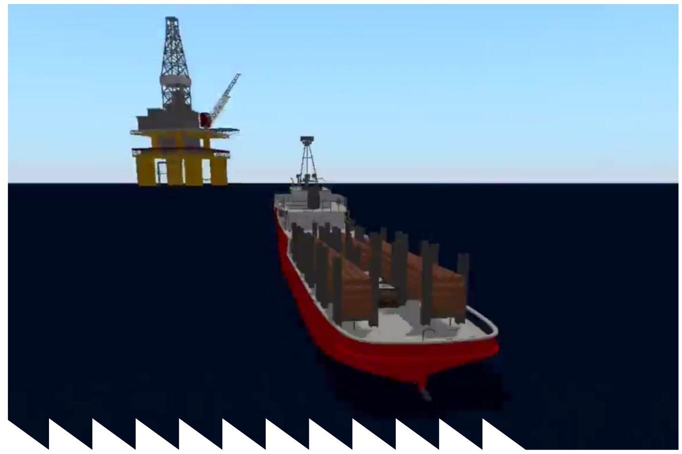
Use of Simulation and Modeling for Efficient and Effective Scheduling of Offshore Supply Vessels



Introduction

Shell Gulf of Mexico (GoM) Logistics moves more than 50,000 tons of materials and equipment to offshore facilities each month using 40+ offshore supply vessels. The shipments are broken into voyages which include loading of the vessel, transiting to offshore locations, transferring of materials offshore, returning to port, unloading, and possibly tank cleaning. The offshore facilities vary from 30 miles to more than 300 miles offshore. In a typical month, Shell will schedule over 200 voyages transporting more than 9,000 tracked items where an item could be a simple pallet of chemicals to 20,000 feet of tubular goods. The offshore supply vessels employed come in variety of sizes and configurations. The vessels range in length of 100 to over 350 feet with cargo capacities ranging from 500 to 6,000 tons. Open back deck areas range from 20' x 80' to 65' x 260'. Below deck storage varies in terms of capacities and types of storage. Many vessels are designed to carry both liquid and dry bulk.

Problem

The challenge is one of size and complexity. The traditional process revolves around shipping requests, which identify materials and equipment that need to be shipped in the next 5-10 days. The requests include the pick-up and delivery points, descriptions, quantities, dimensions, weights, and time constraints. (Offshore facilities have limited storage capacities and carefully plan when material is delivered and picked up offshore.) The shore base can sometimes meet the demand for shipments with regularly scheduled "milk runs" that run to each offshore location at scheduled intervals, but more than not, the demand for cargo is not regular and must be met by scheduling voyages to meet the pick-up and delivery constraints of the offshore location. The manual planning and scheduling of shipments has proven challenging due to frequent shifts in delivery windows, large number of items, variability in transit times and weather, and congestion within the port facilities. A study of "non-productive" vessel time brought to light a significant opportunity to improve the effectiveness of the scheduling process.

Solution

The solution, modeled from land transportation optimization systems, consists of three primary tools—one for real time status of the vessels, another for up-to-date demand requests, and finally a scheduling system. Due to the variability of weather, permissible delivery times, loading and unloading times, vessel traffic, and changing geographical locations of floating rigs, it became clear that the scheduling tool should be built on a spatially aware, discrete event simulator and be capable of assessing the risks of a given schedule. These challenges, coupled with the value of 3D visualization and intelligent objects in model development lead Shell to Simio.

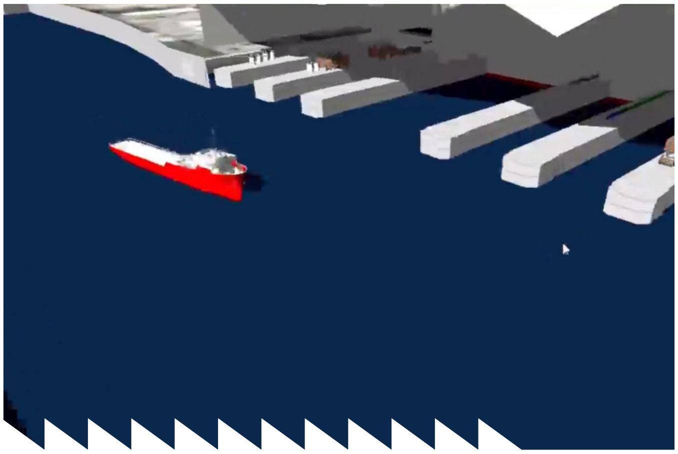
The Model

The model started with a map of the GoM region being placed in the model and sized to match the scale of the model. The ports, slips and offshore facilities were then automatically placed on the map based on their latitude and longitude.

