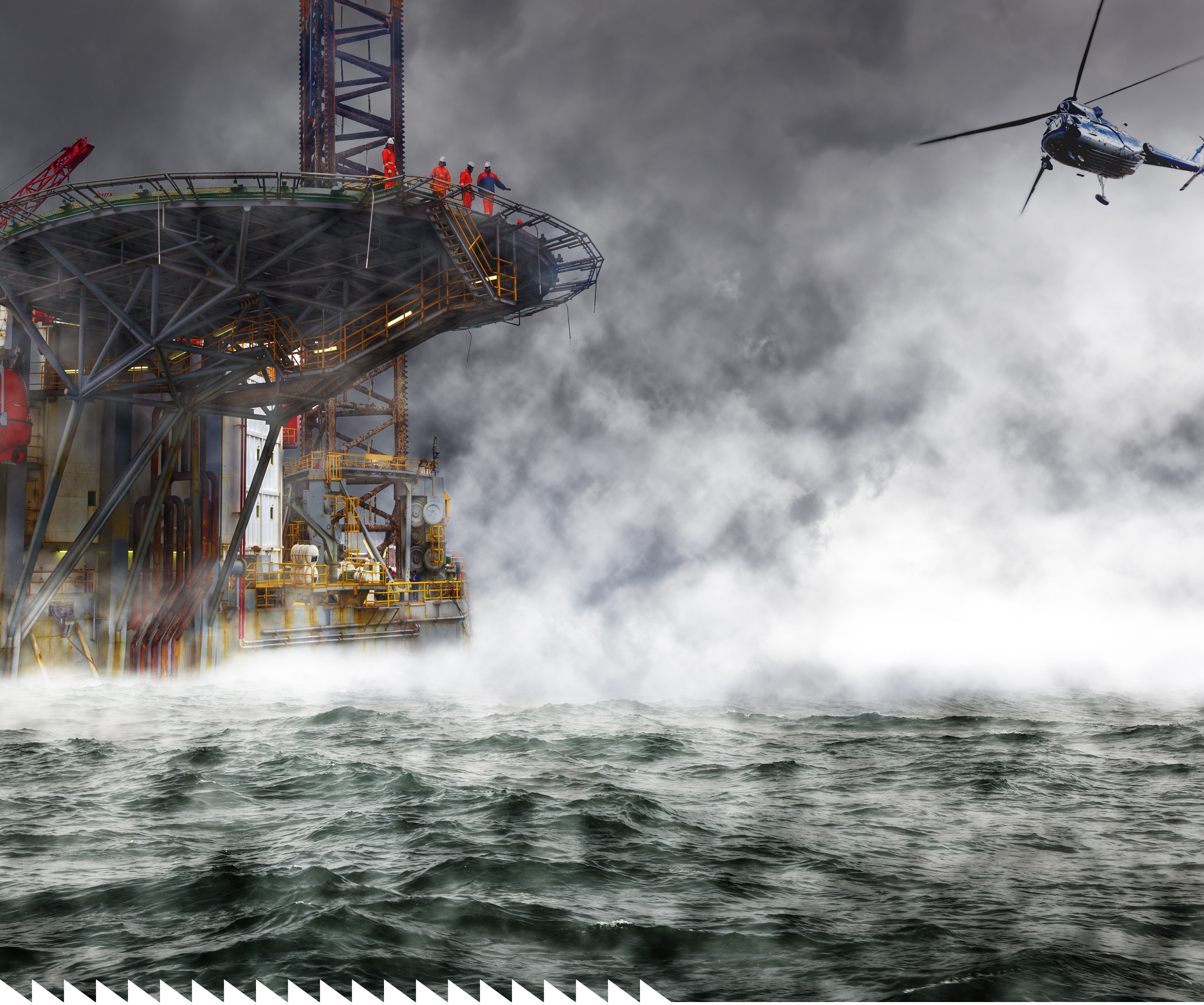


Simio Spring 2015 Student Competition

Simio Drilling Logistics

This contest problem is loosely based on an actual logistics problem at Shell Oil Company.

