Optimisation: Design of a Subsea Trencher Manifold

Wilde Analysis helped Forum Energy Technologies to evaluate the pressure drop through an existing manifold design using ANSYS FLUENT. The pressure drop data was then used with the FLUENT Adjoint Solver to automatically optimise the design of a new manifold for a subsea trencher. This resulted in a significant reduction in the loss coefficient within the system.

Company

Forum Energy Technologies was formed in 2010 by the merging of Forum Oilfield Technologies, Triton Group, Subsea Services International, Global Flow Technologies and Allied Technology.

Forum is a global oilfield products company providing services to the subsea, drilling, completion, production and infrastructure sectors of the oil and natural gas industry.

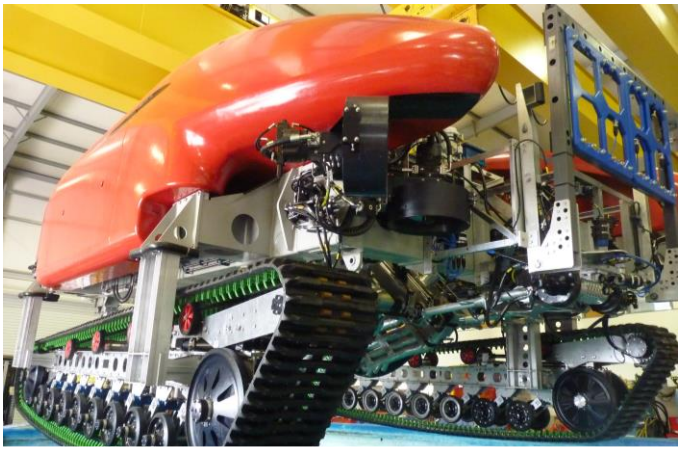

Fig 1: Subsea trenching vehicle (Courtesy: Forum Energy Technologies and Helix Canyon Offshore)

Background

The XT1500 subsea vehicle developed by Forum is used for the trenching and burying of rigid and flexible products and power cables below the seabed.

Jet trenching involves lowering jetting swords of the trenching vehicle into the seabed to create a continuous fluidisation zone. An eductor at the rear of the vehicle removes the fluidised material and ejects it to the sides of the trench. This creates a continuous trench behind the vehicle, so that a stiff product, such as a rigid pipeline, can lie in the trench.

To maintain the fluidisation generated by these main jets, a backwash of low-pressure water is injected into the trench from behind the main swords. This enables small, flexible products to be laid into the trench before the seabed compacts. A swivel manifold assembly on the jet arm allows the swords and nozzles to constantly point in the optimum direction when lowered to the maximum trenching depth.

> “” Wilde **quickly understood** the analysis that needed to be done on the Forward Tooling Assembly and **used their FEA and CFD expertise** to develop a new design to **optimise the efficiency** of the new vehicle **within the required time scales**.

Challenge

Forum was tasked with the design and construction of a new subsea vehicle based upon a smaller XT1200 vehicle currently in operation in the North Sea. A key objective for the new XT1500 vehicle was to improve the performance of the forward tooling assembly in order to fluidise the seabed more efficiently.

Forum is a long term user of **ANSYS** simulation software, and works closely with Wilde Analysis, its long term software, support and training supplier. During this design project, Forum engaged Wilde’s consulting team to assist with the redesign of the forward tooling assembly, including optimisation of:

- Internal flow characteristics
- Structural performance

- Strength to weight ratio
- Spatial design envelope and operational functionality.

