Statistical Modelling of Offshore Wind Farm Construction

Logistics to Provide a Forward View

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Abstract

One of the key challenges faced by windfarm installation contractors, particularly working offshore, is accurate modelling and forecasting of project logistics.

Variables such as inclement weather, variable resource availability, and process flow interdependencies causing bottlenecks can be difficult to predict and model accurately.

Houlder has developed a specialised modelling software, improving logistics planning of windfarm construction. Calculated using real hindcast data, project outcomes across a range of past years give reliable indicators of future performance.

Initial Objectives

The initial scope of the software was a bespoke analysis, tailored to the calculation of whether a buffer of turbine components could be achieved for the Siemens Wind Power Walney extension.

A project specific process-flow network was constructed, and conditional criteria applied to each process, allowing the entire operation to be simulated subject to hindcast weather data for the past 15 years.

The method was then developed in order to apply to any process-chain model.

Refined Objectives

The objectives then evolved to the following:

- Create a simple, intuitive GUI frontend, allowing for rapid modelling of process and component flows.
- Provide tools to easily define conditional activation logic for processes and resources.
- Facilitate modelling the same operation with multiple configurations of committed resources.
- Perform these analyses in the time domain, using real, hindcast data to produce project schedules for each year where data was available.

Fig 1: Achieved component buffer in original analysis.

Tools

Fig 2: A ‘Control Node’ applying its control condition to 6 subject nodes. Each of the subject nodes must meet the control condition in order to operate.

The key building blocks of the concept are nodes (process gates), resources and control nodes. These can rapidly be created and connected within the developed GUI.

Fig 3: Resource Creation, including availability constraints, and defined hours of operation.

Fig 4: Attaching a process node to a control condition (in this case, limiting weather criteria) at an off-screen location.

Control nodes can be connected in groups of and/or conditions. The current control node options include construction and component checking, activation sequencing, active hours, and any limiting environmental criteria, or operating range. Complex logic can be achieved by combining these nodes.

Fig 5: Adding deliveries to factory nodes.

Fig 6: Number of constructed components and sub-components at each node across the project duration.

Fig 7: Subject to a set of control nodes, probability that a weather window will be of length ‘n’ timesteps (timestep duration is user defined)

Capabilities

Useful results from the analyses include:

- Identification of process bottlenecks
- Calculation of resource and process NPT, or slack time.
- Quick comparison of scenarios with differing quantities of committed resources, aiding in cost/benefit analysis.
- Resource-centric models as opposed to Process-centric produce completed tasks rather than products — allowing for resource scheduling and route optimisation.
- Utilisation figures for machinery, equipment, and resources

The data produced is a complete model of the operation from start to finish, the potential exists for further post-processing to extract useful information using the new tools.

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