The Supply Chain Game

The Supply Chain Game is an online simulator where participants can expand and manage a network of factories and warehouses for Jacobs Industry to supply new markets in new regions on the fictional continent of Pangea. Pangea includes Calopeia (NW), Sorange (NE), Entworpe (SW), Tyran (SE), along with Fardo (an island). This document provides a summary of the potential markets for Jacobs Industries, along with a description of the current operations.

Reviewing this information and pondering effective strategies in advance will enhance your profits on Tuesday afternoon (but is not required). Also note the simplifying hint provided in Section 5.3.

Figure 1. Pangea
2 Markets

2.1 The Product

Jacobs Industries produces a single product (an industrial chemical) that can be mixed with air to form foam that is:

- Lightweight;
- Stable over a very wide range of temperatures;
- A very efficient thermal insulator; and
- A very efficient acoustic insulator.

Jacobs sells to manufacturers of products that will pay a premium for foam insulators with these properties. All of Jacobs’ customers purchase the foam chemical as a substitute for competitors' products. If Jacobs cannot meet the order when it is received, the customer makes its purchase from a competitor without any loss of future demand.

Jacobs began marketing to manufacturers of air conditioner retrofit kits on day 1 and on day 640 began extending to other markets in other regions. Additional information on the regions and markets is provided below.

Jacobs will begin migrating demand to a new technology using a different supply chain network on day 1095, as described in Section 2.7 (End of Life Issues).

2.2 Calopeia: Air Conditioner Retrofit Kits

The original application of the foam was for kits to retrofit or repair old industrial air conditioners. The properties of the foam made it possible to improve the efficiency of existing air conditioners within the constraints imposed by existing facilities. The industry that builds and sells these kits is concentrated entirely in Calopeia. The market is highly seasonal but otherwise very stable. There are no long-run market trends, either upward or downward. The size of orders is random with an average size of 7 or 8. Orders also arrive randomly. A representative demand profile is provided in Figure 2, and you will have the opportunity to explore actual historical demand on-line (Section 5.1).
2.3 Sorange: Hardwood Floor Laminates

Hardwood floors are coming back into fashion. A common product addressing this market is a laminated wood panel that is made to snap together to easily cover a floor. However, poor acoustic properties of the laminates have been a problem in apartment buildings and condominiums where sound is easily transmitted to downstairs neighbors. Manufacturing of the laminates is concentrated in Sorange and two large manufacturers of laminates have recently added premium product lines with better acoustic insulation. These laminates are a market for Jacobs' foam chemical.

Although order size and arrivals are random, the long run average demand will grow linearly from day 640 until day 1095. The average order size is about 8 drums and demand is not seasonal. A representative demand profile is provided in Figure 3, and you will have the opportunity to explore actual historical demand on-line (Section 5.1).
2.4 Tyran and Fardo: Premium Home Appliances

Customers of premium home appliances, especially driers and dishwashers, are willing to pay a premium for sound insulation. An appliance manufacturer with factories in Tyran and Fardo is offering a premium acoustic insulation option on several of its high-end appliances. These appliances are a market for Jacobs' foam chemical.

Orders arrive to Jacobs directly from the appliance factories. Both order size and order arrivals are random. Demand began on day 640 and grew to its final long-run average a month later. Long-run average demand is not seasonal and is not trending either upward or downward. The average order size is about 8 drums. A representative demand profile for Tyran is provided in Figure 4, and you will have the opportunity to explore actual historical demand on-line for both Tyran and Fardo (Section 5.1).

Figure 4. Representative Demand Profile for Tyran
2.5 Entworpe: Insulation Products for Commercial Builders

A single manufacturer supplies insulating quilts for insertion into walls in new construction projects where both wall thinness and thermal insulation are important. These projects include laboratories inside office buildings and saunas inside commercial gyms. The insulating quilts are a market for Jacobs’ foam chemical.

The quilt manufacturer uses a reorder point policy where 250 units are purchased whenever its inventory drops to a predetermined level. So although orders are always for 250 units, orders arrive randomly. Demand started on day 640 and was stable by day 670. Long-run average demand is not seasonal and is not trending either upward or downward. A representative demand profile is provided in Figure 5, and you will have the opportunity to explore actual historical demand on-line (Section 5.1).

![Figure 5. Representative Demand Profile for Entworpe](image)

2.6 Fardo: Private Airplanes

A make-to-order assembler of single-engine airplanes uses the foam as an insulator. The order size and order timing are random, although the average order quantity is about the same as that of the appliance factories in Fardo and Tyran described earlier. Demand began on day 640 and stabilized by day 670. Long-run average demand is not seasonal and is not trending either upward or downward.