Simio
Forward Thinking

Problem Overview

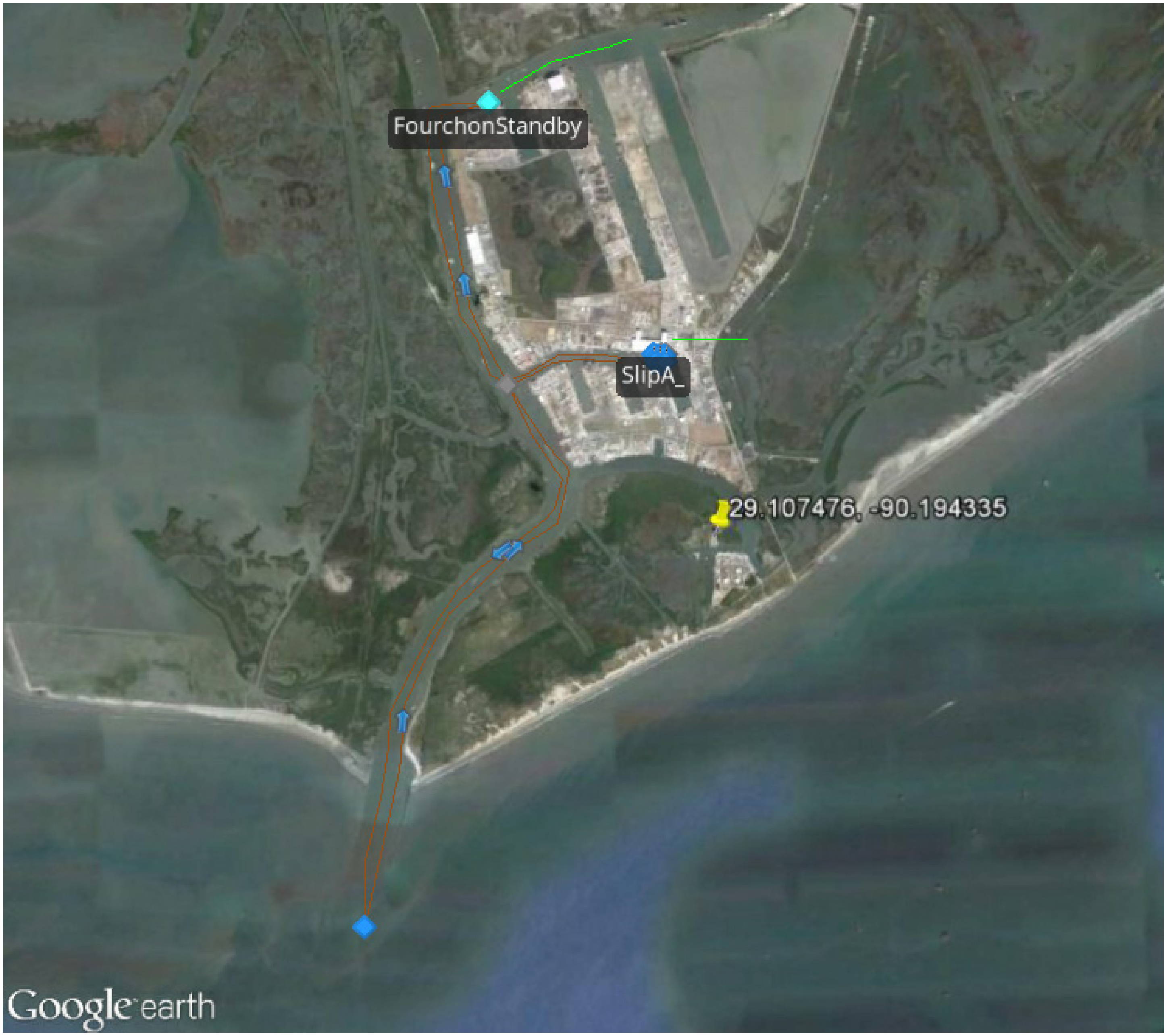
Simio Drilling Logistics (SDL) charters a number of offshore vessels to move material to and from various offshore drilling locations. The "as is" system dedicates a small number of vessels to service four offshore locations. Since the cost of an offshore rig going idle due to a lack of material is extremely high, SDL tends to procure vessels to meet maximum expectations to maximize drilling efficiency. Data indicates that there is much standby time at both ports and the offshore locations. SDL would like to improve vessel scheduling and potentially reduce the size of the offshore vessel fleet through operational improvements.

