Fault Finding by use of a Virtual System Model in SimulationX

TNO-0033

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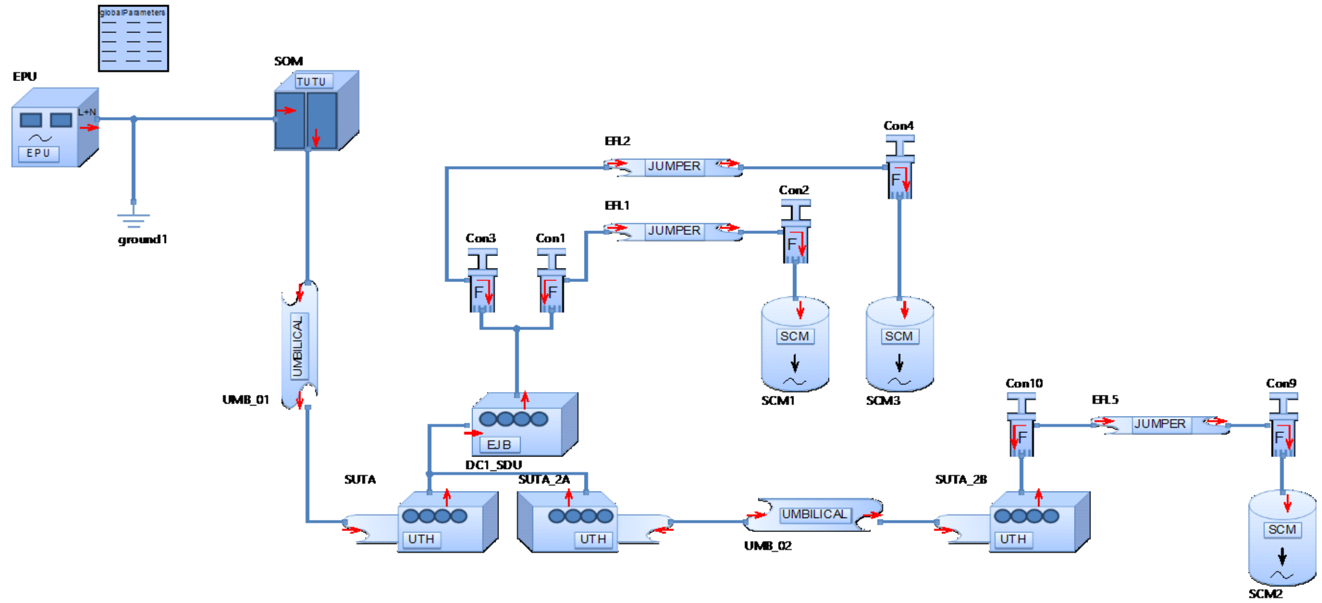

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Visualize the solution – Remove the risk – Reduce the cost

1. Introduction

The majority of complex subsea Power & Communication (P & C) systems will in their lifetime experience problems executing commands or giving feedback from subsea transducers. This can be software problems or malfunction in components. Some of the components will also see some degradation over time, which again can influence in system behaviour and require an operation outside the system limits set during commissioning.

When these problems occur, the engineers often have limited information from system to understand what's causing the problems. Additional tests and measurements are difficult to perform since the system is located under water. By building a virtual prototype of the system the engineers can set up the system with theoretical malfunctions and degradation and see if they get similar results as from the real system transducers.

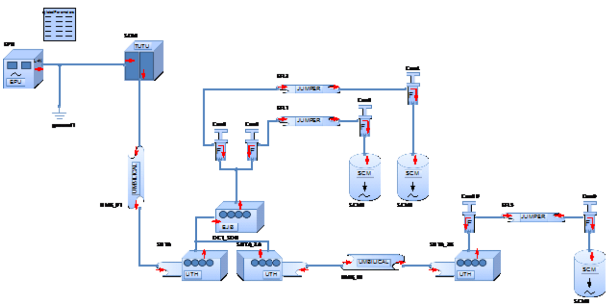


Figure 1 Virtual Subsea P & C System

Figure 1 shows a typical Virtual System Model set-up in SimulationX®. Each main component is represented by separate elements and their behaviour is described by mathematical equations behind.

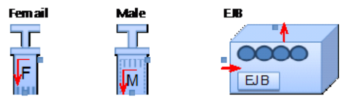
By introducing failure or degradation in single elements, the Virtual System Model will show how the complete system performance will be with the failures included. To achieve as good results as possible it is important that the component experts participate in describing the behaviour of each component in different failure modes. If the behaviour is unknown, separate component tests should be set up to get correct behaviour in each component. When all components are described in sufficient detail, the system engineers can use the Virtual System Model and run different scenarios to better understand what's causing the mal-function.

2. System Elements

Each of the elements used in the Virtual System Model has a certain description of its behaviour. Typically, this description is based on theory, data sheets, test data or in some cases ideal behaviour. Common for all components is that they normally describe the behaviour without any degradation or malfunctions included.

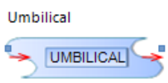
SimulationX® opens for including malfunction and degradation of components locally. A short description of the elements used in the Virtual System Model shown in Figure 1 is given below.

Pin Connector and Electrical Junction Boxes:



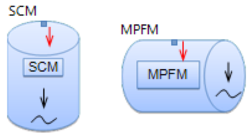
The pin connectors and Electrical Junction Boxes are normally modelled as ideal connections. However, the elements in SimulationX® also includes possibilities for including poor or failing connection by an increased resistance and/or a short circuit between line and ground by an increased conductance. The input for poor or failing connection can be a fixed number, an equation or external function with dependency from other elements in the Virtual System Model.

Cables:



The cables are modelled with line resistance, inductance, capacitance and isolation resistance. The parameter inputs can be fixed, variable or referenced from other elements in the Virtual System Model. Using equations or system references as input allows the user to simulate one or more faults developing over time.

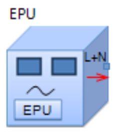
Subsea Control Modules:



The Subsea Control Module and the MPFM contains a power load and a transformer. The load and power factor as well as transformer parameters can be given as fixed numbers, equations or references from other elements in the Virtual System Model.

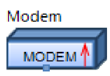
The module power load can also be described as a curve which again enable input of external data directly to the element. This data can for instance be test data of variation in power load with increased temperature or failure in a transducer powered from the module.

Electrical Power Unit:



The EPU can be set with fixed or variable voltage output. This allows the user to quickly examine fault modes at different voltage levels.

Modem:



The modems input parameters are Signal and power levels as well as input and output resistance. The parameters can all be fixed, variable or references.

3. Summary

As described in the previous section, each element used in the Virtual System Model can be set up to represent the real behaviour of the component with all known malfunctions and degradations included. A Virtual System Model is a valuable tool to better understand a systems behaviour when single components starts to fail. Especially for a system with difficult access. The system can be tested with different failures and the results can be compared with the sensor readings from the real system. Based on the comparison the engineers can narrow down the possible failure causes and give the engineers detailed information about the system behaviour under variable conditions. All these virtual test results are valuable information to bring to the table in discussions with experienced field engineers.

In older “Brown Field Systems” there will be a challenge to set up the initial Virtual System Model because the degradation is unknown and can have occurred in several components. However, a Virtual System Model will help the engineers to test their theories and give a better basic for the diagnostic even if the virtual test data does not have the exact same values as from the real test data.

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