A representative demand profile for Fardo is provided in Figure 6, and you will have the opportunity to explore actual historical demand on-line (Section 5.1).
2.7 End of Life Issues

A new foam technology is in development that will render the current technology obsolete. Factories producing the new foam will come online on day 1095. All customers are aware of the pending new technology, and as result, all demand will abruptly end on day 1095. All unsold inventory will be worthless on day 1095.

3 Operations

3.1 Operations Overview

Jacobs’ distribution network consists of a single factory and a single warehouse, both in Calopeia. The warehouse only supplies air conditioner retrofit kit manufacturers, who are all in Calopeia.

Jacobs produces its chemical in batches, loads the chemical into small plastic drums, and then transports the drums to the warehouse by truck. The warehouse sends drums to customers as orders are received.

3.2 New Markets

About a year and a half into operations, Jacobs began looking for new markets and discovered a handful of industries where Jacobs foam would be a superior substitute for the insulating foam currently used in those industries. Marketing campaigns for these target customers began on day 640. Regular communication with target customers allows Jacobs to monitor the demand for its product in each of the new markets. However, Jacobs has not begun actually selling to any of the new markets yet. Jacobs is only selling to the original market in Calopeia.
3.3 Decisions

Jacobs management would like to serve the new markets it has identified if serving those markets is profitable. However, serving those markets could be logistically complex. Some decisions to be made include:

- Which new markets should Jacobs sell to?
- When should Jacobs begin serving its new target markets?
- Should Jacobs continue to serve its original market?
- Should the factory in Calopeia be expanded?
- Should factories in other regions be built?
- Should warehouses in other regions be built?
- How should Jacobs schedule production?
- How should inventory in the warehouses be managed?
- How should chemicals be transported from factories to warehouses?
- Which warehouses should serve each target market?

You have been hired to make these decisions. Your goal is to maximize cash position generated by the foam technology over its lifetime. On day 1095 the technology will become obsolete due to another technology currently in development.

3.4 Production Parameters

A factory can only produce one batch a time. The more capacity a factory has, the faster it produces a batch of a given size. The cost of a factory building is $250,000 regardless of the factory capacity. The cost of factory equipment and fixtures is proportional to capacity: Capacity of one drum per day costs $25,000. For example, the cost to build a new factory with a capacity of 5 drums per day is $250,000 + (5)$25,000 = $375,000. Adding an additional capacity of 2 drums per day later would cost (2)$25,000 = $50,000.

Capacity cannot be retired.

Production in factories is carried out in batches, where each batch is an integer number of drums set by you. The cost to produce one batch equals $1500 plus the number of drums in the batch times $1000. For example, the cost to produce a batch of 10 drums is $1500 + (10)$1000 = $11,500.
3.5 Warehousing Parameters

A new warehouse costs $50,000. There is no practical limit to the number of drums a warehouse can hold.

Jacobs pays insurance and other out-of-pocket holding costs on chemicals once production is complete. The holding costs for one drum for one year is $100, whether the drum is in transit to a warehouse or the drum is physically in a warehouse. There are no such holding costs for work-in-process inventory in the factory.

3.6 Transportation Parameters

Finished drums are shipped from the factory to the warehouse as soon as production is completed. The drums can be shipped by either truck or mail. One truck can carry 200 drums. If the batch is less than 200 drums, then less than a truckload will be used. The cost of full or less-than-full truckload is the same. If drums are shipped by mail, the shipping cost is proportional to the number of drums being mailed. Transportation costs are provided in Table 1, and transportation times are provided in Table 2.

Table 1. Summary of Transportation Costs

<table>
<thead>
<tr>
<th>Origin and Destination</th>
<th>Cost per Truckload</th>
<th>Cost to Mail One Drum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same region</td>
<td>$15,000</td>
<td>$150</td>
</tr>
<tr>
<td>Different regions on continent</td>
<td>$20,000</td>
<td>$200</td>
</tr>
<tr>
<td>Between continent and Fardo</td>
<td>$45,000</td>
<td>$400</td>
</tr>
</tbody>
</table>

Table 2. Summary of Transportation Time

<table>
<thead>
<tr>
<th>Origin and Destination</th>
<th>Truck</th>
<th>Mail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same region</td>
<td>7 days</td>
<td>1 day</td>
</tr>
<tr>
<td>Different regions on continent</td>
<td>7 days</td>
<td>1 day</td>
</tr>
<tr>
<td>Between continent and Fardo</td>
<td>14 days</td>
<td>2 days</td>
</tr>
</tbody>
</table>
3.7 Financial and Other Parameters

All customers pay $1450 per drum of foam. The drum must be shipped within 24 hours of receiving the order or the order is lost. Warehouses may partially fill orders and one order may be filled from multiple warehouses.

