Damage Assessment of a Wellhead Using Geometric Analysis

3D Modelling Case Study
Case Study: Damage Assessment of a Wellhead using 3D Computer-based Photogrammetry as a Geometric Analysis Tool

Location: UK Oil and Gas Sector

The Project:

During installation, a wellhead was impacted by a Blow-out Preventer (BOP), resulting in inward bending of the inner tree hub, deformation and smearing of material at the top and outer BOP mating surfaces of the outer hub, and wedging of the gasket between the inner and outer hubs. The client required the geometry of the wellhead to facilitate removal and replacement of the damaged gasket.

![Figure 1: Wellhead and Tree Cap Prior to Gasket Removal](image)

The Solution:

Welaptega constructed two 3D models to provide the geometry of the wellhead prior to, and following the removal of the gasket. A marker and two magnets were placed on the wellhead during photography to provide scaling references.
Data Collection:

The 3D modeling system was deployed to a depth of approximately 140m to capture images of the wellhead from the camera stations shown in the following figure. Camera stations are represented in purple, and the model point cloud is shown in yellow.

![Camera Stations Used for Image Capture](image)

A total of 164 images were processed to generate the model shown in the following figures.

![Wellhead 3D Model I (2D)](image)

![Wellhead 3D Model I (2D with photo-overlay)](image)
The same model is provided below in 3D. Rotate by clicking the model to activate, then clicking and dragging the mouse cursor. The model surface can be viewed in using different surfaces by changing the “Model Render Mode” setting.

*Click model to activate.

The wellhead I model was exported as a *.stp file and provided to the client to facilitate the design of several remote and diver-operated tool systems, including a tool to hold the well cap in place (Figure 6), a diamond wire cutting tool to remove smeared material and dress sealing faces (Figure 7), and a tool to assist with the removal of the damaged gasket.

Divers were then deployed to remove the damaged gasket, grind the outer hub surface to be flush with the rest of the wellhead, and cut or bend the internal tree cap to prevent obstruction of tooling to be deployed at a later date.
Figures 6: 3D model showing well cap retention tool in place

Figures 7: Illustration of diamond wire cutting tool in place on well head
Following the removal of the gasket and excess material the entire wellhead was surveyed (Figure 8) and a second 3D model of the wellhead was created (Figure 9 and 10).
The model that is illustrated in Figure 9 is provided below in 3D (Figure 11). The model can be rotated by ‘left’ clicking the model to activate the 3D mode, and then clicking and dragging the mouse cursor. The model surface can be viewed in using different surfaces by changing the “Model Render Mode” setting (right click).

*Click model to activate.

Results:

Both 3D models were provided to the client as *.stp files, which allowed them to be imported into standard 3D CAD/CAM software packages.

The first 3D model (wellhead I) was used to design as ‘the plug’ to design the well cap retention tool, the gasket pulling tool, and the diamond wire cutting tool that was used to remove excess material.

The second model (wellhead II) was used to assess the condition of the sealing surface for the replacement gasket, and then was used by the valve assembly manufacturer to design the new interface.