The first part of this problem is to model the "as-is" system with the current fleet of vessels dedicated to specific drilling locations. This system has three different vessel types, and models the transport of a few different cargo items to the offshore rigs. The complexities of the system include the loading of the cargo onto the vessels and impact of weather and wave height on vessel transports and unloading. This "as-is" model will provide a baseline for evaluating improvement strategies for the system.

The second and most important part of this project is to develop and evaluate alternative strategies to develop a "to-be" system that lowers the overall cost while maintaining the same high service levels. The project results will be judged both on the quality of the simulation models as well as the overall effectiveness/cost of the proposed "to-be" system.

A deep water well in the Gulf of Mexico can take months to drill. A well consists of multiple concentric strings of casing (pipe) beginning with the outermost string. A drilling unit or "rig" drills through the bottom of each successive casing to a new depth and then cements a new inner string into the last section of hole drilled. These steps are planned out in advance although variations in the time to complete each step are quite common. The casing, cement, drilling fluids, supporting equipment, etc. are assembled in advance and staged at the vendor's docks (slips) for shipment offshore. Offshore supply vessels pick up the materials at port and transport the material offshore to the drilling unit. The attached file contains a typical demand cycle from a rig. The arrival times in the file represent the time at which the material order is placed – you can assume that the material is instantly available at the port, but cannot be initiated any earlier than this time (except per the deviation described below). Each rig follows the same demand cycle, which repeats itself approximately every 744 hours, but their consumption rates (and hence actual material request time) varies for each item, according to a normal distribution of mean 0 and standard deviation of 6 (e.g. material may be requested 6 hours or more before or after the demand cycle arrival time). And each rig is currently at a different point in the demand cycle. The DonnyAllen rig is currently beginning at 48 hrs into the demand cycle, the DanTeller is currently at 168 hrs into the cycle, the Olympic is at 288 hrs and the Billy is starting at the top of the monthly demand cycle.

SDL has three slips potentially available in their Fourchon Port but only two of these slips are currently active. When active, a slip costs $350,000 per month to operate. If it is used at all during a month it must be acquired for the entire month. When cargo is demanded by a rig, the cargo is loaded onto a vessel while the vessel is waiting at a slip. If a vessel is not being loaded at a slip and not transporting cargo to a rig, it waits in a designated location named FourchonStandby, shown in the figure below. Travel capacity within the canals and the waiting areas at FourchonStandby are not system constraints.



When a vessel has been selected to service a rig, it moves into a slip and is loaded with cargo that has been requested by that rig. Additional cargo is loaded onto the vessel if there is appropriate deck space or storage capacity. There are six different types of cargo considered in this analysis, some of which are transported on the deck of a vessel (Figure Below) and some which are transported below deck in storage. Each vessel has limited deck capacity and can carry a certain amount of items in below deck storage (e.g. bulk storage). Above deck storage is limited by area; below deck storage is limited by the total volume of the items. Each Deck Cargo item (unit) requires 75 sq ft of deck space, each Pipe bundle requires 320 sq ft, and each Casing bundle requires 350 sq ft. Fuel, Liquid Bulk and DryBulk are stored below deck on a vessel with expected volumes as indicated in table below. The quantity of each item that is requested each time a rig requests this type of cargo, is listed below:

Item	Quantity	Loading/Unloading Time
DeckCargo (units)	Discrete – 10%,1, 40%,3, 50%, 5	10 minutes per unit
DryBulk (m^3)	Triangular(1500,2500,3500)	2500 m^3 per hour
Fuel (m^3)	Triangular(2000, 4000, 6000)	3000 m^3 per hour
LiquidBulk (m^3)	Triangular(1000,1200,5000)	2800 m^3 per hour
Pipe (Bundles)	Discrete – 30%,10, 30%,14, 40%, 16	12 minutes per bundle
Casing (Bundles)	Discrete – 30%,8, 30%,10, 40%, 15	14 minutes per bundle

The current fleet of vessels consists of three different types of ships, each which can hold a different amount of cargo and travels at different speeds. These vessels are leased on a monthly basis.