Shell operates from two primary port locations (Fourchon, LA and Galveston, TX) in the GoM region from where the majority of vessel shipments originate. Each port has a number of loading, unloading, and tank cleaning slips. Information regarding the slips' capabilities, vessel capacity, selection ranking, and load and unload times are configured for each slip.

Offshore rigs are the consumers of the demand. Rig definitions are similar to slips with slip capacity, load and unload times. Vessel travel durations are determined based on the distance between the port and rigs and the travel rate of the vessel which can vary by weather and location.

The size of the vessel determines the number of vessels that can fit in a given slip or berth. For each vessel, discrete capacities (area and weight) for above-deck cargo and volume-based capacities for below-deck cargo (fuel, water, dry bulk and liquid build) are configured. Additional data items such as maximum payloads, day rates, travel rates, load and unload times are defined.



General Process Flow

Shipment demand is read into the model from an external data file(s). The data contains information on where and when the material will be available for delivery. Cargo type, priority, quantity, unit of measure as well as time when the demand needs to be at its destination are also contained in the order demand.

When a demand item is available for pickup, vessel selection logic is used to determine when the item will be picked up and on which vessel. The vessel selection logic first chooses the most critical materials to be delivered and then selects the best vessel to deliver the material based on a cost model. In determining cost, a number of factors are considered which include late delivery cost, weather downtime cost, "unused capacity cost", tank cleaning cost, slip usage, and day usage cost.

Once demand and vessel have been determined for a voyage, the vessel will move to the designated slip location(s). On arrival at each slip location, the vessel will progress through stages modeling slip tie-up time, cargo load times, and departure times. If additional demand is to be loaded at another slip on the voyage, the vessel will travel to the alternate slip once it is available.

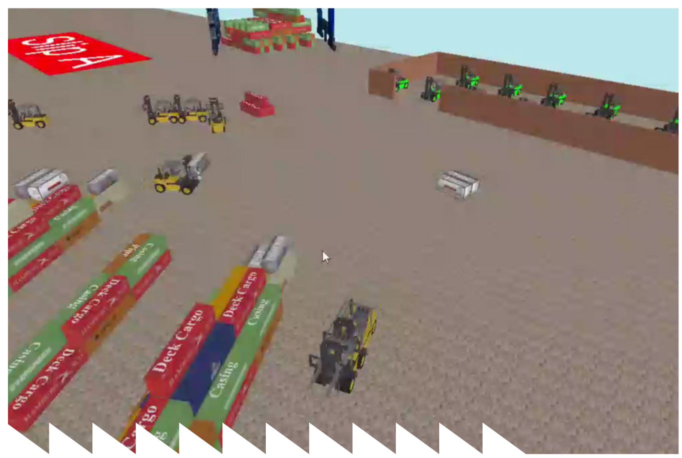
Once all of the demand is loaded on the vessel, the vessel leaves port. The vessel's destination is determined based on the most critical demand item on the vessel. The rate that the vessel will travel is based on weather conditions and whether the vessel is operating in economic or max travel rate mode.

Upon reaching the rig, the vessel will go into offshore standby mode or "buffer time". The buffer time is a way to account for planned "float" in the vessel's delivery schedule and is input with the demand items. After this delay, the vessel seizes the rig's crane to start unloading.

Once the crane is seized, the vessel sets up dynamic positioning to begin unloading. Once all cargo is unloaded, the model will check to see if there is return cargo that can be loaded. The vessel will then depart and determine its next destination. The next destination can either be another rig or port.

Outputs and Reports

Outputs from the Simio tool are both varied and comprehensive. Summary statistics allow the user to quickly gauge the quality of a schedule based on metrics that drive operations. Gantt charts visually display the details of each rig, slip, vessel, and demand item enabling the user to view the schedule from various perspectives. Exportable dashboards and detailed reports promote simple interpretation and constraint analysis. All outputs are customizable which allows the user to react to changing business objectives. When the schedule has been finalized, it is published to a web portal for a number of users both inside and outside of Shell to view. The resulting level of transparency promotes confidence in the schedulers and the ability of logistics to deliver in a complex and dynamic environment.



Paper by:

William Birch, Kate Mick & Neal Hennegan - Shell E&P Company

Glen Wirth - Simio LLC