of the plant is called reconstruction or modeling. This point cloud is the sole original data pool for geometrical information. All checks will be done against this registered point cloud.
- The point clouds are then modeled using 3D modeling software to create a geometric model of the plant. From these model drawings, GA drawings and isometrical- / 3D-views can be generated. The point cloud is used to generate a first basic model consisting of mere shapes.

Attributes like pipe classes, line numbers, specifications, materials, weights etc. will be added to the geometric model according the project requirements, to generate an intelligent model.

- Detailed 2 D drawings can be extracted from the intelligent model Material Take Offs (MTO´s), Isometric Drawings, (ISO´s) Component Object Graphic model (COG).

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A registered point cloud is the direct result of laser scanning. Each point cloud carries its own coordinate information and this is used to generate a detailed model consisting of mere shapes. The model is the basis for discussion in the first phase of an as built generation to set priorities for further modeling. At this stage first layout drawings and views of relevant plant

Fig 1- Complex 3D Reality of a site location

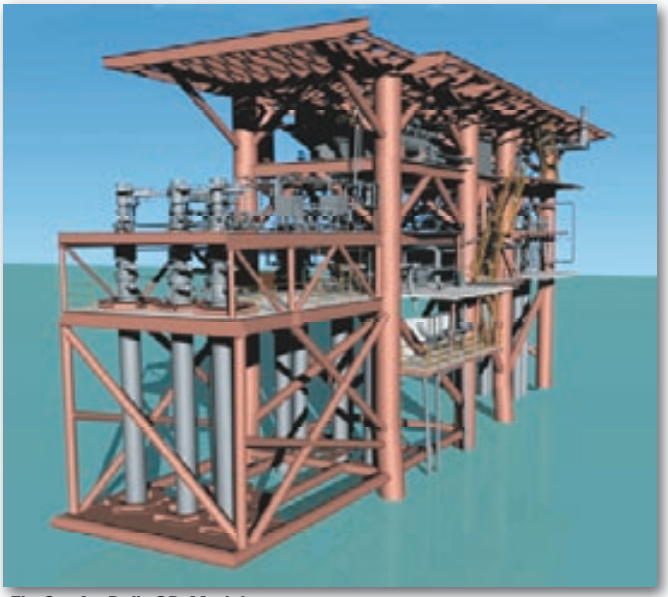

Fig 2 - As Built 3D Model

areas can be generated. In the second phase, attributes such as material grades, pipe classes, weights, etc are added to the model. From this updated model MTO´s, ISO´s, COG and detailed 2D-drawings data can be extracted. Already the basic model allows engineering with 3D design software like PDMS, Tekla structures etc. as all dimensional data is present. Thus tie-in-point's, battery limits and footprints of equipments can be displayed / arranged.

Once an intelligent as built model is created, it needs to be updated frequently to take into account any further modifications made on the plant. Plant mark up drawings are generated for all modifications.

After manual incorporation of mark ups into the intelligent 3D model, on site laser scanning of all modifications is performed to confirm dimensional accuracy. Once confirmed, the changes can be suitably accommodated in the as built status model. For any modification of the plant previous steps are performed in accordance with the requirements of the installation. Thus regular updates of the 3D model establish a robust as built asset management system for the plant.

Functionality of 3D-Scanners

3D laser scanners are very analogous to cameras. Like cameras, they have a cone-like field of view and they can only collect information on surfaces that are not obscured. While a camera collects color information about surfaces within its field of view, 3D scanners collect distance information about surfaces within its field of view. The 'picture' produced by a 3D scanner describes the distance to a surface at each point in the picture.

3D scanners collect distance information about surfaces within its field of view and can collect information on surfaces that are not obscured.

The purpose of a 3D laser scanner is usually to create a point cloud of geometric samples on the surface of the subject. These points can then be used to extrapolate the shape of the subject.

For most situations, a single scan does not produce a complete model of the object. Multiple scans, from different directions are usually required to obtain information regarding all sides of the object. Bringing all scans in a common reference system is called registration of a point cloud to generate a first basic model. The whole process, going from the single range map to the whole model, is usually known as the 3D scanning pipeline.

Classification of 3D Laser Scanning

3D Laser Scanning or 3D Laser Scanners can generally be categorized into three main classes as mentioned below

- **Laser triangulation** is accomplished by projecting a laser line or point onto an object and then capturing its reflection with a sensor located at a known distance from the laser's source. The resulting reflection angle can be interpreted to yield 3D measurements of the part.
- **Time of flight laser scanners** emit a pulse of laser light that is reflected off of the object to be scanned. The resulting reflection is detected with a sensor and the time that elapses between emission and detection yields the distance to the object since the speed of the laser light is precisely known.
- **Phase shift laser scanners** work by comparing the phase shift in the reflected laser light to a standard phase, which is also captured for comparison. This is similar to time of flight detection except that the phase of the reflected laser light further refines the distance detection that is similar to the vernier scale on a caliper.

These laser scanning techniques are typically used independently but can also be used in combination to create a more versatile scanning system. There are also numerous other laser scanning technologies that are hybrids or combinations of other 3D scanning technologies. ■

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