Vessel Type	Travel Rate (Nautical Miles per Hour)	Deck Space Capacity (sq ft)	Bulk Storage Volume Limit (m^3)	Total Daily Cost
200	Triangular(8, 10, 12)	8,000	6,000	$45,000
400	Triangular(8, 10, 12)	11,000	7,000	$55,000
FSB	Triangular(10, 12, 15)	5,000	2,000	$35,000

Vessel Name	Vessel Type
Clapper	200
Pretender	400
SlimDuck	FSB
BlaireDandies	400
BannaWest	200
HarveyBluebird	FSB
HarveyHacker	FSB
DonaldRice	400
SammyDandies	400
MarvinDuck	200
CarlaDandies	FSB
HarveySeaPlane	200

Weather is a factor that needs to be considered in this system. If the weather is severe enough, a vessel can be deemed unable to travel or unable to drop off cargo and the weather restrictions vary depending on the type of vessel. In this model, we will consider two weather factors; wave height and wind speed. The current weather conditions will be sampled from the following distributions;

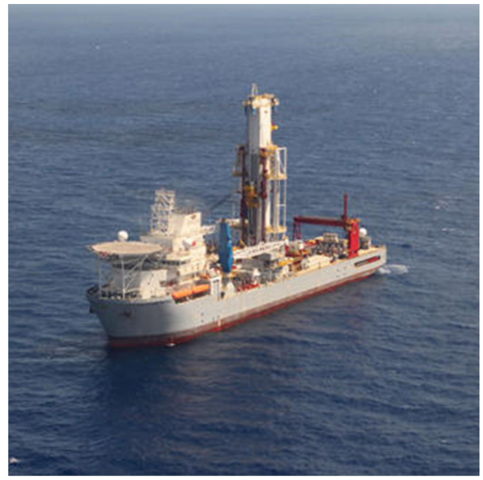
Current Wind Speed: Random.Exponential (10), Nautical Miles per Hour

Current Wave Height: Random.Exponential (4), Feet

The weather conditions are available once every 6 hours and those conditions are considered the current conditions for the next 6 hours. The unloading and travel limitations of each vessel are listed below.

Vessel Type	Wave Height Unloading Limit (Feet)	Wind Speed Unloading Limit (Nautical Miles per Hour)	Wave Height Travel Limit (Feet)	Wind Speed Travel Limit (Nautical Miles per Hour)
200	10	24	15	32
400	10	24	15	32
FSB	8	20	12	30

The current operational procedures specify that certain vessels are assigned to specific rigs and they can only service the rigs to which they are assigned. The figure below illustrates typical drilling rigs that will be serviced. The vessels SlimDuck, Pretender and HarveySeaPlane service rig Billy; BlaireDandies, MarvinDuck and CarlaDandies service rig DanTeller; Clapper, DonaldRice and HarveyBluebird service rig DonnyAllen; and BannaWest, SammyDandies and HarveyHacker service rig Olympic.



Rigs managers desire the delivery of the required cargo within 24 hours of the request, but it is imperative that the demand is filled within 60 hours of receiving the order to avoid any shutdown of the drilling process.   A rig will be forced out of service if any item is late and will incur lost revenue charges of $50,000 per hour until the missing material is delivered and unloaded. Current operations generally fulfill demand within the desired time frame (e.g. most items arrive within 24 hours) but they typically incur a few hours per year of rig downtime. Management would like to explore options that would allow them to reduce the cost of the vessel fleet since it appears as though there is significant idle time for each vessel. Yet because missed demand deadlines are so costly, it is important that the current service levels are maintained or improved after any cost reduction changes are made.

Animation Tips

SDL has provided two images that could optionally be used in the simulation model. If used, these images can be scaled with Simio's facility window grid so when the vessels travel in Simio, everything is "to scale". First place the image titled Fourchon.jpg. The length of this image is 16,720 meters. Place the center of this image at the origin of the Simio grid (0,0). The tools to help place this at the center are provided by Simio in the form of green dots that can be lined up with the Simio grid. Use the grid to visually place the center of the Fourchon image at (0,0). The length of the GOM.jpg image is 647,000 meters. Place this image at the origin also and consider lowering it down the Y axis slightly so you can see the Fourchon image on top, when zoomed in. The following table shows where to place certain nodes in the Simio grid, so the travel distances are calculated correctly. The figure on page 3 shows the nodes placed and some example paths where the vessels travel through the channels.

	X	Z
FourchonChannel	-4114	4619
FourchonStandby	-2667	-5038
Billy	102673	103240
DonnyAllen	91038	114571
DanTeller	106834	105798
Olympic	92628	105585
SlipA	-722	-2046
SlipB	-658	-2049
SlipC	-590	-2049

Extended Problem

This following extensions are not part of the base competition. They may be submitted, but performance on the extensions will not impact the judging on the base problem. Submissions will be considered for Honorable Mention awards. These extensions are provided to supply an extra challenge for instructors and students who want an opportunity to learn more about simulation-based planning and scheduling.