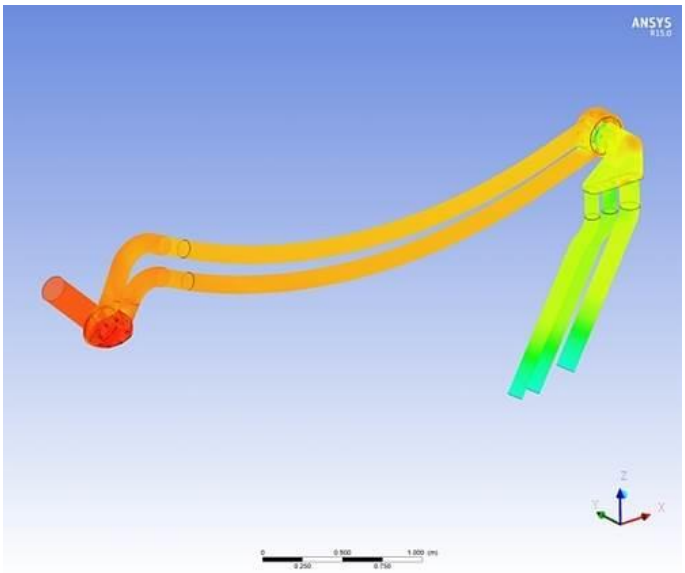

Fig 2: Total pressure through the network (Courtesy: Forum Energy Technologies and Helix Canyon Offshore)

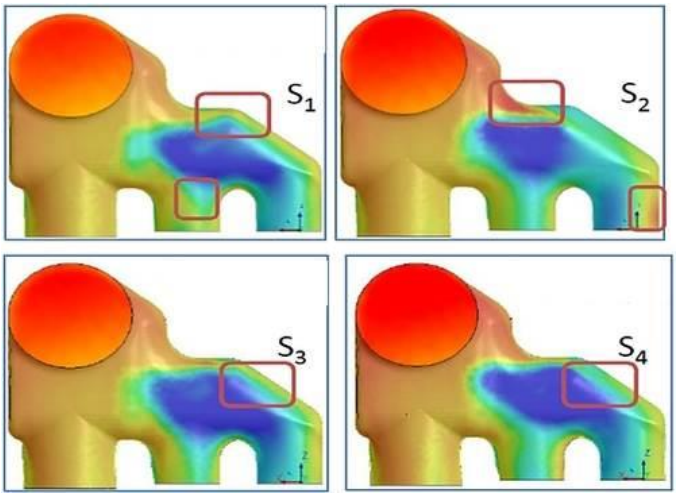

Fig 3: ANSYS Fluent Adjoint Solver design optimisation Iterations (Courtesy: Forum Energy Technologies and Helix Canyon Offshore)

Solution

To achieve these objectives, structural mechanics and fluid dynamics technical specialists at Wilde worked together to perform an initial design assessment and then to evaluate potential design improvements. Computational fluid dynamics (CFD) methods were used to improve the internal flow characteristics and finite element analysis (FEA) was then undertaken to assess the structural significance of any internal alterations. The team used **ANSYS** software throughout the project as the **ANSYS Workbench** user environment provides an ideal platform for geometry editing, meshing and computational solving for both FEA and CFD.

Forum specified the footprint of the manifold's internal components, together with the location of the inlet and three outlets. Wilde engineers analysed each of the components downstream of the manifold using the **ANSYS Fluent** solver to determine a loss coefficient for each. These were then applied to outlets of the manifold, ensuring correct flow distribution during the optimisation phase, in which losses across the system were minimised. This was achieved by exploiting the optimisation capabilities of the **ANSYS Fluent Adjoint Solver**, using pressure loss as the target variable. By allowing the mesh to adapt, an optimised shape was produced for the internals of the manifold.

Results obtained showed that the new design would have an expected reduction in loss coefficient of approximately 26%.

Fig 4: XT1500 Seabed Trenching System – Forward Tooling Assembly (Courtesy: Forum Energy Technologies and Helix Canyon Offshore)

Business Benefits

The FEA and CFD carried out by Wilde enabled Forum to improve the forward tooling assembly on their new trencher vehicle well in excess of what could have been achieved through more traditional engineering methods.

The successful application of simulation and optimisation techniques, together with a close working relationship between the Forum and Wilde engineering teams, resulted in a vastly enhanced design. All initial objectives were satisfied and subsequent physical testing confirmed that operational performance had been significantly improved.