All order fulfillment is by mail, so the cost to fulfill an order is:

- $150 per drum if the order is in the same region as the warehouse
- $200 per drum if the order and the warehouse are in different regions on the continent
- $400 per drum if the order is on Fardo and the warehouse is on the continent, or the order is on the continent and the warehouse is on Fardo.

Interest accrues on cash at 10% per year, compounded daily.

4 Assignment

Your team has been hired to manage the supply chain for the Jacobs Industries. You can make the following changes to the supply chain:

- New factories and warehouses in regions outside Calopeia.
- Capacity additions to existing factories.
- For each factory the finished goods inventory level at each warehouse that would trigger production of a new batch for that warehouse.
- For each factory, the size of batch produced for each warehouse.
- Whether batches are transported from each factory to each warehouse by mail or by truck.

Your objective is to maximize the cash generated by the foam technology over the remaining year of its lifetime. On day 1095 the game will end and all inventory and capacity will be obsolete.

The simulation will run continually at the rate of 8760 simulated days per real day, or 1 simulated day about every 10 seconds. You will have control of the game from day 730 to day 1095, or 365 days total. The game will conclude exactly 1 hour after it started. During that time you can access your supply chain continuously.

The winning team is the one with the highest cash position on day 1095.
5 Administrative Details

5.1 Logging In

Before the game begins, you will have the opportunity to analyze historical data. This information should be available after Friday evening (August 2, 2013) at http://sc.responsive.net/sc/ellis/entry.html

You can log in using:

   Team ID: preview
   Password: preview

If you have popup blocker, you will need to allow popups from the web site. Also, if you have modified your security settings, make sure you have not disabled cookies. There are some less common problems that students sometimes have:

   • If you get a "connection lost" message at the top of the screen after you log in, then click here (http://rlt.responsive.net/nocookie.html)
   • If you are not able to view the data plots, then click here (http://rlt.responsive.net/nojava.html).

To open a new window and log in, then click here (http://sc.responsive.net/sc/ellis/entry.html).

5.2 Viewing Data and Changing Parameters

After you log in, you will see three icons in the Calopeia region: headquarters, a factory, and a warehouse. You are allowed a maximum of one factory and one warehouse in each of the other four regions. A black factory or warehouse icon signifies the factory or warehouse is currently operational. A gray icon signifies the factory or warehouse is under construction. To begin construction of a new factory or a new warehouse, click on the region where you would like to begin construction and fill in the resulting form.

Clicking on each icon will open a window presenting buttons to view historic data and make changes:

<table>
<thead>
<tr>
<th>Icon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headquarters</td>
<td>Plot past demand, past lost demand, and your firm’s past cash position. If there are multiple warehouses, there will also be a description and choice of fulfillment policies.</td>
</tr>
<tr>
<td>Factory</td>
<td>Plot past WIP inventory, add production capacity, and change order point, order quantity, shipping method, and priority to each warehouse.</td>
</tr>
</tbody>
</table>
Plot past finished goods inventory and shipments. Change order point, order quantity, shipping method, and priority from each factory. Select the regions in which that warehouse can fulfill demand.

The terms in the forms are hyperlinked to more detailed definitions.

The menu bar below the map of Pangea provides additional functions:

- **Overall Standing** allows you to view all the teams' current cash balance in rank order.
- **History** allows you to view all your historic changes to your supply chain.
- **Cash** shows the starting cash, and uses and sources of cash that resulted in your current cash position.
- **Update** refreshes your screen, updating the cash position and day appearing above the map of Pangea.
- **Quit** logs you out.

### 5.3 A Few Notes and a Hint

In a typical simulation, a year or two years of demand is simulated during a week of actual time. Students analyze historical demand in advance and then make adjustments as the game progresses throughout the week. For this session, a year of demand is simulated during an hour of actual time to demonstrate the capabilities of simulation. This limits the time for analysis by the participants, but allows time to gain familiarity with ways to enhance supply chain instruction.

**Hint:** For this session, strive to meet demand in one of the new regions profitably and consider this a success (rather than trying to expand to all four new regions). In other words, develop an effective supply chain for Calopeia and one other region initially. If this is successful, then you can expand further.
Authors and Terms of Use

Additional information on using this and other simulation games in your courses is available from:

Sam Wood  
Responsive Learning Technologies  
wood@responsive.net  
info@responsive.net  
http://responsive.net/

The Supply Chain Game was developed under the supervision of professors Sunil Chopra and Philipp Afeche at the Kellogg School of Management at Northwestern University.

Copyright 2004. All rights reserved. No content from the Supply Chain Game or documents supporting the Supply Chain Game may be used without the permission of Responsive Learning Technologies.