Use the extended features of Simio Enterprise Edition to extend the system design model for day to day planning and scheduling. If you do not already have Simio Student Enterprise Edition, you can contact marthur@simio.com to request an upgrade to your student Design Edition license.

Extended Challenges

- Now that you have a well-designed system from your base (design) model experimentation, use Enterprise features to generate an automatic schedule by extending the design model.
    - How will you convert the stochastic model for deterministic use?
    - How will you deal with initializing the system to current state?
- Provide tools to allow a scheduler to generate, evaluate, and distribute good daily schedules:
    - Create a detailed Gantt chart of the next 5 days of operation.
    - Determine how targets may be added to the delivery schedules and evaluate how those targets are met over time.
    - Use output tables and/or states within the data tables to write out information that may be useful for tracking data and generating reports.
    - Create dashboards and other reports that could be shared with ship and rig operators to inform them of the plan.
    - Consider what inputs (like order priority) should be made available to schedulers to provide adequate capability for them to improve a daily schedule.
    - How can a scheduler evaluate the risk and the robustness of the schedule to feel most confident of meeting stated objectives?
- Evaluate other proposed system changes
    - A rig can unload only a single vessel at a time.
    - Restrict unloading of materials at rigs to between 6 am and 6 pm.
    - Each vessel needs to have preventive maintenance once every six months +/- 4 weeks.

Demand Data

CargoItem	ArrivalTime(Hours)
DeckCargo	0
DeckCargo	0
LiquidBulk	0
DeckCargo	24
DeckCargo	24
DeckCargo	24
Fuel	48
DeckCargo	48
LiquidBulk	48
Casing	72
DeckCargo	72
DeckCargo	72
Pipe	96
DeckCargo	96
DeckCargo	96
Fuel	120
DeckCargo	120
DryBulk	120
DeckCargo	144
DeckCargo	144
Casing	144
DeckCargo	168
DeckCargo	168
DeckCargo	192
LiquidBulk	192
DeckCargo	192
DeckCargo	192
DryBulk	216
DeckCargo	216
DeckCargo	240
Pipe	240
DeckCargo	240
DeckCargo	240
Casing	240
DeckCargo	264
DeckCargo	264
LiquidBulk	264
DeckCargo	288

Demand Data

CargoItem	ArrivalTime(Hours)	CargoItem	ArrivalTime(Hours)
DeckCargo	288	DeckCargo	432
Pipe	312	Fuel	432
DeckCargo	312	DeckCargo	432
DeckCargo	336	LiquidBulk	432
DeckCargo	336	DeckCargo	456
DryBulk	336	DeckCargo	456
Casing	336	DeckCargo	480
DeckCargo	336	DeckCargo	480
DeckCargo	360	DeckCargo	480
LiquidBulk	360	Casing	504
Fuel	360	Pipe	504
DeckCargo	360	DeckCargo	504
DryBulk	384	Fuel	504
DeckCargo	384	DeckCargo	504
Pipe	384	DeckCargo	528
DeckCargo	408	Fuel	528
DeckCargo	408	DeckCargo	528
DeckCargo	408	DeckCargo	528
DeckCargo	432	Casing	528

Demand Data

CargoItem	ArrivalTime(Hours)	CargoItem	ArrivalTime(Hours)
DeckCargo	528	Fuel	624
DeckCargo	552	DeckCargo	624
LiquidBulk	552	DeckCargo	624
DeckCargo	552	DeckCargo	624
DeckCargo	552	Pipe	624
Casing	552	Casing	648
Pipe	552	DeckCargo	648
DryBulk	576	DryBulk	648
DeckCargo	576	DeckCargo	648
DeckCargo	576	DeckCargo	672
Pipe	576	DeckCargo	672
DeckCargo	576	DeckCargo	672
Casing	576	DeckCargo	672
DeckCargo	576	DeckCargo	720
DeckCargo	576	DeckCargo	720
DeckCargo	600	Pipe	720
LiquidBulk	600	DeckCargo	720
DeckCargo	600	DeckCargo	720
Pipe	600	EndOfDemandCycle	744
Casing	600		